

AUTOMIZED TRAFFIC SIGNALLING SYSTEM BASED ON TRAFFIC DENSITY AND INTER COMMUNICATION BETWEEN TRAFFIC SIGNAL JUNCTIONS

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Abstract: In recent years popularity of private cars is getting urban traffic more and more crowded. As result traffic is becoming one of important problems in big cities in all over the world.

Some of the traffic concerns are congestions and accidents which have caused a huge waste of time, property damage and environmental pollution. the intelligent traffic administration system, based on Internet of Things, which is featured by low cost, high scalability, high compatibility, easy to upgrade, to replace traditional traffic management system and the proposed system can improve road traffic tremendously.

The Internet of Things is based on the Internet, network wireless sensing and detection technologies to realize the intelligent recognition on the tagged traffic object, tracking, monitoring, managing and processed automatically.

IndexTerms: *lpc2148microcontroler, IRsensors, leds, ESP8266 wifi module.*

I. Introduction

Traffic lights, developed since 1912, are signaling devices that are conceived to control the traffic flows at road intersections, pedestrian crossings, rail trains, and other locations. Traffic lights consist of three universal colored lights: the green light allows traffic to proceed in the indicated direction, the yellow light warns vehicles to prepare for short stop, and the red signal prohibits any traffic from proceeding [1].

Nowadays, many countries suffer from the traffic congestion problems that affect the transportation system in cities and cause serious dilemma. In spite of replacing traffic officers and flagmen by automatic traffic systems, the optimization of the heavy traffic jam is still a major issue to be faced, especially with multiple junction nodes [2]. The rapid increase of the number of automobiles and the constantly rising number of road users are not accompanied with promoted infrastructures with sufficient resources. Partial solutions were offered by constructing new roads, implementing flyovers and bypass roads, creating rings, and performing roads rehabilitation.

However, the traffic problem is very complicated due to the involvement of diverse parameters. First, the traffic flow depends on the time of the day where the traffic peak hours are generally in the morning and in the afternoon; on the days of the week where

weekends reveal minimum load while Mondays and Fridays generally show dense traffic oriented from cities to their outskirts and in reverse direction

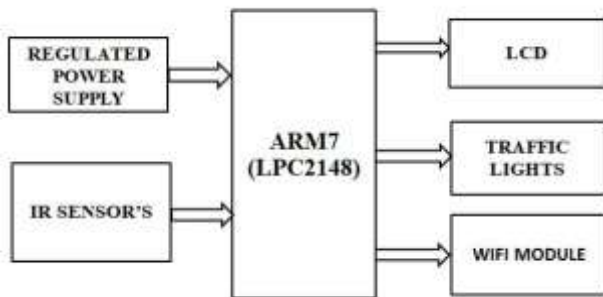
The conventional traffic system needs to be upgraded to solve the severe traffic congestion, alleviate transportation troubles, reduce traffic volume and waiting time, minimize overall travel time, optimize cars safety and efficiency, and expand the benefits in health, economic, and environmental sectors. This paper proposes a simple, low-cost, and real time smart traffic light control system that aims to overcome many defects and improve the traffic management. The system is based on lpc2148 microcontroller that controls the various operations, monitors the traffic volume and density flow via infrared sensors (IR), and changes the lighting transition slots accordingly. Moreover, a handheld portable device communicates wirelessly with the traffic master controller by means of wifi transceivers in order to run the appropriate subroutines and allow the smooth displacement of emergency vehicles through the intersection.

II. INTELLIGENT TRAFFIC CONTROL SYSTEM

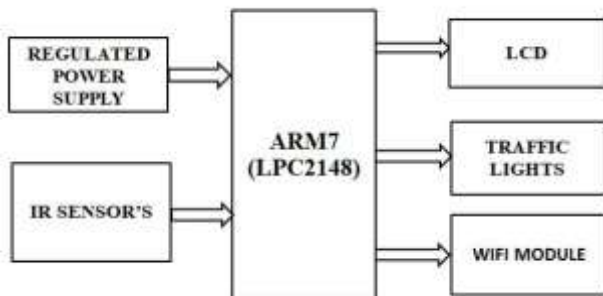
The design of intelligent traffic control system is an active research topic. Researchers around the world are inventing newer approaches and innovative systems to solve this stressful problem. Models based on mathematical equations are applied to estimate the car waiting time at a junction, the number of cars in the waiting queue, the extension of the waiting cars along the lane, the optimal timing slots for green, yellow, and red lights that best fit the real and veritable situation and the efficient combination of routing. In fact, the mutual dependencies between nearby intersections lead to a complicated formulation with cumbersome parameters. These parameters are accidental, hazardous, dependent, and the worse point is the variance of these parameters with time. Thus, finding a dynamic, consistent, and convenient solution is quite impossible. Researchers from different disciplines are collaborating to explore feasible solutions that reduce traffic congestion. Therefore, various methodologies are constantly proposed in the literature and many techniques are implemented profiting from the technological advances of microcomputers, recent manufactured devices and sensors, and innovative algorithms modeling, as much as possible, the complication of traffic lights.

III. BLOCK DIAGRAM

MASTER DIAGRAM



SLAVE DIAGRAM



A. BLOCK DISCRIPTION

The main objective of this project is to control the traffic depending upon the density. As there is much time wastage with the traffic lights which involves the Time, we are designing the new system which controls the traffic depending upon the density. Here we place IR transmitter and the IR receivers at both ends of the roads. Whenever the vehicles pass in-between them the continuity will be lost. Hence the microcontroller senses the density is high. Then the microcontroller will be making the light (green) to be glow much time at the place where the traffic is high. And inter communication between the two junctions based on traffic density. The system uses a compact circuitry build around flash version LPC2148 Microcontroller with a non-volatile memory. Programs will be developed in EMBEDDED C language. FLASH MAGIC is used for loading of programs into microcontroller.

B. IR TRANSMITTER & RECIEVER

The purpose of the transmitter is to transform the information we want to send into a signal that can be propagated by the channel. In the case of our wired copper channel, this means we want the information to be transformed into a modulated voltage level, something like the pulse train. For a wireless channel, however, the transmitter needs to encode the information onto an EM wave that can be easily propagated.

B.A IR TRANSMITTER

The IR transmitter part consists of an Infra-red light emitting diode that can capable of sending modulated data within infra-red band. To match the receiver frequency the data is modulated at 38.7 KHZ by configuring 555 timer at a stable mode of operation, which generates frequency using the components R2 and C2 as shown in

above fig. This frequency can be varied over a long range just by varying the present R1 and C1.

B.B IR RECIEVER

The IR receiver consists of TSOP 1738 module which is a simple yet effective IR proximity sensor built around the TSOP 1738 module. The TSOP module is commonly found at the receiving end of an IR remote control system; e.g., in TVs, CD players etc.[3] These modules require the incoming data to be modulated at a particular frequency and would ignore any other IR signals. It is also immune to ambient IR light, so one can easily use these sensors Outdoor or under heavily conditions. Such modules are available for different carrier frequencies from 32 kHz to 42 kHz. In this particular proximity sensor, we will be generating a constant stream of square wave signal using IC555 centered at 38 kHz and would use it to drive an IR led. So whenever this signal bounces off the obstacles, the receiver would detect it and change its output. Since the TSOP 1738 module works in the active-low configuration, its output would normally remain high and would go low when it detects the signal (the obstacle).

B.C WIFI MODULE

ESP8266 was designed by the Chinese company Espressif Systems for uses in Internet of Things (IoT) systems. ESP8266 is a complete WiFi system on chip that incorporates a 32-bit processor, some RAM and depending on the vendor between 512KB and 4MB of flash memory. This allows the chip to either function as a wireless adapter that can extend other systems with WiFi functionality, or as a standalone unit that can by itself execute simple applications. Depending on the specific module variant (ESP-1 to ESP-12 at the time of this thesis) between 0 and 7 General Purpose Input/Output (GPIO) pins are available, in addition to Rx and Tx pins of the UART, making the module very suitable for IoT applications. The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.

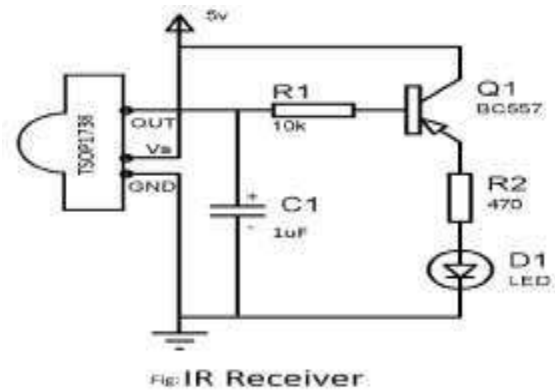
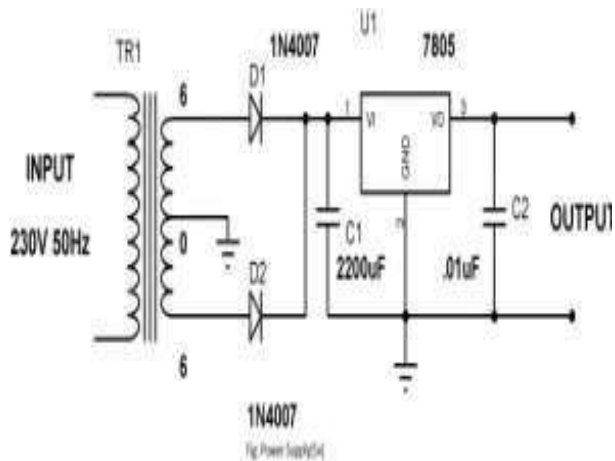
B.D LCD display

Liquid Crystal Display (LCD) [24] is a power economical, tenuous, flat-panel display, simply programmable, and can be used in many digital and electronic circuits. It employs a matrix structure in which the active element forming the pixel cell is located in the intersection of two electrode buses. Particularly, the 16x2 LCD used in the implemented prototype is able to display data over 2 lines, each of 16 characters.

Actually, two types of registers are used to configure the LCD; the command register is recommended for the control instructions as LCD initialization, clearing the screen, setting the cursor position, and controlling display. While the data register holds the ASCII code of the characters that are promptly appeared on the display.

Many microcontroller devices use 'smart LCD' displays to output visual information. LCD displays designed around LCD NT-C1611 module, are inexpensive, easy to use, and it is even possible to produce a readout using the 5X7 dots plus cursor of the display. They have a standard ASCII set of characters and mathematical symbols. For an 8-bit data bus, the display requires a +5V supply plus 10 I/O lines. For a 4-bit data bus it only requires the supply lines plus 6 extra lines (RS RW D7 D6 D5 D4). When the LCD display is not enabled, data lines are tri-state and they do not interfere with the operation of the microcontroller.

IV. CIRCUIT DIAGRAM & DISCUSSION
C. POWER SUPPLY



3) MICROCONTROLLER:

Let us go through the features of LPC214x series controllers. 8 to 40 kB of on-chip static RAM and 32 to 512 kB of on-chip flash program memory. 128 bit wide interface/accelerator enables high speed 60 MHz operation. In-System/In-Application Programming via on-chip boot-loader software. Single flash sector or full chip erase in 400 ms and programming of 256 bytes in 1ms. Embedded ICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip RealMonitor software and high speed tracing of instruction execution. USB 2.0 Full Speed compliant Device Controller with 2 kB of endpoint RAM. In addition, the LPC2146/8 provides 8 kB of on-chip RAM accessible to USB by DMA. One or two 10-bit A/D converters provide a total of 6/14 analog inputs, with conversion times as low as 2.44 µs per channel. Single 10-bit D/A converter provides variable analog output. Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog. Low power real-time clock with independent power and dedicated 32 kHz clock input. Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (400 kbit/s), SPI and SSP with buffering and variable data length capabilities. Vectored interrupt controller with configurable priorities and vector addresses. Up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package. Up to nine edge or level sensitive external interrupt pins available. On-chip integrated oscillator operates with an external crystal in range from 1 MHz to 30 MHz and with an external oscillator up to 50 MHz. Power saving modes include Idle and Power-down. Individual enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization. Processor wake-up from Power-down mode via external interrupt, USB, Brown-Out Detect (BOD) or Real-Time Clock.

D. SOFTWARE REQUIREMENT *Keil software for C programming

- *Proteus for schematic design
- *flash magic software

E. RESULT:

This project is mainly designed to reduce traffic problems, i.e. in general the four sides of the road at a signal point are controlled at regular intervals of time with a certain time delay. But in order to reduce the time at one side of the signal point with respect to the other side where there is more traffic we use IR sensors. It mainly consists of a microcontroller. IR transmitter placed nearer to the signal point and when it detects more density of traffic at any side it and it transmits signal to the receiver. The receiver receives this signal to the microcontroller.

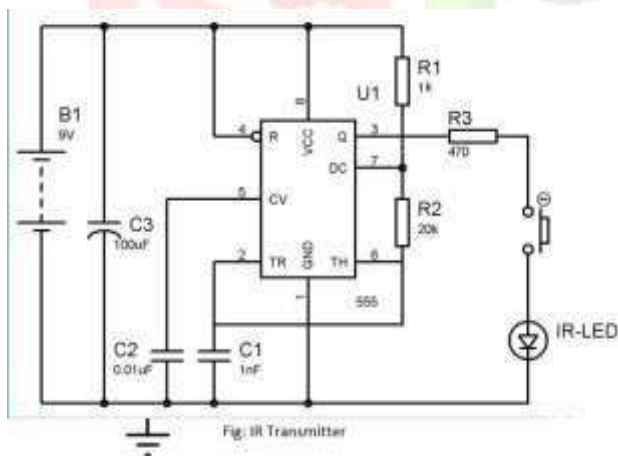
F. ADVANTAGES:

- a) A modernised way of controlling traffic.

The schematic diagram gives the basic hardware connections used in the project. Beginning from the power supply the secondary of the step-down transformer wires are given to the two ends (2, 4) of bridge rectifier which is having the four diodes in the bridge format. The other two ends (1, 3) are connected to the input (pin 1) and output pin 3 of the 7805 regulator and pin no 2 is connected to ground as shown in schematic diagram. The 1000 micro farad capacitor is connected in between the bridge rectifier and regulator to eliminate the ac ripples presented in the rectified output. The 100 micro farad capacitor is used to eliminate the noise at regulator output. Now 5V is available at the pin no 3 of regulator and connected to pin no 40 of micro controller. [6]

IR TRANSMITTER & RECEIVER

1) IR TRANSMITTER: The IR LED is arranged with a resistor, in such a way that Vcc is applied to the positive terminal of the IR LED. [7] These are connected to the port 1 of the microcontroller



2. IR RECEIVER: The IR receivers are arranged with the transistor logic as shown in the diagram.

The two transistors are connected in such a manner that collector terminal is connected to the base terminal of the other. The photo diode is connected to the base of the transistor along with the combination of the resistor.

The IR Receivers are connected to the port 2 P2.0, P2.1, P2.2, P2.3 pins of the microcontroller.

b)Number of road accidents can be reduced to a large extent.

c)Easy traffic regulation in busy cities such as Metro cities, mega cities etc..

d)Help the traffic police in easy control of traffic and to save time.

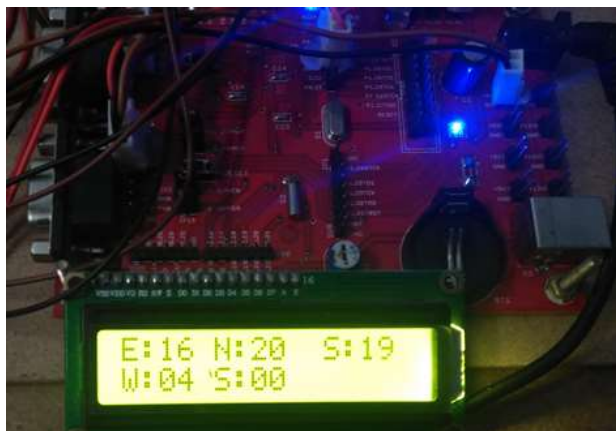
G. FUTURE SCOPE:

The advancement of technologies and the miniature of control devices, appliances and sensors have given the capability to build sophisticated smart and intelligent embedded systems to solve human problems and facilitate the life style. Our smart traffic light control system endeavors to contribute to the scientific society to ameliorate the existing traffic light systems and manage the flow of automobiles at the intersections by implementing innovated hardware and software design systems.

The proposed smart traffic system consists of a traffic light controller that manages the traffic lights of a "+" junction of mono directional roads. The system is capable of estimating the traffic density using IR sensors posted on either side of the roads. Based on this information, the time dedicated for the green light will be extended to allow large flow of cars in case of traffic jam, or reduced to prevent unnecessary waiting time when no cars are present at the opposite route. The system is complemented by portable controller for the emergency vehicles stuck in the traffic. By means of secure communication using wifi/wireless system, the portable controller triggers the traffic master controller to the emergency mode and provides an open path until the stuck emergency vehicle traverses the intersection. The designed system is implemented, realized electronically, and tested to ensure complete validation of its operations and functions. The current design can be promoted by monitoring and controlling an intersection with double roads. Future improvements can be added such as pedestrian crossing button, delay timing displays, as well as car accident and failure modes. The integration of different traffic controllers at several junctions will be investigated in the future in order to accomplish a complete synchronization. To study the system performance, traffic data can be recorded and downloaded to computer platform where statistical data analysis studies could be applied to better understand the traffic flows between the intersections. Finally, traffic light controller could be powered by solar power panels to reduce grid electricity consumption and realize green energy operations.

IV.OUTPUTS

MASTER



SLAVE



V.REFERENCES

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STEGANOGRAPHY TECHNIQUE FOR HIDING DATA IN AN IMAGE

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Abstract: Steganography is the art of hiding data in a seemingly innocuous cover medium. For example – any sensitive data can be hidden inside a digital image. Steganography provides better security than cryptography because cryptography hides the contents of the message but not the existence of the message. So, no one apart from the authorized sender and receiver will be aware of the existence of the secret data. Steganographic messages are often first encrypted by some traditional means and then a cover image is modified in some way to contain the encrypted message. The detection of steganographically encoded packages is called steganalysis. In this paper, we proposed efficient Steganography techniques that are used for hiding secret messages i.e. LSB Steganography using the last two significant bits. Symmetric and asymmetric key has been used to secure the data from the unauthorized persons.

Index Terms - Steganography, Stegananalysis, Cryptography, Data hiding

1. Introduction

With rapid developments in the technology of telecommunication especially the internet and mobile networks have the domain of information transmission, which in turn present new challenges for protecting the information from unauthorized access and use, the data integrity and confidentiality are required. Data security over the networks is an important challenge for researchers and computer engineers for decades. Satellite communication has been used for transfer of images and data to far end places. In order to prevent the unauthorized to access the data we have to encrypt the data that is being send through the network. To accomplish and build such secure systems, many data hiding and encryption techniques have been proposed in the last few decades. Both the data hiding and encryption techniques are found to be the main mechanisms in data security. However, the use of formal mechanisms for hiding the data has come into process recently.

The formal mechanism of data encryption uses the ciphertext that is been used for the transmission to the required person and this text is been embedded and a security key is been used for the data encryption. To receive the original message which has been sent by the sender, receiver has to use the key that is been used at the sender. Any misleamous person who tries to break the key gets a garbage code for his key. Though data encryption is proved to be a secure method to hide data, it has some weaknesses. For example, sometimes appearance of ciphertexts could give a clear impulse to an unauthorized user and this might lead to unauthorized user and this might lead to unauthorized access to the original content by breaking it. As a result, the original receiver would not be able to receive the cipher texts sent by the sender. By this the unauthorized person who tries and didn't get the code may have the chance of destroying the ciphertext and another disadvantage is that the data is not been hidden. By this if the unauthorized person sits for more time he can retrieve the data that has been encrypted. For this reason, research on data hiding has been increasing recently.

A solution to this problem is data hiding. Data hiding techniques could play a major role to embed important data into multimedia files such as images, video's or sounds. Because digital images are insensitive to human visual system. Therefore, images could be good cover carriers. Data hiding has two major applications watermarking and steganography. Steganographic techniques are used to store watermarks in data. Steganography is an ancient art of hiding messages for making the messages not detectable to malicious users. Steganography is the science of invisible communication. Information is transmitted by hiding it in innocuous cover objects to maintain security and confidentiality. In image steganography the cover object is the image and information are embedded in to images which may be color, greyscale binary. A stego image is obtained from the cover image by accommodating the secret message into a digital image using some embedding algorithm that slightly modifies the cover image. In this case, no substitution or permutation was used. The hidden message is plain, but unsuspected by the reader.

Steganography has been widely used, including in recent historical times and the present day. Possible permutations are endless and known examples include: (i) hidden messages within wax tablets, (ii) hidden messages on messenger's body, (iii) hidden messages on paper written in secret inks, under other messages or on the blank parts of other messages, and (iv) agents used photographically produced microdots to send information back and forth. Digital Steganography has three basic components. (a) Obtain the data to be hidden, i.e., secret message, (b) embed the secret message into the cover medium, i.e., images, sounds or videos, etc., and (c) lastly, obtain the stego-carrier to be sent. In the last decades, many Steganography based data hiding techniques have been proposed. We proposed a data hiding technique which is based on simple LSB substitution method by selecting optimal numbers of k LSB substitution method to solve the problem while k is found to be large.

In this paper, we proposed a technique i.e. substitution based on Steganography techniques using last two significant bits. However, LSB based techniques are well-known techniques whereas the Steganography using last pixels of the image is the novel technique, which is proposed in this paper. The rest of the paper is organized as follows. Section 2 has introduced the basic paradigm of LSB based data hiding operation. The next section presents the proposed Steganographic technique. Results obtained from the proposed techniques are discussed in Section 4 and conclusion is made in the last section.

2. PRELIMINARIES

To perform the experiment, gray scale and color images are taken and then steganography techniques are applied by generating the LSB based substitution matrices. The texts, which are used as the hidden texts are evenly distributed among all the pixels of the last significant bits. Finally, the resultant stego image is generated.

2.1 Basic Paradigm of LSB Based Data Hiding Operation

Since the rightmost bits are used for LSB substitution in each pixel in the given image, therefore the first operation used rightmost two bits for LSB substitution. In this 8bit greyscale and 24-bit color images are used. In 8-bit grayscale image, rightmost two bits are used in each pixel. The color image uses three color components – red, green and blue which constitute each pixel. The identical phenomenon is used in color image as that of greyscale image. However, for the color image three different matrices are generated and therefore, LSB substitution is used separately for these three matrices.

Let $I_{\text{Grayscale}}$ be the 8-bit grayscale image of size $P_{I_{\text{gray}}} \times Q_{I_{\text{gray}}}$ Pixels. it can be represented by

$$I_{\text{gray}} = \left\{ X_{ij} \mid 10 \leq i \leq P_{I_{\text{gray}}}, 0 \leq j \leq Q_{I_{\text{gray}}}, X_{ij} \in \{0,1..255\} \right\} \quad (1)$$

Also let, I_{color} be the 24-bit color cover image of size $P_{I_{\text{gray}}} \times Q_{I_{\text{gray}}}$ Pixels. Therefore, it can be represented for three color components red, green and blue by

$$I_{\text{color-red}} = \left\{ X_{ij}^{\text{red}} \mid 10 \leq i \leq P_{I_{\text{color-red}}}, 0 \leq j \leq Q_{I_{\text{color-red}}}, X_{ij}^{\text{red}} \in \{0,1..255\} \right\}$$

$$I_{\text{color-green}} = \left\{ X_{ij}^{\text{green}} \mid 10 \leq i \leq P_{I_{\text{color-green}}}, 0 \leq j \leq Q_{I_{\text{color-green}}}, X_{ij}^{\text{green}} \in \{0,1..255\} \right\} \quad (2)$$

$$I_{\text{color-blue}} = \left\{ X_{ij}^{\text{blue}} \mid 10 \leq i \leq P_{I_{\text{color-blue}}}, 0 \leq j \leq Q_{I_{\text{color-blue}}}, X_{ij}^{\text{blue}} \in \{0,1..255\} \right\}$$

Suppose M is the n – bit secret message and it can be defined by

$$M = \{ M_i \mid 0 \leq i \leq n-1, M_i \in \{0, 1\} \} \quad (3)$$

The secret message S of n – bits is to be embedded into the 8-bit grayscale as well as 24-bit color image with three color components. The secret message S is rearranged to form a K-bit virtual image S' which can be described as

$$M' = \{ M'_i \mid 0 \leq i \leq n', M'_i \in \{0, 1, \dots, 2^k-1\} \} ; \quad (4)$$

Where $n' = P_{grey} \times Q_{grey}$ and $n' = P_{grey} \times Q_{grey}$. Now a mapping is defined between the secret $M' = \{M'_i\}$ and the embedded message $M' = \{M'_i\}$.

Further this can be described by the following mathematical formulation.

$$M'_i = \sum_{j=0}^{k-1} M_i \times 2^j \quad (5)$$

At this stage, all the pixels are chosen from the cover image where the rightmost one bit and rightmost two bit are chosen for the proposed first and second methods and rightmost one bit is selected for the third method in which a subset of pixels are selected containing diagonal pixels only of the image matrix. Hence, the embedding process is completed by replacing the k (K=1,2) LSBs of each pixel is storing the K-bit message to form the stego-pixel as follows.

$$X'_i = X_i \bmod 2^k + M'_i \quad (6)$$

Embedding process for a subset of pixels which contain diagonal pixels only is completed by replacing the K LSBs of each pixel in the subset by M'_i . Mathematically it can be represented by

$$X'_i = X_i - X_i \bmod 2^k + M'_i \quad (7)$$

In Equations (6) and (7), X_i and X'_i the original pixel in cover image and stego-pixel in stego-image respectively.

The embedded message extraction process is accomplished from stego-image by without referring to original cover image. Therefore, k LSBs of all pixels and subset of pixels are extracted and reconstruct the secret message bits. The embedded message can be extracted from stego-image by the following mathematical formulation

$$M'_i = X'_i \bmod 2^k \quad (8)$$

3 LSB Substitution Based on Steganographic Techniques

3.1 LSB Substitution in Grayscale Image

A grey scale digital image is an image in which the value of each pixel carries only intensity information. They are also known as black and white images and are composed of shades of grey varying from black at the weakest intensity to which at the strongest. The purpose of steganography implementation chooses rightmost LSBs (K=2) of each pixel to replace with the secret message bits. The secret message is evenly distributed among all the pixels of the image matrix for the first and second method. However, for the last method a subset of diagonal pixels of the image matrix are used and the secret message is evenly distributed among the diagonal pixels only. The message is encoded in the least significant bit of each pixel in the cover image. This produces no visible change in the original image. The process of LSB substitution in greyscale image is given below.

- An image is read. In case of a gray scale image, a 2-dimensional matrix of unsigned integers with values between 0 and 255 is obtained.
- The pixels are extracted accordingly and converted to binary.
- The secret message can be encrypted using symmetric key.
- The text is encoded in the least significant bits of the pixels. The pixel values of the matrix are changed with a value of (+1) or (-1).
- The pixels are re-inserted into the image.
- Save the image using any lossless compression technique.

3.2 LSB Substitution in Color Image

Each pixel in RGB image is specified by three values, one each for red, blue and green color components. The RGB image is represented by row×column×3 array of class uint8/uint16 or double. In this section, LSB substitution-based Steganography is presented where RGB color image is used. The secret message or plaintext is evenly distributed among the three-color components red, green and blue. A subset of pixels of the nth column or diagonal elements of each dimension of an image is used. The secret message has encoded in the least significant bits of these pixels. The process of LSB substitution in color image is given below.

- A RGB image of 3-D matrix is read and the pixel corresponding to the nth column and diagonal elements of each dimension is extracted and converted into binary. The last significant bits are extracted from binary matrix.
- A secret message entered and which is encrypted using symmetric key or RSA cryptography techniques. The encrypted message is then converted to binary sequence.
- The message has been encoded in the bits of the nth column or diagonal pixels and the secret message is evenly distributed among the three-color components - red, green and blue.
- The extracted bits are changed according to the text bits and inserted into the binary matrix. Thus, each bit is changed with a value of

3.3 Block diagram of encryption

In the encryption phase we will embedded the data that is to be sent for the receiver. In order to do this, we are considering the cover image and the message that is to be sent. Here we are using the LSB algorithm for encrypting the message into the cover image. The encrypted image is called the stego-image where data is present. The stego-image is same as that of the cover image.

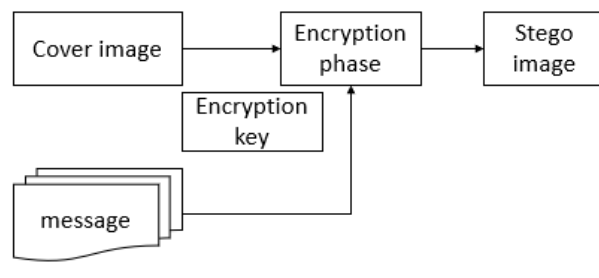


Fig. 1. Block Diagram of Encryption

3.4 Steganalysis

Steganalysis is the process of decoding the secret message from the stego-image. The appropriate pixels of the image, in which the text is stored, are extracted. The pixels are then converted into binary form. Eight bits are extracted at a time and converted into a string. The extracted string can be decrypted using the decryption key. The original message is obtained after string manipulation. In figure 2, the block diagram of steganalysis is illustrated. After obtaining the steganographic or stego-image, steganalysis approach is applied while decryption key is available and finally the original image is obtained.

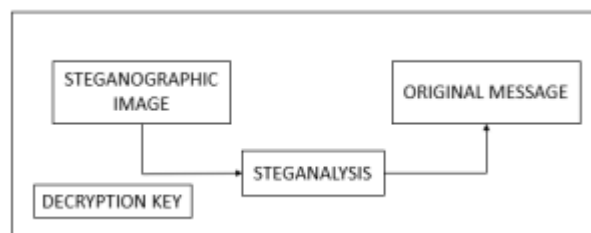


Fig. 2. Block Diagram of Steganalysis

3.5 Security using private key

To increase the security of the message hidden inside the Stego-image we are adding a private key. The key cannot be known to anyone except the sender. If the receiver needs to access the message he must get the code from the sender only. If not, the message cannot be retrieved.

4. Results and Discussions

The Steganographic method used in this work produce any visible change in the color or appearance of the image. The size of the image does not change. The proposed work provides two levels of security. It hides the existence of secret message from malicious users. The proposed two LSB substitution based steganographic techniques have been tested with grayscale and color images. In this section, results of proposed methods are shown. Figure 3 and Figure 4 show the results obtained by applying the proposed method. In Figure 3, original grayscale image is taken for steganography application and a resultant image stego-image is obtained. In Figure 4, left RGB image shows cover image whereas the right image depicts stego-image in which the secret message is hidden. In this experiment, 24-bit true color image is used. In original matrix which is generated from the original image is shown in left and the stego-image matrix which is generated from stego-image is shown in right, In this stego matrix the secret message is hidden and evenly distributed among all last two significant bits.

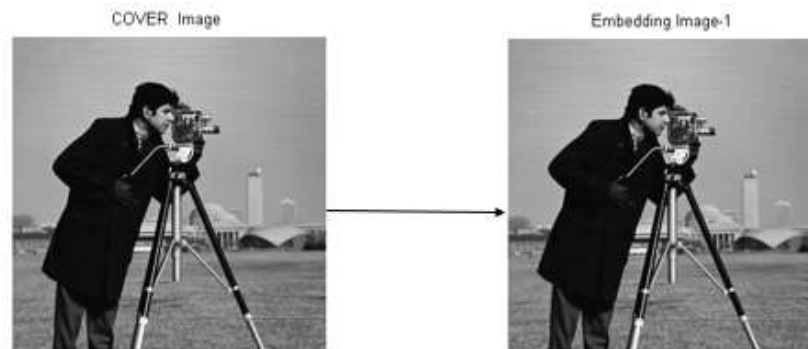


Fig 3: Original (Left) and Stego (right) images of grey are shown

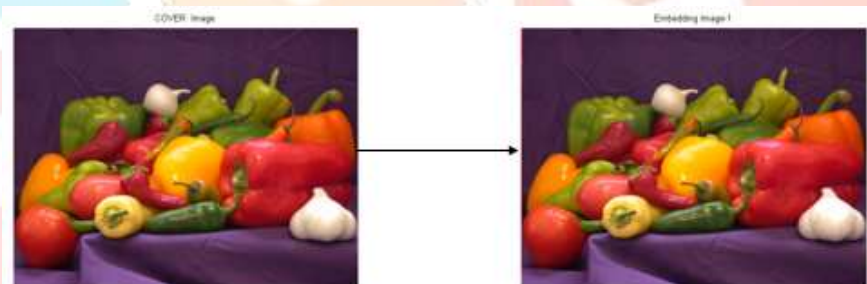


Fig 4. Original (Left) and Stego (right) images of color are shown

5. Conclusion

This paper proposes an efficient technique which can be used to allow the users to securely transmit a confidential message through images without any detection by an intruder or malicious users. The methods presented do not produce any visible change in the cover image. This method is one of the best methods used for hiding data in an image. The proposed method shows remarkable performance in terms of accuracy and less distortions of extracted secret message from stego-image while these steganography technique is used. It also provides high security at the data retrieval. It is very fast and takes less time for retrieving the encrypted data.

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ENERGY OPTIMIZATION IN WSN USING ENERGY EFFICIENT HIERARCHICAL CLUSTERING ALGORITHM

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Abstract: Wireless Sensor Networks (WSN) is the most unpredictable networks which are communicate each other and transfer the data from each node. These are mostly used in any type of environment such as heterogeneous nature. Energy consumption is most widely used for the nodes. Many research has been done on WSN. In the existing techniques, the energy efficiency between the nodes become most complicated and because of their adaptive and mobility nature the energy consumption is more high. In this paper, the proposed system addressed the problem in the existing system such as calculation of cluster head. To overcome this, the proposed EEHCA is introduced to maintain the energy between the nodes and calculating the cluster head more efficiently. Results shows the performance of existing and EEHCA.

Key words- Sensor Networks, Clustering, LEACH, EEHCA.

I. INTRODUCTION

For recent years, Wireless Sensor Networks (WSNs) pulled in heaps of analysts as a result of its potential wide applications and numerous examination challenges. Early investigation on WSNs principally centered around advancements in light of the homogeneous WSN in which all hubs have same framework assets. Be that as it may, heterogeneous WSN is ending up increasingly prominent on the grounds that the advantages of utilizing heterogeneous WSNs with various abilities keeping in mind the end goal to meet the requests of different applications have been introduced in late writing [1], [2].

One of the vital difficulties in the association of the WSNs is vitality effectiveness and soundness since battery limits of sensor hubs are constrained and supplanting them are unfeasible. Since, sensor hubs utilize a lot of vitality for information transmission and collection. Consequently, new vitality productive steering conventions are required to spare vitality utilization. In this paper, we propose a novel Energy-Efficient Clustering and Data Aggregation (EECDA) convention for heterogeneous WSN. In this approach, another Cluster Head (CH) race and information correspondence component is introduced to broaden the lifetime and security of the system. After the CHs race, a way with most extreme aggregate of lingering vitality would be chosen for information correspondence rather than the way with least vitality utilization. In this manner, each CH first totals the got information and afterward transmits the amassed information to the Base Station (BS).

The principle commitments of EECDA convention is to give longest steadiness (when the primary hub is dead) and enhances the system lifetime in contrast with Low-Energy Adaptive Clustering Hierarchy (LEACH), Energy-Efficient Hierarchical Clustering Algorithm (EEHCA) and Effective Data Gathering Algorithm (EDGA).

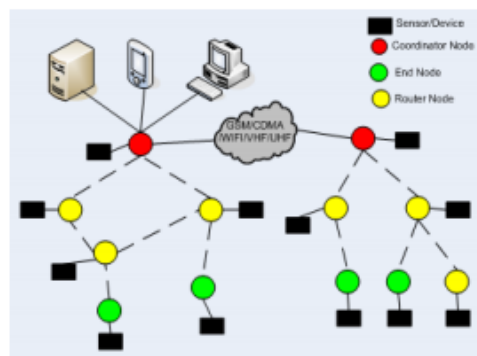


Fig 1: Wireless Sensor Network

II. LITERATURE REVIEW

Wireless sensor networks have gained considerable popularity due to their flexibility in solving problems in different application domains and have the potential to change our lives in many different ways.

1) Lee, S. H., Yoo, J. and Chung, T. C. , “Distance-based energy efficient clustering for wireless sensor networks,” Proc.of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), 2004 In this paper Authors modified the Basic Low Energy adaptive clustering hierarchy (LEACH) protocol with their proposed LEACH-MAE(LEACH Mobile Average Energy based) protocol to overcome its shortcomings to support mobility along with the new average energy based Cluster Head selection technique. Author took LEACH-M, which supports mobility of the nodes, as their reference and modified it. They introduced this mobility of nodes on the energy basis. In this protocol the cluster head selection among the mobile nodes is purely based on the received signal strength of the nodes. The Authors simulated LEACH-MAE protocol in NS2 which shows that proposed algorithm improves network life time up to 25 % as well as helps to maintain the equal distribution of energy resource among the sensor nodes.

2) ZiboudaAliouat, MakhoulAliouat , “Effective Energy Management in Routing Protocol for Wireless Sensor Networks”, IEEE 2012. In this paper, Authors proposed a multi hop routing protocol: PEGASIS-MH for minimizing energy consumption and extending the network life time. This new protocol is a combination of the more efficient well known protocols hierarchical LEACH and PEGASIS. The results obtained through the simulations carried out in an environment of the simulator NS2 have shown that the performances achieved by our proposal are noteworthy and outperform those of the original protocols.

3) Kumar, M V, and Jacob, "Mobility Metric based LEACH-Mobile Protocol", ADCOM 2008, IEEE 2008. Cluster based protocols like LEACH were found best suited for routing in wireless sensor networks. In mobility centric environments some improvements were suggested in the basic scheme. LEACH-Mobile is one such protocol. The basic LEACH protocol is improved in the mobile scenario by ensuring whether a sensor node is able to communicate with its cluster head. Since all the nodes, including cluster head is moving it will be better to elect a node as cluster head which is having less mobility related to its neighbours. In this paper, LEACH-Mobile protocol has been enhanced based on a mobility metric "remoteness" for cluster head election. This ensures high success rate in data transfer between the cluster head and the collector nodes even though nodes are moving. Authorshave simulated and compared LEACH-mobile-enhanced protocol with LEACH-mobile. Results show that inclusion of neighbouring node information improves the routing protocol.

4) Heinzelman, Chandrakan, and Balakrishna, "Energy- efficient Communication protocol for Wireless Micro sensor Networks", In IEEE 2000 proceeding of the Hawaii International Conference on system Sciences.Jan2000. Wireless distributed micro sensor systems will enable the reliable monitoring of a variety of environments for both civil and military applications. In this paper, Author looked at communication protocols, which can have significant impact on the overall energy dissipation of these networks. Based on their findings that the conventional protocols of direct transmission, minimum-transmission-energy, multi-hop routing, and static clustering may not be optimal for sensor networks, so they proposed LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster based station (clusterheads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station. Simulations and results done by author showed the LEACH can achieve as much as a factor of 8 reduction in energy dissipation compared with conventional routing protocols. In addition, LEACH is able to distribute energy dissipation evenly throughout the sensors, doubling the useful system lifetime for the networks.

5) I.F. Akyildiz, W.SU and E.Cayirci, “Wireless sensor networks: A Survey », Georgia Institute of Technology, “ 2001. This paper describes the concept of sensor networks which has been made viable by the convergence of micro electro-mechanical systems technology, wireless communications and digital electronics. First, the sensing tasks and the potential sensor networks applications are explored, and a review of factors influencing the design of sensor networks is provided. Then, the communication architecture for sensor networks is outlined, and the algorithms and protocols developed for each layer in the literature are explored. Open research issues for the realization of sensor networks are also discussed.

6) Indu Shukla, Natarajan Meghanathan, “Impact of leader selection strategies on the PEGASIS data gathering protocol for wireless sensor networks,” Jackson State University, Jackson MS, USA, 2010.

The Power Efficient-Gathering in Sensor Information Systems (PEGASIS) protocol is one of the classical data gathering protocols for wireless sensor networks. PEGASIS works by forming a chain of the sensor nodes starting from the node farthest away to the sink. Data from either end of the chain gathers towards the leader node, selected for each round of data gathering,

through a hop-by-hop transfer and aggregation process. The leader node transmits the aggregated data to the sink node. In this paper, Author investigated the impact of the following leader node selection strategies for every round: Random (randomly selected node), Shuffle (a node is selected as leader only once in N rounds in a network of N nodes), High-energy (node with the highest energy), 2-block and 4-block (the network is divided into 2 or 4 blocks and the leader node is the highest energy node in the randomly chosen block of a round). Author studied the PEGASIS protocol for both TDMA and CDMA systems. For each combination of network topology (square, circular and rectangular) and sink location (centre, origin and outside the network field), author identified the leader selection strategy that yields the longest network lifetime (up to 5% node failures) and the minimum energy*delay per round.

7) Indu Shukla, "Power Efficient Gathering in Sensor Information System (PEGASIS Protocol)," Jackson State University, Jackson MS, USA, 2010. In this paper, Author proposed PEGASIS (power-efficient gathering in sensor information systems), a near optimal chain-based protocol that is an improvement over LEACH. In PEGASIS, each node communicates only with a close neighbour and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Here these nodes doesn't form clusters to transmit data instead they communicate with the nearby node. This method is like passing a data packet from one place to another place through intermediate nodes. This method loses so much energy if there are too many intermediate nodes in between.

8) Lee, S. H., Yoo, J. and Chung, T. C. , "Distance-based energy efficient clustering for wireless sensor networks," Proc.of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), 2004 In this paper, Author proposed a new distributed clustering and data aggregation algorithm, CODA (cluster-based self-organizing data aggregation), based on the distance from the sink in ad-hoc wireless sensor networks. While cluster-based data gathering is efficient in energy and bandwidth, it is difficult to cluster efficiently. We use the distance vector from the sink, which affects the energy depletion of the network. Author mainly concentrated on energy constraint and efficient clustering of the nodes.

III. RELATED WORK

Routing is a process of selecting best path in the network. So, routing protocols are liable for discovering and managing efficient routes in the network. Energy efficiency is an essential issue in WSN routing. Hence, development of energy efficient routing protocol becomes a hot research issue in sensor networks. The energy efficient routing protocols (EERP) can be broadly classified based on four parameters as follows: network structure, computation model, topology, reliability [17]. Here, we focus on the hierarchical or cluster based routing protocols. Several hierarchical routing protocols for WSNs are given by various researchers. LEACH is an eminent protocol of this category.

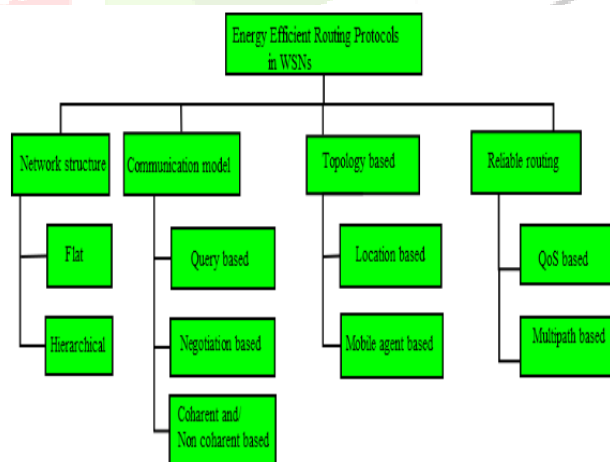


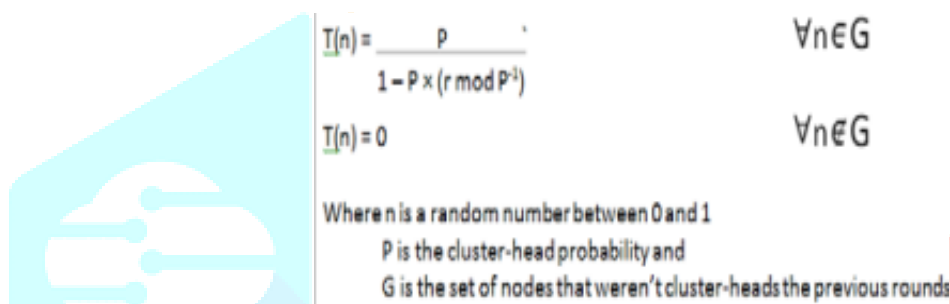
Fig 3: Taxonomy of Energy Efficient Routing Protocols in WSNs

LEACH is a hierarchical routing protocol that reduces the energy expenditure in the network. LEACH outperforms classical routing algorithm since it uses adaptive clustering scheme. But when a CH dies in the LEACH that cluster is of

no use since data gathered at CH will not reach the BS. LEACH suffers from the problem of CH rotation overhead in every round. LEACH elects the CH depend on the random number in the range (0,1]. If chosen number is fewer than threshold $T(n)$ then node become CH for present round. Energy efficient hierarchical clustering algorithm (EEHCA) uses a novel process for CH election with the idea of backup CHs to get better efficiency of the network [18]. The distributed energy efficient clustering (DEEC) uses initial and remaining energy level of node for CH selection. It is developed for heterogeneous wireless sensor networks.

IV. EXISTING SYSTEM

LEACH is the most widely used protocol in the wireless sensor networks. The aim of the LEACH is to calculate the energy efficiency and cluster heads between the nodes. Based on their adaptive nature and mobility of the nodes the energy consumption between the nodes is very high and the nodes in the network stops very soon and the nodes becomes the zero state i.e. with no energy. The other name for the LEACH protocol is hierarchical routing protocol. This protocol is combination of nodes and some of the nodes are cluster heads. The formation of cluster heads is done based on the energy maintaining by the nodes. During the first step cluster head sends the advertisement packet to inform the cluster nodes that they have become a cluster head on the basis of the following formula:



The diagram illustrates the cluster head selection process. It features a light blue trapezoidal shape on the left containing a stylized network icon. To its right, the following mathematical expressions are presented:

$$T(n) = \frac{P}{1 - P \times (r \bmod P^{-1})} \quad \forall n \in G$$

$$T(n) = 0 \quad \forall n \in G$$

Below these equations, explanatory text states: "Where n is a random number between 0 and 1", "P is the cluster-head probability and", and "G is the set of nodes that weren't cluster-heads the previous rounds".

Fig 4.1: Cluster head selection

$T(n)$ is the threshold. Node becomes cluster head for the current round if the number is less than threshold $T(n)$. Once node is elected as a cluster head then it cannot become cluster head again until all the nodes of the cluster have become cluster head once. This is useful for balancing the energy consumption. In the second step, non-cluster head nodes receive the cluster head advertisement and then send join request to the cluster head informing that they are members of the cluster under that cluster head. All non-cluster head nodes save a lot of energy by turning off their transmitter all the time and turn it on only when they have something to transmit to the cluster head [2]. In third step, each of the chosen cluster head creates a transmission schedule for the member nodes of their cluster. TDMA schedule is created according to the number of nodes in the cluster. Each node then transmits its data in the allocated time schedule [3]. B. Steady phase In steady phase, cluster nodes send their data to the cluster head. The member sensors in each cluster can communicate only with the cluster head via a single hop transmission. Cluster head aggregates all the collected data and forwards data to the base station either directly or via other cluster head along with the static route defined in the source code. After predefined time, the network again goes back to the set-up phase.

The performance of the LEACH show in the below:

```

107.254 4 received one packet from 10.1.1.15
107.32 5 received one packet from 10.1.1.16
107.339 3 received one packet from 10.1.1.14
107.34 6 received one packet from 10.1.1.17
107.35 4 received one packet from 10.1.1.15
107.392 1 received one packet from 10.1.1.12
107.395 3 received one packet from 10.1.1.14
107.451 4 received one packet from 10.1.1.15
107.469 7 received one packet from 10.1.1.18
107.492 3 received one packet from 10.1.1.14
107.495 3 received one packet from 10.1.1.14
107.498 3 received one packet from 10.1.1.14
107.5 4 received one packet from 10.1.1.15
107.57 5 received one packet from 10.1.1.16
107.588 3 received one packet from 10.1.1.14
107.59 6 received one packet from 10.1.1.17
107.603 3 received one packet from 10.1.1.14
107.611 3 received one packet from 10.1.1.14
107.612 4 received one packet from 10.1.1.15
107.639 3 received one packet from 10.1.1.14
107.641 1 received one packet from 10.1.1.12
107.654 7 received one packet from 10.1.1.18
107.707 4 received one packet from 10.1.1.15

```

Fig 4.2: Shows the communication between the nodes.

```

Logging Event New Cluster Head Selection(Node-19) @ 1
Logging Event New Cluster Head Selection(Node-13) @ 2
Logging Event New Cluster Head Selection(Node-21) @ 3
Logging Event New Cluster Head Selection(Node-19) @ 4
Logging Event New Cluster Head Selection(Node-21) @ 5
Logging Event New Cluster Head Selection(Node-26) @ 6
Logging Event New Cluster Head Selection(Node-3) @ 7
Logging Event New Cluster Head Selection(Node-3) @ 8
Logging Event New Cluster Head Selection(Node-17) @ 9
Logging Event New Cluster Head Selection(Node-28) @ 10
Logging Event New Cluster Head Selection(Node-9) @ 11
Logging Event New Cluster Head Selection(Node-10) @ 12
Logging Event New Cluster Head Selection(Node-17) @ 13
Logging Event New Cluster Head Selection(Node-14) @ 14
Logging Event New Cluster Head Selection(Node-10) @ 15
Logging Event New Cluster Head Selection(Node-23) @ 16
Logging Event New Cluster Head Selection(Node-3) @ 17
Logging Event New Cluster Head Selection(Node-24) @ 18
Logging Event New Cluster Head Selection(Node-21) @ 19
Logging Event New Cluster Head Selection(Node-30) @ 20
Logging Event New Cluster Head Selection(Node-5) @ 21
Logging Event New Cluster Head Selection(Node-15) @ 22
Logging Event New Cluster Head Selection(Node-16) @ 23
Logging Event New Cluster Head Selection(Node-14) @ 24
Logging Event New Cluster Head Selection(Node-25) @ 25
Logging Event New Cluster Head Selection(Node-14) @ 26
Logging Event New Cluster Head Selection(Node-29) @ 27

```

Fig 4.3: Shows the Cluster Head formation between the nodes. It is known that for every one second the cluster head is changing due to their mobility. For the 30 Nodes the total time taken to form cluster heads and energy consumption is given in table-1.

LEACH it also has some Disadvantages which are as follows:

There is no idea about the cluster head formation between the nodes within the network. Without any strong reason the cluster head may dies and cluster may not be used by the network. The formation of clusters are done randomly, which may cause the uneven results and some of the clusters have higher nodes and some of the clusters have less nodes. Based on their position the cluster may form at the center and sometimes it may form at the border of the network. This may consume more energy and this may cause loss for the network.

RESEARCH METHODOLOGY

V. ACKNOWLEDGMENT

EEHCA (Energy Efficiency hierarchical clustering algorithm) is the most widely used in WSN. There are many advantages for this protocol such as maintain energy between the nodes and better formation of cluster heads. The information is forwarded to all the sensors that are no more than k hops away from the clusterhead. Any sensor that receives such advertisements and is not itself a clusterhead joins the cluster of the closest clusterhead. Any sensor that is neither a clusterhead nor has joined any cluster itself becomes a clusterhead; we call these clusterheads the forced clusterheads. Because we have limited the advertisement forwarding to k hops, if a sensor does not receive a CH advertisement within time duration t (where t units is the time required for data to reach the clusterhead from any sensor k hops away) it can infer that it is not within k hops of any volunteer clusterhead and hence become a forced clusterhead.

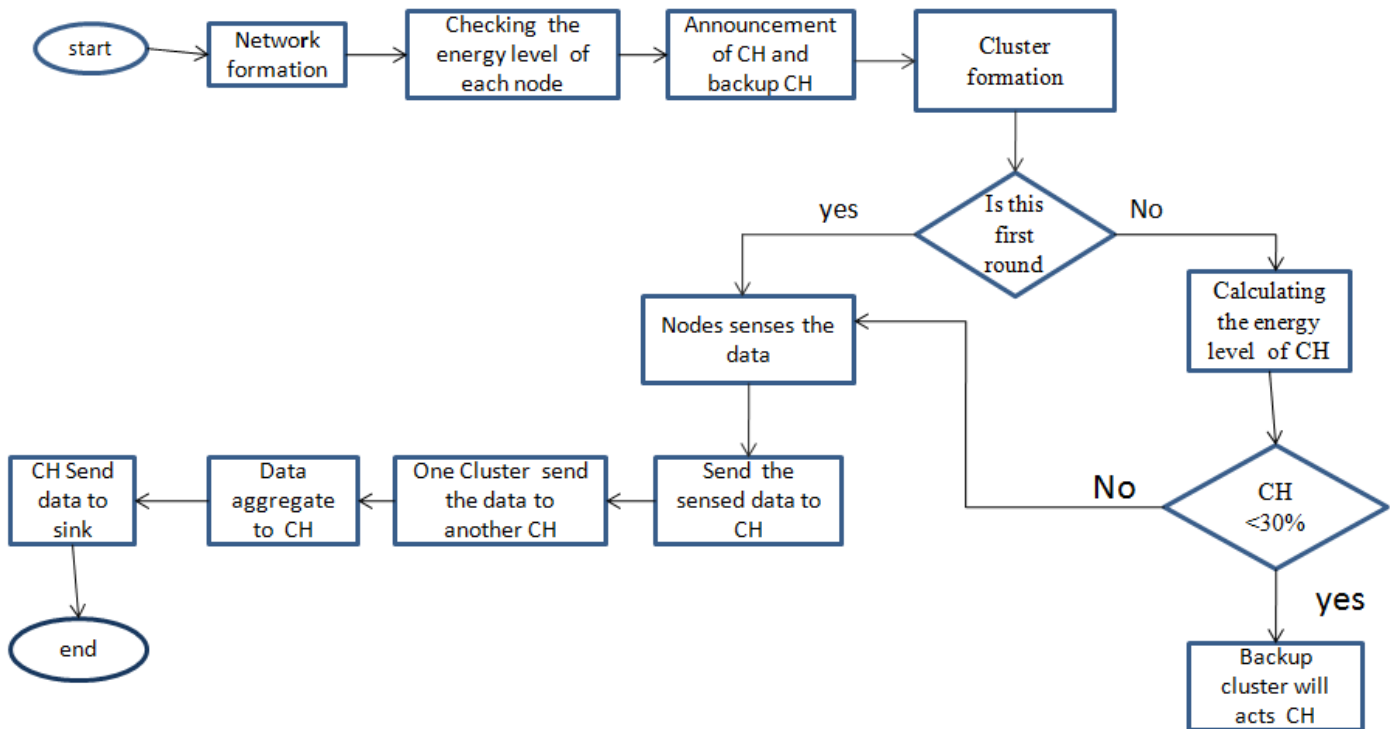


Fig 4.4: Flowchart of EEHCA

Moreover, since all the sensors within a cluster are at most k hops away from the cluster-head, the clusterhead can transmit the aggregated information to the processing center after every t units of time. This limit on the number of hops thus allows the cluster-heads to schedule their transmissions. Note that this is a distributed algorithm and does not demand clock synchronization between the sensors.

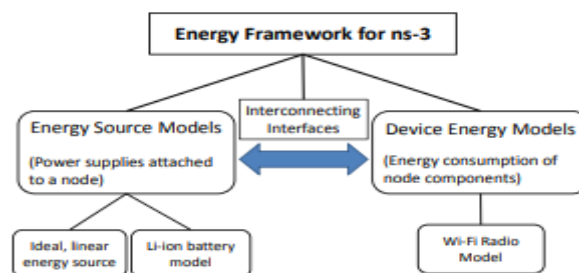


Fig 4.5 Basic Energy Model in NS-3.

The energy used in the network for the information gathered by the sensors to reach the processing center will depend on the parameters p and k of our algorithm. Since the objective of our work is to organize the sensors in clusters to minimize this energy consumption, we need to find the values of the parameters p and k of our algorithm that would ensure minimization of energy consumption. We derive expressions for optimal values of p and k in the next subsection.

```

Logging Event New Cluster Head Selection(Node-7) @ 20
Logging Event New Cluster Head Selection(Node-16) @ 20
Logging Event New Cluster Head Selection(Node-50) @ 20
-----
Logging Event New Cluster Head Selection(Node-5) @ 25
Logging Event New Cluster Head Selection(Node-17) @ 25
Logging Event New Cluster Head Selection(Node-47) @ 25
-----
Logging Event New Cluster Head Selection(Node-6) @ 30
Logging Event New Cluster Head Selection(Node-17) @ 30
Logging Event New Cluster Head Selection(Node-49) @ 30
-----
Logging Event New Cluster Head Selection(Node-3) @ 35
Logging Event New Cluster Head Selection(Node-27) @ 35
Logging Event New Cluster Head Selection(Node-49) @ 35

```

Fig 4.6: Cluster Head Formation & time taking to form Cluster Head between the nodes.

EEHCA Algorithm:

Step-1: Initialize Nodes N.

Step-2: $N=30$;

Step-3: Energy at each node $E=7.5$ (initial energy)

Step-4: Start Communication

Step-5: Calculating Cluster Heads 1-3 & 1 backup

Step-6: time taken to calculate the cluster heads are $t=4-6$ sec.

Step-7: Consider 35 Sec total time taken for this cluster head calculation.

Step-8: then the energy at each node is $E>7.5$.

Step-9: this shows that EEHCA is maintain the energy.

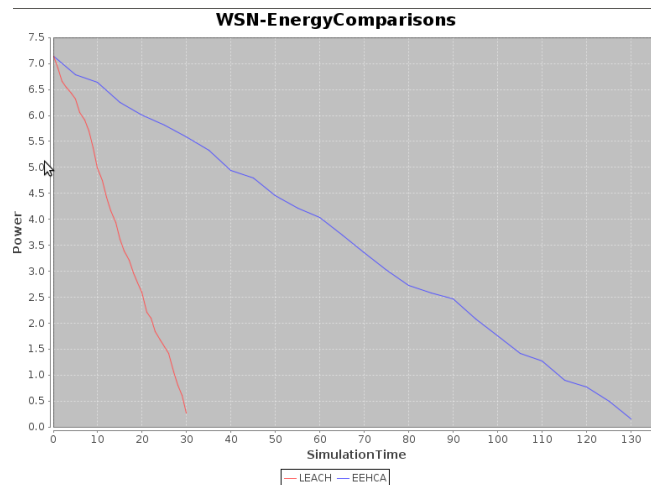
Step-10: Stop.

Optimal parameters for the algorithm. To determine the optimal parameters for the algorithm described above, we make the following assumptions:

- The sensors in the wireless sensor network are distributed as per a homogeneous spatial Poisson process of intensity λ in 2-dimensional space.
- All sensors transmit at the same power level and hence have the same radio range r .
- Data exchanged between two communicating sensors not within each others radio range is forwarded by other sensors.
- Each sensor uses 1 unit of energy to transmit or receive 1 unit of data.
- A routing infrastructure is in place; hence, when a sensor communicates data to another sensor, only the sensors on the routing path forward the data.
- The communication environment is contention- and error-free; hence, sensors do not have to retransmit any data. The basic idea of the derivation of the optimal parameter values is to define a function for the energy used in the network to communicate information to the information-processing center and then find the values of parameters that would minimize it.

VI. RESULTS AND DISCUSSION

The simulations are performed using NS-3. Extensive studies are carried out to study the performance of the proposed EEHC against classical and modern clustering algorithms.



Comparison table:

Algorithm	LEACH	EEHCA
No of Nodes	30	30
Total Energy for all nodes	15 Sec	35 Sec
Time for cluster head	1 Sec	4-6 Sec

Table: 1 Shows the Performance of the LEACH & EEHACE.

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FEATURE EXTRACTION AND DETECTION OF INDIAN CURRENCY USING IMAGE PROCESSING

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Abstract: The main objective of this project is to detect fake currency using image processing. Fake currency detection is a process of finding counterfeit currency. The features are extracted from the image and are compared with the features of original image of currency. In this paper DBC is used for extracting features. This project consists of different steps such as image acquisition, preprocessing, segmentation and feature extraction. Finally compare the image into original or forgery.

Index Terms - DBC (Directional Binary Code), Pre-processing, feature extraction.

I. INTRODUCTION

Digital image processing is the use of computer algorithms to perform image processing on digital images. Digital image processing has many advantages over analog image processing. Digital image processing allows the use of much more complex algorithms, and hence, can offer both more sophisticated performance at simple tasks, and the implementation of methods which would be impossible by analog means. The digital image can be acquired by means of cam scanner. Since the retrieved image is a colour image we are converting that image into HSV image. This can be done in pre-processing. Then HSV image is partitioned into number of segments in segmentation using canny operator. And the features are extracted from that image using directional binary code. Feature extraction is a special form of dimensional reduction. Transforming input data into set of features is called feature extraction.

Ojala et al. proposed the local binary patterns (LBPs) for texture description, and these LBPs are converted to rotational invariant for texture classification. Zhang et al. proposed the local derivative pattern for face recognition. They have considered LBP as a non-directional first-order local pattern, which are the binary results of the first-order derivative in images.

Zhang et al. have proposed the directional binary code (DBC) for face recognition. The DBC encodes the directional edge information in a neighbourhood. To improve the retrieval performance in terms of retrieval accuracy, in this paper, we calculated the co-occurrence matrix on DBC patterns.

Then the characteristics of test image are compared with characteristics of original pre-stored image in data base. If it matches then the currency is genuine otherwise it is counterfeit.

II. Flow chart

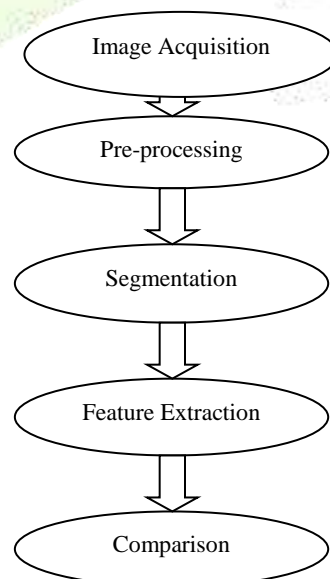


Fig 1: Flow chart

III. Algorithm

1. Load the input image.
2. Convert RGB to HSV image and divide into H, S, and V sub images.
3. Calculate the feature vector length by adding HSV.
4. After conversion, perform edge detection and segmentation by using canny operator.
5. Now perform feature extraction using DBC.
6. Perform the first-order derivative in 0, 45, 90, and 135 degrees directions.
7. Calculate the DBC and make them into rotational invariant.
8. Calculate the co-occurrence matrix.
9. Form the feature vector length by adding HSV and DBC co-occurrence matrix.
10. Compare the total FVL of any currency with the given value. The resultant will be either real or fake.

IV. Modules

1. Image acquisition:

Image acquisition is the first stage for any vision system because without an image no processing can be possible. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. The image can be acquired with the help of camera or scanner.

2. Pre-processing:

The main aim of the pre-processing is to improve the visual appearance of image. Pre-processing of the image contains the operations that are normally required prior to the main data analysis and extraction of information.

Pre-processing is also called as restoration. It involves the correction of distortion, degradation and noise introduced during the image processing. It increases the reliability of optical inspection.

3. Segmentation:

Segmentation is a process of partitioning a digital image into set of pixels. The goal of segmentation is to simplify the presentation of an image. It is mainly used to distinguish objects from background.

Segmentation algorithms for monochrome image are based on basic properties of image intensity.

4. Feature extraction:

Feature extraction is the spatial form of dimensional reduction. It is a method of capturing the visual content of image for retrieval and indexing.

Transforming the input data into set of features is called feature extraction. There are different methods in feature extraction such as LBP, LTP and DBC etc... In this paper, we are using DBC (Directional Binary Code) method for feature extraction. The DBC is proposed to encode the directional edge information in a neighborhood.

5. Comparison:

In this step, the extracted features of input image are compared with extracted features of original image. The features that are considered for comparison are security thread, Mahatma Gandhi portrait, floral design, unique numbers and strings.

V. Results



Fig 2: Image acquisition of real and fake

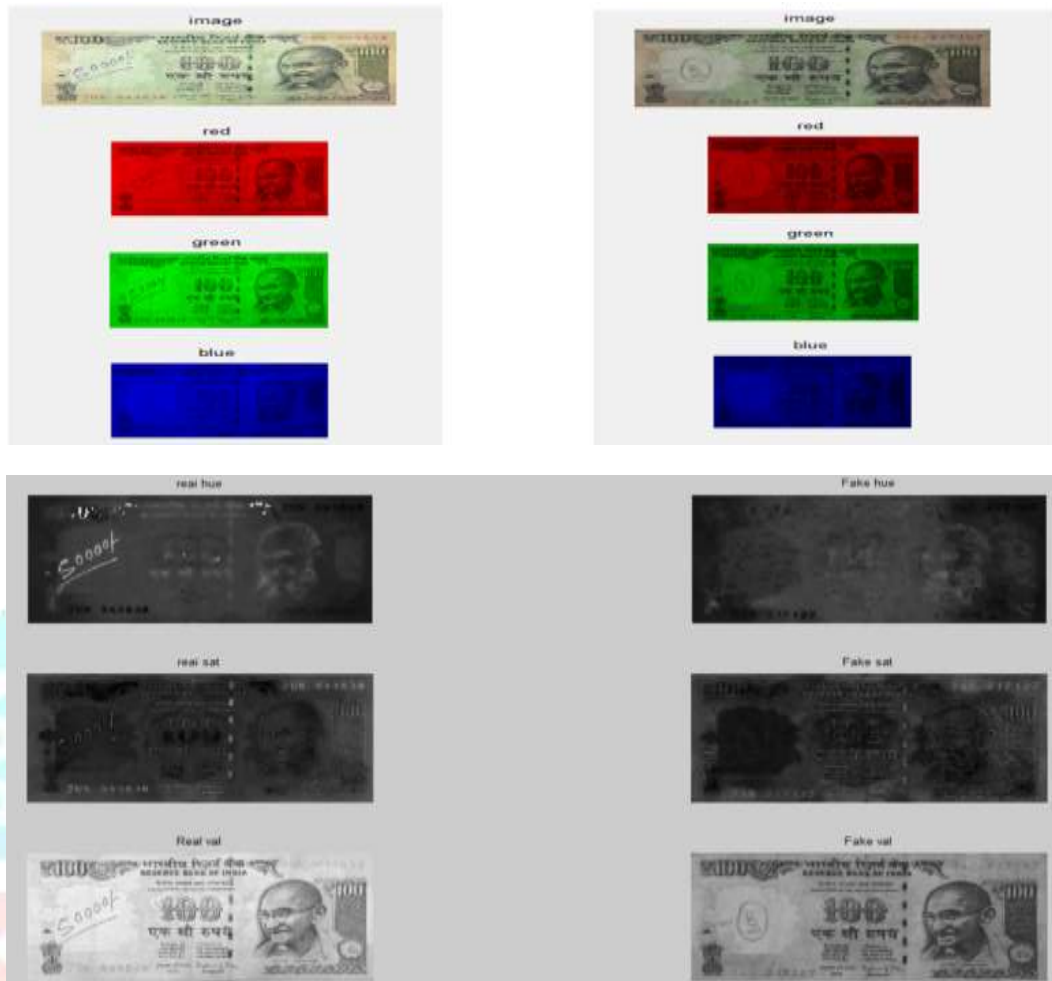


Fig 3: Pre-processing of real and fake



Fig 4: Segmentation of real and fake



Fig 5: Feature extraction of real and fake

VI. Observed Values

PERFORMANCE METRICS	REAL IMAGE VALUES		FAKE IMAGE VALUES	
	MINIMUM	MAXIMUM	MINIMUM	MAXIMUM
MSE	1.29	19.24	1.11	8.34
RMSE	0.1136	0.4387	0.1052	0.2888
SNR	1.3626		1.6512	
PSNR	71.8926	78.9199	80.2514	100.45
ENTROPY	7.1564		6.8690	

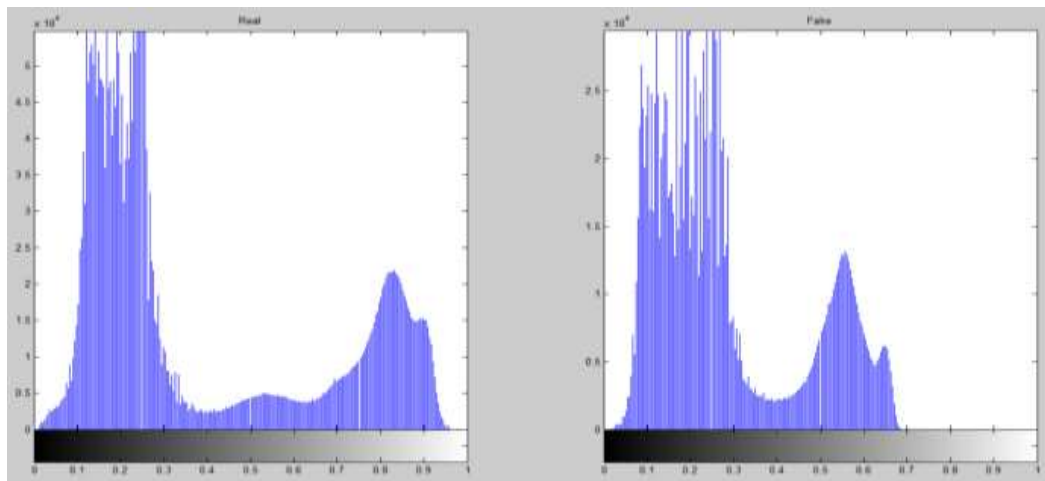


Fig 6: Histogram Outputs of real and fake

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A TECHNIQUE FOR INTENSITY NORMALISATION OF FINGER VEIN IMAGE

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Abstract: Finger vein recognition technology is a new biometric technology, which has the characteristics of the living capture, stability, difficult to steal and imitation, etc. has a wide application space in the field of information security. However, the quality of the finger vein image capture and the accuracy of the finger vein extraction are directly related to the accuracy of the recognition. Finger vein recognition has been considered one of the most promising biometrics for personal authentication. However, the capacities and percentages of finger tissues (e.g. bone, muscle, ligament, water, fat, etc.) vary person by person. This usually causes poor quality of finger vein images, therefore degrading the performance of finger vein recognition systems (FVRSs). In this paper, the intrinsic factors of finger tissue causing poor quality of finger vein images are analyzed, and an intensity variation (IV) normalization method using guided filter based single scale retinex (GFSSR) is proposed for finger vein image enhancement.

IndexTerms - Finger vein, Image segmentation, Edge extraction, intensity variation, guided filter, single scale retinex.

I. INTRODUCTION

The biometric identification technology system is transformed into a production technology, which is used to make relevant products and serve the real life. The biometrical technology is a kind of technology that uses human biological and activity characteristics to identify the identity authentication, and it is subdivided into physical and behavioral characteristics. Through a large number of experiments, it is proved that the biological characteristics are unique and not the same as those of any one. It is an automatic recognition, measurement and validation of the physiological characteristics or behavior. Because the biometric recognition has the characteristics of the human beings, there is no problem of forgotten or lost, difficult to be stolen, then, according to these characteristics, the researchers using the parts of the characteristics of the human body have developed various kinds of biometric recognition technology. It uses automatic technology to measure the characteristics of the physical or individual behavior, with the template data in the database to determine the identity, so as to complete the authentication. Biometric identification technology has the advantage: for the vast majority of people, will never disappear, will not be forgotten. According to the physiological characteristics of the human body, has fingerprint recognition, iris recognition, face recognition, palm print recognition, voice print recognition, vein recognition, brainwave recognition etc. Finger vein recognition is a new biometric technology. Based on the principle that the blood of the human body can absorb the light of the specific wavelength, the blood of the finger vein is captured. The characteristics of the finger vein recognition technology include the living capture, difficult to steal, not easy to imitate, rough and epidermal features are influenced by the external environment temperature is small, suitable for wide. It has broad application prospects in the military, social security, banking, public security, secret units, financial payment, smart city and common security market etc.

II. FINGER VEIN AUTHENTICATION

2.1 Extracting finger veins:

The procedure for finger-vein extraction is shown in detailed as follows.

Step 1: Acquisition of an infrared image of the finger Fig.1 (a) shows an example of the captured image. The image is gray scale, 512 x 384 pixels in size, with 8 bits per pixel. The finger tip's direction is right, but it is out of the region of image.

Step 2: Preprocessing of the image Reduce the original image's size to 128 x 96 to make the processing faster.

Step 3: Remove the noise using the median filter.

Step 4: Extraction of edges of finger and finger-vein features.

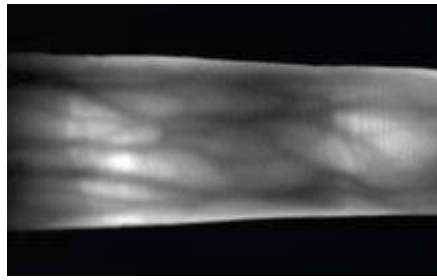


Fig:1(a) Finger vein image

2.2 Intensity normalisation:

As shown in Figure 1 (b),1 (c) finger usually contains fat, bone, skin, and nail components. Veins are located in the subcutaneous layer deep in the skin with fat, connective tissue and other tissues. All the tissues and organs inside a finger can absorb near infrared (NIR) illumination with different absorptivity. As oxyhemoglobin and deoxyhemoglobin in blood vessels absorb more NIR radiation than the other substances, vein vessels are shown in darker color while the other tissues are presented with a brighter background in the captured vein image.

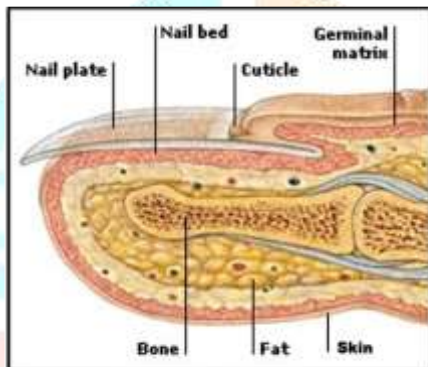


Fig: 1(b) Finger

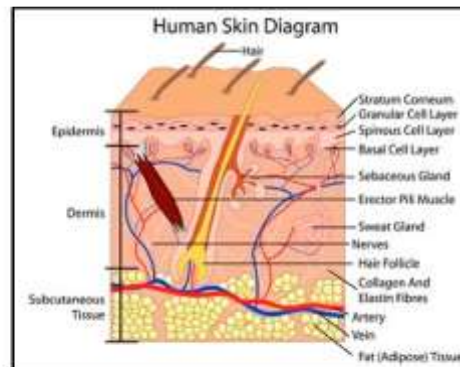


Fig:1(c) Skin

As mentioned above, while each individual has the same types of finger tissues, the capacities and percentages of each tissue vary from person to person. Thick fingers contain more fat, while thin fingers contain less fat. The captured images from a thin finger usually have higher image brightness than those from a thick finger. The acquired finger vein images from different individuals show different global and local contrast, especially between the venous and non-venous regions. Intensity variation in finger vein recognition is an internal factor that results in poor quality of the finger vein images and is inevitably generated in the process of imaging. No matter what kind of imaging model or device is used, intensity variation appears in the finger vein images, degrades the image contrast and thereby degrading the matching performance of an FVRS. Thus, a specialized method that focuses on alleviating the effect of intensity variation would be beneficial for enhancing the quality of finger vein images and the matching performance of the FVRS.

III. PROPOSED METHOD FOR VEIN EXTRACTION AND INTENSITY NORMALISATION.

The proposed system for identifying the edges of the finger, extracting the features of a finger vein and normalizing the intensities of finger vein images is explained below:



Fig 2 (a): Flow chart for proposed system

3.1 Median filter:

The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. Like the mean filter, the median filter considers each pixel in the image in turn and looks at its nearby neighbors to decide whether or not it is representative of its surroundings. Instead of simply replacing the pixel value with the *mean* of neighboring pixel values, it replaces it with the *median* of those values. The median is calculated by first sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value. (If the neighborhood under consideration contains an even number of pixels, the average of the two middle pixel values is used.) Figure 2 (b) illustrates an example calculation.

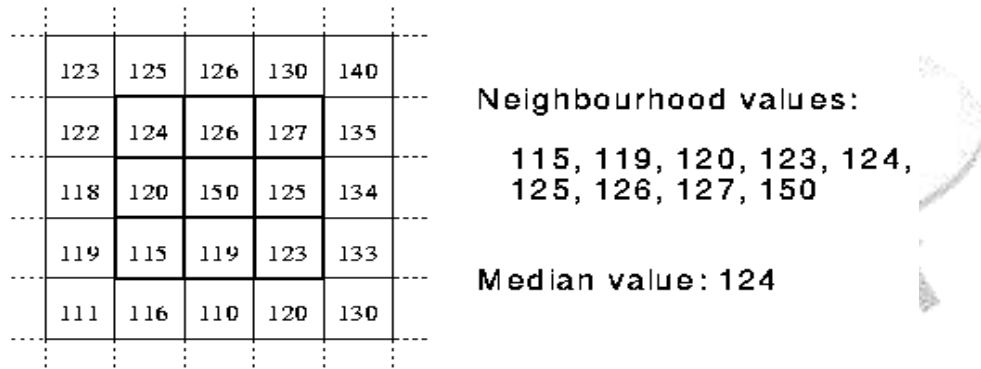


Fig:2(b) Calculating the median

3.2 Edge detection and feature extraction:

- The edges of a finger can be segmented from the image by using the thresholding techniques.
- The features can be extracted from a finger vein image. Here, we are using a special technique called as WIDE LINE BASED DETECTION.

3.3 Procedure for feature extraction:

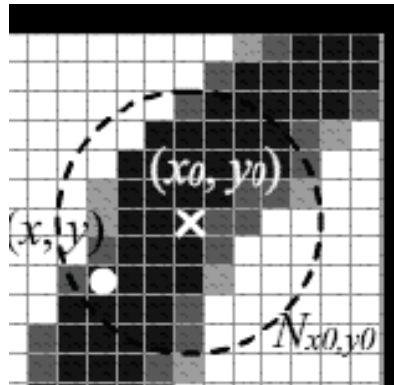


Fig 2 (c): The circular neighborhood region

The method of feature extraction is described in this section. Through observation and experiment, we consider that the vein feature can be presented by lines with different width. We use the wide line detector described in [5] to extract all the points on the vein lines in the image.

Here, F is the finger-vein image and V is the feature image. Both F and V are 8 bit 128 x 96 bitmaps. We define the values of pixels in V as parts of the background as 0 and the values of pixels as parts of the vein region as 255. For each point (x_0, y_0) in F , consider its circular neighborhood region with the radius r :

$$N_{(x_0, y_0)} = \{(x, y) | \sqrt{(x - x_0)^2 + (y - y_0)^2} \leq r\} \quad (1)$$

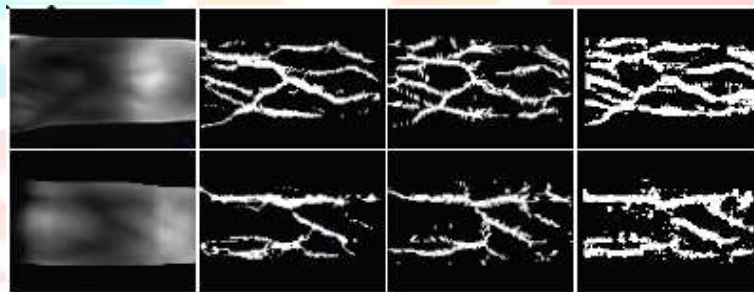
Fig.2 (c) shows the neighborhood region $N_{(x_0, y_0)}$. Using the pixels in it, we can calculate the $v(x_0, y_0)$ by (2)-(4):

$$V(x_0, y_0) = \begin{cases} 0 & m(x_0, y_0) > g \\ 255 & \text{otherwise} \end{cases} \quad (2)$$

$$m(x_0, y_0) = \sum_{(x, y) \in N_{(x_0, y_0)}} s(x, y, x_0, y_0, t) \quad (3)$$

$$s(x, y, x_0, y_0, t) = \begin{cases} 0 & F(x, y) - F(x_0, y_0) > t \\ 1 & \text{otherwise} \end{cases} \quad (4)$$

Here t , g and the radius r are parameters. We set $r = 5$, $t=1$ and $g = 41$. Fig 2 (d) shows the extracted feature images of the proposed method and two other methods: line tracking and curvature. We can find that almost all points on the vein are extracted by proposed method while the other two methods lose a part of points, thus the proposed method can extract more information.



(a) Original. (b) Line tracking. (c) Curvature. (d) Proposed.

Fig 2(d):Results of pattern extracting using different methods.

3.4 Procedure for Intensity normalisation:

3.4.1 Guided Filter:

Guided filter is an effective smoothing filter and its edge-preserving smoothing ability can be controlled by parameters. Taking into account this property and vague edges in some finger vein images due to intensity variation, guided filter is adopted in the present paper for smoothing the input images. The key assumption of the guided filter is a local linear model between the guidance S , and the filter output g . The guidance image is guided for smoothing an input image. It is supposed that g is a linear transform of S in a window w_k , centered at pixel k .

$$g_i = a_k S_i + b_k \quad \forall i \in w_k \quad (5)$$

where (a_k, b_k) are some linear coefficients assumed to be constant in w_k . This local linear model ensures that g has an edge only if S has an edge since $\Delta g = a \Delta S$. To determine the linear coefficients, the cost function that minimizes the difference between the input image L and the output is as follows:

$$E(a_k, b_k) = \sum_{i \in w_k} ((a_k S_i + b_k - L_i)^2 - \epsilon a_k^2) \quad (6)$$

$$a_k = \frac{\frac{1}{|w|} \sum_{i \in w_k} S_i L_i - \mu_k \bar{L}_k}{\sigma_k^2 + \epsilon}$$

$$b_k = \bar{L}_k - a_k \mu_k \quad (7)$$

where Σ is a regularization parameter preventing $k a$ from being too large, μ , and σ_k^2 are the mean and variance of S in $k w$, and L_k is the mean of L in $k w$. w is the number of pixels in $k w$. Hence, after computing (a_k, b_k) for all patches $k w$ in the image, the filter output can be computed by:

$$g_i = \frac{1}{|w|} \sum_{k \in w_k} (a_k S_i + b_k) = \bar{a}_i S_i + \bar{b}_i \quad (8)$$

where a_i and b_i are the mean values in a_k and b_k , respectively. Due to the linear model between the guidance and the filter output, the guided filter has a better edge-preserving smoothing property than other filters. The non-approximate manner in implementation results in good quality of the generated results. Furthermore, the linear running time of the algorithm depends only on the number of pixels in the image.

3.4.2 Single scale retinix algorithm:

Single scale retinex (SSR) is based on the assumption that an observed image L can be regarded as the multiplication of the illumination I and the reflectance images R . R can be considered as the textures without any illumination variations. Moreover, it is assumed that the reflectance changes sharply and that illumination changes smoothly. There are a lot of methods for decomposition of the intensity into these two components and the SSR algorithm is used as a technique to enhance images in various applications. The mathematic description for each pixel (x, y) in an image is defined as follow:

$$L(x, y) = I(x, y) \cdot R(x, y) \quad (9)$$

To eliminate the illumination from the captured image, a subtraction operator is applied in the logarithm domain.

$$\log R(x, y) = \log L(x, y) - \log I(x, y) \quad (10)$$

Since SSR is based on the idea that the illumination component tends to change smoothly, contrary to the reflectance, the illumination image I can be estimated by the convolution operation of the Gaussian filter on the captured image L . The operation for each pixel (x, y) is as shown below:

$$I(x, y) = L(x, y) \times F(x, y) \quad (11)$$

$$F(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (12)$$

Substituting Equation (11) into Equation (10), we have

$$\log R(x, y) = \log L(x, y) - \log(L(x, y) \cdot F(x, y)) \quad (13)$$

Consequently, $\log R(x, y)$ is the retinex output, called single scale retinex (SSR), while it is also the illumination-normalized output. The block diagram for SSR is shown in Figure 2(e).

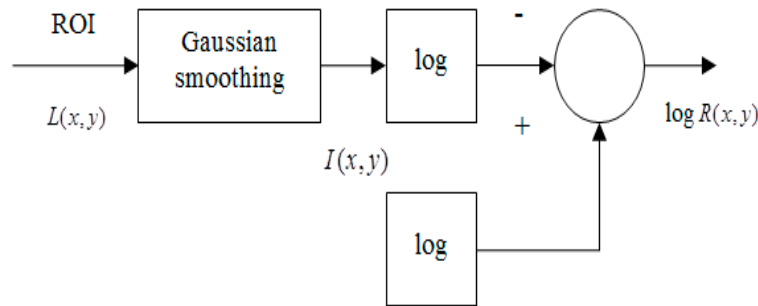


Fig 2(e):Block diagram of SSR algorithm

3.4.3 Proposed GFSSR algorithm:

Each tissue in a finger can absorb NIR illumination to different extents, causing undesired intensity variations in a finger vein image. The intensity variation normalization proposed in this paper is designed to eliminate this effect. Inspired by the assumption of SSR, it was assumed that a captured finger vein image L could be regarded as the multiplication of the intensity variation IV and the reflectance R . The mathematic description for each pixel (x, y) can be represented as follow:

$$L(x, y) = IV(x, y) \cdot R(x, y) \quad (14)$$

As mentioned it is common that an intensity variation image IV can be estimated by the convolution operation of the smoothing filter on the captured image L . Here, we use a guided filter as a smoothing filter to obtain an intensity variation image of a finger vein image. A result of guided filter at a point (x, y) , is obtained by a weighted sum of an intensity value at (x, y) in a given guidance image, s , and an average of a patch centered at (x, y) in a given input image, $f(x, y)$. a and b are used as its weights, which are determined by whether a patch centered at a point in the guidance image has relatively high variance, as defined in Equations (3) and (4). If a patch has relatively high variance, a becomes relatively large and contributes to $g(x, y)$ more than $f(x, y)$. Otherwise, $f(x, y)$ contributes to $g(x, y)$ more than $s(x, y)$. As shown in Figure 4, r is a radius of a patch and becomes larger. A region with relatively high variance also becomes larger and their variance values become smaller, so the contribution of $s(x, y)$ to $g(x, y)$ at a position (x, y) becomes smaller than in a case of using a smaller r . While its smoothing effect becomes stronger, its edge-preserving effect becomes weaker, but its tendency still remains. Therefore, the guided filter can work pursuing for a given purpose, when its parameter values and a guidance image are chosen properly. The proposed Guided filter based SSR (GFSSR) algorithm can be described as:

$$\log R(x, y) = \log L(x, y) \square \log(L(x, y) \cdot G(x, y)) \quad (15)$$

where $IV(x, y)$ is estimated by the convolution operation of the guided filter, $G(x, y)$, on the captured image L ,

$$IV(x, y) = L(x, y) \cdot G(x, y) \quad (16)$$

The block diagram of GFSSR is depicted in Figure 2(f):

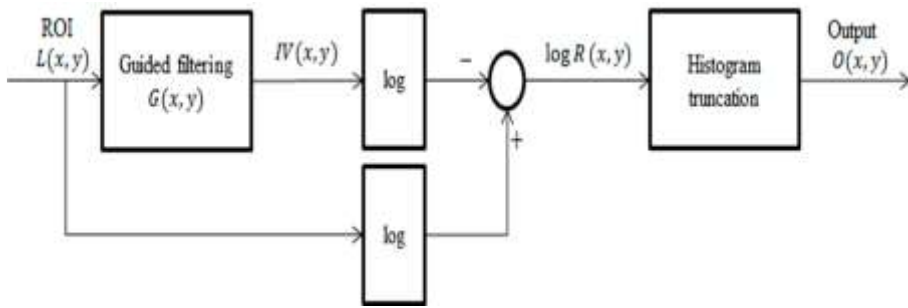


Fig 2(f):Block diagram of GFSSR algorithm.

IV.RESULTS

The following are the results obtained :

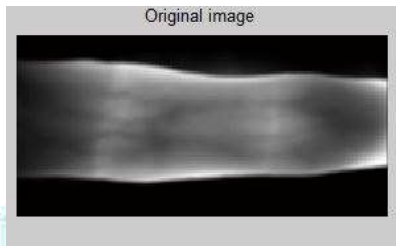


Fig 4(a):Input image

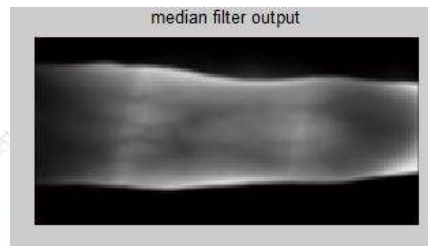


Fig 4(b): Output of the median filter

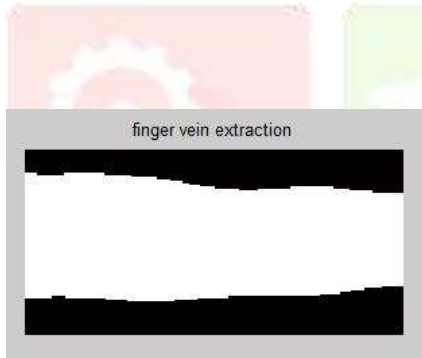


Fig 4(c): Output of the finger edge segmentation



Fig 4(d):Output of wide line based feature extraction

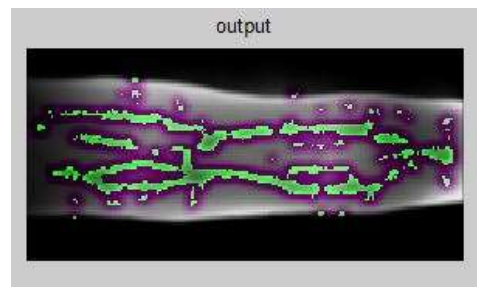
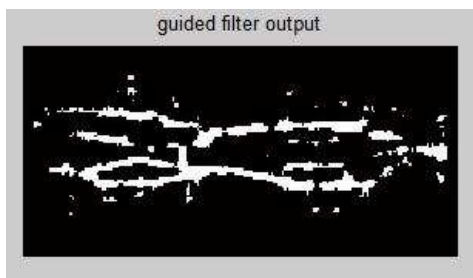


Fig 4(e):Output of guided filter

Fig 4(f):Output of the proposed method

V.CONCLUSION

In this paper, we have proposed a new method to improve the feature extracting capability of the finger vein by using wide line detector obtained. It can obtain all the points on the lines of vein in the image and increase the information of the feature. And, moreover we have introduced a new method for normalizing the intensities that are obtained while capturing the finger vein images using infrared rays due to the variations in the internal factors of each individual. We described a personal identification method based on patterns of veins in a finger. To extract the patterns from an unclear original image.

VI.FUTURE SCOPE

In this paper, we have designed the algorithm for identifying the finger vein images. But usually our finger veins will shrink and get un-clear. This will happen during cold weather or in the condition we've stayed in the air conditioned room too long. Therefore, we'll still learn and investigate to create a device that can grab the vein image more clearly and/or algorithms or methods that can extract better vein pattern under this condition.

VII.ACKNOWLEDGEMENTS

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ROBUST WIRELESS IMAGE TRANSMISSION USING ASYMMETRIC TURBO CODES

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Abstract: Today's world thrives on information exchange. Hence the need of the day is the information be protected well enough to the transmitted over a noisy environment. This is achieved by adding redundant bits to the information bit streams. If the purpose of adding redundancy bits is just to detect error and inform the sender to re-transmit the information. Forward error correction(FEC) is another way of adding redundancy to the information bit stream. So, error can be detected and corrected by preventing needed re-transmission.

Turbo codes is a very powerful error correction technique that has made tremendous impact on channel coding in last few years. Turbo code bit error rate drops very rapidly with increasing E_b/N_0 values. It achieves 10^{-5} BER with Recursive Systematic Convolution encoder. The iterative decoding mechanism, RSC and use of inter-leaver are the characteristics features of turbo codes. That it enhance data transmission efficiency in digital communication system. Turbo codes play a major role in multimedia services in mobile phones. The performance of turbo codes is superior with a little E_b/N_0 .

The original JPEG (Joint Photography Expert Group) image is encoded using turbo codes and subjected to additive white gaussian noise. In this random inter-leaver is used and MAP decoding algorithm is used. We can almost retrieve original image by number of iterations by iterative decoder. As the number of iterations increases the noise in image removed.

IndexTerms - Turbo Coding, Forward error correction, Interleaving, puncturing, Iterative decoding, MAP decoding.

I. INTRODUCTION

Turbo Code proposed in 1993 by Berrou *et al*, is known for excellent coding gain. It provides the error free communication near to Shannon Limit at great extent. Due to many research efforts of the turbo coding community, it is used in standardized system such as third-generation (3G) mobile radio system and so many other emerging wireless Applications.

Basically, the Turbo code can be classified into two types based on their generator polynomial structures. The component with identical encoders is basically known as symmetric turbo codes, otherwise asymmetric turbo code. The parallel concatenated turbo codes can assumes identical component code, as in the Symmetric turbo codes, have either a good "waterfall" Bit Error Rate (BER) performance or a good "error floor" BER performance but not both. Since, the asymmetric turbo code uses non identical component codes and can be designed with proper selection of weight configuration for better BER performance. In this paper, several new classes of asymmetric turbo codes are introduced which improves the performance compared to the original turbo codes (symmetric) over the entire range of signal to noise ratios. A practical setup with symmetric and asymmetric turbo codes is described and the performance results are discussed.

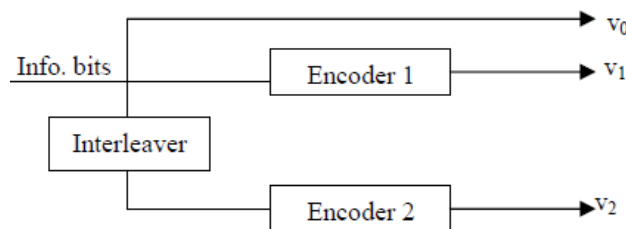


Figure.1. Block diagram of turbo code encoder.

II. ASYMMETRIC TURBO CODE

The turbo code with non-identical component encoders is known as Asymmetric turbo codes. The BER curve of a turbo code is divided into two region i.e. "waterfall" region and "error floor" region. "Waterfall" region is given as a steep slope for a long block of information bits and appears at a smaller SNR's but "error floor" region appears at higher SNR's and has a shallower slope due to code words of small weight. So, by using

symmetric turbo codes we can't get the better BER performance simultaneously for both waterfalls as well as error floor region. In that respect asymmetric turbo code satisfy the requirements for both the regions provided the selection of component encoders are proper.

A. Asymmetric Turbo Encoders

The asymmetric turbo code, like symmetric code has two un-identical recursive systematic convolutional (RSC) codes which generate the systematic codeword that consist of parity bit and information bit. The block diagram of turbo encoders are shown in figure 1. Two components encoders are separated by an interleaver.

In fig.1, we can see that there are three outputs, systematic output (v0), and two recursive convolutional sequence output (v1 and v2). Two parallel concatenated RSC encoders are joint with an interleaver. The simple structure of turbo encoders with code rate 1/2, constraint length 3 with un-identical components shown in figure 1.

B. Asymmetric Turbo Decoders

In this case also we can use similar decoding algorithms which are applicable for symmetric turbo decoders like Maximum-a-posteriori (MAP), Logarithmic Maximum-a posteriori (Log-MAP), Maximum Logarithmic Maximum-a posteriori (Max Log-MAP) and Soft output Viterbi decoding (SOVA). However we use un-identical component code in the Corresponding turbo decoders.

The MAP algorithm is the optimum decoding technique but the complexity is high. It is used to determine the most probable information bit that was transmitted but the SOVA is used for most probable information sequence that was transmitted. In Max Log-MAP the values and operation are easier to implement due to logarithmic domain but Log-MAP avoid the approximation as in Max Log-MAP. Hence, we used Log-MAP decoding algorithm for performance evaluation with low computational cost without much compromise in the BER performance. The block diagram of Log MAP turbo decoder is shown in figure 2.

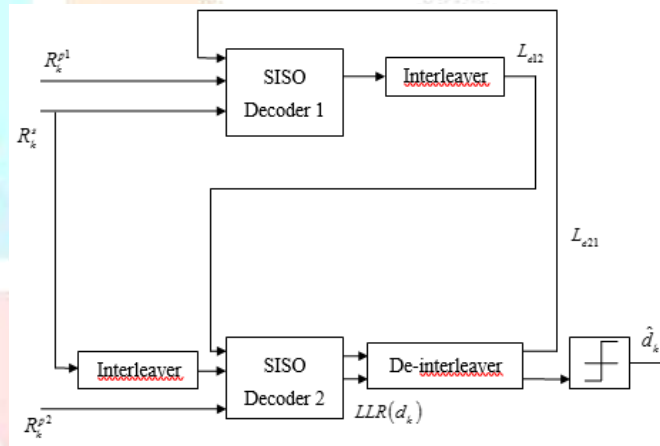


Figure.2.Block Diagram of Turbo decoder

The improvement in the error floor region can be done by serially concatenated turbo code or a parallel concatenated code of primitive components which have worse performance than original Berrou code in waterfall region. In asymmetric turbo code we consider the performance characteristic in both region i.e. in “waterfall” region as well as “error floor” region. In this paper we reduce the flattening of the “error floor” curve by applying asymmetric turbo code. The asymmetric turbo code with encoder with (7,5) and (15,13) component codes taking half code rate is shown in figure 3. Here, we can see that the two component codes are not identical, so it can be treated as asymmetric turbo code. The generated polynomial of the components codes are constructed with mixed type of the primitive polynomial and prime polynomial.

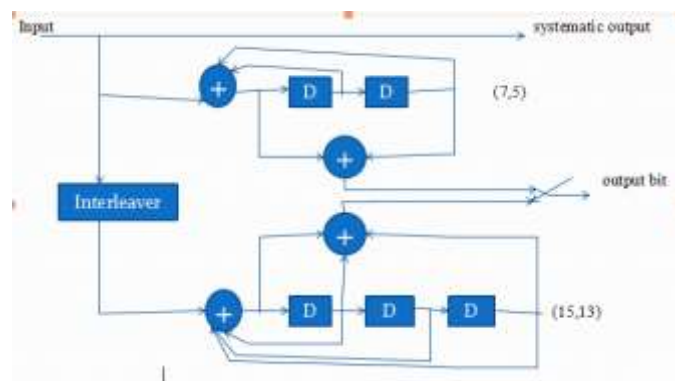


Figure.3.Block Diagram of Asymmetric Turbo Encoder

Table I
STANDARD PARAMETERS USED IN ASYMMETRIC TURBO CODE

channel	Additive White Gaussian Noise (AWGN)
Modulation	Binary Phase Shift Keying (BPSK)
Component Encoder	Two Non-identical Recursive convolutional codes (RSC _s)
RSC Parameters	$N=2, k=1, K=3, G_1=7,5$ (or 37,21 or 17,15); $G_2=5,7$ (or 21,37 or 15,17) etc
Puncturing used	YES (depends on coderate)
Components Decoder	Log-MAP decoder
Iteration	8

III. THE EFFECT OF VARIOUS CODEC PARAMETERS IN ASYMMETRIC TURBO CODE

There are many parameters, which affect the performance of asymmetric turbo codes. The various simulation results for asymmetric turbo code by using Binary Phase Shift Keying (BPSK) over Additive White Gaussian Noise (AWGN) channels are presented in this section. The parameters which affect the performance are as follows:-

- The number of decoding iteration
- Puncturing (or code rate)
- Frame-Length
- Component codes
- Constraint length

The parameters which we have used in our simulation are shown in Table I. Before going through the various results for different parameters, we have tested and verified the simulation model of asymmetric turbo code by substituting generator polynomials as $g_1=g_2=(15, 13)$ than comparing the result with symmetric turbo code for $g_0=(15, 13)$

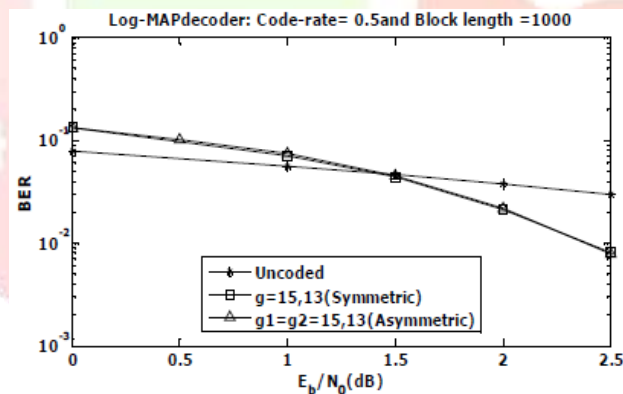


Figure 4: comparison between Asymmetric & Symmetric after identical components

The curves shown in figure 4 verify the asymmetric turbo codes simulation model. It is found that the result is matching with symmetric turbo codes BER performance, as expected. Mainly, the generated polynomials are optimum in terms of maximizing the minimum free distance of the components codes [9]. Most of the results in this paper for half code rate and also the decoding technique used are Log MAP decoder. All simulation results are taken over an AWGN channel with BPSK modulation.

A. The Effect of Number of iterations used

The performance of an asymmetric turbo code using Log-MAP algorithm with different decoding iteration is shown in figure 5. The generated polynomial used for the encoders are taken as (7, 5) and (5, 7). It can be seen from the above figure that the performance is nearly same as the encoded bits at low E_b/N_0 but at high E_b/N_0 the BER performance is improved after one iteration. When we increase the iteration like 2, 4, 6 and 8 then we get the better performance progressively. But after 6 iteration, there are a little improvement in performance approximately less than 0.1dB, so we use only 8 iteration due to complexity reason because as we increase the iteration more accurate the result, so more complexity.

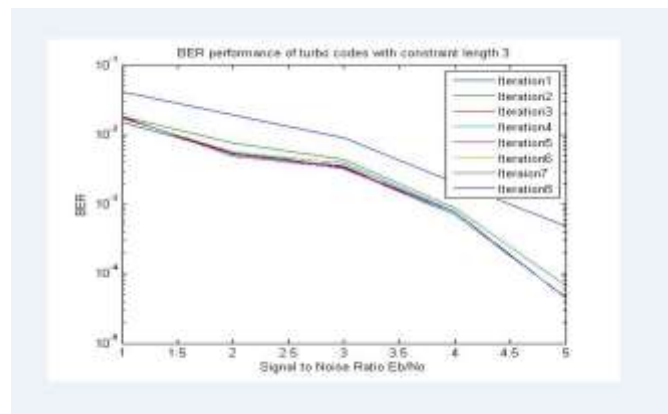


Figure 5: Performance using different number of iteration

B. The Effect of Puncturing or different code rate

Half of the parity bits from each component encoders are punctured when we use the half-rate code. But it is possible to avoid the puncturing and transmit all the parity bits through both the components encoder with one third code rate. Hence, the figure 6, shows the performance of BER taking parameters from table I, but the code rate is different i.e. half and one third. Like symmetric turbo code, the effect of puncturing in asymmetric turbo is also similar and effect reflected in the figure 6 which shows the performance graph for rate one-third is better than the rate one-half.

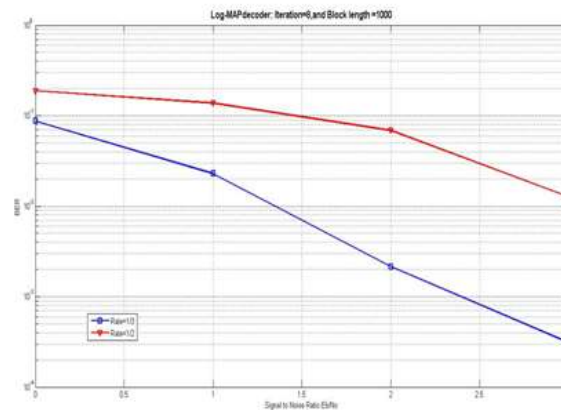


Figure 6: performance using half and one third code rate

C. The Effect of Frame Length

The BER performance is better as we increase the frame length. Since, the analysis of associated theoretical performance limits as a function of the coded frame length is already given by Dolinar *et al.*, So, a large number of frame length is an unacceptable in real time performance because of the delay in transmission. In speech transmission we use 169 bit code while in video transmission we use 1000 bit code. So as we increase the frame length we don't get the real time transmission however it would be useful in data or non-real time transmission.

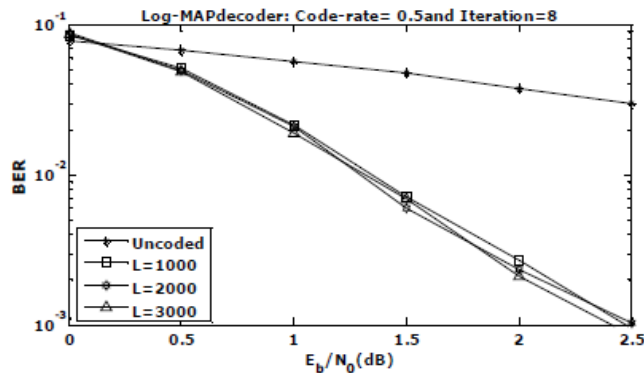


Figure 7: Performance using different frame length

D. The Effect of Components codes

The generator polynomial is also the important parameter used in the component codes. Figure 8, shows the different generated polynomials which affect the performance by using Log-MAP decoding technique. The generated polynomial used in this paper is for maximizing the minimum free distance of the component codes. The performances corresponding to the generator polynomials (7, 5; 5, 7) and (15, 17; 17, 15) are shown and compared in this graph. The orders of generated polynomial are important and mostly the octal value can be used for feedback to the encoder. There is an important role of generated polynomials in affecting the performance of turbo codes. The generator polynomials which consist of the primitive polynomials (P-G) and non-primitive polynomials (NP-G) as the feedback generator polynomials (known as mixed type of generator polynomials), gives the best performance in water-fall and error-floor region at low SNR as well as high SNR. Table 2 consists of different types of generated polynomials.

Table 2
DIFFERENT TYPES OF ASYMMETRIC TURBO CODES WITH DIFFERENT GENERATOR POLYNOMIALS

P1-P2	NP1-NP2	NP1-P2	P1-NP2
G1=[7,5] G2=[23,35]	G1=[5,5] G2=[37,21]	G1=[5,5] G2=[23,35]	G1=[7,5] G2=[37,21]
G1=[13,17] G2=[23,35]	G1=[15,17] G2=[37,21]	G1=[15,17] G2=[23,35]	G1=[13,17] G2=[37,21]
G1=[23,35] G2=[7,5]	G1=[37,21] G2=[5,5]	G1=[37,21] G2=[7,5]	G1=[23,35] G2=[5,5]
G1=[23,35] G2=[13,17]	G1=[37,21] G2=[15,17]	G1=[37,21] G2=[13,17]	G1=[23,35] G2=[15,17]

IV. IMAGE TRANSMISSION USING TYPICAL AND PROPOSED ASYMMETRIC TURBO CODES

In this section, an image transmission system over AWGN and Rayleigh fading channels using typical and proposed asymmetric turbo codes as error control coding is provided. The baseline JPEG algorithm is used to compress a QCIF (176 × 144) “Suzie” image.

A. The baseline JPEG image coding

The implementation of JPEG algorithm in this work is based on the baseline sequential DCT based, which is lossy. At the input to the encoder, the source image samples will be grouped into 8 × 8 blocks. Then the elements will go through level shift, FDCT, quantization, zigzag, run length and DC encoding, and then the entropy encoding. Finally, a bit stream of compressed image data will be obtained at the end of the encoder. Decompression is the exact reverse process. To deal with synchronization problems due to channel errors for bit streams containing variable length codes, restart intervals are implemented during the encoding process by keeping track the size of each interval. The decoding process will be performed on each interval individually, instead of the whole stream of image data bits. Using this method, any error will be contained in the particular interval only, without propagating the error to subsequent data. After decoding an interval, the process will resynchronize and restart to decode the next interval.

Table 3
Reconstructed image quality using typical turbo code over AWGN channel.

Iteration	MSE	PSNR
1	1158.3	17.49
2	626.57	20.16
3	275.16	23.73
4	21.058	34.9
5	9.1	38.54

B. Simulation results of image transmission system

Simulations are done to compress a QCIF (176 × 144) grey level “Cameraman” image for the quality factor of 68. The JPEG compressed data is then encoded using typical and proposed asymmetric turbo codes. BPSK modulation is used. The image transmission system is shown in Figure 9. After every iteration, the output of turbo decoder is given to the JPEG decoder to reconstruct the image and the decoded image is compared with the original to compute mean square error (MSE) and peak signal-to-noise ratio (PSNR) according to the following formula:

$$MSE = \left(\sum_{i=1}^M \sum_{j=1}^N (f(x, y) - f'(x, y))^2 \right) \times (M \times N)^{-1}.$$

$$PSNR = 20 \text{Log}_{10} \left(\frac{255}{RMSE} \right).$$

The original and the decoded “Cameraman” images at the output of typical turbo code system over AWGN channel for iteration 1 to iteration 5. The E_b/N_0 is set as 2 dB. As shown in Table 3, the MSE Therefore, a zero MSE value is achieved for identical images. Higher values denote higher deviation between the original and degraded images. Note that a low MSE does not necessarily indicate high subjective quality. PSNR is derived using the root mean square error (RMSE) to denote deviation of a compressed image from the original in dB. For an eight-bit image, with intensity values between 0 and 255, the PSNR is given by decreases and PSNR increases as we increase the iteration. It is also noticed that even after 5th iteration, MSE of 9.1 is left uncorrected, which conforms that baseline JPEG is lossy. The original and the decoded “Camera man” images at the output of proposed asymmetric turbo code system over AWGN channel are shown in Figure 11. It is observed that it requires only four iterations to correct the errors where as typical turbo code requires five iterations. The quality of the reconstructed images for every iteration. The decoded image quality (in PSNR) of typical turbo code and the proposed turbo code systems over AWGN channel are also provided in Figures respectively. We observe that higher performance gains are achieved using proposed asymmetric turbo code for all iterations and there is no increase in gain after the fourth iteration. The original and the decoded “Cameraman” images at the output of proposed asymmetric turbo code system without interleaver over AWGN channel.

V. RESULTS

In this paper, we presented the results of a study on the performance of an image transmission system using typical and proposed asymmetric turbo codes. Although the search procedure of perfect parameters for good component encoder at low and high SNR is quiet exhaustive, the modifications in turbo encoder really contribute performance improvements in turbo code system. The simulation results in-dicate that the performance of image transmission system using proposed asymmetric turbo code is superior to that using typical turbo code for different channel conditions.



Figure 8: Original and decoded “Cameraman” images over AWGN channel using proposed asymmetric turbo code without interleaver with an E_b/N_0 of 2 dB.

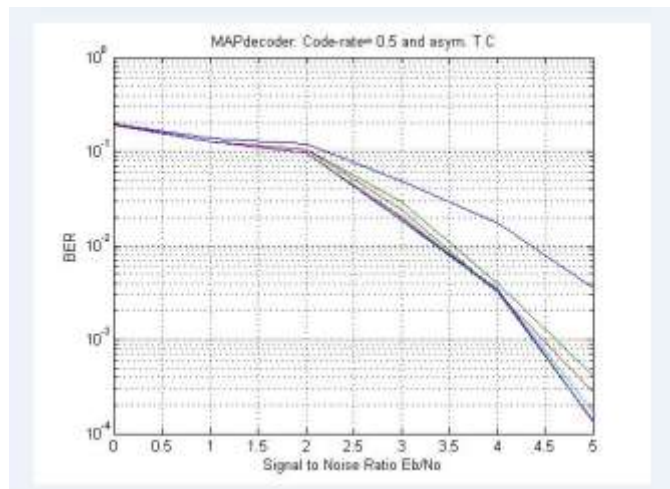


Figure 9: Performance Of Asymmetric Turbo codes with $g_1=(7, 5)$ and $g_2=(15, 13)$.

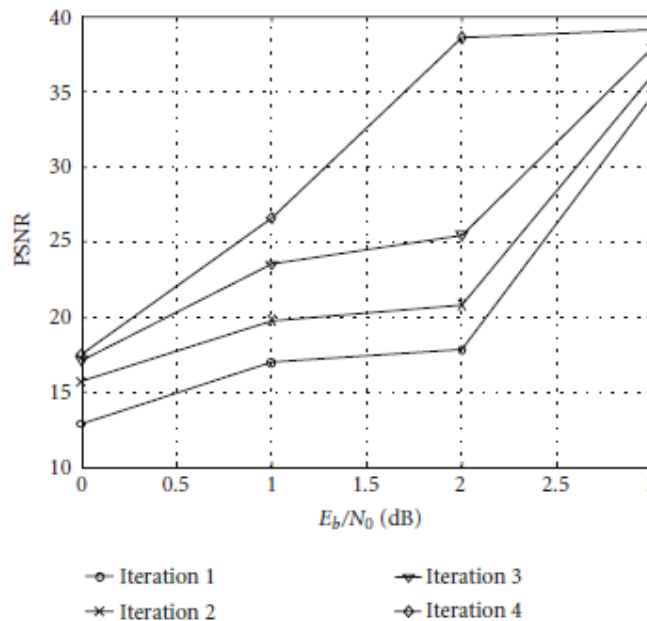


Figure 10: Decoded image quality (in PSNR) of proposed asymmetric turbo code with intrleaver over AWGN channel.

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Design and Implementation of Coal Mine Safety using IoT

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Abstract:

Now a day's due to global warming and climate changes there are challenging situation in field of coal mine. To reduce the cost and improve the productivity along with product quality the atomization in the field of coal mine is indeed necessary, which will also reduce the mine workers efforts. This paper proposes a design of a Wireless Sensor Network (WSN) with the help of Raspberry pi controller which is able to monitor the temperature, humidity, gas and status of smoke in an underground mine. This system also controls the ventilation demand to mine workers depending upon present climate conditions within the mine field. This system utilizes the low power, cost effective Raspberry pi a temperature sensor LM35, humidity sensor HR202, smoke detector, gas sensor, MEMS sensor for sensing the mine climate parameters and Wi-Fi for remote logging of data at central location to control the climate state with the help of motor and value control circuitry.

Keywords: *Raspberry pi, Gas Sensor, Humidity Sensor, LDR, Temperature Sensor, MEMS sensor, IoT.*

I. INTRODUCTION:

Traditional coal mine monitoring systems tend to be wired network systems, which play an important role in coal mine safe production. This system controls the ventilation demand to mine workers depending upon present climate conditions within the mine field. Here we propose a design of a Wireless Sensor Network (WSN) with the help of Raspberry pi controller which is able to monitor and control the underground mine climate condition. With continuous enlarging of exploiting areas and extension of depth in coal mine, many laneways become blind areas, where in there are lots of hidden dangers. Moreover, it is inconvenient to lay cables which are expensive and consume time. In order to solve the problems, we will design a coal mine safety monitoring system based on wireless sensor network, which can improve the level of monitoring production safety and reduce accident in the coal mines. Wireless sensor networks is composed of a large number of micro-sensor nodes which have small volume and low cost.

II. LITERATURE REVIEW:

Previously there are many of the projects which are related to coal mine safety system. Following are the previous projects.

A. The innovation mechanism research of coal mine safety production supervision. The current coal mine security situation grim, malignant accidents occur frequency, the main reason is the serious illegal or irregular act, the manage problem of false lax in some places is relatively outstanding. The coal mine enterprises to form effective restriction mechanism, can make up for government macroscopic supervision and limitation of their own management and shortage.

B. Advance of fiber optic gas sensors for coal mine safety applications. Coal mine combustion is major safety hazard which is conventionally detected by monitoring characteristic gases such as CO, C₂H₄ and C₂H₂. Fiber optic multi gas sensors have been developed which provide advantage of real time in detection, low cross sensitivity and low cost for coal mine combustion detection.

C. Light Weight Mash up Middleware for Coal Mine Safety Monitoring and Control Automation. Recently the frequent coal mine safety accidents have caused serious casualties and huge economic losses. It is urgent for the global mining industry to increase operational efficiency and improve overall mining safety. This paper proposes a lightweight mash up middleware to achieve remote monitoring and control automation of underground physical sensor devices. First the cluster tree based on ZigBee Wireless Sensor Network (WSN) is a deployed in underground coal mine and propose an Open Service Gateway Initiative (OSGI) based uniform message space and data distribution model and also a lightweight services mash up approach is implemented.

III. COAL MINE SAFETY USING RASPBERRY PI: HARDWARE:

By using the Raspberry pi we can access the coal mine through the internet by the concept of IoT (Internet of Things) and this Raspberry pi also the very efficient when compared to other technology. Through which we can connecting the sensors in the GPIO pin layout. It is also a mini CPU where we can interface with audio and video. So under the mine it will be monitor through the system. It can

also be useful transmit the data where we want. We can also extend the memory by giving the external memory as SD card

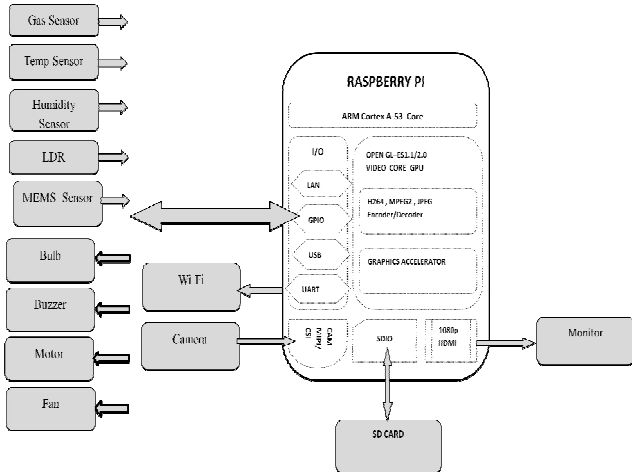


Fig.1. Coal mine safety system block diagram

This is the main block diagram used in the propose system. While using the four sensors that can be detected and given to raspberry pi, while motor, fan, blub are be used control under the mine which will be connected wired to raspberry pi and camera is connected to capture the image of detected sensor. The raspberry pi will be monitor through the system. The four sensors as the input to the raspberry pi.

A. Raspberry Pi:

The Raspberry is a computer it uses a different kind of processor. The Raspberry pi is used to surf the internet, send an email or write a letter using a word processor. If it was connect the Pi directly to a PC or laptop, it won't be able to connect out onto the Internet by default. To do so, should be needed to configure the PC to bridge the wired Ethernet port and another (typically wireless) connection. But if it was completely unable to connect the Pi to the Internet in any other way, that can try searching your operating systems helps file for "bridge network" to find more guidance. With a cable connected, the Pi will automatically receive the details it needs to access the Internet when it loads its operating system through the Dynamic Host Configuration Protocol (DHCP). This assigns the Pi an Internet Protocol (IP) address on the network, and tells it the gateway it needs to use to access the Internet (typically the IP address of your router or modem).For some networks, there is no DHCP server to provide the Pi with an IP address.



Fig.2. Raspberry Pi 3 model

B. Gas sensor:

The intent of this reference guide is to describe in detail the Gas Sensor Platform with Bluetooth® Low-Energy Reference Design from Texas Instruments. After reading this reference design, a user should better understand the features and usage of this reference design platform. The Gas Sensor Platform with Bluetooth Low-Energy (BLE) is intended as a reference design that customers can use to develop end products for consumer and industrial applications to monitor gases like Carbon Monoxide (CO), oxygen (O2), ammonia, fluorine, chlorine dioxide and others.



Fig.3.gas sensor

C. Temperature sensor:

The LM-35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55°C to 150°C temperature range.

for different operating systems. Python runs on Linux, OS X and Windows computer systems.

Cross-platform support guarantees that the programs which are written in Python are also compatible in other platforms.

B. Raspbian Jessie OS:

Raspbian is a Debian based computer operating system for Raspberry Pi. It is now officially provided by the Raspberry Pi Foundation, as the primary operating system for the family of Raspberry Pi single-board computers. Raspbian was created by Mike Thompson and Peter Green as an independent project. The initial build was completed in June 2012. The operating system is still under active development. Raspbian is highly optimized for the Raspberry Pi line's low performance ARM CPUs. Raspbian uses LXDE, Pi Improved X windows Environment, Lightweight as its main desktop environment as of the latest update. It is composed of a modified LXDE desktop environment and the Open box stacking window manager with a new theme and few other changes.

The distribution is shipped with a free copy of computer algebra program Mathematical. It also includes a version of Mine craft called Mine craft Pi and includes a Pi-enhanced version of Chromium as of the latest version. Raspbian is an unofficial port of Debian Wheezy armful with compilation settings adjusted to produce optimized "hard float" code that will run on the Raspberry Pi. This provides significantly faster performance for applications that make heavy use of floating point arithmetic operations. All other applications will also gain some performance through the use of advanced instructions of the ARMv6 CPU in Raspberry Pi.

Although Raspbian is primarily the efforts of Mike Thompson and Peter Green (plug wash), it has also benefited greatly from the enthusiastic support of Raspberry Pi community members who wish to get the maximum performance from their device.

V Working Process:

These five sensors are be connected to the raspberry pi when their will be change in the mine of any gases are temperature. The sensor will be detected then camera will capture the photo the message will be send it our phone by the IoT process used in the raspberry pi. The sensor detecting also be monitor. Photo which are capture will be sent it our email address for our requirements. This coal mine will be also control through the mobile to change the temperature and also to reduce the unwanted gas in the mine by the concept of IoT in raspberry pi system

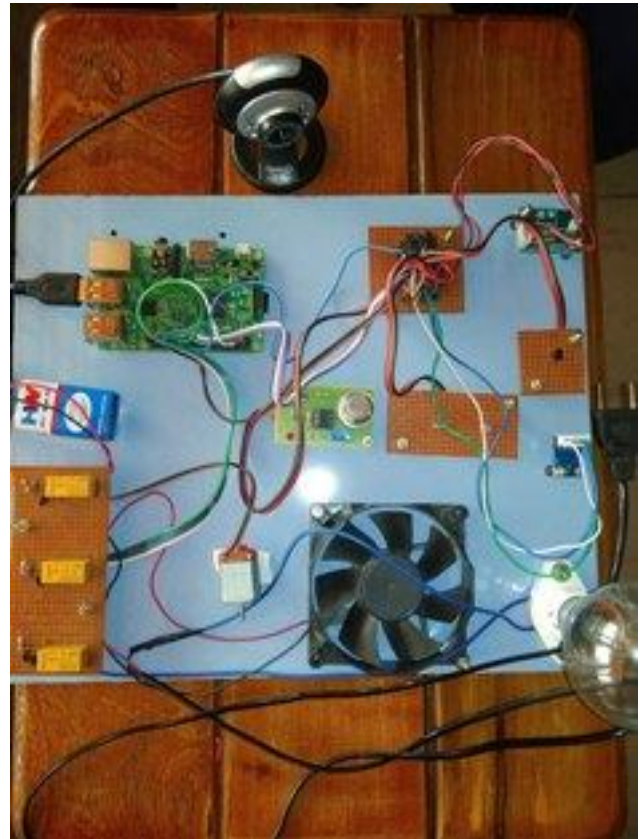


Fig.8. coal mine safety kit

VI Result:

In this paper, We reviewed the current state and projected future directions for robotics and industries by applying sensors, particularly those equipped with IoT intelligence, offer attractive options for enabling observation and recording of data in industries and work environments the safety regulators should introduce the Relevant Policies Rules and Regulations and Standards and trained professionals, as a set of scientific management system. Results through sms as shown below that we can see the actual condition of the coal mine at anywhere in world through sms.



Fig.9. sms notification

Through email we can store images and videos (if we include video capturing) that is by camera connection to the equipment it detects the situation and sends to the mail with those pictures. Example as below:

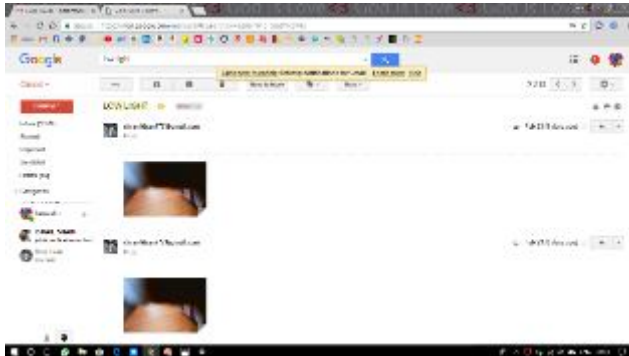


Fig.10.mail notification

Through web page we manually control the loads like bulb, motor, fan what we are connected to raspberry pi which we are seeing or getting values on the web page by pressing button like options on web page as shown as:



Fig.11.web page controlling

Thingspeak what we are added additional to sms and mail to check the values regularly and in graph format to estimate the problem issues before they occur by identifying the rising peak of the graph of certain sensor reading window. Which as show below:

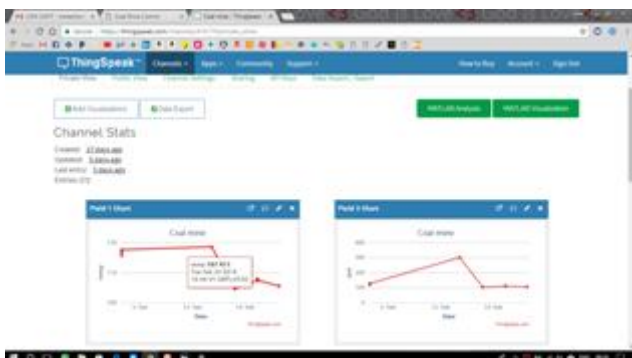


Fig.12.graphical format

Finally what we are to going to say is we can surveillances the mine and we can control the mine equipment through IoT technology across the world.

VII Future scope:

The system can also be used for various other applications such as for security in Robotics and industries etc., the system can provide a more efficient, compact and also it will be control by the workers throughout mobile.

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SMART GLOW ASSISTANCE SYSTEM FOR ILL AND DUMB PEOPLE

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Abstract: this world so many of people facing the physically handicapped problems. In this situation they can't do their own works and every time they need others help. To face this problem, we have tried to make a system, it helps for physically handicapped persons, also for ill people who can't even walk in that period and dumb people. This paper presents a smart glove system that contains transmitter and receiver sections. We can fix the receiver part wherever we want in the home and it contains RF receiver, fan and bulb, speakers and raspberry pi controller. Transmitter part contains glove that can easily wearable to hand and it contains flex sensors, accelerometer and RF transmitter and Arduino microcontroller. It gives the voice output what they want to say, also gives the present location of patient and it can controls the devices like fan and bulb etc. In this we have used Zigbee for wireless communication, GPS module for getting location, Arduino controller for transmitter section and raspberry pi for receiver section.

IndexTerms - Flex sensor, Zigbee, RF transmitter and receiver, accelerometer, GPS module, Arduino and raspberry pi.

I. INTRODUCTION

This paper presents an assisting device for ill, dump and handicapped people as the receiver section gets different signals from the transmitter section that contains a glove with flex sensors, accelerometer and RF transmitter. That glove can easily wearable to hand with this they can make voice output what they want to say, control the devices like fan and bulb without any others help and also, they can remind their family people with location when they are outside. Here we have used Zigbee for wireless communication between transmitter section and receiver section.

In the transmitter part flex sensors, accelerometer, Arduino UNO controller, GPS module, RF transmitter and Zigbee Transceiver are used to make different signals by ill, dumb and handicapped people. Flex sensors are stick across the fingers of the glove and these are connected to the Analog pins of Arduino microcontroller. By bending each finger gives different voice output at the receiver side. Three axes accelerometer is also attached to glove while any interrupt in mems it gives the signal to Arduino controller then it requests the GPS module to get location and transmit that to receiver using Zigbee transceivers on both sides of the system. RF transmitter is also attached to glove with this fan and bulb controlled by transmitting different signals to RF receiver.

In the receiver section all the things can be controlled by Raspberrypi3 which is connected to PC which display

location transmitted by them. A relay device used to control the fan and bulb. Initially user requires some guidance for this system.

II. LITERATURE SURVEY

Various techniques have been employed in the recent past to achieve the objectives outlined in Section I. These include visual recognition techniques using image processing which, however, come with their own limitations [1]. Skin color detection, though a popular strategy used in computer vision-based algorithms, is sensitive to lighting conditions [2]. Moreover, a flexible and progressively adapting model for skin color recognition is a challenging task [1]. Besides, motion cues limit the gesturer to a stationary background [3].

The concept of wired gloves has also been used by researchers and developers in the recent past. Bend sensors and linear sensors together with back propagation (BP) algorithm were proposed in [4]. However, a difficulty faced by the gesturer wearing such a glove is the restriction he feels while wearing it. Bend sensors and accelerometers were used in a data glove that was used as an alternative to keyboards and mice for air writing and 3D sketching [5].

III. PROPOSED SYSTEM

The overall system block diagram is shown in Fig 1. The basic functions of the proposed system are:

- Detecting the finger movement using flex sensors.
- Speech output comes based upon this finger movements.
- Detecting the latitude and longitude values of the patient by using 3-axis accelerometer sensor.
- Controlling the devices like fan and bulb using RF transmitter and receiver.
- Wireless communication using Zigbee.

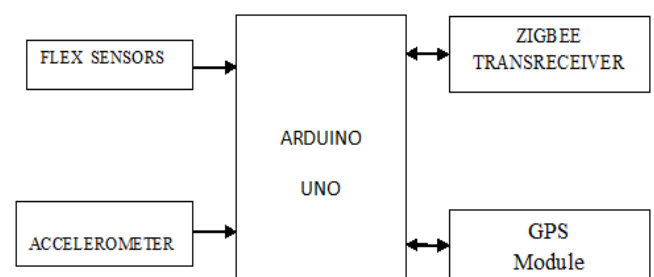


Figure 1: Block Diagram of Transmitter side

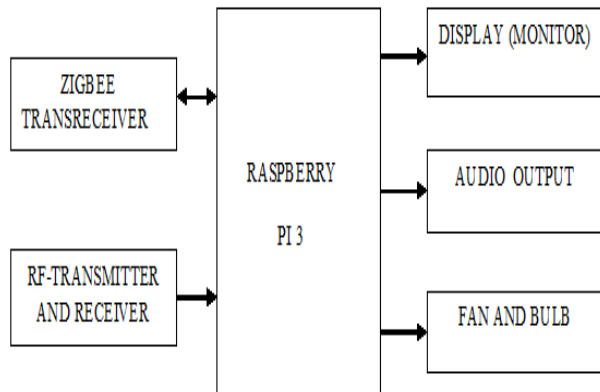


Figure 2: Block Diagram of Receiver side

IV. SYSTEM DESIGN

The block diagram in Figure 1 & 2 shows the entire design of the system, which includes the transmitter side and receiver side. In the transmitter side, there are four flex sensors and one accelerometer are attached to the glove to detect the bending of each finger and hand movement. The controller used in the transmitter side is Arduino UNO interfaced with Zigbee transceiver and GPS module. The transmitter is used to transmit the signals to the receiver. The flex sensors and Zigbee are interfaced with the microcontroller. In the receiver side, there is an Zigbee module to receive the signals. The microcontroller used in the receiver side is Raspberry pi3. In the receiver side RF transmitter and receiver modules are using for controlling devices like fan and bulb.

V. HIGH LEVEL DESIGN

In this section, we elaborate on different components and hardware modules used in the project. Our goal is to create a wireless device for the bed rest patients to make it easier for them to getting assistance from others. By using a group of sensors, we can determine the state of the hand by looking at numerical values being generated by the sensors. Flex Sensors are used as variable resistors to detect how much each finger is bent deformed, and the accelerometer can identify the orientation and hand movement. The flowchart of different layers inherent to the working of this project is shown in Figure 3

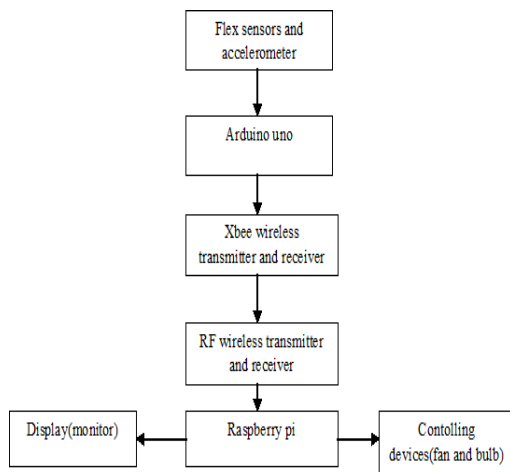


Figure 3: Flowchart of project

A. HARDWARE

i. Sensor Modules

a. Flex sensor:

Flex sensors are bidirectional sensors and these are unique component that changes resistance when bent either direction. It has nominal resistance of 25k ohms as the flex sensor is bent in one direction the resistance gradually increases. They measure the bend of fingers and generate analog output corresponding various bending angles. The connection of flex sensor is in figure 11.

b. Accelerometer:

An accelerometer is used to measure the orientation movements of the hand, which is also required to get the latitude and longitude values from the GPS module.

ii. Networking Modules:

a. Zigbee Module:

Zigbee is a standard-based specification for a suite of high-level communication protocols used to create personal area network with small, low-power digital radios. It provides the network infrastructure required for wireless sensor network applications. In the proposed system it we are using two Xbee's: One transmits the data from glove to another Xbee, which receive the data and transfer it to the processing unit.



Figure 4: Zigbee module for wireless data communication

a. GPS Module:

We are using GPS module L10-M29. this brings the high performance of the MTK positioning engine to the Industrial standard. It acquires and tracks the satellites in the shortest time even at indoor signal level. In the proposed system by using this GPS module we are obtaining the Latitude and Longitude values of the patients.



Figure 5:L10-M29 GPS Module

c. RF Module:

A radio frequency module is a small electronic device used to transmit and receive radio signals between two devices. In this proposed system we are using HT-12E and HT-12D with 433.92 MHz frequency to control device like fan and bulb through Relay.

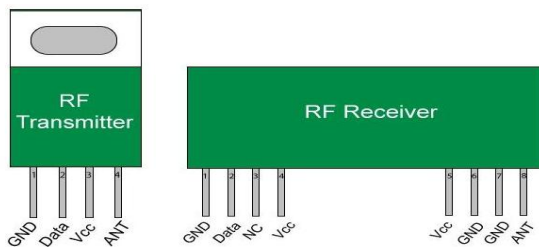


Figure 6 : RF transmitter and receiver

iii. Processing modules:

a. Arduino UNO:

At transmitter side we are using Arduino UNO. It is an open source computer hardware and software company, project and user community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices. It contains both Analog and digital pins. It also supports serial communication. It supports programming languages like c, c++.



Figure 7:Arduino UNO Microcontroller

In this proposed system, it is used to converts analog output data into digitals using ADC converter .it contains one UART support inbuilt only we can create two more UART support externally. It is also helpful for wireless communication by using serial pins.

b. Raspberry pi:

The Raspberry pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

In this proposed system it is used in the Receiver side. It get the signals from the transmitter by using Zigbee. By using the GPIO pins the serial communication will be done easily.



Figure 8: raspberry pi 3 BCM2835

c. E-speak module:

it is a speech synthesizer present in a raspberry pi .it is used to convert Text-to-Speech. By using this voice output is obtained from the speakers.

B. SOFTWARE

Arduino Software (IDE) is an open source software is used to program the Arduino at transmitter side and it is written in a c language and Raspbian software is used to program the raspberry pi3 at a receiver side and it is written in a Python language. The flow charts of the codes are illustrated in Figures 9 and 10. Figure 10 shows the flow chart of the software design in the transmitting side, while the receiver side flow chart of the software is shown in Figure 9. Figure 10 shows how the code in the transmitter side helps in transmitting the sign which user interprets. Once the user shows the gesture, the code in the transmitter side checks whether the values are in range for the particular output and if it is in range the transmitter transmit, else the code will wait for new values and the process keeps repeating.

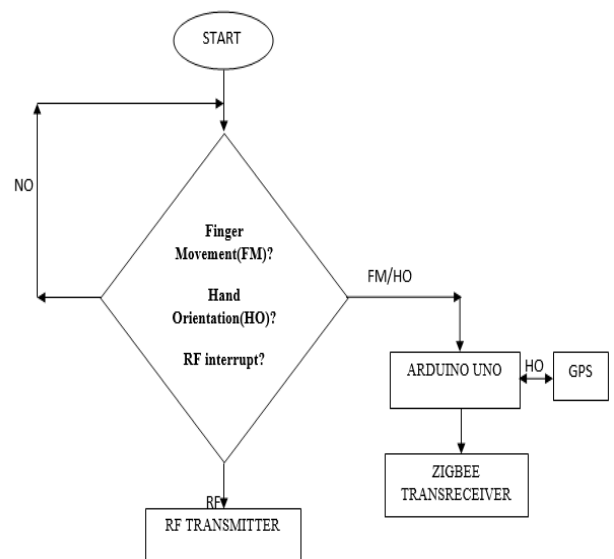


Figure 9: A flow chart for software transmitter side

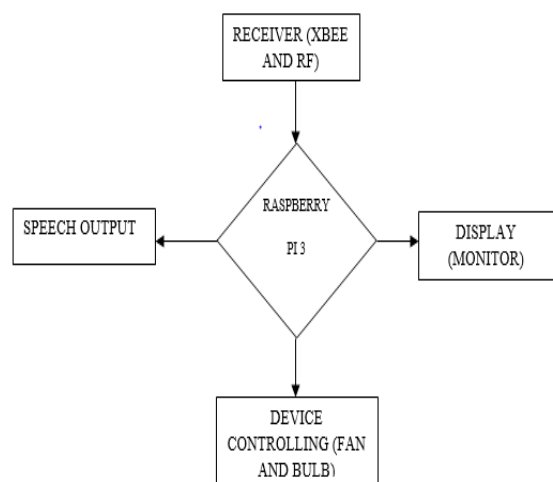


Figure 10: a flowchart for software receiver side

Figure 10 shows how the code in the receiver side works. Once the receiver receives a value, the code in the receiver side reads the value received and checks whether the letter received meets the requirements speech output will be obtained through speakers and it will be displayed on

display and finally the devices will be controlled by using RF. This process will be repeated as long as there are values being transmitted from the transmitter side.

VI. LOGICAL STRUCTURE

Each flex sensor is treated as a variable resistor, with the resistance increasing as the flex sensor is bent. Each of the flex and accelerometer constitute a part of their own voltage divider circuit (VDC). The output is sent to the microcontroller unit (MCU), where analog values are converted to discrete digital binary values. The analog input to the MCU changes as a function of how much the finger is bent using flex sensor. The MCU's digital conversion in the transmitter side is then utilized by the c-based script to classify the gesture being made. The accelerometer (ADXL-335) uses the I2C interface to send data to Arduino microcontroller. the transmitter data is send to Raspberry pi 3 at receiver side to get the output based on requirement

VII. DETAILED WORKING

The data collected from the flex sensors and accelerometer is a simple range of analog values, which are processed and digitized before transmitting via Arduino UNO microcontroller. The output of flex sensors changes upon bending of the fingers. The accelerometer output depends upon the orientation of the hand. The data from each bending corresponds to a resistance value. Thus, resistive data is collected from the flex sensors and 3 bits from the accelerometer corresponding to each axis. This serial data is transmitted using Xbee transmitter and receiver, configured to transmit and receive data serially.

Once the data is received, it is processed by Raspberry pi 3 microprocessor and the output is shown according to its response. There are three applications will be performed by using the smart glow. First, the speech output will be obtained based on the finger movement. those finger movements will be sensed by Flex sensor. second, the patient in an emergency situation he will be tracked by using GPS module. this GPS module will be activated by the hand movement of a patient, those movements will be tracked by the accelerometer. If GPS module is activated it shows the Latitude and Longitude values of a patient location. finally, the patient can easily control the devices like fan and bulb using RF transmitter and receiver. All those activities will be displayed on a monitor which is connected to receiver side. All these modules setup will be showed in figure 12 & 13

VIII. RESULTS

The four flex sensors are connected with four 10 kΩ resistors, which are interfaced with the Arduino UNO in the transmitter side. As can be seen in Figure, each flex sensor is connected between +5 V and the resister 10 kΩ resistor. To make the system wireless we have added Zigbee transceiver module to the transmitter and receiver side which is interfaced directly to the Arduino. Along with the RF module in the receiver side, a LCD monitor has been connected on the Raspberry pi 3 to display the transmitting text. Finally, speaker is connected to Raspberry pi 3 to get speech output. All these components are mounted on a glove and on a board for flexibility. Figure 12 & 13 shows the final realized system.

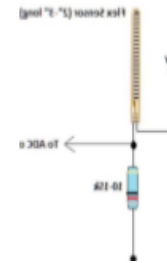


Figure 11: connection of flex sensor

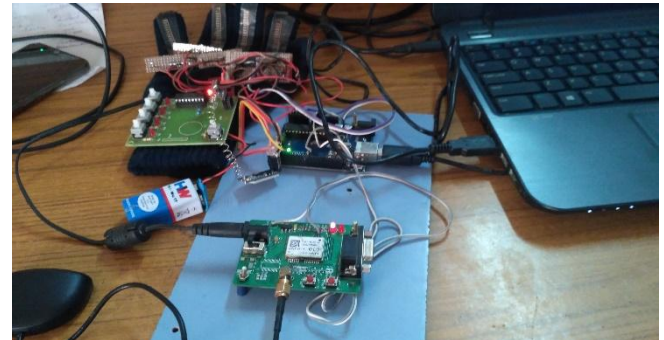


Figure 12: transmitter system



Figure 13: Receiver system

The final realized system in figure: 12 & 13 has been tested and wearing the smart glove dose a finger or hand movement, the LCD displays the letter and GPS will give latitude and longitude values of patient and finally the speaker outputs. Figure show some of the results

Table 1: values of flex sensor and accelerometer

S.NO	COMPONENT	RESPONSE VALUE (DIGITAL VALUES)
1	FLEX SENSOR 1	1012-1021
2	FLEX SENSOR 2	756-810
3	FLEX SENSOR 3	815-820
4	FLEX SENSOR 4	850-860
5	MEMS SENSOR	<280 (LEFT SIDE ORIENTATION)

IX. CONCLUSION & FUTURE WORK

This paper presents the smart glove assistive system for ILL and Dumb patients. The glove gives the

speech output, control device and tracks the patient in an emergency situation. The important of the research is related to its aim to assist the ill and dumb patients who needs a bed rest for certain period of time and it also class of non-vocal people to communicate with others.

The future scope of this project is to achieve high degree of accuracy for gesture recognition using the smart glove. The glove must be used for live tracking of the patient to know the exact location and that information must be carried not nearest hospitals and ambulances and it is also used to monitor the patient health like pulse rate and heart beat etc.

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SMART NAVIGATION ASSIST FOR VISUALLY IMPAIRED AND DIFFERENTLY ABLED

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Abstract: The objective of this project is to provide an efficient navigation assist to overcome the limitations of conventional methods employed for the differently abled and visually impaired. This is achieved by employing sensors like MEMS accelerometer, Obstacle detection sensor. Use of ultrasound based ranging enhances the horizontal and vertical range of the obstacle detection. Also, with a simple twist of wrist, the wheelchair can be moved in the desired direction. Bluetooth module is also used to control the wheel chair by smart phone with the help of a specially designed application. Special three-wheel structure is used which helps the wheel chair climb pavements or staircases. The person sitting on the wheel chair himself can move it through gesture controlled mechanism providing independent mobility for the visually challenged and differently abled as well.

Key words- Ultrasonic sensor, obstacle detection, MEMS accelerometer, gesture control, Bluetooth, staircase climbing.

I. INTRODUCTION

Many smart devices have come up for the past two decades to help the blind people with obstacle detection. Sensors like obstacle detection sensor have been integrated with the conventional cane, making it a 'Smart cane'. Smart cane managed to enhance the obstacle detection range making the travel of the blind people less risky. However, it also has certain limitations in some cases. The major difficulty arises when the blind person is old or cannot walk on his own (physical disability). In such case, the person may be bed ridden and often require a wheelchair to navigate from one place to other or an escort. But, the person being blind, wheel chair may often collide with the obstacles. The operation of the wheel chair by the person himself is strenuous task. There are Smart wheel chair systems which use joystick or tactile screen and even voice recognition based controlling. Moreover, these wheel chairs cannot be moved upstairs/downstairs or onto small pavements on road without lifting it up. Lifting up the person along with the wheel chair is again a difficult task. All these limitations of the conventional systems can be overcome in this by combining altogether the obstacle detection, gesture control, Bluetooth control and staircase climbing mechanisms into a single project.

II. BLOCK DIAGRAM

The figure shows block diagram of the proposed system. It consists of a battery, MEMS sensor, Bluetooth module, Ultrasonic obstacle detection sensors, Fall detection sensor, Relay, Motors, Switch, Buzzer and Arduino UNO. The entire circuit is supplied with power from a 12V Battery. Arduino is connected to a power bank for its power supply. When the battery is connected to the power supply circuit, the system initializes. The Relay circuit acts as a low current amplifier to provide large current that is required for the operation of the motors. The motors used in this project are 60rpm DC motors.

If the Bluetooth module is receiving any commands from the paired smart phone, the Arduino is programmed to prefer the Bluetooth to MEMS commands. In the other case, where there is no command received from the Bluetooth, Arduino takes the input from the MEMS sensor and carries out the operation according to the previously dumped program. Simultaneously, code written also determines the distance of an obstacle from the wheelchair. The control mechanisms are carried out as written until the distance of the obstacle from the wheelchair is safe. If any obstacle comes closer or is at a deadly distance, both the control mechanisms cease and the wheelchair automatically stops. The operation is resumed when the obstacle moves far beyond the deadly range.

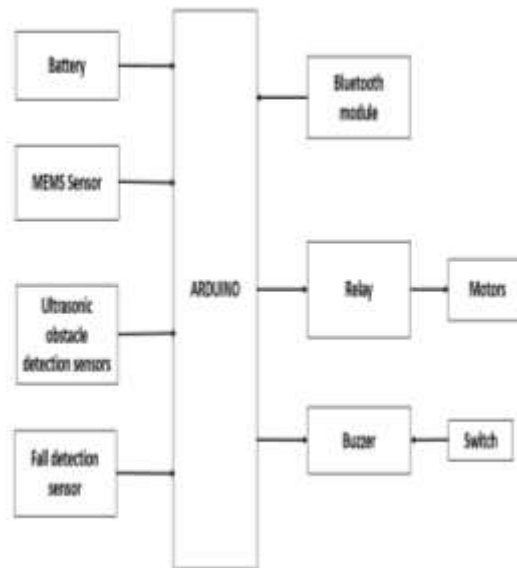


Fig 3.2: Block diagram

III. FLOWCHART

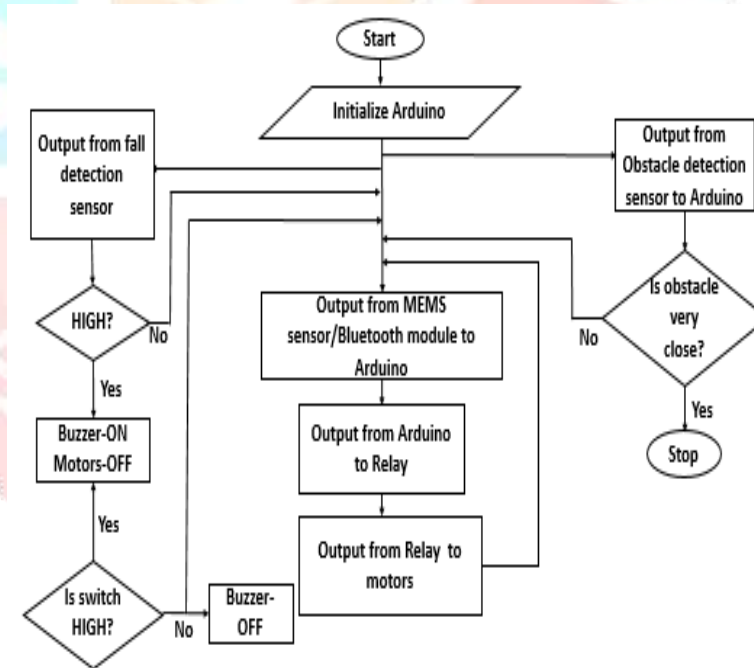


Fig 3.2: Flowchart

The operation of the proposed system is shown in the above flowchart. When the supply is given to the Arduino, all the components are initialized. Either of the gesture control or controlling via Bluetooth are carried out in parallel with the obstacle detection mechanism. The fall detection sensor is used in order to detect falling of the wheelchair. When the wheelchair falls down, an output is generated from the vibration sensor, and a buzzer gets ON and continues to be ON until the chair is lifted up and is switched OFF.

IV. METHODOLOGY

4.1 Ultrasonic sensor



Fig 4.1 HC- SR04

The obstacle detection sensor is used in this project in order to calculate the distance of the obstacle from the wheelchair. The transmitter continuously transmits the ultrasonic waves. When any obstacle comes in the path of the waves, the waves hit the object and are reflected back. The reflected waves are captured by the Receiver. Based on the time elapsed between the transmission and reception of the ultrasonic waves, the distance of the obstacle from the wheelchair is calculated.

4.2 MEMS Accelerometer

Output information from accelerometer is voltage which depends on movement or tilt of sensor in space. The MEMS sensor is employed here for detecting the gesture of the person holding it. Depending on the gesture (tilt of the accelerometer in space), the movement of the wheel chair is determined.



Fig: MMA 7361

4.3 Bluetooth module



Fig: HC-05

Bluetooth module is used in order to control the wheel chair using a smart phone. The idea behind using a Bluetooth module is that even if a person accompanies the disabled, he could control the movement of the chair using his smart phone with the help of a specially designed application reducing the physical strain to the maximum extent.

IV. RESULTS AND DISCUSSION

4.1 Results

The following are the results observed:

1. Movement of the wheelchair based on the gestures.
2. Staircase climbing with the help of three-wheel structure.
3. Halt in rotation of wheels when an obstacle is at a deadly distance.

4.2 Conclusion

Ultrasonic obstacle detection has paved way for numerous number of applications in the field of Embedded systems. One of the major areas of its application is navigation assist for the visually impaired people. Many difficulties like going upstairs / downstairs, collisions with vehicles or other obstacles on road while moving faced by the visually impaired people having trouble to walk which may be due to age factor or due to physical disability are overcome with the help of this navigation aid.

4.3 Future work

1. Pits or potholes in the path can also be detected by placing more number of obstacle detection sensors at various parts of the vehicle.
2. Preventing the vehicle from falling can be made by using angle detection sensors.
3. Obstacle detection mechanism can be used in vehicles travelling on road to avoid the accidents and to avoid any collisions in low light as well.
4. GPS and many other sensors can be integrated.

V. ACKNOWLEDGMENT

We take this opportunity to convey special thanks to our family members, project guide and all other members who extended their support which helped us to implement our project successfully.

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MULTI-HOP CLUSTERING WITH CONDITIONAL PRIVACY PRESERVATION FOR VANETS

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Abstract: In Vehicular Ad hoc Networks, authentication is a crucial security service for both inter-vehicle and vehicle-roadside communications. On the other hand, vehicles have to be protected from the misuse of their private data and the attacks on their privacy, as well as to be capable of being investigated for accidents or liabilities from non-repudiation. In this paper, we investigate the authentication issues with privacy preservation and non-repudiation in VANETS. We propose a security framework for providing Authentication with Conditional Privacy-preservation and Non-repudiation for VANETS. In ACPN, we introduce the public-key cryptography to the pseudonym generation, which ensures legitimate third parties to achieve the non-repudiation of vehicles by obtaining vehicles' real IDs. The self-generated PKC-based pseudonyms are also used as identifiers instead of vehicle IDs for the privacy-preserving authentication, while the update of the pseudonyms depends on vehicular demands. Typical performance evaluation has been conducted using efficient IBS and IBOOS schemes. We show that the proposed ACPN is feasible and adequate to be used efficiently in the VANET environment.



Fig.1:Traffic Monitoring

It is commonly named as conditional privacy. This model consists of a trust authority, roadside units along the roads and on-board units embedded in vehicles. RSU is trustable and usually equipped with not only high-storage capacity but strong computational capability as well. Author assumed that TA is always online, trusted and will never be compromised. The responsibility of TA is to publish digital certificates for RSUs and vehicles. RSUs are distributed in the roadside and have higher computation power than OBUs. It uses a conventional public key infrastructure for initial handshaking. Each vehicle has a conventional public key and a private key, and public key is not revealing the vehicle's real identity with the pseudonym certificate. The working procedure is given in the following figures with Initial handshaking process, Message signing, Batch verification, and Group key generation and verification.

IndexTerms: VANET, IBS, IBOOS, security, Trust Authority.

I. INTRODUCTION

It is designed in order to provide a security Framework for Authentication with Conditional Privacy-preservation and Non-repudiation for VANETS. In Vehicular Ad hoc Networks, authentication is a crucial security service for both inter-vehicle and vehicle-roadside communications and vehicles have to be protected from the misuse of their private data and the attacks on their privacy, as well as to be capable of being investigated for accidents or liabilities from non-repudiation. Many related studies have been reported on security and privacy issues in VANETS. For instance, the message from an OBU has to be authenticated and integrity-checked before it can be relied on. Because, an attacker can alter the safety message from a vehicle or even impersonate a vehicle to transmit a fake safety message. Thus, an anonymous communications protocol is needed. While being anonymous, a vehicle's real identity should be able to be revealed by a trust authority when necessary. For example, a driver who sent out fake messages causing an accident should not be able to escape by using an anonymous identity. Therefore, the anonymous identity in vehicular communications should be conditional, such that a trust authority can find a way to obtain a vehicle's real identity.



Fig. 2. Initial handshaking.

II. RELATED WORK

In [1] paper, author presents a position-based routing scheme called Connectivity-Aware Routing (CAR) designed specifically

for inter-vehicle communication in a city and/or highway environment. A new Connectivity-Aware Routing protocol for VANETs is proposed. The CAR protocol is based on PGB and AGF to provide a scalable low overhead routing algorithm for intervehiclecommunication both in the city and on the highway but the design of CAR does not naturally allow for the inclusion of location errors in the analysis. In [2] paper, author presents Ad-hoc On Demand Distance Vector Routing a novel algorithm for the operation of such ad-hoc networks. Each Mobile Host operates as a specialized router, and routes are obtained as needed (i.e., on-demand) with little or no reliance on periodic advertisements. AODV is an on demand routing protocol in which routes are established on demand and destination sequence numbers are used to find the latest route to the destination. The connection setup delay is less. The HELLO messages supporting the routes maintenance are range-limited, so they do not cause unnecessary overhead in the network but the intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries. The VANET has witnessed several endeavors toward the development of suitable routing solutions. Multi-hop information dissemination in VANETs is constrained by the high mobility of vehicles and the frequent disconnections. In [3] project, we propose a hop greedy routing scheme that yields a routing path with the minimum number of intermediate intersection nodes while taking connectivity into consideration. Moreover, we introduce anchor nodes that play a key role in providing connectivity status around an intersection. Apart from this, by tracking the movement of source as well as destination, the anchor nodes enable a packet to be forwarded in the changed direction. Vehicular communication networks, which are also, referred to as VANETs, inherently provide us a perfect way to collect dynamic traffic information and sense various physical quantities related to traffic distribution. Such functionalities simply turn a VANET into a Vehicular Sensor Network. Many challenging security and privacy issues in VANETs have been identified. To ensure both identity authentication and message integrity in VSNs, one appealing solution is to sign each message with a digital signature technique before the message is sent. However, conventional signature schemes that verify the received messages one after the other may fail to satisfy the stringent time requirement of the vehicular communication applications. In order to tackle the above mentioned problems and make VSNs suitable for the intelligent traffic systems, this paper introduces an efficient batch signature verification scheme for the communications between vehicles and RSUs. Author's scheme has the following unparalleled features: 1) multiple signatures can be verified at the same time instead of one after the other as that in the previously reported approaches. Therefore, the signature verification speed can be significantly improved such that the computational workload of the RSUs can be alleviated; 2) By generating distinct pseudo identities and the corresponding private keys for signing each message with a tamper-proof device, privacy regarding user identity and location of the vehicles can be protected; 3) The identities of the vehicles can be uniquely revealed by the trusted authorities under exceptional cases.

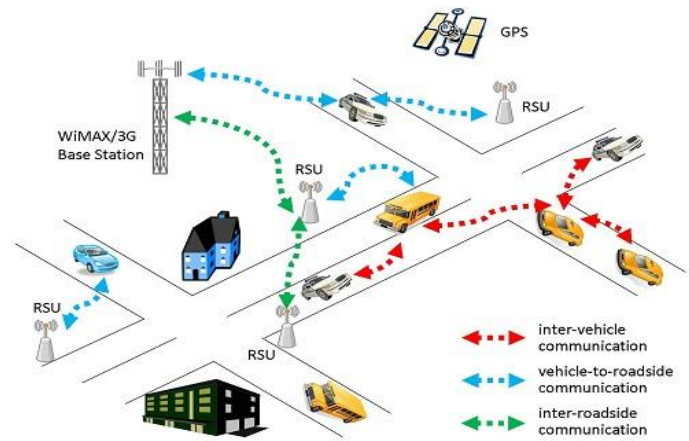


Fig.Types of vehicle communication

III.PROPOSED TECHNIQUE

The main aim of this paper is to provide the bulk verification to reduce the delay in message authentication. We are mainly focusing on the city side vehicular communication. To make communication, vehicle must register with the RTA. RSU is one of the main sources for secured communication. To make long enough communication RSU should be present in the network. In our project, we have made the following assumptions. 1) Each vehicle equipped with damper proof WiFi communication device. 2) V-V communication range is ~150m and V-R-V communication range is ~300m. 3) Each vehicle has enough memory to store the key information's. 4) In network necessary counts of RSU's available.

a)Module Description:

The project is divided into the following modules:

- Network Design
- RTA registration
- RSU Registration
- V-V communication

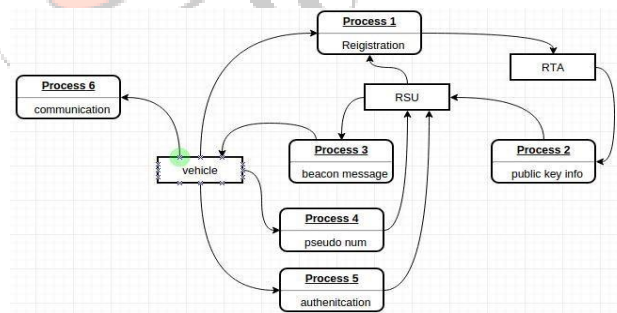


Fig.3 Data flow of proposed model

i. Network Design:

A VANET basically consists of three network components: road side units, vehicles (users) and a regional trusted authority. In this project we assume the vehicles in an urban vehicular communications structure mainly travel on roads, and do not frequently stop at certain places. The RSUs are always reliable to cover the wireless vehicular communications of the whole region, while vehicles are vulnerable to being compromised by attackers but can change their pseudonyms as IDs on demand for the privacy preservation. The wireless communication in this structure of VANETs can be classified mainly into the following three types, the vehicle-to-roadside communication, and the roadside-to- vehicle communication, and the vehicle-to-

vehicle communication. Other communications are through secure wired channels, such as inter-RSU communication and RSU-to- RTA communication. The transmission range of an RSU is assumed to be much longer than that of vehicles. All vehicles use symmetric radio channels. An RTA generates cryptographic domain parameters for the RSUs and vehicles in its region, and delivers these keys to them over secure channels. It manages a list of vehicles of which the participations have been revoked, updates the list periodically, and advertises the list to the network to isolate the compromised vehicles. If a vehicle transmits false messages for malicious purposes on the road, the RTA is responsible for tracing and identifying the source of the messages to resolve any dispute. An RTA serves in one region, e.g., a city, a province or a country. An ID pool of RSUs in a region is preloaded in each vehicle, in which the number of RSUs is usually fixed that does not change frequently.

Network Model summary is given below.

- RTA (Trust Authority Can generate the key's and act as admin) .
- RTA broadcasts Random pubic key via Registered RSU's .
- RSU controller (Region RSU controller) .
- Used to share info b/w V-V or V-RTA Vehicles.
- Legitimated vehicles and attacker vehicles.

ii. RTA Registration

The cryptographic key pairs are generated by the RTA periodically, and the public keys are transmitted to every RSU in its service region through secure channels. Each key is broadcast to all vehicles by the RSU, while the corresponding private key is known only to the RTA. The RTA computes a master key s and public parameters for the private key generator (PKG), and gives to all vehicles. The vehicle registration is required before a vehicle starts off to hit the road in a region. If the vehicle is newly manufactured, it can be registered to the RTA at the car dealer via a secure network infrastructure. If a vehicle is driven into a new region, it can be registered to the RTA at the entry- exit administration or the border immigration office via the secure network infrastructure. Through the vehicle registration of each vehicle, the RTA registers the vehicle ID and profile.

iii. RSU Registration:

The PKC-based pseudonym of a vehicle is generated instead of the real-world ID in the authentication process. Since the RTA is periodically broadcasting the current public key via RSUs for the PKC in the pseudonym generation, the vehicle can use it for the PKC-based pseudonym generation, when it wants to update its current pseudonym or generate a new pseudonym.

The summary of RSU base registration is given below:

- Vehicle has to generate the Pseudonym by using Time, Home region, Current RSU, Modified vehicle id. RSU has to broadcast the own information's periodically, which contains the Time, own public key, RSU id, Digital Sign.
- Vehicle joins into the RSU with newly generated Pseudonym .

- RSU verifies the Pseudonym from the vehicles if it correct then RSU will reports to RTA.

iv. V-V Communication:

Authentication in VANETs can be divided into three categories, namely vehicle-to-roadside authentication, to- vehicle authentication and vehicle-to- to-roadside authentication, roadside to- vehicle authentication and vehicle-to-vehicle authentication. In the proposed ACPN, RSUs are broadcasting their information periodically, and all the operations at RTAs and RSUs are tamper-proof and being performed trustfully. The proposed ACPN operates adaptively, whenever a vehicle wants to newly authenticate itself to others, or update its current pseudonym.

The summary of vehicle communication is given below:

- Each vehicle can verify the neighbour vehicle is correct or wrong by using the offline signature verification.
- If vehicle verified correctly then the vehicle can make communication.
- If a vehicle is not having any clear info about neighbour vehicle then it will verify with RTA.

IV. RESULTS

Fig.4.1. Vehicle Registration: On terminal when we enter ./6.tcl the following window is appeared.

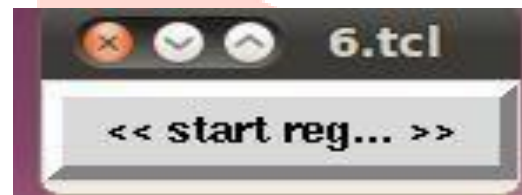


FIGURE 4.1: START REGISTRATION WINDOW

FIG 4.2. ON CLICKING START REG.. THE FOLLOWING SCREEN IS DISPLAYED.

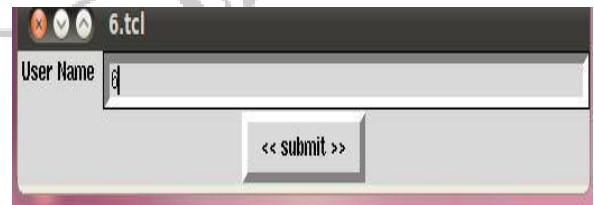


Figure 4.2: Enter User Name window

In the above screen enter the username i.e. vehicle name (example 6). After entering click on submit. Fig 4.3. When clicked on submit the following window is displayed.



Figure 4.3: Enter Password window

Enter the password as (3 33 7). First field (3) represents the public key, third field (7) represents the private key and second

field (33) is the n value calculated according to RSA algorithm. After entering the password click on submit.

Fig 4.4. Once submit is clicked the following window is displayed.



Figure 4.4: Enter Default RSU

The default RSU is set to 1 and then click on submit & exit.

Fig.4.5. On Clicking submit& exit the following window is displayed.

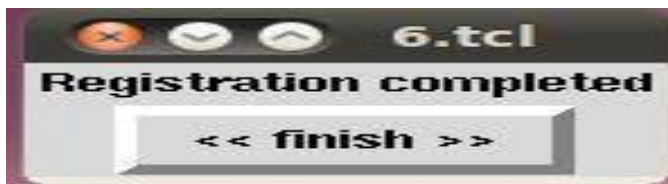


Figure 4.5: Registration finished

Click on finish. The registration of vehicle 6 is done. After Completion of registration of vehicles the next step is to create the system Architecture i.e. display the RTA, RSU and all the vehicles that are registered as shown in Fig4.6. System Architecture.

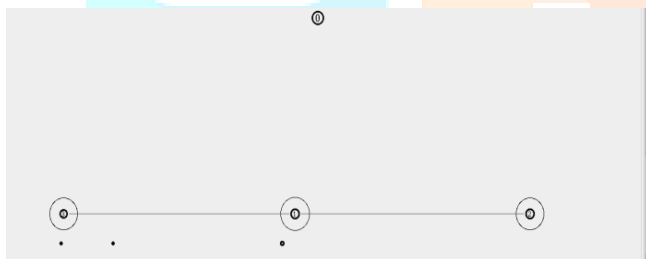


Figure 4.6: System Architecture

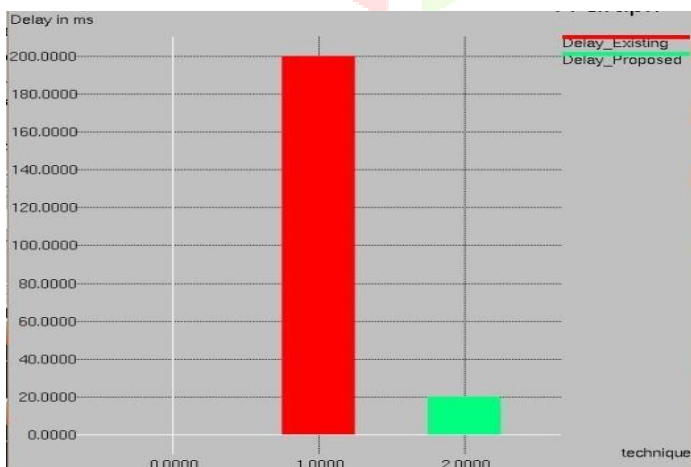


Figure 4.7 Delay Graph

- The Delay in the proposed system is low, compared to existing system.

V. Conclusion

The efficient for VANETs has been proposed, which utilizes the IBS and IBOOS schemes for the authentication, the pseudonym-based scheme for the privacy preservation, and the PKC-based scheme for the pseudonym generation. ACPN achieves the desired authentication, privacy preservation, non- repudiation and other security objectives for UVC in VANETs. Another important characteristic of ACPN is its reusability, i.e., it can also be utilized with other new schemes for security and performance improvements. In our project, we considered only security system, but in vehicles safety solution is also one of the main factors. So in the future work we need to concentrate on the safety alert system so as to provide safety for the vehicles.

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IRREVERSIBLE COMPRESSION OF MRI BRAIN IMAGE WITH HEVC

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Abstract: Currently many superior image compression strategies have been proposed in response to the increasing demands for medical image to store at very excessive quality and for efficient compression. Instead of lossless compression we used diagnostically suited lossy compression (Irreversible Compression) to lessen facts length for garage, coping with and transmitting content. At present JPEG 2000 is normally used compression format for medical images shared using DICOM (Digital Imaging and Communication in Medicine) general. However JPEG 2000 isn't always efficiently used for storing series images and 3D images. So we choose new format HEVC with the intention to offer better compression efficiently as compared to JPEG 2000. HEVC is a maximum current standardized video compression generation that is evolved by way of Joint Collaborative Team on Video Coding (JCT-VC). Generally for medical images consisting of CT, CR, MR, and Digital Radiography the bit intensity is 1024 or 4096. HEVC range is appropriate for scientific photos programs. It offers more bit rate reduction while maintaining the identical subjective image excellent relative to its predecessor H.264/AVC. With HEVC, intra encoding complexity can be reduced with negligible increase in file length.

Index Terms

Medical Image, Irreversible Compression, DICOM, JPEG 2000, HEVC, MRI

Introduction

Emergence of cloud based healthcare offerings necessitates medical provider carriers to proportion the medical pictures generated by using extraordinary systems and gadget. These images are considered on heterogeneous platforms such as net and cell clients. The need of interoperability between the medical

programs and gadget has caused the usage of DICOM widespread. However the bandwidth and garage constraints would possibly require better compression of big medical pics. In addition to this requirement the cloud based healthcare situation requires an efficient and uniform lossless and lossy compression widespread. The project in the usage of the consumer gadgets to access scientific images .The High Efficiency Video Coding (HEVC) general supports lossless and lossy compression with bit intensity of as much as sixteen bits . Normally medical pics are of diverse modalities ranging from Computed Tomography (CT), Computed Radiography (CR), Magnetic Resonance (MR), PET-CT and, Ultrasound (US). Medical take a look at of a patient may additionally require a series of research and every look at generates a series of pix. The record length of the consequent photo collection might be big. For instance: Full Body PET may

have six hundred images according to set, wherein the scale of one set may be 1.2 GB and typically in one observe there are 4 units. Thus general record size shall be 4.8 GB.

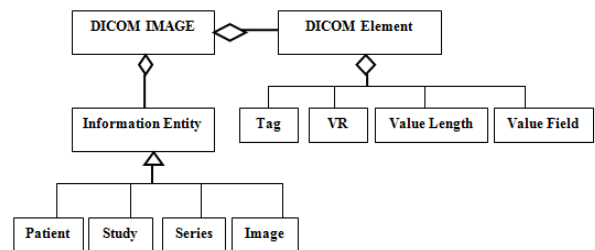


Fig.1: Relationship between DICOM Information Entities and Elements

The Medical images used in this study were DICOM images. DICOM is a medical imaging standard which enables interoperability between heterogeneous medical applications and devices . The core part of the standard includes information entities, modules, file format, and a networking protocol. A DICOM medical image file normally contains medical image data and meta data included as Information Entities (IE) describing attributes such as patient, study, series, and image. IE is an aggregation of several DICOM elements or DICOM attributes. Each DICOM element is an aggregation of four fields: a tag, a data type called value representation (VR), value length, and the value field. The relationship diagram depicting the association between DICOM objects is shown in Fig. 1. A DICOM tag is made up of group and element number fields; for example, the tag with group number 0028 is an image pixel group. These group tags are used to obtain the image configuration information that is required for image compression. A few commonly used image pixel group tags are defined in Table I. The second goal of this paper is complexity reduction for high bit-depth medical images. The proposed model for computational complexity reduction is evaluated for medical images of more DICOM modalities.

Table 1

DICOM IMAGE PIXEL GROUP TAGS

DICOM Image Tags	Description
Samples per pixel (0028,0002)	Number of color channels.

Photometric interpretation (0028,0004)	Monochrome1 / Monochrome2. Defines whether zeroes be interpreted as black or white
Planar configuration (0028,0006)	Shows how color channels are arranged in the pixel data buffer
Bits Allocated (0028,0100)	Defines how much space in bits is allocated in the buffer for every sample.
Bits Stored (0028,0101)	Defines how many of the bits allocated are actually used.
High Bit (0028,0102)	Defines how the bits stored are aligned inside the bits allocated.
Number of Frames (0028,0008)	Defines the total no. of frames in the image

II.LITERATURE SURVEY

A. High Efficiency Video Coding (HEVC) Text Specification: HEVC (H.265) standard is the latest enhanced video coding standard which was planned to improve the rendered specifications of its preceding standard MPEG-4 (H.264). The main goal of the HEVC standardization effort is to enable significantly improved compression performance relative to existing standard H.264. For similar video quality, HEVC bit streams consume only about half of the bit rate compare to previous standard H.264. HEVC gives higher compression comparing with previous standard H.264 because of its new features like quad tree structure, more directional intra-prediction modes. In this paper, intra-prediction for equal block sizes and variable block size are implemented for luminance component of different video sequences. Luminance component is important for brightness information. For variable block size canny edge detection method is used. HEVC gives better PSNR compare to H.264. HEVC suitable for resolutions up to Ultra High Definition (UHD) video coding in the future.

B. Evaluation of HEVC compression for high bit depth medical images :We evaluate the performance of HEVC Intra and Inter coding of Digital Imaging and Communications in Medicine (DICOM) standard based medical images in both lossless and lossy mode compared to JPEG 2000 (JP2). Prior studies have used Main Still Profile to evaluate lossless HEVC Intra coding whereas we have used HEVC Range extension Profiles. Besides lossless Intra coding, our study evaluates lossless Inter prediction of DICOM based medical image series. The results show that HEVC Inter Prediction achieves reduction in file size up to 39% for the lossless inter mode and up to 94% for lossy mode in case of images with low loss accepted in some medical imaging (PSNR greater than 50 dB). This reduction of file size is significant and can be used to reduce transmission and storage cost especially in a cloud based e-healthcare scenario.

C. Content dependent intra mode selection for medical image compression using HEVC: This paper presents a method for complexity reduction in medical image encoding that exploits the structure of medical images. The amount of texture detail and structure in medical images depends on the modality used to capture the image and the body part captured by that image. The proposed approach was evaluated using Computed Radiography (CR) modality, commonly known as x-ray imaging, and three body parts. The proposed method essentially reduces the number of CU partitions evaluated as well as the number of intra prediction modes for each evaluated partition. Evaluation using the HEVC reference software (HM) 16.4 and lossless intra coding shows an average reduction of 52.47% in encoding time with a negligible penalty of up to 0.22%, increase in compressed file size.

D.Lossy and lossless intra coding performance evaluation:High Efficiency Video Coding (HEVC), the latest international standard of video coding under development, has shown a major breakthrough with regards to compression efficiency. But most of the currently published studies were intended to evaluate the overall R-D performance of HEVC in comparison to prior H.264/AVC video coding standard. In this paper, we present sufficient rate-distortion performance comparisons of image coding between the HEVC and previous image and intra-only video coding standards, including JPEG 2000, JPEG LS and H.264/AVC intra high profile. In addition, some recently reported performances of HEVC are also reviewed and compared. The coding simulations are conducted on a set of recommended video sequences during the development of the HEVC standard. Experimental results show that HEVC can offer consistent performance gains over a wide range of bitrates on natural video sequences as expected. Besides, we also present the comparison results of all these standards in the scenario of lossless image coding.

III.PROPOSED TECHNIQUE

The main steps involved in our algorithm is,

1. Firstly we have to take DICOM series of images as the input.
2. For the number of DICOM series we have to perform the HEVC operation for every image.
3. Next for every image we have to take JPEG 2000 format images i.e., lossy compression.
4. At finally, by varying compression ratios like 5 to 20 we can observe performance by using PSNR and SSIM for the HEVC and JPEG 2000.

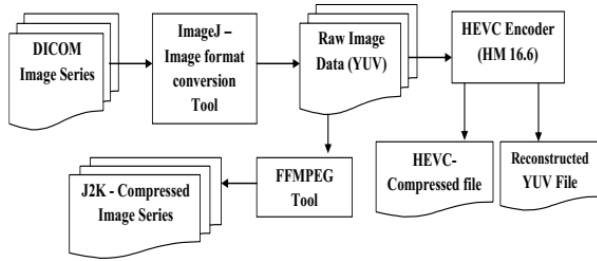


Fig.2 : Overview of the proposed method

A) HEVC (H.265) Using MATLAB:

HEVC (H.265) standard is the latest enhanced video coding standard which was planned to improve the rendered specifications of its preceding standard MPEG-4 (H.264).

An overview of the main features in intra-frame prediction of H.265 could be written as follows: *f*

- A quad-tree block division structure with respect to amount of details in an image.*f*
- 33 Angular modes in angular prediction (just 8 different modes in H.264) *f*
- Planar prediction for smoothing the sample surfaces.

It's worth mentioning that the quad-tree structure of H.265 intra normally uses square block with sizes in range 4, 8, 16, 32 and 64 (different block sizes based-on the level of granularity in the image), while in H.264 the processing units are up to macro-blocks of 16x16 samples.

Moreover, while this video coding standard splits images to one luma and two chroma parts, thesis focuses only on the implementation of intra-prediction on luma part of an image.

This thesis aims at implementation of the intra-frame prediction of HEVC using MATLAB. All the steps of implementation process are listed as follows:

- Converting RGB images to YUV colour-space and working on the luma part (or Y)
- Splitting images to square blocks ranging from 4 to 64 pixels *f*
- Implementing intra-frame prediction algorithm *f*
- Comparing intra-prediction output of H.264 and H.265 in square blocks with size 4 and 16 pixels

The considered set of images for this thesis was organized in 3 different resolutions (VGA: 480x640, HD720: 720x1280, HD1080: 1080x1920) to implement and evaluate the HEVC intra-frame prediction outcomes. The performance of our algorithm can be evaluated by using PSNR and SSIM.

Finally in the last step, it's time to merge all predicted small blocks (separate matrices of a cell) to a single matrix and also remove the zero-padding added in the first step (block decomposition) and the output would be the decoded picture (predicted) with HEVC intra-frame prediction algorithm.

For intra encoding, high-throughput-RExt profile was used and "Intra period" encoder parameter was set to 1. In this case, all the frames were encoded as Intra (I) frames. HEVC Inter coding was used to evaluate the benefits of temporal predictive coding for medical image series, which is not supported in Motion JPEG and J2K. For inter encoding, main-RExt profile was used and the "Intra period" parameter was set to -1. This configuration results in the first frame being directionally predicted B-frames. The HEVC lossy encoding of high bit depth medical images was carried out by varying the quantization parameter, in order to match the PSNR and SSIM values of HEVC with J2K. The above mentioned experimental method is depicted in Fig

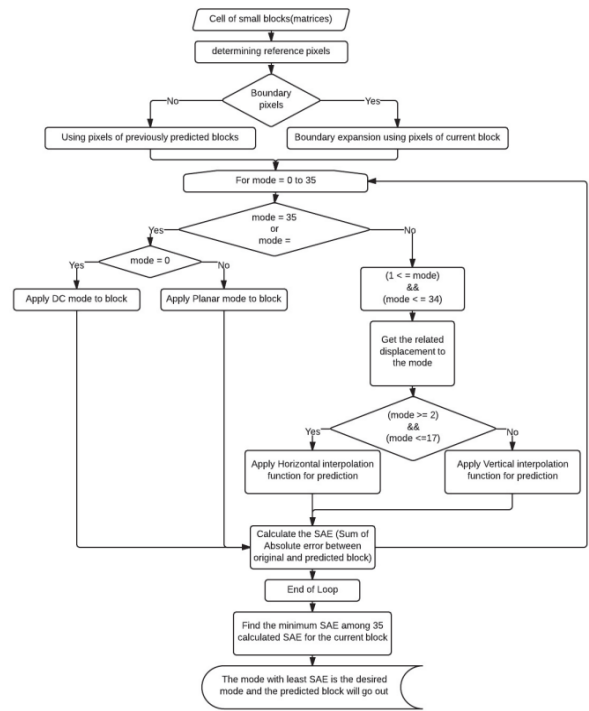


Fig3: HEVC Intra-frame prediction function process flowchart

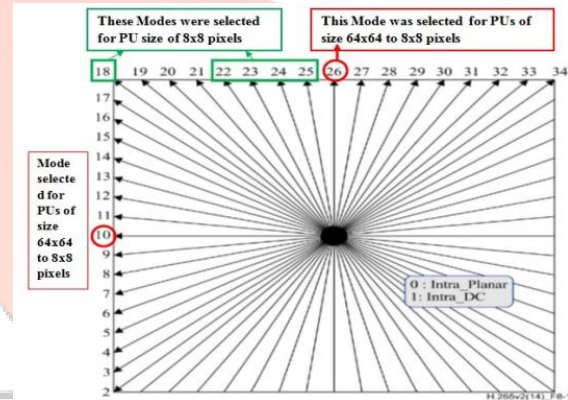
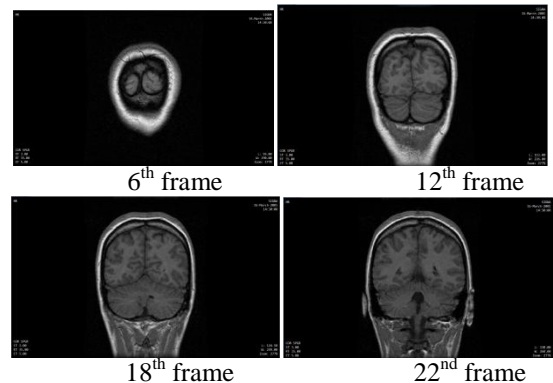


Fig4: Set of Angular Directional Intra Prediction modes that were selected for 95% times

IV.RESULTS:

Input Images:



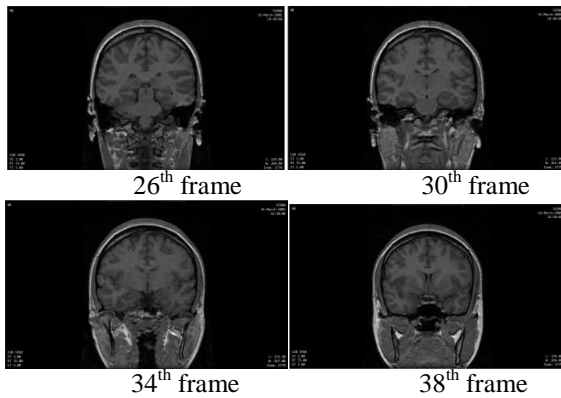


Fig4: Medical Images of DICOM Modalities and body parts used in this study.

Output Images:

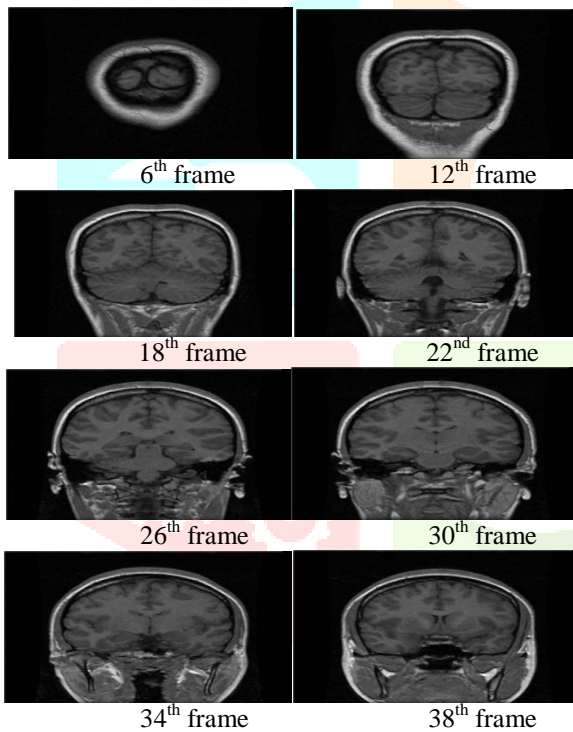


Fig5: Compressed HEVC images

GRAPHS:

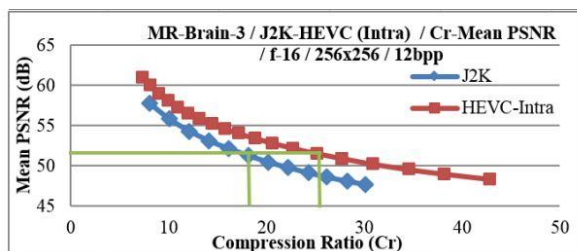


Fig.5: Graph of medical images of various modalities showing correlation between HEVC-Intra and J2K for equivalent PSNR quality.

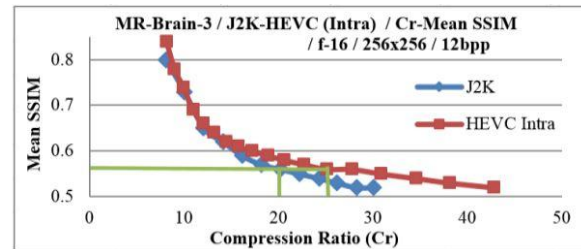


Fig.6: Graph of medical images of various modalities showing correlation between HEVC-Inter and J2K for equivalent SSIM quality.

ADVANTAGE

The J2K compression ratios which fall within the irreversible compression range are used to establish the compression comparison with HEVC and the irreversible compression performance of J2K and HEVC are compared for equivalent quality measured using Structural Similarity Index (SSIM) and Peak Signal to Noise Ratio (PSNR).

V. Conclusion

In this paper shows that using HEVC for medical image compression can reduce storage and bandwidth upto 54% compared in comparison to J2K. The evaluation was limited to the diagnostically acceptable compression ranges established in prior studies. Even HEVC-Inter shows similar gains in terms of % reduction in file size. The ICR bounds established for HEVC are based on equivalent objective metrics and subjective assessments are necessary to determine subjective equivalence for the same objective distortion. The study also developed a method for computational complexity reduction in lossless Intra HEVC compression. Results show 55% reduction in computational complexity with negligible increase in file size. Using such complexity reduction approaches reduces the cost of HEVC encoding while retaining the compression benefits..

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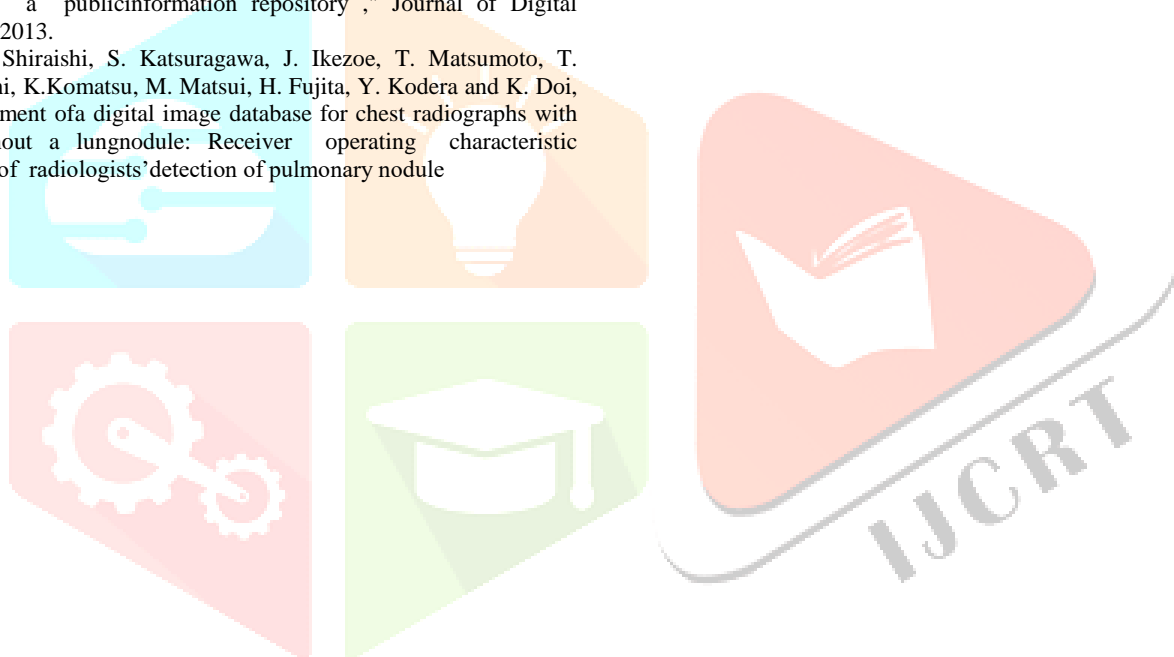
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EEG - CONTROLLED WHEELCHAIR MOVEMENT USING WIRELESS NETWORK

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Abstract: This project discusses about a brain controlled wheel chair based on Brain-computer interfaces (BCI). BCI's are systems that can bypass conventional channels of communication (i.e., muscles and thoughts) to provide direct communication and control between the human brain and physical devices by translating different patterns of brain activity into commands in real time. The intention of the project work is to develop a robot that can assist the disabled people in their daily life to do some work independent of others.

Here, we analyze the brain wave signals. Human brain consists of millions of interconnected neurons, the pattern of interaction between these neurons are represented as thoughts and emotional states. According to the human thoughts, this pattern will be changing which in turn produce different electrical waves. A muscle contraction will also be generate a unique electrical signal. All this electrical waves will be sensed by the brain wave sensor it will convert the data into packets and transmit through Bluetooth medium. Level analyzer unit (LAU) will receive the brain wave raw data and it will extract and process the signal using MATLAB platform. Then the control commands will be transmitted to the robot module to process. With this entire system, we can move a robot according to the human thoughts and it can be turned by blink muscle contraction.

Index Terms - Brain-computer interfaces (BCI), level analyzer unit (LAU), blink muscle contraction.

I. INTRODUCTION

Brainwaves are the crucial part of this system. There are various kinds of waves based on our Meditation and Attention levels. We set some threshold values, which guide the wheelchair for forward or backward movement and steering. The wheelchair is properly calibrated when it's not used to ensure that it functions optimally. The Wheelchair is integrated with ultrasonic sensor. It is used to detect the distance between obstacle and wheelchair. If the obstacle is very nearer to wheelchair, the wheelchair moves backward. Next, the meditation and attention levels of the patient are recorded with a brainwave sensor, which also transmits them wirelessly to the PC by using Bluetooth. Subsequently, these waves are sent to Arduino module by using Zigbee module. If the patient blinks both the eyes, the wheelchair is turned left or right, depending on the number of blinks. As a result, the patients are made to be autonomous and self-reliant.

II. BLOCK DIAGRAM DESCRIPTION

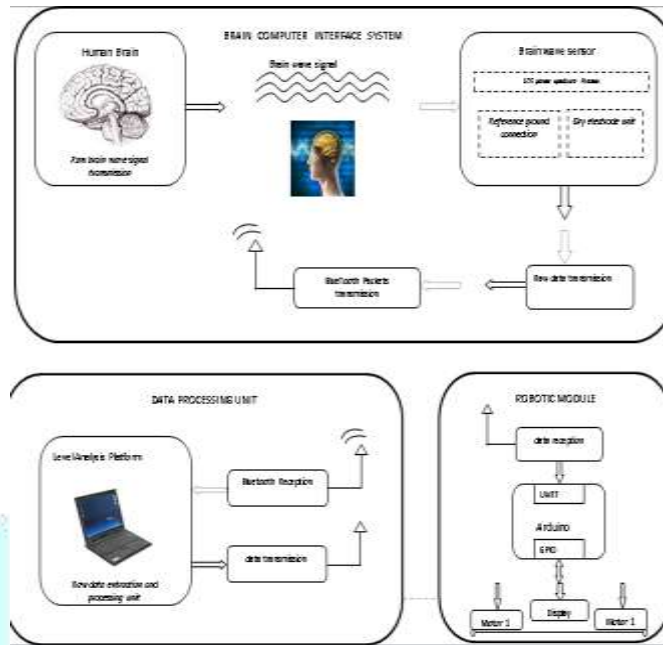


Figure 1 Block Diagram

Firstly, a dry electrode is used to record the brain waves .These raw waves are sent via Bluetooth to a data processing unit whose output is serial data. Subsequently, this data is sent to Arduino. Furthermore, the Arduino is connected to a display and two motors which rotate according to the commands of Arduino.

Here, the data processing unit is programmed using IDE such as Matlab and interfaced with Arduino. Moreover, Arduino is also programmed by using an Arduino IDE. Furthermore, Thinkgear Connector scans the ports for EEG signal and sends it to Matlab for further processing.

III. FLOW CHART

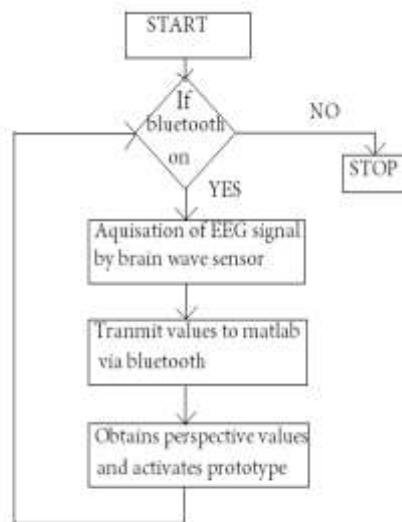


Figure 2 Flow Chart

Initially, Bluetooth should be turned on. Next, the brain wave sensor acquires the EEG signals from the brain using a dry electrode. Subsequently, these values are transmitted to Matlab using Bluetooth. Now, these values are sent to prototype using Zigbee connection.

IV. EXISTING SYSTEM

In the existing system, patient must depend on other person for moving wheelchair. It is more time consuming task and it is less effective. Moreover, the normal person may not be available all the time. As a result, it becomes uncomfortable for both patient and his/her helper. Furthermore, pushing a wheelchair is a mundane task and it requires lots of concentration. In the end, the hospital may be crowded due to increased number of visitors.

V. PROPOSED SYSTEM

In this system, the disabled people needn't call others to move their wheelchair. Instead, a robotic module that consist of various components like Arduino, Brainwave Sensor, and Zig-bee will take care of the task .In other words, the nerves of the patient are bypassed using this wireless technology. An Ultrasonic sensor is used, which detects obstacles and moves the wheelchair backwards. The steering of the wheelchair is guided by using eye blink of the patient.

VI. METHODOLOGY

6.1 Ultrasonic Sensor

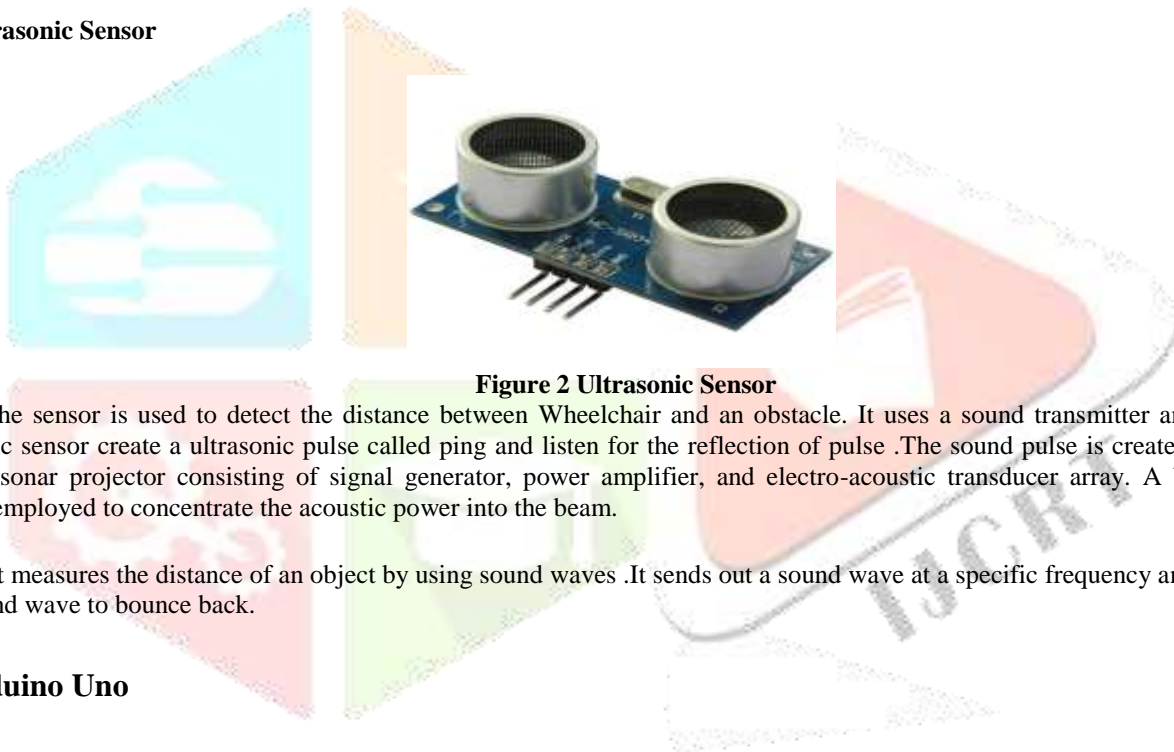


Figure 2 Ultrasonic Sensor

The sensor is used to detect the distance between Wheelchair and an obstacle. It uses a sound transmitter and receiver .An ultrasonic sensor create a ultrasonic pulse called ping and listen for the reflection of pulse .The sound pulse is created electronically using a sonar projector consisting of signal generator, power amplifier, and electro-acoustic transducer array. A beam former is usually employed to concentrate the acoustic power into the beam.

It measures the distance of an object by using sound waves .It sends out a sound wave at a specific frequency and listening for that sound wave to bounce back.

6.2 Arduino Uno



Figure 4 Arduino Uno

Arduino Uno is a simple microcontroller which is used in making interactive projects like drone, EEG-based wheelchair, and so on. A program that is almost nearer to C++ is written on the Arduino IDE. Next, it is dumped into the Arduino. However, we can

erase the program on the Arduino by pressing reset button. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button.

6.3 Mindwave Sensor



Figure 5 Mindwave Sensor

Mindwave sensor for Arduino can record the EEG waves of the mind. It has a dry electrode, an ear clip, and a Bluetooth transmitter, which are combined together to transmit brain waves.

6.4 ZIGBEE MODULE



Figure 6 Zigbee Module

Zigbee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks with small, low-power digital radios, such as for home automation, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection. Hence, Zigbee is a low-power, low data rate, and close proximity (i.e., personal area) wireless ad hoc network.

The technology defined by the Zigbee specification is intended to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or more general wireless networking such as Wi-Fi. Applications include wireless light switches, home energy monitors, traffic management systems, and other consumer and industrial equipment that requires short-range low-rate wireless data transfer.

VII. RESULTS AND DISCUSSION

The following are the results which obtained from this work.

- Wheel chair can be moved just by using brainwaves
- Transmit the information wirelessly to motors
- The data of the brain waves can be stored and it is retrieved later.
- The real-time data transmission and access
- Obstacles are taken care of by using Ultrasonic sensor.
- Avoids dependence on others



Figure 7 Project Prototype

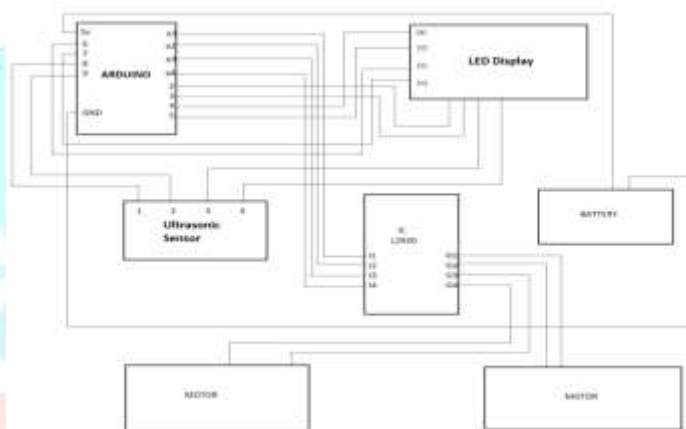


Figure 8 Circuit Diagram

VIII. CONCLUSION:

The objective of the project is for the real time support for disabled and paralysed patients. Once implemented, we are sure that it is an invaluable tool for both patients and doctors. In this information about the brainwaves is sent and movement is performed immediately based on their values. The range is very small, as the patient is very near to the wheelchair.

The attention and meditation values vary for different kinds of persons. However, they are normally low for disabled people. Hence, the threshold values are set very low. Moreover, The doctors easily get the information about the patient's brain waves using this setup.

VIII. FUTURE WORK

We can add some complementary features like Artificial intelligence, Cruise control, distress call, and an alarm. However, the basic functionality remains unchanged except for blind people, for whom we insert the electrode in the brain.

IX. ACKNOWLEDGEMENT

We are technically supported by our project guide. we were encouraged by our head of the department and our department.

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DIABETIC RETINOPATHY DETECTION USING OPTIMISED GABOR FILTER WITH LOCAL ENTROPY THRESHOLDING

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Abstract: Diabetic retinopathy (DR) is one of the largest cause of blindness that occurs to the retina due to diabetes mellitus. It is a serious sight-threatening complication of diabetes. Around 80 percent of the people having diabetes for 20 years or more are affected with diabetic retinopathy. Blood vessels in retina play a vital role in medical diagnosis of diabetic retinopathy. In addition, many diseases like hypertension, autoimmune disorders, high cholesterol, and cancer can also be detected. Segmentation of blood vessels is helpful for ophthalmologists to detect patients suffering with diabetic retinopathy.

Imaging and computer vision systems offer the ability to quantitatively determine the human physiology. Manual interpretation requires tremendous amount of work, expertise, and processing time. Automated segmentation offers a varied range of applications in the field of biomedical imaging. In this project, an algorithm comprising optimized Gabor filter with local entropy Thresholding was utilized for automatic segmentation of blood vessels. The frequency and orientation of Gabor filter is tuned to match part of blood vessels that are to be enhanced. The classification of blood vessel pixels is done using local entropy Thresholding technique. The proposed algorithm is evaluated on the DRIVE database and is shown to provide an average accuracy (ACC) of 97.72% and sensitivity (Se) of 98.15%. Results indicate that the proposed approach presents a path toward precise and automated diabetic retinopathy diagnosis on a massive scale.

Keywords: Diabetic mellitus, Retinal blood vessels, Diabetic retinopathy, Optimized Gabor filter, Local entropy thresholding.

I. INTRODUCTION

This chapter gives an overview of extension in Automated segmentation of retinal blood vessels using Gabor filter with local entropy thresholding which was intimated in the below data. It crucially comprises of optimized Gabor filter with entropy threshold.

Background:

Diabetic Retinopathy (DR) is the result of damage due to diabetes to the very small blood vessels which are located in the retina. The blood vessels which are affected from diabetic retinopathy leads to vision loss. Diabetic retinopathy is a leading reason of adult blindness, and screening can decrease the incidence. Screening just increases the chances that a condition will be neglected, found early, or are able to be cured. It is widely suggested that all persons with diabetes should regularly check for diabetic retinopathy.

Computer aided analysis for automatic segmentation of blood vessels in retinal images will help ophthalmologists to screen larger patient database for vessel abnormalities. So many varieties of paths have been suggested for retina blood vessels segmentation. Many image processing methods proposed for retinal vessels extraction. This work is based on "AUTOMATED SEGMENTATION OF RETINAL BLOOD VESSELS USING OPTIMIZED GABOR FILTER WITH LOCAL ENTROPY THRESHOLDING". Gabor filters have been widely applied to image processing and computer vision application problems such as face recognition and texture segmentation.

Gabor filter methods often give false positive detections and fail to detect vessel of different widths. And also detection process is much more complicated when retinal image abnormal condition. This paper has been proposed a much robust and fast method of retinal blood vessels extraction using optimized Gabor filter with local entropy thresholding.

Types of Diabetic Retinopathy:

This is a group of metabolic diseases in which a person has high blood sugar, either because the pancreas does not produce enough insulin, or because cells do not respond to the insulin produced by the body. This high blood sugar produces the classical symptoms of polyuria, polydipsia, and polyphagia. There are two main types of diabetes mellitus (DM).

- **Diabetes mellitus Type1 (DM1)**
Results from the body's failure to produce insulin, and currently requires the person to inject insulin or wear an insulin pump.
- **Diabetes mellitus Type 2 (DM2)**

This type results from insulin resistance, a condition in which cells fail to use insulin properly, sometimes combined with an absolute insulin deficiency. Others forms of diabetes mellitus are recognized, including a genetically mediated form secondary to endocrinopathies and drug –or chemical –induced diabetes mellitus. Diabetes mellitus affects the blood vessels leading to microvascular and macrovascular complications which manifest in the eyes, kidneys, brain, extremities and other parts of the body.

Materials:

The main material used to check the performance of the algorithm is done by using Matlab with drive software. The preferable software versions are 2012a, 2013a, 2013b and 2014a. Here we will take the image with pixel size above 256 pixels that is RGB image as shown below.



Fig: RGB color image

Proposed methodology:

The proposed algorithm contains the following steps they are:

- (1) Original RGB color image.
- (2) Original RED image.
- (3) Green channel extraction.
- (4) Gabor filter extracted image.
- (5) Morphological clone.
- (6) Entropy analysis.
- (7) Histogram span.
- (8) Highlighted probable areas.
- (9) Gabor filter image response.

In this proposed system Blood vessels will normally have low local contrast compared to background. The proposed algorithm uses the following steps as given above. In this the green channel image extraction has high pixel size than the normal image that is the intensity of the image is increased. This is as shown below in the below figure.

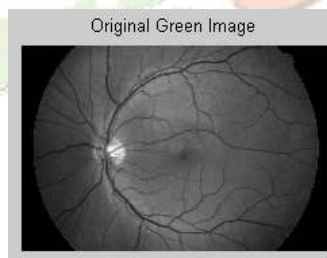


Fig: Green channel extracted image

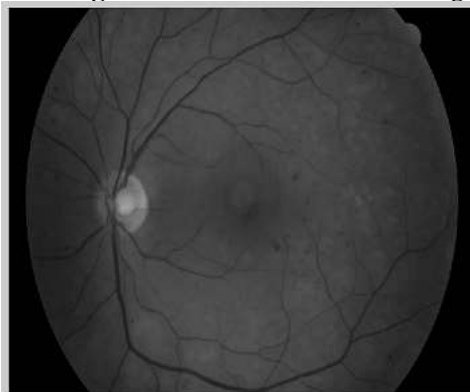
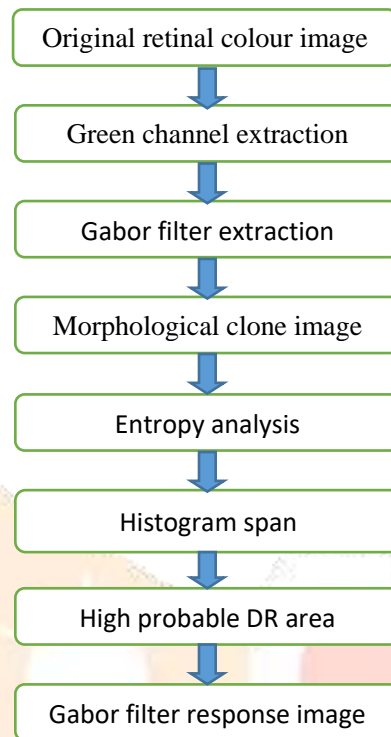
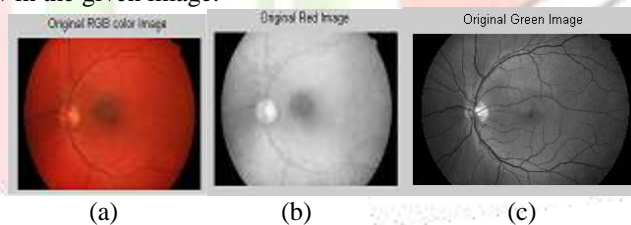
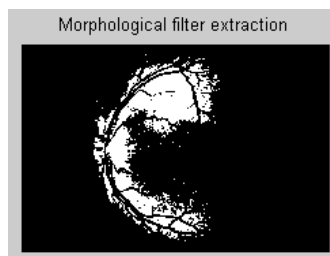


Fig: standalone Gabor filter**Fig: Flowchart of the proposed methodology****Preprocessing:**

This done to remove the noise in the image where all the further processing are performed in the image with help of green channel extraction method which is also called as preprocessing. This algorithm is used to increase the contrast and intensity and precision of images and also helps to decrease some responses from abnormalities which do not resemble any blood vessels otherwise reduce the performance of blood vessels segmentation methods. The green channel extraction of the image is done to extract the quality of the image. This is as below in the given image.

**Fig: (a) live image (b) binary image (c) green channel extracted image****Morphological clone:**

To this the input image given is extracted with the help of morphological tools. This image is called morphologically cloned image. This is as shown below.

**Fig: Morphological clone image****Optimized Gabor filter:**

This filter is otherwise called as white Gaussian filter. It is used to remove the noise from the image. These are mainly of two dimensions they are

- (1) 2-D
- (2) 3-D

But here we will use 2-D filter where these are used for multi directional filtering purposes. Gabor filter is applied for detecting the blood vessel in retinal image. These Filters are a set of enhanced and frequency sensitive filters which have the optimal localization in both the frequency contents of the patterns. These are a set of band pass filters. Gabor filter kernels are sinusoids modulated.

$$\begin{aligned}\Sigma_x &= K \\ \Sigma_y &= \Sigma_x / \gamma \\ X_0 &= x \cos \theta + y \sin \theta \\ Y_0 &= -x \sin \theta + y \cos \theta\end{aligned}$$

Optimized Gabor filter kernel:

$$g_{\theta}(x, y) = \exp\left\{-\frac{1}{2}\left(\frac{x^2_{\theta}}{\sigma_x} + \frac{(\gamma y_{\theta})^2}{\sigma_y}\right)\right\} \cos\left(2\pi \frac{x_{\theta}}{\lambda} + \psi\right)$$

Where,

Σ_x : Standard deviation of Gaussian in x direction along the filter that determine the bandwidth of the filter.

Σ_y : Standard deviation of Gaussian filter that control the orientation selectivity of the filter.

θ : Orientation of the filter, an angle of zero gives a filter responds to vertical feature.

λ : Wavelength of the cosine factor of the Gabor filter kernel i.e. preferred wavelength of this filter.

γ : Spatial aspect ratio, specifies the elasticity of the support of the Gabor function.

ψ : Phase offset.

This Gabor filter image is rotated in different ways with optimized parameters set as follows

$$\sigma_x \in [3.91, 4], \lambda \in [5.1, 5.3], \gamma \in [1.2, 1.4]$$

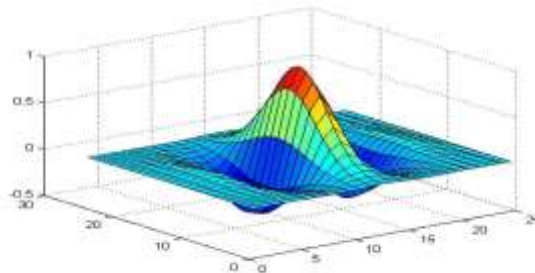
$$\lambda = 5.7$$

$$\gamma = 1.7$$

$$\psi = 2\pi$$

Σ_x is required so that the shapes of the filter are invariant to the scale.

The width of the blood vessel is said to lie in between the range (1-15) pixels.



The above image is called Gabor response image. Here lambda and delta maintains false positive values. Ψ always maintains (2π) rotation phase in this method. Now let us see the Gabor response image as below.

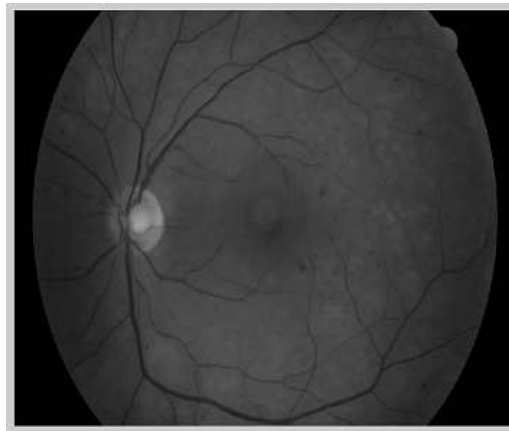


Fig: Gabor response image

Local Entropy Threshold:

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. Image can be expressed as an information source with a probability vector described by its grey-level image histogram; histogram entropy can be used to represent a certain level of information contained in the image. The grey-level co-occurrence matrix developed by Haralick is used to obtain the Haralick texture feature for retinal image segmentation. To perform the proper segmentation of the image effective local entropy threshold is applied.

Let us assume that a Gabor filter response image has a size of M * N with L grey levels denoted by

$$G = \{0, 1, \dots, L - 1\}.$$

The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity $I\{i,j\}$ is less than some fixed constant T (that is, $I\{i,j\} < T$), or a white pixel if the image intensity is greater than that constant.

In the example image on the right, this results in the dark tree becoming completely black, and the white snow becoming completely white.

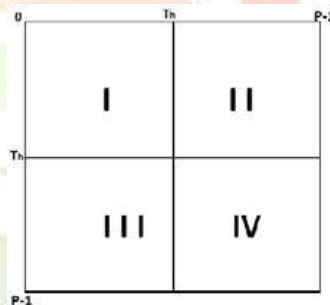


Fig: GLCM quadrants

Let t, be a value used to threshold an image. It partitions the co-occurrence matrix into four quadrants, namely, I, II, III and IV. We assume that pixels with grey levels above the threshold are assigned to the foreground (corresponding to objects), and those equal to or below the threshold are assigned to the background. Then quadrants I and III correspond to local transitions within background and foreground, respectively, whereas quadrants II and IV are joint quadrants which represent joint transitions across boundaries between background and foreground. The probabilities associated with each quadrant are then given by

$$P_{ij} = \frac{t_{ij}}{\sum_i \sum_j t_{ij}}$$

Obviously $0 \leq P_{ij} \leq 1$

$$P_{ij}^{(2)} = \frac{t_{ij}^2}{\sum_{i=0}^{L-1} \sum_{j=0}^{L-1} t_{ij}^2}$$

$$P_{ij}^{(2)} = \frac{t_{ij}^2}{\sum_{i=0}^{L-1} \sum_{j=i+1}^{L-1} t_{ij}^2}$$

The second order local entropy of the object can be given by the entropy analysis image as below.

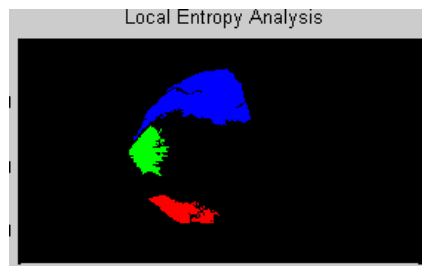


Fig: Entropy analysis

RESULTS:

Detection of the diabetic areas:

The input of the image is taken as the entropy analysis image from there, the image is converted to histogram span by using adaptive histogram equalization. The image is shown as below.

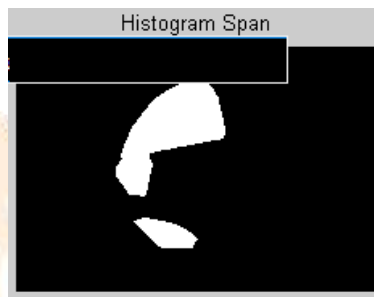


Fig: Histogram span

Now from the above image the image is converted to original color image with highlighted probable areas. This image is as shown below with the diabetic detection.



Fig: detection of diabetic retinopathy (mild stage)

The above figure represents mild stage of the diabetic person now let us see the severe stage of diabetic person which leads to permanent blindness.



Fig: detection of diabetic retinopathy (severe stage)

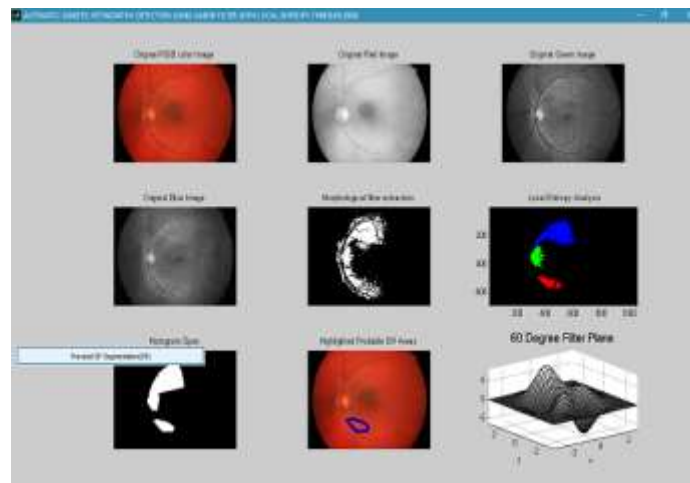


Fig: The overall segmentation and detection of the original image

Finally the image is complimented for evaluating the sensitivity, specificity and accuracy with respect to ground truth image given in DRIVE database. By using this method we can get the result within 4 to 6 seconds maximum. The speed of execution also come in with accuracy and sensitivity.

To enhance the speed of this algorithm we used Matlab 2014a with Intel i7 processors and 3.0 GHz speed system. To get complete result of the algorithm it took overall 5.36 seconds. To get required results as given above use the systems with the above specifications. Now let us compare our proposed result with other results we got as below.

Method	Accuracy	Sensitivity
Frangi et al	89%	64%
Hoover et al	91%	89%
Our Proposed method	97%	94%

Conclusion:

The retinal blood vessels are highly responsible for the detection of retinal pathology therefore segmentation of retinal blood vessels from their background is an important task. In this paper, an automatic local entropy thresholding based fast, efficient and accurate retinal blood vessels segmentation method is proposed by modifying the standard Gaussian shaped matched filter to identify the thin blood vessels together with large blood vessel segments. The proposed method has been tested for their efficacy for forty retinal images taken from DRIVE database and segmented results were compared with hand-labeled ground truth images also available in the DRIVE database. The efficacy of the proposed method was examined and presented in terms of overall sensitivity, specificity and accuracy. Further, the performance of the proposed algorithm was compared with some other existing standard methods for the same task available in literature and the performance of the proposed method was found to be performing significantly better.

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Soil Condition and Crop Disease Monitoring System using IOT

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Abstract:*This project deals about the status and efficiency of agricultural land i.e.,soil condition checking and crop disease as agricultural production inversely affected by pest infection and plant diseases .The IOT in environmental monitoring helps to know about the condition of soils and crop to enhance the productivity of farm .Here,unmanned aerial vehicle ,an aircraft with no pilot onboard,commonly known as drone used to survey the farmland and collect information regarding the soil properties and crop condition and sends those to server. The flying drone consists of camera,sensors and IOT system .With the help of electronic sensors we are able to obtain values of phosphorous,nitrogen,moisture etc. Thus the property of soil.IOT system picks up the sensor data and captures the image regarding the infected areas in farm.Thus the image processing unit receives image as input and produces image characteristic features.Image processing hardware follows the steps as 1)Image acquisition 2)Image pre-processing 3)Segmentation 4)Feature extraction 5)Identification .To view remotely the conditions in the form of images the hardware device i.e.,microcontroller is connected to a wireless technology as Zigbee.*

Keywords: IoT, drone, image processing, zigbee, electronic sensors.

1. INTRODUCTION

With the drastically growing population the current model of agriculture is unsustainable. But with the advancement of new range of technologies and automation innovative solutions can be explored thus to feed the growing crowd. In an environmentally isotropic country like India ,where the larger section depend on agriculture for livelihood the crop production is hampered by nutritional deficiency ,climatic conditions and the various crop diseases, temperature and conditions of the soil, and also the intrusion of animals in to the field. IOT can also play a significant role in precision farming to enhance the productivity of the farm. The rapid development of agricultural IOT has an important role in realizing intensive Agriculture ,high yield and high quality

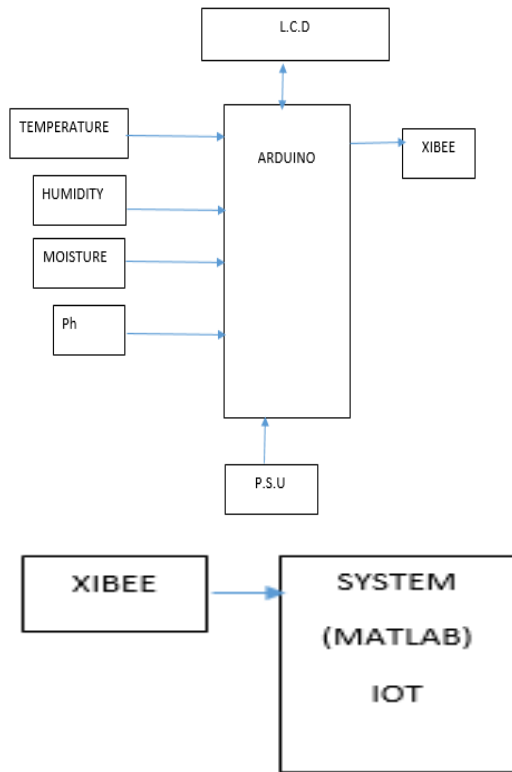
providing solid foundation for development with in Agricultural information technologies. In this paper we monitor the various diseases those effects the paddy crops along with soil condition required

2. LITERATURE SURVEY:

As early as in the 90's an attempt was made by Hetzroni et al. (1994) cited by [1] using neural networks to monitor the health of plants. In their system, they tried to detect zinc, iron and nitrogen deficits by observing lettuce leaves. An analogue video camera was used in image capturing and then digitalized afterwards. The digital image is segmented into background and leaf in the first phase of their algorithm. The required feature (colour and size) are extracted from both the HIS and RGB pictures of the image. These extracted parameters are fed finally into the analysis phase made of neural networks and statistical classifiers, which then determines the condition of the plant [1]. Sena et al. (2003) proposed a method of detecting diseases on leafs using a pre-set threshold value (h), which aims at differentiate among maize plants affected by fall armyworm from healthy employing digital images. Their proposed algorithm was divided into two sections namely the image processing and image analysing. At the processing stage the captured image is transformed to grey scale, filtered and threshold to removed noise. The image is then divided into twelve block at the analysis stage of their algorithm and blocks with leafs less than 5% with respect to the total area are thrown away. The number of connected objects (n) signifying the diseased areas is totalled for each remaining block. The plant is concluded to be disease infected if this number is above a set value (threshold), (thus if $n > h$) which, after experimental assessment, was set to 10 [11]. Al Bashish et al. (2010) proposed a method which attempts to detect 5 diverse plant diseases. The authors of this paper didn't lay down the types of plants used in their tests, and the images existed in situ. After a pre-processing stage to cleanup the image, a K-means crowding algorithm was applied to divide the image into 4 clusters. From their

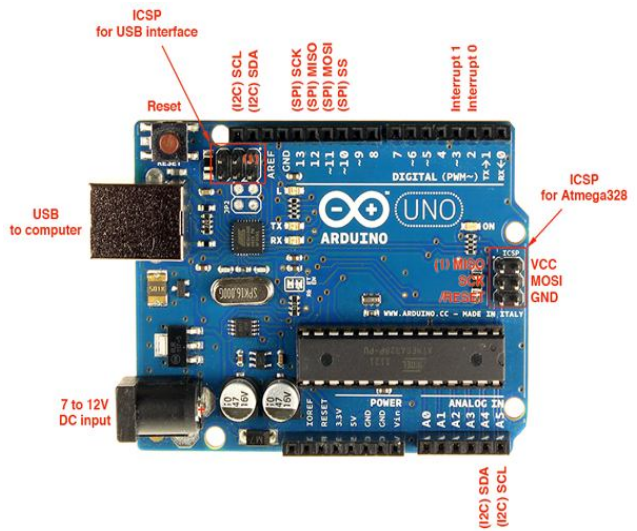
paper, at least one of the clusters must match to one of the diseases. Afterwards, a number of texture and colour features are extracted from each by means of the supposed Colour Co-Occurrence Technique, which runs with images in the HSI presentation. The features are then fed to a MLP Neural Network with ten (10) concealed layers, which implements the final identification and classification [12]. A mobile enhanced image processing approach for detecting plant leaf diseases was proposed. The research aimed at developing. An image recognition system that can recognize crop diseases. The first stage of their methodology was to digitalize the uploaded leaf image by the system user via mobile phone to a remote server. A mathematics morphology is employed to segment these images, then shape, texture and colour features of colour image of disease spot on leaf is extracted, and finally a classification technique of associates functions was used to discriminate between the three types of diseases

3.PROPOSEDSYSTEM:



The proposed hardware of this system includes Arduino Uno board, Temperature, Humidity, pH, Moisture sensors, a power supply unit, LCD Display, Zigbee module, System and a drone with thermal camera to capture the images.

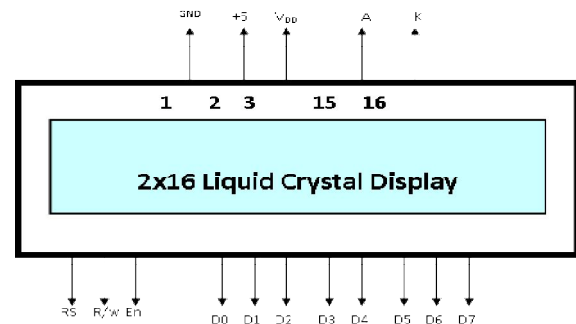
4.HARDWARE COMPONENTS



1.ARDUINO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

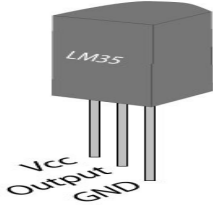
2. LCD



The LCD display consists of two lines, 20 characters per line that is interfaced with the PIC16F73. The protocol (handshaking) for the display is as shown in Fig. The display contains two internal byte-wide registers, one for commands (RS=0) and the second for characters to be displayed (RS=1). It also contains a user-programmed RAM area (the character RAM) that can be programmed to generate any desired character that can be formed using a dot matrix. To distinguish between these two data areas, the hex command byte 80 will be used to signify that the

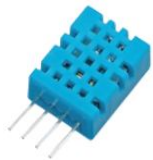
display RAM address 00h will be chosen Port1 is used to furnish the command or data type, and ports 3.2 to 3.4 furnish register select and read/write levels.

3. Temperature sensor



LM35 is a precision IC **temperature sensor** with its output proportional to the temperature (in °C). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor. It also possess low self-heating and does not cause more than 0.1°C temperature rise in still air.

4. Humidity sensor



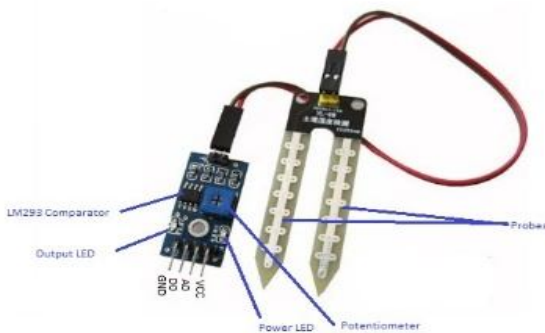
DHT11



DHT22

0 - 50°C / ± 2°C	Temperature Range	-40 - 125 °C / ± 0.5 °C
20 - 80% / ± 5%	Humidity Range	0 - 100 % / ± 2-5%
1Hz (one reading every second)	Sampling Rate	0.5 Hz (one reading every two seconds)
15.5mm x 12mm x 5.5mm	Body Size	15.1mm x 25mm x 7.7mm
3 - 5V	Operating Voltage	3 - 5V
2.5mA	Max Current During Measuring	2.5mA

5. Moisture sensor



The soil Moisture sensor FC-28 has four pins

The Module also contains a potentiometer which will set the threshold value and then this threshold value will be

compared by the LM393 comparator. The output LED will light up and down according to this threshold value

6.pH Sensor

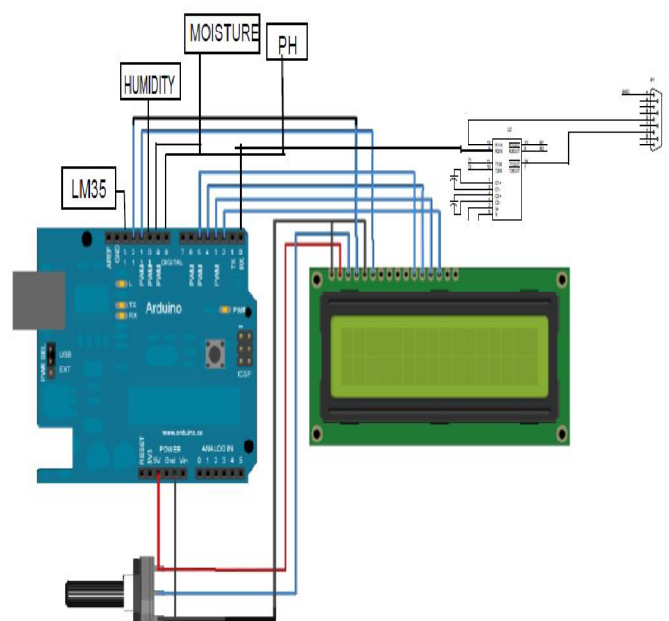
A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH.[2] The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution.[3] The pH meter is used in many applications ranging from laboratory experimentation to quality control. Potentiometric pH meters measure the voltage between two electrodes and display the result converted into the corresponding pH value. They comprise a simple electronic amplifier and a pair of electrodes, or alternatively a combination electrode, and some form of display calibrated in pH units.

7. Zigbee

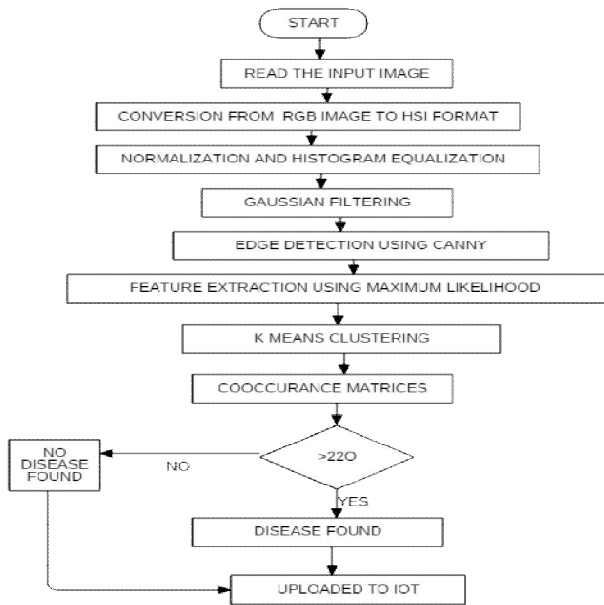
Now-a-days Zigbee is becoming very popular for low data rate wireless applications.

It has two bands of operation 868/915MHz and 2450MHz. 868/915 band provides about 20-40Kb/s and 2450MHz band provides about 250 kb/s data rates. In addition to this uses Zigbee end devices can go to sleep mode which saves battery consumption and it also takes care of security of the information owing to security layer.

CIRCUIT DIAGRAM:



CROP DISEASE DETECTION



The flow chart above looks into the step by step procedure for analysing diseases in crops.

RESULT:

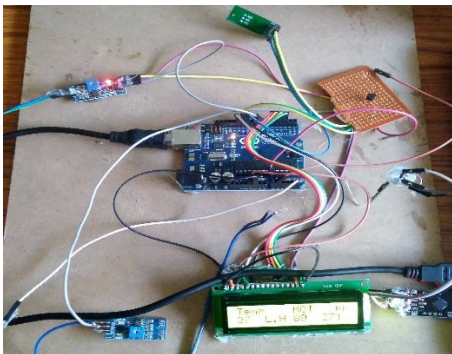


Fig:Electronic Setup for Soil Condition Monitoring

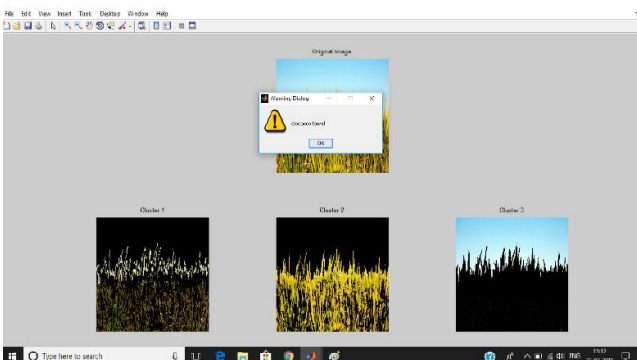


Fig:Crop Disease Detected using Matlab Software

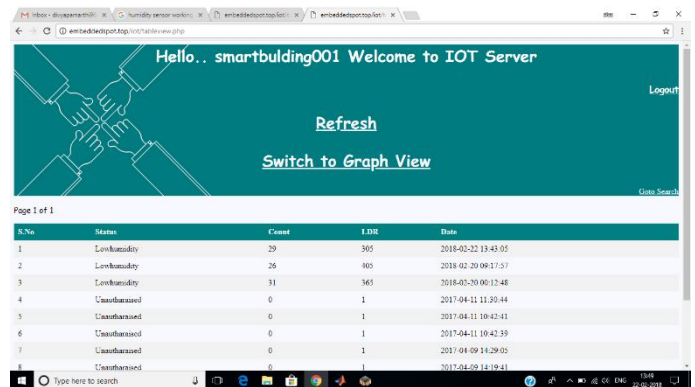


Fig:Uploading of Data

CONCLUSION

Here, we made use of IoT in a most advanced and simplest way so as to observe the soil condition and continuous monitoring for crop diseases. This points to a future with automation of agriculture with drones and self-sufficient electronic systems.

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Deep Analysis of Textual Data in Multiple formats using Hadoop Techniques

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Abstract — the analysis of different types of text content in sending mails, social online journals, messages, gatherings and different types of printed correspondence constitutes what we call content analysis. Content analysis is material to most businesses: it can help divide a great of many messages; you can break down client's remarks and inquiries in gatherings; you can perform assessment investigation utilizing content investigation via evaluating productive or depressing impression of an organization, variety, otherwise product. Content scrutiny has likewise considered as content extraction, and is a subset of the Accepted Communication Handling (ACH) background, identified as the establishing twigs of simulated intellects, when an enthusiasm for understanding content initially created. Right now Content Investigation is frequently measured as the following stride in Big Data investigation. Content Investigation has various subsets: Content Extraction, Named Individual Identification, Semantic network commented on area's portrayal, and some more. A few methods are right now utilized and some of them have picked up a great deal of consideration, for example, Machine Learning, to demonstrate a semi supervised improvement of frameworks, yet they additionally introduce various restrictions which make them not generally the main or the best decision

A wide range of machine robotized frameworks are producing extensive measure of information in various structures like truthful data, text content, and bio-metric information that develops the term Big Data. In this Research article we are exaextraction issues, difficulties, and use of these sorts of Big Data with the thought of enormous information measurements. Here we are talking about online networking information analysis, content based analysis, content information analysis, their issues and expected application zones. It will inspire scientists to address these issues of capacity, administration, and recovery of information known as Big Data.

Keywords — Big Data Investigation, content extraction, Textual Investigation, Information Measurements.

I. INTRODUCTION

Accepted Communication Handling (ACH) is the reasonable field of Computational Linguistics, albeit a few creators utilize the terms reciprocally. Once in a while ACH has been viewed as a associate authority of simulated Intelligence, and all the more as of late it assembles at the center of Cognitive Calculations, since most psychological procedures are moreover comprehended or produced as characteristic dialect expressions.[2]

ACH is an extremely expansive theme, and incorporates a gigantic measure of subsets: Natural Speech Consideration, Natural Speech Creation, Knowledge Base Construction, Dialog Handling organizations (and intellectual Coach Methods in scholastic erudition frameworks), Speech handing, Data extraction – Text Extraction – Text Analysis, et cetera. It is processed in this manuscript in Text Investigation (TA).

Content Investigation is considered as the latest identifier given to Natural Speech Identification, Data and Text Extraction. Over the most recent couple of years another name has picked up prominence, Big Data, to allude for the most part to unstructured content (or other data sources), more regularly in the business instead of the scholarly territory, likely in light of the fact that unstructured free content records for 75% in a production setting, which includes tweets, online journals, wikipeidias and reviews [1].No scholastic papers are covering this ideas is a fact.

II. DISCERNMENT AND METHODOLOGIES FOR TEXTUAL CONTENT ANALYSIS:

Content Investigation is an augmentation of information extraction, that is used to discover printed designs from enormous non-organized resources, rather than information put away in social databases. Content Investigation,

otherwise called Smart Content Analysis, Data Extraction or Knowledge-Discovery in Text (KDT), alludes by and large to the way toward removing non-minor data and information from unstructured content. Content Investigation is like information extraction, with the exception of that information extraction apparatuses are intended to deal with organized information from databases, either put away all things considered or accordingly from processing them with unstructured information. Content Investigation can cover shapeless or semi-organized informational indexes, for example, messages, full-content records and HTML documents, online journals, daily paper articles,

comprises of the accompanying strides and undertakings [6]

Beginning with a gathering of records, a content extraction device recovers a specific report and preprocess them by identifying arrangement and quality sets. At that point it would experience a content examination stage, infrequently rehashing strategies until data is extricated. The fundamental methodology in every one of the parts is to discover an example (from either a rundown or a past procedure) which coordinates a control, and afterward to apply the lead which clarifies the content. Every segment plays out a specific procedure on the content.

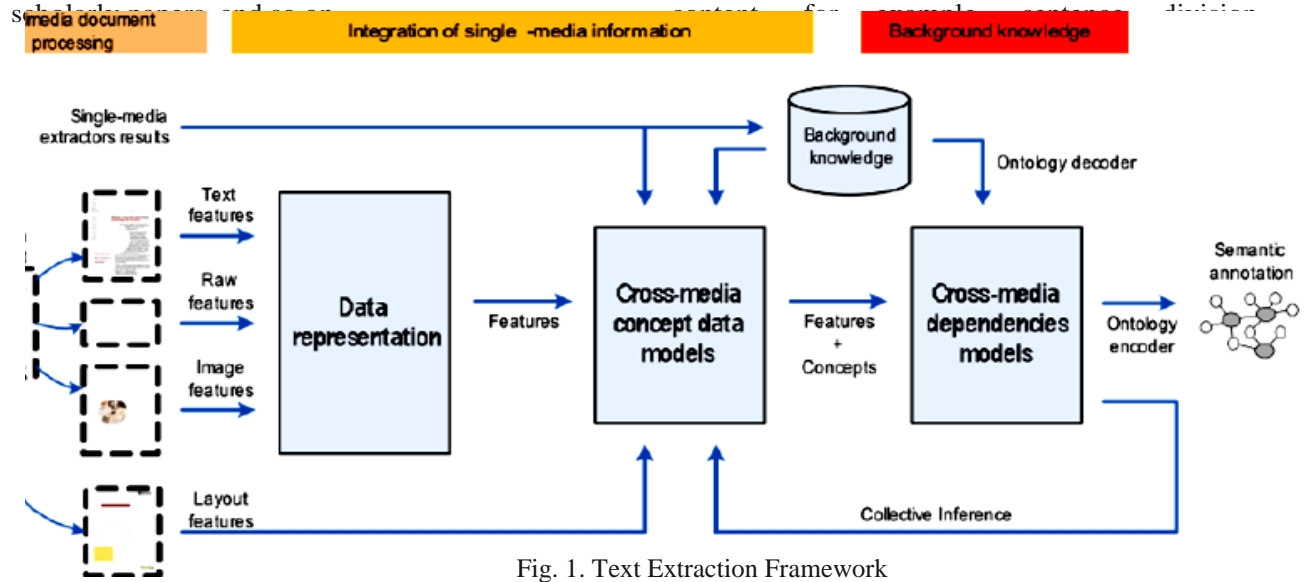


Fig. 1. Text Extraction Framework

Content Investigation is an inter penalizing background which depicts on data extraction, information extraction, machine erudition, insights and calculational etymology[1].

The subsequent procedure gives "organized" or semi-organized data to be additionally utilized (e.g. Information Foundation Edifice, Ontology enhancement, and Contraption Knowledge calculation approval, uncertainty indicators for Problem and Response frameworks[8]).

Content Investigation is picking up noticeable quality in numerous businesses, from advertising to back, on the grounds that the way toward extricating and dissecting extensive amounts of content can assist chiefs with understanding business sector flow, foresee results and patterns identify extortion and oversee chance. The multidisciplinary way of Text Investigation is vital to comprehend the unpredictable incorporation of various skills: PC engineers, language specialists, specialists in Law, BioMedicine or Finance, information researchers, analysts, bringing about that the innovative work approach is divided because of various customs, strategies and interests. A regular content examination application

A portion of the systems that has produced and utilized as a part of the content extraction procedure are data extraction, theme following, synopsis, arrangement, grouping, idea linkage, data perception, address replying, and profound learning.

A. INFORMATION EXTRACTION

Data extraction (IE) programming distinguishes key terminologies and associations inside contented. It does it by identifying for already defined arrangements in available information, a procedure more often than not

called design coordinating, commonly in view of customary indications. The most mainstream type of IE is a substance acknowledgment (NER). NER tries to find and characterize nuclear components in content into preinstructed classes (generally coordinating preestablished ontologies). NER procedures remove elements, for example, the names of people, associations, areas, transient or spatial expressions, amounts, fiscal qualities, stock qualities, rates, quality or protein names, and so forth. These are a few apparatuses applicable to the undertaking: Apache OpenACH [2], Stanford Named Individual Identifier [3] [4], LingPipe [5].

B. THEME IDENTIFICATION AND DETECTION

Watchwords are an arrangement of noteworthy terms in a research manuscript which results an abnormal state portrayal of its substance to perusers. Distinguishing catchphrases from a lot of news information is exceptionally valuable which inturn can create a short outline of news articles. As content which is available online archives quickly increment in size with the development of WWW, watchword mining [6] has turned into the premise of a few content extraction applications, for example, web indexes, content order, rundown, and theme location. Manual watchword extraction is a to a great degree troublesome and tedious errand; truth be told, it is practically difficult to concentrate catchphrases physically if there should be an occurrence of news reports distributed in a solitary date because of their volume.

A point following structure facilitates by keeping client summary and, in light of the available reports the user sees, calculates dissimilar records which are important to the client. Google offers a free subject following apparatus [7] that enables clients to pick watchwords and advises them when news identifying with those points ends up plainly accessible. NER procedures are additionally utilized as a part of upgrading point following and recognition by coordinating names, areas or regular terms in a given subject by speaking to similitudes with different archives of comparative substance [8]. Theme recognition is firmly related with Classification (see underneath).

C. CONTENT ILLUSTRATION

Content outline has a extended and productive convention in the concept of Content Investigation. It might be said content synopsis falls additionally under the class of Accepted Communication Handling (ACH). It helps in making sense of regardless of whether a elongated report which represents the customers troubles and qualities inspecting for supplementary data. With vast writings, content synopsis forms and outlines the record which is considered with client to peruse the main section. The way to synopsis is to decrease the extention and description of a report along with holding its principle focuses and general importance.

The methodologies mainly utilized by content rundown devices are stretch extraction. Imperative verdicts in an research article are factually subjected and positioned. Outline instruments may likewise intended for headings and different indicators of subtopics with a specific end goal to distinguish the key purposes of a report.

The techniques for outline can be ordered in two general gatherings:

- Shallow investigation, limited to the structured level of portrayal and attempt to extricate critical parts of the content;
- Deeper investigation, accept a semantics level of portrayal of the first content (regularly utilizing Information Retrieval strategies).

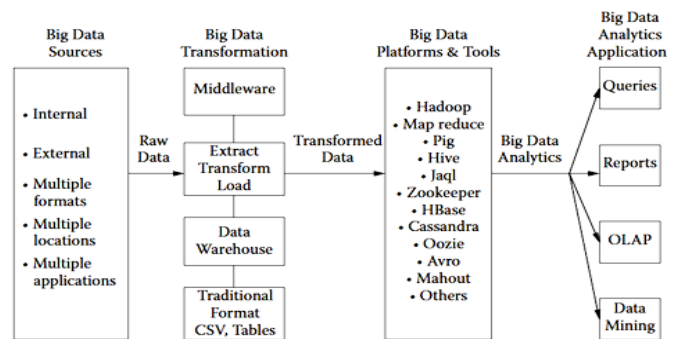


Fig. 2. Content Summarization

A. ARRANGEMENT OR CLASSIFICATION

Arrangement includes distinguishing the fundamental subjects of an archive by putting the report into a

predescribed location of points (moreover as scientific classifications or ontologies). Order just tallies words that show up and, from the checks, distinguishes the primary themes that the archive covers. Classification frequently depends on connections recognized by searching for wide provisos, smaller provisos, comparable words, and associated terms. Arrangement instruments regularly have a strategy for positioning the archives all together of which reports have the most substance on a specific point [10]. Another technique is to speak to subjects as topical diagrams, and utilizing a level of closeness (or separation from the "reference" chart) to order archives under a given class [11].

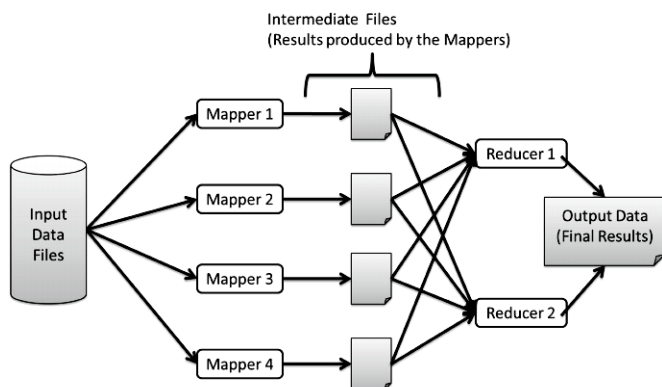


Fig. 3. Content Classification

B. DATA ASSEMBLING

Bunching method is wormed to gather comparable archives, yet it varies from order in that reports are grouped without the utilization of predefined themes. At the end of the day, while order suggests administered (machine) learning as in past information is utilized to dole out an offered archive to a given class, bunching is unsupervised learning: there are no already characterized points or classifications. Utilizing grouping, archives can show up in different subtopics, in this way guaranteeing a helpful record won't be precluded from query items (numerous ordering references). An essential grouping calculation makes a vector of points for each report and doles out the archive to a given theme bunch

C. TEXT INVESTIGATION IDENTIFIED DISTURBANCES

With regards to TA, Big Data is just a monstrous volume of composed dialect information. Be that as it may, wherever does the wilderness recline among analytics of Big Data and Small Data. At hand a process is evolving truth: while just 15 years prior a

content capacity of 160 million words was viewed as colossal, at present no less than 8.500 million utterance datasets are accessible. Niether exclusively which questions essentially about its extent, additionally about excellence and genuineness: information from online networking is brimming with clamor and contortion. All data clusters have these issues however they are all the more possibly genuine for extensive datasets in light of the fact that the PC is a mediator and the human master don't see them specifically, similar to the case in little datasets. In this manner, information purging procedures devour huge endeavors and frequently after the purifying, the accessibility of data to prepare frameworks is insufficient to get solid expectations, as occurred in the Google Flu Movements fizzled analyze [27].

The motivation behind is that numerous enormous data clusters are not the yield of utensils intended to deliver substantial and solid information for examination, and furthermore in light of the fact that information purging is about (for the most part subjective) choices on the applicable plan highlights. Another key issue is the entrance to the information. Much of the time, the scholastic gatherings have no entrance to information from organizations, for example, Google, Twitter or Facebook. For example, Twitter just makes a little part of its tweets accessible to the general population with its APIs. Also, the tweets accessible don't take after a given example (they are a "different pack") so it is hard to land at a decision relating to their indications. As an outcome, the imitation of investigations is practically inconceivable, while the underneath resources and the hidden innovation are not freely accessible. Boyd and Crawford [29] go advance: restricted admittance to Big Data makes new computerized isolates, the Big Data rich and the Big Data poor. Customer needs the way to gather them, and the mastery to break down them. Strikingly, little yet very much curated accumulations of dialect information (the conventional corpora) offer data that can't be deduced from huge datasets [30].

Step by step instructions to get a handle on the metaphorical employments of dialect, fundamentally incongruity and similitude, is likewise an outstanding issue to legitimately comprehend content. Basically, the client's expectations are concealed on the grounds that the surface importance is distinctive to the basic significance. As an outcome, the terms have to be deciphered in setting and through additional etymological information, a reality that has been difficult for people, which is significantly complex for equipment. Step by step instructions to make an interpretation of a given allegory into another dialect is to a great degree troublesome. A few

assessments ascertain that allegorical dialect is around 15-20% of the aggregate substance in web-based social networking discussions.

III. PROPOSED METHODOLOGY

Step 1. Input request ought to as .JAR document t which includes Driver source code, Mapper relative code and Reducer code.

Step 2. Job hunter does out the mapper errands by following the business foundation from the .JAR document on the all the accessible assignment handlers.

Step 3. when all the assignment trackers are finished with mapper processes, they propel a similar status back to Job Tracker.

Step 4. With all the errand trackers do with mapper stage, at that point work tracker starts sort and rearrange stage on all the mapper yields.

Step 5. After finishing sort and rearrange, work hunter starts reducer stage on all accessible assignment hunters.

Step 6. If all assignment hunters do with compressing stage, they refresh a similar condition back to the occupation trailer.

Mapper and Reducer are client driven stages. Mapper class yield filename is "part-m-00000" and Reducer class yield filename is "part-r-00000". Work Tracker and Task Tracker are the two daemons which are totally in charge of MapReduce handling.

IV. EXAMPLES OF TEXTUAL INVESTIGATION APPLICATIONS

We will quickly audit two conspicuous territories of use of Content Investigation, with a substantial business affect: (1) Medical Investigation – grouping of research articles of medicinal substance, and (2) Legal Investigation – Information retrieval from legitimate writings.

A. Health Check Investigation – Categorization of research manuscripts or therapeutic substance Biomedical content extraction or BioACH exhibits some interesting information sorts. Their average writings are digests of logical papers, and additionally therapeutic reports. The primary errand is to group papers by a wide range of classifications, to bolster a database (like MEDLINE). Different

applications incorporate ordering records by ideas, normally based or identified with ontologies or representing "translational research," that is, utilizing essential organic investigation to educate scientific practice (for example, naturally extraction of medication cooperations, or quality relationship with infections, or transformations in proteins).

The ACH strategies incorporate biomedical elements acknowledgment, design acknowledgment, and mechanism learning for extricating structured relations with ideas. Biomedical elements acknowledgment comprises of perceiving and ordering substance identities in biomedical spaces, for example, proteins, qualities, illnesses, medications, organs and medicinal claims to fame. An assortment of lexical assets are accessible in English and different dialects, and additionally a wide gathering of commented on corpora (as GENIA) with structured and applied associations between substances. In spite of their accessibility, no single asset is sufficient nor exhaustive since new medications and qualities are found continually. This is the fundamental test for BioACH.

Totally three methodologies for extricating relations between elements are available:

- Linguistic-dependent methodologies: the thought is to utilize parsers to get a handle on meaningful structures and guide them into structured portrayals. They are normally in light of lexical assets and their principle disadvantages are the wealth of equivalent words and spelling varieties for substances and ideas.
- Pattern-based methodologies: these strategies make utilization of an arrangement of examples for potential connections, characterized by space specialists.
- Machine Learning-based methodologies: from commented on writings by human specialists, these strategies extricate relations in new accumulations of comparable writings. Their principle weakness is the prerequisite of calculating cost and preparing and testing on a lot of manual-labeled information. To enlarge the mining framework to other kind of information or dialect involves new individual exertion in explanation. Friedman et al. proposed a study on the best in class and projected in BioACH, supported by the US National documents of drugs. This testimony recognizes that "the most huge frustrating component for quantifiable ACH is unavailability of vast scale de-distinguished quantifiable structure, which are

required for preparing and assessment."

B. Authorized Investigation – Knowledge mining from legitimate writings. Individual territory receiving a considerable measure of consideration concerning the items of common sense of Content Investigation is that regarding to the data retrieving from writings with legitimate substance. All the more particularly, suit information is brimming with references to judges, legal advisors, parties (organizations, open associations, et cetera), and licenses, assembled from a few a large number of pages containing a wide range of Intellectual possessions (IP) case data. This has offered ascend to the expression authorized Investigation, since examination assists in finding designs with importance covered up in the archives of information. What it intends to legal advisors is the blend of bits of knowledge originating from base up information with high-low expert and knowledge originated in statutes, directions and incite sentences. This spots target information at the middle rather than the purported narrative information.

The fundamental issue is that lawful literary data is communicated in normal dialect. While a scan can be made for the string offended party, there are no looks for a string that speaks to a person who tolerates the part of offended party. To make dialect on the maze more important and organized, extra substance must be combined to the base substance, where the Semantic Web (semantic parts' labeling) and Natural Language Processing play out their commitment.

We begin with information, the corpus of writings, and afterward a yield, writings commented on with XML labels, JSON labels or different systems. Nonetheless, getting from a corpus of printed data to clarified yield is a requesting undertaking, blandly alluded to as the information procurement bottleneck [43]. This errand is extremely requesting on assets (particularly labor with enough mastery to prepare the frameworks) and it is likewise exceptionally information escalated since whoever is doing the comment must comprehend what and how to comment on learning identified with a given space.

Handling Natural Language (NL) to bolster such luxuriously commented on records displays some innate issues. NL underpins the greater part of the accompanying, in addition to additional equipments:

(1) Inherent or Assumed data – "When did you quit taking medications?" (Assumes that the individual is addressed regarding taking medications sooner or later previously);

(2) The same frame with various logically subordinate implications. Normally a legitimate examination framework will comment on components of enthusiasm, so as to distinguish a scope of specific snippets of data that would be pertinent to lawful experts, for example,

- Case reference
 - Names of gatherings
 - Roles of gatherings, which means offended
 - Identities of judges
 - Identities of lawyers
 - Roles of lawyers, which means the side they speak to
- (Offended party or litigant)
- Final choice
 - Cases referred to
 - Nature of the case, which means utilizing watchwords to group the case as far as subject (e.g., criminal attack, protected innovation, and so on.)

The business ramifications of authorized Investigation have begun a packed branch of literary Big Data submissions. A few organizations have profited from a beneficial souk, for example, LexisNexis, concentrated on contribution of expectations on potential medicinal negligence issues to particular lawyers. In recent times, LexisNexis has gained Lex Machina [44], an organization that mines primarily case information around IP data.

Consistently, Lex Machina's crawler separates information (and records archives) from a few U.S. Law vaults. The flatterer naturally catches each docket occasion and downloads input case archives. It changes over the archives by visual disposition acknowledgment (OCR) to identified content and supplies every one as a PDF document. At the point when the flatterer finds a specify of a copyright, it gets data related to the copyright from the copyrights and Trademarks Office (CTO) site. The flatterer conjures Lexpressions, an exclusive lawful content order motor. The ACH innovation groups cases and dockets and determines substance names (utilizing a NER motor). A procedure of segmentation of the data separated is achieved by specific lawyers to guarantee great information. The organized content indexer then plays out an information purging operation to request every one of the information and stores it for hunt. Lex Machina's electronic submission empowers clients to run look questions that convey simple data recovery of the significant docket passages and records.

V. RESULTS & DISCUSSIONS

MapReduce execution for Word Count algorithm computation. The result is the rundown of words with the number of emergence of every utterance. The below figure shows the pattern of research data on the local Apache Hadoop. The inquire about pattern indicates, the the majority of the examination ponders are done specifically spaces. The research work demonstrates that in Zoology space, the greater part of centered research zones are vermin, composition, Cestode, and Fishes. It demonstrates that in the Botany space, predominantly look into focus is on Airospora, crop harvest, Fungi and Aerobiological. Results are conceivable utilizing a MapReduce WordCount calculation.

```

Total time spent by all maps in occupied slots (ms)=2979
Total time spent by all reduces in occupied slots (ms)=3200
Total time spent by all map tasks (ms)=2979
Total time spent by all reduce tasks (ms)=3200
Total vcore-seconds taken by all map tasks=2979
Total vcore-seconds taken by all reduce tasks=3200
Total megabyte-seconds taken by all map tasks=3050496
Total megabyte-seconds taken by all reduce tasks=3276800
Map-Reduce Framework
  Map Input records=1
  Map output records=22
  Map output bytes=194
  Map output materialized bytes=244
  Input split bytes=107
  Combine input records=0
  Combine output records=0
  Reduce input groups=18
  Reduce shuffle bytes=244
  Reduce input records=22
  Reduce output records=18
  Spilled Records=44
  Shuffled Maps =1
  Failed Shuffles=0
  Merged Map outputs=1
  GC time elapsed (ms)=264
  CPU time spent (ms)=2730
  Physical memory (bytes) snapshot=311898112
  Virtual memory (bytes) snapshot=3826933760
  Total committed heap usage (bytes)=247463936
    
```

Fig.4 Performing Mapreducing operation

```

admin1@admin1: /usr/local/spark/bin
File Edit View Terminal Help
media: 1
language: 1
Contributions.: 2
mean: 10
individual: 3
How: 1
reserved.: 1
computer: 1
notices: 9
SHALL: 1
Neither: 1
reasonable: 1
SUBSTITUTE: 1
agreed: 3
Licensor: 8
advised: 1
STRICT: 1
HOWEVER: 1
made: 1
classes.: 1
authorship.: 2
PROFITS.: 1
bind: 1
DAMAGES: 1
    
```

Fig.5 Result of text analysis

```

hduser@Rohit-Dell: /usr/local/hadoop/bin
rohit@Rohit-Dell:~$ su hduser
Password:
hduser@Rohit-Dell:~/home/rohit$ cd -
hduser@Rohit-Dell:~$ cd /usr/local/hadoop/bin
hduser@Rohit-Dell:~/usr/local/hadoop/bin$ ./start-all.sh
Warning: SHADOOP_HOME is deprecated.

starting namenode, logging to /usr/local/hadoop-1.0.4/libexec/./logs/h
localhost: starting datanode, logging to /usr/local/hadoop-1.0.4/libex
localhost: starting secondarynamenode, logging to /usr/local/hadoop-1.0
starting jobtracker, logging to /usr/local/hadoop-1.0.4/libexec/./logs
localhost: starting tasktracker, logging to /usr/local/hadoop-1.0.4/lib
hduser@Rohit-Dell:~/usr/local/hadoop/bin$ jps
21230 DataNode
21885 TaskTracker
20995 NameNode
21888 Jps
21570 JobTracker
21473 SecondaryNameNode
hduser@Rohit-Dell:~/usr/local/hadoop/bin$ jps
    
```

Fig.6 Hadoop checking

VI. FUTURE WORK

The innovations around content investigation are right now being connected in a few enterprises, for example, assumption and sentiment examination in media, back, medicinal services, promoting marking or buyer markets. Experiences are extricated from the conventional endeavor information sources, as well as from on the web and web-based social networking, since more the overall population has ended up being the biggest generator of content substance (simply envision web based informing frameworks like Whatsapp or Telegram).

The present condition of content investigation is extremely sound, however there is space for development in zones, for example, client familiarity, or societal regulation in. This bears great guarantees for both logical trialing and specialized development alike: Multi-lingual investigation is encouraged by mechanism learning (ML) and progress in mechanism interpretation; client encounter, statistical surveying, and buyer bits of knowledge, and computerized examination and media estimation are upgraded through content examination; other than the eventual fate of profound learning in ACH, since quite a while ago settled dialect building approaches scientific categorizations, parsers, lexical and semantic systems, and syntactic-administer frameworks will proceed as bedrocks in the zone; feeling investigation, emotional states intensified of discourse and content and additionally pictures and outward appearance investigation; new types of supratextual interchanges like emojis need their own way to deal with concentrate semantics and touch base at significant examination; semantic pursuit and information diagrams, discourse examination and synchronous machine interpretation; and machine-composed substance, or the ability to create articles (and email, instant messages, rundowns, and interpretations) from

content, information, principles, and setting, as caught beforehand in the examination stage.

VII. CONCLUSION

Content Investigation, with its extended and impressive track, is a region in steady advancement. It stands at the focal point of Big Data's assortment vector, that of amorphous data, particularly with societal interchanges, where substance is created by a huge number of clients, substance comprising of pictures as well as the vast majority of the circumstances literary remarks or all out articles. Data communicated by methods for writings includes heaps of learning about the humanity and regarding the substances in this humanity and in addition the connections among them. That learning about the world has as of now considered to use so as to make the subjective applications, similar to IBM's Watson and IP soft's Amelia, that will communicate with people growing their capacities and helping them perform better. With expanded correspondence, Text Investigation will be extended and it will be expected to deal with the commotion and the insignificant from the truly critical data.

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Working Capital Management in Naga Hanuman Solvent Oils Private Limited-A Case Study of Andhra Pradesh

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Abstract: Naga Hanuman Solvent Oils Private Limited is a thirty years old company located at Eluru, which is a head quarter of West Godavari District of Andhra Pradesh. Naga Hanuman Solvent Oils Private Limited is a Private company incorporated on 10 June 2004. It is engaged in Production, processing and preservation of meat, fish, fruits, vegetables oils and fats. Naga Hanuman is currently exporting about 7500 tons of frozen sea foods consisting of shrimps and Fishes to Asian, Middle East, Europe and USA destinations and enjoys very good reputation among its customers. In this paper an attempt is made to examine and analyse working capital Management of Naga Hanuman Solvent Oils Private Limited. In this paper structure and composition of working capital in the enterprise for a period of ten years is analysed. Current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period are calculated for the study period. Hypotheses are tested using chi square test.

Keywords: Current Ratio, Gross working capital, Net working capital, Inventory turnover, Average collection period

I. INTRODUCTION

Naga Hanuman Solvent Oils Private Limited is a thirty years old company located at Eluru, which is a head quarter of West Godavari District of Andhra Pradesh. Naga Hanuman Solvent Oils Private Limited is a Private company incorporated on 10 June 2004. It is classified as Non-Government Company and is registered at Registrar of Companies, Hyderabad. It's authorized share capital is Rupees 65,000,000 and its paid up capital is Rupees 43,885,640. It is engaged in Production, processing and preservation of meat, fish, fruits, vegetables oils and fats. Naga Hanuman is currently exporting about 7500 tons of frozen sea foods consisting of shrimps and Fishes to Asian, Middle East, Europe and USA destinations and enjoys very good reputation among its customers. In this paper an attempt is made to examine working capital management in Naga Hanuman Solvent Oils Private Limited

II. REVIEW OF LITERATURE

Mishra (1975)¹ studied the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992)² in their research conducted an in-depth survey to analyse the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999)³ in his study on working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency. Reddy (2000)⁴ analysed the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003)⁵ made an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004)⁶ conducted a study on the issue pertaining to the relationship between working capital management and profitability of Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012)⁷ investigated the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013)⁸ conducted a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and two and three wheelers sectors of Indian automobile industry. Utkarsh Goel et al. (2015)⁹ conducted a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms. S. Selvanayaki et al. (2015)¹⁰ focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on profitability. Venkateswararao.P, Surya Chandra Rao.D and Hema Venkata Siva Sree.Ch (2017)¹¹ examined working capital management in PL Plast Pvt Ltd. Venkateswararao.P, and Hema Venkata Siva Sree.Ch (2018)¹² examined working capital management in Sri Rama Chandra Paper Boards Ltd. Venkateswararao.P, and

HemaVenkata Siva Sree.Ch (2018)¹³ examined working capital management in Sri Nagavalli solvent oils Pvt. Ltd. Venkateswararao.P (2018)¹⁴ examined the working capital management in Cuddapah Spinning Mills Ltd. It was found that there was no study on working capital management in a Solvent oils company. Hence, this study is taken up.

Objectives

The general objective of the study is to examine the working capital management in Naga Hanuman Solvent Oils Private Limited. The specific objectives include the following.

1. To examine the structure and composition of working capital in Naga Hanuman Solvent Oils Private Limited during the period of study.
2. To analyse the liquidity position of Small Enterprise during the period of study.
3. To find the gross working capital turnover and networking capital turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.
5. To offer suggestions for effective working capital management if required.

Hypotheses

H₀₁: Current ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₂: Quick ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₃: Super quick ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₄: Gross working capital turnover ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₅: Net working capital turnover ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₆: Cash turnover ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₇: Inventory turnover ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₈: Debtors turnover ratio in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

H₀₉: Average collection period in Naga Hanuman Solvent Oils Private Limited is uniform during the period of study.

III. METHODOLOGY

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Naga Hanuman Solvent Oils Private Limited. The period of study is ten years covering the financial years from 2006-07 to 2015-16. The data gathered is analysed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed.

Structure and composition of working capital

Working capital structure of Naga Hanuman Solvent Oils Private Limited is presented in table 1. It is observed that Debtors occupied the highest per cent of total current assets during the period of study except 2007, 2009, 2010 and 2014. Debtors as a percentage of total current assets varied in between 23.27 during 2009 and 80.81 during 2016. Inventory as a percentage of total current assets varied in between 14.33 during 2016 and 53.64 during 2010. It is also observed that cash and bank balance as a percentage of current assets varied between 0.63 during 2010 and 22.98 during 2009. Loans and advances as a percentage of current assets varied between 0.45 during 2015 and 19.17 during 2009 and nil during 2008, 2011 and 2012. Other Current assets as a percentage of total current assets varied in between 1.42 during 2016 and 9.89 during 2010. Sundry creditors occupied the highest percentage in the total current liabilities for the first seven years of the study. Sundry creditors as a percentage of total current liabilities varied between 17.95 during 2016 and 94.87 during 2007. Short-term borrowings by the Business organisation were made only in the year 2015 and 2016. Short-term borrowings as a percentage of total current liabilities are 73.58 during 2015 and 77.04 during 2016. Short-term provisions were maintained throughout the period of study. Short-term provisions as a percentage of total current liabilities varied between 3.73 during 2016 and 58.58 during 2014. Other current liabilities were nil during the first five years of study. They varied between 0.18 during 2015 and 2.41 during 2014. It is observed that Net Working Capital in the company varied between Rs.-23.49 Lakhs during 2007 to Rs.2570.85 Lakhs during 2014. It was maintained at high levels during 2013 and 2014.

Table1: Working Capital structure (Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	12.93	12.18	254.76	7.87	283.02	226.29	170.19	244.94	123.54	72.91
% of TCA	4.81	1.71	22.98	0.63	16.91	10.44	5.91	8.90	3.59	1.93
Debtors	74.63	366.78	258	441.33	699.21	1329.61	1757.24	1092.17	2476.06	3051.27
% of TCA	27.75	51.36	23.27	35.26	41.77	61.35	60.97	39.70	72.02	80.81
Loans & Advances	31.66	0	212.45	7.34	0	0	80.21	29.28	15.3	57.16
% of TCA	11.77	0.00	19.17	0.59	0.00	0.00	2.78	1.06	0.45	1.51
Other Current Assets	13.24	52.22	100.18	123.77	162.06	148.86	140.08	144.69	90.69	53.66
% of TCA	4.92	7.31	9.04	9.89	9.68	6.87	4.86	5.26	2.64	1.42
Inventory	136.47	282.97	283.16	671.45	529.83	462.47	734.23	1239.68	732.47	540.98
% of TCA	50.75	39.62	25.54	53.64	31.65	21.34	25.48	45.07	21.30	14.33
Total Current Assets (TCA)	268.92	714.15	1108.53	1251.76	1674.12	2167.23	2881.95	2750.76	3438.06	3775.98
Current Liabilities										
Sundry Creditors	277.4	295.55	329.43	440.2	243.97	346.69	302.48	70.18	701.71	594.74
% of TCL	94.87	89.82	85.26	88.93	75.37	78.83	73.16	39.01	22.47	17.95
Other current liabilities	0	0	0	0	0	4.19	4.72	4.33	5.76	42.46
% of TCL	0.00	0.00	0.00	0.00	0.00	0.95	1.14	2.41	0.18	1.28
Short term borrowings	0	0	0	0	0	0	0	0	2298.36	2552.26
% of TCL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	73.58	77.04
Short term provisions	15.01	33.5	56.97	54.79	79.74	88.93	106.26	105.4	117.58	123.44
% of TCL	5.13	10.18	14.74	11.07	24.63	20.22	25.70	58.58	3.76	3.73
Total Current Liabilities (TCL)	292.41	329.05	386.4	494.99	323.71	439.81	413.46	179.91	3123.41	3312.9
NWC	-23.49	385.1	722.13	756.77	1350.41	1727.42	2468.49	2570.85	314.65	463.08

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Current Ratio

The current ratio in the company was maintained at higher level during 2011 to 2014 in the company. It has varied between 0.92 during 2007 and 15.29 during 2014 as shown in the table. The current ratio of the company is maintained at high levels. It is found in the significance test that current ratio is not uniform during the period of study.

Table2: Current Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	268.92	714.15	1108.53	1251.76	1674.12	2167.23	2881.95	2750.76	3438.06	3775.98
Current Liabilities	292.41	329.05	386.4	494.99	323.71	439.81	413.46	179.91	3123.41	3312.9
Current ratio	0.92	2.17	2.87	2.53	5.17	4.92	6.97	15.29	1.10	1.14

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for current ratio = 39.558.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is greater than Critical Value i.e., 39.558 > 16.919. Hence H_{01} is rejected.

Quick Ratio

The quick ratio of the company as shown in the table has varied between 0.45 during 2007 to 8.40 during 2014. It is found in the significance test that quick ratio is not uniform during the period of study.

Table3: Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	132.45	431.18	825.37	580.31	1144.29	1704.76	2147.72	1511.08	2705.59	3235
Current Liabilities	292.41	329.05	386.4	494.99	323.71	439.81	413.46	179.91	3123.41	3312.9
Quick ratio	0.45	1.31	2.13	1.17	3.53	3.88	5.19	8.40	0.87	0.98

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Quick ratio =20.30.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., $20.30 > 16.919$, Hence, H_0 is rejected.

Super Quick Ratio

The super quick ratio of the company as shown in the table has varied between 0.02 during 2010, 2016 and 1.36 during 2014. It is found in the significance test that super quick ratio is uniform during the period of study.

Table4: Super Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	12.93	12.18	254.76	7.87	283.02	226.29	170.19	244.94	126.88	72.91
Current Liabilities	292.41	329.05	386.4	494.99	323.71	439.81	413.46	179.91	3123.41	3312.9
Super Quick ratio	0.04	0.04	0.66	0.02	0.87	0.51	0.41	1.36	0.04	0.02

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Super Quick ratio =4.785.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., $4.785 < 16.919$, Hence, H_0 is accepted.

Gross Working Capital Turnover Ratio

The Gross working capital turnover ratio of the company as shown in the table has varied between 4.14 during 2016 and 14.18 during 2007. It is found in the significance test that Gross working capital turnover ratio is uniform during the period of study.

Table5: Gross Working Capital turnover Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	3814.31	6085.47	8087.11	8526.39	11368.66	13836.44	16046.41	16614.87	17921.50	15619.26
Gross working capital	268.92	714.15	1108.53	1251.76	1674.12	2167.23	2881.95	2750.76	3438.06	3775.98
Ratio	14.18	8.52	7.30	6.81	6.79	6.38	5.57	6.04	5.21	4.14

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Gross Working Capital turnover ratio =9.681. The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919 Calculated value is less than Critical Value i.e., $9.681 < 16.919$, Hence, H_0 is accepted.

Net Working Capital Turnover Ratio

The net working capital turnover ratio of the company as shown in the table has varied between -162.38 during 2007 and 56.36 during 2015. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table6: Net Working Capital Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	3814.31	6085.47	8087.11	8526.39	11368.66	13836.44	16046.41	16614.87	17921.50	15619.26
Net Working Capital	-23.49	385.1	722.13	756.77	1350.41	1727.42	2468.49	2570.85	314.65	463.08
Ratio	-162.38	15.80	11.20	11.27	8.42	8.01	6.50	0.65	56.36	33.73

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Net Working capital turnover ratio =-30029.1.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e., $-30029.1 < 16.919$, Hence, H_0 is accepted.

Cash Turnover Ratio

The cash turnover ratio of the company as shown in the table has varied between 54.33 during 2012 and 484.70 during 2008. It is found in the significance test that cash turnover ratio is not uniform during the period of study.

Table7: Cash Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	3814..31	6085.47	8087.11	8526.39	11368.66	13836.44	16046.41	16614.87	17921.50	15619.26
Average Cash Balance	12.93	12.56	133.47	131.32	145.45	254.66	198.24	207.57	184.24	98.225
Ratio	295	484.70	60.59	64.93	78.16	54.33	80.94	80.05	97.27	159.02

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Cash turnover ratio =1202.176.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 1202.176>16.919, Hence, H_{06} is rejected.

Inventory Turnover Ratio

The inventory turnover ratio of the company as shown in the table has varied between 16.83 during 2014 to 29.02 during 2008. It is found in the significance test that Inventory turnover ratio is uniform during the period of study.

Table8: Inventory Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	3814..31	6085.47	8087.11	8526.39	11368.66	13836.44	16046.41	16614.87	17921.50	15619.26
Average Inventory	136.47	209.72	283.07	477.31	600.64	496.15	598.35	986.96	986.08	636.73
Ratio	27.95	29.02	28.57	17.86	18.93	27.89	26.82	16.83	18.17	24.53

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Inventory turnover ratio =9.836.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e.9.836<16.919, Hence, H_{07} is accepted.

Debtors Turnover Ratio

The debtor's turnover ratio of the company as shown in the table has varied between 5.65 during 2016 to 51.47 during 2007. It is found in the significance test that Debtors turnover ratio is not uniform during the period of study.

Table9: Debtors Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	3814..31	6085.47	8087.11	8526.39	11368.66	13836.44	16046.41	16614.87	17921.50	15619.26
Average debtors	74.63	220.71	312.39	349.67	570.27	1014.41	1543.43	1424.71	1784.12	2763.67
Ratio	51.47	27.57	25.89	24.38	19.94	13.64	10.40	11.66	10.05	5.65

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Debtors turnover ratio =80.169.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 80.169>16.919, Hence, H_{08} is rejected.

Average Collection Period

The average collection period as shown in the table has varied between 7 days during 2007 to 65 days during 2016. It is found in the significance test that Average collection period is not uniform during the period of study.

Table10: Average Collection Period (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	51.47	27.57	25.89	24.38	19.94	13.64	10.40	11.66	10.05	5.65
Average Collection Period	7	13	14	15	18	27	35	31	36	65

Source: Annual Reports of Naga Hanuman Solvent Oils Private Limited from 2006-07 to 2015-2016.

Calculated value of χ^2 for Average collection period =99.114.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e.99.114>16.919, Hence, H_{09} is rejected.

IV. CONCLUSION

It is clear that inventory occupied first place followed by debtors as a percentage of current assets in Naga Hanuman Solvent Oils Private Limited during the period of study. The Business organisation has credit worthiness because there is a significant increase in creditors during the study period. Current ratio of the company is very high during the period of study which indicates that the company is not using its current assets

efficiently. But, the current ratio was maintained at reasonable level during last two years of study. Debtors' turnover ratio was very less during the period of study which reflects in high Average collection period. Current ratio, Quick ratio, Cash turnover ratio, debtor turnover ratios and average collection periods are not uniform during the period of study and showed wide fluctuations. Collection of debts and cash utilization was poorly done in the company during the period of study. Super quick ratio, Gross working capital to total assets ratio, Gross working turnover ratio, Net working capital turnover ratio, Inventory turnover ratio, are uniform during the period of study. To conclude, Working capital Management is satisfactory in the company during last years of the study.

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Working Capital Management in Power Plant Engineering Works - A Case Study of Andhra Pradesh

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Abstract

This paper deals with working capital management in Power Plant Engineering Works. Power Plant Engineering Works is a reputed Indian electric transformer manufacturer company catering to people in Visakhapatnam, Kakinada, Rajahmundry, Srikakulam and Vizianagaram regions of Andhra Pradesh. Power Plant Engineering Works was serving people for the last Twenty four years. The company is popular for offering quality and reliable products to the customers. Their institutional clients include big giants like VCTTL, CPWD and BHEL. In this paper an attempt is made to examine the structure and composition of working capital in the Enterprise during the period of study covering ten years from 2006-07 to 2015-16. The data gathered is analysed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed. Cash turnover ratio, Inventory turnover ratio, debtor turnover ratios and average collection periods are not uniform during the period of study and showed wide fluctuations. Current ratio, Quick ratio, super quick ratio, Gross working turnover ratio, Net working capital turnover ratio are uniform during the period of study. To conclude, working capital management is satisfactory in the company.

Key words: Current Ratio, Debtors Turnover, Inventory Turnover, Net Working capital, Working capital structure

Introduction

Power Plant Engineering Works is a reputed Indian electric transformer manufacturer catering to people in Visakhapatnam, Kakinada, Rajahmundry, Srikakulam and Vizianagaram regions of Andhra Pradesh. Power Plant Engineering Works was serving people for the last Twenty four years. The company is popular for offering quality and reliable products to the customers. Depending on the work, the Company reach customer within two to three hours. Their institutional clients include big giants like VCTTL, CPWD and BHEL. This Enterprise has an annual turnover of Rs.100.70 lakhs. The total Current Assets of the company are Rs.89.72 lakhs and the current liabilities are Rs. 21.13 lakhs. The company has man power of Forty five. It is an ISO 9001:2008 certified company. In this paper an attempt is made to examine working capital management in Power Plant Engineering Works.

Review of Literature

Mishra (1975) studied the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992) in their research conducted an in-depth survey to analyze the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999) in his study

on working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency. eddy (2000) analyzed the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003) made an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004) conducted a study on the issue pertaining to the relationship between working capital management and profitability of Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012) investigated the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013) conducted a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and two and three wheelers sectors of Indian automobile industry. UtkarshGoel et al. (2015) conducted a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms. S.Selvanayaki et al. (2015) focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on profitability. Venkateswararao.P, Surya Chandra Rao.D and HemaVenkata Siva Sree.Ch (2017)¹¹ examined working capital management in PL Plast Pvt Ltd. Venkateswararao.P, and HemaVenkata Siva Sree.Ch (2018)¹² examined working capital management in Sri Rama Chandra Paper Boards Ltd. Venkateswararao.P, and HemaVenkata Siva Sree.Ch (2018)¹³ examined working capital management in Sri Nagavalli solvent oils Pvt. Ltd. Venkateswararao.P (2018)¹⁴ examined the working capital management in Cuddapah Spinning Mills Ltd. It was found that there was no study on working capital management in a transformer manufacturing company. Hence, this study is taken up.

Objectives

The general objective of the study is to examine the working capital management in Power Plant Engineering Works. The specific objectives include the following.

1. To examine the structure and composition of working capital in Power Plant Engineering Works during the period of study.
2. To analyse the liquidity position of Small Enterprise during the period of study.
3. To find the gross working capital and networking capital turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.
5. To offer suggestions for effective working capital management if required.

Hypotheses

H₀₁: Current ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₂: Quick ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₃: Super quick ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₄: Gross working capital turnover ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₅: Net working capital turnover ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₆: Cash turnover ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₇: Inventory turnover ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₈: Debtors turnover ratio in Power Plant Engineering Works is uniform during the period of study.

H₀₉: Average collection period in Power Plant Engineering Works is uniform during the period of study.

Methodology

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Power Plant Engineering Works. The period of study is ten years covering the financial years from 2006-07 to 2015-16. The data gathered is analysed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed.

Analysis and Discussion Of Results

Working capital structure of Power Plant Engineering Works is presented in table 1. It is observed that Inventory occupied highest percentage of total current assets during 2007 and 2008. It varies between 90.96 during 2007 and 5.53 during 2010. Debtors as a percentage of total current assets varied in between 4.85 during 2007, 2008 and 59.14 during 2010. It is also observed that cash and bank balance as a percentage of current assets varied between 3.59 during 2008 and 26.35 during 2009. Loans and advances as a percentage of current assets varied between 1.34 during 2009 and 45.81 during 2016. There were no loans and advances during the first two years of the study. Other current assets as a percentage of total current assets varied between 0.54 during 2008 and 8.21 during 2010. Sundry creditors as a percentage of total current liabilities varied between 14.12 during 2014 and 92.11 during 2009. Short-term borrowings by the Business organisation were nil during the period of study. Short-term provisions were nil during 2007, 2008 and 2016. Short-term provisions as a percentage of current liabilities were 3.59 during 2013 and 17.79 during 2014. Other current liabilities were nil during 2009. It varies between 22.31 during 2008 and 68.09 during 2014. It is observed that Net Working Capital in the company varied between Rs.7.31 Lakhs during 2007 to Rs.68.59 Lakhs during 2016. It was maintained at high levels during 2015 and 2016.

Table-1: Working Capital structure of Power Plant Engineering Works during 2006-2007 to 2015-2016

(Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	0.77	0.8	5.92	4.88	8.65	11.88	11.37	8.42	17.89	13.65
% of TCA	3.63	3.59	26.35	8.38	11.44	19.07	18.70	15.62	22.57	15.21
Debtors	1.03	1.08	7.92	34.45	28.71	15.49	17.54	19.36	24.64	22.05
% of TCA	4.85	4.85	35.25	59.14	37.97	24.86	28.84	35.93	31.09	24.58
Loans & Advances	0	0	0.3	10.92	18.62	17.28	20.36	15.44	22.83	41.1
% of TCA	0.00	0.00	1.34	18.75	24.63	27.74	33.48	28.65	28.80	45.81
Other Current Assets	0.12	0.12	0.22	4.78	0.67	2.4	1.88	3.11	5.07	4.43
% of TCA	0.57	0.54	0.98	8.21	0.89	3.85	3.09	5.77	6.40	4.94
Inventory	19.31	20.27	8.11	3.22	18.96	15.25	9.66	7.56	8.83	8.49
% of TCA	90.96	90.94	36.09	5.53	25.08	24.48	15.89	14.03	11.14	9.46
Total Current Assets (TCA)	21.23	22.29	22.47	58.25	75.61	62.3	60.81	53.89	79.26	89.72
Current Liabilities										
Sundry Creditors	10.81	11.35	7.71	20.16	25.85	14.41	17.6	3.46	12.33	6.96
% of TCL	77.66	77.69	92.11	47.37	42.74	34.15	44.17	14.12	29.71	32.94
Other current liabilities	3.11	3.26	0	17.81	30.09	23.14	20.82	16.69	24.35	14.17
% of TCL	22.34	22.31	0.00	41.85	49.75	54.83	52.25	68.09	58.67	67.06
Short term borrowings	0	0	0	0	0	0	0	0	0	0
% of TCL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Short term provisions	0	0	0.66	4.59	4.54	4.65	1.43	4.36	4.82	0
% of TCL	0.00	0.00	7.89	10.78	7.51	11.02	3.59	17.79	11.61	0.00
Total Current Liabilities (TCL)	13.92	14.61	8.37	42.56	60.48	42.2	39.85	24.51	41.5	21.13
NWC	7.31	7.68	14.1	15.69	15.13	20.1	20.96	29.38	37.76	68.59

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Current Ratio

The current ratio in the company was maintained at normal level in the company. It has varied between 1.25 during 2011 and 4.24 during 2016 was shown in the table. It is found in the significance test that current ratio is uniform during the period of study.

Table-2: Current Ratio

(Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	21.23	22.29	22.47	58.25	75.61	62.3	60.81	53.89	79.26	89.72
Current Liabilities	13.92	14.61	8.37	42.56	60.48	42.2	39.85	24.51	41.5	21.13
Current ratio	1.52	1.52	2.68	1.36	1.25	1.47	1.52	2.19	1.90	4.24

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for current ratio = 3.795.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 3.795 < 16.919. H_0 is accepted.

Quick Ratio

The quick ratio of the company as shown in the table has varied between 0.14 during 2007, 2008 to 3.84 during 2016. It is found in the significance test that quick ratio is uniform during the period of study.

Table -3: Quick Ratio

(Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	1.92	2.02	14.36	55.03	56.65	47.05	51.15	46.33	70.43	81.23
Current Liabilities	13.92	14.61	8.37	42.56	60.48	42.2	39.85	24.51	41.5	21.13
Quick ratio	0.14	0.14	1.72	1.29	0.94	1.11	1.28	1.89	1.70	3.84

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for Quick ratio =7.034.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 7.034<16.919, Hence, H_{02} is accepted.

Super Quick Ratio

The super quick ratio of the company as shown in the table has varied between 0.05 during 2008 and 0.71 during 2009. It is found in the significance test that super quick ratio is uniform during the period of study.

Table-4: Super Quick Ratio

(Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	0.77	0.8	5.92	4.88	8.65	11.88	11.37	8.42	17.89	13.65
Current Liabilities	13.92	14.61	8.37	42.56	60.48	42.2	39.85	24.51	41.5	21.13
Super Quick ratio	0.06	0.05	0.71	0.11	0.14	0.28	0.29	0.34	0.43	0.65

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for Super Quick ratio =1.605.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919.

Calculated value is less than Critical Value i.e., 1.605<16.919, Hence, H_{03} is accepted.

Gross Working Capital Turnover Ratio

The Gross working capital turnover ratio of the company as shown in the table has varied between 1.28 during 2007, 2008 and 4.59 during 2009. It is found in the significance test that Gross working capital turnover ratio is uniform during the period of study.

Table-5: Gross Working Capital turnover Ratio

(Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	27.25	28.61	103.24	131.79	139.77	109.66	96.96	71.13	94.62	100.70
Gross working capital	21.23	22.29	22.47	58.25	75.61	62.3	60.81	53.89	79.26	89.72
Ratio	1.28	1.28	4.59	2.26	1.85	1.76	1.59	1.32	1.19	1.12

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for Gross Working Capital turnover ratio =5.287.

The Critical value of x_2 at 9 degrees of freedom at 5% level of Significance is 16.919
 Calculated value is less than Critical Value i.e., $5.287 < 16.919$, Hence, H_{04} is accepted.

Net Working Capital Turnover Ratio

The net working capital turnover ratio of the company as shown in the table has varied between 1.47 during 2016 and 9.24 during 2011. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table-6: Net Working Capital Turnover Ratio

(Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	27.25	28.61	103.24	131.79	139.77	109.66	96.96	71.13	94.62	100.70
Net Working Capital	7.31	7.68	14.1	15.69	15.13	20.1	20.96	29.38	37.76	68.59
Ratio	3.73	3.73	7.32	8.40	9.24	5.46	4.63	2.42	2.51	1.47

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.
 Calculated value of x_2 for Net Working capital turnover ratio =13.022.

The Critical value of x_2 at 9 degrees of freedom at 5% level of Significance is 16.919
 Calculated value is less than Critical Value i.e., $13.022 < 16.919$, Hence, H_{05} is accepted.

Cash Turnover Ratio

The cash turnover ratio of the company as shown in the table has varied between 6.39 during 2016 and 36.22 during 2008. It is found in the significance test that cash turnover ratio is not uniform during the period of study.

Table-7: Cash Turnover Ratio

(Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	27.25	28.61	103.24	131.79	139.77	109.66	96.96	71.13	94.62	100.70
Average Cash Balance	0.77	0.79	3.36	5.4	6.77	10.27	11.62	9.90	13.16	15.77
Cash Turnover Ratio	35.39	36.22	30.73	24.41	20.65	10.68	8.34	7.18	7.19	6.39

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.
 Calculated value of x_2 for Cash turnover ratio =72.391.

The Critical value of x_2 at 9 degrees of freedom at 5% level of Significance is 16.919
 Calculated value is greater than Critical Value i.e. $72.391 > 16.919$, Hence, H_{06} is rejected.

Inventory Turnover Ratio

The inventory turnover ratio of the company as shown in the table has varied between 1.41 during 2007 to 23.26 during 2010. It is found in the significance test that Inventory turnover ratio is not uniform during the period of study.

Table-8: Inventory Turnover Ratio

(Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	27.25	28.61	103.24	131.79	139.77	109.66	96.96	71.13	94.62	100.70
Average Inventory	19.31	19.79	14.19	5.665	11.09	17.105	12.455	8.61	8.195	8.66
Ratio	1.41	1.45	7.28	23.26	12.60	6.41	7.78	8.26	11.55	11.63

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.
 Calculated value of x_2 for Inventory turnover ratio =38.827.

The Critical value of x_2 at 9 degrees of freedom at 5% level of Significance is 16.919
 Calculated value is greater than Critical Value i.e. $38.827 > 16.919$, Hence, H_{07} is rejected.

Debtors Turnover Ratio

The debtors' turnover ratio of the company as shown in the table has varied between 3.86 during 2014 to 26.99 during 2008. It is found in the significance test that Debtors turnover ratio is not uniform during the period of study.

Table-9: Debtors Turnover Ratio

(Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	27.25	28.61	103.24	131.79	139.77	109.66	96.96	71.13	94.62	100.70
Average debtors	1.03	1.06	4.5	21.19	31.58	22.1	16.52	18.45	22	23.35
Debtors Turnover Ratio	26.46	26.99	22.94	6.22	4.43	4.96	5.87	3.86	4.30	4.31

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for Debtors turnover ratio =82.172.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e., $82.172 > 16.919$, Hence, H_{08} is rejected.

Average Collection Period

The average collection period as shown in the table has varied between 14 days during 2007, 2008 to 95 days during 2014. It is found in the significance test that Average collection period is not uniform during the period of study.

Table-10: Average Collection Period

(Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	26.46	26.99	22.94	6.22	4.43	4.96	5.87	3.86	4.30	4.31
Average Collection Period	14	14	16	59	82	74	62	95	85	85

Source: Annual Reports of Power Plant Engineering Works from 2006-07 to 2015-2016.

Calculated value of χ^2 for Average collection period =507.877.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. $507.877 > 16.919$, Hence, H_{09} is rejected.

Conclusion

It is clear that inventory occupied first place followed by debtors as a percentage of current assets in Power Plant Engineering Works during the period of study. Current ratio of the company is maintained at normal level which indicates that liquidity in the company is good. Debtors' turnover ratio was very less in the last seven years of the study which reflects in high Average collection period. Cash turnover ratio, Inventory turnover ratio, debtor turnover ratios and average collection periods are not uniform during the period of study and showed wide fluctuations. Collection of debts and cash utilization was poorly done in the company during the period of study. Current ratio, Quick ratio, super quick ratio, Gross working turnover ratio, Net working capital turnover ratio are uniform during the period of study. To conclude, working capital management is satisfactory in the company.

Andhra Pradesh New Industrial Development Policy – A Testimony for Commitment

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Abstract: The new state of Andhra Pradesh in India was formed on June 2nd 2014 by the Andhra Pradesh Reorganization Act. Andhra Pradesh has strong base in Cement industry, Paper industry, Food processing industry, Aqua culture, Steel industry, Fertilizer industry, chemicals and Petrochemical industry, textile industry, automobile industry and in ship building. Andhra Pradesh Government gave top priority to the development of industrial sector. The prime objectives of the Government are to make state, a centre for innovation and technology and also to make it a progressive and highly industrialised state. The Government had introduced its new Industrial Development Policy to make Andhra Pradesh most preferred destination for investors. The new policy aims at creating favourable business climate, excellent infrastructure, good law and order and peaceful industrial relations. The new policy aims to create a productive ecosystem thereby helping industries of Andhra Pradesh to become innovative and globally competitive. In this paper an attempt is made to explain incentives offered under the new Industrial development policy to Large Enterprises, MSMEs, Women Entrepreneurs and Incentives to Backward Class, SC and ST entrepreneurs.

Keywords: Incentives, Large Enterprises, MSMEs, Women Entrepreneurs, Industrial Development

I. INTRODUCTION

The new state of Andhra Pradesh in India was formed on June 2nd 2014 by the Andhra Pradesh Reorganization Act. It contains thirteen districts. The state is blessed with long sea coast. It is having a strategic advantage of being the Gateway to East and South-East Asia. It is having good water resources useful for industrial development with two perennial rivers. Andhra Pradesh has strong base in Cement industry, Paper industry, Food processing industry, Aqua culture, Steel industry, Fertilizer industry, chemicals and Petrochemical industry, textile industry, automobile industry and in ship building. Emerging industries include electronics, hardware and aerospace industries. Andhra Pradesh Government gave top priority to the development of industrial sector. The prime objectives of the Government are to make state, a centre for innovation and technology and also to make it a progressive and highly industrialised state and to make its population confident about its future. The Government had introduced its new Industrial Development Policy to make Andhra Pradesh most preferred destination for investors. The new policy aims at creating favourable business climate, excellent infrastructure, good law and order and peaceful industrial relations. The new policy aims to create a productive ecosystem thereby helping industries of Andhra Pradesh to become innovative and globally competitive. Government also laid emphasis on sustainable industrial development coupled with capacity building at the grass roots level. The incentives offered under the Andhra Pradesh new Industrial Development policy can be grouped into six heads. They include Incentives offered to Large Enterprises, Incentives to MSMEs, Incentives to Women Entrepreneurs, Incentives to Backward Class entrepreneurs, Incentives to SC and ST entrepreneurs and Incentives to Mega projects.

II. REVIEW OF LITERATURE

Somayajulu V. V. N. (1994) made a study on Industrial Development in Andhra Pradesh. His period of study is 1956-1980. He had examined role of parameters relating to structure in industrial development. Kambhampati (1996) made a study on microeconomic performance of the Indian industry. Her study was based on RBI data for fifteen years. She had examined the conduct, pattern of structure and performance of the industries during the study period. Narayanan (1998) had done a study in Indian Automobile Industry. He had analysed the effects of policy of deregulation on technology acquisition and competitiveness in the Indian automobile industry during the 1980s. Piplai (2001) carried out a study on the effects of liberalisation on the Indian vehicle industry. Katz and Shelanski (2004) had done a study on the developing role of innovation in merger policy of USA. Cecile Carpenter and Jean Marc Suret (2005) reviewed the taxation policy introduced by the government for the progress of the MSME sector. They suggested that there is an urgent need to introduce more result-oriented measures. Sharma (2006) conducted a study on the performance of the Indian auto industry with respect to the productivity growth. His study covered the data from 1990-91 to 2003-04. Venkateswararao.P, Siva Sree.Ch and Suryachandra Rao.D (2017) examined comprehensively the various

schemes introduced by the Government of India for the development of MSMEs. Venkateswararao.P had examined various aspects of MSME policy of Andhra Pradesh. Venkateswararao.P had reviewed tourism policy of Andhra Pradesh.

After doing extensive review of literature it was found that there was no study which exclusively dealt with new industrial Development Policy of Andhra Pradesh. Hence, this study was taken up.

Objectives

The main objective of this paper entitled “Andhra Pradesh New Industrial Development Policy – A Testimony for Commitment” to examine the new Industrial Development Policy of Andhra Pradesh. The specific objectives are the following

1. To explain incentives offered in new Industrial Development policy to Large Enterprises in Andhra Pradesh.
2. To elucidate incentives offered in new Industrial Development policy to MSMEs in Andhra Pradesh.
3. To spell out incentives offered in new Industrial Development policy to Women Entrepreneurs in Andhra Pradesh.
4. To throw light on Incentives offered to Back ward Class entrepreneurs and Incentives offered to SC and ST entrepreneurs in new Industrial Development policy of Andhra Pradesh.
5. To explicate Incentives offered to Mega projects

III. METHODOLOGY

The study namely “Andhra Pradesh New Industrial Development Policy – A Testimony for Commitment” is a descriptive and theoretical study. An attempt is made to review the existing literature on Industrial development and other related issues. After extensive survey of the literature it is found that there was no specific study which dealt with Andhra Pradesh New Industrial Development Policy. Hence, this study is made.

Incentives to Large Enterprises

1. The large industry means an Enterprise in which investment in plant and machinery is less than five hundred crores or any Enterprise other than MSMEs.
2. When the company purchases land for industrial purpose, hundred per cent of stamp duty and transfer duty paid by the company will be reimbursed by the Government. This will be reimbursed only one time on the land. It will not be reimbursed on subsequent transactions on the same land.
3. Hundred per cent of stamp duty will be reimbursed by the Government, for lease of land or shed or buildings, mortgages and hypothecations.
4. Government assures to provide uninterrupted quality power to all companies operating in the state.
5. For large companies fixed power cost at the rate of one rupee per unit will be reimbursed from the date of commencement of commercial production for a period of five years.
6. Fifty per cent of SGST will be reimbursed from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment with in the period.
7. Large companies which are engaged in waste recycling are exempted from the payment of sales tax.
8. If companies adopt specific cleaner production measures and are certified by the Andhra Pradesh Pollution Control Board (APPCB), they get a ten per cent subsidy on the cost of plant and machinery up to Thirty five lakhs.
9. Large companies also get Twenty Five per cent subsidy on total fixed capital investment of the project with a limit of Rupees Fifty Crores on adoption of green measures. Green measures include Waste water treatment, Green Buildings, use of renewable source of power, Installing Continuous Emission Monitoring System (CEMS) for red category industries and adopting rain water harvesting

Incentives to MSMEs

1. When the MSME purchase land for industrial purpose, hundred per cent of stamp duty and transfer duty paid by the MSME will be reimbursed by the Government. This will be reimbursed only one time on the land. It will not be reimbursed on subsequent transactions on the same land.
2. Hundred per cent of stamp duty will be reimbursed by the Government, for lease of land or shed or buildings, mortgages and hypothecations.
3. Government assures to provide uninterrupted quality power to all MSMEs operating in the state.
4. For MSMEs fixed power cost at the rate of one rupee per unit will be reimbursed from the date of commencement of commercial production for a period of five years.
5. Hundred per cent of SGST will be reimbursed for Micro and Small Enterprises from the time of commencement of commercial production for a period of five years.
6. Seventy Five per cent of SGST will be reimbursed for Medium Enterprises from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment with in the period.

7. MSMEs which are engaged in waste recycling are exempted from the payment of sales tax.
8. If MSMEs adopt specific cleaner production measures and are certified by the Andhra Pradesh Pollution Control Board (APPCB), they get a Thirty Five per cent subsidy on the cost of plant and machinery up to Thirty five lakhs.
9. MSMEs also get Twenty Five per cent subsidy on total fixed capital investment of the project with a limit of Rupees Fifty Crores on adoption of green measures. Green measures include Waste water treatment, Green Buildings, use of renewable source of power, Installing Continuous Emission Monitoring System (CEMS) for red category industries, adopting rain water harvesting and any other project of environment management approved by the concerned committee of secretaries.

Incentives to Women Entrepreneurs

Special Incentives apart from all other incentives are offered under the policy to units established by women entrepreneurs as sole proprietors or to units established as partnership or private limited companies having hundred per cent share of women entrepreneurs.

1. Twenty Five per cent subsidy with a limit of Thirty Lakhs per unit on fixed capital investment.
2. Fifteen per cent of Machinery cost will be paid as subsidy to first generation women entrepreneurs in the form of seed capital assistance. This will be deducted from investment subsidy given.

Incentives to Back ward class Entrepreneurs

Special Incentives apart from all other incentives are offered under the policy to units established by Back ward Class entrepreneurs as sole proprietors or to units established as partnership or private limited companies having hundred per cent share of Back ward Class entrepreneurs.

1. When the Back ward Class entrepreneur purchases land for industrial purpose, hundred per cent of stamp duty and transfer duty paid by the Back ward Class entrepreneur will be reimbursed by the Government.
2. Hundred per cent of stamp duty will be reimbursed Back ward Class entrepreneurs by the Government, for lease of land or shed or buildings, mortgages and hypothecations.
3. Fifty per cent rebate on land cost will be given to Backward Class Entrepreneurs in industrial estates or industrial parks to a limit of Rs. Twenty Lakhs.
4. Twenty Five per cent land conversion charges will be paid to Backward Class Entrepreneurs up to a limit of Rs. Ten Lakhs.
5. For Backward Class Entrepreneurs fixed power cost at the rate of one rupee Fifty paise per unit will be reimbursed from the date of commencement of commercial production for a period of five years.
6. Twenty Five per cent of Machinery cost will be paid as subsidy to first generation Backward Class Entrepreneurs in the form of seed capital assistance. This will be deducted from investment subsidy given.
7. With a maximum limit per unit of Rupees Seventy Five Lakhs, Thirty five per cent investment subsidy on fixed capital investment is offered to Backward Class Entrepreneurs and forty five per cent to Backward Class women Entrepreneurs
8. Hundred per cent of SGST will be reimbursed for Micro and Small Enterprises established by Backward Class Entrepreneurs from the time of commencement of commercial production for a period of five years.
9. Seventy Five per cent of SGST will be reimbursed for Medium Enterprises established by Backward Class Entrepreneurs from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment with in the period.
10. Fifty per cent of SGST will be reimbursed for Large Enterprises established by Backward Class Entrepreneurs from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment with in the period.
11. Interest subsidy on term loans taken was offered to Backward Class Entrepreneurs on fixed capital investment. This subsidy was offered for a period of five years from the date of commencement of commercial production. Here, Maximum reimbursement is up to Nine per cent and subsidy is given on interest rate in excess of three per cent.
12. Infrastructure facilities like road, power and water will be provided to stand alone enterprises established by Backward Class Entrepreneurs by bearing Fifty per cent cost subject to fulfilment of certain conditions.
13. Fifty per cent reimbursement of the cost will be done for Backward Class Entrepreneurs in case of skill up gradation and training of local manpower subject to a limit of Rupees five thousand per person.
14. Fifty per cent subsidy was offered to MSMEs established by Backward Class Entrepreneurs with a limit of Rupees three lakhs on the expenses incurred in patent registration and quality certification.
15. Apart from above Swachh Andhra incentives are also offered to Backward Class Entrepreneurs

Incentives to SC and ST Entrepreneurs

Special Incentives apart from all other incentives are offered under the policy to units established by SC and ST entrepreneurs as sole proprietors or to units established as partnership or private limited companies having hundred per cent share of SC and ST entrepreneurs.

1. When the SC and ST entrepreneurs purchase land for industrial purpose, hundred per cent of stamp duty and transfer duty paid by the SC and ST entrepreneurs will be reimbursed by the Government.
2. Hundred per cent of stamp duty will be reimbursed SC and ST entrepreneurs by the Government, for lease of land or shed or buildings, mortgages and hypothecations.
3. Fifty per cent rebate on land cost will be given to SC and ST entrepreneurs in industrial estates or industrial parks to a limit of Rs. Twenty Lakhs.
4. Twenty Five per cent land conversion charges will be paid to SC and ST entrepreneurs up to a limit of Rupees Ten Lakhs.
5. For SC and ST entrepreneurs fixed power cost at the rate of one rupee Fifty paise per unit will be reimbursed from the date of commencement of commercial production for a period of five years.
6. Twenty Five per cent of Machinery cost will be paid as subsidy to first generation SC and ST entrepreneurs in the form of seed capital assistance. This will be deducted from investment subsidy given.
7. With a maximum limit per unit of Rupees Seventy Five Lakhs, Thirty five per cent investment subsidy on fixed capital investment is offered to SC and ST entrepreneurs and forty five per cent to SC and ST women entrepreneurs. An additional Five per cent investment subsidy for ST entrepreneurs if they set up units in scheduled areas.
8. Hundred per cent of SGST will be reimbursed for Micro and Small Enterprises established by SC and ST entrepreneurs from the time of commencement of commercial production for a period of five years.
9. Seventy Five per cent of SGST will be reimbursed for Medium Enterprises established by SC and ST entrepreneurs from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment within the period.
10. Fifty per cent of SGST will be reimbursed for Large Enterprises established by SC and ST entrepreneurs from the time of commencement of commercial production for a period of seven years. This will be done up to realisation of fixed capital investment within the period.
11. Interest subsidy on term loans taken was offered to SC and ST entrepreneurs on fixed capital investment. This subsidy was offered for a period of five years from the date of commencement of commercial production. Here, Maximum reimbursement is up to Nine per cent and subsidy is given on interest rate in excess of three per cent. This benefit is offered to service sector units also.
12. Infrastructure facilities like road, power and water will be provided to stand alone enterprises established by SC and ST entrepreneurs by bearing Fifty per cent cost subject to fulfilment of certain conditions.
13. Fifty per cent reimbursement of the cost will be done for SC and ST entrepreneurs in case of skill up gradation and training of local manpower subject to a limit of Rupees five thousand per person.
14. Fifty per cent subsidy was offered to MSMEs established by SC and ST entrepreneurs with a limit of Rupees three lakhs on the expenses incurred in patent registration and quality certification.
15. Apart from above Swachh Andhra incentives are also offered to SC and ST entrepreneurs.

Incentives to Mega projects

Projects involving an investment of Rupees Five hundred crores or projects which provide direct employment opportunities to Two thousand persons are defined as Mega projects. The Government assured in the policy that tailors made benefits on case to case basis will be offered to Entrepreneurs of Mega projects. Factors to be considered while offering benefits include technology, project's importance to the state's industrial growth, pioneering nature, the gestation period, location aspects, revenues for the state and its ability to generate large scale employment for people

IV. CONCLUSION

The new Industrial Development policy of Andhra Pradesh aims to create a productive ecosystem thereby helping industries of Andhra Pradesh to become innovative and globally competitive. Government also laid emphasis on sustainable industrial development coupled with capacity building at the grass roots level. The incentives provided for large scale enterprises, MSMEs, Women entrepreneurs, Back ward Class entrepreneurs and SC and ST entrepreneurs in the policy is really a testimony for the commitment of the Government towards industrial development in Andhra Pradesh.

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Working Capital Management in Small Enterprise -A Case Study of Radika Vegetables Oils Pvt. Ltd

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Abstract: This paper deals with working capital management in Radhika Vegetables Oils Pvt. Ltd., which is an Indian Small Enterprise of Vizianagaram district in the state of Andhra Pradesh. It is engaged in production, extraction and delivery of palm oil to major Vanaspati makers in India. It was the first company in India to import Oil Palm sprouts and to start a 5MT per hour extraction unit. In this paper an attempt is made to examine the structure and composition of working capital in the Enterprise during the period of study covering ten years from 2006-07 to 2015-16. An attempt is also made to analyze the liquidity position, to find the gross working capital and networking capital turnover and to examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.

Keywords –Current ratio, Gross Working Capital, Net Working capital, Inventory turnover, Small Enterprise

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I. Introduction

Radhika Vegetables Oils Pvt. Ltd. is an Indian unlisted private company in the state of Andhra Pradesh. It was located at Garividi of Vizianagaram District. It was incorporated on 06 February, 1984. The total paid-up capital of the company is Rupees 87.75 lakhs. Secured loans in the company are 87.05 lakhs. It is engaged in production, extraction and delivery of palm oil to major Vanaspati makers in India. It was the first company in India to import Oil Palm sprouts and to start a 5MT per hour extraction unit. Radhika Vegetables Oils Pvt. Ltd. today sources palm fruit from over Fifteen thousand acres of assisted plantations in over ten mandals within Andhra Pradesh. This Small Enterprise has an annual turnover of Rs.2719.51 lakhs. The total Current Assets of the company are Rs.378.6 lakhs and the current liabilities are Rs. 667.78 lakhs. The company had provided employment to fifty people. In this paper an attempt is made to examine working capital management in Radhika Vegetables Oils Pvt. Ltd.

Review of literature

Mishra (1975)¹ studied the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992)² in their research conducted an in-depth survey to analyze the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999)³ in his study on working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency. Reddy (2000)⁴ analyzed the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003)⁵ made an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004)⁶ conducted a study on the issue pertaining to the relationship between working capital management and profitability of a Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012)⁷ investigated the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013)⁸ conducted a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and two and three wheeler sectors of Indian automobile industry. Utkarsh Goel et al. (2015)⁹ conducted a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms. S. Selvanayagi et al. (2015)¹⁰ focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on profitability. Venkateswararao.P, Surya Chandra Rao.D and HemaVenkata Siva Sree.Ch (2017)¹¹ examined working capital management in PL Plast Pvt Ltd. Venkateswararao.P, and HemaVenkata Siva Sree.Ch (2018)¹² examined working capital management in Sri Rama Chandra Paper Boards Ltd. Venkateswararao.P, and

HemaVenkata Siva Sree.Ch (2018)¹³ examined working capital management in Sri Nagavalli solvent oils Pvt. Ltd. Venkateswararao.P (2018)¹⁴ examined working capital management in Cuddapah Spinning Mills Ltd. It was found that there was no study on working capital management in a Vegetable oil company. Hence, this study is taken up.

II. Objectives

The general objective of the study is to examine the working capital management in RadhikaVegetable Oils Pvt. Ltd. The specific objectives include the following.

1. To examine the structure and composition of working capital in Radhika Vegetable Oils Pvt. Ltd. during the period of study.
2. To analyze the liquidity position of Small Enterprise during the period of study.
3. To find the gross working and networking turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.
5. To offer suggestions for effective working capital management if required.

Hypotheses

H₀₁:Current ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₂:Quick ratioin Radhika Vegetable Oils Pvt. Ltd.is uniform during the period of study.

H₀₃:Super quick ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₄:Gross working capital turnover ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₅:Net working capital turnover ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₆:Cash turnover ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₇:Inventory turnover ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₈:Debtors turnover ratioin Radhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

H₀₉:Average collection period inRadhika Vegetable Oils Pvt. Ltd. is uniform during the period of study.

III. Methodology

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Radhika Vegetable Oils Pvt. Ltd. The period of study is ten years covering the financial years from 2006-07 to 2015-16.The data gathered is analyzed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed.

Analysis and discussion of results

Working capital structure of Radhika Vegetables Oils Pvt. Ltd.is presented in table1. It is observed that Inventory occupied lowest percentage of total current assets during the period of study except in 2015. It varies between 5.51 during 2010 and 34.60 during 2015. Debtors as a percentage of total current assets varied in between 21.74 during 2008 and 64.11 during 2010. It is also observed that cash and bank balance as a percentage of current assets varied between 6.51 during 2015 and 52.82 during 2008. Loans and advances as a percentage of current assets varied between 14.71 during 2011 and 34.76 during 2015. There were no other current assets during the period of study. Sundry creditors occupied the highest portion in the current liabilities. Sundry creditors as a percentage of total current liabilities varied between 73.35 during 2008 and 96.29 during 2016. Short-term borrowings by the Business organisation were nil during the period of study. Short-term provisions were maintained for the first six years of study. Short-term provisions as a percentage of current liabilities varied in between 0.37 during 2009 and 19.70 during 2008. Other current liabilities as a percentage of total current liabilities varied between 1.63 during 2007 and 14.53 during 2011. It is observed that Net Working Capital in the company varied between Rs.-289.18 Lakhs during 2016 to Rs.251.62 Lakhs during 2012. Net Working Capital is negative during the last three years of the study; this indicates that the company has a substantial increase in its accounts payable as a result of a large purchase. It was maintained at high level during 2012.

Table 4.2.1: Working Capital structure of Radhika Vegetables Oils Pvt. Ltd. during 2006-2007 to 2015-2016 (Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	61.45	135.96	39.85	27.28	129.94	118.35	83.34	100.53	21.18	130.22
% of TCA	23.65	52.82	12.51	8.52	41.50	23.93	22.25	26.14	6.51	34.40
Debtors	91.15	55.97	160.67	205.18	108.01	199.38	122.71	154.75	78.54	86.35
% of TCA	35.09	21.74	50.44	64.11	34.50	40.32	32.77	40.24	24.13	22.81
Loans & Advances	81.78	46.31	81.44	69.93	44.38	136.4	93.88	75.81	113.11	66.29
% of TCA	31.48	17.99	25.57	21.85	14.17	27.58	25.07	19.71	34.76	17.51
Other Current Assets	0	0	0	0	0	0	0	0	0	0
% of TCA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Inventory	25.4	19.16	36.57	17.62	30.78	40.41	73.57	53.44	112.59	95.74
% of TCA	9.78	7.44	11.48	5.51	9.83	8.17	19.64	13.90	34.60	25.29
Total Current Assets (TCA)	259.78	257.4	318.53	320.02	313.11	494.54	374.5	384.53	325.42	378.6
Current Liabilities										
Sundry Creditors	77.61	88.63	146.52	238.14	173.12	198.22	279.88	396.73	550.72	643.03
% of TCL	89.60	73.35	89.52	89.45	79.07	81.60	89.36	95.76	95.79	96.29
Other current liabilities	1.41	8.4	16.55	25.35	31.82	21.04	33.32	17.58	24.19	24.75
% of TCL	1.63	6.95	10.11	9.52	14.53	8.66	10.64	4.24	4.21	3.71
Short term borrowings	0	0	0	0	0	0	0	0	0	0
% of TCL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Short term provisions	7.6	23.8	0.6	2.75	14	23.46	0	0	0	0
% of TCL	8.77	19.70	0.37	1.03	6.39	9.66	0.00	0.00	0.00	0.00
Total Current Liabilities (TCL)	86.62	120.83	163.67	266.24	218.94	242.92	313.2	414.31	574.91	667.78
NWC	173.16	136.57	154.86	53.78	94.17	251.62	61.3	-29.78	-249.49	-289.18

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Current Ratio

The current ratio in the company was maintained at normal level in the company except last three years of study. It has varied between 0.56 during 2015, 2016 and 2.99 during 2007 is shown in the table. It is found in the significance test that current ratio is uniform during the period of study.

Table-2: Current Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	259.78	257.4	318.53	320.02	313.11	494.54	374.5	384.53	325.42	378.6
Current Liabilities	86.62	120.83	163.67	266.24	218.94	242.92	313.2	414.31	574.91	667.78
Current ratio	2.99	2.13	1.94	1.20	1.43	2.03	1.19	0.92	0.56	0.56

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for current ratio = 3.60.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., 3.60 < 16.919. H_0 is accepted.

Quick Ratio

The quick ratio of the company as shown in the table has varied between 0.37 during 2015 to 2.70 during 2007. It is found in the significance test that quick ratio is uniform during the period of study.

Table-3: Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	234.38	238.24	281.96	302.4	282.33	454.13	300.93	331.09	212.83	282.86
Current Liabilities	86.62	120.83	163.67	266.24	218.94	242.92	313.2	414.31	574.91	667.78
Quick ratio	2.70	1.97	1.72	1.13	1.28	1.86	0.96	0.79	0.37	0.42

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Quick ratio = 3.742.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., 3.742 < 16.919, Hence, H_0 is accepted.

Super Quick Ratio

The super quick ratio of the company as shown in the table has varied between 0.03 during 2015 and 1.12 during 2008. It is found in the significance test that super quick ratio is uniform during the period of study.

Table-4: Super Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	61.45	135.96	39.85	27.28	129.94	118.35	83.34	100.53	21.18	130.22
Current Liabilities	86.62	120.83	163.67	266.24	218.94	242.92	313.2	414.31	574.91	667.78
Super Quick ratio	0.70	1.12	0.24	0.10	0.59	0.48	0.26	0.24	0.03	0.19

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Super Quick ratio =2.513.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., 2.513<16.919, Hence, H_{03} is accepted.

Gross Working Capital Turnover Ratio

The Gross working capital turnover ratio of the company as shown in the table has varied between 0.34 during 2009 and 8.71 during 2015. It is found in the significance test that Gross working capital turnover ratio is uniform during the period of study.

Table-5: Gross Working Capital turnover Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	729.5	832.2	111.2	779.4	1200.7	2120.9	2084.1	2737.6	2836.8	2719.5
Gross Working Capital	259.8	257.4	318.5	320.0	313.11	494.54	374.5	384.53	325.42	378.6
Ratio	2.80	3.23	0.34	2.43	3.83	4.28	5.56	7.11	8.71	7.18

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Gross Working Capital turnover ratio =13.066.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., 13.066<16.919, Hence, H_{04} is accepted.

Net Working Capital Turnover Ratio

The net working capital turnover ratio of the company as shown in the table has varied between -91.92 during 2014 and 33.99 during 2013. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table-6: Net Working Capital Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	729.5	832.2	111.2	779.4	1200.8	2120.99	2084.12	2737.67	2836.88	2719.51
NetWorking Capital	173.16	136.57	154.86	53.78	94.17	251.62	61.3	-29.78	-249.49	-289.18
Ratio	4.21	6.09	0.71	14.49	12.75	8.42	33.99	-91.92	-11.37	-9.40

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Net Working capital turnover ratio =-3190.25.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., -3190.25<16.919, Hence, H_{05} is accepted.

Cash Turnover Ratio

The cash turnover ratio of the company as shown in the table has varied between 1.26 during 2009 and 46.62 during 2015. It is found in the significance test that cash turnover ratio is not uniform during the period of study.

Table-7: Cash Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	729.5	832.2	111.20	779.44	1200.75	2120.99	2084.12	2737.67	2836.88	2719.51
AverageCash Balance	42.51	98.70	87.90	33.56	78.61	124.14	100.84	91.93	60.85	75.7
Ratio	17.16	8.43	1.26	23.22	15.27	17.08	20.66	29.77	46.62	35.92

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Cash turnover ratio =72.829.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. $72.829 > 16.919$, Hence, H_{06} is rejected.

Inventory Turnover Ratio

The inventory turnover ratio of the company as shown in the table has varied between 3.99 during 2009 to 59.59 during 2012. It is found in the significance test that Inventory turnover ratio is not uniform during the period of study.

Table-8: Inventory Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	729.5	832.2	111.20	779.44	1200.75	2120.99	2084.12	2737.67	2836.88	2719.51
Average Inventory	18.96	22.28	27.86	27.09	24.2	35.59	56.99	63.50	83.01	104.16
Ratio	38.47	37.35	3.99	28.77	49.61	59.59	36.56	43.11	34.17	26.10

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Inventory turnover ratio =55.302.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. $55.302 > 16.919$, Hence, H_{07} is rejected.

Debtors Turnover Ratio

The debtors’ turnover ratio of the company as shown in the table has varied between 1.02 during 2009 to 32.98 during 2016. It is found in the significance test that Debtors turnover ratio is not uniform during the period of study.

Table-9: Debtors Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	729.5	832.2	111.20	779.44	1200.75	2120.99	2084.12	2737.67	2836.88	2719.51
Average debtors	74.25	73.56	108.32	182.925	156.59	153.69	161.04	138.73	116.64	82.445
Ratio	9.82	11.31	1.02	4.26	7.66	13.80	12.94	19.73	24.32	32.98

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Debtors turnover ratio =60.108.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e., $60.108 > 16.919$, Hence, H_{08} is rejected.

Average Collection Period

The average collection period as shown in the table has varied between 11 days during 2016 to 357 days during 2009. It is found in the significance test that Average collection period is not uniform during the period of study.

Table-10: Average Collection Period (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	9.82	11.31	1.02	4.26	7.66	13.80	12.94	19.73	24.32	32.98
Average Collection Period	37	32	357	85	47	26	28	18	15	11

Source: Annual Reports of Radhika Vegetables Oils Pvt. Ltd. from 2006-07 to 2015-2016.

Calculated value of χ^2 for Average collection period =1499.579.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. $1499.579 > 16.919$, Hence, H_{09} is rejected.

IV. Conclusion

It is clear that debtors occupied first place followed by cash and Bank balances as a percentage of current assets in Radhika Vegetables Oils Pvt. Ltd. during the period of study. The Business organisation has credit worthiness because there is a significant increase in creditors during the study period. Current ratio of the company is high during the period of study which indicates that the company is more likely to meet its current liabilities. Debtors’ turnover ratio was high during the period of study which reflects in high Average collection period. Cash turnover ratio, Inventory turnover ratio, debtor turnover ratios and average collection periods are not uniform during the period of study and showed wide fluctuations. Net working capital is negative is negative during last three years of the study. Collection of debts and cash utilization was poorly done in the company during the period of study. Current ratio, Quick ratio, super quick ratio, Gross working turnover ratio, Net

working capital turnover ratio are uniform during the period of study. To conclude, working capital management in the company is to be improved.

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Working Capital Management in Tulasi Seeds Pvt. Ltd - A Case Study in Andhra Pradesh

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Abstract: *Tulasi Seeds Pvt. Ltd. was an Indian seed producing company was established in the year 1992 near Guntur in the state of Andhra Pradesh. Since then, the company has been focusing on research in cotton hybrid seeds and today TSPL stands among the top four cotton seed companies in India. With the ability to build up its capacity to innovate and adapt to the new challenges, TSPL has been able to cater to the growing demand of the Indian farming community. This Company has an annual turnover of Rs. 16600.66 lakhs. The total current assets of the company are Rs. 26810.14lakhs and current liabilities are Rs. 16812.3lakhs as per 2015-16 Accounts. In this paper an attempt is made to examine working capital management in Tulasi Seeds Pvt. Ltd. In this paper structure and composition of working capital in the enterprise for a period of ten years is analysed. Current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period are calculated for the study period.*

Keywords: *Gross working capital, Current ratio, Net working capital Turnover, Debtors Turnover, Inventory turnover, Cash Turnover*

I. INTRODUCTION

Tulasi Seeds Pvt. Ltd (TSPL) is a flagship company in Tulasi group of companies. Tulasi Seeds Pvt. Ltd. was an Indian seed producing company was established in the year 1992 near Guntur in the state of Andhra Pradesh. Since then, the company has been focusing on research in cotton hybrid seeds and today TSPL stands among the top four cotton seed companies in India. TSPL has been in the forefront to adopt new technologies like Bollgard II and Roundup Ready Flex for the benefit of the Indian farmers. Similarly TSPL has always been producing and launching new cotton seed hybrids every year, which are developed in its own Research and Development facility, for which TSPL was honoured with a National Award for the year 2009 (first prize). The Company's dual objective is being recognized as the premier provider of quality seeds and as the leading hybrid cotton seed producer in India by 2014. With the ability to build up its capacity to innovate and adapt to the new challenges, TSPL has been able to cater to the growing demand of the Indian farming community. This Company has an annual turnover of Rs. 16600.66 lakhs. The total current assets of the company are Rs. 26810.14lakhs and current liabilities are Rs. 16812.3lakhs as per 2015-16 Accounts. In this paper an attempt is made to examine working capital management in Tulasi Seeds Pvt. Ltd.

II. REVIEW OF LITERATURE

Mishra (1975) examined the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992) conducted an in-depth survey to analyze the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999) studied working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency. Reddy (2000) studied the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003) had done an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004) made a study on the issue pertaining to the relationship between working capital management and profitability of a Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012) examined the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013) had done a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and two and three wheelers sectors of Indian automobile industry. Utkarsh Goel et al. (2015) made a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms. S. Selvanayaki et al. (2015) focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on

profitability. Venkateswararao.P, Surya Chandra Rao.D and Hema Venkata Siva Sree.Ch (2017) examined working capital management in PL Plast Pvt Ltd. Venkateswararao.P, and Hema Venkata Siva Sree.Ch (2018) examined working capital management in Sri Rama Chandra Paper Boards Ltd. Venkateswararao.P, and Hema Venkata Siva Sree.Ch (2018) examined working capital management in Sri Nagavalli solvent oils Pvt. Ltd. It was found that there was no study on working capital management in a seed producing company. Hence, this study is taken up.

Objectives

The general objective of the study is to examine the working capital management in Tulasi Seeds Pvt. Ltd. The specific objectives include the following:

1. To examine the structure and composition of working capital in Tulasi Seeds Pvt. Ltd during the period of study.
2. To analyse the liquidity position of company during the period of study.
3. To find the gross working and networking turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the company under study.
5. To offer suggestions for effective working capital management if required.

III. METHODOLOGY

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Tulasi Seeds Pvt. Ltd. The period of study is ten years covering the financial years from 2006-07 to 2015-16. The data gathered is analysed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period.

Structure and Composition of working capital

Working capital structure of Tulasi Seeds Pvt. Ltd. is presented in table 1. It is observed that Inventory was 15.70 percent of total current assets during 2011. It is the lowest percentage during the period of study. Its percentage was highest at 53.42 during 2016. Debtors as a percentage of total current assets varied in between 14.91 during 2013 and 77.37 during 2011. It is also observed that cash and bank balance as a percentage of current assets varied between 0.02 during 2015 and 12.25 during 2010. Loans and advances as a percentage of current assets varied between 0.06 during 2010 and 62.72 during 2012. Other current assets as a percentage of total current assets varied between 0.19 during 2009 and 1.97 during 2016. Sundry Creditors occupied highest percent of current liabilities during the first five years of study. They varied between 99.94 during 2011 and 12.97 during 2012. Short-term borrowings were nil for the first five years of the study. Short-term borrowings as a percentage of current assets varied between 20.10 during 2014 and 52.43 during 2015. Short-term provisions by the firm were nil for the first five years of study. Short-term provisions as a percentage of current liabilities varied between 0.68 during 2016 and 5.17 during 2012. Other current liabilities vary between 0.06 during 2011 and 60.47 during 2012. It is observed that Net Working Capital in the company varied between Rs.654.46 Lakhs during 2007 to Rs.9997.84 Lakhs during 2016. It was maintained at high levels during 2015 and 2016.

Table1: Working Capital structure of Tulasi Seeds Pvt. Ltd. during 2006-2007 to 2015-2016 (Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	28.51	127.56	17.28	1947.76	192.16	177.79	145.76	103.08	4.29	67.19
% of TCA	0.63	1.72	0.13	12.25	1.12	1.05	0.68	0.34	0.02	0.25
Debtors	2205.71	4337.15	8963.1	10415.9	13236.15	2856.99	3203.33	11999.8	10529.6	6763.81
% of TCA	49.12	58.45	67.20	65.51	77.37	16.92	14.91	39.09	42.60	25.23
Loans & Advances	24.46	241.29	24.79	10.08	872.86	10588.4	9775.26	8121.8	5647.93	5130.66
% of TCA	0.54	3.25	0.19	0.06	5.10	62.72	45.50	26.46	22.85	19.14
Other Current Assets	35.91	45.63	25.67	46.43	120.59	270.7	360.16	461.26	472.84	526.98
% of TCA	0.80	0.61	0.19	0.29	0.70	1.60	1.68	1.50	1.91	1.97

Inventory	2195.88	2668.61	4307.88	3478.7	2686.43	2987.28	7998.58	10009.4	8063.5	14321.5
% of TCA	48.90	35.96	32.30	21.88	15.70	17.70	37.23	32.61	32.62	53.42
Total Current Assets (TCA)	4490.47	7420.24	13338.72	15898.87	17108.19	16881.16	21483.09	30695.34	24718.16	26810.14
Current Liabilities										
Sundry Creditors	3828.62	6378.34	10007.4	10512	13011.5	1576.62	3143.47	12669	3847.14	7668.36
% of TCL	99.81	99.88	99.93	99.93	99.94	12.97	20.18	55.88	25.01	45.61
Other current liabilities	7.39	7.39	7.39	7.39	7.39	7352	7890.57	5114.05	3204.44	2436
% of TCL	0.19	0.12	0.07	0.07	0.06	60.47	50.65	22.56	20.83	14.49
Short term borrowings	0	0	0	0	0	2600.58	4412.83	4557.8	8065	6593.68
% of TCL	0.00	0.00	0.00	0.00	0.00	21.39	28.32	20.10	52.43	39.22
Short term provisions	0	0	0	0	0	627.94	132.49	331.67	265.83	114.21
% of TCL	0.00	0.00	0.00	0.00	0.00	5.17	0.85	1.46	1.73	0.68
Total Current Liabilities (TCL)	3836.01	6385.73	10014.8	10519.4	13018.9	12157.1	15579.4	22672.5	15382.4	16812.3
NWC	654.46	1034.51	3323.92	5379.47	4089.29	4724.06	5903.69	8022.84	9335.76	9997.84

Source: Annual Reports of Tulasi Seeds Pvt. Ltd. from 2006-07 to 2015-2016

It is observed that Net Working Capital in the company varied between Rs.654.46 Lakhs during 2007 to Rs.9997.84 Lakhs during 2016. It was maintained at high levels during 2015 and 2016.

Current ratio

The current ratio in the company has varied between 1.16 during 2008 and 1.61 during 2015 as was shown in the table. The current ratio of the company is maintained at normal levels during the period of study.

Table2: Current Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	4490.47	7420.24	13338.72	15898.87	17108.19	16881.16	21483.09	30695.34	24718.16	26810.14
Current Liabilities	3836.01	6385.73	10014.8	10519.4	13018.9	12157.1	15579.4	22672.5	15382.4	16812.3
Current ratio	1.17	1.16	1.33	1.51	1.31	1.39	1.38	1.35	1.61	1.59

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Quick Ratio

The quick ratio of the company as shown in table has varied between 0.6 during 2007 to 1.18 during 2010.

Table3: Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	2294.59	4751.63	9030.84	12420.17	14421.76	13893.88	13484.51	20685.94	16654.66	12488.64
Current Liabilities	3836.01	6385.73	10014.8	10519.4	13018.9	12157.1	15579.4	22672.5	15382.4	16812.3
Quick Ratio	0.6	0.74	0.90	1.18	1.11	1.14	0.87	0.91	1.08	0.74

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Super quick Ratio

The super quick ratio of the company as shown in the table has varied between 0.002 during 2009 and 0.18 during 2010.

Table4: Super Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	28.51	127.56	17.28	1947.76	192.16	177.79	145.76	103.08	4.29	67.19
Current Liabilities	3836.01	6385.73	10014.8	10519.4	13018.9	12157.1	15579.4	22672.5	15382.4	16812.3
Super Quick Ratio	0.007	0.02	0.002	0.18	0.01	0.01	0.009	0.005	0.0003	0.004

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Gross Working Capital Turnover Ratio

The gross working capital turnover ratio of the company as shown in the table has varied between 0.62 during 2016 and 1.24 during 2012.

Table5: Gross Working Capital (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2846.62	8432.99	14200.99	17141.21	19600.88	20899.25	22867.64	25198.58	21013.85	16600.66
Gross working capital	4490.47	7420.24	13338.72	15898.87	17108.19	16881.16	21483.09	30695.34	24718.16	26810.14
Ratio	0.63	1.14	1.06	1.08	1.15	1.24	1.06	0.82	0.85	0.62

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Net Working Capital Turnover Ratio

The net working capital turnover ratio of the company as shown in the table has varied between 1.66 during 2016 and 8.15 during 2008.

Table6: Net Working Capital Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2846.62	8432.99	14200.99	17141.21	19600.88	20899.25	22867.64	25198.58	21013.85	16600.66
Net Working Capital	654.46	1034.51	3323.92	5379.47	4089.29	4724.06	5903.69	8022.84	9335.76	9997.84
Ratio	4.35	8.15	4.27	3.19	4.79	4.42	3.87	3.14	2.25	1.66

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Cash Turnover Ratio

The cash turnover ratio of the company as shown in the table has varied between 17.45 during 2010 and 464.48 during 2016.

Table7: Cash Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2846.62	8432.99	14200.99	17141.21	19600.88	20899.25	22867.64	25198.58	21013.85	16600.66
Average Cash Balance	24	78.04	72.42	982.52	1069.96	184.98	161.78	124.42	53.69	35.74
Ratio	118.60	108.	196.	17.45	18.32	112.98	141.35	202.53	391.39	464.48

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Inventory Turnover Ratio

The inventory turnover ratio of the company as shown in table has varied between 1.48 during 2016 to 7.37 during 2012.

Table8: Inventory Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2846.62	8432.99	14200.99	17141.21	19600.88	20899.25	22867.64	25198.58	21013.85	16600.66
Average Inventory	1463.63	2432.25	3488.25	3893.29	3082.57	2836.86	5492.93	9003.99	9036.45	11192.5
Ratio	1.94	3.47	4.07	4.40	6.36	7.37	4.16	2.80	2.33	1.48

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Debtors Turnover Ratio

The debtor's turnover ratio of the company as shown in table has varied between 1.61 during 2007 to 7.55 during 2013.

Table9: Debtors Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2846.62	8432.99	14200.99	17141.21	19600.88	20899.25	22867.64	25198.58	21013.85	16600.66
Average debtors	1769.73	3271.43	6650.13	9689.5	11826.03	8046.57	3030.16	7601.565	11264.7	8646.71
Ratio	1.61	2.58	2.14	1.77	1.66	2.60	7.55	3.31	1.87	1.92

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

Average Collection Period

The average collection period as shown in table has varied between 48 days during 2013 to 227 days during 2007.

Table-10: Average Collection Period (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	1.61	2.58	2.14	1.77	1.66	2.60	7.55	3.31	1.87	1.92
Average Collection Period	227	141	171	206	220	140	48	110	195	190

Source: Annual Reports of Tulasi Seeds Pvt. Ltd... from 2006-07 to 2015-2016

IV. CONCLUSION

The above analysis depicts that inventory occupied first place followed by debtors as a percentage of current assets in Tulasi Seeds Pvt. Ltd. during the period of study. The firm has credit worthiness because there is a significant increase in creditors during the first five years of study. Short term borrowings during the first five years of study were nil. Current ratio of the company is normal which indicates that the company is more likely to meet its current liabilities. Debtors' turnover ratio was comparatively less during the period of study which reflects in high Average collection period. Collection of debts and cash utilization was poorly done in the company during the period of study. To conclude, working capital management is good in Tulasi Seeds Pvt. Ltd.

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DIVERSITY OF MANGROVE FLORA IN MUDFLATS OF KRUTHIVENNU MANDAL, KRISHNA DISTRICT

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ABSTRACT

Mangroves are plant communities of the tropical and subtropical intertidal coastal zones which play an important and significant role in maintaining the coastal environment by reducing the impact of wave action and erosion in the coastal areas, preventing salinity and seawater ingress into the inland agricultural areas, and also providing protection to the coastline from the impact of cyclones. The present study was carried in mudflats mangrove patches, to find ecological status of the mangrove vegetation and to analyze significant changes). Results shows, *Avicennia marina* has highest Important Value Index (IVI) in Interu is 31.82, in Kruthivennu is 43.75 and in Nidamaru is 33.33. Maturity index values (MIV) of the field stations in the study area 67.00 of Interu, 61.00 of Kruthivennu and 71.00 of Nidamaru. Similarity indices (SI) is 100 and highest coefficient difference (CD) is 55.56. In the present study there is the densest mangrove vegetation at Nidamaru.

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INTRODUCTION

Mangroves are opportunistic colonizers of intertidal along tropical and sub tropical coasts, these salt-tolerant trees that dominate the mudflats. Mudflats are described as very shallow, muddy areas along or near a shoreline that are exposed at low tide, at low tide the intertidal mud are exposed as a bare stretch of mud leaving water only in permanent channels while at high tide the mudflat is covered with water. Mudflats are recognized by Sutton, A, Sorenson, L & Keely, M. (2001) as one of the primary wetland ecosystems in the Caribbean. Mudflat ecosystems are very significantly influenced by biological, chemical and physical processes including predation and nutrient cycling and most of these processes are strictly influenced by the state of the tide (Hiscock, K. & Marshall, C. 2006).

Keshavarz, M, Kamrani, E, and Dabbagh (2013) undertook a study aimed at quantifying the higher macrobenthic infaunal taxa of mangrove mudflats at Khamir Por, Iran. Mangrove forests could play a crucial role in protecting coastal areas from sea level rise caused by climate change (Van Maanen *et al.*, 2015). Apart from these ecological functions, mangroves play a very significant economic role in the lives of the coastal village communities. The villagers are dependent on mangroves mainly for fodder, fuel-wood and fishing activities. Elliot *et al.* (1998) notes that mudflats typically have low

species diversity but support large numbers of particular kinds of animals especially invertebrates, many of which live buried in the [oxygen-poor] sediment and are specially adapted to life in these conditions. Other animals also exhibit special adaptations to living in mudflats and the ecosystem serves as an important food source for birds and fish. Curd (2009) noted that Intertidal areas such as mudflats dissipate wave energy, thus reducing the risk of eroding salt marshes, damaging coastal defenses and flooding low-lying land.

Study Area

Krishna district in Andhra Pradesh consists of 126 Sq.km mangrove vegetation protecting the coastal line by the uniqueness of vegetation present in between the riverine and coastal ecosystems. Krishna deltaic region covered by moderate dense mangrove forests is 39 Sq.km while that covered by open mangrove forests is 87 Sq.km.

Machilipatnam is from 16°10'N to 16°.17' N latitudes and from 81°09' E to 81.13°E longitudes on the southeast coast of India and in the eastern corner of Andhra Pradesh. Mangroves in this area are present between 16° 0'-16° 15'N latitude and 81° 10'-81° 15' E longitude. The northern distributary of Krishna river drains in this area near Hamsaladeevi.

Study areas are selected on the northward and eastward regions of agriculture drain systems to identify the mangrove diversity at which they join the sea. The study was carried out from June 2014 to May 2016. The study consists of the

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mudflat based villages in kruthivenu mandal viz., Interu, Kruthivenu, Nidamaru at which mangrove vegetation is present.

Interu

Interu is a medium size village located at a distance of 36.5 km from Machilipatnam. Interu is from 16° 20' 45"N latitudes and from 81° 19' 50"E longitudes. Its boundaries are Bay of Bengal on east and south side. It has 6 km coast line with Krishna river high tide and low tide zone the coastal side is full of mangrove forest.

Kruthivenu

kruthivenu is a large village located at a distance of 44.7 km from Machilipatnam. kruthivenu is from 16° 24' 21"N latitudes and from 81° 21' 28"E longitudes. Its boundaries are Bay of Bengal on east and south side. It has 6 km coast line with Krishna river high tide and low tide zone the coastal side is full of mangrove forest

Nidamaru

Nidamaru is a large village located at a distance of 41.9 km from Machilipatnam. Nidamaru is from 16° 21' 9"N latitudes and from 81° 23' 57"E Longitudes. Its boundaries are Bay of Bengal on east and south side. It has 5 km coast line with Krishna river high tide and low tide zone the coastal side is full of mangrove forest.

Volumes of the Department of Botany, Nagarjuna University, Guntur.

Various parameters like Frequency, Relative Frequency etc. are calculated by the using formulae (1) and (2),

$$\text{Frequency} = \frac{\text{No of occurrences of a species}}{\text{Total no of site samples taken}} \times 100 \quad (1)$$

$$\text{Relative Frequency} = \frac{\text{No of occurrences of particular species}}{\text{Total no of occurrences of all the species}} \times 100 \quad (2)$$

The values of relative frequency are calibrated on a 10-point scale to assign a status to the species in each region. Four distinct groups are derived from this 10-point scale and each group in each region is designated as follows:

7-10 Very Frequent; 5-7 Frequent; 3-5 Less Frequent; < 3 Rare

The abundance and density represent the numerical strength of species in the community (Mishra, 1968). Abundance is described as the number of individuals occurring per sampling unit and density as the number of individuals per sampling unit. Abundance and density were calculated using the formulae (3) (4) (5) and (6),

$$\text{Abundance (A)} = \frac{\text{Total number of individuals}}{\text{Number of Sampling units of occrance}} \times 100 \quad (3)$$

$$\text{Relative Abundance} = \frac{\text{Abundance of a particular species}}{\text{Sum of the abundances of all species}} \times 100 \quad (4)$$



Figure 1 Satellite map showing the mangrove vegetation in mudflats of study area

MATERIALS AND METHODS

The mangrove vegetation ecological status was determined by making several field visits. Line transects of varying widths and quadrates from 4 m x 4 m to 10 m x 10 m are laid on either side of the creeks and data from each one are recorded from ten such transects / quadrats. Plant materials collected during sampling are identified with the help of the standard herbaria of the Botanical Survey of India and Gamble

$$\text{Density} = \frac{\text{Total no of individuals of a species in all quadrats}}{\text{Total no of quadrats sampled}} \times 100 \quad (5)$$

$$\text{Relative density} = \frac{\text{Density of a particular species}}{\text{Sum of the densities of all species}} \times 100 \quad (6)$$

Importance Value Index (IVI)

The concept of ‘Important Value Index (IVI)’ has been developed for expressing the dominance and ecological success of any species, with a single value, (Mishra, 1968). This index utilizes three characteristics, viz. relative

frequency, relative density and relative abundance. The three characteristics are computed using frequency, density and abundance for all the species falling in all the transects using formula (7),

$$IVI = \text{Relative frequency} + \text{Relative abundance} + \text{Relative density} \quad (7)$$

Maturity Index Value (MIV), Similarity Index (SI), Coefficient Difference (CD) are used to assess the maturity, similarity, diversity of mangrove vegetation among various field stations (Philips 1959).

Maturity Index Value (MIV)

The degree of maturity of a plant community is established based on the percent frequency of all species in the sites of study regions and divided by the number of species occurrence this is Maturity Index Value (MIV). Sampling is done by selecting 10 quadrats at each site and the frequency of each species is calculated, before calculating the percentage frequency. The Maturity Index Values are compared among different sites and it is inferred that the one nearer to 100 is highly matured in the community over others as suggested by Pichi-Sermolli (1948). The formulae for MIV is given in (8),

$$MIV = \frac{\text{Frequency of all species}}{\text{No of species studied}} \times 100$$

Similarity Index (SI) and Coefficient Difference (CD)

Expression of similarity of species and community coefficients indicate the degree of homogeneity of vegetation which reflects habitat status. The Similarity Index (SI) is calculated by using the formula (9) given by Oosting (1956).

$$S = \frac{2W}{(a+b)} \times 100 \quad (9)$$

where

- S = Similarity index between the sites being compared
- W = Sum of the species
- a = Total number of species in site number one
- b = Total number of species in site number two

The degree of similarity is determined among the sites as percentage of resemblance and categorised into highest, medium, lowest and no similarity. The corresponding Coefficient Difference (CD) values are obtained by subtracting the percentage similarity from 100. The formulae for CD is given in (10),

$$C.D = 100 - S$$

RESULTS AND DISCUSSION

Mangrove vegetation

The mangrove vegetation in the study area has been broadly classified into three main categories, based on the composition of species and distribution pattern. (Sasidhar.K and Brahmaji rao P. (2015).

Table 1 Systematic Position of the species present in the Mangrove Region of the Study area

S.No	Family	Name of the Species	Vernacular name	Habit
1	Avicenniaceae	<i>Avicennia marina</i>	Tellamada	Tree
2	Avicenniaceae	<i>Avicennia officinalis</i>	Nallamada	Tree
3	Rhizophoraceae	<i>Bruguiera gymnorhiza</i>	Thoddu ponna	Tree
4	Rhizophoraceae	<i>Ceriops decandra</i>	Calhasu / Thogara	Tree
5	Euphorbiaceae	<i>Excoecaria agallocha</i>	Tilla	Tree
6	Rhizophoraceae	<i>Rhizophora apiculata</i>	Ponna	Tree
7	Acanthaceae	<i>Acanthus ilicifolius</i>	Allchi	Shrub
8	Chenopodiaceae	<i>Suaeda maritima</i>	Elakura	Herb
9	Chenopodiaceae	<i>Suaeda monoica</i>	Elakura	Herb

The mangrove vegetation of the interior area consists of species of Avicenniaceae and Rhizophoraceae, central area consists of species of Euphorbiaceae and Acanthaceae, and peripheral area consists of species of Chenopodiaceae.

Floral Composition

Mangrove vegetation in the study area consisting of 9 genera and 9 species of 5 families has been recorded as 6 trees, 1 shrub and 2 herbs (Table-1). Habitat-wise distribution of mangroves in the three field stations of study area is shown in the (Figure-2(a) (b) and (c)).

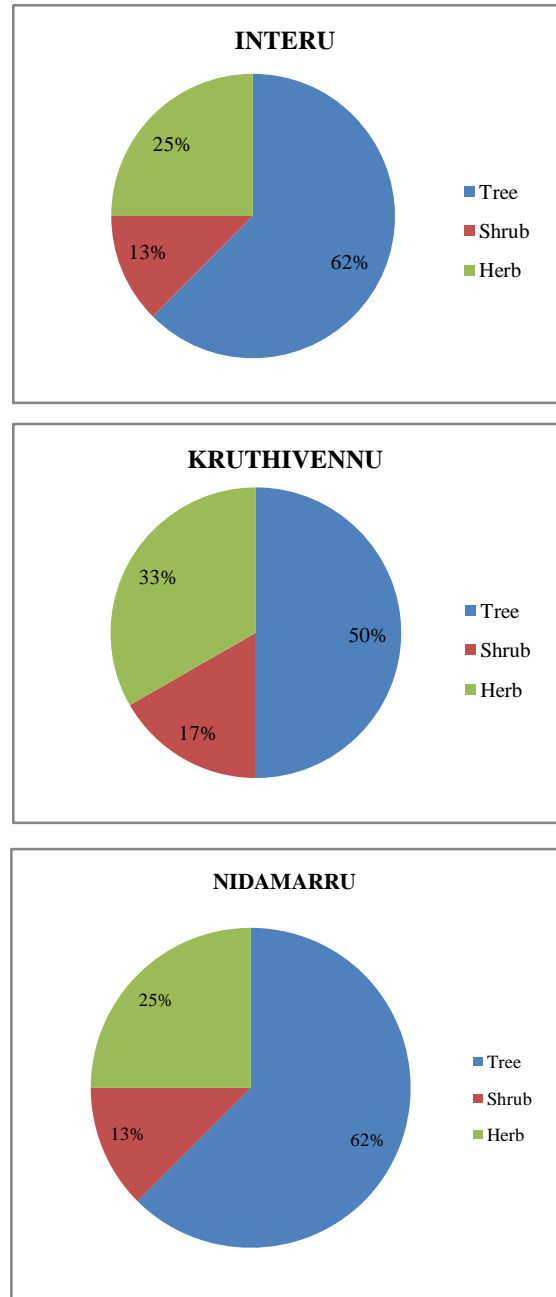


Figure 2(a, b and c) Habitat-Wise Distribution of Mangroves In Study area

Distribution Pattern in study areas

The mangrove habitat-wise distribution is calculated in the three areas i.e. Interu, Kruthivenu and Nidamaru and species-wise distribution in those field stations (Figure-3) is discussed below, Nabi A. and Brahmaji Rao P. (2012).

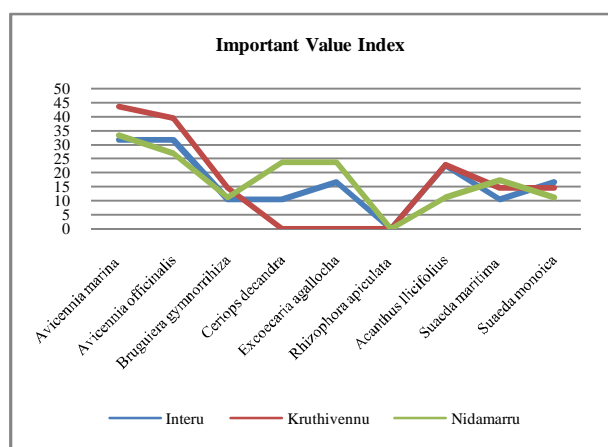


Figure 3 Distribution of Mangroves In Study area based on IVI values

Interu

Land areas towards sea influenced by river water, tidal inundation is moderate and hence the vegetation composition is moderate having 3 species like *Avicennia officinalis*, *Avicennia marina* and *Acanthus ilicifolius* are recorded in all the three areas. *Excoecaria agallocha* and *Suaeda monoica* Species are widely distributed only in two areas out of interior, central and peripheral areas. *Bruguiera gymnorrhiza*, *Ceriops decandra*, *Rhizophora apiculata* and *Suaeda maritima* have occasional occurrence in the interior and central zone. Habitat-wise distribution of mangrove vegetation in this region is observed as trees 62%, herbs 25 % and shrubs 13% (Figure-2 a).

Status of abundance of species is enumerated based on Relative Frequency values. 5 species with a Relative Frequency value ranging between 13.62 - 9.09 are “very frequent”. 3 species with a Relative Frequency value of 4.55 are “less frequent” followed by 1 specie with a Relative Frequency value 0 and fall in the category of “rare” status in this field station. It is worth noting that there are no species with “frequent” status and The Relative Frequency values and status of 9 existing species are shown in (Table-2).

Kruthivennu

Land areas towards sea influenced by river water, tidal inundation is moderate and hence the vegetation composition is moderate having 2 species like *Avicennia officinalis* and *Avicennia marina* are recorded in all the three areas. *Acanthus ilicifolius* Specie is widely distributed only in two areas out of interior, central and peripheral areas. *Excoecaria agallocha*, *Bruguiera gymnorrhiza*, *Ceriops decandra*, *Rhizophora apiculata*, *Suaeda maritima* and *Suaeda monoica* have occasional occurrence in the interior and central zone. Habitat-wise distribution of mangrove vegetation in this region is observed as trees 50%, herbs 33 % and shrubs 17% (Figure-2b).

Status of abundance of species is enumerated based on Relative Frequency values. 3 species with a Relative Frequency value ranging between 18.8- 12.5 are “very frequent”. 3 species with a Relative Frequency value of 6.25 are “frequent” followed by 3 specie with a Relative Frequency value 0 and fall in the category of “rare” status in this field station. It is worth noting that there are no species with “less frequent” status and The Relative Frequency values and status of 9 existing species are shown in (Table-2).

Species dominance is calculated based on the Important Value Index (IVI). In Kruthivennu the highest IVI value is 43.75 for *Avicennia marina* next for *Avicennia officinalis* by 39.58 followed by *Acanthus ilicifolius* with an IVI value of 22.92 (Table-3). The dominant species in this village is *Avicennia marina*.

Nidamaru

Land areas towards sea influenced by river water, tidal inundation is moderate and hence the vegetation composition is moderate having 5 species like *Avicennia officinalis*, *Avicennia marin*, *Ceriops decandra*, *Excoecaria agallocha* and *Suaeda maritima* are recorded in all the three areas. *Bruguiera gymnorrhiza*, *Acanthus ilicifolius* and *Suaeda monoica* Specie is widely distributed only in two areas out of interior, central and peripheral areas. *Rhizophora apiculata*

Table 2 Status of Mangrove Species based on Relative Frequency present at Interu, Kruthivennu and Nidamaru in study area

S.no	Name of the Plant Species	Interu			Kruthivennu			Nidamaru		
		Frequency %	Relative Frequency	Status	Frequency %	Relative Frequency	Status	Frequency %	Relative Frequency	Status
1	<i>Avicennia marina</i>	100	13.62	I	100	18.8	I	100	14.3	I
2	<i>Avicennia officinalis</i>	100	13.62	I	100	18.8	I	100	14.3	I
3	<i>Bruguiera gymnorrhiza</i>	33.33	4.55	III	33.33	6.25	II	33.33	4.76	III
4	<i>Ceriops decandra</i>	33.33	4.55	III	0	0	IV	100	14.3	I
5	<i>Excoecaria agallocha</i>	66.67	9.09	I	0	0	IV	100	14.3	I
6	<i>Rhizophora apiculata</i>	0	0	IV	0	0	IV	0	0	IV
7	<i>Acanthus ilicifolius</i>	100	13.62	I	66.67	12.5	I	33.33	4.76	III
8	<i>Suaeda maritima</i>	33.33	4.55	III	33.33	6.25	II	66.67	9.52	I
9	<i>Suaeda monoica</i>	66.67	9.09	I	33.33	6.25	II	33.33	4.76	III

> 7= Very Frequent-I, 5-7 = Frequent-II, 3-5 = Less Frequent - III, < 3 = rare - IV

Species dominance is calculated based on the Important Value Index (IVI). In Interu the highest IVI value is 31.82 for *Avicennia marina* and *Avicennia officinalis* next for *Acanthus ilicifolius* by 22.73 followed by *Excoecaria agallocha* and *Suaeda monoica* with an IVI value of 16.67 (Table-3). The dominant species in this village is *Avicennia marina* and *Avicennia officinalis*.

have occasional occurrence in the interior and central zone. Habitat-wise distribution of mangrove vegetation in this region is observed as trees 62%, herbs 25 % and shrubs 13% (Figure-2c).

Status of abundance of species is enumerated based on Relative Frequency values. 5 species with a Relative Frequency value ranging between 14.3 - 9.52 are “very frequent”. 3 species with a Relative Frequency value of 4.76 are “less frequent” followed by 1 specie with a Relative

Frequency value 0 and fall in the category of “rare” status in this field station. It is worth noting that there are no species with “frequent” status and The Relative Frequency values and status of 9 existing species are shown in (Table-2).

Species dominance is calculated based on the Important Value Index (IVI). In Nidamarru the highest IVI value is 33.33 for *Avicennia marina* next for *Avicennia officinalis* by 26.98 followed by *Excoecaria agallocha* with an IVI value of 23.81 (Table-3). The dominant species in this village is *Avicennia marina*.

Table 3 Species dominance based on the Important Value Index (IVI) Values present in the study area

S.No	Name of the Plant Species	IVI Values in different field stations		
		Interu	Kruthivenu	Nidamarru
1	<i>Avicennia marina</i>	31.82	43.75	33.33
2	<i>Avicennia officinalis</i>	31.82	39.58	26.98
3	<i>Bruguiera gymnorrhiza</i>	10.61	14.58	11.11
4	<i>Ceriops decandra</i>	10.61	0.00	23.81
5	<i>Excoecaria agallocha</i>	16.67	0.00	23.81
6	<i>Rhizophora apiculata</i>	0.00	0.00	0.00
7	<i>Acanthus Ilicifolius</i>	22.73	22.92	11.11
8	<i>Suaeda maritima</i>	10.61	14.58	17.46
9	<i>Suaeda monoica</i>	16.67	14.58	11.11
	Total	151.52	150.00	158.73

Maturity Index

Maturity index values of the field stations in the study area 67.00 of Interu, 61.00 of Kruthivenu and 71.00 of Nidamarru show that there is the densest mangrove vegetation at a place (Nidamarru in the present case), where there is a maximum frequency of inundation. Further, it can be inferred that places where there is less frequency of inundation, have less dense mangrove vegetation (Table -4). Prabhakar rao.V.V, Brahmaji rao.P (2017)

A comparison of MIV values of the study area is shown in the bar graph (Figure - 4)

Table-4 Maturity Index Values (MIV) of Mangrove at different field stations of the Mangrove in the study area

S.No.	Name of the Plant Species	Frequency %		
		Interu	Kruthivenu	Nidamarru
1	<i>Avicennia marina</i>	100.0	100.0	100.0
2	<i>Avicennia officinalis</i>	100.0	100.0	100.0
3	<i>Bruguiera gymnorrhiza</i>	33.3	33.3	33.3
4	<i>Ceriops decandra</i>	33.3	0.0	100.0
5	<i>Excoecaria agallocha</i>	66.7	0.0	100.0
6	<i>Rhizophora apiculata</i>	0.0	0.0	0.0
7	<i>Acanthus Ilicifolius</i>	100.0	66.7	33.3
8	<i>Suaeda maritima</i>	33.3	33.3	66.7
9	<i>Suaeda monoica</i>	66.7	33.3	33.3
	Total	533.3	366.7	566.7
	MIV	67	61	71

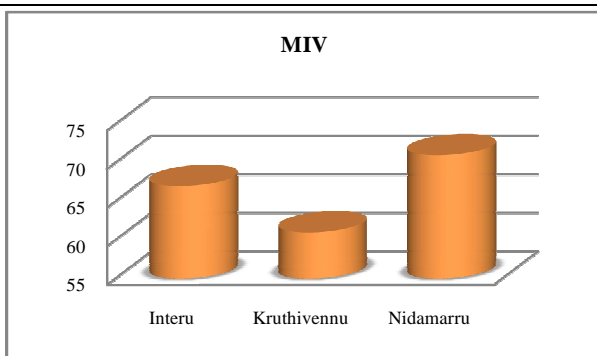


Figure 4 Station-Wise Maturity Index Values (MIV) of Mangrove Vegetation in study area

Similarity Index

Similarity Index for each station is calculated to know the extent of homogeneity of vegetation. Depending on the extent of homogeneity, the regions are categorized as given below:

80 to 100% --highest resemblance 60 to 80% -- medium resemblance

40 to 60% -- least resemblance 0 to 40% --no resemblance

Table 5 Species-wise distribution pattern of different field stations of the Mangrove in study area

S.No.	Name of the Plant Species	Sites								
		1	2	3	4	5	6	7	8	9
1	<i>Avicennia marina</i>	+	+	+	+	+	+	+	+	+
2	<i>Avicennia officinalis</i>	+	+	+	+	+	+	+	+	+
3	<i>Bruguiera gymnorrhiza</i>	+	-	-	+	-	-	-	+	-
4	<i>Ceriops decandra</i>	-	+	-	-	-	-	+	+	+
5	<i>Excoecaria agallocha</i>	+	-	+	-	-	-	+	+	+
6	<i>Rhizophora apiculata</i>	-	-	-	-	-	-	-	-	-
7	<i>Acanthus Ilicifolius</i>	+	+	+	+	+	-	-	+	-
8	<i>Suaeda maritima</i>	-	+	-	-	-	+	+	-	+
9	<i>Suaeda monoica</i>	+	-	+	-	-	+	-	+	-
	Total no. of species in each station	6	5	5	4	3	4	5	7	5

The following table helps to understand the similarity in species diversity in study area

Table 6 Similarity Index (SI) of Mangroves at different field stations of the study area

Site No	1	2	3	4	5	6	7	8	9
1	54.54	90.90	80.00	66.66	60.00	54.54	92.30	54.54	
2		60.00	66.66	75.00	66.66	80.00	66.66	80.00	
3			66.66	75.00	66.66	60.00	83.33	60.00	
4				85.71	50.00	44.44	72.72	44.44	
5					57.14	50.00	60.00	50.00	
6						66.66	54.54	66.66	
7							66.66	100	
8								66.66	

In the study area, majority of the sampling sites showed medium resemblances nearly in 18 sites with regard to species diversity with similarity indices ranging from 75.00 between sites 1&5, 1&6, 2&3, 2&4, 2&5, 2&6, 2&8, 3&4 and 3&5 to 60.00 between sites 3&6, 3&7, 3&9, 4&8, 5&8, 6&7, 6&9, 7&8 and 8&9. Similarly, the highest resemblance in 8 sites ranging from 100.00 between the sites 1&3, 1&8, 4&5 and 7&9 to 80.00 between the sites 1&4, 2&7, 2&9 and 3&4. The least resemblances nearly in 10 sites from 54.54 between the sites 1&2, 1&7, 1&9, 4&6 and 4&7 to 44.44 between the sites 5&6, 5&7, 5&9 and 6&8.(Table -6).

Coefficient Difference

In the study area highest coefficient difference of 55.56 is recorded between sub field stations 4&7 and 4&9 while the least coefficient difference value of 0.0 is obtained between the sub field stations 7&9. Other field stations show coefficient difference ranging from 50.50 to 7.70 (Table -7).

Coefficient Difference is made based on data present in the (Table-6)

Table 7 Coefficient difference of Mangrove at different field stations of the Study area

Site No	1	2	3	4	5	6	7	8
1								
2	45.46							
3	9.10	40.00						
4	20.00	33.34	33.34					
5	33.34	25.00	25.00	14.29				
6	40.00	33.34	33.34	50.00	42.86			
7	45.46	20.00	40.00	55.56	50.00	33.34		
8	7.70	33.34	16.67	27.28	40.00	45.46	33.34	
9	45.46	20.00	40.00	55.56	50.00	33.34	00.00	33.34

CONCLUSIONS

From the results of the present study the family Avicenniaceae is the single largest family in study. It is found that Nidamaru region has highly matured in the mangrove community.

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ABSTRACT

Mangrove flora is unique vegetation that survives at high salinity; tidal regimes, strong wind velocity, high temperature and muddy anaerobic soil with the development of some adaptive morphological characteristics. The present study was carried in creeks and mudflats mangrove patches, to find ecological status of the mangrove vegetation and to analyze significant changes. Results shows, highest Important Value Index (IVI) in Kanuru 33.33 and Achyyavaripalem is 31.82 for *Avicennia marina*. Highest Maturity index values (MIV) is 71.00 of Kanuru and 31.82 of and 71.00 of Achyyavaripalem. Similarity indices (SI) is 80.00 highest, medium 76.92 to 72.72, least 66.64 to 50.00, majority of sites showed medium resemblance. 50.00 is highest coefficient difference (CD) and least is 20.00. In the present study mudflats regions showed densest mangrove vegetation than creek region and most dominating species in both regions are *Avicennia marina* and *Avicennia officinalis*.

KEYWORDS: Mangrove Vegetation, creeks, mudflats, Important Value Index (IVI), Maturity Index Values (MIV), Similarity Index (SI), Coefficient Difference (CD).

I. INTRODUCTION

Mangroves comprise salt tolerant plant species that occur along inter-tidal zones of rivers and seas in the form of narrow strips or as extensive patches in estuarine habitats and river deltas of tropical and sub-tropical regions. These plants have special adaptations such as stilt roots, viviparous germination, salt-excreting leaves, breathing roots, knee roots by which these plants survive in water-logged, anaerobic saline soils of coastal environments. Rahaman (1990), Swaminathan (1991) and Moorthy & Kathiresan (1996) observed that the mangrove plants have a great potential to adapt to the changes in climate, rise in sea levels and to solar ultraviolet-B radiation

Mangrove vegetation comprises approximately 59 species 41 genera, of which 34 species 29 genera are present in India. This includes 25 species along the east coast and 25 species on the west coast as cited by Banerjee *et al.*, (1989); Singh (1990); Deshmukh (1994). East coast mangroves represent 51 species, 41 genera belonging to 29 families. [Venkateswarlu (1944), Mathauda (1957), Rao (1959), Sidhu (1963)]. Recent estimates by Mandal & Naskar (2008) reveal that 82 species of mangroves are distributed in 52 genera and 36 families in all the 12 habitats in India.

The Indian subcontinent anecdotal studies are studied by Chatarjee (1958), Sidhu (1963), Ahmed (1964), Chapman (1976), Lakshman (1984), Untawale (1984) and Dagar (1988), Rao and Rao (1992). All these scientists recognized that the mangrove ecosystems had been an important source of livelihood, subsistence economy and were the most exploitable for the traditional use of aquaculture and agriculture practices.

II. STUDY AREA

The present study is carried out to identify the mangrove vegetation distributed in and around creeks and mudflats of Machilipatnam. Study areas are selected on the northward region of riverine systems to identify the mangrove diversity at which the river joins the sea and mudflat based sea coast, which is receiving tidal inundation. The study was carried out from June 2016 to June 2017. The first region (Region – I) consists of the creek based villages around Machilipatnam viz., Pallethummalapalem, Kona at which mangrove vegetation is

present. The second region (Region – II) consists of mudflat based villages Kanuru, Achayyavaripalem at which mangrove vegetation is present.

A. Palletummalapalem is a small- sized village located at a distance of 15.1 km from Machilipatnam. Palletummalapalem is from 16°5'38"N latitudes and from 81°7'3"E longitudes. Its boundaries are Bay of Bengal on east and south side, a tributary of river Krishna on west and Kona village on north side. Coastal side is with mangrove vegetation.

B.Kona is a mid- sized village located at a distance of 16.8 km from Machilipatnam. Kona is from 16°5'5"N latitudes and from 81°6'45"E longitudes. Its boundaries are Bay of Bengal on east and south side, a tributary of river Krishna on west and Kona village on north side. Coastal side is with mangrove vegetation.

C.Kanuru is a medium size village located at a distance of 19.7 km from Machilipatnam. Kanuru is from 16°17'3"N latitudes and from 81°15'30"E longitudes. Its boundaries are Bay of Bengal on east and south side. Coastal side is with mangrove vegetation.

D.Achyyavaripalem is a large village located at a distance of 25.1 km from Machilipatnam. Achyyavaripalem is from 16°17'54"N latitudes and from 81°14'51"E longitudes. Its boundaries are Bay of Bengal on east and south side. Coastal side is with mangrove vegetation.



Figure-1: Satellite map showing the mangrove vegetation in region-1&2

III. MATERIALS & METHODS

The mangrove vegetation ecological status was determined by making several field visits. Line transects of varying widths and quadrates from 4 m x 4 m to 10 m x 10 m are laid on either side of the creeks and data from each one are recorded from ten such transects / quadrats. Plant materials collected during sampling are identified with the help of the standard herbaria of the Botanical Survey of India and Gamble Volumes of the Department of Botany, Nagarjuna University, Guntur. Brahmaji Rao, P (1998)

Various parameters like Frequency, Relative Frequency etc. are calculated by the using formulae (1) and (2),

$$\text{Frequency} = \frac{\text{No of occurrences of a species}}{\text{Total no of site samples taken}} \times 100 \quad (1)$$

$$\text{Relative Frequency} = \frac{\text{No of occurrences of particular species}}{\text{Total no of occurrences of all the species}} \times 100 \quad (2)$$

The values of relative frequency are calibrated on a 10-point scale to assign a status to the species in each region. Four distinct groups are derived from this 10-point scale and each group in each region is designated as follows:

7 – 10 Very Frequent; 5 – 7 Frequent; 3 – 5 Less Frequent; < 3 Rare

The abundance and density represent the numerical strength of species in the community (Mishra, 1968). Abundance is described as the number of individuals occurring per sampling unit and density as the number of individuals per sampling unit. Abundance and density were calculated using the formulae (3) (4) (5) and (6),

$$\text{Abundance (A)} = \frac{\text{Total number of individuals}}{\text{Number of Sampling units of occurrence}} \times 100 \quad (3)$$

$$\text{Relative Abundance} = \frac{\text{Abundance of a particular species}}{\text{Sum of the abundances of all species}} \times 100 \quad (4)$$

$$\text{Density} = \frac{\text{Total no of individuals of a species in all quadrats}}{\text{Total no of quadrats sampled}} \times 100 \quad (5)$$

$$\text{Relative density} = \frac{\text{Density of a particular species}}{\text{Sum of the densities of all species}} \times 100 \quad (6)$$

Importance Value Index (IVI)

The concept of 'Important Value Index (IVI)' has been developed for expressing the dominance and ecological success of any species, with a single value, (Mishra, 1968). This index utilizes three characteristics, viz. relative frequency, relative density and relative abundance. The three characteristics are computed using frequency, density and abundance for all the species falling in all the transects using formula (7),

$$\text{IVI} = \text{Relative frequency} + \text{Relative abundance} + \text{Relative density} \quad (7)$$

Maturity Index Value (MIV), Similarity Index (SI), Coefficient Difference (CD) are used to assess the maturity, similarity, diversity of mangrove vegetation among various field stations (Philips 1959).

Maturity Index Value (MIV)

The degree of maturity of a plant community is established based on the percent frequency of all species in the sites of study regions and divided by the number of species occurrence this is Maturity Index Value (MIV). Sampling is done by selecting 10 quadrats at each site and the frequency of each species is calculated, before calculating the percentage frequency. The Maturity Index Values are compared among different sites and it is inferred that the one nearer to 100 is highly matured in the community over others as suggested by Pichi-Sermolli (1948). The formulae for MIV is given in (8),

$$\text{MIV} = \frac{\text{Frequency of all species}}{\text{No of species studied}} \times 100 \quad (8)$$

Similarity Index (SI) and Coefficient Difference (CD)

Expression of similarity of species and community coefficients indicate the degree of homogeneity of vegetation which reflects habitat status. The Similarity Index (SI) is calculated by using the formula (9) given by Oosting (1956).

$$S = \frac{2W}{(a+b)} \times 100 \quad (9)$$

where S = Similarity index between the sites being compared
 W = Sum of the species
 a = Total number of species in site number one
 b = Total number of species in site number two

The degree of similarity is determined among the sites as percentage of resemblance and categorised into highest, medium, lowest and no similarity. The corresponding Coefficient Difference (CD) values are obtained by subtracting the percentage similarity from 100. The formulae for CD is given in (10),

$$\text{C.D} = 100 - S \quad (10)$$

IV. RESULTS & DISCUSSION

V. Mangrove vegetation

The mangrove vegetation in the region-1&2 areas has been broadly classified into three main categories, based on the composition of species and distribution pattern. (Sasidhar.K and Brahmaji rao P. (2015).

The mangrove vegetation in region -1, the interior area consists of species of Avicenniaceae Euphorbiaceae and Rhizophoraceae, central area consists of species of Acanthaceae, Combretaceae. Myrsinaceae and Sonneratiaceae and peripheral area consists of species of Chenopodiaceae, Convolvulaceae, Fabeceae and Plumbaginaceae.

The mangrove vegetation in region-2, the interior area consists of species of Avicenniaceae and Rhizophoraceae, central area consists of species of Euphorbiaceae and Acanthaceae, and peripheral area consists of species of Chenopodiaceae.

Floral Composition

Mangrove vegetation in region-1 consisting of 12 genera and 18 species of 11 families has been recorded as 13 trees, 2 shrubs and 3 herbs. Habitat-wise distribution of mangrove vegetation Palletummalapalem is observed as trees 72%, herbs 17 % and shrubs 11% and Kona is observed as trees 72%, herbs 17 % and shrubs 11%. The two field stations of region-1 are shown in the (Figure – 2(a) and (b)).

Mangrove vegetation in region-2 consisting of 9 genera and 9 species of 5 families has been recorded as 6 trees, 1 shrub and 2 herbs. Habitat-wise distribution of mangrove vegetation in Kanuru is observed as trees 57%, herbs 29 % and shrubs 14% and in Achyyavaripalem is observed as trees 67%, herbs 22 % and shrubs 11%. The two field stations of region-2 are shown in the (Figure – 2(c) and (d)).

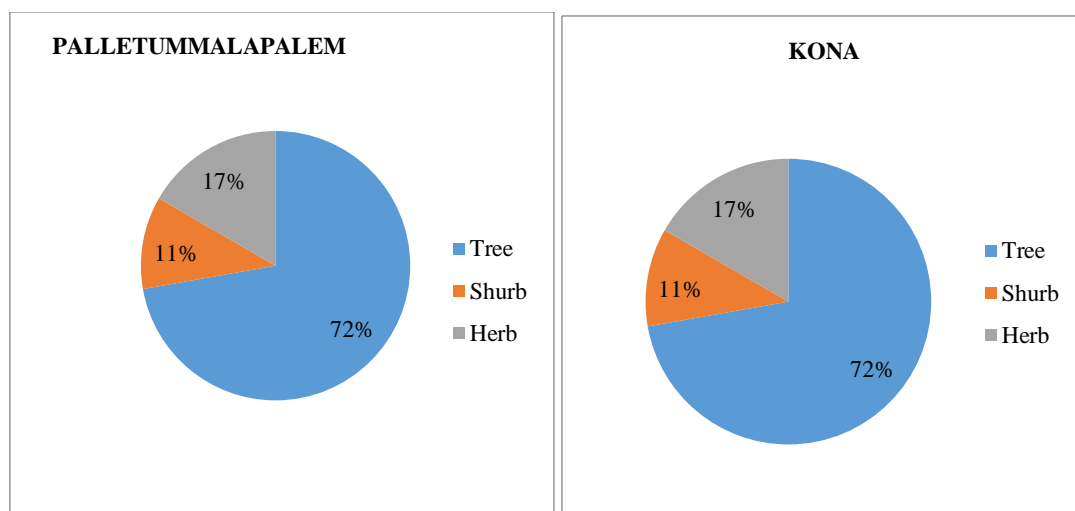
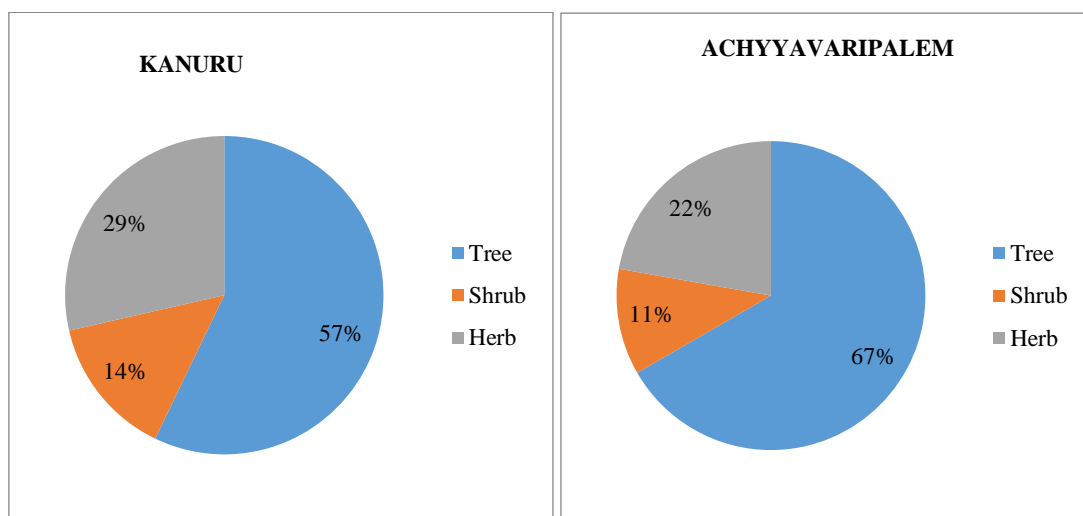


Figure - 2(a, b, c and d): Habitat-Wise Distribution of Mangroves in Region-1&2



4.3 Distribution Pattern of mangrove vegetation in region-1&2

The mangrove habitat-wise distribution is calculated in the four areas i.e. Palletummalapalem, Kona, Kanuru and Achyavaripalem and species-wise distribution in region-1&2 (Figure – 3) is discussed below, Nabi A. and Brahmaji Rao P. (2012).

In Palletummalapalem land areas towards sea influenced by river water, tidal inundation is moderate and hence the vegetation composition is high having 4 species like *Avicennia officinalis*, *Avicennia marina*, *Bruguiera gymnorhiza*, *Excoecaria agallocha* are recorded in all the three areas. *Aegiceras corniculatum*, *Avicennia alba*, *Bruguiera cylindrica*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia apetala*, *Sueda maritime* Species are widely distributed only in two areas out of interior, central and peripheral areas. *Ceriops decandra*, *Acanthus ilicifolius*, *Cuscuta Reflexa Roxb*, *Lumnitzera recemosa*, *Aegialitis rotundifolia*, *Dalbergia Spinosa Roxb*, *Suaeda monoica* have occasional occurrence in the interior and central zone and are more abundant in marginal area. Status of abundance of species is enumerated based on Relative Frequency values. 4 species with a Relative Frequency value of 6.8 are “frequent” followed by 7 species with a Relative Frequency value 4.5 and fall in the category of “less frequent” species. 7 species with a Relative Frequency value 2.3 and fall in the category of “rare” status in this field station. It is worth noting that there are no species with “very frequent” status.

In Kona land areas towards sea influenced by river water, tidal inundation is moderate and hence the vegetation composition is moderate having 3 species like *Avicennia officinalis*, *Avicennia marina*, *Excoecaria agallocha* are recorded in all the three areas. *Avicennia alba*, *Bruguiera cylindrica*, *Rhizophora apiculata*, *Rhizophora mucronata*, *Ceriops decandra*, and *Acanthus ilicifolius* Species are widely distributed only in two areas out of interior, central and peripheral areas. *Aegiceras corniculatum*, *Bruguiera gymnorhiza*, *Sonneratia apetala*, *Cuscuta Reflexa Roxb*, *Lumnitzera recemosa*, *Aegialitis rotundifolia*, *Dalbergia Spinosa Roxb*, *Sueda maritime* and *Suaeda monoica* have occasional occurrence in the interior and central zone and are more abundant in marginal area. Status of abundance of species is enumerated based on Relative Frequency values. 3 species with a Relative Frequency value of 7.7 are “very frequent” 6 species with a Relative Frequency value of 5.1 are “frequent” followed by 9 species with a Relative Frequency value 2.6 and fall in the category of “rare” status in this field station. It is worth noting that there are no species with “less frequent” status.

In Kanaru, water is influenced by agricultural drains and low tidal inundation and hence there are 9 moderate species namely *Avicennia marina*, *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Ceriops decandra*, *Excoecaria agallocha*, *Rhizophora apiculata*, *Acanthus ilicifolius*, *Sueda maritime* and *Suaeda manoica*. *Suaeda maritima* and *Suaeda manoica* are common in the degraded areas. *Bruguiera gymnorhiza*, *Ceriops decandra*, *Excoecaria agallocha*, *Rhizophora apiculata*, *Acanthus ilicifolius* occurs in stunt form. *Avicennia marina*, *Avicennia officinalis*, and *Excoecaria agallocha* are the dominant species in this area. Dense vegetation of *Prosopis juliflora* is seen in the uplands. Status of abundance of species is computed with Relative Frequency value. The species *Avicennia officinalis*, *Bruguiera gymnorhiza*, *Rhizophora apiculata*, *Suaeda maritima* and *Suaeda manoica* are “very frequent” species, with a maximum Relative Frequency value ranging from of 14.3 - 9.52 followed by 2 “less frequent” species with a Relative Frequency value 4.76. The minimum value of 0 is observed in 2 species, which fall in “rare” category. It is worth noting that there are no species with “frequent” status.

In Achyavaripalem dense vegetation is seen, with 3 species like *Avicennia officinalis*, *Avicennia marina* and *Bruguiera gymnorhiza*. The species *Prosopis* is conspicuous in some places along with mixed vegetation of *Rhizophora apiculata*, *Excoecaria agallocha*. Large areas of degraded mangroves occur with stunted growth of *Acanthus ilicifolius*, *Suaeda maritima*, *Ceriops decandra* and *Rhizophora apiculata*. Status of abundance of species is computed with Relative Frequency value. 5 species with a Relative Frequency value ranging between 13.62 - 9.09 are “very frequent” species. 4 species having Relative Frequency value of 4.55 are “less frequent”. In this field station also there are no species with “very frequent” and “rare” status. (Table-1).

Table – 1: Status of Mangrove Species based on Relativ Frequency in region -1&2

S. N O	Name of Plant species	Creek						Mudflat					
		Palletummala palem			Kona			Kanuru			Achyavaripalem		
		Fr equency %	Rel ative frequency	st atus	Fre quency %	Rel ative frequency	stat us	Fre quency %	Rel ative frequency	stat us	Fre quency %	Rel ative frequency	stat us
1	<i>Aegiceras corniculatum</i>	66.7	4.5	III	33.3	2.6	IV	Plant species not present					
2	<i>Avicennia alba</i>	66.7	4.5	III	66.7	5.1	II	Plant species not present					
3	<i>Avicennia marina</i>	100	6.8	II	100	7.7	I	100.0	14.3	I	100	13.6	I
4	<i>Avicennia officinalis</i>	100	6.8	II	100	7.7	I	100.0	14.3	I	100	13.6	I
5	<i>Bruguiera cylindrical</i>	66.7	4.5	III	66.7	5.1	II	Plant species not present					
6	<i>Bruguiera gymnorhiza</i>	100	6.8	II	33.3	2.6	IV	0.0	0.0	IV	100	13.6	I
7	<i>Ceriops decandra</i>	33.3	2.3	IV	66.7	5.1	II	0.0	0.0	IV	33.3	4.55	III
8	<i>Excoecaria agallocha</i>	100	6.8	II	100	7.7	I	100.0	14.3	I	66.6	9.09	I
9	<i>Lumnitzera racemosa</i>	33.3	2.3	IV	33.3	2.6	IV	Plant species not present					
10	<i>Rhizophora apiculata</i>	66.7	4.5	III	66.7	5.1	II	33.3	4.76	III	33.3	4.55	III
11	<i>Rhizophora mucronata</i>	66.7	4.5	III	66.7	5.1	II	Plant species not present					
12	<i>Sonneratia apetala</i>	66.7	4.5	III	33.3	2.6	IV	Plant species not present					
13	<i>Acanthus ilicifolius</i>	33.3	2.3	IV	66.7	5.1	II	66.7	9.52	I	33.3	4.55	III
14	<i>Aegialitis rotundifolia</i>	33.3	2.3	IV	33.3	2.6	IV	Plant species not present					
15	<i>Cuscuta reflexa Roxb</i>	33.3	2.3	IV	33.3	2.6	IV	Plant species not present					
16	<i>Dalbergia spinosa Roxb.</i>	33.3	2.3	IV	33.3	2.6	IV	Plant species not present					
17	<i>Suaeda maritima</i>	66.7	4.5	III	33.3	2.6	IV	66.7	9.52	I	33.3	4.55	III
18	<i>Suaeda monoica</i>	33.3	2.3	IV	33.3	2.6	IV	33.3	4.76	III	66.6	9.09	I

> 7 = Very Frequent – I, 5 – 7 = Frequent – II, 3 – 5 = Less Frequent - III, < 3 = rare – IV

Species dominance is calculated based on the Important Value Index (IVI). In Pallemthummalapalem the highest IVI value is 17.42 for *Avicennia marina* and followed by 15.91 for *Avicennia officinalis* and by *Bruguiera gymnorrhiza* with an IVI value of 14.39. The dominant species in this village is *Avicennia marina*. In Kona the highest IVI value is 19.66 for *Avicennia officinalis* and followed by 14.53 for *Avicennia marina* and *Excoecaria agallocha* by *Bruguiera cylindrica*, *Ceriops decandra* with an IVI value of 11.54. The dominant species in this village is *Avicennia officinalis*. In Kanuru the highest IVI value is 33.33 for *Avicennia marina* and *Avicennia officinalis* followed by 23.81 for *Excoecaria agallocha* and for *Acanthus ilicifolius* and *Suaeda maritima* with a value of 17.46. In Kanuru also the dominant species are *Avicennia marina* and *Avicennia officinalis*. In Achayavaripalem the highest IVI value is 31.82 for *Avicennia marina* followed by 28.79 for and *Avicennia officinalis* which is further followed by *Bruguiera gymnorrhiza* with 22.73. In this village also the dominant species are *Avicennia marina* and *Avicennia officinalis*. (Table-2)

Table –2: Species dominance based on the Important Value Index (IVI) Values in region-I&2

S.No	Name of Plant species	IVI Values			
		Creek		Mudflat	
		Palletummapalem	Kona	Kanuru	Achyyavaripalem
1	<i>Aegiceras corniculatum</i>	8.33	9.40	Plant species not present	
2	<i>Avicennia alba</i>	8.33	9.40	Plant species not present	
3	<i>Avicennia marina</i>	17.42	14.53	33.33	31.82
4	<i>Avicennia officinalis</i>	15.91	19.66	33.33	28.79
5	<i>Bruguiera cylindrical</i>	10.23	11.54	Plant species not present	
6	<i>Bruguiera gymnorrhiza</i>	14.39	5.98	0.00	22.73
7	<i>Ceriops decandra</i>	5.30	11.54	0.00	10.61
8	<i>Excoecaria agallocha</i>	11.36	14.53	23.81	16.67
9	<i>Lumnitzera racemosa</i>	5.30	5.98	Plant species not present	
10	<i>Rhizophora apiculata</i>	10.23	9.40	11.11	10.61
11	<i>Rhizophora mucronata</i>	8.33	9.40	Plant species not present	
12	<i>Sonneratia apetala</i>	8.33	5.98	Plant species not present	
13	<i>Acanthus Ilicifolius</i>	5.30	9.40	17.46	10.61
14	<i>Aegialitis rotundifolia</i>	5.30	5.98	Plant species not present	
15	<i>Cuscuta reflexa Roxb</i>	5.30	5.98	Plant species not present	
16	<i>Dalbergia spinosa Roxb.</i>	5.30	5.98	Plant species not present	
17	<i>Suaeda maritima</i>	8.33	5.98	17.46	10.61
18	<i>Suaeda monoica</i>	5.30	5.98	11.11	16.67
	Total	158.33	166.67	147.62	159.09

Maturity Index:

Maturity index values of the field stations in Region – I i.e. 61.00 of Pallemthummalapalem, 56.00 of Kona and in Region – II i.e. 71.00 of Kanuru, 63.00 of Achayavaripalem shows that there is the densest mangrove vegetation at a place (Kanuru in the present case), where there is a maximum frequency of inundation. Further, it can be inferred that places where there is less frequency of inundation, have less dense mangrove vegetation (Table-3).

Table –3: Maturity Index Values (MIV) of Mangrove in Region-I&2

S.No	Name of Plant species	Frequency %			
		Creek		Mudflat	
		Palletummapalem	Kona	Kanuru	Achyyavaripalem
1	<i>Aegiceras corniculatum</i>	66.67	33.33	Plant species not present	
2	<i>Avicennia alba</i>	66.67	66.67	Plant species not present	
3	<i>Avicennia marina</i>	100.00	100.00	100.0	100.0
4	<i>Avicennia officinalis</i>	100.00	100.00	100.0	100.0
5	<i>Bruguiera cylindrical</i>	66.67	66.67	Plant species not present	
6	<i>Bruguiera gymnorrhiza</i>	100.00	33.33	0.0	100.0
7	<i>Ceriops decandra</i>	33.33	66.67	0.0	33.3

8	<i>Excoecaria agallocha</i>	100.00	100.00	100.0	66.7
9	<i>Lumnitzera racemosa</i>	33.33	33.33	Plant species not present	
10	<i>Rhizophora apiculata</i>	66.67	66.67	33.3	33.3
11	<i>Rhizophora mucronata</i>	66.67	66.67	Plant species not present	
12	<i>Sonneratia apetala</i>	66.67	33.33	Plant species not present	
13	<i>Acanthus Illicifolius</i>	33.33	66.67	66.7	33.3
14	<i>Aegialitis rotundifolia</i>	33.33	33.33	Plant species not present	
15	<i>Cuscuta reflexa Roxb</i>	33.33	33.33	Plant species not present	
16	<i>Dalbergia spinosa Roxb.</i>	33.33	33.33	Plant species not present	
17	<i>Suaeda maritima</i>	66.67	33.33	66.7	33.3
18	<i>Suaeda monoica</i>	33.33	33.33	33.3	66.7
Total		1100.00	1000.00	500.0	566.7
		61	56	71	63

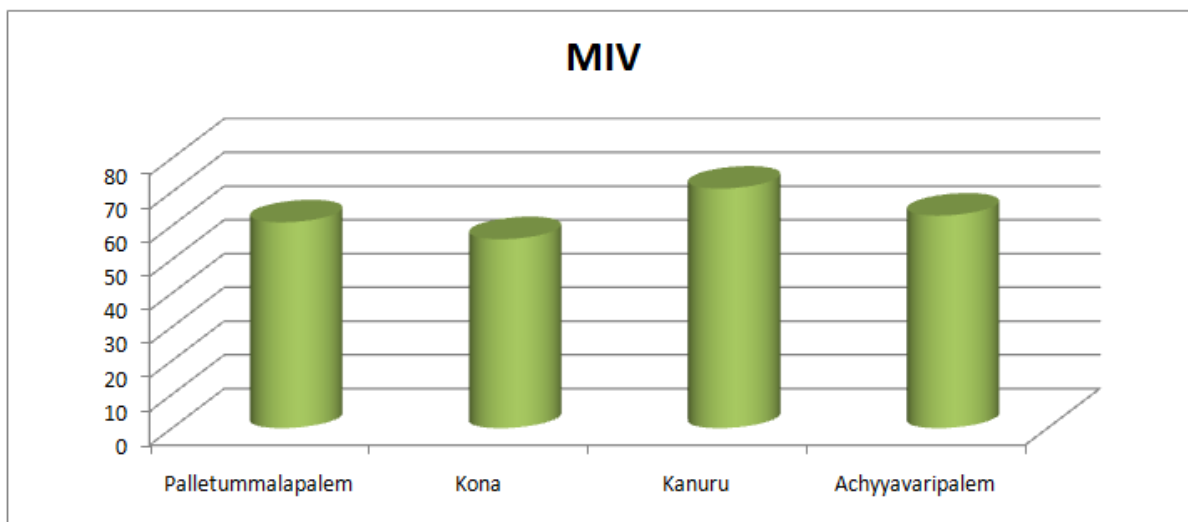


Figure – 3: A comparison of MIV values of Mangrove Vegetation in Region-1&2

Similarity Index:

Similarity Index for each station is calculated to know the extent of homogeneity of vegetation. Depending on the extent of homogeneity, the regions are categorized as given below: (Table-4).80 to 100% --highest resemblance, 60 to 80% --medium resemblance, 40 to 60% --least resemblance, 0 to 40% --no resemblance

Table –4: Species-wise distribution pattern of Mangrove vegetation in region-1&2

S.No.	Name of the Plant Species	Sites											
		Creek						Mudflat					
		1	2	3	4	5	6	1	2	3	4	5	6
1	<i>Aegiceras corniculatum</i>	+	+	-	-	+	-	Plant species not present					
2	<i>Avicennia alba</i>	-	+	+	+	+	-	Plant species not present					
3	<i>Avicennia marina</i>	+	+	+	+	+	+	+	+	+	+	+	+
4	<i>Avicennia officinalis</i>	+	+	+	+	+	+	+	+	+	+	+	+
5	<i>Bruguiera cylindrica</i>	-	+	+	-	+	+	Plant species not present					
6	<i>Bruguiera gymnorrhiza</i>	+	+	+	+	+	+	-	-	-	+	+	+
7	<i>Ceriops decandra</i>	-	+	-	+	-	+	-	-	-	-	+	-

8	<i>Excoecaria agallocha</i>	+	+	+	+	+	+	+	+	+	+	+	+
9	<i>Lumnitzera racemosa</i>	-	+	-	-	+	-	Plant species not present					
10	<i>Rhizophora apiculata</i>	+	+	-	-	+	+	+	-	-	-	-	+
11	<i>Rhizophora mucronata</i>	+	-	+	-	+	+	Plant species not present					
12	<i>Sonneratia apetala</i>	+	-	+	-	+	-	Plant species not present					
13	<i>Acanthus Illicifolius</i>	-	+	-	+	+	-	-	+	+	-	-	+
14	<i>Aegialitis rotundifolia</i>	+	-	-	-	-	+	Plant species not present					
15	<i>Cuscuta reflexa Roxb.</i>	+	-	-	+	-	-	Plant species not present					
16	<i>Dalbergia spinosa Roxb.</i>	-	+	-	-	-	+	Plant species not present					
17	<i>Suaeda maritima</i>	+	-	+	+	-	-	+	+	-	+	-	-
18	<i>Suaeda monoica</i>	-	+	-	+	-	-	-	+	-	-	+	+
Total no. of species in each station		11	13	9	10	12	10	5	6	4	5	6	7

In region-1 majority of sampling sites showed medium resemblances with regard to species diversity with similarity indices ranging from 63.63 between sites 1&6,2&6,3&6,4&6 and 5&6 to 63.15 between sites1&4,2&4and3&4.Similarly, the least resemblance ranging from 54.54 between the sites 1&3,1&5,2&3&2&5,3&5and4&6 to50.00 between the sites1&2.(Table-5)

Table -5: Similarity Index (SI) of Mangroves at region-1

Site No	1	2	3	4	5	6
1		50.00	54.54	63.15	54.54	63.63
2			54.54	63.15	54.54	63.63
3				63.15	54.54	63.63
4					54.54	63.63
5						63.63

In region-2 majority of sampling sites showed medium resemblances with regard to species diversity with similarity indices ranging from 76.92 between sites 1&5,2&5,3&5 and 4&5 to 66.66 between sites1&4,2&4and3&4.and highest least resemblance 80.00 between the sites 1&3and 2&3.(Table-6). Prabhakar rao.V.V,Brahmaji rao.P(2017)

Table -6: Similarity Index (SI) of Mangroves at region-2

Site No	1	2	3	4	5	6
1		72.72	80.00	66.66	72.72	76.92
2			80.00	66.66	72.72	76.92
3				66.66	72.72	76.92
4					72.72	76.92
5						76.92

Coefficient Difference:

In region-1 highest coefficient difference of 50.00 is recorded between sub field stations 1&2 while the least coefficient difference value of 36.37 is obtained between the sub field stations 1&6,1&2,1&3,1&4and1&5 (Table -7).

Table -7: Coefficient difference of Mangrove at region-1

Site No	1	2	3	4	5
1					
2	50.00				
3	45.46	45.46			
4	36.85	36.85	36.85		
5	45.46	45.46	45.46	45.46	
6	36.37	36.37	36.37	36.37	36.37

In the region-2 highest coefficient difference of 33.34 is recorded between sub field stations 1&4,2&4 and 3&4 while the least coefficient difference value of 20.00 is obtained between the sub field stations 1&2and2&2 (Table -8).

Table -8: Coefficient difference of Mangrove at region-2

Site No	1	2	3	4	5
1					
2	27.28				
3	20.00	20.00			
4	33.34	33.34	33.34		
5	27.28	27.28	27.28	27.28	
6	23.08	23.08	23.08	23.08	23.08

VI. CONCLUSIONS

The mangrove vegetation present in both creeks and mudflat areas shows divergent distribution of mangroves. In creeks there are 18 species and in mudflats 9 species are present, 9 species are less comparative to creek region reason is because of tidal inundation, more salt accumulation and difference in soil nutrition in mudflats. In both the region's most dominating species are *Avicennia marina* and *Avicennia officinalis*. In the present study mudflats regions showed densest mangrove vegetation than mudflats region and reforestation activities need to be taken to increase species diversity.

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Working Capital Management in Small Enterprise -A Case Study of Sri Nagavalli Solvent Oils Ltd

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Abstract: *Small and Medium Enterprises(SMEs)play a crucial role in Indian economy.SMEs' success much depends upon effective working capital management.This paper deals with working capital management in Sri Nagavalli Solvent oils Ltd, which is an Indian Small Enterprise of Srikakulam district in the state of Andhra Pradesh. It is a Supplier and Manufacturer of rice bran Oil Company.In this paper an attempt is made to examine the structure and composition of working capital in the Enterprise during the period of study covering ten years from 2006-07 to 2015-16. An attempt is also made to analyze the liquidity position, to find the gross working and networking turnover and to examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.*

Keywords: *Cash Turnover, Debtors turnover, Inventory turnover, Liquidity,Small Enterprise*

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I. Introduction

Working Capital Management is concerned with the management of current assets and current liabilities and the relationship between them. Efficient working capital management is essential for successful running of any Enterprise.Especially SMEs' success much depends upon effective working capital management. Sri Nagavalli solvent oils Pvt. Ltd.is the Supplier and manufacturer of rice bran oil. This is a Private Company incorporated on 17 February 1989. It is classified as Non-Government Company and is registered at Registrar of Companies, Hyderabad. Its authorized share capital is Rs. 10,000,000 and its paid up capital is Rs. 10,000,000. It has a man power of 40. This SME has an annual turnover of Rs. 3788.5 lakhs. The total current assets of the company are Rs.1401.73 lakhs and current liabilities are Rs. 1153.81 lakhs as per 2015-16 Accounts.In this paper an attempt is made toexamine working capital management in Sri Nagavalli solvent oils Pvt. Ltd

II. Review Of Literature

Mishra (1975)¹ studied the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992)² in their research conducted an in-depth survey to analyze the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999)³ in his study on working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency.Reddy (2000)⁴ analyzed the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003)⁵ made an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004)⁶ conducted a study on the issue pertaining to the relationship between working capital management and profitability of a Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012)⁷ investigated the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013)⁸ conducted a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and twoandthree wheelerssectors of Indian automobile industry. UtkarshGoel et al. (2015)⁹ conducted a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms.S. Selvanayaki et al. (2015)¹⁰ focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on profitability. Venkateswararao.P, Surya Chandra Rao.D and HemaVenkata Siva Sree.Ch (2017) examined working capital management in PL Plast Pvt Ltd.It was found that there was no study on working capital management in a solvent oil company. Hence, this study is taken up.

III. Objectives

The general objective of the study is to examine the working capital management in Sri Nagavalli Solvent oils Ltd. The specific objectives include the following.

1. To examine the structure and composition of working capital in Sri Nagavalli Solvent oils Ltd during the period of study.
2. To analyze the liquidity position of Small Enterprise during the period of study.
3. To find the gross working and networking turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the SME under study.
5. To offer suggestions for effective working capital management if required.

IV. Hypotheses

H₀₁: Current ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₂: Quick ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₃: Super quick ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₄: Gross working capital turnover ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₅: Net working capital turnover ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₆: Cash turnover ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₇: Inventory turnover ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₈: Debtors turnover ratio in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

H₀₉: Average collection period in Sri Nagavalli Solvent oils Ltd is uniform during the period of study.

V. Methodology

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Sri Nagavalli Solvent oils Ltd. The period of study is ten years covering the financial years from 2006-07 to 2015-16. The data gathered is analyzed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed.

VI. Analysis And Discussion Of Results

Working capital structure of Sri Nagavalli solvent oils Pvt. Ltd is presented in table 1. It is observed that Inventory was 32.66 percent of total current assets during 2009. It is the lowest percentage during the period of study. Its percentage was highest at 62.87 during 2011. Debtors as a percentage of total current assets varied in between 30.74 during 2013 and 51.97 during 2009. Of all current assets inventory occupied highest percentage during the period of study except during 2007, 2008, 2009 and 2016. It is also observed that cash and bank balance as a percentage of current assets varied between 0.69 during 2011 and 12.02 during 2016. Loans and advances as a percentage of current assets varied between 0.02 during 2016 and 10.88 during 2015. Other current assets as a percentage of total current assets varied between 0.07 during 2011 and 5.30 during 2012. Sundry Creditors occupied highest percent of current liabilities during the period of study. They varied between 52.25 during 2009 and 92.39 during 2011. Short-term borrowings were nil for the first five years of the study. Short-term borrowings as a percentage of current assets varied between 47.50 during 2012 and 67.64 during 2015. Short-term provisions by the firm were made for all years except 2012. Short-term provisions as a percentage of current liabilities varied between 0.05 during 2015 and 23.04 during 2009. Other current liabilities vary between 5.67 percent during 2011 and 28.39 percent during 2009. It is observed that Net Working Capital in the company varied between Rs.137.04 Lakhs during 2013 to Rs.625.52 Lakhs during 2011. It was maintained at high levels during 2011 and 2010.

Table 1: Working Capital structure of Sri Nagavalli Solvent oils Ltd, Srikakulam (Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	13.59	13.61	40.89	39.02	6.52	1.31	59.32	143.51	83.72	168.54
% of TCA	3.91	2.14	8.96	6.47	0.69	0.14	4.89	9.58	5.49	12.02
Debtors	165.85	327.6	237.09	195.04	304.74	310.61	372.77	481.24	515.45	711.67
% of TCA	47.70	51.43	51.97	32.34	32.46	32.31	30.74	32.13	33.83	50.77
Loans & Advances	31.4	36.14	28.01	20.52	36.67	0.7	0.34	4.33	165.71	0.28

% of TCA	9.03	5.67	6.14	3.40	3.91	0.07	0.03	0.29	10.88	0.02
Other Current Assets	0.74	0.96	1.19	0.54	0.62	50.96	42.33	42.28	39.59	28.49
% of TCA	0.21	0.15	0.26	0.09	0.07	5.30	3.49	2.82	2.60	2.03
Inventory	136.12	258.6	149.02	348.01	590.14	597.63	737.79	826.2	719.26	492.72
% of TCA	39.15	40.60	32.66	57.70	62.87	62.17	60.84	55.17	47.20	35.15
Total Current Assets (TCA)	347.73	636.93	456.21	603.13	938.7	961.21	1212.58	1497.56	1523.76	1401.73
Current Liabilities										
Sundry Creditors	94.01	213.76	62.98	153.18	297.97	322.66	329.45	302.09	319.87	299.07
% of TCL	62.19	79.43	52.25	77.93	92.39	74.57	75.50	72.78	77.02	79.88
Other current liabilities	25.88	27.81	31.77	37.38	17.77	110.02	100.43	98.13	94.78	65.97
% of TCL	19.00	10.76	28.39	19.69	5.67	13.35	9.74	7.76	7.38	5.72
Short term borrowings	0	0	0	0	0	391.49	595.18	848.95	868.2	779.42
% of TCL	0.00	0.00	0.00	0.00	0.00	47.50	57.70	67.16	67.64	67.55
Short term provisions	31.28	27.54	25.78	5.99	6.81	0	6.45	14.87	0.67	9.36
% of TCL	22.96	10.65	23.04	3.16	2.17	0.00	0.63	1.18	0.05	0.81
Total Current Liabilities (TCL)	136.22	258.5	111.91	189.83	313.18	824.17	1031.51	1264.04	1283.52	1153.81
NWC	211.51	378.43	344.3	413.3	625.52	137.04	181.07	233.52	240.24	247.92

Source: Annual Reports of Sri Naga valli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

The current ratio in the company has varied between 1.16 during 2012 and 4.07 during 2009 as was shown in the table. The current ratio of the company is maintained at normal levels during the second half of the study period. It is found in the significance test that current ratio is uniform during the period of study.

Table 2: Current Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	347.73	636.93	456.21	603.13	938.7	961.21	1212.58	1497.56	1523.76	1401.73
Current Liabilities	136.22	258.5	111.91	189.83	313.18	824.17	1031.51	1264.04	1283.52	1153.81
Current ratio	2.55	2.46	4.07	3.17	2.99	1.16	1.17	1.18	1.18	1.21

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd. from 2006-07 to 2015-2016

Calculated value of χ^2 for current ratio = 4.911.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919.

Calculated value is less than Critical Value i.e., 4.911 < 16.919. H_0 is accepted.

The quick ratio of the company as shown in table has varied between 0.44 during 2012 to 2.74 during 2009. It is found in the significance test that quick ratio is uniform during the period of study.

Table 3: Quick ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	211.61	378.33	307.19	255.12	348.56	363.58	474.79	671.36	804.5	909.01
Current Liabilities	136.22	258.5	111.91	189.83	313.18	824.17	1031.51	1264.04	1283.52	1153.81
Quick ratio	1.55	1.46	2.74	1.34	1.11	0.44	0.46	0.53	0.62	0.78

Source: Annual Reports of Sri Naga valli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Quick ratio =4.154.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 4.154<16.919, Hence, H_{02} is accepted.

The super quick ratio of the company as shown in the table has varied between 0.001 during 2012 and 0.36 during 2009. It is found in the significance test that super quick ratio is uniform during the period of study.

Table 4: Super Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	13.59	13.61	40.89	39.02	6.52	1.31	59.32	143.51	83.72	168.54
Current Liabilities	136.22	258.5	111.91	189.83	313.18	824.17	1031.5	1264.04	1283.52	1153.81
Super Quick ratio	0.09	0.05	0.36	0.20	0.02	0.001	0.05	0.11	0.06	0.14

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Super Quick ratio = 0.939.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919.

Calculated value is less than Critical Value i.e., 0.939<16.919, Hence, H_{03} is accepted.

The gross working capital turnover ratio of the company as shown in the table has varied between 2.03 during 2015 and 7.12 during 2007. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table 5: Gross working capital Turnover Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2479.2	2764.2	3084.3	2307.0	2769.0	4936.3	4659.9	4670.6	3104	3788.5
Current Assets	347.73	636.93	456.21	603.13	938.7	961.21	1212.5	1497.5	1523.7	1401.7
Ratio	7.12	4.33	6.76	3.82	2.94	5.13	3.84	3.11	2.03	2.70

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Gross Working Capital turnover ratio = 6.215.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 6.215<16.919, Hence, H_{04} is accepted.

The net working capital turnover ratio of the company as shown in the table has varied between 4.42 during 2011 and 36.02 during 2012. It is found in the significance test that net working capital turnover ratio is not uniform during the period of study.

Table 6: Net Working Capital Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2479.2	2764.23	3084.3	2307.03	2769.05	4936.36	4659.93	4670.6	3104	3788.5
Net Working Capital	211.51	378.43	344.3	413.3	625.52	137.04	181.07	233.52	240.24	247.92
Ratio	11.72	7.30	8.95	5.58	4.42	36.02	25.73	20.00	12.92	15.28

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Net Working capital turnover ratio = 60.389.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e., 60.389>16.919, Hence, H_{05} is rejected.

The cash turnover ratio of the company as shown in the table has varied between 27.32 during 2015 and 203.25 during 2008. It is found in the significance test that cash turnover ratio is not uniform during the period of study

Table 7: Cash Turnover Ratio. (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2479.2	2764.2	3084.3	2307.0	2769.0	4936.3	4659.9	4670.6	3104	3788.5
Average Cash Balance	19.66	13.6	27.25	39.95	52.11	33.25	30.31	101.41	113.61	126.13
Ratio	126.10	203.25	113.18	57.74	53.13	148.46	153.74	46.05	27.32	30.03

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Cash turnover ratio =350.941.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 350.941>16.919, Hence, H_{06} is rejected.

The inventory turnover ratio of the company as shown in table 9 has varied between 4.01 during 2015 to 17.70 during 2007. It is found in the significance test that Inventory turnover ratio is not uniform during the period of study.

Table 8: Inventory Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2479.2	2764.23	3084.3	2307.03	2769.05	4936.36	4659.93	4670.6	3104	3788.5
Average Inventory	140.05	197.36	203.81	248.51	469.07	593.88	667.71	781.99	772.73	605.99
Ratio	17.70	14.00	15.13	9.28	5.90	8.31	6.97	5.97	4.01	6.25

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Inventory turnover ratio =20.633.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 20.633>16.919, Hence, H_{07} is rejected.

The debtor's turnover ratio of the company as shown in table has varied between 6.17 during 2016 to 16.04 during 2012. It is found in the significance test that Debtors turnover ratio is uniform during the period of study.

Table 9: Debtors Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2479.2	2764.23	3084.3	2307.03	2769.05	4936.36	4659.93	4670.6	3104	3788.5
Average debtors	180.71	246.72	282.34	216.06	249.89	307.67	341.68	427.00	498.34	613.56
Ratio	13.71	11.20	10.92	10.67	11.08	16.04	13.63	10.93	6.22	6.17

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Debtors turnover ratio = 7.776.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 7.776<16.919, Hence, H_{08} is accepted.

The average collection period as shown in table has varied between 23 days during 2012 to 59 days during 2015 and 2016. It is found in the significance test that Average collection period is not uniform during the period of study.

Table 10: Average Collection Period (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	13.71	11.20	10.92	10.67	11.08	16.04	13.63	10.93	6.22	6.17
Average Collection Period	27	33	33	34	33	23	27	33	59	59

Source: Annual Reports of Sri Nagavalli solvent oils Pvt. Ltd.. from 2006-07 to 2015-2016

Calculated value of χ^2 for Average collection period = 39.582.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 39.582>16.919. Hence, H_{09} is rejected

VII. Conclusion

The above analysis depicts that inventory occupied first place followed by debtors as a percentage of current assets in Sri Nagavalli solvent oils Pvt. Ltd. during the period of study except 2007,2009 and 2016 . The firm has credit worthiness because there is a significant increase in creditors during the period of except 2009. Short term borrowings during the first five years of study were nil. Current ratio of the company is maintained at reasonable levels during the second half of study period. Debtors' turnover ratio was comparatively less in last two years of the study which reflects in high Average collection period. Net working capital turnover ratio, Inventory turnover Ratio, Cash turnover ratio and average collection periods are not uniform during the period of study and showed wide fluctuations. Collection of debts and cash utilization was poorly done in the company during the period of study. Current ratio, Quick ratio, super quick ratio, Gross working turnover ratio, and debtor turnover ratios are uniform during the period of study.

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Role of dielectric layer and beam membrane in improving the performance of capacitive RF MEMS switches for Ka-band applications

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Abstract

In this paper, we have analyzed the role of dielectric layer and different beam membranes on the performance parameters of shunt capacitive RF MEMS switch. The investigation mainly focused on the major challenges of performance parameters are reducing actuating voltage and improving the isolation. The actuation voltage is reduced by incorporation of non-uniform meanders to the serpentine membrane structure and also improved the isolation using 50 nm AlN dielectric thin film. Here, we have incorporated the holes to the top membrane which help the switch to improve the insertion property. The actuation voltage required to move the switch downwards is 5.4 V and the switch operates at transition time of 12 μ s. The isolation – 72.4 dB is observed at the frequency of 27 GHz and insertion – 0.34 dB is observed at the frequency of 27 GHz. The characteristics of switch have been observed by simulating the switch design in FEM tool and results have been compared with theoretical calculations. Finally, the switch is optimized based on the switch performance parameters and it is suitable for Ka-band applications.

1 Introduction

The increasing demand for the reconfigurable devices in the modern day communication systems is widely attracting the researchers to investigate on RF MEMS technology and its applications. In this aspect an intense research has been going on RF MEMS switches which are preferable when compared to the solid state switches like PIN diode, FET etc. (Sharma et al. 2017). It is noticed that, RF MEMS switches are highly recommended to design various communication modules such as reconfigurable antennas, filters and resonators etc. (Chawla and Khanna 2014). RF MEMS switches are widely used due to low insertion loss, high

linearity, good isolation, high reliability and larger bandwidths at higher frequency K-band applications where the conventional switches are fail to offer (Raji George et al. 2017). RF MEMS switches consists of membranes and thin films of dielectric material such that the performance of the device depends on structural dimensions and the material selection.

Few researchers, have achieved the low actuation voltage of 14–16 V by considering the serpentine cantilever string structure at the ends of the beam and 3 μ m gap between the actuation electrodes and beam (Peroulis et al. 2003). Based on the configuration the MEMS switches have been designed as a series and shunt structures with cantilever and fixed–fixed beam (Rebeiz and Muldavin 2001). A light weight membrane with non-uniform meanders and the perforations will help the switch to reduce the actuation voltage (Guha et al. 2016). Because of perforations, the overall mass of the membrane is not supposed to be less than one-third of initial mass, i.e., mass of membrane, and the membrane may be fatigue (Sharma et al. 2017). The switching time of the switch mainly depends on the actuation technique and membrane material. Perforation to the top electrode will ease the electrostatic actuation of the membrane which will help to reduce the switch settling time (Philippine et al. 2013). The upper limit of

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operating frequency of the switch is limited to 40 GHz in direct metal to metal contact switches (Rebeiz and Muldavin 2001). It is avoided by considering a thin dielectric layer between the electrodes which is nothing but a capacitive type switch (Mardivirin et al. 2009; Guha et al. 2017). The device essentially switches between two capacitive states due to the presence of dielectric layer between the electrodes (Berland et al. 2003). The capacitive switch isolation depends on the thickness and relative permittivity (ϵ_r) of the dielectric material (Agarwal et al. 2016). The insertion losses depend on the height of the membrane and the perforation holes dimension of the membrane (Philippine et al. 2013).

In this paper, the popular MEMS structures are cantilevers, bridges, clamped-clamped flexure, and serpentine flexure have been designed and presented. The spring constant of each switch is modeled to obtain the pull in voltage of switches. The various performance characteristics such as resonant frequency, ON and OFF state capacitance and the s-parameters have been investigated and presented.

The work is organized as follows: in Sect. 2, we have presented the shunt capacitive switch mechanical and electrical parameters theoretical analysis. The radio frequency and electro mechanical analysis discussions are presented in Sect. 3, and followed by conclusions in Sect. 4.

2 The structure of different RF MEMS switches

The proposed structure consists of thin films of metals, semiconductors, insulators which plays an important role in the design of RF MEMS switches. Generally, to design RF MEMS switch we require substrate (Ex.: Si, Ge, GaAs, and quartz) in millimeter thickness range, insulators (Ex.: SiO₂, Si₃N₄), conductor (Ex.: Cu, Au, Al) for transmission line in

micrometer thickness range and dielectric films (Ex.: Si₃N₄, HfO₂) for isolation in nanometer range as shown in Fig. 1. A nanometer range metal (Ex.: Al, Au, Cu) membranes are considered as the actuation beams and electrodes (Sharma et al. 2017) as shown in Fig. 2.

The actuation voltage of the proposed switch has been reduced due to selection of thin membrane with perforations. The introduced perforations of the switch will help to ease the electrostatic actuation and improves the isolation. The coplanar wave guide is selected at the transmission line which is placed on the insulating layer of the switch over the substrate as shown in the Fig. 1. Overall all the switches are designed with uniform dimensions. Silicon material is chosen as substrate material with 400 $\mu\text{m} \times 250 \mu\text{m}$ dimension. The length and width of actuation electrodes is 380 $\mu\text{m} \times 220 \mu\text{m}$. A SiO₂ insulating layer is placed in between the substrate and the CPW conductor. The CPW conducting layer is micro machined using Au material.

2.1 Modelling of spring constant of proposed structures

MEMS technology based devices are mainly depends on micro level membrane structures, which are actuated by different mechanisms. Among them electrostatic actuations is preferable due to realization and performance is more. The spring constant is primary parameter to analyse the performance and characteristics of the switch. The mechanical force on a rigid body can be expressed as (Rebeiz and Muldavin 2001).

$$F_m = m \frac{d^2\delta}{dt^2} + b \frac{d\delta}{dt} + K\delta \tag{1}$$

where δ is the displacement of rigid body after applying the force F, $d\delta/dt$ is the first order derivative of displacement which gives velocity, $d^2\delta/dt^2$ is the second order derivative

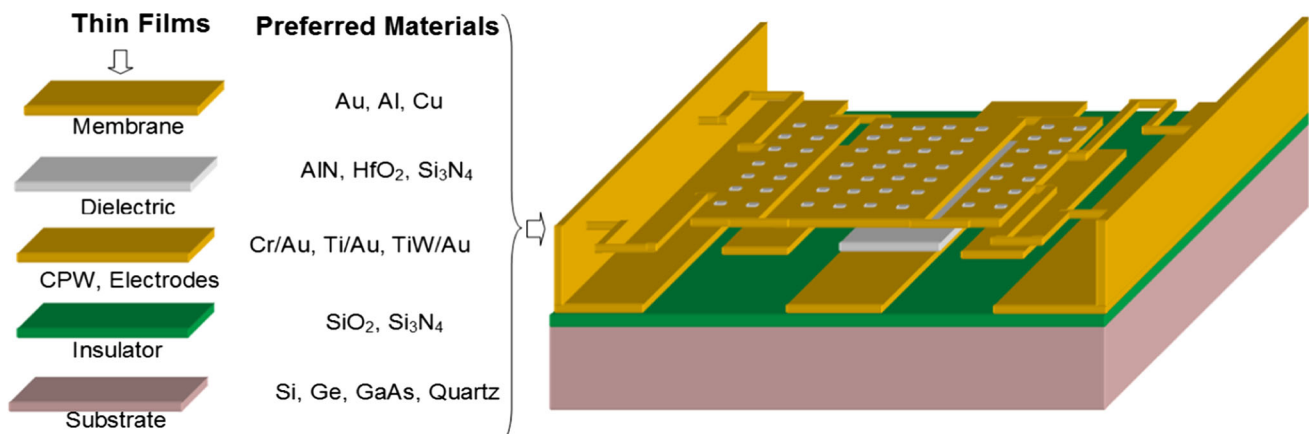


Fig. 1 Schematic structure of different layers of RF MEMS switch

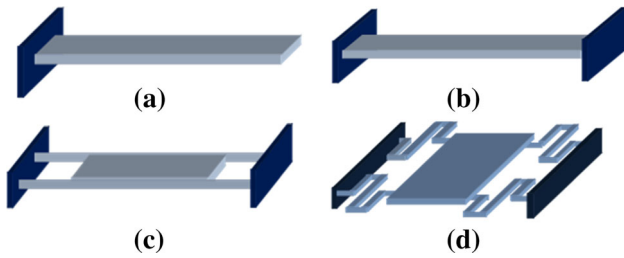


Fig. 2 a Cantilever, b bridge, c clamped-clamped, d serpentine

of displacement which gives acceleration, m is the structure mass, B is the damping coefficient, K is the spring constant.

According to the Hooke’s law, a mechanical force is associated with the structure mass such that it acts opposite to electrostatic force generated. This mechanical force is generated by the stiffness of the spring which holds the structure mass (Mulloni et al. 2015) and it is given by the Eq. 2,

$$F_m = K\delta \tag{2}$$

Hence the expression for the spring constant ‘ k ’ is the ratio of the force on the spring to the displacement which is measured in N/m.

$$K = \frac{F_m}{\delta} \tag{3}$$

2.1.1 Spring constant for cantilever structure

The expression for the displacement (δ) after applying a force (F) for the cantilever structure as shown in Fig. 3, is given as (Rebeiz and Muldavin 2001)

$$\delta = \frac{Fl^3}{Ewt^3} \tag{4}$$

where δ , E is the young’s modulus of the structure material, l is the length, w is the width, t is the thickness of the structure and F is the mechanical force acting on it.

By substituting the Eq. (4) in Eq. (3) we get the expression for the spring constant K for the cantilever structure as the function of structure dimensions (Rebeiz and Muldavin 2001; Mulloni et al. 2015) is

$$K_{cantilever} = \frac{Ewt^3}{4l^3} \tag{5}$$

2.1.2 Spring constant for bridge structure

The mathematical expression obtained from the investigation on the spring constant of bridge structure as shown in Fig. 4, can be written as

$$K_{bridge} = 32 \frac{Ewt^3}{l^3} \tag{6}$$

2.1.3 Spring constant for clamped-clamped structure

The spring constant of the fixed-fixed bridge structures can be reduced by introducing meander technique. In this clamped-clamped structure 4 rectangular meanders are arranged on the either side of the membrane. The simplified equation obtained to calculate the spring constant of the clamped-clamped structure, i.e.,

$$K_{clamped-clamped} = T \frac{Ewt^3}{l^3} \tag{7}$$

where T is the constant value (1.5), depends on the total number of anchors supporting the membrane.

2.1.4 Spring constant for serpentine meander structure

The spring constant of the serpentine structure with non-uniform meanders will depend on the number of legs for each meander. The proposed model consists of non-uniform meander with seven rectangular sections. Hence the spring constant of the proposed model is obtained by calculating the spring constant of each rectangular section and substituting these values in Eq. 8. The spring constant of each rectangular section in a single meander is

$$K_{(1,2,3,4,5,6,7)} = \frac{Ewt^3}{l^3} \tag{8}$$

Hence, these rectangular sections in the single meander are in series connection, the spring constant of the single meander is obtained by the Eq. 9.

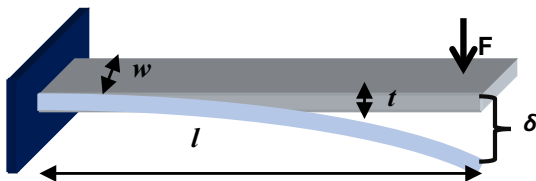


Fig. 3 Cantilever micro mechanical structure

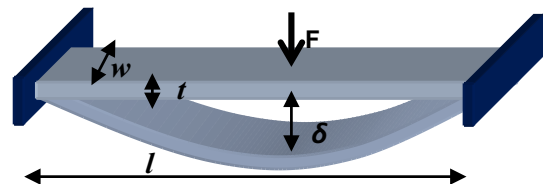


Fig. 4 Micromechanical bridge structure

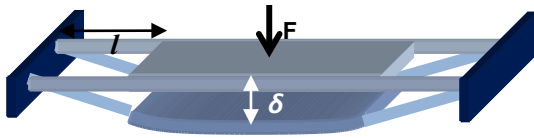


Fig. 5 Clamped-clamped micro mechanical structure

$$\frac{1}{K_{\text{single serpentine meander}}} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \frac{1}{K_4} + \frac{1}{K_5} + \frac{1}{K_6} + \frac{1}{K_7} \tag{9}$$

The serpentine structure is anchored with four supporting meanders which are parallel to each other as shown in Fig. 5, so the effective spring constant of the structure is (Figs. 6, 7)

$$K_{\text{eff}} = 4K_{\text{single serpentine meander}} \tag{10}$$

2.2 Optimized shunt capacitive RF MEMS switch

The optimization of the switch is done on the basis of low spring constant. The spring constant expressions obtained from the previous analysis are listed in Table 1.

The proposed structures designed and analysed using FEM tool with the dimension and results are listed in Table 2. The spring constant values at different actuation voltages are shown in the Fig. 8 and Table 3.

Among the four structures the cantilever and the serpentine structures has low spring constants. Here, we have designed the structures using Al, the material is most fatigue in nature. If we design the switch with cantilever structure because of fatigue nature the reliability of the switch will effect. So in this paper, in the process of optimization we have chosen serpentine structure to design capacitive RF MEMS switch other than using cantilever. Not only the spring constant we have compared all the structures actuation voltage and resonant frequencies as shown in Figs. 9 and 10. The shunt capacitive RF MEMS switch using serpentine menders structure with perforations has high performance in terms of reliability, switching time, pull in voltage.

Hence, the serpentine meander structure capacitive RF MEMS switch is designed on a CPW transmission line with

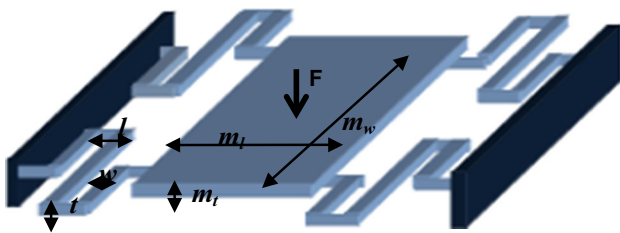


Fig. 6 MEMS serpentine meander switch structure

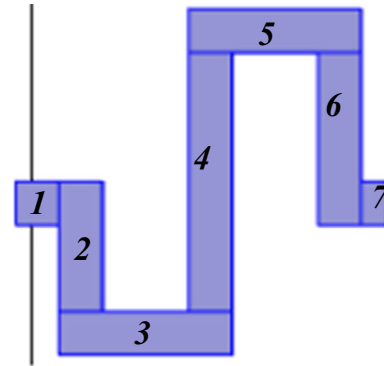


Fig. 7 Serpentine structure meander legs

G/S/G values 90/60/90 μm. The AlN as a dielectric material with ε_r = 9.8 which offers very high isolation is shown in the Figs. 11, 12 and Table 4.

3 Results and discussions

3.1 Electromechanical analysis

3.1.1 Pull-in voltage





The four structured RF MEMS capacitive shunt switches, which are electrostatically actuated with vertical deflection are designed using FEM tool. The switch performance is mainly depends on the pull in voltage. The actuation voltage (or) pull in voltage (V_p) is the minimum voltage required to pull the micro mechanical structure 2/3 down of the actual height or gap between the membrane and the bottom electrode (Guha et al. 2016). The perforations on the membrane is introduced to ease the switch actuation and release process. We can express the pull in voltage of the switch as

$$V_p = \left(\frac{2}{3}g_2\right)V = \sqrt{\frac{8k_{\text{eff}}}{27(2(A_e - A_p))\epsilon_0}}(g_2)^3 \tag{11}$$

where g₂ is the gap between the electrodes, k_{eff} is the spring constant of the membrane, A_e is the area under the electrodes, A_p is the area removed because the perforation, V is the supply voltage.

The FEM simulations have been carried out using COMSOL tool and observed that the serpentine meander structure is having spring constant is approximately equal to the cantilever and also stiffness is more. The Fig. 9 presents the calibration of membrane displacement at different actuation voltages of the optimized switch. It is observed that membrane displaces 2 μm at the pull-in voltage of 5.4 V. Therefore, the meander structure possesses excellent performance characteristics in terms of

Table 1 Spring constant of different micro mechanical structures

Type	Structure	Spring constant (K) in N/m
Cantilever		$\frac{Ewt^3}{4l^3}$
Bridge		$32 \frac{Ewt^3}{l^3}$
Clamped-clamped		$T \frac{Ewt^3}{l^3}$
Serpentine meander		$4K_{\text{single serpentine meander}}$

actuation voltage when compared to the other three structures

3.1.2 Resonant frequency

The mass of the cantilever and bridge membrane structures depends on the dimensions and material density used for the membranes as expressed in the Eq. 11 and for the

clamped-clamped and serpentine structures the mass of the membrane structure and support meanders are considered, but the mass of the supporting meanders is very less when compared to the mass of membrane structure. The mass of such structure is given as in Eq. 12,

$$m = \rho lwt \tag{12}$$

$$m = \rho m_l m_w m_t \tag{13}$$

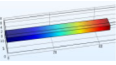
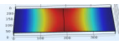
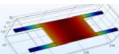
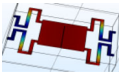
where m_l is the length of membrane, m_w is the width of membrane, m_t is the thickness of membrane. The resonant frequency is the natural frequency of the switch at which maximum displacement of the membrane occurs and is given by the Eq. 13.

$$f_r = \frac{1}{2\pi} \sqrt{\frac{K}{m}} \tag{14}$$

where k is the spring constant, m is the mass of the structure.

The frequency analysis of the proposed structures are presented in the Fig. 13, illustrates that the resonant frequency of the cantilever switch is very less when compared to the other three structures. The Fig. 14, depicts the displacement of the serpentine meander structure switch at different frequencies and occurrence of constant spring stiffness (Fig. 15).

Table 2 Spring constant of different structures

Structure	Dimensions in μm	Theoretical values (K in N/m, m in kg, f_r in Hz)	Simulated value (K in N/m, m in kg, f_r in Hz)
 Cantilever	$l = m_l = 380$	$K = 0.255$	$K = 0.266$
	$t = m_t = 1$	$m = 205.2 \times 10^{-12}$	$m = 205.2 \times 10^{-12}$
	$w = m_w = 200$	$f_r = 5.6 \times 10^3$	$f_r = 5.73 \times 10^3$
 Bridge	$l = m_l = 380$	$K = 8.16$	$K = 8.445$
	$t = m_t = 1$	$m = 205.2 \times 10^{-12}$	$m = 205.2 \times 10^{-12}$
	$w = m_w = 200$	$f_r = 31.75 \times 10^3$	$f_r = 32.3 \times 10^3$
 Clamped-clamped	$l = 45, m_l = 290$	$K = 5.76$	$K = 5.73$
	$t = 1, m_t = 1$	$m = 156.6 \times 10^{-12}$	$m = 156.6 \times 10^{-12}$
	$w = 5, m_w = 200$	$f_r = 30.53 \times 10^3$	$f_r = 30.45 \times 10^3$
 Serpentine	$l = 45, m_l = 290$	$K = 1.08$	$K = 0.98$
	$t = 1, m_t = 1$	$m = 156.6 \times 10^{-12}$	$m = 156.6 \times 10^{-12}$
	$w = 5, m_w = 200$	$f_r = 13.2 \times 10^3$	$f_r = 12.59 \times 10^3$

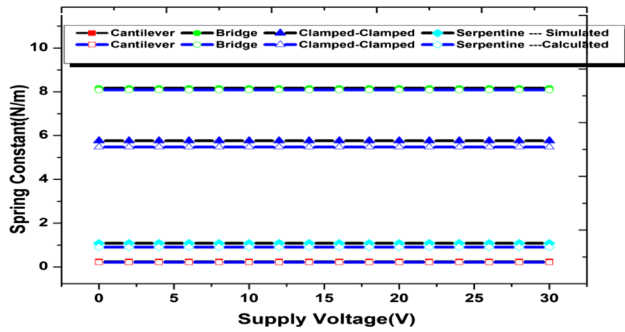


Fig. 8 Comparison of simulated and calculated spring constant values of different micromechanical structures

3.1.3 Switching time

The switching time of the proposed structures are very much depends on pull-in voltage (V_p), actuation voltage (V_s) applied between the electrodes (Guha et al. 2016). The switching time t_s is given by

$$t_s = 3.67 \frac{V_p}{V_s \omega_0} \tag{15}$$

where ω_0 is the angular frequency of the membrane structures and is given by

$$\omega_0 = \sqrt{\frac{K}{m}} \tag{16}$$

where m is the mass of the membrane structure, k is effective spring constant of each structure. That meander type structure with low spring constant help the structure to reduce the actuation voltage. Here, the switching time obtained to displace the membrane $2 \mu\text{m}$ is $12 \mu\text{s}$ as shown in the Fig. 17.

3.1.4 Capacitance analysis

The isolation and insertion losses of the capacitive shunt switch mainly depends on the upstate capacitance and the down state capacitance of the switch. The gap between the conductors and the dielectric material are primary factors for the switch capacitances. The dielectric constant of the

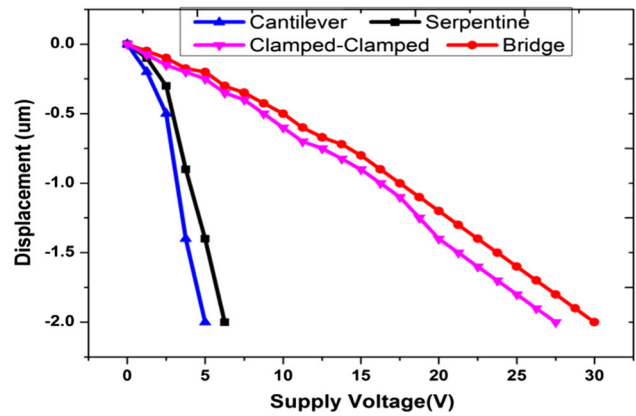


Fig. 9 Comparison of supply voltage (Vs) displacement of different micro mechanical structures

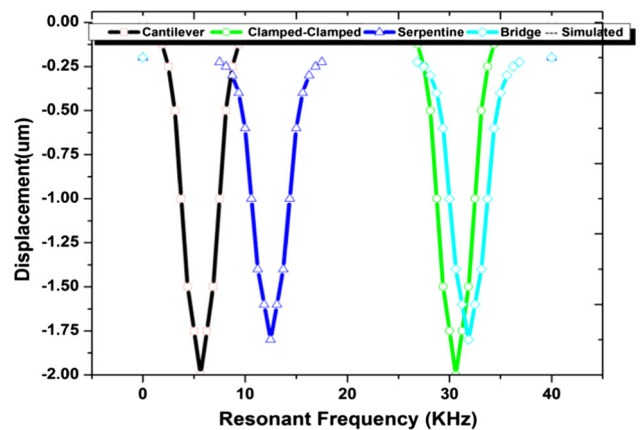


Fig. 10 Comparison of simulated resonant frequency values of different micro mechanical structures

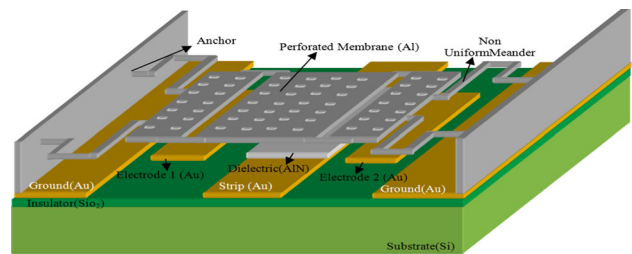


Fig. 11 Optimized shunt capacitive RF MEMS switch top view

Table 3 Serpentine structure with non-uniform meander legs dimensions and spring constant (K) value of each leg

Meander legs	Dimensions in μm	Spring constant, $K_{(1,2,3,4,5,6,7)}$ in N/m
1	$l = 5, t = 1, w = 5$	2800
2	$l = 30, t = 1, w = 5$	12.9
3	$l = 20, t = 1, w = 5$	43.7
4	$l = 60, t = 1, w = 5$	1.62
5	$l = 20, t = 1, w = 5$	43.7
6	$l = 40, t = 1, w = 5$	5.46
7	$l = 5, t = 1, w = 5$	2800

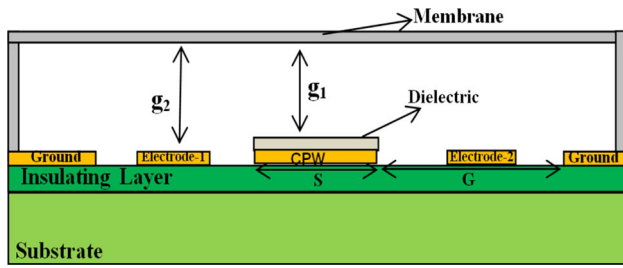


Fig. 12 Optimized shunt capacitive RF MEMS switch side view

Table 4 Optimized shunt capacitive RF MEMS switch dimensions

Parameter	Value (μm)
CPW ($t_g-t_w-t_g$)	90-60-90
Substrate height	100
Substrate width	400
Substrate length	500
Dioxide (insulator) thickness	0.5
Dielectric thickness	0.050
Dielectric constant (ϵ_r)	12.9
Gap between CPW strip and ground	90
Strip width	60
Bottom electrode width	60
Bottom electrode length	200
Gap between membrane and bottom electrode(g_2)	2.2
Overlap area under electrodes ($A_e = 2 (W \times w)$)	2 (200 × 60)
Gap between dielectric and membrane (g_1)	2
Membrane thickness (t)	1
Area between membrane and CPW strip line (A_c)	200 × 60

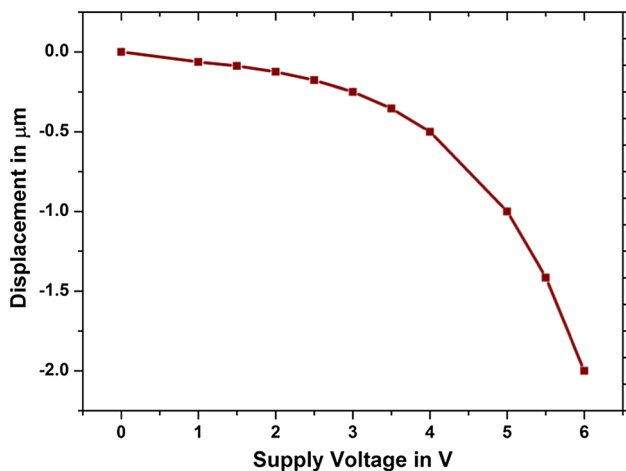


Fig. 13 Pull-in voltage of optimized switch

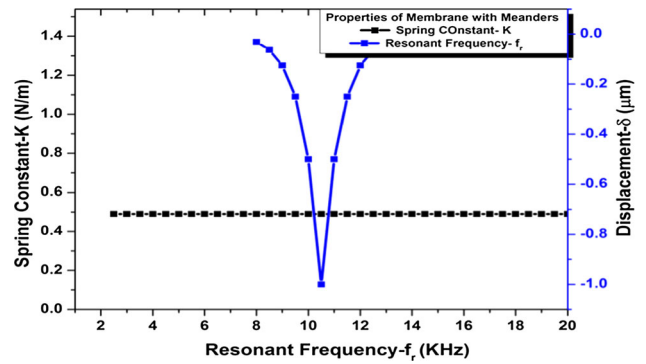


Fig. 14 Resonant frequency and spring constant of optimized switch

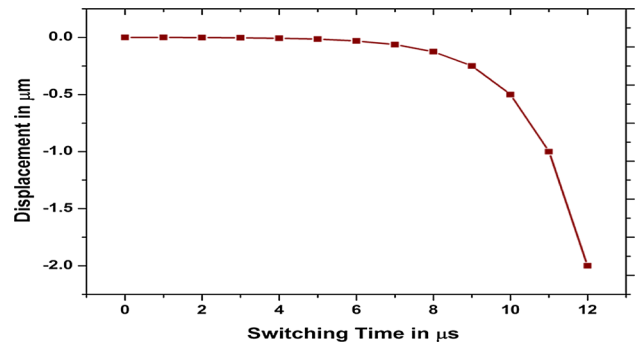


Fig. 15 Switching time of optimized switch

membranes used for the switch is generally in between 3.3 and 12.9 (Fig. 16).

The membrane structure are initially in upstate when no actuation voltage is applied between the electrodes, hence the upstate capacitance (C_{up}) of the switch can be given as

$$C_{up} = \frac{\epsilon_0 A_c}{g_1 + \frac{t_d}{\epsilon_r}} + C_f \tag{17}$$

The membrane is deflected downward due to electrostatic force generated between the membrane and electrode with an applied actuation voltage, the downstate capacitance (C_{down}) of the switch is expressed as

$$C_{down} = \frac{\epsilon_0 \epsilon_r A_c}{t_d} \tag{18}$$

Here, A_c is the area between the membrane and the CPW strip line. T_d is the dielectric thickness, ϵ_0 is the permittivity of the free space

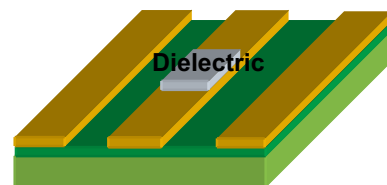


Fig. 16 Dielectric thin film on the top of the CPW line

The perforation on the shunt switch membranes are considered to reduce the stiction forces while releasing the membrane. Therefore, overlapping area between the membranes and the electrodes gets reduced. The upstate and downstate capacitance of the switch with perforation can be expressed as

$$C_{up} = \frac{\epsilon_0(A_c - A_p)}{g_1 + \frac{t_d}{\epsilon_r}} + C_f \tag{19}$$

$$C_{down} = \frac{\epsilon_0 \epsilon_r (A_c - A_p)}{t_d} \tag{20}$$

where A_p is the area removed because of perforation, it can be expressed as,

$$A_p = 2Nl_h w_h \tag{21}$$

Here l_h is the length of the perforation hole, w_h is the width of the perforation hole. The fringing field capacitance (C_f) of the switch is 0.1–0.5% of the parallel plate capacitance.

The upstate capacitance of 2.4 pF and downstate capacitance of 72.4 pF is observed by electromechanical simulations and are plotted in the Fig. 17. The larger difference between them enables the clear switching activities during the operation of the switch. The capacitance ratio of the switch is defined as the ratio of max capacitance (down state capacitance) to minimum capacitance (upstate capacitance) i.e. C_{down}/C_{up} which is observed as 30 for the proposed optimized switch (Fig. 18).

3.2 RF performance analysis

The characteristic impedance of the transmission line also influences the operating frequency of the RF MEMS switch. Most of the shunt type capacitive switch design is done using CPW transmission line as the base, the shunt capacitive switch isolation losses (S_{21}) and return losses (S_{11}) are can be expressed as (Sharma et al. 2017)

$$|S_{11}|^2 = \frac{\omega^2 C_{up}^2 Z_0^2}{4} \tag{22}$$

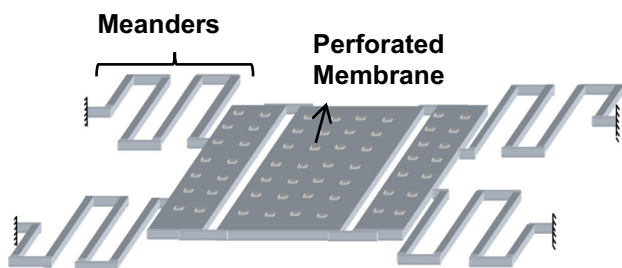


Fig. 17 Perforated membrane with more meanders

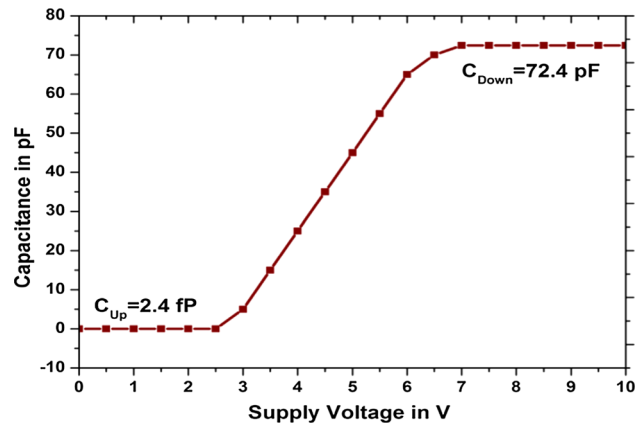


Fig. 18 Switch up state and down state capacitances

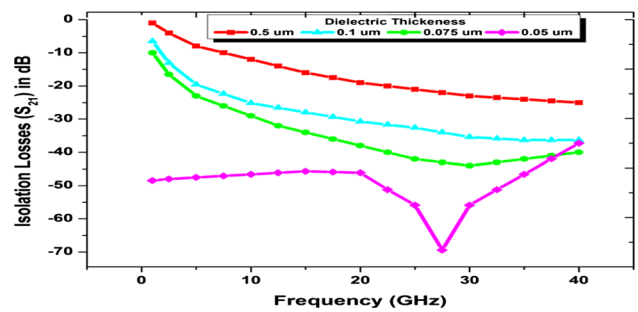


Fig. 19 Role of dielectric thickness on isolation losses (S_{21}) in dB

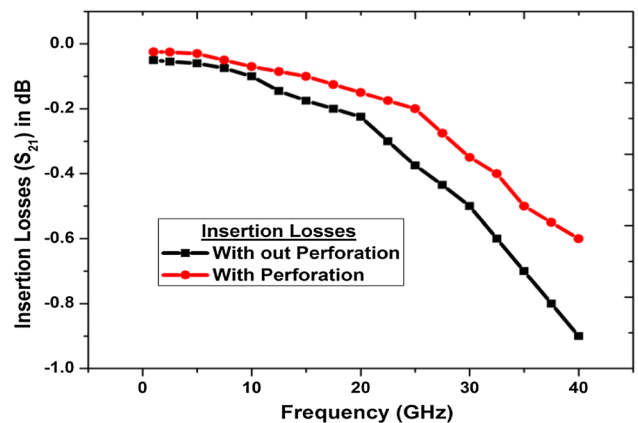


Fig. 20 Role of perforation on insertion losses (S_{21}) in dB

$$|S_{21}|^2 = \begin{cases} \frac{4}{\omega^2 C_{down}^2 Z_0^2} & \text{for } f \ll f_0 \\ \frac{4R_s^2}{Z_0^2} & \text{for } f \approx f_0 \\ \frac{4\omega^2 L^2}{Z_0^2} & \text{for } f \gg f_0 \end{cases} \tag{23}$$

Here, R_s is contact resistance, Z_0 is characteristic Impedance, f_0 is down state resonant frequency, it can

Table 5 Comparison of present work with previous works

Shunt Switches	Li et al. (2016)	Molaei and Ganji (2016)	Proposed switch
Suspender material	Au (1 μm)	Al (0.5 μm)	Al (1 μm)
Dielectric	Si_3N_4	AlN	AlN
Air gap (g_1)	3 μm	0.7 μm	2 μm
Up state capacitance (C_{up})	9.8 fF	–	2.4 fF
Down state capacitance (C_{down})	0.83 pF	–	72.4 pF
Insertion losses	– 0.29 dB @35 GHz	– 0.8 dB @27 GHz	– 0.34 dB @27 GHz
Isolation losses	– 20.5 dB @35 GHz	– 58 dB @27 GHz	– 72.4 dB @27 GHz
Actuation voltage	18.3 V	2.9 V	5.4 V
Switching time (t_s)	–	–	12.5 μs
Spring constant (K_{eff})	–	–	0.49 N/m
Rigid body mass (m)	–	–	108×10^{-12} kg
Resonant frequency (f_r)	–	–	10.8 kHz

express as $1/(2\pi\sqrt{LC_{\text{down}}})$. The optimized switch designed in this paper, model structure top view and side view are shown the Figs. 14 and 15.

The isolation of the RF MEMS switch can be improved by reducing the thickness of the dielectric film. The aluminium nitride (AlN) is taken as the dielectric material and isolation loss analysis have been carried out in HFSS 15.0 V tool. It is observed that the isolation of the switch is increasing with increase in the dielectric thickness. The results are shown in Fig. 12 illustrates the high isolation of – 72.4 dB at 27 GHz is observed at 50 nm dielectric thickness (Figs. 19, 20).

The optimized switch is resonating at 10.8 kHz, the serpentine membrane spring constant is 0.49 N/m and it requiring an actuation voltage of 5.4 V. Because of the perforation the insertion losses are limited to – 0.34 dB. A thin 50 nm AlN dielectric material is helped to increase the isolation of the switch and the optimized switch is offering – 72.4 dB at 27 GHz (Table 5).

4 Conclusions

In this paper, a novel shunt capacitive RF MEMS switch is design and simulated using dielectric material i.e., AlN. This paper proposes a four different structure MEMS switches. Among them a novel serpentine structure with non-uniform meander and the dimensions is designed and optimized. The electromechanical and RF performance analysis for the serpentine meander structured switch with 1 μm optimized thickness is performed and observed that the structure shows excellent performance in terms of actuation voltage. The actuation voltage is reduced by incorporation of non-uniform meanders to the serpentine

membrane structure and also improved the isolation using 50 nm AlN dielectric thin film. The actuation voltage required to move the switch downwards is 5.4 V and the switch operates at transition time of 12 μs . The extended analysis includes role of dielectric on the isolation improvement and observed good isolation of – 72.4 dB @ 27 GHz with 50 nm thickness of AlN as a dielectric material with the dielectric constant 9.8. The perforated structure helps us to ease the electrostatic actuation process and the switch insertion is also improved significantly. The optimized switch designed in this paper offers the best performance at 27 GHz which can be preferably used to design reconfigurable antennas at Ka-band.

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A Micro Level Electrostatically Actuated Cantilever and Metal Contact Based Series RF MEMS Switch for Multi-Band Applications

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Abstract— In this paper, a micro level electrostatically actuated cantilever and metal contact based series RF MEMS Switch is designed and analyzed using Finite Element Method Tool. The designed switch is simulated and the performance is verified over the frequency range 0.8 GHz to 20 GHz. In investigation, it is noticed that the performance of the RF MEMS Switch is decided by the actuation voltage, insertion losses, isolation losses and reliability. The switch designed in this paper achieved a constant insertion losses of -0.08dB to -0.14dB, isolation losses of -58dB to -20dB. This work also concentrated on the cantilever actuation voltage, and it is reduced to 3.55V by using less weight polymer material like Poly Tetra Fluoro Ethylene (PTFE). The series metal contact based electrostatically driven switching is created in Microstrip Transmission line using cantilever structure associated with gold contact material. The designed RF MEMS switch is preferable in the design and implementation of reconfigurable communication devices like microstrip based antennas and RF filters.

Keywords— Microstrip Transmission Lines, MEMS Technology, RF Switches, FEM Tools.

Nomenclatures:

MEMS—Micro-Electro-Mechanical-Systems
RF—Radio Frequency
FEM-Finite Element Method
TEM—Transfers Electro Magnetic

I. Introduction

Now a day the micro level RF switches are playing an important role in the design of reconfigurable communication circuits. The real challenge in the design of RF switches is creation of switching in the electromagnetic transmission lines with good performance i.e. low insertion losses and high isolation losses. There exist different technologies like Complementary Metal Oxide Semiconductor (CMOS), Gallium Arsenide (GaAs), and Micro Electro Mechanical Systems (MEMS) which are useful to create the switching in transmission lines. Compared to other technologies MEMS technology based switches provide good isolation losses, insertion losses and the major advantage with the MEMS technology is power handling which is in the range of 0.2-10W. The operating frequency of the RF MEMS Switches is very high compared to other technology based RF switches.

RF MEMS switches use a mechanical movement to create switching in Radio Frequency operating transmission lines [1]. RF MEMS switches are the specific micromechanical switches that are designed to operate at Radio frequency (0.3GHz to 300 GHz) [1]. In RF capacitive switches, the Upstate capacitance is sensitive to the power of RF signal and generates nonlinear effects. Nonlinear effects like Inter Modulation (IM) are negligible in MEMS devices compared to other switching components like PIN diode and FET Transistor [13].

GaAs FET switches do not have sufficient isolation to minimize cross interference and signal jamming when the channels are in proximity. The major disadvantage with the PIN diode is it requires more operating power. RF MEMS series resistive switches provide high isolation losses when switch is open and low insertion loss when switch is closed with a very less operating voltage [14]. The performance of MEMS technology based RF switch is good in Radio Frequency [14]. MEMS switches provide high isolation, which is required in communication base stations and satellite systems [16]. By using MEMS technology in different ways we can create the switching in microstrip and coplanar transmission lines. Figure 1. shows the different ways to create switching in RF transmission lines.

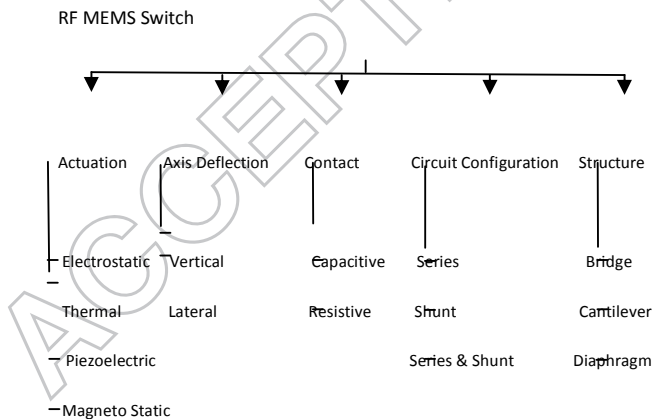


Figure 1: Classification of RF MEMS Switches

Dielectric is not required in resistive (or) metal contact RF MEMS switches, so there is no fringing field effect. But the main drawback with the resistive switches is it will lead to stiction and long term actuation because of this the switch reliability will be affected.

As an investigation we referred a series, DC contact, cantilever (gold) structure, thickness $2.2\mu\text{m}$, length $75\mu\text{m}$, height of contact is $0.6\mu\text{m}$, offering insertion loss of $0.4\text{--}0.9\text{dB}$ over the frequency $1\text{--}75\text{GHz}$, isolation losses of $30\text{--}8\text{dB}$ over the frequency $1\text{--}25\text{GHz}$ [18]. A metal contact series sliding anchor based switch with actuation voltage of 90V offering an isolation loss of $55\text{--}25\text{dB}$, insertion loss of $40\text{--}9\text{dB}$ over the frequency $1\text{--}8\text{GHz}$ [19]. A bridge structure (gold) based switch is achieved an isolation of $55\text{--}25\text{dB}$, $0.5\text{--}0.9\text{dB}$ over the frequency $1\text{--}26\text{GHz}$ [20].

In this paper, we have explained the theoretical and Mathematical analysis about the Series metal contact base electrostatically actuated RF MEMS switch in Section II. Section III discusses the results and the improvements. Finally the paper is concluded in Section IV.

II. Theoretical Analysis

This paper concentrates solely on the design of electrostatically actuated, vertically deflected, resistive contact, series type, cantilever based RF MEMS switch which is suitable to operate in the frequency range of 0.8GHz to 20GHz . This work tries to improve the insertion losses, isolation losses and actuation voltage. In resistive contact based RF MEMS Switches the insertion losses mainly depend on the contact material, which closes the gap in the transmission line. The isolation losses mainly depend on the length of the gap in the transmission line shown in figure 3, and the actuation voltage depends on the cantilever structure which is used to create switching in the RF transmission line. The switch dimensions are in micro level as a Finite Element Method (FEM) tool is used for design and analysis.

A. MEMS Actuation:

In RF MEMS Switches the mechanical actuation can be created by using different mechanisms, like electrostatic (or) Thermal (or) Piezoelectric (or) Magneto Static [1]. Within these mechanisms, electrostatics is preferable [1]. Any electrostatically actuated mechanical structure can be characterized using the parameters like mass of the actuation structure (m), Spring Constant (K), Natural Resonant Frequency (ω_0) and Pull in voltage ($V_{\text{Pull_in}}$).

1) Actuation Structure Total Mass: Here the cantilever is associated with the contact material and the top electrode, as shown in figure 2. So, the total mass of the structure is considered as the sum of individual structure masses. In this electrostatically actuation, a Cantilever structure is associated with two sub structures i.e. a top electrode and contact material. Here material preferred as a cantilever is a light weight polymer i.e. Poly Tetra Fluoro Ethylene (PTFE). A high conductive material gold (Au) is used as top electrode and contact material. Finally the electrostatically actuated structure total mass is considered as a sum of cantilever mass (m_1), top electrode mass (m_2), and contact material mass (m_3) i.e.

$$\text{Actuation Structure Mass (m)} = m_1 + m_2 + m_3 \quad \text{in Kg} \quad (1)$$

Where:

$$\text{Mass of cantilever} = m_1 = l_1 * w_1 * t_1 * \rho_1$$

Cantilever Dimensions:- Length- l_1 ; width- w_1 ; thickness- t_1 ; Density- ρ_1 .

$$\text{Mass of top electrode} = m_2 = l_2 * w_2 * t_2 * \rho_2$$

Top Electrode Dimensions:- Length- l_2 ; width- w_2 ; thickness- t_2 ; Density- ρ_2 .

$$\text{Mass of Contact Material} = m_3 = l_3 * w_3 * t_3 * \rho_3$$

Contact Material Dimensions:- Length- l_3 ; width- w_3 ; thickness- t_3 ; Density- ρ_3 .

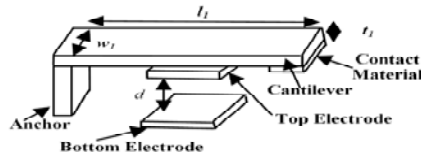


Figure 2: Electrostatically Actuated Cantilever

2) Stiffness or Spring Constant (K): From the Hooke's Law it is clear that the required force for deformation is proportional to the spring constant i.e. if the spring constant of the actuation structure is high, more actuation voltage or pull in voltage is required to deform the structure. So, it is better to choose the actuation material with low spring constant. In this work, a light weight polymer material is used as a deformable cantilever material, so that the spring constant value is low. Because of the low spring constant, the required deformation force also decreases and it will help in the reduction of the actuation voltage. The spring constant of rectangular cantilever can be expressed as

$$\text{Spring Constant (K)} = (2Ewt^3) / (3l^3) \quad \text{in N/m} \quad (2)$$

Here 'E' is Young's Modulus in Pa, 'l' is Length of Cantilever in μm , 't' is the Cantilever Thickness in μm , and 'w' is Width of the Cantilever in μm .

3) Natural Resonant Frequency (ω_0): If the switch is considered as a second order device, the output is a function of static sensitivity (ζ), damping ratio, and un-damped natural resonant frequency (ω_0). The un-damped natural frequency of the actuation structure is useful to find the switching time of the switch. The un-damped natural resonant frequency is directly

proportional to the stiffness of the actuation structure and is inversely proportional to the mass of the actuation structure. The un-damped natural resonant frequency is expressed as

$$\omega_0 = (k/m)^{1/2} \text{ in Rad/Sec} \quad (3)$$

Here, 'K' is the spring constant in N/m; 'm' is the total mass of the actuation structure in Kg.

4) Pull-In Voltage ($V_{\text{Pull_in}}$): The basic principle of electrostatic RF MEMS Switch is, a significant voltage need to apply between the electrodes as shown in figure 2, to get the deformation in the rectangular cantilever. The minimum actuation voltage required for structure deformation is known as pull-in voltage. For the rectangular beam the pull-in voltage is expressed as

$$V_{\text{pull_in}} = \sqrt{\frac{8K}{27A\epsilon_0}} d^3 \text{ in V} \quad (4)$$

Here, 'A' is the effective area between electrodes, 'd' is the gap between the electrodes in μm , ' ϵ_0 ' stands for free space permittivity and is equal to $8.85 \times 10^{-12} \text{ F/m}$.

B. Microstrip Transmission Line with Gap:

Transmission lines are used to transmit the RF signal from one point to other point. In this paper, a microstrip transmission line is taken with a gap (g) as shown in figure 3, and switching is created using electrostatically actuation structure as shown in figure 5. The fabrication of micro level transmission line suitable for RF MEMS switch is a real challenge.

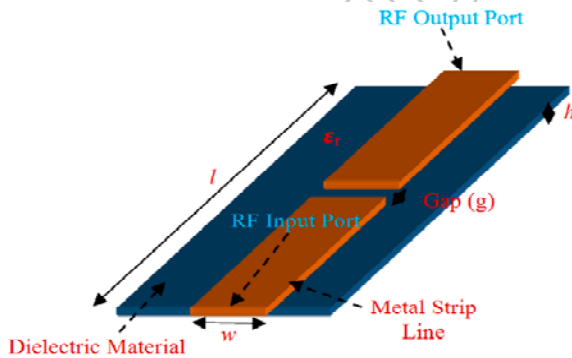


Figure 3: Microstrip Transmission Line with Gap (g)

Why MEMS technology to create the switching in the microstrip transmission line means, which provides high isolation losses and minimum insertion losses. These two parameters mainly depend on the gap (g) in the transmission line and the contact material which is used to cover the gap in the transmission line.

There are two types of transmission lines which support PCB and IC technologies. One is microstrip and the other is coplanar transmission line. These transmission lines are used to feed the microstrip

antennas. By creating switching in the microstrip transmission lines reconfigurable antennas, filters can be designed.

Microstrip transmission line is a very good medium to transmit radio frequency signals. The design of these transmission lines requires placing of ultrathin metal strip on the top of a dielectric material with appropriate dielectric constant as shown in Fig. 3. The real challenge in design of this transmission line is maintaining fewer losses and less distortion. The mode of RF signal transmission in this transmission line is quasi TEM, because the wave propagates through air and dielectric medium with different speeds [4]. Few materials suitable for dielectric and microstrip are listed with properties in the Table I.

Table I
List of Materials and Properties Useful To Design
Microstrip Transmission Lines

Dielectric Material	Dielectric Constant	Microstrip Material	Electrical Conductivity (σ) in (S/m)
FR-4	4.35-4.8	Gold(Au)	$4.1 * 10^7$
Alumina (Al_2O_3)	≈ 9.8	Copper (Cu)	$5.96 * 10^7$
Polytetrafluoroethylene (PTFE)	≈ 2.1	Nickel(Ni)	$1.43 * 10^7$
Silicon Nitride (Si_3N_4)	≈ 7.5	Tungsten (W)	$1.79 * 10^7$

1) Characteristic Impedance (Z_0): The reflection losses in the transmission lines can be reduce by matching the source impedance and the characteristic impedance. In general the source impedance is 50Ω . The characteristic impedance of the microstrip transmission line is defined as the ratio of circular integration of electric field over the length to the circular integration of magnetic field over the same length. i.e.

$$Z_0 = \frac{V}{I} = \frac{\oint \mathbf{E} \cdot d\mathbf{l}}{\oint \mathbf{H} \cdot d\mathbf{l}} \quad \text{in } \Omega \quad (5)$$

And the same characteristic impedance is expressed in terms dielectric height (h), width of the microstrip (w) by I.J.Bahl and D.K.Trivedi [5] for two different conditions i.e. $w/h < 1$, $w/h > 1$. The characteristic impedance of a microstrip transmission line under the condition $w/h < 1$ is,

$$Z_0 = \frac{60}{\sqrt{\epsilon_{\text{eff}}}} \ln \left(8 \frac{h}{w} + 0.25 \frac{w}{h} \right) \quad \text{in } \Omega \quad (6)$$

Under the condition ($w/h < 1$) the effective relative permittivity (ϵ_{eff}) can be expressed as

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[\frac{1}{\sqrt{1 + \frac{12h}{w}}} + 0.04 \left(1 - \frac{w}{h} \right)^2 \right]$$

The characteristic impedance of a microstrip transmission line under the condition $w/h > 1$ is,

$$Z_0 = \frac{120\pi}{\sqrt{\epsilon_{\text{eff}} \left[\frac{w}{h} + 1.393 + \frac{2}{3} \ln \left(\frac{w}{h} + 1.444 \right) \right]}} \quad (7)$$

Under the condition ($w/h > 1$) the effective relative permittivity (ϵ_{eff}) can be expressed as

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[\frac{1}{\sqrt{1 + \frac{12h}{w}}} \right]$$

The characteristic impedance of the microstrip transmission line depends on the relative permittivity (ϵ_r), height (h) of the substrate material, and the width (w) of the conductive material. In microstrip transmission line, wave propagation happens in air and substrate. So the effective relative permittivity (ϵ_{eff}) should be measured to find the accurate characteristic impedance of the microstrip.

C. Series RF MEMS Switch:

The main intention of this paper is, creation of switching in the microstrip transmission line using MEMS technology. Here when the cantilever is in upstate, because of the gap in the transmission line the RF input signal is unable to reach the RF output port. When a voltage is applied an electric field created between the electrodes, then the cantilever will come to down state and the contact material associated with cantilever covers the gap in the microstrip transmission line [5]. Therefore the RF signal applied to the input port is able reach the output port with less reflection.

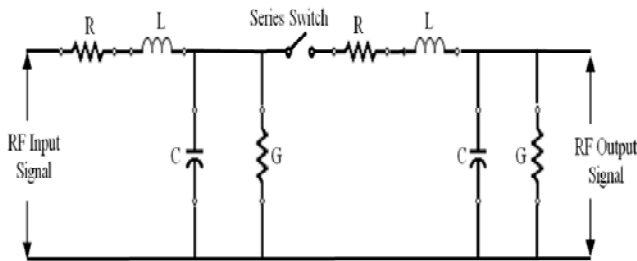


Figure 4: Lumped Model of Series RF MEMS Switch

D. Working Principle:

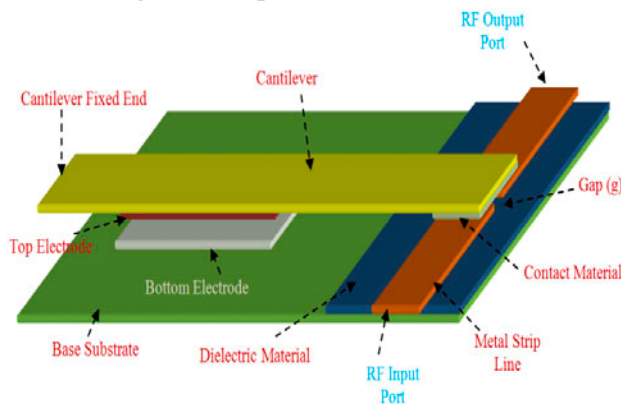


Figure 5: Series RF MEMS Switch

The working principle of the series RF MEMS switch designed in this paper is as follows, if the applied actuation voltage between the electrodes is 0V, the structure (Cantilever) never deforms and it is always in upstate so the gap (g) in the microstrip transmission line creates good isolation. Under this condition RF input signal will not reach RF output port. When a significant actuation voltage is applied between the electrodes, some electrostatic force will be created between the top electrode and the bottom electrode. Then the structure (Cantilever) starts deforming and come to down state and covers the gap (g) in the transmission line. It acts as a channel to the RF signal. Hence the RF input signal reaches to the RF output port. The complete RF MEMS Switch designed in this paper is shown in figure 5.

E. Design Methodology:

The series RF MEMS switch design is done in two phases, in the first phase a microstrip (gold) is placed on the top of substrate with significant dielectric constant. A small gap is created in transmission line for switching purpose. In the second phase an electrostatically actuated MEMS

structure is placed on the top of the transmission line to cover the gap when required. In each phase required materials are assigned to the design structures.

III. Results and Discussions

A miniaturized series RF MEMS switch is designed with the dimensions shown in Table II, using a Finite Element Method (FEM) Tool COMSOL. The main aim of this work is design of high performance series RF MEMS switch by improving the parameters like insertion losses, isolation losses and the actuation voltage. The RF transmission line means it is a medium used to transmit a high frequency signal from source point to destination point. Present day's applications require transmission lines which need to carry ultrahigh frequencies and super high frequency signals.

Table II
Switch Design Dimensions, Materials and Properties

Type	Substrate Type	Dimensions (μm)	Materials	Material Properties
MEMS Actuation Section	Cantilever	Length(l_1)=825 Width(w_1)=40 Thickness(t_1)=5	Polytetrafluoroethylene (PTFE)	Young's Modulus (E) = 0.4×10^9 Pa, Density(δ_1) = 2200 Kg/m^3
	Top Electrode	Length(l_2)=500 Width(w_2)=40 Thickness(t_2)=3	Gold(Au)	Density(δ_2) = 19300 Kg/m^3
	Bottom Electrode	Length(l)=500 Width(w)=450 Thickness(t)=20	Gold(Au)	Density(δ) = 19300 Kg/m^3
	Contact Material	Length(l_3)=50 Width(w_3)=80 Thickness(t_3)=6	Gold(Au)	Density(δ_3) = 19300 Kg/m^3
RF Section	Microstrip Transmission Line with Gap	Width(w)=50 Thickness(t)=0 Gap(g)=1	Gold(Au)	Electrical Conductivity (σ) = $45.6 \times 10^6 \text{ S/m}$
	Dielectric Material	Height(h)=20	Silicon Dioxide (SiO_2)	Dielectric Constant (ϵ_r) = 3.8

Microstrip transmission lines are appropriate when the transmission distance is of millimetre and micrometre range. In the design of these transmission lines it is important to maintain the characteristic impedance in the range of 50Ω - 150Ω range.

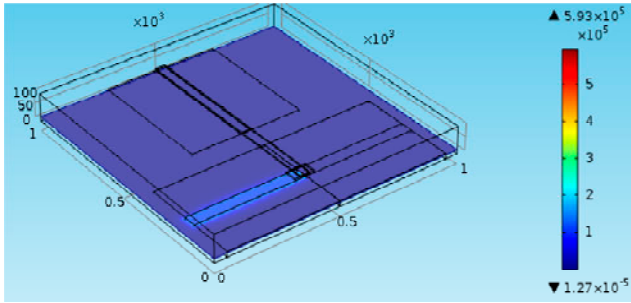


Figure 6: Cantilever in Up State, Switch OFF

To maintain the characteristic impedance within the range the switch dimensions and dielectric material properties are important. This paper, principally analyses the variations in the characteristic impedance of microstrip transmission lines depending on dimensions and dielectric materials in micro level which are suitable to design RF MEMS Switches. The analysis is done with the mode of transmission in microstrip is Quasi TEM mode.

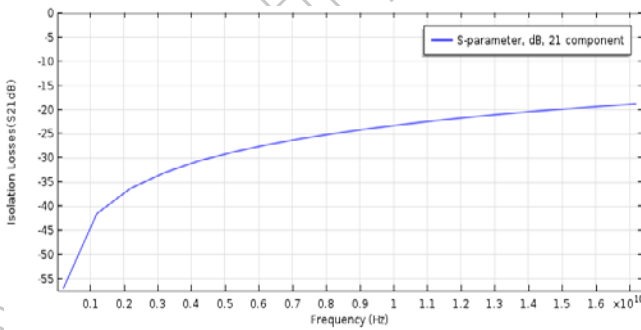


Figure 7: Isolation losses(S₂₁), When Cantilever is in Up State

First the isolation losses mainly depends on the gap (g) in the microstrip transmission line, here a $1\mu\text{m}$ gap (g) is created in the transmission line. If the voltage applied between the electrodes is 0V the cantilever structure is in upstate as shown in the figure 6, which results an isolation loss in the range -58dB to -20dB over the frequency 0.8GHz to 20GHz respectively as shown in the figure 7. Under this condition the RF input signal is unable to reach to RF output port which is clearly shown in figure 6.

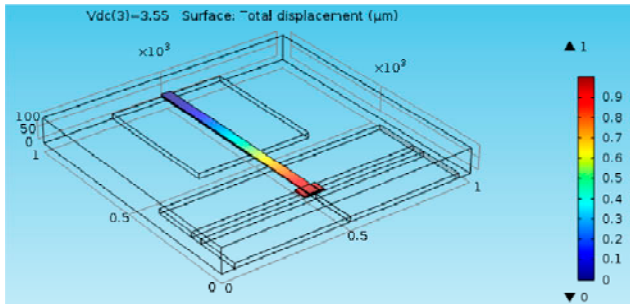


Figure 8: Cantilever Deformation

The insertion losses are depends on the contact material which is used to cover the gap (g) in the transmission line, here in this work a gold(Au) material is used as a contact material to cover the gap in the transmission line. Whenever an actuation voltage of 3.55V is applied between the electrodes the structure will start deform as shown in in figure 8, and cover the gap (g) in the transmission line. Now the RF input signal will reach to the RF output port as shown in figure 9. Which resulting a constant insertion loss of -0.08dB to -0.14dB over the frequency range 0.8GHz to 20GHz as shown in figure 10. The parameter actuation voltage is mainly depends on the linear elastic material, here a light weight Poly Tetra Fluoro Ethylene (PTFE) polymer material is used, which is deformed $1\mu\text{m}$ for the actuation voltage of 3.55V as shown in figure 8. Few mechanical properties of the cantilever are theoretically calculated and listed in Table III.

Table III
Theoretical Calculations

Parameter	Theoretical Value
Total Cantilever Mass (m) = $m_1+m_2+m_3$	19.842×10^{-10} Kg
Spring Constant(K)	2.3745×10^{-3} N/m
Pull-In Voltage	0.2229 V
Resonant Frequency	0.173 KHz

Microstrip transmission line is very good medium to transmit radio frequency signals. The design of these transmission lines require placing of ultrathin metal strip on the top of a dielectric material with appropriate dielectric constant. The real challenge in design of this transmission line is maintaining fewer losses and less distortion. The mode of transmission in this transmission line is quasi TEM, because the wave will propagate through air and dielectric medium with different speed.

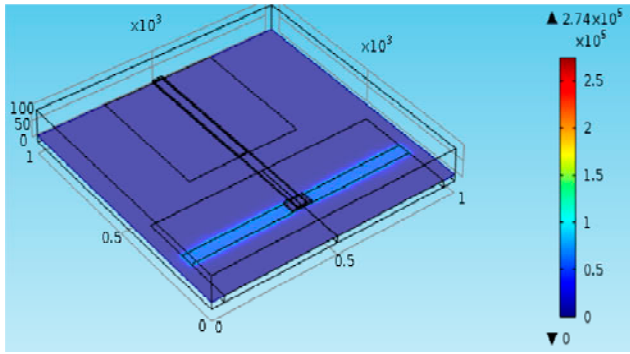


Figure 9: Cantilever in Down State, Switch ON

In this paper, an analysis is done on the effect of young's modulus (E) on the actuation voltage and noticed that, if the young's modulus (E) of the actuation structure is increasing the strength of the structure is increasing so required actuation voltage also increasing as shown in figure 11. After comparing with the past work, as listed in Table IV, the cantilever switch discussed in this paper is provided a solution to reduce the actuation voltage (≈ 3.55) by using polymer material as actuation structure. Achieved low insertion losses of 0.08dB, high isolation losses of 58-20dB.

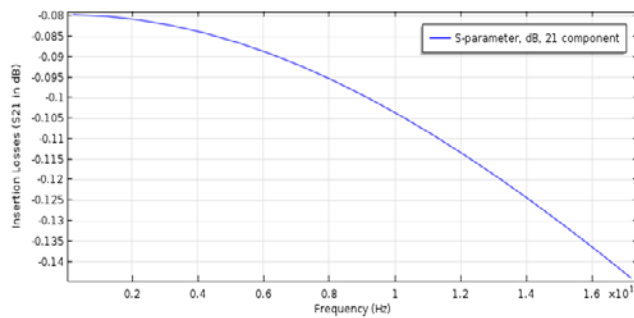


Figure 10: Insertion Losses (S_{21}), When Cantilever is in Down State

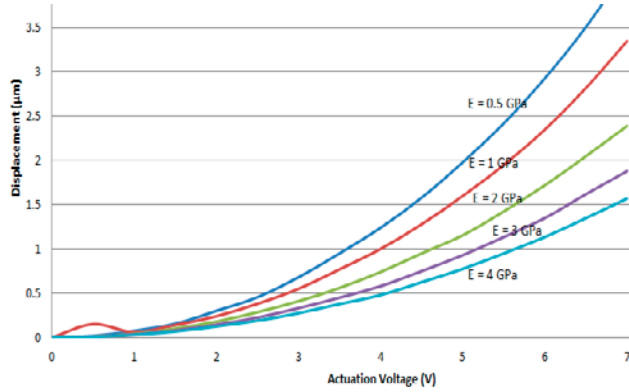


Figure 11: Displacement Vs. Actuation Voltage w.r.t Young's Modulus (E)

Table IV
Different RF MEMS Series Switches Comparison

Parameter	Ref. [18] 2009	Ref. [19] 2014	Ref. [20] 2014	Proposed
Type	DC Contact	Metal Contact	Metal Contact	Metal Contact
Structure (Material)	Cantilever (Gold)	sliding Anchor	Bridge (Gold)	Cantilever (PTFE)
Structure Thickness & Length	2.2µm & 75 µm	-	1.8-3 µm & 580 µm	5 µm & 825 µm
Actuation Voltage	-	80-90 V	20V	3.55V
Transmission Line	CPW	CPW	CPW	Microstrip
Gap	0.6µm	0.9 µm	2.37 µm	1 µm
Insertion Losses	0.4-0.9dB @ 1- 75GHz	0.25-0.5dB @ 1- 8GHz	0.5-0.9dB @ 1- 26 GHz	0.08-0.14dB @ 0.8-20GHz
Isolation Losses	30-8dB @ 1- 25GHz	40-9dB @ 1- 8GHz	55-25dB @ 1- 26 GHz	58-20dB @ 0.8-20GHz

IV. CONCLUSION

Present day communication applications need the things like microstrip antennas and filters with reconfigurable feature. From the investigation it is clear that MEMS technology based switches are the best solution to design reconfigurable Radio Frequency devices. Series RF MEMS switches will fulfil the requirement in communication applications for transmission and reception of data in different frequency bands. In this paper, an electro statically actuated, series, metal contact RF

MEMS is designed and simulated over the frequency range 0.8GHz to 20GHz. The main achievement in this work is high isolation losses in the range -58dB to -20dB. The switch is offering an insertion loss of -0.08dB to -0.14dB. Here a high conductive contact material like gold (Au) is used to cover the gap (g) in the transmission line. One more challenge in the MEMS technology based switches is requirement of high actuation voltage. This work tried providing the solution for it by referring a light weight polymer material as linear elastic material. Because of using of polymer material like Polytetrafluoroethylene (PTFE) with young's modulus of 2200 kg/m^3 , the actuation voltage is restricted to 3.55V for the deformation of $1\mu\text{m}$. The designed switch results show that the switch can give good performance over the frequency range 0.8GHz to 20GHz, i.e. the switch can be referred for L, S, C, X, Ku band communication applications.

V. Acknowledgement

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Public Interest Statement

Micro Electro Mechanical Systems (MEMS) is an eminent technology, which will facilitates miniaturization, low power consumption, high performance. Because of this reason the MEMS technology is adopted in many applications. Especially in RF applications like RF Switches, Phase shifters, Filters design MEMS technology is referred by many researchers.

- A micro level electro statically actuated cantilever and metal contact based series RF MEMS Switch is designed and analysed using Finite Element Method Tool.
- The designed switch is simulated and the performance is verified over the frequency range 0.8 GHz to 20 GHz.
- In investigation, it is noticed that the performance of the RF MEMS Switch is decided by the actuation voltage, insertion losses, isolation losses and reliability.
- The switch designed in this paper achieved constant insertion losses of -0.08dB to -0.14dB, isolation losses of -58dB to -20dB.



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ELECTRICAL & ELECTRONIC ENGINEERING | RESEARCH ARTICLE

Design and analysis of CPW based shunt capacitive RF MEMS switch

T. Lakshmi Narayana^{1,2}, K. Girija Sravani³ and K. Srinivasa Rao^{3*}

Abstract: This paper is about, the design and analysis of shunt capacitive RF MEMS switch with less actuation voltage, low insertion losses and high isolation losses. The switch design is incorporated the Electrostatics MEMS actuation technique with vertically deforming bridge. In terms of actuation voltage the switch performance is improved by choosing step type actuation structure with holes. The switch Radio Frequency (RF) performance is analysed over the frequency range from 0.6 to 40 GHz. The major achievements in this work are actuation voltage is reduced to 4.2 V for 0.9 μm displacement, the return loss is below -16 dB, the insertion loss is below -0.44 dB, and the isolation loss is -20 dB. The dielectric material used between the membrane and the CPW line is Aluminum Nitride (AlN) with dielectric constant 9.5. The substrate material used for the CPW transmission line is quartz with dielectric constant 3.9. The bridge is designed with meanders, step structure by using gold material with thickness 0.5 μm . The switch upstate capacitance is capacitance ratio of the shunt capacitive switch is 65.22.

Subjects: Technology; Design; Electromagnetics & Communication; Electronic Devices & Materials

Keywords: RF MEMS switch; CPW transmission line; pull-in voltage; up capacitance; down capacitance; MEMS actuation mechanisms; electrostatic MEMS actuation; insertion losses; isolation losses



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PUBLIC INTEREST STATEMENT

RF MEMS Switches are mainly used to design the reconfigurable communication modules like antennas and filters. There are different types of RF MEMS switches i.e. series and shunt switches. Shunt switches has more operating frequency and offer high isolation. In this work we designed a shunt capacitive Radio Frequency (RF) operated MEMS Switch which offers more isolation, good insertion and requiring low actuation voltage. The switch is having good capacitance ratio. Here, the working of the proposed switch, if the membrane or beam is in upstate the switch is act like open circuit and RF_{in} is equal to RF_{out} , the the membrane is downstate switch is acts like closed circuit and RF_{out} is equal to zero.

1. Introduction

The RF MEMS switches have a predominant role in the design of present day advanced communication applications. To design reconfigurable microwave antennas and filters RF MEMS switches are preferable than solid state devices like FET and PiN diode (Molaei & Ganji, 2017). MEMS technology has scope for miniaturization when compared to CMOS and GaAs technologies. The major advantages in MEMS technology based RF MEMS switch are better linearity, high isolation, low noise, low power consumption, and high operating frequency (Rebeiz & Muldavin, 2001). The RF MEMS switch performance depends on return losses, isolation losses, insertion losses, switching time and actuation voltage (Bakri-Kassem & Mansour, 2015). The materials used in the design also decides the performance, stiction of the cantilever depends on the contact material used in the switch (Ravirala et al., 2017; Srinivasa Rao & Thalluri, 2016). MEMS technology offers different actuation mechanisms like electrostatic, magneto static, piezoelectric and thermal. In this electrostatic actuation technique is preferable because other techniques require more dc voltage to actuate the structure (Rebeiz & Muldavin, 2001). The RF MEMS switches are electrically classified as series type and shunt type. Based on contact type the switches are classified as capacitive and resistive (Barbato & Meneghesso, 2015). Capacitive switches are preferable for high frequency and resistive switches are preferable for low frequency applications (Guha, Kumar, Parmar & Baishya, 2016). In capacitive switches the isolation losses mainly depends on the dielectric material used between the electrodes, generally silicon nitride, silicon dioxide and Aluminum Nitride are used. The MEMS structure may be bridge type (or) cantilever type (or) diaphragm type (Mafinejad, Zarghami & Kouzani, 2013). The bridge structure with supporting meanders and step type will help to minimize the actuation voltage (Chawla & Khanna, 2014; Molaei & Ganji, 2017).

2. Theoretical analysis

In this paper an electrostatically actuated shunt type capacitive RF MEMS Switch is designed by adopting new techniques in the shape of structure like meanders, step, and holes to the structure as shown in Figure 4.

2.1. CPW transmission line

CPW and Microstrip transmission lines are used to design RF MEMS switches. The return losses, operating frequency depends on the dimensions of the transmission line. In this paper co-planar wave (CPW) transmission line is used to design the shunt capacitive RF MEMS switch. In CPW transmission line both the conductors are in same plane as shown in the Figure 1.

Here t_h is the height of the substrate, t_w is the width of the CWP line and t_g is the gap between the CPW planes. ϵ_r is the substrate dielectric constant generally in between 3.3 and 4.7. The switches are designed for radio frequency applications so the CPW line metal thickness is considered as $0.0001 = 0 \mu\text{m}$.

2.2. Beam structure

To design an RF MEMS switch different structures like cantilever, diaphragm, and beam or bridge are preferable. The shape and dimensions of the beam decides the magnitude of actuation voltage and isolation losses. In this paper an RF MEMS switches is design using beam structure with meanders, step and holes as shown in Figure 2.

The mass of the structure is associated with the mass of the meanders (m_d), mass of the steps (m_s) and mass of the membrane (m_m). The total effective mass (m_e) can be calculated by subtracting holes mass (m_h) from overall mass.

Figure 1. CPW transmission line.

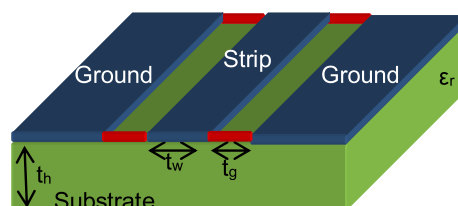
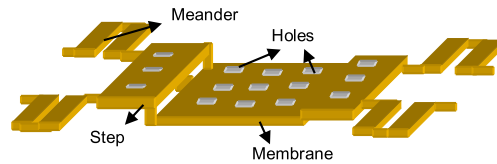


Figure 2. MEMS actuation structure (beam).



$$m_t = m_d + m_s + m_m - m_h \quad (1)$$

The switch is an electrostatically actuated switch, which require a actuation voltage (V_p) to deform the structure can be expressed as:

$$V_p = \sqrt{\frac{8k_{\text{eff}}}{27A\epsilon_0} \left(g_1 + \frac{t_d}{\epsilon_r} \right)^3} \quad (2)$$

where k_{eff} is the effective spring constant of the beam i.e. it is the overall spring constant of the meanders, step and membrane.

The spring constant will decide the required actuation voltage i.e. more spring constant means more actuation voltage is required. The deforming structure spring constant generally expressed as:

$$k = \frac{EWt^3}{l^3} \quad (3)$$

where E is the young's modules, W is the width, t is the thickness, l is the length of the beam.

The meander structure used in this paper is associated with different beams as shown in Figure 3 and Table 1. Each beam is associated with own spring constant i.e. k_1, k_2, k_3, k_4, k_5 . The mean spring constant (k_m) can be expressed as:

$$\frac{1}{k_m} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \frac{1}{k_4} + \frac{1}{k_5} \quad (4)$$

The overall effective spring constant (k_{eff}) associated with actuation structure can be expressed as:

$$k_{\text{eff}} = 4k_m \quad (5)$$

Here the mean spring constant is multiplied by 4 because the structure is associated with for meanders on four sides as shown in Figure 2.

The capacitive RF MEMS switch performance can be improve by decreasing the upstate capacitance and increasing the downstate capacitance. The capacitance variation mainly depends on the dielectric material used between the bottom electrode and membrane, generally silicon nitride or silicon dioxide or Aluminum nitride is used as dielectric material. The dielectric constant of these materials is in between 3.3 and 9.5 (see Tables 2 and 3). The upstate capacitance (C_u) can be expressed as:

Figure 3. Meander with non-uniform spring constants.

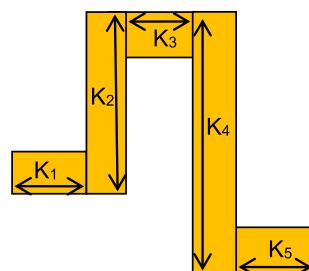


Figure 4. Shunt capacitive RF MEMS switch top view.

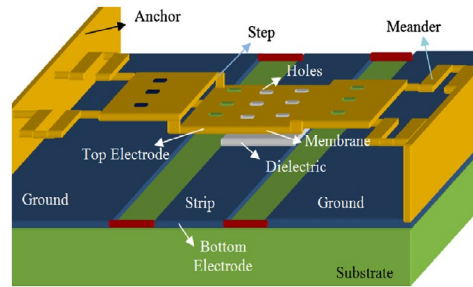


Table 1. Meander with non-uniform spring constants dimensions

Name	Length (μm)	Width (μm)	Thickness (μm)
K1	10	5	0.5
K2	30	5	0.5
K3	10	5	0.5
K4	40	5	0.5
K5	10	5	0.5

Table 2. Switch materials and properties

Name	Material	ϵ_r	Young's modules (E)	Electrical conductivity (σ)
Substrate	Quartz	3.9	-	-
Bridge	Gold	-	70GPa	-
CPW lines	Gold	-	-	45.6e6 (S/m)
Dielectric material	AlN	9.5	-	-

Table 3. Switch upstate and downstate capacitance

Parameter	Equation	Theoretical value (in F)	Practical value (in F)
Upstate capacitance (C_u)	$C_u = \frac{\epsilon_0 A}{g_1 + \frac{t_d}{\epsilon_r}} + C_f$	46×10^{-15}	57.08×10^{-15}
Downstate capacitance (C_d)	$C_d = \frac{\epsilon_0 \epsilon_r A}{t_d}$	3.78×10^{-12}	3.74×10^{-12}
Capacitance ratio (C_r)	$C_r = \frac{C_{max}}{C_{min}} = \frac{C_d}{C_u}$	82	65.22

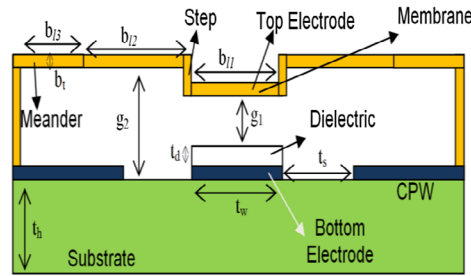
$$C_u = \frac{\epsilon_0 A}{g_1 + \frac{t_d}{\epsilon_r}} + C_f \quad (6)$$

where $A = W \times w$ is effective area between membrane and bottom electrode as shown in Figure 5. W is the width of the membrane, w is width of the bottom electrode, g_1 is the gap between the bottom electrode and membrane, t_d is the thickness of the dielectric used between the membrane and bottom electrode, ϵ_r is the dielectric constant, C_f is the fringing field capacitance.

When an actuation voltage is applied the membrane associated with the structure start deforming and come to downstate. Under this condition the downstate capacitance (C_d) can be expressed as:

$$C_d = \frac{\epsilon_0 \epsilon_r A}{t_d} \quad (7)$$

Figure 5. Capacitive shunt RF MEMS switch side view.



Generally the capacitance ratio is defined as the ratio of downstate capacitance to upstate capacitance i.e. C_d/C_u .

The switch speed is decided by the switching time of the switch, the switching time depend on the actuation voltage (V_p), supply voltage (V_s), and the resonant frequency (ω_0). The actuation structure resonant frequency is given as:

$$\omega_0 = \sqrt{\frac{k_{eff}}{m}} \quad (8)$$

where k_{eff} is effective spring constant, m is the total mass associated with the deforming structure.

Generally the RF MEMS switches switching time is in milliseconds. The switching time of the switch is expressed as:

$$t_s = 3.67 \frac{V_p}{V_s \omega_0} \quad (9)$$

The RF MEMS switch designed in this paper is shown in Figures 4 and 5 in top view and side view respectively.

3. Design and simulation

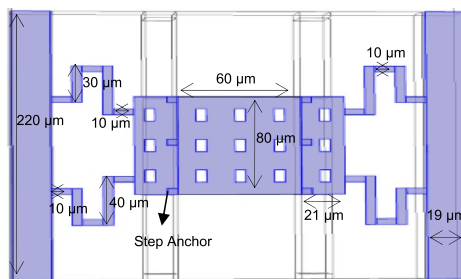
A micro level RF MEMS switch can be design and simulate using Finite Element Method (FEM) or Finite Element Analysis (FEA) tool's. The capacitive shunt RF MEMS switch designed in this paper is using COMSOL FEM tool. The designed switch performance is analysed over the frequency raange from 0.6 to 40 GHz. The overall switch is designed on a quartz die with dimintions 220 μm length, 220 μm width, 30 μm height. The switch dementions are shown in Table 4 and Figure 6.

The switch designed in this paper, works depending on electrostatic actuated, i.e. if the actuation voltage is not applied the actuation structure is in upstate and the capacitance offered by the shunt switch is very low in the order of femto farad under this condition the input Radio frequency input signal will go to the output ($RF_{out} = RF_{in}$). if an actuation voltage is applied to the switch electrodes then the actuation structure will come to downstate and the switch offer a capacitance in the order of pico farad under this condition the input Radio frequency input signal will not go to the output ($RF_{out} = 0$).

Table 4. Switch dimensions

Parameter	Value (μm)
CPW substrate height (t_h)	30
CPW substrate dielectric constant (ϵ_r)	3.9
Gap between strip and ground (t_g)	15
Width of the strip (t_w)	60
Length of CPW lines	200
Membrane width (W)	80
Bottom electrode width (w)	60
Gap between membrane and bottom electrode (g_1)	0.9
Overlap Area ($A = W \times w$)	80×60
Dielectric thickness (t_d)	0.1
Dielectric constant (ϵ_r)	9.5
Gap between transmission line and membrane (g_2)	2.5
Bridge thickness (b_1)	0.5

Figure 6. Dimensions of RF MEMS switch.



The RF MEMS switch designed in this paper, is designed with a membrane structure associated with the non uniform meander's which is helped to reduce the actuation voltage. Here we achieved a displacement of $0.9 \mu\text{m}$ for actuation voltage of 4.2 V is as shown in Figure 7. The switch actuation structure is a step type structure because of this also the actuation voltage is reduced significantly. The switch Radio Frequency (RF) properties are analyzed over $0.6\text{--}40 \text{ GHz}$ frequency range, and we observed that the switch is offering a return losses in the range -42 to -16 dB as shown in Figure 8(a), insertion losses in the range -0.01 to 0.45 dB as shown in Figure 8(b), isolation losses of -20 dB at 21 GHz is shown in Figure 8(c).

Uniform rectangular holes are formed in the beam structure to minimize the mass of the beam, each hole dimension is $5 \mu\text{m}$ width and $10 \mu\text{m}$ length. A step is taken in the structure, the dimensions of the anchors used in this is $2 \mu\text{m}$ height, $5 \mu\text{m}$ length and $5 \mu\text{m}$ width.

The overall mass of the actuation structure is $57514 \times 10^{-15} \text{ kg}$, the mass removed by the rectangular holes is $7237 \times 10^{-15} \text{ kg}$, so final mass of the structure is $50276 \times 10^{-15} \text{ kg}$, because of the holes in the structure 12.58% of the mass is removed from the overall mass.

Figure 7. A displacement of $0.9 \mu\text{m}$ for 4.2 V actuation voltage.

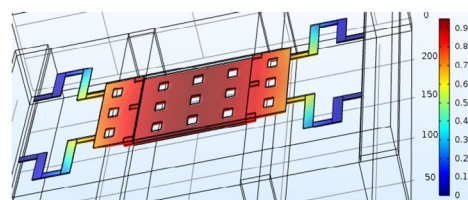
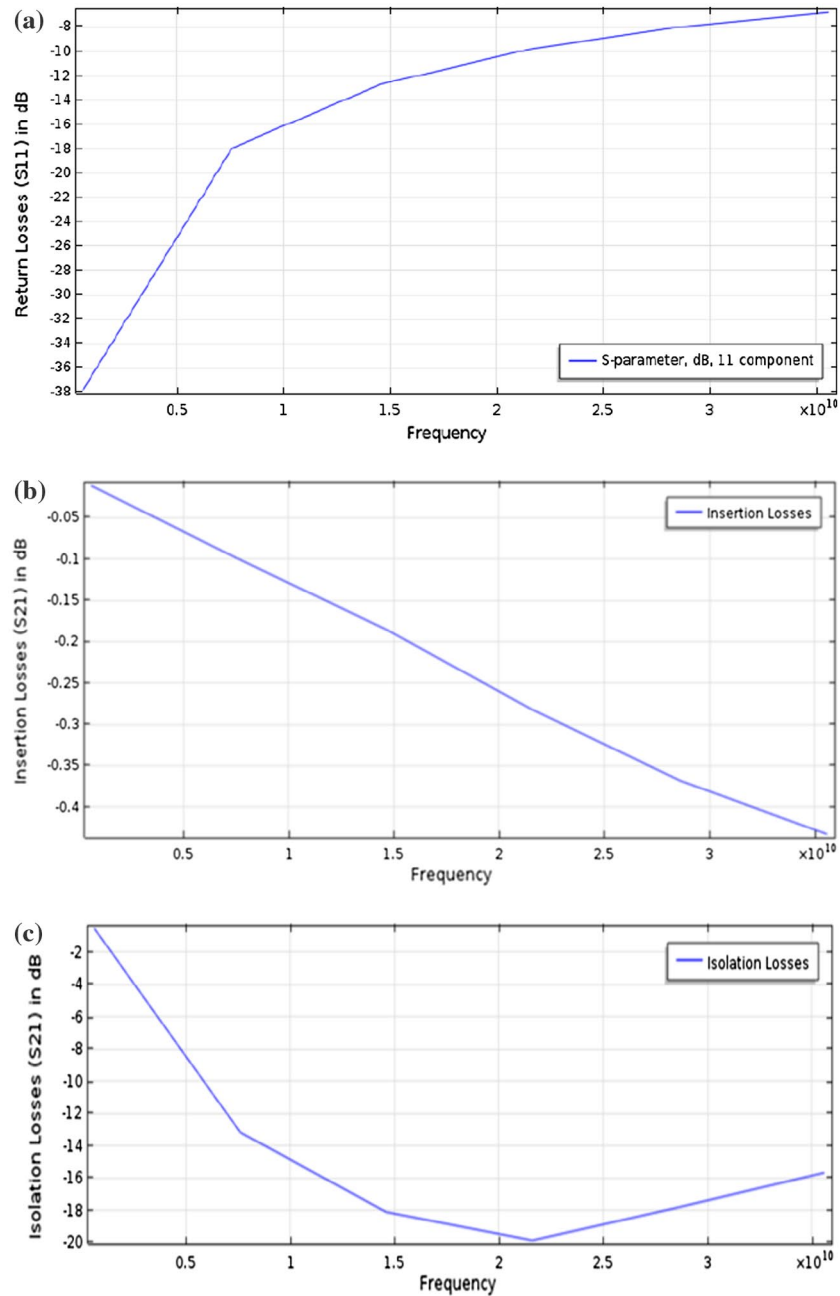


Figure 8. Losses in switch
(a) return loss (S_{11}) in dB (b)
insertion loss (S_{21}) in dB (c)
isolation loss (S_{21}) in dB.



If the beam is in upstate the gap (g_1) between the membrane and the bottom electrode is $1 \mu\text{m}$ and a parallel plate capacitance of 0.05708 pF is achieved. When an actuation voltage of 4.2 V is applied the beam deforms and come to downstate therefore the resultant gap (g_1) is $0.1 \mu\text{m}$, and the resultant capacitance is 3.74 pF . So, the capacitance ratio (C_d/C_u) for the proposed switch is 65.22 (see Table 5).

Table 5. Different capacitive shunt RF MEMS switches comparison

Switches @ 40 GHz	Rebeiz (2003)	Blondy et al. (2004)	Ziaei, Dean, and Mancuso (2005)	Fernández-Bolaños, Tsamados, Dainesi, and Ionescu (2009)	Proposed
Suspender material	0.9 μm Ti/Au	0.35/7.5 μm Ti-Au/Au	0.5 μm Al	0.9 μm Au/Ni/Au	0.5 μm Au
Dielectric	150 nm Si ₃ N ₄ ε _r = 7.6	Dielectric Less	400 nm PZT ε _r = 190	300 nm AlN ε _r = 9.8	100 nm AlN ε _r = 9.5
Air gap	1.5 μm	0.3 μm	2.5–3 μm	2–2.5 μm	0.9 μm
Upstate capacitance (C _u)	70 fF	224 fF	–	40 fF	57.05 fF
Downstate capacitance (C _d)	2.7 pF	2.2 pF	–	1.55 pF	3.74 pF
Capacitance ratio (C _d /C _u)	38	10	400	38	65.22
Insertion Losses	0.1 dB	1.5 dB	0.1 dB	0.2 dB	0.1–0.4 dB
Isolation losses	35 dB	20 dB	38 dB @ 10 GHz	38.5 dB	20 dB
Actuation voltage	25–30 V	30 V	35–40 V	12 V	4.2 V

4. Conclusion

In this paper a capacitive shunt RF MEMS Switch is designed and analysed over the frequency range from 0.6 to 40 GHz using FEM Tool. The actuation structure used in the design is anchored with the meanders, having step and holes to the membrane these all things helped to reduce the actuation voltage to 4.2 V. The beam and the CPW lines are designed using Gold (Au) material. The dielectric used between the electrodes is an Aluminum nitride (AlN) which is helped to improve the quick change capacitance. The structure is in upstate the capacitance is 0.05708 pF, and structure is in downstate the capacitance is 3.74 pF. The capacitance ratio for the proposed switch is 65.22. The RF MEMS switch designed in this paper is achieved a displacement of 0.9 μm for actuation voltage of 4.2 V. Return losses in the range –42 to –16 dB, insertion losses in the range –0.01 to –0.45 dB, isolation losses of –20 dB. Based on the switch performance the switch can be used in X, Ku band applications.

Authors' contributions

All the authors contributed in the design and analysis of RF MEMS capacitive shunt Switch for the current study by COMSOL and HFSS. T. Lakshmi Narayana and K. Girija Sravani performed the coding in MATLAB and drafted the manuscript. K. Srinivasa Rao supervised the study and advised on the draft and the corrections in the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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STUDY OF VARIOUS DOMINATIONS IN REGULAR FUZZY GRAPHS

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ABSTRACT

In this paper we study about dominations in regular fuzzy graphs. A set $D \subseteq V$ is said to be fuzzy dominating set of G , if every $v \in V - D$ there exist $u \in D$ such that u dominates v . We discuss the concept of regular split and non split domination in fuzzy graphs, regular connected domination in fuzzy graph, totally regular domination in fuzzy graphs and discuss their properties. Prompt some applications on them like as computer communication network, social network theory.

Keywords: Regular domination, regular connected domination, regular split and non split domination, inverse regular connected domination.

AMS Classification: 05C72, 05C75

Introduction:

The concept of fuzzy sets and fuzzy relations was introduced by L.A. Zadeh in 1965 [1]. His aim was to develop a mathematical theory to deal with uncertainty and imprecision. The distinction between the set and fuzzy set is that the set divide the universal set into two subsets,

namely members and non-members while fuzzy set assigns a sequence of membership values to elements of the universal set varies from 0 to 1. Fuzzy graphs are useful to represent relationships which deal with uncertainty and it differs greatly from classical graph. The first definition of Fuzzy graph by Kaufman (1973) was based on Zadeh's fuzzy relations (1971). After that Rosenfeld (1975) [5], who considered fuzzy relation on fuzzy sets and developed the theory of fuzzy graphs.

The concept of domination in graphs found its origin in 1850s with the interest of several chess players. Chess enthusiasts in Europe considered the problem of determining the minimum number of queens that can be placed on a chess board so that all the squares are either attacked by a queen or occupied by a queen. The domination number is introduced by Cockayne and Hedetniemi. The study of domination set in graphs was begun by Ore and Berge [6]. V.R. Kulli wrote on theory of domination in graphs. A. Somasundram and S. Somasundram [8] discussed domination in Fuzzy graphs. The problem of selecting two disjoint sets of transmitting stations so that one set can provide service in the case of failure of some of the transmitting stations of the other set. This led them to define the inverse domination number. In this aspect, it is worthwhile to concentrate on dominating and inverse dominating sets. The Inverse domination in graphs was introduced by V.R. Kulli and Sigarkanti [10].

1. PRELIMINARIES

It is known that graphs are simply models of relations. A graph is a convenient way of representing information involving relationship between objects. The objects are represented by vertices and relations, by edges. When there is vagueness in the description of the objects or in its relationships or in both, it is natural that we need to design a fuzzy graph model. Here we summarize some basic definitions of dominations in fuzzy graph.

Definition: 2.1 A fuzzy graph $G(\sigma, \mu)$ is a set with two functions, $\sigma: V \rightarrow [0,1]$ and $\mu: E \rightarrow [0,1]$ such that $\mu(xy) \leq \sigma(x) \wedge \sigma(y) \forall x, y \in V$.

Definition: 2.2 Let $G(\sigma, \mu)$ be a fuzzy graph on V and $V_1 \subseteq V$. Define $\sigma_1 = \sigma(x)$ for all $x \in V_1$ and μ_1 on the collection E_1 of two element subsets of V_1 by $\mu_1(xy) = \mu(xy)$ for all $x, y \in V_1$. Then (σ_1, μ_1) is called the fuzzy sub graph of G induced by V_1 and is denoted by $\langle V_1 \rangle$.

Definition: 2.3 The order p and size q of a fuzzy graph $G(\sigma, \mu)$ are defined to be $p = \sum_{x \in V} \sigma(x)$ and $q = \sum_{xy \in E} \mu(xy)$.

Definition: 2.4 Let $G(\sigma, \mu)$ be a fuzzy graph on V and $S \subseteq V$. Then the fuzzy cardinality of S is defined to be $\sum_{v \in S} \sigma(v)$.

Definition: 2.5 Let $G(\sigma, \mu)$ be a fuzzy graph on E and $D \subseteq E$. Then the fuzzy edge cardinality of D is defined to be $\sum_{e \in D} \mu(e)$.

Definition: 2.6 Let $G(\sigma, \mu)$ be a fuzzy graph. Define the degree of a vertex v to be $d(v) = \sum_{\mu \neq v} \mu(u, v)$. The minimum degree of G is $\delta(G) = \wedge \{d(v) / v \in V\}$ and maximum degree of G is $\Delta(G) = \vee \{d(v) / v \in V\}$.

Definition: 2.7 An edge $e = uv$ of a fuzzy graph is called an effective edge if $\mu(uv) = \sigma(u) \wedge \sigma(v)$. $N(u) = \{v \in V / (uv) = \sigma(u) \wedge \sigma(v)\}$ is called the neighborhood of u and $N[u] = N(u) \cup \{u\}$ is the closed neighborhood of u .

Definition: 2.8 The effective degree of a vertex u is defined to be the sum of weights of the effective edges incident at u and is denoted by $d_E(u)$. $\sum_{v \in N(u)} \sigma(v)$ is called the neighborhood degree of u and is denoted by $d_{N(u)}$. The minimum effective degree $\delta_E(G) = \min \{d_E(u) / u \in V(G)\}$ and the maximum effective degree $\Delta_E(G) = \max \{d_E(u) / u \in V(G)\}$.

2. Dominations in Regular fuzzy graphs

Definition: 3.1 Let $G(\sigma, \mu)$ be a fuzzy graph. A subset D of V is said to be a dominating set of G if for every $v \in V - D$ there exists an element $u \in D$ such that $\mu(u, v) = \sigma(u) \wedge \sigma(v)$. A dominating set D of G is called the minimal dominating set of G if every node $v \in D$, $D - \{v\}$ is not a dominating set. The minimum scalar cardinality of D is called the domination number and it is denoted by $\gamma(G)$.

Definition: 3.2 Let $G(\sigma, \mu)$ be a fuzzy graph. A subset S of X is said to be an edge domination set in G if for every edge in $X - S$ is adjacent to at least one effective edge in S . The minimum Fuzzy cardinality of an edge domination set G is called the edge Domination number of G and is denoted by $\gamma'(G)$.

Definition: 3.3 Let $G(\sigma, \mu)$ be a regular fuzzy graph on $G^* = (V, E)$. If $d_G(v) = k$ for all $v \in V$, if each vertex has same degree k , then G is said to be a regular fuzzy graph of degree k or k -regular fuzzy graph.

Definition: 3.4 Let $G(\sigma, \mu)$ be a fuzzy graph on G^* . The total degree of a vertex $u \in V$ is defined by $td_G(u) = d_G(u) + \sigma(u) = \sum_{uv \in E} \mu(uv) + \sigma(u)$. If each vertex of G has the same total degree k then G is said to be a totally regular fuzzy graph of total degree k or k -totally regular fuzzy graph.

Definition: 3.5 Let $G(\sigma, \mu)$ be a fuzzy graph. A set S subset of V is called regular fuzzy dominating set if (i) Every vertex in $V - S$ is adjacent to some vertex in S . (ii) All the vertices in S has the same degree. The minimum size of regular fuzzy dominating set is called regular fuzzy domination number and is denoted by $\gamma_r(G)$.

Example: 3.6 Consider $G(\sigma, \mu)$ be a fuzzy graph. Define $\sigma(u) = 0.3$, $\sigma(v) = 0.4$, $\sigma(w) = 0.6$, $\sigma(x) = 0.2$, $\sigma(y) = 0.6$, $\sigma(z) = 0.5$ and $\mu(uv) = 0.3$, $\mu(vw) = 0.4$, $\mu(wz) = 0.4$, $\mu(zy) = 0.5$, $\mu(xy) = 0.2$, $\mu(ux) = 0.2$.

Definition: 3.7 The dominating set D of a fuzzy graph $G(\sigma, \mu)$ is said to be totally regular dominating set if all vertices in D are same total

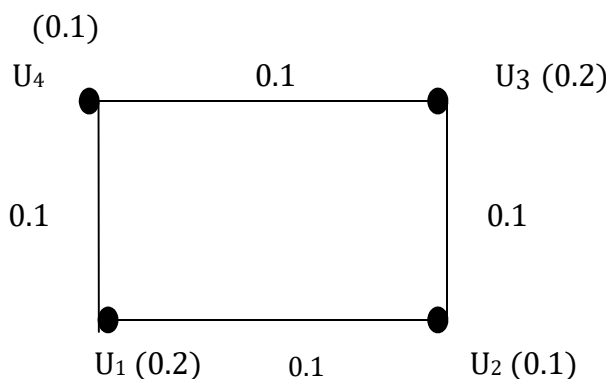
degree, the fuzzy totally regular dominating number $\gamma_{tr}(G)$ is the minimum fuzzy cardinality taken over all minimal totally regular dominating set of G .

Definition : 3.8 A set S is called connected regular fuzzy dominating set if all the vertices of S are connected and have the same degree. The minimum size of regular connected fuzzy dominating set is called regular connected domination number and is denoted by $\gamma_{rc}(G)$.

Example: 3.9 Consider $G(\sigma, \mu)$ be a fuzzy graph. Define $\sigma(u)=0.5$, $\sigma(v)=0.3$, $\sigma(w)=0.6$, $\sigma(x)=0.1$, $\sigma(y)=0.4$, $\sigma(z)=0.7$, and $\mu(uv) = 0.3$, $\mu(ux) = 0.1$, $\mu(vw) = 0.2$, $\mu(wx) = 0.1$, $\mu(xy) = 0.1$, $\mu(yz) = 0.4$, $\mu(xz) = 0.1$. Here $S = \{u, x\}$ is connected regular fuzzy dominating set of minimum size. Hence $\gamma_{rc}(G) = 0.6$.

Definition: 3.10 The Domination set D of the fuzzy graph $G(\sigma, \mu)$ is said to be regular split dominating set if the following conditions are satisfied (i) Every vertex in D is of same degree (ii) $\langle V - D \rangle$ is disconnected. The fuzzy regular split domination number $\gamma_{rs}(G)$ is the minimum fuzzy cardinality taken over all minimal regular split dominating sets of G .

Example: 3.11

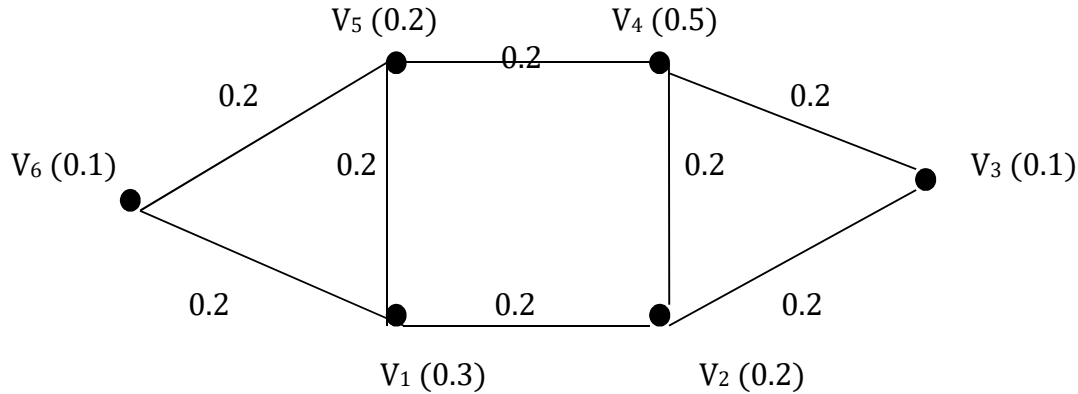


$$D_{rs}(G) = \{u_2, u_4\}, \gamma_{rs}(G) = 0.2.$$

Definition: 3.12 The dominating set D of the fuzzy graph $G(\sigma, \mu)$ is said to be regular non split dominating set if the following conditions are satisfied (i) Every vertex in D is of same degree (ii) $\langle V - D \rangle$ is connected. The fuzzy regular non split domination number $\gamma_{rn_s}(G)$ is the

minimum fuzzy cardinality taken over all minimal regular non split dominating sets of G.

Example: 3.13



$$D_{rns} (G) = \{ V_3, V_6 \}, \gamma_{rns} (G) = 0.8$$

4. Main Results

Theorem: 4.1

For any regular fuzzy graph $G (\sigma, \mu)$, $\gamma (G) \leq \gamma_{rs} (G)$.

Proof: By the definition of $\gamma (G)$ and $\gamma_{rs} (G)$ the result is obvious.

Theorem: 4.2

For any fuzzy graph $G (\sigma , \mu)$, if D_{rs} is a regular dominating set the $V - D_{rs}$ is a regular split dominating set.

Theorem: 4.3

A regular split dominating set D of G is minimal if and only if for each vertex $v \in D$ one of the following conditions holds.

- (i). There exists a vertex $u \in v - D$ such that $N(u) \cap D = \{V\}$.
- (ii). v is an isolated vertex in $\langle D \rangle$.
- (iii). $\langle V - D \rangle$ is connected.

Proof:

Suppose that D is minimal and there exists a vertex $v \in D$ such

that v does not satisfy any of the above conditions. Then by conditions (i) and (ii) $D' = D - \{v\}$ is a dominating set of G , also by (iii) $\langle V - D' \rangle$ is disconnected. This implies that D' is a regular Split dominating set of G , which is contradiction.

Theorem: 4.4

For any regular fuzzy graph $G(\sigma, \mu)$, $\gamma_c(G) \leq \gamma_{rc}(G)$.

Proof:

Every regular connected dominating set is a connected dominating set is a connected dominated set hence the theorem.

Theorem: 4.5

For any regular fuzzy graph $G(\sigma, \mu)$, $\gamma_{tr}(G) \leq \gamma_r(G)$.

Observation: 4.6

For any regular fuzzy graph $G(\sigma, \mu)$

$$\gamma_r(G) \leq \gamma_{rs}(G) \leq \gamma_{rc}(G) \leq \gamma_{rns}(G) \leq \gamma_{tr}(G).$$

5. Applications

The application of domination in fuzzy graph lies in various fields in solving real life problems. It includes social network theory, land surveying, radio station computer communication networks, school bus routing sets of representatives, interconnection networks etc. The online social network has been developed significantly in the recent years as a medium of communication, sharing the information and spreading the influence,. The dominating set plays a vital role in analyzing the effect on a real online social network data set through simulation. The dominating set concept can be applied to the social network graph to determine the amount of positive

influence that is possessed by an individual as well as its impact to their related neighbor.

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Digital India Initiatives for Social and Economic Emancipation of Indian Women

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Abstract: *The Digital India programme is an important programme of the Government of India. This programme was started with a broad vision to convert India into a digitally empowered society and knowledge economy. One of the three important areas of Digital India is forming digital infrastructure as a utility for every citizen. The second important area of digital India is providing governance and services on demand. The ultimate objective was to make all government services accessible to the common man in his locality, through common service delivery outlets, and ensure efficiency, transparency, and reliability of such services at affordable costs. The third important area in digital India is digital Empowerment of Citizens. This also places emphasis on universal digital literacy and availability of digital resources or services in Indian languages. In this direction, Government of India had introduced 115 digital India initiatives. Out of all the initiatives there are certain digital India initiatives which empower rural women and urban women in particular. In this paper an attempt is made to present some of the important digital India initiatives which empower women.*

Keywords: *Digital India, Women Empowerment, MCTS, Mahila E-Haat, Beti Bachao*

I. INTRODUCTION

The Digital India programme is an important programme of the Government of India. This programme was started with a broad vision to convert India into a digitally empowered society and knowledge economy. One of the three important areas of Digital India is forming digital infrastructure as a utility for every citizen. Once the remotest of the Indian villagers are digitally connected through broadband and high speed internet, the idea is that then delivery of electronic government services to every citizen, targeted social benefits, and financial inclusion can be achieved. It is planned to set up enabling infrastructure for digital identity, financial inclusion and ensure easy availability of common services centres. The second important area of digital India is providing governance and services on demand. The ultimate objective was to make all government services accessible to the common man in his locality, through common service delivery outlets, and ensure efficiency, transparency, and reliability of such services at affordable costs. Six elements are crucial for ensuring that governance and services are made available on demand to all citizens in the country. The six elements include seamlessly integrated services across departments, availability of services in real time from online and mobile platforms, all citizen entitlements to be portable and available on the cloud, digitally transformed services for improving ease of doing business, making financial transactions electronic and cashless and leveraging Geospatial Information Systems (GIS) for decision support systems and development. The third important area in digital India is digital Empowerment of Citizens. This also places emphasis on universal digital literacy and availability of digital resources or services in Indian languages. In this direction, Government of India had introduced 115 digital India initiatives. Out of all the initiatives there are certain digital India initiatives which empower rural women and urban women in particular. In this paper an attempt is made to present some of the important digital India initiatives which empower women.

II. REVIEW OF LITERATURE

Saikia, Gogai and Anjali Lekharu (1986) studied the role and status of women in rural areas of Assam in three situations including peri-urban, interior rural and tribal village. Mahapatra and EswarRao (1988) have discussed the role of women in economic development. Yadagiri (1996) found that the SHGs had a positive impact on poverty reduction, social change, and family planning and income generation activities in Andhra Pradesh. AppaRao (1999) expressed that rural women are to be associated with poverty alleviation programmes right from the planning stage to make the programme need based and successful. Ramakrishna (2002) conducted a study on rural development programme beneficiaries and expressed the view that self-help group is far better in socioeconomic empowerment. Fernandez (2003) analyzed the impact of Self Help Groups on the social status and empowerment of women in India. Archana Sinha (2004) found that micro-credit or microfinance from nongovernmental organizations reduced poverty and led to economic empowerment of women. Malathi (2004) had explained the rise and growth of Shri Mahila Griha Udyog Lijjat Papad, resulting from a group of women's practical step to get supplementary earnings. Kavita (2008) had studied under nutrition in a tribal and rural community of south India. She found that lack of empowerment of women is an important factor in the persistent prevalence of under nutrition. Meera Bai (2009) conducted a study on

women's education and social externalities in Kerala. Vimala (2009) had made study on Kudumbashree and found that it led to the empowerment of women. Lakshmi (2010) found that the self help group - bank linkage programme has made enormous contribution to empowerment of women in rural areas of Tamilnadu. Savitha and et al (2011) had conducted a study on livelihood systems for women of rural community in Chitradurga District of Karnataka State. Arpita (2011) has highlighted the challenges faced by women in the path of empowerment. She had concluded that India is committed to the cause of empowerment of women. Swaleha (2012) studied the prospects and challenges in empowerment of Tribal women in India. Puttaraja and Heggade (2012) had studied economic empowerment of Tribal women in Mysore and Chamarajanagara Districts of Karnataka. Satija and Sharma (2013) had studied economic empowerment of women through State Govt. Scheme (SakhiMandal Scheme) in Kheda District. The review of literature results in the conclusion that there was no study on Digital India Initiatives helping women. Hence, this study was done.

Objectives

The main objective of this paper is to examine various Digital India initiatives empowering women in India. The specific objectives are the following

1. To explain about Mother and child Tracking System initiative.
2. To describe about Nirbhaya app and Betibachavo and betipadhaao campaign
3. To elucidate about Mahila E-Haat.
4. To throw light on Women helpline scheme
5. To detail about Mahila Saksharta Abhiyan and Prime Minister Gramin Digital Saksharta Abhiyan

III. METHODOLOGY

The study namely "Digital India initiatives for Social and Economic Emancipation of Indian women" is a descriptive and theoretical study. An attempt is made to review the existing literature on women empowerment and other related issues. After extensive survey of the literature it is found that there was no specific study which dealt with Digital India initiatives for empowerment of women. Hence, this study is made.

Digital India Initiatives of women empowerment

Mother and child Tracking System (MCTS)

This is a Digital India initiative started by Ministry of Health and Family welfare. This initiative uses information technology for ensuring delivery of full variety of healthcare and immunization services to pregnant women and children having below five years age. This application was developed by National Informatics Centre. It provides communication between beneficiaries and service sources. This initiative is useful for Auxiliary Nurse and Midwives to generate their work plans. It is also useful to provide alerts about service due dates to both beneficiaries and service providers. This initiative also provided a dash board to provide information to health managers of various levels to ensure quality service delivery. This initiative is also useful in universal immunisation and micro birth planning. This facility is much useful for women in Ante Natal care, delivery and Post Natal care services. This initiative is useful to give thirty varieties of immunisation to children.

Nirbhaya app

This is an android emergency application, which can send a distress call or emergency message to a specified contact or group in an emergency situation faced by a woman.

Beti Bachao and Beti Padhao campaign

It is aimed at guaranteeing girls are born, nurtured and educated without discrimination. From 1961, Child Sex Ratio is continuously declining in India. CSR is defined as the number of girls between zero and six years per One thousand boys. The CSR is 945,927 and 918 during 1991, 2001 and 2011 respectively. This indicates women disempowerment and the situation is alarming. CSR indicates pre-birth discrimination and post birth discrimination. Misuse of diagnostic tests is leading to Decreasing Child Sex Ratio. To deal with declining CSR Government of India had announced Beti Bachao Beti Padhao initiative. This is being implemented in hundred selected districts where we find low child sex ratio. This campaign is jointly carried out by Ministry of women and child development, Ministry of Human Resource development and Ministry of Health and Family welfare. The prime objectives of this initiative include to prevent gender biased sex selective elimination, to Ensure survival and protection of the girl child and to ensure education and participation of the girl child.

Mahila E-Haat

This is a portal in two languages. It was started in 2016. This is an online Marketing platform useful for women entrepreneurs, women NGOs and self Help Groups. This portal is useful for showcasing the products manufactured by women. This portal facilitates direct contact between buyer and seller. Women entrepreneurs from 24 states are showcasing more than two thousand products as on date. There is a provision for eighteen categories of products. They include clothing, bags, home décor, carpets, rugs, foot mats, fashion accessories, jewellery, decorative and gift items, baskets, boxes, pottery, grocery, cushion covers, staples, organic, natural products, file folders, soft toys, industrial products, educational aids, and miscellaneous items. This is useful for more than three lakh beneficiaries directly and indirectly.

Women helpline scheme

According to this scheme a toll free twenty four hours service is provided to girls or women facing violence in any sphere including both private and public. They can also get information about women schemes and welfare programmes. This scheme also facilitate intervention in crisis and non-crisis situations by directing to police, hospitals, protection officers, ambulance and local district level authorities.

Mahila Digital Saksharta Abhiyan

This initiative was formulated to instruct training in Information Technology to Fifty Two and Half Lakh women including Anganwadi and ASHA workers in different states across the country.

Prime Minister Gramin Digital Saksharta Abhiyan (PMGDSA)

This is the scheme implemented to make six crore People in rural areas of different states digitally literate. The main aim is to reach around forty percent of households in rural areas. The prime goal of digital India programme is to make one person digitally literate in one family. The main purpose of the scheme is to make train a woman or man in such a way that they can operate a smart phone or a tablet or any other computing device. They should be able to browse internet, make digital payments and send and receive e-mails. The main aim of this scheme is bridging digital divide. The main concentration of this scheme is marginalised sections of the country. Much concentration is on Scheduled castes, Minorities, Scheduled Tribes, people of below poverty line and women. They should be able to access government services.

IV. CONCLUSION

Government of India had introduced several digital initiatives for empowering different sections of the society. It had also introduced some initiatives especially for the empowerment of women. The Digital India programme promises to transform India into a digitally empowered society by focusing on digital literacy, digital resources, and collaborative digital platforms. To conclude, the digital initiatives for empowerment of women hope to transform India into a digitally empowered country.

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Working Capital Management in Kristna Engineering Works - A Case Study of Andhra Pradesh

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Abstract: *Kristna Engineering Works is one of the leading manufacturers and exporters from India engaged in the manufacturing of Sugar Mill Rollers, Blank Shells, Mill Spares, Crane Preparatory Devices and spares for sugar and for other allied industries. It is located at Vijayawada of Krishna district in the state of Andhra Pradesh. Kristna Engineering Works was established in the year 1969. This company is catering the needs of more than Two hundred and fifty sugar mills located in India and overseas. This Enterprise has an annual turnover of Rupees 3401.95 lakhs. The total current assets of the company are Rupees 3169.83 lakhs and current liabilities are Rupees 931 lakhs. In this paper an attempt is made to examine and analyse working capital Management of Kristna Engineering Works. In this paper structure and composition of working capital in the enterprise for a period of ten years is analysed. Current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period are calculated for the study period. Hypotheses are tested using chi square test.*

Keywords: *Quick Ratio, Working capital, Debtors Turnover, Inventory turnover, Average collection period*

I. INTRODUCTION

Kristna Engineering Works is one of the leading manufacturers and exporters from India engaged in the manufacturing of Sugar Mill Rollers, Blank Shells, Mill Spares, Crane Preparatory Devices and spares for sugar and for other allied industries. It is located at Vijayawada of Krishna district in the state of Andhra Pradesh. Kristna Engineering Works was established in the year 1969. This company is catering the needs of more than Two hundred and fifty sugar mills located in India and overseas. This company is an ISO 9001:2008 certified company, certified by Bureau Veritas Quality International (BVQI). It has a man power of 450 including skilled, semi-skilled and supervisory staff working round the clock in three shifts. This Enterprise has an annual turnover of Rupees 3401.95 lakhs. The total current assets of the company are Rupees 3169.83 lakhs and current liabilities are Rupees 931 lakhs. In this paper an attempt is made to examine working capital management in Kristna Engineering Works.

II. REVIEW OF LITERATURE

Mishra (1975)¹ studied the efficiency of working capital management in six sample public sector units. The study identified that management of various components of working capital in sample units was highly unsatisfactory. Suk, Seung and Rowland (1992)² in their research conducted an in-depth survey to analyze the liquidity practices of ninety four sample Japanese companies operating in the United States. Sivarama (1999)³ in his study on working capital management in the Indian paper industry, found a close association between profitability and working capital efficiency. Reddy (2000)⁴ analyzed the working capital management in thirty small scale industries in the Cuddapah district of Andhra Pradesh and found that debtor management policy and the collection mechanism to be very unsystematic and highly inefficient that resulted into excess investment in debtors. Ghosh and Maji (2003)⁵ made an empirical study on the relationship between utilization of current assets and operating profitability in the Indian cement and tea industries. Bardia (2004)⁶ conducted a study on the issue pertaining to the relationship between working capital management and profitability of Navaratna steel manufacturing public sector enterprise. Prof. B.P.Singh (2012)⁷ investigated the relationship between the components of working capital and profitability. He observed that the telecom industry is operating below average so far as working capital is concerned. Pasupathi (2013)⁸ conducted a comparative study of WCM performance in commercial vehicles, passenger cars and multi utility vehicles and two and three wheelers sectors of Indian automobile industry. Utkarsh Goel et al. (2015)⁹ conducted a study to explore the impact of corporate governance practices on Working capital Management (WCM) in Indian firms. S. Selvanayaki et al. (2015)¹⁰ focused on evaluating the WCM practices adopted by the rice milling firms and analyzed its impact on profitability. Venkateswararao.P, Surya Chandra Rao.D and Hema Venkata Siva Sree.Ch (2017)¹¹ examined working capital management in PL Plast Pvt Ltd. Venkateswararao.P, and Hema Venkata Siva Sree.Ch (2018)¹²

examined working capital management in Sri Rama Chandra Paper Boards Ltd. Venkateswararao.P, and HemaVenkata Siva Sree.Ch (2018)¹³ examined working capital management in Sri Nagavalli solvent oils Pvt. Ltd. Venkateswararao.P (2018)¹⁴ examined the working capital management in Cuddapah Spinning Mills Ltd. It was found that there was no study on working capital management in a company engaged in the manufacturing of Sugar Mill Rollers, Blank Shells, Mill Spares, Crane Preparatory Devices and spares for sugar and for other allied industries. Hence, this study is taken up.

Objectives

The general objective of the study is to examine the working capital management in Kristna Engineering Works. The specific objectives include the following.

1. To examine the structure and composition of working capital in Kristna Engineering Works during the period of study.
2. To analyse the liquidity position of Small Enterprise during the period of study.
3. To find the gross working capital turnover and networking capital turnover in the company.
4. To examine the efficiency in cash, debtors and inventory management in the Small Enterprise under study.
5. To offer suggestions for effective working capital management if required.

Hypotheses

H₀₁: Current ratio in Kristna Engineering Works is uniform during the period of study.

H₀₂: Quick ratio in Kristna Engineering Works is uniform during the period of study.

H₀₃: Super quick ratio in Kristna Engineering Works is uniform during the period of study.

H₀₄: Gross working capital turnover ratio in Kristna Engineering Works is uniform during the period of study.

H₀₅: Net working capital turnover ratio in Kristna Engineering Works is uniform during the period of study.

H₀₆: Cash turnover ratio in Kristna Engineering Works is uniform during the period of study.

H₀₇: Inventory turnover ratio in Kristna Engineering Works is uniform during the period of study.

H₀₈: Debtors turnover ratio in Kristna Engineering Works is uniform during the period of study.

H₀₉: Average collection period in Kristna Engineering Works is uniform during the period of study.

III. METHODOLOGY

The present study is mainly based on secondary data. The data is taken from the financial statements including balance sheet, trading account and profit and loss account of Kristna Engineering Works. The period of study is ten years covering the financial years from 2006-07 to 2015-16. The data gathered is analysed through the technique of percentages and certain appropriate ratios relating to working capital management. The ratios covered includes current ratio, quick ratio, super quick ratio, gross working capital turnover ratio, net working capital turnover ratio, cash turnover ratio, inventory turnover ratio, debtors turnover ratio and average collection period. Chi square test is used for testing the hypotheses formed.

Structure and composition of working capital

Working capital structure of Kristna Engineering Works is presented in table1. It is observed that Inventory was 26.38 per cent of total current assets during 2014. It is the lowest percentage during the period of study. Its percentage was highest at 44.85 during 2010. It is observed that inventory occupied highest percentage of current assets during the year 2010. Debtors as a percentage of total current assets varied in between 31.79 during 2010 and 61.32 during 2014. Of all current assets debtors occupied highest percentage during the period of study except 2010. It is also observed that cash and bank balance as a percentage of current assets varied between 0.31 during 2014 and 8.14 during 2015. Loans and advances as a percentage of current assets varied between 4.54 during 2007 and 10.71 during 2010. Other current assets as a percentage of total current assets varied between 3.68 during 2014 and 11.43 during 2010. Sundry Creditors occupied highest per cent of current liabilities during the period of study except 2009 and 2013. They varied between 16.81 during 2013 and 69.42 during 2008. Short-term borrowings were nil during the period of study. Short-term provisions by the Business organisation were made during the years 2007,2008,2010,2013 and 2014. Short-term provisions as a percentage of current liabilities were 1.14 during 2010 and 11.33 during 2007. Other current liabilities vary between 25.04 during 2007 and 80.61 during 2013. It is observed that Net Working Capital in the company varied between Rs.610.08 Lakhs during 2013 to Rs.2264.2 Lakhs during 2015. It was maintained at high levels during 2015 and 2016.

Table1: Working Capital structure of Kristna Engineering Works during 2006-2007 to 2015-2016 (Figures in Lakhs)

Particulars	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets										
Cash & Bank balances	70.85	52.91	67.92	15.13	22.8	9.76	9.31	7.96	260.05	17.46

% of TCA	6.23	4.35	4.88	1.22	1.29	0.47	0.38	0.31	8.14	0.55
Debtors	503.98	665.16	577.19	394.73	889.42	870.78	1125.61	1578.93	1552.23	1421.95
% of TCA	44.28	54.64	41.46	31.79	50.23	42.08	46.47	61.32	48.60	44.86
Loans & Advances	51.64	59.94	86.99	133	95.18	218.71	210.77	213.87	231.22	299.84
% of TCA	4.54	4.92	6.25	10.71	5.38	10.57	8.7	8.31	7.24	9.46
Other Current Assets	126.31	51.23	106.76	141.87	124.75	121.04	97.76	94.73	171.3	284.78
% of TCA	11.10	4.21	7.67	11.43	7.05	5.85	4.04	3.68	5.36	8.98
Inventory	385.36	388.14	553.42	556.95	638.5	849.02	979.03	679.33	979.07	1145.8
% of TCA	33.86	31.88	39.75	44.85	36.06	41.03	40.41	26.38	30.65	36.15
Total Current Assets (TCA)	1138.14	1217.38	1392.28	1241.68	1770.65	2069.31	2422.48	2574.82	3193.87	3169.83
Current Liabilities										
Sundry Creditors	334.78	264.89	153.4	172.7	378.76	286.79	304.75	366.61	532.06	477.78
% of TCL	63.86	69.42	41.79	58.11	63.02	51.29	16.81	53.68	57.23	51.32
Other current liabilities	131.28	103.41	213.7	121.13	222.31	272.41	1461	279.47	397.61	453.22
% of TCL	25.04	27.10	58.21	40.75	36.99	48.71	80.61	40.92	42.77	48.68
Short term borrowings	0	0	0	0	0	0	0	0	0	0
% of TCL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Short term provisions	59.4	13.27	0	3.39	0	0	46.65	36.89	0	0
% of TCL	11.33	3.48	0.00	1.14	0.00	0.00	2.57	5.40	0.00	0.00
Total Current Liabilities (TCL)	524.28	381.57	367.1	297.22	601.06	559.2	1812.4	682.97	929.67	931
NWC	613.86	835.81	1025.18	944.46	1169.59	1510.11	610.08	1891.85	2264.2	2238.83

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016.

Current Ratio

The current ratio in the company was maintained at above normal level in the company. It has varied between 1.34 during 2013 and 4.18 during 2010 was shown in the table. It is found in the significance test that current ratio is uniform during the period of study.

Table2: Current Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Current Assets	1138.14	1217.38	1392.28	1241.68	1770.65	2069.31	2422.48	2574.82	3193.87	3169.83
Current Liabilities	524.28	381.57	367.1	297.22	601.06	559.2	1812.4	682.97	929.67	931
Current ratio	2.17	3.19	3.79	4.18	2.95	3.70	1.34	3.77	3.44	3.40

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016

Calculated value of χ^2 for current ratio = 2.056.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., $2.056 < 16.919$. Hence H_{01} is accepted.

Quick Ratio

The quick ratio of the company as shown in the table has varied between 0.80 during 2013 to 2.78 during 2014. It is found in the significance test that quick ratio is uniform during the period of study.

Table-3: Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Liquid Assets	752.78	829.24	838.86	684.73	1132.15	1220.29	1443.45	1895.49	2214.8	2024.03
Current Liabilities	524.28	381.57	367.1	297.22	601.06	559.2	1812.4	682.97	929.67	931
Quick ratio	1.44	2.17	2.29	2.30	1.88	2.18	0.80	2.78	2.38	2.17

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016

Calculated value of χ^2 for Quick ratio = 1.358.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919 Calculated value is less than Critical Value i.e., $1.358 < 16.919$, Hence, H_{02} is accepted.

Super Quick Ratio

The super quick ratio of the company as shown in the table has varied between 0.005 during 2013 and 0.28 during 2015. It is found in the significance test that super quick ratio is not uniform during the period of study.

Table4: Super Quick Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Cash	70.85	52.91	67.92	15.13	22.8	9.76	9.31	7.96	260.05	17.46
Current Liabilities	524.28	381.57	367.1	297.22	601.06	559.2	1812.4	682.97	929.67	931
Super Quick ratio	0.14	0.14	0.19	0.05	0.04	0.02	0.005	0.01	0.28	0.02

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016

Calculated value of χ^2 for Super Quick ratio =0.878.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919. Calculated value is less than Critical Value i.e., 0.878<16.919, Hence, H_0 is accepted.

Gross Working Capital Turnover Ratio

The gross working capital turnover ratio of the company as shown in the table has varied between 1.07 during 2016 and 2.18 during 2009. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table5: Gross Working Capital turnover Ratio (Figures in Lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2266.9	2635.1	3032.46	2234.29	3440.65	3692.85	3972.15	3931.89	3984.70	3401.95
Gross working capital	1138.14	1217.38	1392.28	1241.68	1770.65	2069.31	2422.48	2574.82	3193.87	3169.83
Ratio	1.99	2.16	2.18	1.80	1.94	1.78	1.63	1.53	1.25	1.07

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016

Calculated value of χ^2 for Gross Working Capital turnover ratio =0.705.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 0.705<16.919, Hence, H_0 is accepted.

Net Working Capital Turnover Ratio

The net working capital turnover ratio of the company as shown in the table has varied between 1.52 during 2016 and 6.51 during 2013. It is found in the significance test that net working capital turnover ratio is uniform during the period of study.

Table6: Net Working Capital Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2266.9	2635.1	3032.46	2234.29	3440.65	3692.85	3972.15	3931.89	3984.70	3401.95
Net Working Capital	613.86	835.81	1025.18	944.46	1169.59	1510.11	610.08	1891.85	2264.2	2238.83
Ratio	3.69	3.15	2.96	2.37	2.94	2.45	6.51	2.08	1.76	1.52

Source: Annual Reports of Kristna Engineering Works. from 2006-07 to 2015-2016

Calculated value of χ^2 for Net Working capital turnover ratio =6.138.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e., 6.138<16.919, Hence, H_0 is accepted.

Cash Turnover Ratio

The cash turnover ratio of the company as shown in the table has varied between 24.52 during 2016 and 455.08 during 2014. It is found in the significance test that cash turnover ratio is not uniform during the period of study.

Table7: Cash Turnover (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2266.9	2635.1	3032.46	2234.29	3440.65	3692.85	3972.15	3931.89	3984.70	3401.95
Average Cash Balance	70.85	61.88	60.42	41.53	18.97	16.28	9.54	8.64	134.01	138.76
Ratio	32	42.58	50.19	53.80	181.37	226.83	416.37	455.08	29.73	24.52

Source: Annual Reports of Kristna Engineering Works. from 2006-07 to 2015-2016

Calculated value of χ^2 for Cash turnover ratio =1625.076.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 1625.076>16.919, Hence, H_0 is rejected.

Inventory Turnover Ratio

The inventory turnover ratio of the company as shown in the table has varied between 3.20 during 2016 to 6.81 during 2008. It is found in the significance test that Inventory turnover ratio is uniform during the period of study.

Table8: Inventory Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2266.9	2635.1	3032.46	2234.29	3440.65	3692.85	3972.15	3931.89	3984.70	3401.95
Average Inventory	385.36	386.75	470.78	555.19	597.73	743.76	914.03	829.18	829.2	1062.44
Ratio	5.88	6.81	6.44	4.02	5.76	4.97	4.35	4.74	4.81	3.20

Source: Annual Reports of Kristna Engineering Works. from 2006-07 to 2015-2016

Calculated value of χ^2 for Inventory turnover ratio =2.223.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is less than Critical Value i.e. 2.223<16.919, Hence, H_{07} is accepted.

Debtors Turnover Ratio

The debtor's turnover ratio of the company as shown in the table has varied between 2.29 during 2016 to 5.36 during 2011. It is found in the significance test that Debtors turnover ratio is uniform during the period of study.

Table9: Debtors Turnover Ratio (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sales	2266.9	2635.1	3032.46	2234.29	3440.65	3692.85	3972.15	3931.89	3984.70	3401.95
Average debtors	503.98	584.57	621.18	485.96	642.08	880.1	998.20	1352.27	1565.58	1487.09
Ratio	4.50	4.51	4.88	4.60	5.36	4.20	3.98	2.91	2.55	2.29

Source: Annual Reports of Kristna Engineering Works from 2006-07 to 2015-2016

Calculated value of χ^2 for Debtors turnover ratio =2.450.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919 Calculated value is less than Critical Value i.e., 2.450<16.919, Hence, H_{08} is accepted.

Average Collection Period

The average collection period as shown in the table has varied between 68 days during 2011 to 159 days during 2016. It is found in the significance test that Average collection period is not uniform during the period of study.

Table10: Average Collection Period (Figures In lakhs)

Years	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Days in a year	365	365	365	365	365	365	365	365	365	365
Debtors Turnover Ratio	4.50	4.51	4.88	4.60	5.36	4.20	3.98	2.91	2.55	2.29
Average Collection Period	81	81	75	79	68	87	92	125	143	159

Source: Annual Reports of Kristna Engineering Works. from 2006-07 to 2015-2016

Calculated value of χ^2 for Average collection period =90.808.

The Critical value of χ^2 at 9 degrees of freedom at 5% level of Significance is 16.919

Calculated value is greater than Critical Value i.e. 90.808>16.919, Hence, H_{09} is rejected.

IV. CONCLUSION

The above analysis depicts that debtors occupied first place followed by inventory as a percentage of current assets in Kristna Engineering Works during the period of study. The Business organisation has credit worthiness because there is a significant increase in creditors. Short term borrowings during the period of study are nil. Current ratio of the company is high which indicates that the company is more likely to meet its current liabilities. But, high current ratio indicates high liquidity but profitability is affected to some extent. Debtors' turnover ratio was comparatively less in last four years of the study which reflects in high Average collection period. Cash turnover ratio and average collection periods are not uniform during the period of study and showed wide fluctuations. Collection of debts and cash utilization was poorly done in the company during the period of study. Current ratio, Quick ratio, super quick ratio, Gross working turnover ratio, net working capital turnover ratio, Inventory turnover and debtor turnover ratios are uniform during the period of study. To conclude, though working capital management is satisfactory, there is further scope for improvement in working capital management.

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