DIGITAL MARKETING: CHALLENGES AND OPPORTUNITIES IN INDIAN CONTEXT

Dr. Subba Rayudu Thunga

Associate Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India.

Mrs. Lavanya P B

Assistant Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India.

Abstract

Today the world's most powerful platform is digital marketing. Digital marketing is growing in India with rapid speed. Many Indian companies are using digital marketing for core competence. India is the second largest country with over 560 million internet users. With a massive internet, population come the opportunity for companies to network with prospective clients. This is one main motive why digital marketing as emerged as one of the profession in India. The past few years have seen a number of startups came up with digital marketing model. The study is an effort to understand the key challenges and opportunities of digital marketing in Indian context. Data has been collected from journals, news papers and websites. The study would be useful to the public, customers as well as digital marketing startups. The outcome indicates that internet users, internet penetration, internet accessibility and social media advertising are the key opportunities for digital marketing, customer awareness, privacy; trust and security are the major challenges of digital marketing in India.

Keywords: Digital marketing, Web marketing, Digital marketing startups.

Introduction

Information Technology plays a major role in the marketing division. Nowadays everything traditional became everything digital; this revolution called digital marketing. Digital marketing is the marketing of products or services using digital technologies, mainly on the internet, but also including mobile phones, display advertising, and any other digital medium (Patrutitu, Loredana, 2015) As digital platforms are increasing incorporated into marketing plans and everyday life and as people use digital devices instead of visiting shops physically, digital marketing campaigns are becoming more prevalent and competent. Digital marketing is also referred to as online marketing, internet marketing or web marketing. Worldwide as well as in India digital marketing has become the most common term, especially after the year 2013. The era of digital innovations has come along with a dynamic change in the world business environment, whereby business transactions are constantly shifting from ash-based transactions to electronic based transactions (Mohamad & Haroon, 2015).

Review of Literature

Many studies have focused on digital marketing. The important studies which are relevant to the present study are reviewed and their key findings are analyzed to determine the research gap.

Yasmin,Tasneem, and Fatema (2015) conducted a study on 150 firms and 50 executives to examine the effect of digital marketing on the firm's sales. The study suggests the companies can use various

forms of digital marketing as a tool to promote company products and services. Additionally, digital marketing may succeed more if firms consider customer needs as a top priority. The researcher suggests that companies should create specific strategies for digital media to analyze the best path for driving up digital marketing performance. *Dara (2016)* studied the effectiveness of the digital marketing strategies for both marketers and consumers. The study suggested determining customer needs should be the top priority before selling the products and services on the various digital marketing channels. *Dar, Joshi, and Bali (2016)* studied the effect of information technology through websites and applications in hospitality industry, and concluded that use of applications and websites in this industry positively affects the customer satisfaction. *Anjalli Vachhani (2016)* analyzed the idea of digital marketing in India and its challenges and opportunities in the expanding area of e-marketing. The study indicates the growth of e-marketing depends on the growth of business ethics and on the consumer protection laws. Moreover, the problem of lack of personal contact, security and privacy are the major challenges of digital marketing. *Rathore, Pant, and Sharma (2017)* discussed the emerging trends in digital marketing in India. The study indicates that digital tools and websites play an important role in Individual lives. To find out the best promotional offers from the sellers around India customers spend more time online. *Pitchandi Balaji (2019)* discussed the social media marketing: opportunities and challenges. The study concluded that protecting user privacy and securing the user's personal data has become one of the most imperative goals of social media marketing. Social networking sites are becoming more popular than before because of various internet facilities. Hence, it is advisable that businesses not ignore the opportunities to jump in and expand their customer base.

Objectives of the Study

To understand the comprehensive overview of the digital marketing and examine the key challenges and opportunities of digital marketing in Indian context based on existing literature.

Research Methodology

The aim of this study is to study the key challenges and opportunities of digital marketing in India. The present study is based on secondary data; secondary data was collected from various sources like journals, research articles, literature reviews, magazines and various web sources.

Analysis and Discussion

Figure 1: Number of Internet Users in India from 2015-2020 (in Millions)
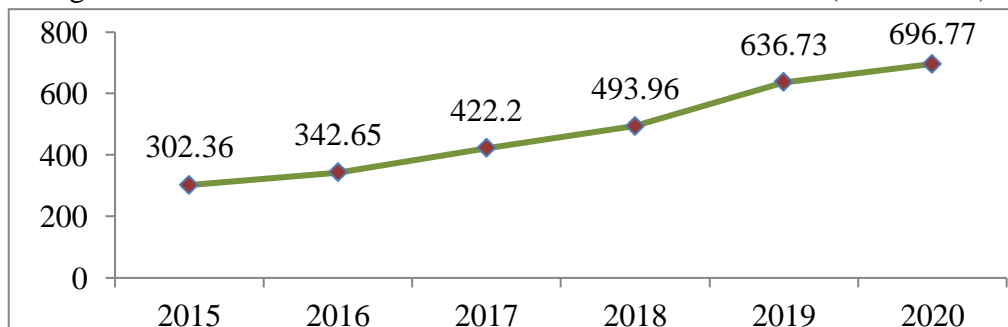
Source: statista.com

The above diagram depicts the total number of Internet users during 2015-2020 in India. It is evident that the number of internet users is continuously increasing from 302.36 million in 2015 to 696.77

million users in 2020. It represents more adoption of internet by the public in general which catered the need for development of digital marketing in India.

Figure 2: Digital Population across India as of Jan, 2020 (in Millions)
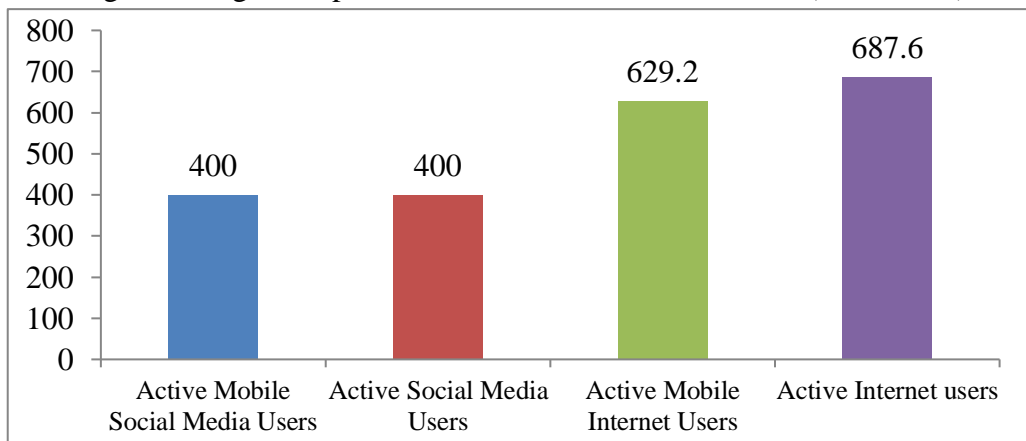
Source: statista.com

The above figure 2 shows the population of India who are digital savvy either through mobile or other platforms. In India, we have 400 million active mobile social media users and 400 million active social media users through other modes till January, 2020. During the same period, internet users using active mobile internet is 629.2 millions and other modes is 687.6 millions. It represents that 63.57%, 58.17% of internet users are active in social media through mobile and other modes respectively.

Figure 3: Social Media Ad Spending in India (in Million USD)
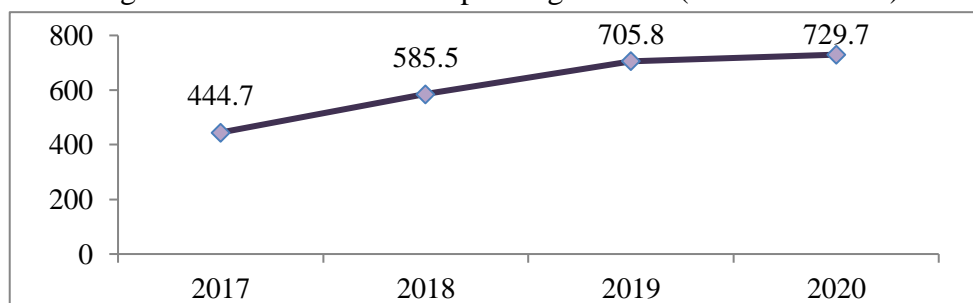
Source: statista.com

The above picture describes the social media advertising spending during 2017-2020 period in India. It is clear that for the last four years the amount spent on social media advertising rose from US $ 444.7 million in 2017 to US $ 729.7 million in 2020. The increase in the amount spent on social media advertising is 64.09% from 2017-2020 which shows the increasing importance of social media.

Figure 4: Average Ad spending per internet user (in USD)
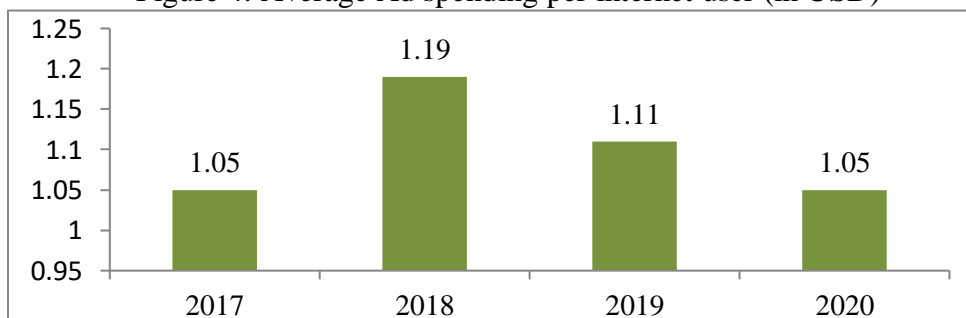
Source: statista.com

The above figure represents the average advertisement spending per internet user from 2017-2020 in India. The average ad spending per internet user is US $1.05, US $1.19, US $1.11 and US $1.05 during 2017, 2018, 2019 and 2020 respectively. This is proportionate to the total number of internet users and total advertising expenditure incurred. This reveals around US $ 1.1 was spent per internet user on an average of four years.

Figure 5: Ad spending in different platforms in India (in USD Billion)
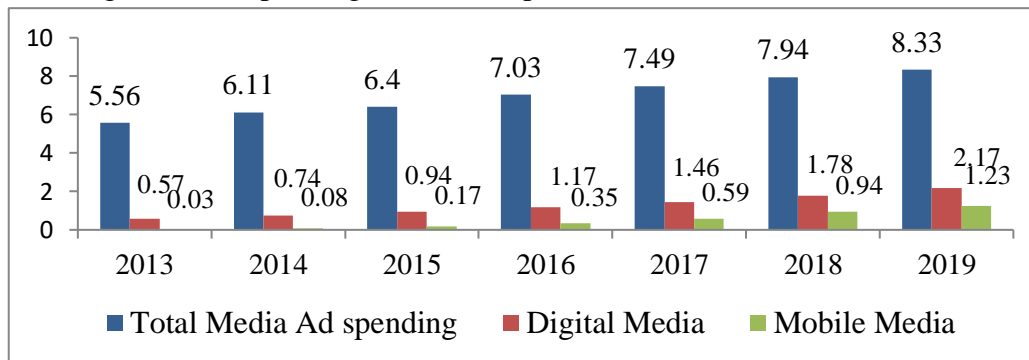
Source: quora.com

The above picture reveals the ad spending in different platforms during 2013 to 2019 in India. It focuses on Total amount spent on advertising and the proportion of digital and mobile media. The total media advertising increased from US $ 5.56 billion in 2013 to US $ 8.33 Billion in 2020. During the same period the advertising amount spent on digital media rose from US $ 0.057 Billion in 2013 to US $ 2.17 Billion in 2020. And mobile media advertising contributed US $ 0.03 Billion in 2013 and increased to US $ 1.23 Billion. It is evident from the above figure that more figure that the contribution of digital marketing is increasing in India.

Challenges and Opportunities of Digital Marketing

Even the well established industry is not away from the challenges posed by the dynamic business world and ever changing customer demand. Digital marketing is still in budding stage in India and requires lot of technological adaption by the companies. One of the major constraints of digital marketing is awareness among public. Digital Literacy is very less in villages where potential population of the country resides. Reaching consumers through digital marketing in these areas is highly difficult which limit the market scope and churns the market share.

More of Indian business is in unorganized sector and well established family businesses in organized sector. The hallmark of Indian business is family kind association maintained by the businesses with its customers. They treat customers with great respect and completely understand the purchase habits and deliver them best with great bondage. The customers are also loyal to the shops and brands for generations together. The virtual shopping dwindle this bondage as direct contact with customers is almost nil in this format of business. Attracting the customers with traditional mindset of shopping becomes a challenging task for digital marketing companies.

Even the tech savvy consumers who find pleasure shopping online also look discontented with the advertisements placed by the competing companies on same web pages or online shopping platforms. Many a times advertisements speak something, goods and services delivered are something else which shows the false promise made by the businesses to attract customers. The customers feel that they were

deceived and misinterpret the reputation of all companies which are placed on the platforms and tend not to purchase other companies genuine products also. It takes long time for companies to gain trust among customers and create their digital marking as competitive advantage.

Digital marketing requires customers to provide their personal information for online shopping. Protecting customer's interest, maintaining customer information confidentially is a major challenge. Even after taking all protective measures, the information can be hacked and the hard earned money of the customers is lost. Because of this reason many of the customers are reluctant to switch themselves to digital marketing.

India is estimated to be the second largest online market with 696.77 Million internet users as of 2020 and ranked just next to China. More adoption of internet by the public in general catered the need for development of digital marketing in India. Social Media has given a great opportunity for digital marketing to develop with people's presents in both mobile and other platforms using Facebook, Twitter, What's App, LinkedIn, Instragram, Google+, Yelp and Youtube etc.,. Entry of new players like Jio in the Telecommunication industry has spread the wings of internet usage in India with more penetration into hooks and corners of the country and made internet a service meant for every common consumer. This in turn has created more opportunity of digital marketing to grow at a quicker pace.

Indian family system is witnessing a tremendous change from joint to nuclear families having double income members working at different time schedules. This has lead to reduced family time and more work pressure. Families can spend time together only during weekends and shopping during the same days reduces this time. Traditional format of business models demand consumers to spent lot of time in travel and shopping and even created chaos in rush shopping centers and markets. Digital marketing has come as a solution to fix the problems of modern day consumers. Companies have taken this pulse and started spending more money on social media advertising to attract and retain customers using digital marketing. The average ad spending per internet user is also increasing in India to make the product visible to customer any time any place according to their convenience this further creates more penetration of digital marketing.

Covid 19 pandamic even though a big bane for many industries, it has turned to be boon for digital marketing world across in particular to India. During the unlock process, consumer purchase process changed drastically from physical to online shopping. It compelled even traditional business entities to change their mindset and adapt to technology driven business creating more scope for digital marketing.

Conclusion

Digital marketing has emerged as revolution in the way business operates from traditional physical format of business to virtual mode for better serving the customer from hook and corner of the country. Even some companies have spread their wings and started internationalizing themselves and cater to larger group of customers which was not easy without digitalization. Companies are using social media and other platforms to reach customers with much ease and serve with digital marketing. On one side availability of internet, customers access to social networking sites, advertisement spending on social and mobile media, changing mindset and habits of customers creating greater opportunities for the companies to build digital marketing as a core competence. But, companies need to strongly address the challenges of competition, digital literacy among customers, and disinclined behavior of customer virtual shopping, building customer trust, maintaining privacy and security. The companies which are willingness to transform with holistic digital marketing strategy and face challenges with positive attitude will have sustainable competitive advantage.

Limitations and Scope for Future Studies

The present study has certain limitations such as: it considered only secondary source of data and studied only digital marketing in a generalized manner and has not considered specific segment. So in future, researchers can consider primary data and can also consider other segments such as digital marketing in retail, entertainment, consumer durable and non durables, real-estate, education, hospitality, agriculture, travel and tourism and etc..

References:

1. Amit Singh Rathore, Mohit Pant, Chetan Sharma. (2017). Emerging trends in digital marketing in India. International Conference on Innovative Research in Science, Technology and Management by Modi Institute of Management and Technology, Rajasthan, 22-23 January 2017, ISBN: 978-93-86171-20-7, 107-115.

2. Auwal Kabir, M., Aidi Ahmi, Siti Zabedah, S. (2015). Adoption of e-payment systems: A review of literature. Proceedings of the International conference on E-commerce (ICoEC), 20-22 October 2015 Malaysia.

3. Balaji, P., (2019). Social media marketing: opportunities and challenges. International Journal of Management, Technology and Engineering, 9(4), 5637-5648.

4. Bhojaraja, Muniraju, M.,(2018). Challenges and opportunities in digital marketing. IAETSD Journal for Advanced Research in Applied Sciences, 5(1), 170-172.

5. Dara, S. (2016). Effectiveness of Digital Marketing strategies. International Journal for Innovative Research in Multidisciplinary Field, 2(12), 290-293.

6. Dar, I.A., Joshi, M.C., & Bali (2016). In era of applications and websites: Effect of information technology on satisfaction and loyalty of customers in hotel industry. International Journal of Applied Business and Economic Research, 14(4) 2529-2532.

7. https://www.statista.com/statistics/309866/india-digital-population/

8. https://www.statista.com/statistics/255146/number-of-internet-users-in-india/

9. https://www.statista.com/topics/2157/internet-usage-in-india/#:~:text=With%20over%20560%20million%20internet,million%20internet%20users%20the%20country.

10. Loredana Patrtitu Baltes, (2015). Content marketing-the fundamental tool of digital marketing. Bulletin of the Transilvania University of Brasov.Servies V: Econoic Sciences, 8(57). 112-118.

11. Vachhani,A., (2016). Digital marketing in India and its challenges and opportunities ahead. International Journal of Advanced Research, 4(12), 1554-1558.

12. Yasmin, A., Tasneem,S., & Fatema,K. (2015). Effectiveness of digital marketing in the challenging age: An empirical study. International Journal of Management Science and Business Administration, 1(5), 69-80.

Experimental Analysis of VCR Engine Operated with Prosopis Juliflora Biodiesel Blends

Selvan. P. Tamil, Gangeya Srinivasu Goteti **‡

* Associate Professor, ** Research Scholar, School of Mechanical and Building Sciences, VIT University, Chennai, India.

(tamilselvan.p@vit.ac.in, ggsvas@gmail.com)

‡ Corresponding Author: Gangeya Srinivasu Goteti, School of Mechanical and Building Sciences, VIT University, Chennai, India, ggsvas@gmail.com

Abstract- The depletion of conventional fuel reserves, ambient conditions along with increased global warming and emission standards have emerged the research interests in utilisation of advanced combustion concepts on existing engines. This also made concern over the capability of using alternate energy sources along with conventional fuels. This research work indicates the results of analysis conducted to investigate the performance, exhaust emission and combustion characteristics of a VCR diesel engine fuelled with non-edible biodiesel at a rated speed of 1500 rpm with 300 bar injection pressure at three compression ratios. The test fuel was derived from Prosopis Juliflora seed oil methyl ester blends15% (B15) and 25% (B25) by volume. Biodiesel was produced by the transesterification process using methanol along with KOH as catalyst. The combustion characteristics investigated were rise in cylinder pressures, net heat release rate, cumulative heat release rate and mass fraction of fuel burned. The lower heat release rates, increased cylinder pressures were observed for both the blends compared to diesel. Increased brake thermal efficiency observed at higher compression ratio for B25 blend. It has also been observed that the emissions were decrease in trend with increase in compression ratios.

Keywords Thermal efficiency, Compression ratio, Combustion, Heat release rate, Ignition delay.

1. Introduction

Increase in demand regarding energy utilizations lead to major dependence on fossil fuels which are in a drastic depletion state, which in turn increased concern over renewable energy sources like bio fuels. Major concern for renewable energy sources is going on for diesel engines which occupy major portion in all engineering machinery like automotive and agricultural purposes because of their comparable thermal efficiencies and power outputs. Biodiesels derived from various non-edibles and edible oils are considered as alternative sources for diesel engines and various research works are in progressive stages to adopt these biodiesels as alternate source for diesel engines [1]. The primary advantages of these biodiesels are that they are non-toxic, renewable, void of sulphur traces and biodegradable in nature compared to conventional fossil fuels. The comparisons and tests conducted by using biodiesels by different researchers [2-3] shown the suitability of biodiesels as alternative fuel sources for diesel engines. Experimental analysis was also done by changing various operating parameters like varying injection pressures, timings and compression ratios. Senthil Kumar.K and

Thundil kruppa Raj [4] conducted performance test on a Diesel engine using ethanol blended biodiesel. Experimental results with increased inlet air temperatures (40^0 to 60^0 C) and advanced injection timings (12^0, 15^0, 18^0 BTDC) showed the suitability of ethanol blended biodiesel as an alternative fuel with decreased HC and CO emissions. Sathish Kumar.R et al [5] used Manilkara Zapota methyl ester blend on Variable Compression Ratio (VCR) engine and obtained the results. The results revealed its suitability as an alternative substitute to replace pure diesel. The results showed that the use of these blends resulted in increased brake thermal efficiencies and decreased brake specific fuel consumptions. Performance, combustion and emission characteristics were studied [6] by using bael oil-diesel-diethyl ether blends on VCR engine. The results reveal that there was an increase in brake thermal efficiency by 3.5% and decreased nitrogen oxides by 4.7% by injecting fuel at 23^0 BTDC. Water emulsified hybrid Pongamia biodiesel was used by Varatharaju Perumal and Ilangkumaran.M [7] on single cylinder naturally aspirated diesel engine. The results show 9% increase in BSFC, 5% decrease in BTE along with decreased emissions like smoke, CO and NOx. Senthur Prabhu.S et al [8] conducted experimental investigations

using blends of pre heated palm oil (20%), diesel and n-butanol with BHT (2000ppm) on DI diesel engine. The results obtained were increased BSFC and BTE with decreased CO, smoke and EGT with 1.9% increased NOx emission. The experimental work carried by Prakash.T et al [9] using blends of bio-ethanol (30%), diesel (30%) and castor oil (40%) show that the BTE was comparable to diesel with increased smoke emission. Experimental analysis done by Houssem El Haj Youssef et al [10] using the blend of diesel and waste cooking oil (20%) with 2^0 advanced injection timing. The results had shown increased performance with a reduction in smoke opacity. The blends of diesel (70%), gasoline (15%) and n-butanol (15%) showed increased maximum pressure rise rates with decreased ignition delay and combustion duration. The BSFC and CO emissions increased when compared to diesel, whereas there was reduction in NOx levels [11]. Oxygen enriched fuels like biodiesels promote increased combustion phenomenon [12, 13] which in turn results in less pollutants, when used in conventional and HCCI engines. Tsutsumi.Y et al [14] used ignition improvers like Di Ethyl Ether (DEE), Di Methyl Ether (DME) to biodiesel fuel blends at lower percentages lead to further reduction of emissions by allowing the fuel blends to evaporate immediately and also to maintain the blend cetane value to the required extent. The Pongamia oil blends with addition of DEE lead to reduction of NOx and smoke emissions [15]. Experimental analysis on diesel engine operated with methyl ester of Sesame oil shown higher BTE with lower emissions of HC, CO and NOx [16].

Zhang et al [17] used butanol with diesel and biodiesel blends, and observed reduced PM emissions at higher engine loads. Similar trend has been observed by Xiaoye Han et al [18] using n-butanol blends with diesel. The performance parameters obtained were comparable with diesel and shown reduction in NOx and smoke emissions. Sharifah Najiha Badar et al [19] concluded that Algae-derived bio-energy is one of the best alternative energy sources to replace fossil-based fuels. K. Vijayaraj and Sathiyagnanam.A.P [20] used blends of methyl ester of Cotton seed oil and studied combustion characteristics of a DI diesel engine. The results reveal that 25% of methyl ester of Cotton seed oil showed optimum combustion characteristics at all load conditions.

From the above literature survey it has been concluded that several edible and non-edible oils could be used as biodiesels in conventional diesel engines with little or no engine modifications. This is because of their higher cetane and oxygen percentages which can cause optimum combustion and heat release rates [21] by influencing the combustion efficiency.The Prosopis Juliflora plant is widely spread all over the world and it consists of 44 species in that 40 known species are native to America. This plant is plentifully available in arid regions of India, and is also remaining in several countries [22]. Its seed oil is non-edible in nature. Earlier reports have also suggested suitability of some non-edible oils in a diesel engine by blending with diesel. The novelty of this study is such that no analyzations are available on the use of PJME –diesel blends in a VCR CRDI diesel engine at various compression ratios. The present study aims at evaluating the performance, emission and combustion characteristics of a VCR CRDI diesel engine fuelled with PJME–diesel blends.

2. Materials and Methods

2.1. Preparation of Fatty Acid Methyl Esters

To prepare methyl esters by transesterification requires raw Juliflora seed oil, 15% of methanol & 5% of sodium hydroxide on a mass basis. The Juliflora seed oil was chemically reacted with an alcohol in the presence of a catalyst to produce methyl esters. The mixture was stirred continuously and then allowed to settle under gravity in a separating funnel. Two distinct layers form after gravity settling for 24 hours. The upper layer was of ester and the lower layer was of glycerol. The lower layer was separated out. The methyl ester was then blended with diesel in various concentrations for preparing biodiesel blends to be used in the test engine. The properties of PJME and its blends compared to diesel are shown in Table 1.

Table 1. Properties of test fuel compared to diesel

Properties	Diesel	PJME	B15	B25
Density(kg/m^3)	840	970	860	873
Calorific Value(MJ/kg)	42.80	40	42.38	42
Viscosity at 40^{0}C(mm^2/sec)	2.85	4.90	4.59	3.36
Cetane Number	46	49	46.45	46.75
Oxygen % by weight	0	12	1.8	3

2.2. Experimental Setup

The photographic view of experimental setup is shown in Fig. 1 and its technical specifications are shown in Table 2. Experimental investigations were carried out by using CRDI vertical single cylinder water cooled computerized direct injection VCR diesel engine with eddy current dynamometer at a rated rpm of 1500 with an injection pressure of 300 bar and with an injection timing of 280 BTDC. The VCR engine was provided with AVL DI GAS 444 N five gas analyzer and AVL 437C Smoke meter. This CRDI VCR engine works with programmable Open ECU for Diesel injection, fuel injector, common rail with rail pressure sensor and pressure regulating valve, crank position sensor, fuel pump and wiring harness. The setup enables study of CRDI VCR engine performance with programmable ECU at different compression ratios. Various necessary instruments were used along with experimental setup to measure crank angle, combustion rate, in cylinder pressure and temperatures and fuel flow rates. The signals from all the measuring instruments were connected to a computer through a data acquisition system.
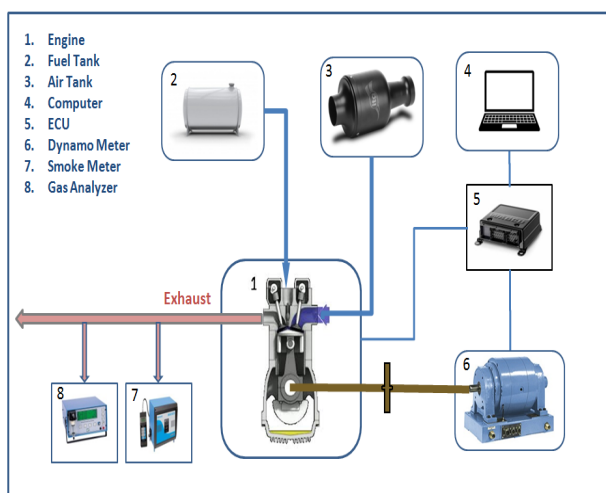
1. Engine
2. Fuel Tank
3. Air Tank
4. Computer
5. ECU
6. Dynamo Meter
7. Smoke Meter
8. Gas Analyzer

Fig. 1. Schematic view of Experimental setup

Table 2. Test engine specifications

Parameter	Specification
Type of engine	Kirloskar, CRDI, Four Stroke, Single Cylinder, Naturally aspirated diesel engine with eddy current dynamometer
Power	3.5 kW at 1500 rpm
Bore * Stroke	87.5 mm * 110mm
Compression Ratio	17.5 (VCR 12 to 22)
Injection pressure	300 bar
Injection timing	28^0 BTDC
Swept volume	661.45 (cc)

2.3. Experimental Procedure

The test fuel PJME was mixed with diesel in volume ratios of 15% and 25% and named as B15 and B25 blends. These blends were tested on VCR engine with compression ratios of 16, 18 and 20. A series of experimental trails were conducted on the test engine with test fuels and average value of all trail readings from no load to full load conditions was obtained. After allowing the engine to get stabilized with applied loads during each experimental trail, the emission, combustion and performance details were recorded by using the data acquisition system connected between experimental setup and computer.

3. Results and Discussion

3.1. Engine Performance Analysis

3.1.1. Brake thermal efficiency

This efficiency is described as the ratio of amount of heat actually converted to the brake power to the total heat supplied. There was no considerable variation in BTE at compression ratio 16 for B15 and B25 blends when compared to diesel, but it was improved in lateral stages with increase in compression ratios to 18 and 20. The BTE values for diesel, B15 and B25 at CR16 were 34.5%, 34.8% and 33.8% respectively. The variation of BTE with BP at CR16

is shown in Fig. 2, and it is clear that the BTE was more for the blends when load reaches the maximum. The increased in-cylinder pressures and temperatures at maximum loads for biodiesel blends lead to better evaporation and mixing with air, which resulted in the maximum BTE [23].
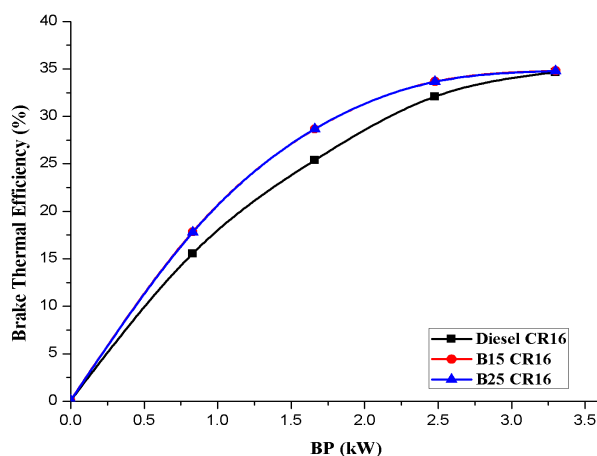

Fig. 2. Variation of BTE with BP at CR16

With increased compression ratios, the operating temperatures of the test engine were improved. The evaporation and mixing rates of blends into air were also promoted, resulting in improved BTE values. The BTE values at CR20 for diesel, B15 and B25 were 27.4%, 34.7% and 34.5% respectively at full load conditions. The BTE was improved by 20.5% compared to diesel for the blend B25 at CR20 at full load condition, because of higher compression ratio and improved oxygen percentage with this blend strength. It was also observed that BTEs were closer to each other for all blends with diesel at full load conditions because of closer heating values and cetane number. Higher cetane number and oxygen percentages in biodiesel blends resulted in better ignition quality which in turn increased the BTE. Variation of BTEs with brake powers at CR18 and CR20 is shown in Figs. 3 and 4.
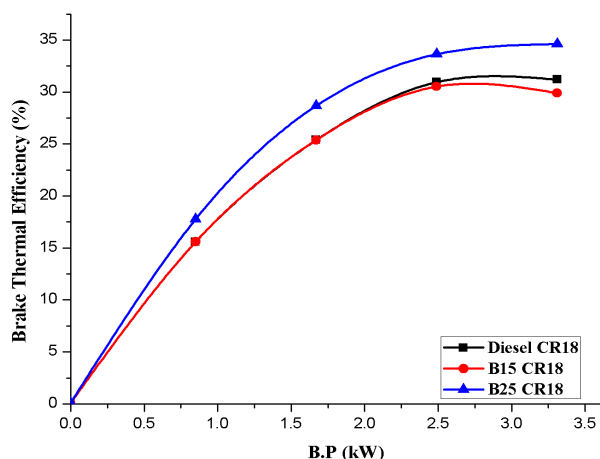

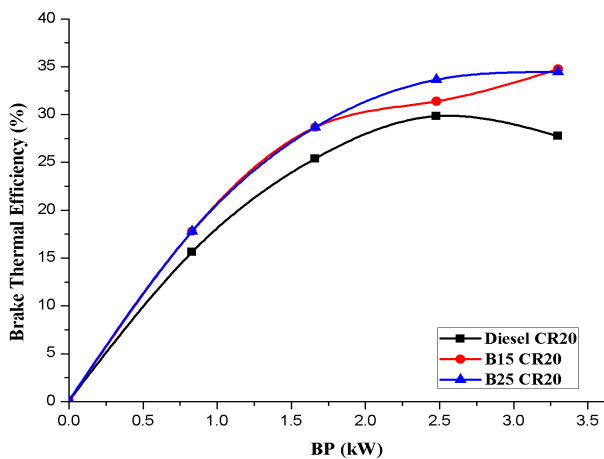**Fig. 3.** Variation of BTE with BP at CR18

Fig. 4. Variation of BTE with BP at CR20

3.1.2. Brake specific fuel consumption

It is defined as the amount of fuel consumed per unit brake power output or it is the effectiveness to convert chemical energy of the fuel into useful work and it depends on fuel properties like viscosity, oxygen content, density, cetane number and heating value.

From the graph, it is observed that BSFC was reduced with an increase in load or at higher brake powers. The results also reveal that there was no considerable variation of BSFC for all compression ratios. The decrease in BSFC with increase in load was mainly due to variation of mixture strength from leaner to stoichiometric ratio. The lower heating value of all the blends is also considered to be another factor for increase of BSFC [24, 25]. The BSFC slightly increased for both the blends at CR16 when compared with diesel. The BSFC values were observed as 0.24, 0.28 and 0.28 kg/kW-hr for diesel, B15 and B25 respectively as shown in Fig. 5.
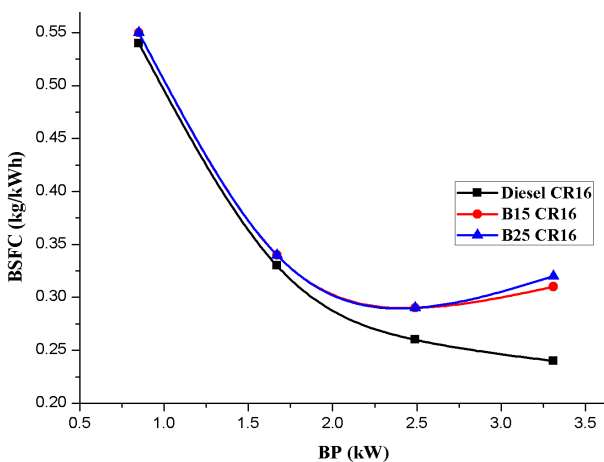

Fig. 5. Variation of BSFC with BP at CR16

It was also observed that BSFC for diesel slightly increased with increase in compression ratio, whereas no considerable variation in BSFC for B15 and B25 blends from CR16 to CR20. This opposite trend with increase in compression ratio may be due to higher operating temperatures at higher compression ratios that may lead to increased energy losses with increased frictional losses.

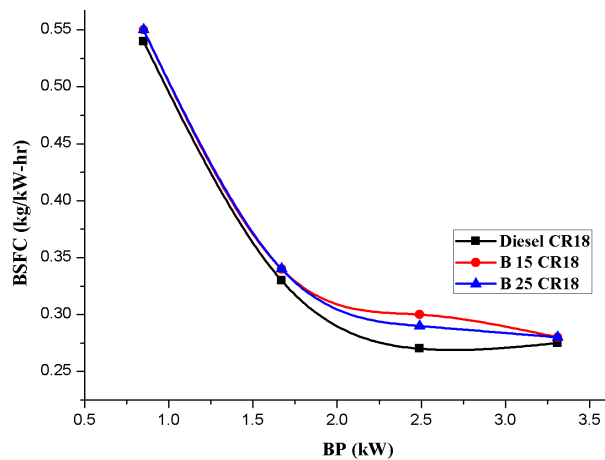Variation of BSFCs with BP at CR18 and CR20 is shown in Figs. 6 and 7.

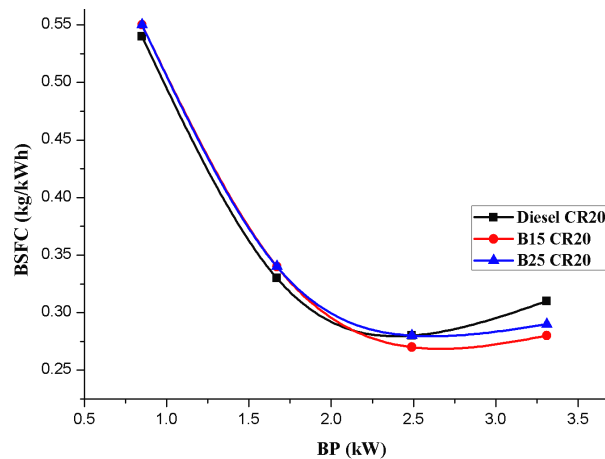**Fig. 6.** Variation of BSFC with BP at CR18

Fig. 7. Variation of BSFC with BP at CR20

The SFA content in PJME can also influence its cetane number near to that of diesel, since the cetane number depends upon the molecular structure of the fuel [26]. The SFAs like palmitic acid (C16:0) and stearic acid (C18:0) have straight chain molecular structure when compared to unsaturated fatty acids. The SFA content in PJME was 23%. In addition, the increased density of the blend can cause earlier injection of fuel allowing better mixing time and evaporation. It can influence better combustion in lateral stages of combustion with improved compression ratios.

3.2. Emission Analysis

3.2.1. Analysis of carbon monoxide

The main reason for CO emission is due to heterogeneous mixture formation, decreased reactive rates or slow flame propagation. The decreased oxygen percentage, rich mixture and incomplete combustion are also considered as collective reason for the formation of this emission. Variation of carbon monoxide emission with respect to brake

power is shown in Fig. 8. Intermediate results were obtained at CR18.

The emission of CO increased with increase in blend strength and also increased with compression ratios compared to diesel at full loads. The higher unsaturated fatty acids led to poor oxidation and accumulation of more fuel droplets increased the carbon monoxide quantity. The increased blend strength also resulted in increase of fuel density and viscosity, which requires increased injection pressures. The same injection pressure and increased compression ratio resulted in decreased penetration of spray fuel droplets leading to poor combustion compared to diesel.
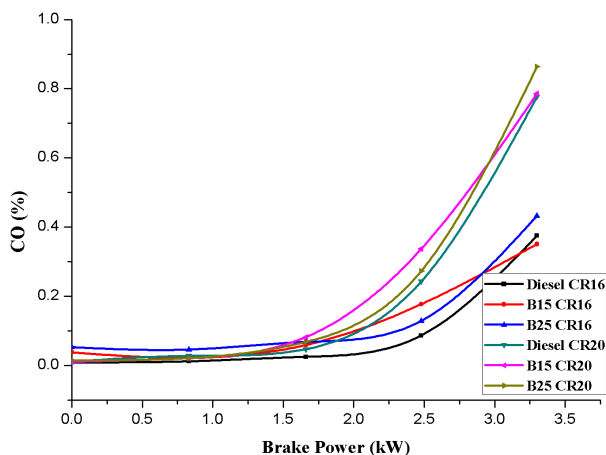

Fig 8. Variation of CO with BP at CR16 and CR20

The emission of CO at peak load conditions with CR16 for diesel, B15 and B25 was observed as 0.375%, 0.351% and 0.433%, and with CR20 it was observed as 0.777%, 0.786% and 0.864% respectively.

3.2.2. Analysis of hydrocarbons

The influencing parameters for this emission are fuel atomization, quality of air fuel mixture, combustion quality and operating parameters. At lower compression ratios the unburnt hydrocarbons (UHC) emissions were more for diesel and test blends, and at higher compression ratios, there was no considerable variation in UHC emissions. The UHC emissions for diesel, B15 and B25 blends at CR16 were 72ppm, 77ppm and 81ppm respectively. For increased compression ratios of 18 and 20, slight decrease in UHC emissions was observed. At CR20 the UHC emissions for diesel, B15 and B25 were observed as 69ppm, 68ppm and 80ppm respectively at full load conditions and intermediate results were obtained at CR18. Variation of hydrocarbon emission with respect to brake power is shown in Fig. 9 for CR16 and 20. Lower compression ratios led to lower operating temperatures which in turn reduces evaporating capacity of fuels causing increased UHC emissions particularly at higher blend strengths, and also the blend strength reduces the calorific value of the fuel and cetane number.

Increase in blend strength also increases the kinematic viscosity which in turn requires higher injection pressures. It was also observed that increase in compression ratios

increased the operating temperatures leading to better evaporation and combustion rates, which further resulted in reduction of UHC emissions.
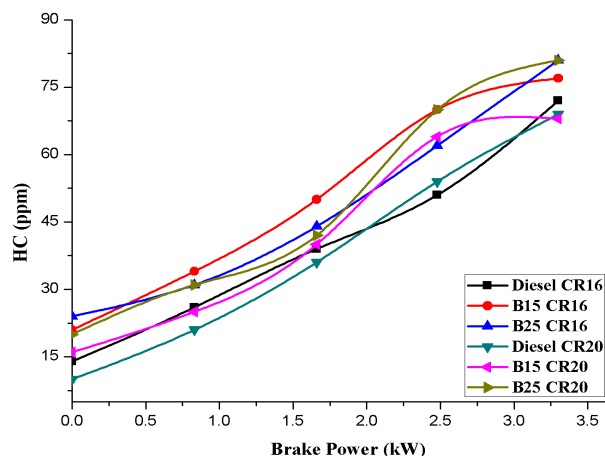

Fig. 9. Variation of HC with BP at CR16 and 20

3.2.3. Analysis of carbon dioxide

Higher carbon dioxide emission is possible either because of higher Oxygen quantity available in biodiesels [27] or because of carbon monoxide conversion to carbon dioxide after complete combustion of fuel at higher temperatures. The emission of carbon dioxide was slightly more for diesel compared to other blends at compression ratio 16, and it was almost same at compression ratio 20 meaning increase of compression ratio led to increased operating temperatures, resulting in increased combustion rate for both the blends. At lower compression ratios the evaporation rate for diesel was more compared to other blends. The increased viscosity and density of other blends led to incomplete evaporation rates causing heterogeneous combustion.

The CO_2 emission for diesel, B15 and B25 fuels at CR16 was observed as 7.84%, 7.6% and 7.69% respectively. At CR20, the CO_2 emission for diesel was decreased to 7.63% and for B25 it was decreased to 7.64%. Variation of CO_2 at peak loads with respect to increase in brake power is shown in Fig. 10 for CR16 and CR20.
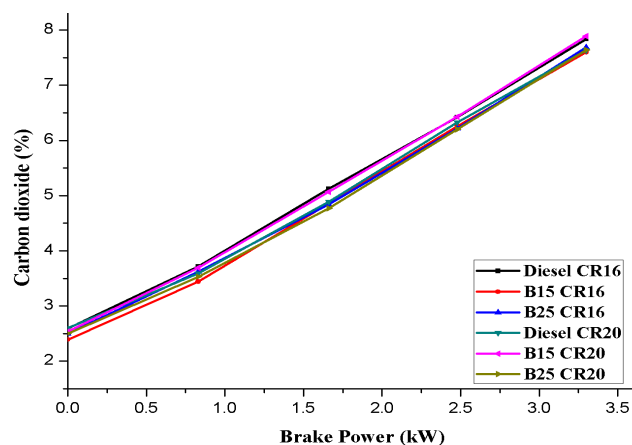

Fig. 10. Variation of CO_2 emission with BP

3.2.4. Analysis of nitrogen oxides

The mixing of oxygen with nitrogen at elevated operating temperatures is the primary cause for emission of NO and NO_2. This is because at higher operating temperatures the diatomic Nitrogen (N_2) is separated into monatomic Nitrogen (N), which is highly reactive with Oxygen and water vapors [28].

In this experimental analysis, initially NOx emissions were more at lower compression ratio 16 at peak load conditions for all blends along with diesel. Because of higher heating value, the diesel emits more NO_X compared to B25. Variation of NOx emission with respect to brake power is shown in Fig. 11 for CR16 and 20. Intermediate results were obtained at CR18. The NO_X emission at full load for CR16 was 2021ppm for diesel, and 1956ppm for B25 which is less by 3.21% compared to diesel. There was no considerable variation in NOX emission for B15 compared to diesel.
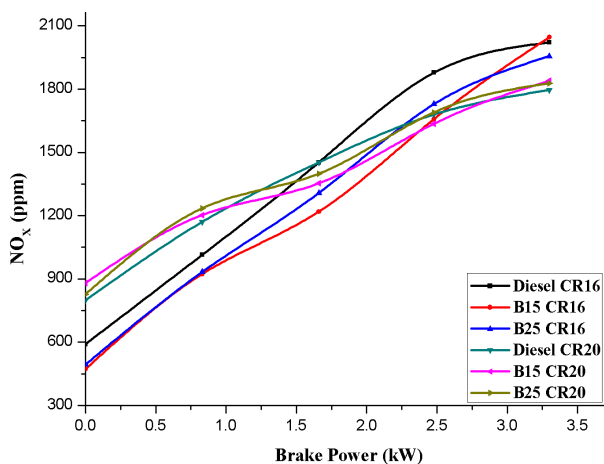

Fig. 11. Variation of NOx emission with BP

Lower heating values of B25 blend lead to lower NO_X emission. But as the compression ratio increases to 18 and 20, the higher operating temperatures led to increasing trend of NOx emissions for both the blends compared to diesel. The NO_X emissions for diesel, B15 and B25 at CR20 at full loads were 1796ppm, 1840ppm and 1828ppm respectively.

3.2.5. Analysis of smoke opacity

Generation of smoke emissions is due to insufficient mixing of air with fuel particles, and incomplete evaporation of fuel into air. Smoke emissions were in decreasing trend for blend B25 with increase in compression ratio because of increased operating temperatures led to increased evaporation rates. This decrease in trend of smoke opacity was also because of increased oxygen percentage with increased blend strength, resulting in the maximum carbon content to burn. The emission of smoke with respect to brake power is shown in Fig. 12.

It was observed that smoke emissions at CR20 for diesel, B15 and B25 were 63.7%, 62.4% and 54% respectively. It was reduced by 15.22% for B25 compared to diesel. It was observed as 56.7% at CR16 and 55.2% at CR18 for B25 blend.
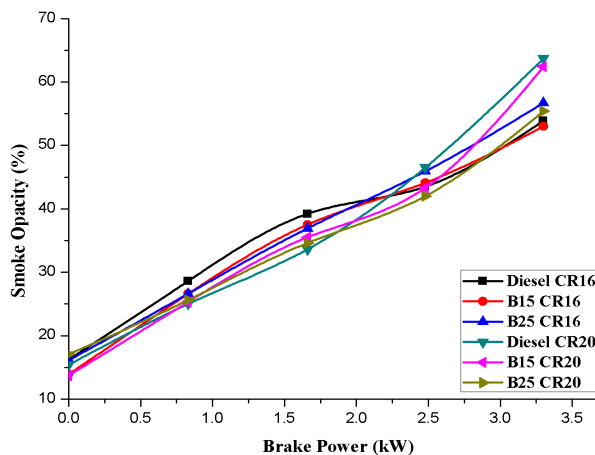

Fig. 12. Variation of Smoke Opacity with BP

3.3. Combustion Analysis

3.3.1. Analysis of blends cylinder pressure

The cylinder gas pressures depend upon the operating parameters of the particular engine and combustion characteristics. In-cylinder pressure directly related to power output. The in-cylinder pressure with respect to crank angle is shown in Fig. 13.
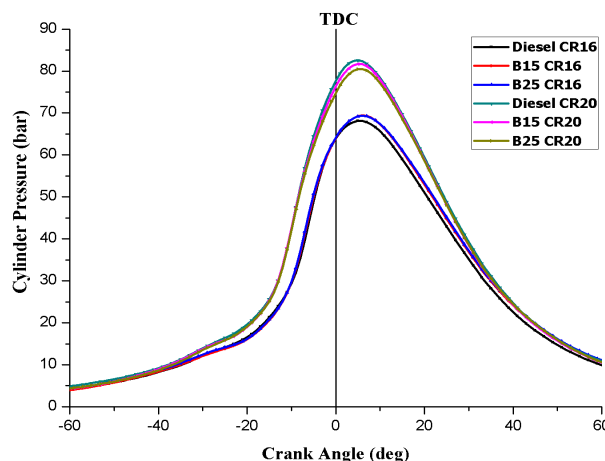
Fig. 13. Variation of Cylinder Pressure with Crank angle at CR16 and CR20

It had been observed that the peak pressures were slightly more for both the blends compared to diesel at compression ratio 16. The highest peak pressure was obtained for B25 followed by B15 and diesel. The value of peak pressure obtained for the blend B25 was 69.5 bar compared to 69.3 and 68 bars for B15 and Diesel respectively. The peak pressures were increased by 2.16% for B25 compared to Diesel. The maximum peak pressures were obtained by the result of uncontrolled combustion stage and availability of oxygen percentages in biodiesels.

The increased fuel supply with increased load conditions influenced the combustion rate with elevated temperature ranges was considered as one of the causes for improved cylinder pressures. Shorter ignition delay with increased

blend strength oxygen content was also another cause for increase in peak pressures. In lateral stages of compression ratios of 18 and 20 the peak pressures were slightly reduced for the blends B15 and B25 because of improper protrusion of fuel droplets into compressed air with same injection pressure. Increase in viscosity and reduced cetane number can also influence spray atomization manner and ignition delay period in negative manner which can reduce the peak pressures in cylinder [29] for biodiesel blends.

3.3.2. Analysis of blends heat release rate

The heat release rate analysis is the better way to do in-depth analysis of combustion phenomenon. The net heat release rate depends upon the type of fuel used, injection pressure and compression ratio. It has been observed that for diesel HRR is more compared to other blends at all compression ratios, because of higher calorific value, evaporation rate and cetane number. The variation of HRR with respect to crank angle is shown in Figs. 14 and 15 at CR20 and CR16.

Negative HRR was observed before the start of combustion near 25^0 BTDC, because of evaporation of fuel caused heat to absorb from its surroundings in the combustion chamber space and also heat losses from engine cylinder walls [30, 31]. The Lower HRR for B15 and B25 blends has been observed as their increased viscosity with lower evaporation rate influences the physical delay period. The air temperature, pressure, air turbulence and velocity also can influence physical delay period [32]. The oxygen percentage can decrease the chemical delay period. The oxygen concentration of B25 blend resulted in more HRR compared to B15 blend. The B25 blend shown more HRR compared to B15 blend at all compression ratios because of increased ignition delay due to its decreased evaporation rate. This could result more quantity of fuel to accumulate in the combustion chamber, which was considered as another factor for increased HRR after the combustion process was initiated [33, 34].
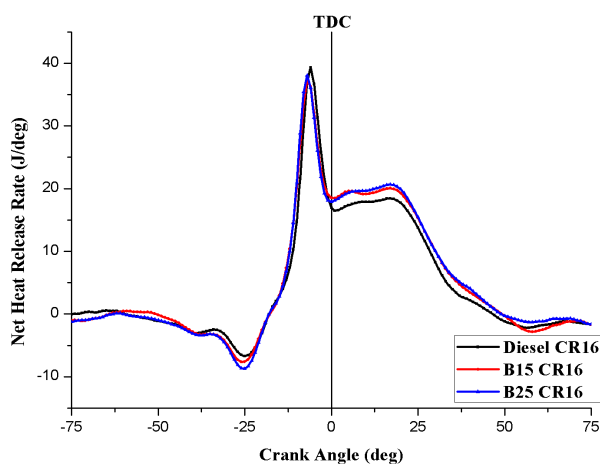

Fig. 14. Variation of HRR with Crank angle at CR16

The ignition delay further provides better fuel and air mixing time, which will reduce the heterogeneous mixture formations and allows better fuel atomization [35].
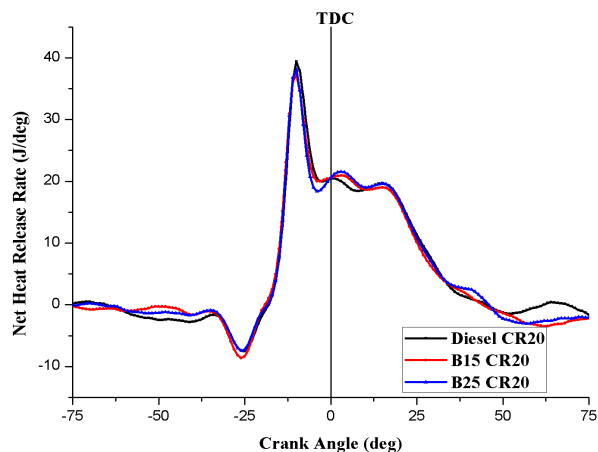
Fig. 15. Variation of HRR with Crank angle at CR20

The lower viscosity rates of biodiesel blends also influenced the atomization resulting in increased HRR [36]. At CR16, the maximum HRR for Diesel, B15 and B25 blends was found at 7^0 BTDC as 39.33 J/deg, 37.18 J/deg and 38.04 J/deg respectively. And at CR20, the maximum HRR for Diesel, B15 and B25 blends was found at 10^0 BTDC as 39.41 J/deg, 37.30 J/deg and 38.5 J/deg respectively at full load conditions.

3.3.3. Analysis of blends cumulative heat release

The cumulative heat release provides the information regarding progress of combustion and heat energy released by particular chemical nature of the fuel. Figure 16 shows the CHR with respect to crank angle for both the blends at CR16 and CR20 compared to diesel at full load conditions.

At the beginning of combustion both the blends followed the same trend like diesel, but as the combustion progresses the blend B25 showed higher CHR compared to diesel. This is because of B25's rapid rate of combustion due to its higher ignition delay compared to diesel. Presence of higher Oxygen percentage also considered as another cause for more CHR for B25 blend compared to diesel [37]. The similar trend has been observed for both the blends at CR20 compared to diesel.

Fig. 16. Variation of CHR with Crank angle at CR16 and CR20

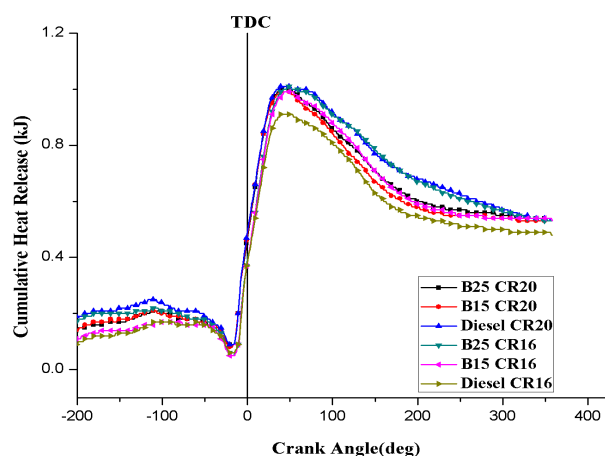The primary factor influencing the CHR is ignition delay which is a combination of both physical and chemical delays, and can be defined as the time lag between initiation of injection and pre-ignition [38, 39].

The maximum CHR at CR16 was observed as 0.91kJ, 0.99kJ and 1.01kJ and with CR20 it was observed as 1.01kJ, 0.99kJ and 1.01kJ for diesel, B15 and B25 respectively at full load conditions. Intermediate results were obtained at CR18.

3.3.4. Analysis of blends mass fraction burned

The mass fraction burned is the amount of injected fuel burned to the total mass of fuel injected per cycle of the combustion process [40]. This is also used for to estimating time interval between the flame initiation and rapid rate of combustion [41].

Figs. 17 and 18 show the initiation of combustion from zero position by MFB curve and up to 100% means the end of combustion. The difference of zero to 100% indicates the period of combustion. The comparison of MFB at CR16 for both the blends with diesel is shown in Fig. 17 and at CR20 shown in Fig. 18. It is observed that from graphs, the initiation point of combustion for both the blends is same as that of diesel at CR16 and CR20. Increased oxygen levels for both the blends and cetane number near to diesel are considered as primary factors for initiation of combustion even at lower compression ratio 16. Even though the combustion duration of diesel was same as of the two blends, the burning process exceeded the combustion process of blends because of its higher combustible nature compared to the blends. As the CR value increased from 16 to 18 and 20, the blend B25 showed similar trend like diesel at higher loads because of increased operating temperatures and evaporation rates. This condition further influenced the mixing of fuel with air leading to reduction in the ignition lag period.
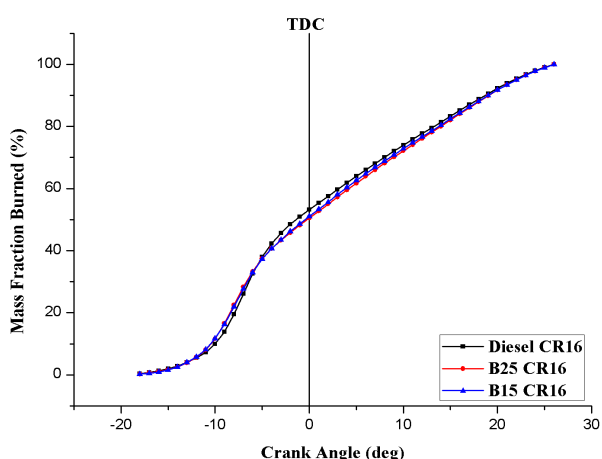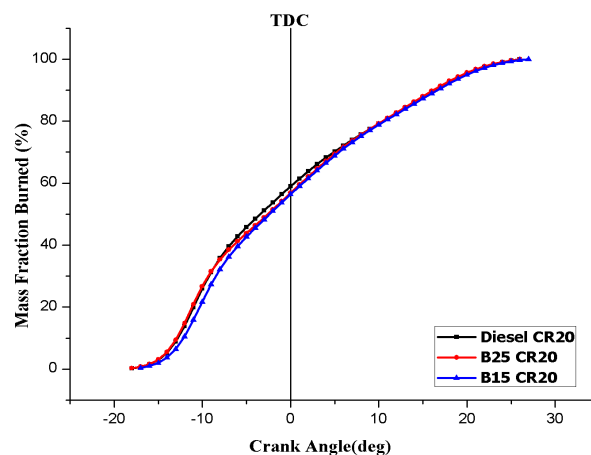
Fig. 18. Variation of MFB with Crank angle at CR20

4. Conclusions

The experimental work using PJME blends at compression ratios 16, 18 and 20 has drawn the following conclusions compared to diesel

➢ There is no considerable variation in combustion process using both the blends compared to diesel.
➢ The slight improvement in peak pressure occurred for B25 blend compared to diesel at lower compression ratio and with increase in compression ratios the peak pressures obtained were near to diesel for both the blends.
➢ The pressure rising trend was followed like diesel with variation in crank angle and no unusual behavior was observed.
➢ All the blends shown the HRR near to diesel at all compression ratios.
➢ The rate of combustion was faster with increased mass fraction burned for all the blends. The blend B25 followed the similar nature as of diesel with increased loads.
➢ The emissions for both the blends were slightly increased compared to diesel at lower compression ratios and they were in decreasing trend with increase in compression ratios.
➢ This analysis also concluding to concern over suitable injection pressure (especially for biodiesel blends having higher viscosity), which was maintained constant even compression ratios were increased.
➢ From all above it is proved that the PJME could be added to diesel in small proportions to save conventional fuel usage for diesel engines for some extent.

Acknowledgments

Fig. 17. Variation of MFB with Crank angle at CR16

Nomenclature

B15	15% Biodiesel, 85% Diesel	CR18	Compression ratio 18
B25	25% Biodiesel, 75% Diesel	CR20	Compression ratio 20
PJME	Prosopis Julyflora oil methyl ester	SFA	Saturated Fatty Acids
VCR	Variable Compression Ratio	BSFC	Brake Specific Fuel Consumption
CRDI	Common Rail Direct Injection	BTE	Brake Thermal Efficiency
CHR	Cumulative Heat Release	CO_2	Carbon dioxide
CR16	Compression ratio 16	NOx	Nitrogen Oxides
deg	Degree	HC	Hydro Carbons
SFC	Specific Fuel Consumption	ppm	Parts per million
BP	Brake power	BTDC	Before Top Dead Centre
UHC	Unburnt Hydro Carbons	MFB	Mass Fraction Burned
cc	cubic centimetres		
HRR	Heat Release Rates		

References

[1] A.Gopinath, S. Puhan, and G. Nagarajan, "Effect of unsaturated fatty acid esters of biodiesel fuels on combustion, performance and emission characteristics of a DI diesel engine", International Journal of Energy and Environment, Vol.1, No.3, pp.411-430, 2010.

[2] P.Tamil Selvan, and G.Nagarajan, "Combustion and Emission Characteristics of a Diesel Engine Fuelled with Biodiesel Having Varying Saturated Fatty Acid Composition", International Journal of Green Energy, Vol.10 No.9, pp.952-965, 2013.

[3] P.Tamilselvan, G.Nagarajan, and M. Sasikumar, "Performance and Emission Characteristics of a Diesel Engine using Blends of Biodiesel by varying Saturated Fatty acid Compositions", International Journal of ChemTech Research, Vol.9 No.9, (2016), pp.508-513.

[4] K.Senthil Kumar and T. Kruppa Raj, "Effect of fuel injection timing and elevated intake air temperature on combustion and emission characteristics of dual fuel diesel engine", Procedia Engineering, Vol.64, pp.1191 – 1198, 2013.

[5] R.Sathish Kumar, K.Sureshkumar, and R. Velraj, "Combustion, performance and emission characteristics of an unmodified diesel engine fueled with Manilkara Zapota Methyl Ester and its diesel blends", Fuel Processing Technology, Vol.157, pp.108–115, 2017.

[6] M.Krishnamoorthi, and R.Malayalamurthi, "Availability analysis, performance, combustion and emission behaviour of bael oil diesel and diethyl ether

blends in a variable compression ratio diesel engine", Renewable Energy, Vol. 119, pp. 235-252, 2018.

[7] V. Perumal, M. Ilangkumaran, "Water emulsified hybrid pongamia biodiesel as a modified fuel for experimental analysis of performance, combustion and emission characteristics of a direct injection diesel engine", Renewal Energy, Vol.221, pp.623 – 631, 2018.

[8] S.Senthur Prabu, M.A.Asokan, S.Prathib, S. Ahmed and G. Puthean. "Effect of additives on combustion, performance and emission behaviour of pre heated palm oil/diesel blends in DI diesel engine", Renewable Energy, Vol.122, pp.196-205, 2018.

[9] T.Prakash, V. Edvin Geo, L. Jesu Martin and B.Nagalingam, "Effect of ternary blends of bio ethanol, diesel and castor oil on performance, emission and combustion in a CI engine", Renewable Energy, Vol.122, pp.301-309, 2018.

[10] H. El Haj Youssef, S. Fetni, C. Boubahri, R. Said, I. Lassoued, "An experimental study of Optimization of biodiesel synthesis form waste cooking oil and effect of the combustion duration on engine performance", International Journal of Renewable Energy Research, Vol.9(3), pp.542-550, 2019.

[11] M. Wei, S. Li, H. Xiao, and G. Guo, "Combustion, performance and pollutant emissions analysis using diesel/gasoline/iso-butanol blends in a diesel engine", Energy Conversion and Management, Vol.149, pp.381–391, 2017.

[12] A.J.Donkerbroek, M.D.Boot, C.C.M.Luijten, N.J. Dam. and., JJ. Meulen, "Flame lift-off length and soot production of oxygenated fuels in relation with ignition delay in a DI heavy-duty diesel engine", Combustion and Flame, Vol 158, pp.525–538, 2011.

[13] G. Vourliotakis, G. Skevis and M. A. Founti, "Some aspects of combustion chemistry of C1–C2 oxygenated fuels in low pressure premixed flames", Proceedings of the Combustion Institute, Vol 35, pp.437–445, 2015.

[14] Y.Tsutsumi, A.Iijima, and., K.Toshida, "Combustion characteristics during operation on DME and methane fuels", International Journal of Automotive Technology, Vol.10, No.6, pp.645-652, 2009.

[15] M.Pugazhvadivu, G. Sankaranarayanan, "Investigations on a Diesel Engine fuelled with biodiesel blends and diethyl ether as an additive", Indian Journal of Science and Technology, Vol.2, No.5, pp.31-35, 2009.

[16] N.R.Banapurmath, P.G.Tewari and R.S.Hosmat, "Performance and Emission Characteristics of a DI Compression Ignition Engine Operated on Honge, Jatropha and Sesame Oil Methyl Esters", Renewable Energy, Vol 33, pp.1982–1988, 2008.

[17] ZH.Zhang, R.Balasubramanian, "Influence of butanol addition to diesel–biodiesel blend on engine performance and particulate emissions of a stationary diesel engine", Applied Energy, Vol.119, pp.530–536, 2014.

[18] X. Han, Z.Yang, M. Wang, J. Tjong, and M. Zheng, "Clean combustion of n-butanol as a next generation biofuel for diesel engines", Applied Energy, Vol.198, pp.347–359, 2017.

[19] S. Najiha Badar, M. Mohammad, Z. Emdadi and., Z. Yaakob, "Algae and their growth requirements for

bioenergy: a review", Biofuels, DOI: 10.1080/17597269.2018.1472978, 2018.

[20] K.Vijayaraj, A.P.Sathiyagnanam, "Combustion characteristics of a DI diesel engine fuelled with blends of methyl ester of cotton seed oil", International Journal of Ambient Energy, DOI: 10.1080/01430750.2015.1023841, 2015.

[21] P.TamilSelvan, G.Nagarajan, "Combustion and emission characteristics of a diesel engine fuelled with biodiesel having varying palmitic acid, stearic acid and oleic acid in their fuel composition", International Journal of Oil, Gas and Coal Technology, Vol.8 No.3, pp.353-368, 2014.

[22] P. Patnaik, T. Abbasi and S. A. Abbasi "Prosopis (Prosopis juliflora): blessing and bane", Tropical Ecology, Vol.58 No.3, pp.455–483, 2017.

[23] S. Savariraj, T. Ganapathy and., C.G.Saravanan., "Performance and emission characteristics of diesel engine using high-viscous vegetable oil", International Journal of Ambient Energy, Vol. 33 No.4, pp.193-203, 2012.

[24] A. Anbarasu, A. Karthikeya, "Diesel engine performance and emission evaluation using Canola biodiesel emulsion fuel", Australian Journal of Mechanical Engineering, DOI: 10.1080/14484846.2015.1093222, 2016.

[25] K. Venkatesan, M. Senthil Kumar, "Performance and Emission Studies on a Diesel Engine using Bio Oil Obtained from Pyrolysis of Prosopis Juliflora as Fuel", Journal of Chemical and Pharmaceutical Sciences, Vol.7, pp.245-248, 2015.

[26] M.Rajeshwaran, K.Raja, P.Marimuthu and Duraimurugan alias Saravanan, "Biodiesel Production and Optimization from Prosopis Julifera Oil – A Three Step Method", International Journal of Advanced Engineering Technology, Vol.7 No.2, pp.214-224, 2016.

[27] M.R.Subbarayan, J.S.Senthil Kumaar, "A study of performance and emissions of Direct Injection diesel engine fuelled with cotton seed oil methyl ester and pumpkin seed oil methyl ester and its blends with diesel using Exhaust Gas Recirculation", Biofuels, Vol.6 No.3-4, pp.171-177, 2015.

[28] Y. Kutti Pochareddy, A. Krishna Ganeshram, H. Machgahe Pyarelal, S. Sridharan, A. Asokan, Gopinath Dhamodaran and P.Duraisamy, "Performance and emission characteristics of a stationary direct injection compression ignition engine fuelled with diethyl ether–sapote seed oil methyl ester–diesel blends", Biofuels, http://dx.doi.org/10.1080/17597269.2016.1225646, 2016.

[29] S.S.Hoseini, G.Najafi, B.Ghobadian, R.Mamat, M.T.Ebadi and., Talal Yosaf, "Novel environmentally friendly fuel: the effects of nanographene oxide additives on the performance and emission characteristics of diesel engines fuelled with Ailanthus altissima biodiesel", Renewable Energy, Vol 125, pp.283-294, 2018.

[30] I.Ahmed. EL-Seesy, Hamdy Hassana and., S. Ookawara, "Performance, combustion, and emission characteristics of a diesel engine fueled with Jatropha methyl ester and graphene oxide additives", Energy Conversion and Management, Vol 166, pp.674–686, 2018.

[31] AI.Seesy, H.Hassan and., S.Ookawara, "Effects of graphene nanoplatelet addition to jatropha Biodiesel-Diesel mixture on the performance and emission characteristics of a diesel engine", Energy, Vol.147, pp.1129–52, 2018.

[32] G.Najafi, "Diesel engine combustion characteristics using nano-particles in biodiesel diesel blends", Fuel, Vol.212, pp.668–78, 2018.

[33] H. Liu, J. Ma, F. Dong, Y. Yang, X. Liu, G. Ma, Z. Zhenga and M. Yao. "Experimental investigation of the effects of diesel fuel properties on combustion and emissions on a multi-cylinder heavy-duty diesel engine", Energy Conversion and Management, Vol 171, pp.1787–1800, 2018.

[34] Z. Zhang, E. Jiaqiang, Y. Deng, M. Hieu Pham, W. Zuo, Q. Peng and., Z. Yin, "Effects of fatty acid methyl esters proportion on combustion and emission characteristics of a biodiesel fuelled marine diesel engine", Energy Conversion and Management, Vol.159, pp.244–253, 2018.

[35] B. Li, Y.Li, H. Liu, F. Liu, Z. Wang, and J. Wang, "Combustion and emission characteristics of diesel engine fueled with biodiesel/PODE blends", Applied Energy, Vol 206, pp.425–431, 2017.

[36] S.Murugan, M.Ramaswamy, and., G.Nagarajan, "The use of tyre pyrolysis oil in diesel engines", Waste Management, Vol.28, pp. 2743–2749, 2008.

[37] S. Suresh, D. Sinha, and., S. Murugavelh, "Biodiesel production from waste cotton seed oil: engine performance and emission characteristics", Biofuels, DOI: 10.1080/17597269.2016.1192442, 2016.

[38] J.B.Heywood, Internal Combustion Engine Fundamentals, 2011 ed., McGraw-Hill Series, New Delhi, 2011, pp.539-553.

[39] V.Ganesan, Internal Combustion Engines, Tata Mc Graw-Hill Publishing Company Limited, New Delhi, Third Edition, 2011, ch .4.

[40] JI Ghojel, "Review of the development and applications of the Wiebe function: a tribute to the contribution of Ivan Wiebe to engine research", International Journal of Engine Research, Vol 11, pp.297–312, 2010.

[41] C. Vipavanich, S. Chuepeng and S. Skullong, "Heat release analysis and thermal efficiency of a single cylinder diesel dual fuel engine with gasoline port injection", Case Studies in Thermal Engineering, Vol 12, pp.143–148, 2018.

AWARENESS ON CLINICAL LITERACY AMONG GENERAL PUBLIC-AN EXPLORATIVE STUDY OF DIRECT OPINIONS OF PATIENTS IN URBAN AND RURAL OF VIJAYAWADA, ANDHRA PRADESH

K. V. B. GANESH, SUBBA RAYUDU THUNGA & G. TAVITI NAIDU

Assistant Professor, Department of MBA, KL Business School, KLEF Vaddeswaram, Guntur, India

Associate Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, India

Research Scholar, Indian Council of Social Science Research (Andhra University), Visakhapatnam., India

ABSTRACT

Literacy is different from illiteracy; where both are quite differentiate from clinical literacy that is what the researcher would like to focus with the help of the present study. The present study conducted on patients of urban and rural area hospitals on the basis of literacy levels. Both literate and illiterate patients in and around Vijayawada area are considered as the respondents in the study. Awareness on clinical terminology, Interest on clinical literacy improvements, are the variables in the study. The researcher constructed a scale based on awareness and interest the questionnaire has been developed and circulated among patients in both local and English language respectively. And for analysis SPSS software has been used.

KEYWORDS: *Clinical literacy, Clinical Issues & Clinical Terminology*

Original Article

1. INTRODUCTION

Clinical literacy is the state of a literacy, where one can understand or to provide knowledge on their or any others 'diseases / disorders and its control. Clinical literacy management is to create awareness among people on patients diseases/disorders and treatment.

In the present study the researcher focused on the awareness of clinical literacy on general literates and illiterates of urban and rural patients, whether they are good enough to know and understand about themselves and family members. Clinical literacy includes various aspects like diseases, disorders, first aid, diagnosis, medication, drug dosages, its reactions, medical terminology, and dietary precautions etc.

1.1. Research Gap:

Due to increased patient rush in hospitals, though technology upgraded the rate of deaths or recoveries not decreased, it is the need of the hour to know what is happening around us is a basic requirement. And we are observing, the Government also emphasize in recent days on clinical education among people. There are number of studies in healthcare issues, hospital management, but very limited research is available in this regard. Clinical literacy is also a new term in general so that the researcher would like to find out the significant impact among the public with the help of present study.

1.2. Statement of the Problem:

The present study reveals the public how it is helpful to every one's life and understands what impact on us.

2. OBJECTIVES OF THE STUDY:

- To examine the awareness levels among the patients towards clinical literacy.

- To find out the differences in the perceptions if any between urban and rural patients about Clinical literacy.

- To suggest suitable ways to improve clinical literacy levels in public.

2.1. Hypotheses of the Study:

- **H_01**: There is no significant difference in the perceptions among the patients on clinical literacy awareness.

- **H_11**: There is a significant difference in the perceptions among the patients on clinical literacy awareness.

- **H_02**: There is no significant difference in the perceptions between urban and rural patients about literacy on medical services.

- **H_12**: There is a significant difference in the perceptions between urban and rural patients about literacy on medical services.

- **H_03**: There is no significant difference in the perceptions between urban and rural patients about association with medical staff.

- **H_13**: There is a significant difference in the perceptions between urban and rural patients about association with medical staff.

3. RESEARCH METHODOLOGY:

The researcher constructed a sample frame of 2000 patients in 10 days, based on average visitors to the government hospitals in and around Vijayawada. The researcher has taken one urban and one rural hospital near Vijayawada area in A.P. Out of which 10 percent i.e., 200 respondents are selected as a sample on random basis. Around 100 respondents are daily population for both hospitals each, among them the researcher selected 10 respondents from each day from both urban and rural area hospitals.

3.1. Occupation Wise Classification among Patients:

Table 1 shows the Classification of the respondents based on occupation. It is observed that, out of a total of 200 respondents in both urban and rural of Vijayawada, 59 respondents are farmers; 72 respondents are employees and 69 respondents are self employed.

Table 1: Classification of the Respondents Based on Occupation

Occupation	Urban	Rural
Farmers	15	44
Employees	45	27
Self employed	40	29

3.2. Correlation:

Table 2 shows it is clear that in all occupations, almost perfect Negative correlation (-0.99) is observed between Urban and rural people with respect to Occupation.

Table 2: Correlation

Occupation	Urban	Rural
Urban	1	
Rural	-0.99883	1

3.3. Qualification Wise Classification of the Respondents:

Table 3 shows the Classification of the respondents based on qualification. It is observed that, out of a total of 200 respondents in both urban and rural of vijayawada, 60 respondents are studied up to SSC; 64 respondents are having qualification up to UG, 55 respondents are having qualification up to PG, and only 10 respondents are above PG.

Table 3: Classification of the Respondents Based on Qualification

Qualification of Respondent	Urban	Rural
Upto SSC	20	40
Upto UG	37	27
Upto PG	33	23
Above PG	10	10

3.4. Correlation:

Table 4 shows it is clear that in different qualifications of the respondents a very low positive correlation (0.34) is observed between Urban and rural people with respect their qualification.

Table 4: Correlation

	Urban	Rural
Urban	1	
Rural	0.344978	1

3.5. Income Level of the Patients

Table 5 shows the Classification of the respondents based on the income levels. It is observed that, out of a total of 200 respondents in both urban and rural of Vijayawada, 21 respondents are having less than 1 lakh of income; 33 respondents are having an income of 1 lakh to 2 lakhs, 93 respondents are having an income levels from 2 lakhs to 5 lakhs, and 53 respondents are having above 5 lakhs of income.

Table 5: Classification of the Respondents Based on the Income Levels

Income Levels	Urban	Rural
Less than 100000	15	6
100000200000	15	18
200000500000	30	63
above 500000	40	13

3.6. Correlation:

Table 6 it is clear that in different income levels of the respondents a very low positive correlation (0.28) is observed between Urban and rural people with respect their income levels.

Table 7 shows it is observed that 138 respondents out of a sample of 200 are less aware about Disease/Disorder and its symptoms; 132 out of 200 are less aware about First aid/diagnosis requirements; 112 and 104 respondents out of a sample of 200 are not aware about Medication, dosages and their reactions and Dietary precautions.

Table 6: Correlation

	Urban	Rural
Urban	1	
Rural	0.284747	1

Table 7: Level of Awareness on Various Medical Issues among the Respondents

Statements	Level of awareness					Total
	Very High	High	Normal	Low	Very Low	
Disease / Disorder and its symptoms	10	24	28	90	48	200
First aid / diagnosis requirements	12	32	24	88	44	200
Medication, dosages and their reactions	20	36	20	112	12	200
Dietary precautions	28	40	16	104	12	200
Total	**70**	**132**	**88**	**394**	**116**	**800**

3.7. Chi-Square Tests

Table 8 shows the chi-square results about the awareness levels on diseases, diet and medication. The chi-square value is 31.813 with p-value 0.001. The relation between the statement of awareness and the level of awareness is significant. That is the awareness about various statements differs significantly.

Table 9 shows the comparison of awareness levels about clinical literacy in both urban and rural respondents. Out of a sample of 214 urban respondents majority (106) respondents felt low awareness levels on clinical literacy. Similarly, Out of a sample of 186 rural respondents majority (91) respondents felt low awareness levels on clinical literacy.

Table 8

	Value	Df	A symp. Sig. (2-Sided)
Pearson Chi-Square	31.813[a]	12	.001
Likelihood Ratio	33.094	12	.001
Linear-by-Linear Association	13.627	1	.000
N of Valid Cases	800		

a. 0 cells (0 %) have expected count less than 5. The minimum expected count is 8.75.

Table 9: Level of Awareness among Urban and Rural Respondents

Area	Level of awareness					Total
	Very High	High	Normal	Low	Very Low	
Urban	21	35	21	106	31	214
Rural	14	31	23	91	27	186
Total	35	66	44	197	58	400

3.8. Chi-Square Tests

Table 10 shows the chi-square results about the awareness levels on diseases, diet and medication in both urban and rural is shown to know the association. The chi-square value is 1.197 with p-value 0.879. The relation between the statement of awareness and the area of the respondent is not significant. That is the awareness about various statements did not influenced by the area of the respondents. Hence Null hypothesis-1 is accepted

Table 11 it is observed that 134 respondents out of a sample of 200 are perceived that they do not have liberty in choosing the second opinion with another doctor also in sparing time by the doctors in completing the information about

patient condition. Similarly, the respondents are equally perceived about sharing information before and after the treatment. Majority of the respondents (110 out of a sample of 200) are perceived disagreement with the statement "forcing that doctor for diagnosis, pharmacy and surgeries".

Table 12 the comparison of awareness levels on liberty in medical services among the respondents in Urban and Rural Patients. Out of the responses of 520, urban respondents majority (322) respondents felt disagreement on liberty in choosing medical services. Similarly, Out of the responses of 480 rural respondents majority (294) respondents felt disagreement on liberty in choosing medical services.

Table 13 the Descriptive statistics on liberty in medical services among the respondents. The mean of the perceptions of urban patients on liberty in medical services among is 2.6774 with a standard deviation of 0.80991. The mean of the perceptions of rural patients on liberty in medical services among is 2.3602 with a standard deviation of 0.3602.

Table 14 the significant differences of the perceptions of both urban and rural patients are analyzed and shown with t-test. The data is satisfied with normality. So, parametric test (t-test) is suitable to apply. The t-value in comparing the perceptions of both Urban and Rural patients is 1.284 with p-value 0.20. Here, the p-value is more than to 0.05.Therefore, it is not significant. Therefore, it is concluded that the perceptions of both urban and rural patients are same about the liberty in medical services. So, Null hypothesis-2 is accepted.

Table 15 Level of perception on various medical aspects among the respondents. It is observed that 140 respondents out of a sample of 200 are perceived that the conduction of more medical camps is required. 140 respondents out of a sample of 200 are agreeing that the Counseling implementation is required / mandatory. 160 respondents out of a sample of 200 are agreeing that the government emphasis/participation should be more. Majority of (170) respondents out of a sample of 200 are agreeing that the knowledge on medical issues is mandatory in primary schooling for everyone.

Table 17 the comparison of awareness levels on various medical aspects among the respondents in Urban and Rural Patients. Out of the responses of 378, urban respondents majority (282) respondents felt agreement on various medical services which are mentioned in the above table. Similarly, Out of the responses of 422responses from rural respondents majority (328) respondents felt agreement on various medical services which are mentioned in the above table.

Table 18 the Descriptive statistics on comparison of awareness levels on various medical aspects among the respondents in Urban and Rural Patients. The mean of the perceptions of Urban patients on medical aspects is 4.132 with a standard deviation of 0.452. The mean of the perceptions of Rural patients on various medical aspects medical services is 4.011 with a standard deviation of 0.623.

Table 19 the significant differences of the perceptions of both urban and rural patients are analyzed and shown with t-test. The data is satisfied with normality. So, parametric test (t-test) is suitable to apply. The t-value in comparing the perceptions of both urban and rural patients is -2.341 with p-value 0.120. Here, the p-value is more than to 0.05.Therefore, it is not significant. Therefore, it is concluded that the perceptions of both urban and rural patients are same about various medical aspects.

Table 20 shows Level of perception on association with various medical staff among the respondents is shown in the above table. It is observed that 120 respondents out of a sample of 200 are perceived that they do not have good association with doctors. 110 respondents out of a sample of 200 are perceived that they do not have good association with Radiographer/ Diagnostician. 100 respondents out of a sample of 200 are perceived that they do have good association with

Pharmacist. 106 respondents out of a sample of 200 are perceived that they do not have good association with Counselors but 100 respondents out of a sample of 200 are perceived that they do have good association with Nurses and caretakers.

Table 21 the comparison of Level of agreement on association with different medical staff among the respondents in Urban and Rural respondents is shown in the above table. Out of the responses of 484, urban respondent's majority (219) respondents felt they do have association with different medical staff which is mentioned in the above table. Similarly, Out of the responses of 516 responses from rural respondents majority (274) respondents felt disagreement on association with medical staff which is mentioned.

Table 22 the Descriptive statistics on comparison of Level of agreement on association with different medical staff among the respondents in Urban and Rural areas. The mean of the perceptions of Urban patients on association with medical staff is 3.983 with a standard deviation of 0.613. The mean of the perceptions of Rural patients on association with medical staff is 2.642 with a standard deviation of 0.761.

Table 23 the significant differences of the perceptions of both urban and rural patients are analyzed about the association with medical staff with t-test. The data is satisfied with normality. So, parametric test (t-test) is suitable to apply. The t-value in comparing the perceptions of both urban and rural patients regarding the association with medical staff is -2.380 with p-value 0.018. Here, the p-value is less than to 0.05.Therefore, it is significant. Therefore, it is concluded that the perceptions of both urban and rural patients are different about association with medical staff. So, Null hypothesis-3 is failed to accept.

Table 10

	Value	Df	Asymp. Sig. (2-Sided)
Pearson Chi-Square	1.197[a]	4	.879
Likelihood Ratio	1.201	4	.878
Linear-by-Linear Association	.098	1	.754
N of Valid Cases	400		

a. 0 cells (0 %) have expected count less than 5. The minimum expected count is 16.28.

Table 11: Level of Awareness on Liberty in Medical Services among the Respondents

Statement	Level of Agreement					Total
	SA	A	N	D	SD	
Liberty in choosing hospital / doctor for second opinion	24	30	12	84	50	200
Doctors spare time for complete information about condition	26	30	10	82	52	200
Doctors allow you for sharing information before and after the treatment	40	32	16	72	40	200
Forcing you for diagnosis, pharmacy, surgeries	40	32	18	70	40	200
Taking decisions about medication, dietary advices.	30	40	4	50	76	200
Total	**160**	**164**	**60**	**358**	**258**	**1000**

Table 12: Level of Awareness on Liberty in Medical Services among the Respondents in Urban and Rural Patients

Area	Level of Agreement					Total
	SA	A	N	D	SD	
Urban	84	82	32	180	142	520
Rural	76	82	28	178	116	480
Total	**160**	**164**	**60**	**358**	**258**	**1000**

Table 13: Significance Testing by t-test

Area	N	Mean	Std. Deviation	Std. Error Mean
Urban	200	2.6774	0.80991	.15959
Rural	200	2.3602	0.92486	.19039
Total	**400**			

Table 14: Independent Samples Test

		Levine's Test for Equality of Variances		t-test for Equality of Means		
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
Liberty in medical services among the respondents	Equal variances assumed	.099	0.753	1.284	544	0.200
	Equal variances not assumed			1.277	495.29	0.202

Table 15: Level of Perception on Various Medical Aspects among the Respondents

Statement	Level of Agreement					Total
	SA	**A**	**N**	**D**	**SD**	
Conduction of more medical camps is required.	100	40	40	8	12	200
Counseling implementation is required / mandatory	90	50	24	20	16	200
Government emphasis/participation should be more	100	60	22	8	10	200
Mandatory in primary schooling for everyone	120	50	20	6	4	200
Total	**410**	**200**	**106**	**42**	**42**	**800**

Table 16: Level of Agreement on Various Medical Aspects among the Respondents in Urban and Rural Respondents

Area	Level of Agreement					Total
	SA	**A**	**N**	**D**	**SD**	
Urban	182	100	54	20	22	378
Rural	228	100	52	22	20	422
Total	**410**	**200**	**106**	**42**	**42**	**800**

Table 18: Significance Testing by t-test

Area	N	Mean	Std. Deviation	Std. Error Mean
Urban	200	4.132	0.452	0.112
Rural	200	4.011	0.623	0.311
Total	**400**			

Table 19: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**
Awareness levels on various medical aspects	Equal variances assumed	4.134	0.073	-2.341	544	0.120
	Equal variances not assumed			-2.328	489.22	0.110

Table 20: Level of Perception on Association with Different Medical Staff

Statement	Level of Agreement	Total

	SA	A	N	D	SD	
Association with doctors	20	40	20	40	80	200
Association with Radiographer / Diagnostician	30	30	30	30	80	200
Association with Pharmacist.	50	50	40	40	20	200
Association with Nurses and caretakers	50	50	40	40	20	200
Association with Counselors	22	22	50	54	52	200
Total	**172**	**192**	**180**	**204**	**252**	**1000**

Table 21: Level of Agreement on Association with Different Medical Staff among the Respondents in Urban and Rural Respondents

Area	Level of Agreement					Total
	SA	A	N	D	SD	
Urban	98	112	92	94	88	484
Rural	74	80	88	110	164	516
Total	**172**	**192**	**180**	**204**	**252**	**1000**

Table 22: Significance Testing by t-test

Area	N	Mean	Std. Deviation	Std. Error Mean
Urban	200	3.983	0.613	0.132
Rural	200	2.642	0.761	0.112
Total	**400**			

Table 23: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	Df	Sig. (2-tailed)
association with different medical staff among the respondents in Urban and Rural	Equal variances assumed	.040	.842	-2.380	552	.018 **
	Equal variances not assumed			-2.371	497.36	.018

4. DISCUSSIONS

From the study, it is observed that, the farmers are low in urban area, and employees are low in rural area. Highest qualification is UG in urban area, where as SSC is highest in rural area. It is clear that the awareness about various statements differs significant among patients, but not significant between urban and rural patients. The awareness about various statements did not influenced by the area of respondents. Majority of the respondents felt low awareness levels on clinical literacy. The respondents are equally perceived about sharing information before and after the treatment. Majority of the respondents are perceived disagreement with the statement "forcing that doctor for diagnosis, pharmacy and surgeries".

According to the descriptive statistics on liberty in medical services among the respondents the mean of the perceptions of urban patients on liberty in medical services is 2.6774 with a standard deviation of 0.80991. The mean of the perceptions of rural patients on liberty in medical services among is 2.3602 with a standard deviation of 0.3602. So, both urban and rural patients are almost equally perceived about liberty in medical services.

The mean of the perceptions of urban patients on medical aspects is 4.132 with a standard deviation of 0.452. The mean of the perceptions of rural patients on various medical aspects 4.011 with a standard deviation of 0.623. Both urban and rural patients are almost equally perceived about liberty in medical aspects such as Conduction of more medical

camps, Counseling implementation, Government emphasis/participation and Mandatory in primary schooling about medical knowledge.

Regarding the comparison of Level of agreement on association with different medical staff among the respondents, out of the responses of 484, urban respondent's majority (219) respondents felt they do have association with different medical staff. Similarly, Out of the responses of 516 responses from rural respondents majority (274) respondents felt disagreement on association with medical staff which are mentioned in the above table.The mean of the perceptions of Urban patients on association with medical staff is 3.983 with a standard deviation of 0.613. The mean of the perceptions of rural patients on association with medical staff is 2.642 with a standard deviation of 0.761. Therefore, it is observed that urban patients are having better association with medical staff than rural patients. \

5. SUGGESTIONS

- It is suggested that Clinical literacy practices are necessary for irrespective of literacy levels, and area.

- It is suggested that governing bodies, and educational institutions take mandatory steps to create minimum awareness on Clinical literacy among public.

- It is also suggested that all clinical related members, associations extend their association with patients, as well as general public to improve Clinical literacy awareness.

- It is also necessary to provide timely information by using technology.

6. CONCLUSIONS

Literacy is different from illiteracy; where both are quite different from clinical literacy. It is not based on education, and area. It is a conscious awareness among people where certain efforts are required to have Clinical Literacy. Clinical literacy management is a management concept how to improve literacy levels towards Clinical area among public.

REFERENCES

1. *Kumar, Navneet, TanuMidha, and Yashwant Kumar Rao. "Determinants of Epilepsy in Children and Adolescents (6-19 Years) in a Tertiary Care Hospital in Kanpur." International Journal of Medicine and Pharmaceutical Science (IJMPS) 8.1 (2018): 5358.*

2. *Debbarma, Shibajee, et al. "Epidemiology of Accident Cases Attending a Tertiary Care Hospital in Kanpur." International Journal of Medicine and Pharmaceutical Sciences (IJMPS) 6.1 (2016): 125130.*

3. *Suresh, Suja, S. ARUNA, and G. VALLI. "Prevalence and Health Seeking Behavior among Specific Women Group on Reproductive Tract Infection in Rural Community Area of Kancheepuram District, Tamil Nadu: A Cross Sectional Study Report." International Journal of Medicine and Pharmaceutical Sciences (IJMPS) 7.4 (2017): 1-6.*

4. *SINGH, NARINDER. "EMOTIONAL DISTURBANCES AND DISCRIMINATION EXPERIENCED BY DYSLEXIC CHILDREN."International Journal of Humanities and Social Sciences (IJHSS) ISSN(P): 2319- 393X; ISSN(E): 2319-3948 Vol. 4, Issue 6, Oct -Nov 2015, 4152.*

A Hybrid Approach on Metamaterial-Loaded Fractal Antenna Design

D. Prabhakar [1], C. H. Rajendra Babu [2], V. Adinarayana [3], and V. V. K. D. V. Prasad [1]

[1] Department of ECE, Gudlavalleru Engineering College (A)
Seshadri Rao Knowledge Village, Gudlavalleru, Andhra Pradesh, India
prabhakar.dudla@gmail.com, varaprasadvvkd@gmail.com

[2] Department of CSE, Andhra Layola Institute of Engineering and Technology, Andhra Pradesh, India
chikkalarajendra@gmail.com

[3] Department of ECE, Avanthi Institute of Engineering &Technology (AIET), Andhra Pradesh, India
joy.adi2011@gmail.com

Abstract – The paper provides the interoperable hybrid Grasshopper–Grey Wolf optimization (GHGWO) of the Square Split-Ring Resonator (SRR) metamaterial unit cell. This paper discusses the complex phase strategies of the electric and magnetic interplay of the charged microstrip line of the split ring resonator (SRR). Optimized unit of metamaterial cells for their bandwidth enhancement is packed into a new square fractal antenna. In the interim period of dual band efficiency, a new design is introduced for a microstrip line-feeding square fractal antenna with a faulty ground composition. In the second stage, a quasi-static SRR model is being used to streamline its structural parameters in an effort to reinforce the bandwidth so that optimized composition resonates at the required intensity area. In the GHGWO hybrid algorithm, SRR unit cell size limitations should be optimized and the convergence actions of the algorithm improved. Certain evolutions termed modified hybrid BF-PSO classical BFO, chaos PSO and IWO are being tested for efficiency of the Hybrid GHGWO algorithm. In the final stage, optimized SRR unit cells are stacked into a square fractal antenna that provides bandwidth output suited to wireless usages with upper and lower band. The prototype square fractal antenna without and with SRR unit cells is efficiently evaluated by trial results.

Index Terms – Grasshopper–Grey Wolf Optimisation (GHGWO), metamaterial unit cell, quasi-static SRR model and microstrip line, Split-Ring Resonator (SRR).

I. INTRODUCTION

An antenna is known as a broadband unless its impendence or configuration varies considerably over about one octave or more [5]. In contemporary wireless transmission networks the miniaturization of antenna layout focused on fractal geometry is of significant importance [1].

In this study, we are proposing a new model of a three-step square fractal antenna. The bandwidth of the planned fractal antenna is increased by partial ground plane on the reverse side of a substratum. Secondly, we prioritize bandwidth in the built fractal antenna with the use of MTM unit cells with optimized split-ring resonator. A hybrid Grass Hopper [2], and grey wolf optimization [2] (GHGWO) algorithm are used to optimize structural variables in split ring resonant unit cells. However, a disadvantage of these techniques is the extensive amount of CPU times utilized in determining the numerical solution compared to the fully explicit methods for the same selection of values. Thus if we were to write them in matrix form, the coefficient matrix would be penta diagonal. The rest of paper is structured as follows: Section II discusses the brief review of hybrid GHGWO algorithm is proposed, Section III comprises of experimental results, and Section IV gives a brief conclusion.

Bilal Babayigit et al. [3] developed a Taguchi Method (TM) to model a non-side lobe level deletion (SLL) optimization for the CAA (non-uniform circular antenna array). TM, a rigorous design strategy, incorporated the numerical nature of experiments as a signal to noise ratio and orthogonal array devices. Such methods decrease the design parameters rather than complete factor evaluation, thus increased the rate of convergence and produced more precise solutions. TM's high output in achieving reduced SLLs was demonstrated by experimental results.

Although the methods mentioned above often focus on the problem of the fractal antenna design more effectively for various kinds of problems, there exist some obvious shortages when compared with other algorithms.

II. PROPOSED METHODOLOGY

A. Fractal antenna functionality

An antenna that utilizes fractal and self-similar layout to improve the perimeter (internal and external) of the equipment that can send data or obtain electromagnetic radiation inside a particular surface area or velocity may be outlined as a fractal antenna. Up to the third cycle, the process is continued, resulting in new fractal geometry as shown in Fig. 1. Two unit cells (MTM) of the metamaterial are placed on both sides of the feed line above the support to increase the bandwidth of the designed antenna for broadband enhancement [4].

Base Iteration

1st Iteration

2nd Iteration
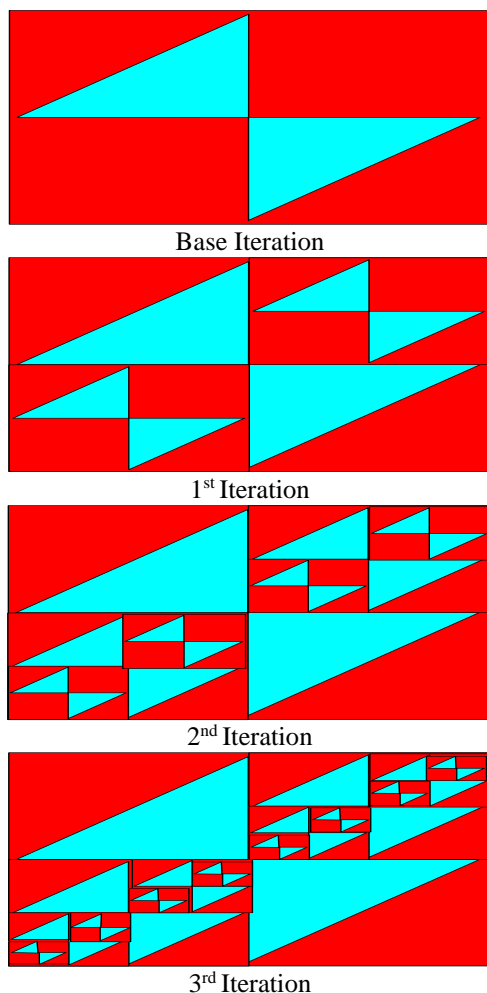
3rd Iteration

Fig. 1. Proposed square fractal geometry with different iterations (0th (base iteration), 1st, 2nd and 3rd).

The model for the proposed fractal antenna is shown in Fig. 2 (a), while Fig. 2 (b) portrays the partial ground layer on the backside of substrate.

(a)

(b)
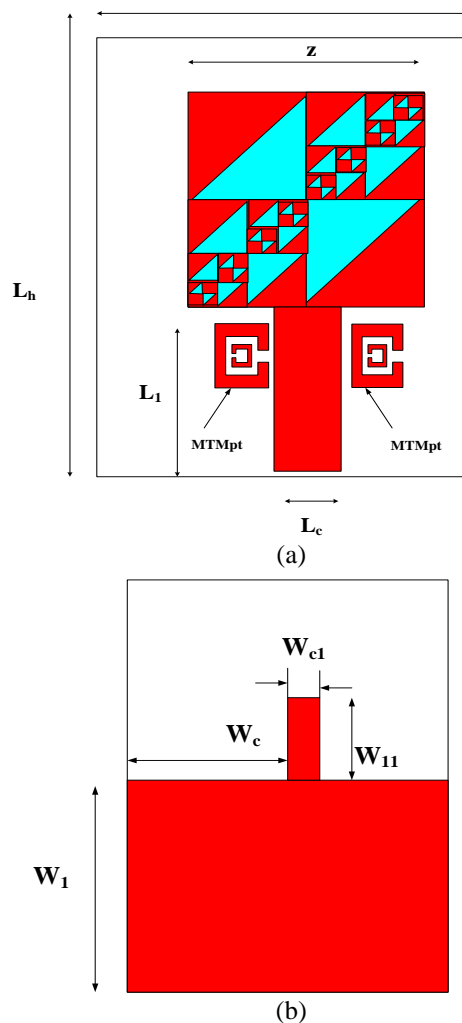
Fig. 2. (a) Top view of optimized fractal antenna. (b) Bottom view of optimized fractal antenna.

B. Hybridizing GHGWO

Hybridizing Grasshopper (GH) with Grey Wolf Optimization (GWO) to counteract early convergence and long computation time, entangled in large space with local minimums.

The computational modelling used to precisely evaluate the swarming activities of grasshoppers is shown as defines:

$$A_s = C_s + D_s + E_s, \qquad (1)$$

where, A_s Dictates the position of the sth grasshopper, C_s is the social interaction, D_s is the gravity force and E_s defines the wind advection.

To provide random behaviour, the equation can be written as $A_s = rd_1C_s + rd_2D_s + rd_3E_s$, where rd_1, rd_2 and rd_3 are random numbers in [0, 1]:

$$C_s = \sum_{\substack{v=1 \\ v \neq 1}}^{p} g(e_{sv})e_{sv}, \qquad (2)$$

where, e_{sv} is the distance between sth and the vth grasshopper, computed as $e_{sv} = |d_1 - d_2|$, g is a function to state the strength of social forces, as shown in Eq. (3), and $e_{sv} = (d_1 - d_2)/e_{sv}$ is a unit vector from the sth grasshopper to the vth grasshopper.

The g function, which defines the social forces, is calculated as follows:

$$g(rd) = Pe^{-rd/k} - e^{-rd}, \qquad (3)$$

where, P denotes the intensity of attraction and k is the length scale. The shape of the function g have D component and is computed as:

$$D_s = -qy_q, \qquad (4)$$

where, q is the gravitational constant and y_q shows a unity vector towards the centre of earth.

The E component is computed as follows:

$$E_s = kh_b, \qquad (5)$$

where, k is a constant drift and h_b is a unity vector in wind direction.

The first component of the Eq. (6) will apparently elucidate the location of the present grasshoppers concerning other grasshoppers:

$$P_x^h = z\left(\sum_{\substack{y=1 \\ y \neq 1}}^{p} z\frac{u_h - l_h}{2}w\left(\left|k_y^h - k_x^h\right|\right)\frac{k_y - k_x}{h_{xy}}\right) + Q_h. \qquad (6)$$

In Eq. (6), the first x from the left has the same weight as inertial (w) in GH. It minimizes grasshopper's movements throughout the goal. Exploration and exploitation of the whole prey balances the parameter. The second x decreases the attraction zone, comfort zone, and repulsion zone between grasshoppers. By using the element $z\frac{u_h - l_h}{2}w\left(\left|k_y - k_x\right|\right)$, $z\frac{u_h - l_h}{2}$ linearly diminishes the space that the grasshoppers should explore and exploit. The element $w\left(\left|k_y - k_x\right|\right)$ implies if a grasshopper should be repelled from (exploration) or attracted to (exploitation) the target. The z internal contributes to a decrease of the repulsion or attraction between grasshoppers proportionally to the number of iterations, and the z external decreases the search covers around the target with the rise of the iteration count. In short, Eq. (6) first expression, the sum takes into account the role of other grasshoppers and applies the fragility of the grasshopper's relationship [6,7]. The second term Q_h, facilitates their tendency to travel towards the food source. The parameter h also facilitates the change in momentum of grasshoppers that evaluate and subsequently consume the source of food. The coefficient c minimizes the comfort space in proportion to the number of iterations and computed as defines:

$$h = h\max - a\frac{h\max - h\min}{A}, \qquad (7)$$

where, $h$max is the maximum value, $h$min is the minimum value, a indicates the current iteration, and A is the maximum number of iterations.

In GHGWO, a search medium upgrades its position by using alpha and beta as shown in Eq. (8):

$$P(t+1) = P + f1*rand*((P_1 - P) + (P_2 - P))/2. \qquad (8)$$

A further mural for the upgrade of the alpha and beta direction is not upgraded by all people of the population, but by alpha only in the GHGWO proposed to maintain their workforce homogeneity. The proposed algorithm acts as a declining strategy to avoid the local optimum:

$$P(t+1) = P + f1*rand*(P_1 - P). \qquad (9)$$

Chaos is known for non-linear probabilistic systems as a computational pseudorandom phenomenon. One-dimensional pseudo-invertible maps can produce chaotic motion. This paper uses a well-known chaotic map called a logistic map that depends sensibly on its initial condition. The logistic map is depicted as:

$$p_{t+1} = \mu \cdot p_t(1 - p_t), \qquad (10)$$

where, p_t is a variable, and μ is usually set to four, thus for any p_t located in [0, 1], the equation can generate a deterministic chaotic sequences recursively.

A chaotic search strategy was formulated subject to the logistic map. Chaotic search techniques can be interpreted as:

$$lp_t^{q+1} = \mu \cdot lp_t^q(1 - lp_t^q), \qquad (11)$$

where, p_t^q represents the chaotic variable and q denotes the iteration number.

C. Split-ring resonator MTM cell configuration

Two concentric conductor circles with divisions in direction opposite to one another comprise of a square split-ring resonator. The magnitudes are much lower than the operational wavelength of these metallic resonant additions and thus, quasi-static theory can be very well implemented in predicting its electromagnetic attitudes using the appropriate RLC resonant model. The integration of SRR with the quasi-static electric system counterpart is shown in Fig. 3 (a) and Fig. 3 (b) represents the equivalent circuit model. The capacitance between the two conductor rings (G12) of the resulting current and voltage distribution is in series in the first half of SRR with a capacitance in the second half of the circle. It is presumed that rings of wavelength "wd" and split length "sl" are the same in both SRR rings for the derivation of the corresponding inductance A_d and capacitance B_d. The SRR framework shall be etched

with a thickness of 1.575 mm on a FR4 epoxy substratum. The inductance interpretation A_d is specified as:

$$A_d = \frac{\mu_0}{2} \frac{h_{avg}}{4} 4.86 \left[In\left(\frac{0.98}{\rho}\right) + 1.84\rho \right], \quad (12)$$

where, μ_0 is free-space permeability and h_{avg} is the average strip length of both rings, computed as defies:

$$h_{avg} = 4[rl - (wd + sl)], \quad (13)$$

Rl is the length of outer ring, *wd* is the width of each ring and *sl* is the separation between both rings.

'ρ' being the filling ratio is given as below:

$$\rho = \frac{wd + sl}{[rl - wd + sl]}. \quad (14)$$

The expression for effective capacitance 'B_d' is computed as:

$$B_d = \frac{B_{12}}{4} = \left[rl - \frac{(wd + sl)}{2} \right] B_0, \quad (15)$$

where, 'B_0' is the per-unit length capacitance between two conductor rings in the presence of dielectric substrate of height '*ht*' and dielectric constant 'ε_a', presented as follows:

$$B_0 = \varepsilon_0 \varepsilon_b^t \frac{H(\sqrt{1 - m^2})}{H(m)}. \quad (16)$$

Here, ε_0 is free-space permittivity and H is the complete elliptic integral of first type:

$$m = \frac{sl}{sl + wd}. \quad (17)$$

The ε_b^t, effective relative permittivity, of dielectric substrate is given as:

$$\varepsilon_b^t = 1 + \frac{2}{\pi} arctg\left[\frac{ht}{2\pi(wd + sl)} \right](\varepsilon_t - 1). \quad (18)$$

The resonant intensity for the RLC models is generated by A_d and B_d (as in Eq. (19)). This is additionally based on geometrical parameters of SRR, i.e., '*rl*' outer ring length, '*wd*' ring width and '*sl*' separation of both rings:

$$fq_t = \frac{1}{2\pi\sqrt{A_d B_d}}. \quad (19)$$

The goal is to optimize SRR layout so that the optimized unit cell resonates at an appropriate resonance frequency by tuning its geometric parameters (*rl*, *wd*, *sl*). Given this goal, the cost function is derived as observes for optimization as:

$$fq_{ct} = fq_{dr} - fq_{cr}. \quad (20)$$

The ideal frequency of resonance is '*fq_{dr}*' and the resonant frequency of '*fq_{cr}*' is determined using the RLC method. Resonant intensity fq_t and resonant frequency fq_{cr} are

related to the built fractal antenna is designed to simulate and observationally tested without metamaterial cells in order to acquire the double band output at 3.68 GHz. When evaluating the data, the signal transmission is interrupted at a 4.4 GHz narrow band which makes the intensity band inoperable.
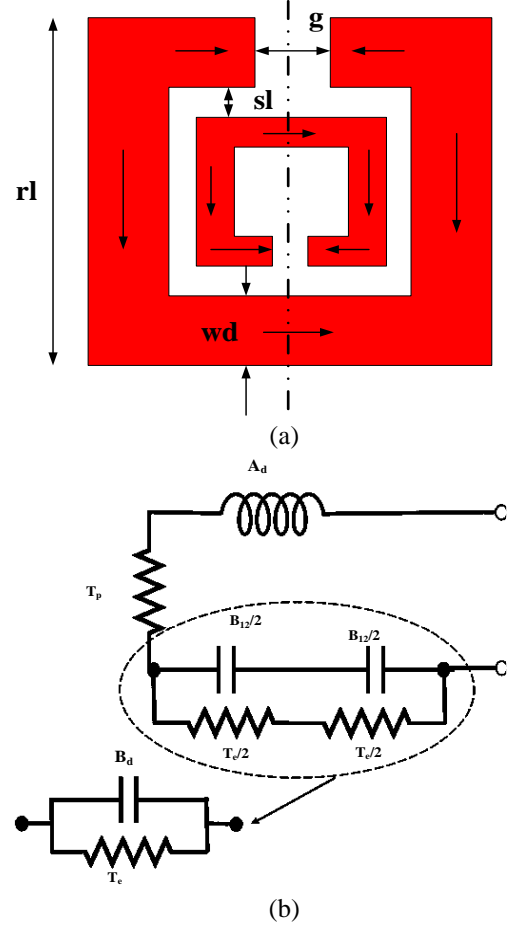

(a)

(b)

Fig. 3. (a) Structural dimensions of split-ring resonator. (b) Its quasi-debilitated frequency range into usable band, the desired static equivalent circuit model.

D. Selection of parameters for optimization algorithms

A wide selection of parameter settings associated with the specific optimization algorithm strongly influences the performance of optimization. For proposed hybrid GHGWO, A_s Dictates the position of the grasshopper, C_s is the social interaction, D_s is the gravity force and E_s defines the wind advection.

For original BFO techniques and hybrid BF-PSO, highest possible chemical count 'N_c', reproductive count 'N_{re}' and removal and neutralization count 'N_{ed}' are perceived to be 50, 4 and 4, respectively.

III. EXPERIMENTAL RESULTS

The fitness chart is shown in Fig. 4, the convergence graph. As shown in the graph, the GHGWO, BF-PSO output is close to that of chaos PSO. Nonetheless, the conversion rate is slow compared to other algorithms, while the IWO-classical BFO is compatible with the peak iteration termination requirements.
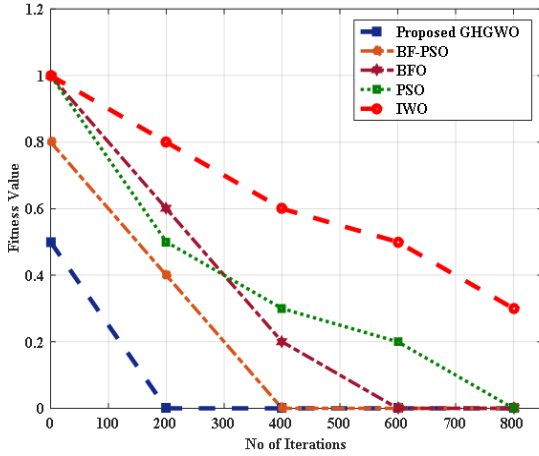

Fig. 4. Convergence plot for proposed GHGWO, modified BF-PSO, classical BFO, PSO and IWO algorithms.

In Table 1 the proposed GHGWO algorithm is obviously efficient in comparison with other algorithms. In this optimizing task, the mean value and standard deviation achieved in the GHGWO algorithm is better than in other algorithms [8, 9]. PSO and modified BF-PSO results are also identical to the GHGWO algorithm:

$$j = \pm \sqrt{\frac{(1+Q_{11})^2 - Q_{21}^2}{(1-Q_{11})^2 - Q_{21}^2}}, \qquad (21)$$

$$c^{ik_0 b} = \frac{Q_{21}}{1 - Q_{11}\frac{j-1}{j+1}}, \qquad (22)$$

$$p = \frac{1}{r_0 b}\left[\left\{\left[In\left(c^{ik_0 b}\right)\right]' + 2w\pi\right\} - s\left[In\left(c^{ik_0 b}\right)\right]\right], \quad (23)$$

where, $\left[In\left(c^{ik_0 b}\right)\right]$ represents imaginary components, and

$\left[In\left(c^{ik_0 b}\right)\right]'$ represents real components of complex number Q_{11} and Q_{21} are derived correspondingly, p and j represent both refractive index and product impedance, r_0 for wave events in free room shows wave number, b for peak cell length and w for periodical functions typical of sinusoidal structure. The cell of the MTM unit has a homogenous effective index and impedance, because the optimized size of the external ring (rl) is $\frac{\lambda}{12}$ for the optimal resonant frequency of 4.4 GHz. It makes the simple branch ($w = 0$) to be used for continuous refractive index. Active permeability and permeability are extracted from the corresponding refractive index and impedance:

$$\varepsilon = \frac{p}{j}, \qquad (24)$$

$$\mu = pj. \qquad (25)$$

Figures 5 (a), (b) applies to a Q-parameter (Q11 and Q21) magnitude and stage Chart derived from HFSS simulation of optimized SRR design. The real and imaginary portions of derived complex permeability and permittivity are shown in figure 5c d, accordingly. It's evident from the Fig. 5 (c), (d), that in frequency ranges from 3.9 up to 4.5 GHz both permittivity and permeability are negative and hence have dual-negative metamaterial properties in target frequency range. Therefore, the framework used to forecast costs is efficiently using a quasi-static analogous model.

In Fig. 6 displays retarded loss functionality, reflecting an increase of the bandwidth in the newly designed fractal antenna after charging optimized SRR unit cells. From the figure, the fractal antenna contributes to dual-band output at 3.68 GHz and 4.72 GHz without metamaterial unit cells. In the frequency range between 4.2 and 4.5 GHz the signal transmission is limited, so this band felt the impact.

Figure 7 contrasts simulated and measured coefficient outcomes with MTM unit cells, respectively for modelled fractal antenna without charging.

The data are collected from the bench top vector network analyzer with a frequency between 10MHz and 20GHz.

Table 1: Comparative performance of proposed GHGWO algorithm with various methods

| Criteria	Proposed GHGWO	Modified BF-PSO	Classical BFO	PSO	IWO
Best solution	0.000001	0.000002	0.000005	0.000002	0.00003
Mean solution	0.054213	0.528061	0.492478	0.517842	0.440051
Worst solution	0.691249	0.741507	0.870005	0.782456	0.880102
Standard deviation	0.354328	0.381412	0.454483	0.418753	0.463854
Average time(T)	4.018	4.546	9.411	4.587	11.151

For optimized antennas loaded with SRR, Fig. 8 shows simulated and measured VSWR performance.

VSWR is an important parameter that indicates a signal feed location corresponding impedance.
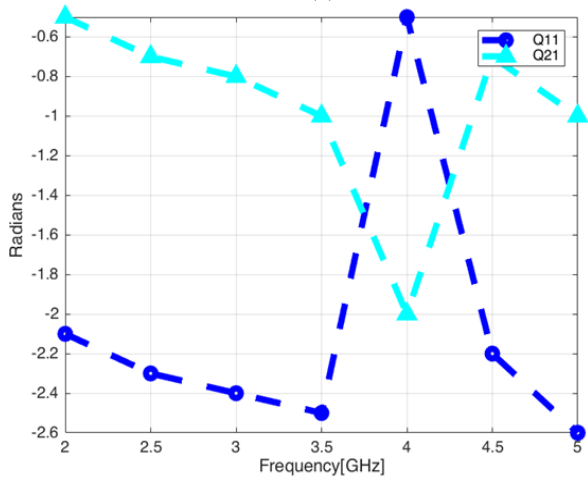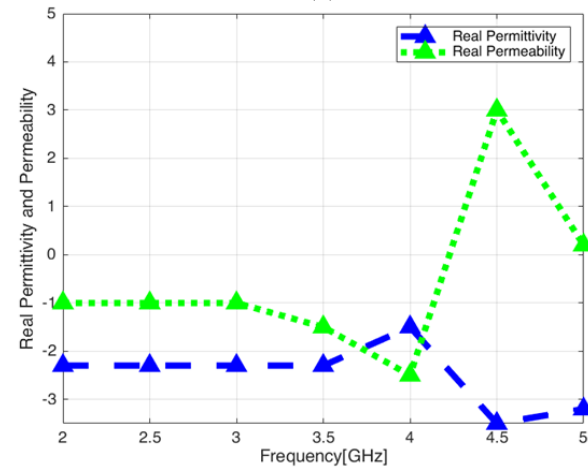
(a)

(b)

(c)

(d)
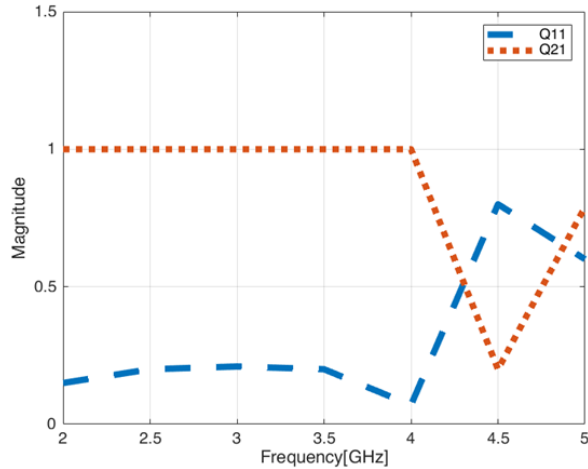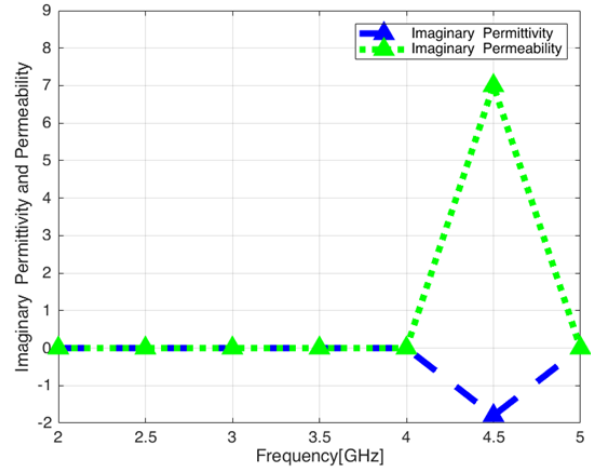
Fig. 5. (a) Extracted magnitude of Q11 and Q21 for optimized SRR. (b) Extracted phase (radians) of Q11 and Q21 for optimized SRR. (c) Real components of permittivity and permeability. (d) Imaginary components of permittivity and permeability.
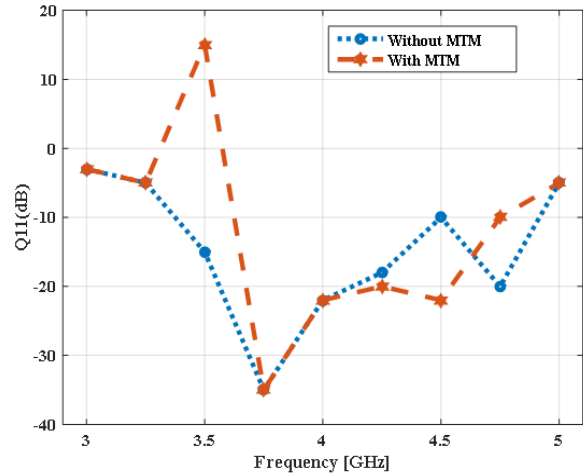

Fig. 6. Antenna without MTM and with MTM performance comparison.

The antenna gain vs. frequency plot for an integrated fractal antenna equipped with SRR shown in Fig. 9. The optimistic strong gain in the small frequency range between 3.44 and 4.85 GHz can be seen. At 4 GHz, the peak frequency is 13.8 dB, and the lowest at 4.4 GHz is 3.2 dB.
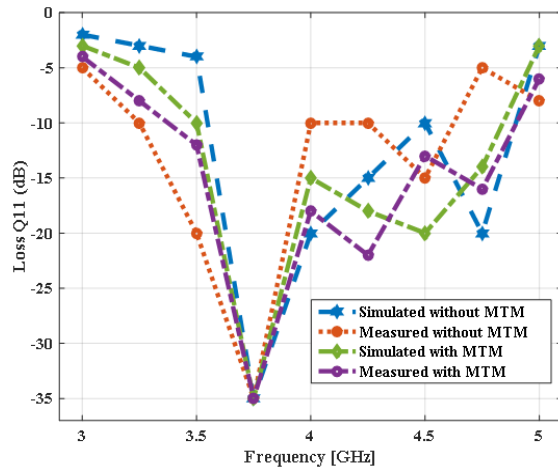
Fig. 7. Return loss properties simulated and measured for fractal antenna cells without and with MTM unit cells.
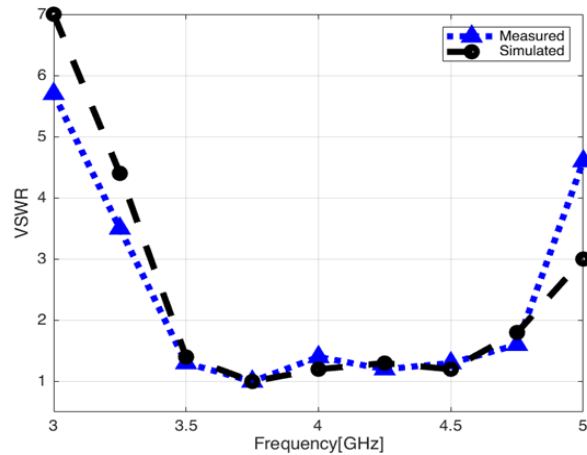

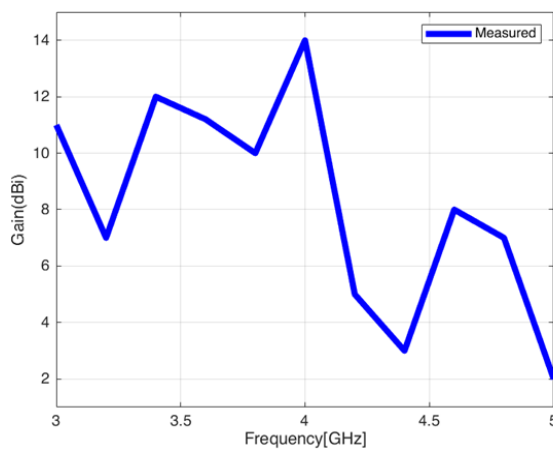Fig. 8. VSWR for configured SRR-loaded fractal antenna simulated and measured.

Fig. 9. Measured antenna gain versus frequency track for SRR-presented antennas optimized.

IV. CONCLUSION

The paper envisages the new design of a partial-ground square fractal microstrip line-fed antenna. Enhanced rectangular band on a partial plane increases capacitance stability, leading to a double-band output of 3.68 GHz and 4.72 GHz. The GHGWO hybrid algorithm is proven superior to other algorithms due to its stronger mean solution, the lowest standard deviation and substantially lower time. Two square split-ring resonators, a common metamaterial unit cell, are charged after an optimization close to the micro-line feed of the formulated fractal antenna. Upon processing of the antenna with optimized SRR structures, dual band response from the built fractal antenna is converted into bandwidth efficiency (3.49–4.73 GHz). For the conceptual testing of simulation effects the modelled fractal antenna without and with metamaterial mounting is generated. The enhanced findings show that an optimisation in the antenna design and engineering of the SRR metamaterial unit Cell for the throughput progression of the designed fractal antenna.

REFERENCES

[1] D. Werner, R. Haupt, and P. Werner, "Fractal antenna engineering: The theory and design of fractal antenna arrays," *IEEE Antennas and Propagation Magazine*, vol. 41, no. 5, pp. 37-58, 1999.

[2] E. Ekmekci, K. Topalli, T. Akin, and G. Turhan-Sayan, "A tunable multi-band metamaterial design using micro-split SRR structures," *Optics Express*, vol. 17, no. 18, pp. 16046-16058, 2009.

[3] D. Srivastava, A. Khanna, and J. Saini, "Design of a wideband gap-coupled modified square fractal antenna," *Journal of Computational Electronics*, vol. 15, no. 1, pp. 239-247, 2015.

[4] B. Babayigit and E. Senyigit, "Design optimization of circular antenna arrays using Taguchi method," *Neural Computing and Applications*, vol. 28, no. 6, pp. 1443-1452, 2016.

[5] P. Mishra, S. Pattnaik, and B. Dhaliwal, "Square-shaped fractal antenna under metamaterial loaded condition for bandwidth enhancement," *Progress In Electromagnetics Research C*, vol. 78, pp. 183-192, 2017.

[6] M. Dorostkar, R. Azim, and M. Islam, "A novel Γ-shape fractal antenna for wideband communications," *Procedia Technology*, vol. 11, pp. 1285-1291, 2013.

[7] R. Bojanic, V. Milosevic, B. Jokanovic, F. Medina-Mena, and F. Mesa, "Enhanced modelling of split-ring resonators couplings in printed circuits," *IEEE Transactions on Microwave Theory and Techniques*, vol. 62, no. 8, pp. 1605-1615, 2014.

[8] Y. Choukiker and S. Behera, "Modified Sierpinski square fractal antenna covering ultra-wide band application with band notch characteristics," *IET Microwaves, Antennas & Propagation*, vol. 8, no. 7, pp. 506-512, 2014.

[9] A. Numan and M. Sharawi, "Extraction of material parameters for metamaterials using a full-wave simulator [Education Column]," *IEEE Antennas and Propagation Magazine*, vol. 55, no. 5, pp. 202-211, 2013.

Routing Metric for Cognitive

Radio Networks

[1]Rajendra Babu Chikkala, [2]B Tarakeswara Rao, [3*]Subba Rao Peram, [4]B Premamayudu

[1]Department of Computer Science and Engineering, Andhra Loyola Institute of Engineering and Technology, Vijayawada, AP,India.

[2]Department of Computer Science and Engineering, Kallam Haranadhareddy Institute of Technology, Guntur,
AP,India.

[3*,4] Department of Information Technology, Vignan's Foundation for Science Technology & Research (Deemed to be University), Vadlamudi, Guntur, AP,India.

[1]chikkalarajendra@gmail.com, [2]tarak7199@gmail.com, [3]subbarao.peram@gmail.com,
[4]premamayudu@gmail.com

Abstract:

Wireless technology is spreading fast. While devices such as cell phones, laptops etc. receive a lot of attention, wireless technology impact has become broader such as through sensor networks, smart grid, embedded wireless devices etc. So many wireless applications create more demand for radio spectrums. Easily avail- able spectrum bands are assigned and legalized to a few known to us as Primary users. Studies have shown that these bands are not fully utilized. Thus, we need some new technologies to use these resources to their full potential. Cognitive radios maximize the use of such bands. For this technology to work better, we need efficient routing metrics for the best route selection. In paper aims at proposing a new routing metric for Cognitive Radio Networks which would consider some important factors affecting the route selection and compare it with other existing routing metric.

I. INTRODUCTION

The radio spectrum, which ranges from 30 kHz to 300 kHz, is a subset of the electromagnetic spectrum. The purpose of radio waves is to communicate. Although private radio operators already have access to a portion of the radio spectrum, the development of new technologies such as Bluetooth, Wi-Fi, and satellite has increased the demand for this limited resource. The concept of cognitive radio was developed to address this issue. In recent years, cognitive wireless mesh networks have tremendous popularity in networking field because of its some properties like self-configuration, robustness, self-healing etc., low cost network hardware fulfills the incentive of

high performance mesh networks[1]. In this kind of networks, multiple radio interfaces are allowed to work on single node in order to handle the problem of co-channel interference.

WMNs are classified in three basic types on the basis of topology and architecture, and they are:

Client Mesh Networks: same as MANET, mobile client devices are involved and there routing and exchange of functionalities takes place by client devices. Infrastructure Mesh Networks: a backbone wireless multi-hop network is provided as backbone infrastructure, and client devices do not perform routing and functionalities by own, they just use that backbone infrastructure for these tasks.

Hybrid Mesh Networks: in this both client and infrastructure mesh networks come into play, here both client devices and dedicated backbone infrastructure performs routing and other functionalities in order to increase network reach. To efficiently utilize multiple interfaces on a single node, proper routing should be performed[2]. For many years, routing in cognitive wireless mesh networks has been an intriguing area of research. Numerous studies have been conducted and there are still many more to be conducted in this field. Routing metrics and protocols are critical features of mesh networks because they govern the network's formation, configuration, and maintenance. Much of the research in this area of networking is prompted by mobile application networks. The initial objective in this environment is to provide extremely scalable routing in the presence of mobile nodes. Recent years have seen the emergence of some very interesting commercial multi-node mobile networks. A commercial network of this type is Community Wireless Networks[21,22]. Utilizing multiple interfaces on a single node opens up numerous possibilities for improving the performance and efficiency of these networks, such as allowing multiple radios to transmit and receive simultaneously, allowing for the simultaneous use of more radio spectrum, and ultimately, multiple radios with a variety of characteristics aid in improving the performance, connectivity, robustness, and efficiency of the network[3]. The paper's objectives are to I develop a new routing metric for cognitive radio networks, (ii) implement the metric using NS2, and (iii) evaluate the metric's performance and efficiency.

II. LITERATURE REVIEW

In this section we will discuss about what has been done yet in the field of routing   in wireless mesh networks. As we have already discussed routing is key component of any network to perform well and give efficient results[4]. There are many characteristics and parameters which has to be taken care of when designing a routing metric, on the basis of those basic parameters and characteristics we can comment on the working of any metric whether that metric works well and if yes then in what scenarios and what situation.

1.1. Components of Routing Metrics

Let us discuss metric components that can be utilized to compose a routing metric for multi-radio wireless mesh networks.:

Number of Hops

In networking a hop means simply a device and it can be anything like bridges, routers, gateways, and any node which comes in the routing path from source to destination, each time when any of these device occurs, a hop occurs, and the count of these many hops will result in hop count. Hop count is an overwhelming measure of the distance between two hosts[5]. A hop count of n means that n gateways separate the source host. Hop count may be the routing metric in itself, as in many mobile ad hoc network routing protocols, but when complex networks come, and hop counts play a key role in routing. Hop count also functions as a routing metric for the wireless mesh network itself and has substantial limitations[6]. It has been shown that a route with higher quality links shows significant performance improvements over a shorter route consisting of low quality links. Hop count also leads to congestion and hot spots as it tends to pass through a few central nodes.

Capacity link

It is the highest limit rate at which any link can convey any information. Current connection capacity can be measured by measuring the connecting capacity. It also depends on an increase in bandwidth and a decrease in bandwidth leading to changes in bandwidth[7]. There are some ways of doing this, from actively testing the link to measuring transmission speeds to relying on current rate of radio interfaces. The connected capacity also plays an important role in determining any routing metric and is therefore also a very important part of the routing metric In addition, since most radio interfaces are able to automatically decreasing their transmission speeds to handle loss links, finding links with higher capacity reduces medium access time and improves topology performance. Higher capacity connections increase network routing efficiency and performance, and decrease medium access time. For a good quality route from the source to the destination, a connection with a higher connection capacity or the higher transmission rate should therefore be selected or weighted.

Quality link

Link quality means signal value, it contains all associated link parameters such as the nit error rate (BER) and signal levels plus noise plus noise distortion plus distortion of noise. By measuring, accessing and analysing all link parameters, link quality is determined. High link quality will greatly enhance the performance of every routing metric, and when selected high quality links, high transmission speeds and lower error rates will lead to a good route[8]. In a number of ways, link quality can be measured. The most frequent metrics are noise ratio (SNR) and loss rate of packets (PLR). This information is usually available from the wireless interface device driver. Alternatively, active sampling can determine the PLR value.

Diversity of the Channel

A diversity scheme means a method to improve the reliability of a message signal through the use of two or more communication channels with different features. Diversity is mainly used in radio communication and is a common technique to fight fading and interference with the co-channel and prevent error bursts. Use of the same channel through several hops can lead to significant interference with the co-channel and therefore to a reduction in overall performance, efficiency and throughput. Ideally, all path links within the interference range should operate on non-overlapping channels, which results in significant performance gains. To what extent this can be accomplished is called channel diversity. Channel diversity is only involved in multi-radio wireless networks, because all channels operate on the same radio and problems of interference occur in single radio. Therefore, one should choose a channel or link to maximum diversity. Maximum diversity in each channel implies minimum co-channel interferences and therefore high performance and efficient communication routes can be achieved.

2.2. Metric features

We shall now discuss metric characteristics that also play an important role in the design of any routing metric. We have many criteria for comparing a metric whether or not it performs well and how well it performs taking which metric feature is not met with all metric features to choose a better metric, in some cases we have to compromise some of the features to achieve a good result and compensate for some of the features.

Interference intra-flow

Interference is something that in any wireless communication modifies, distracts or disrupts or distracts any signal coming from a source to a destination. Due to interference signal quality decreases and increases signal/noise ratio and ultimately link quality decreases, which is very important to perform well and to achieve efficient performance on every route[9]. Intraflow interferences occur in wireless networks when two or more radio stations with the same path run or flow on the same channel, and co-channel interference occurs and thus the quality of link degrades. Link Diversity can be used to reduce interference with the intra-flow by using various radios for adjacent hops in each route to communicate, thereby lowering the interference level and improving performance. Interference intra-flow is not restricted to neighbouring connections and can occur over several hops[10]. This is because the interference range of a node is usually larger than a single hop. Different radios for neighboring nodes are required to prevent interference intra-flow.

Interflow Interference Interference

Interflows occur when neighboring routers or nodes compete for the same occupied channel. Inter-flow interference also reduces the connection quality and therefore route performance[11]. Inter-flow interference affects more than the inter-flow quality, since inter-flows are very

difficult to control because they involve many different routers and nodes and also involve multiple flows to the same channel.

Interference with external flow

If interference occurs, and this is beyond the reach of any node in the network, then interference is called external interference as caused by an external body, which node within the network is known. External interference is divided into two different types: Controlled interference- This occurs if networking technologies are used by external nodes that are not known to overlap the network nodes themselves[12]. The second type of external interference is: uncontrolled interference- and is caused by any other radio source that is broadcast in the same rate, but does not participate in the same MAC protocol. Examples include cable, microwave or Bluetooth phones. Both these controlled and uncontrolled kinds of external interference have a serious effect on the network performance throughput, but controlled interference can be controlled by some measures.

Balancing load

Load balance is also one of the important features we have studied, as the network can sometimes be greedy to achieve maximum performance and output in relation to one path, without taking into account network overall performance[13,14]. This may happen because the metric only considers local measurements to form routes or because the metric uses the highest capacity links regardless of their current loads. On the other hand, neighbouring understanding nodes can work together and reduce the load of highly-loaded nodes in order to maintain network performance. Balancing the load on each node and maintaining a balanced network will lead to overall network performance and performance. It is almost analogous to equal distribution so that not some of the nodes have full network loading, it should be distributed to ensure maximum performance in each node with co-operation.

Agility

Ability of any network to respond to the changes made in topology and load in the network, and almost like reflex action by our organism, too quickly and efficiently[15]. To make a metric agile, the rate of measurement should be higher than the rate of change in the network. If the change rate is higher or exceeds the measurement rate, the network fails to provide the correct picture of the network status, which can cause errors or failures, thus degrading the performance and the performance. In more complex measures, which require sampling and time averaging, the number of hops outperforms as it is calculated instantaneously. In very dynamic scenarios, i.e. high mobility networks, hop counts output many more complex metrics if agility in that metric is less pronounced.

Information location

Some metrics require information like channels used in past tracks or other metrics observed on other network nodes, such as packet delivery rate or noise levels. This non-local information can be included in the routing metric and can be used to make better routing choices. If the metric demands a lot of information from nodes outside itself, two problems may result[16]. Firstly, the control packets used to obtain this information can become excessively large and common, and therefore increase the overhead routing in the network. Secondly, increased processing overheads could lead to greater delays in establishing routes.

Isotonicity

Isotonicity is also a routing metric property and simply means that the metric should ensure a weight order of two different paths that can then be used in the future along the same third path. Isotonicity is the key feature or necessary condition of a routing metric to find minimum weight paths for the existence of some effective algorithms like bellman ford and dijkstra. Sometimes this property also guarantees loop-free routes. If a routing metric is not isotonic, it can only find minimal weight paths by algorithms of exponential complexity.

Stability

The measurement of a connection should not vary too much over time. Abrupt metric changes may trigger a protocol to send route updates and may result in extremely high overhead protocols. Load-sensitive measurements can cause a metric to fluctuate considerably. Topology-based metrics vary significantly and are significantly more stable, particularly in low mobility scenarios.

Throughput

Throughput is something which is very important to decide whichever metric is per- forming the best, it can be called as deciding factor for better of two metrics. Greater the throughput will transmit the data at very faster rate and hence improves the delays and hence the performance of the network[16,17]. Greater throughput also takes less time oc- cupation of channels and allows other channels to use that channels and medium, hence allowing greater use of the medium.

III PROPOSED WORK

Our aim is to include as many factors affecting the calculation of a route to transfer packets from source to destination in Cognitive Radio Networks as possible to make the metric perform better than the other already existing metrics.

The main idea involves the joining of different metrics with the help of tuning parameter to include the factors of both the metrics

3.1 Metrics to choose

We have chosen to join STOD-RP and Power-aware. The STOD-RP metric includes delay factors as well as route stability. For road stability, a factor T is necessary that determines the time available to a link for a spectrum band which can be predicted from the statistical history of PU activities. For end-to-end delays, the channel access overhead and the overhead protocol are very small in comparison to the length/bandwidth (packet length) of the ETT metric.

Metric for STOD-RP:

$$O_{ca} + O_p + \left(\frac{pkt}{r}\right) \ X \ \frac{1}{1 - P_{loss}} \ X \ \left(\frac{1}{T}\right)$$

O_{ca} channel access time
O_p protocol overhead

pkt packet length

r rate(bandwidth)

P_{loss} packet error rate

T time of availability of spectrum band for the link

Metric for Power:

Power consumed in link (i, i+1) = P(n_i, n_{i+1})

Proposed Metric

$(1 - \alpha)P\ ath + \alpha Power$

$(1 - \alpha) \ (O_{ca} + O_p + \left(\frac{pkt}{r}\right) \ X \ \frac{1}{1 - P_{loss}} \ X \ \left(\frac{1}{T}\right) + \ \alpha \ (P(n_i, n_{i+1}\ ))$

This metric takes into account three very important factors namely delay which itself accounts for link load by using packet length and bandwidth (as in ETT) along with channel access time and protocol overhead time and link quality by using the packet er- ror rate (as in ETX), route stability (because of activities of PU) and power consumption.

The tuning parameter alpha varies with time. In starting when network is set up alpha takes very less value. As during the starting phase, all the nodes have enormous power to work. With time, power of nodes decreases due to various activities done by the nodes. Apart from transmission power, receiving power, power is consumed during sleeping, sitting idle, and sensing[18,19,20]. Sensing is needed to detect PU activity and find free channel. Every time PU interrupts, new channel needs to be sensed which consumes power. Thus, gradually with time, power of the nodes becomes an important issue to be considered in route selection.

3.2 Numerical Analysis

Nodes Setup

We have taken test bed of 30 nodes. These nodes are randomly deployed. A range is set for the nodes to communicate and same initial power is given to all the nodes.

ETX graph

Initially a graph is made by the ETX values of the links between the nodes which is based on the distances between them. If this ETX value is more than the range, there is no link between the nodes.

Packet transmission

There are 200 random source and destination nodes and 20 packets are sent between them each time. Random bandwidth and route stability times are used in every packet to create another graph so that not every packet takes the same route. This graph calculates our metric, which combines path with power metric by alpha. Power here is the total amount of power consumed throughout the route. To find the shortest path between source and destination nodes, the Dijkstra shortest path algorithm is used. With each alpha packet transmission, a very small value is increased, so that in the last it is close to or equal to 1.

Metric comparison

The other metric we have taken for comparison is the path metric part of our metric (STOD-RP), and noted the remaining power of all the nodes. Then a graph is plotted for remaining powers of the nodes for our metric and the other metric and the average power remaining is noted in both the cases.
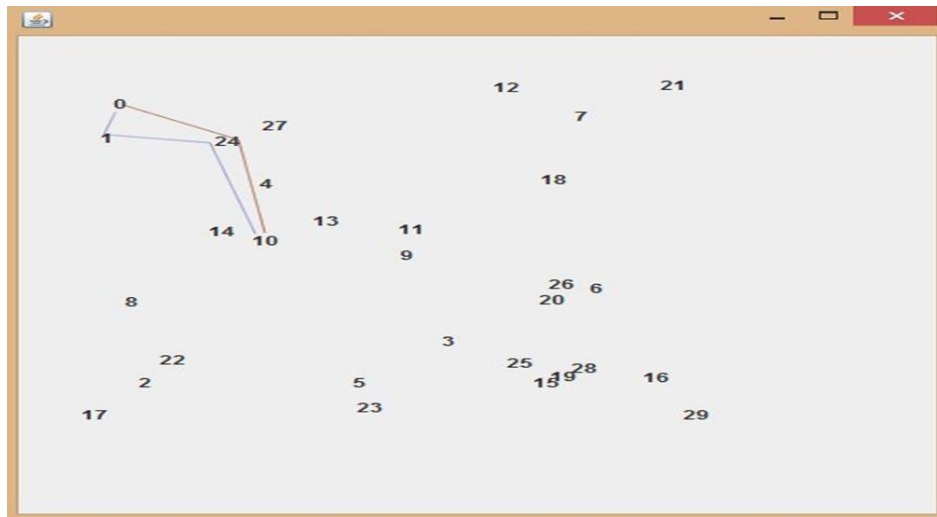
IV RESULTS
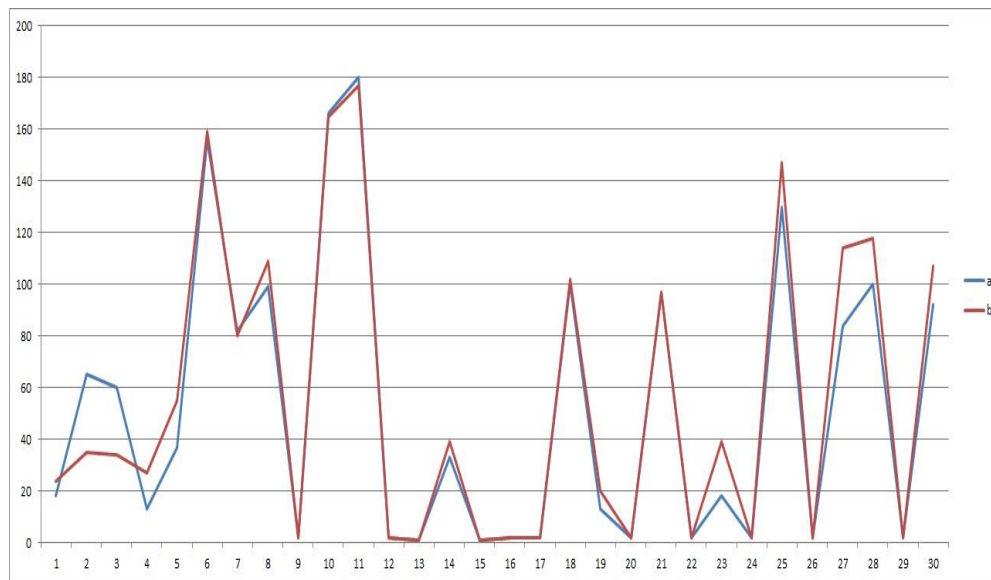

Figure 4.1: *random nodes deployment*

Figure 4.2: *remaining power graph*

Using the above configuration and values, our metric showed better output than the other metric. The output difference was not that significant, but to some extent. That might be because of the values we chose.

Nodes and Route setup

See Figure [4.1] Here the route [0, 1, 24, 10] is selected by other metric and the route [0, 24, 10] is selected by our metric.

Nodes remaining power graph

See Figure [4.2] This is the energy vs nodes graph. Our metric is plotted in red color and the other metric is in blue. More number of nodes has greater power in case of our metric.

The average remaining power in the nodes was a little more for our metric as compared to the other metric.

V CONCLUSION AND FUTURE WORK

Conclusions

Our metric proved to be somewhat better than the other existing metric we have compared with having average remaining power more than the other metric. Too many factors inclusion may result in protocol overhead. Factors should be very carefully chosen which can be easily calculated and have a large impact on route selection, such as delay, power, stability. Cognitive radio will be highly preferable technology in the future. Thus, more performance metrics and routing protocols need to be developed for it to work better.

Future work

This metric can be simulated to show improvements in a network simulator. By taking other factors into account, the metric can be further improved. The cognitive radio technology will become a programmable radio for general purposes and will be used for wireless applications everywhere, just like in computer microprocessor.

REFERENCE

[1] Jonathan Guerin, Marius Portmann, Asad Pirzada, "Routing Metrics for Multi- Radio Wireless Mesh Networks", The University of Queensland Brisbane, Australia.

[2] R. Draves, J. Padhye, and B. Zill, "Comparison of Routing Metrics for Static Multi- Hop Wireless Networks," ACM SIGCOMM Comput. Commun. Rev., vol. 34, pp. 133-144, August 2004.

[3] R. Draves, J. Padhye, and B. Zill, "Routing in Multi-Radio, Multi-Hop Wireless Mesh Networks," in MobiCom '04: Proceedings of the 10th annual international conference on Mobile computing and networking Philadelphia, PA, USA: ACM Press, 2004, pp. 114-128.

[4] S. J. De Couto, D. Aguayo, B. A. Chambers, and R. Morris, "Performance of Multihop Wireless Networks: Shortest Path is Not Enough," SIGCOMM Comput. Commun. Rev., vol. 33, pp. 83-88, 2003.

[5] S. J. De Couto, D. Aguayo, J. Bicket, and R. Morris, "A High- Throughput Path Metric for Multi-Hop Wireless Routing," 9th annual international conference on mobile computing (MobiCom 03), September 2003.

[6] A. P. Subramanian, M. M. Buddhikot, and S. Miller, "Interference Aware Rout- ing in Multi-Radio Wireless Mesh Networks," in Proceedings of the 6th ACM international symposium on Mobile ad hoc networking and computing: Urbana- Champaign, IL, USA 2005, pp. 68 77.

[7] Moustafa Youssef, Mohamed Ibrahim, Mohamed Abdelatif, Lin Chen, and Athanasios V. Vasilakos, "Routing Metrics of Cognitive Radio Networks: A Survey," IEEE COMMUNICATIONS SURVEYS TUTORIALS, VOL. 16, NO. 1, FIRST QUAR- TER 2014

[8] S.-C. Lin and K.-C. Chen, "Spectrum Aware Opportunistic Routing in Cognitive Radio Networks", in GLOBECOM, 2010, pp. 16.

[9] P.-Y. Chen, S.-M. Cheng, W. C. Ao, and K.-C. Chen, "Multi-path routing with end- to-end statistical QoS provisioning in underlay cognitive radio networks", in Computer Communications Workshops (INFOCOM WKSHPS), 2011 IEEE Conference on. IEEE, 2011, pp. 712.

[10] S. ju Lee and M. Gerla, "Split multipath routing with maximally disjoint paths in ad hoc networks", in IEEE International Conference on Communications (ICC02), vol. 10, 2002, pp. 32013205.

[11] X. Li and L. Cuthbert, "On-demand Node-Disjoint Multipath Routing in Wireless Ad hoc Network, Local Computer Networks", Annual IEEE Conference on, pp. 419420, 2004.

[12] A. Sampath, L. Yang, L. Cao, H. Zheng, and B. Y. Zhao, "High Throughput Spectrum-aware Routing for Cognitive Radio Networks", in Proc. Third International Conference on Cognitive Radio Oriented Wireless Networks and Communications (CROWNCOM 2008), 2008.

[13] A. Guo-Mei Zhu and I. G.-S. Kuo, "STOD-RP: A Spectrum-Tree Based On-Demand Routing Protocol for Multi-Hop Cognitive Radio Networks", IEEE GLOBECOM, 2008.

[14] M. F. K. Chowdhury, SEARCH: a routing protocol for mobile cognitive radio ad-hoc networks, Computer Communications, 2009.

[15] H. Yi Shi and Y.T., SAMER, "Spectrum Aware Mesh Routing in Cognitive Radio Networks", IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks (DySPAN), 2008.

[16] X. M. H. Ma, L. Zheng and Y. luo, "Spectrum Aware Routing for Multi- Hop Cognitive Radio Networks with a Single Transceiver", 3rd International Conference on Cognitive Radio Oriented Wireless Networks and Communications, CrownCom, 2008.

[17] W. L. Geng Cheng and W. C. Yunzhao Li, "Spectrum Aware On- Demand Routing in Cognitive Radio Networks", IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Networks (DySPAN 2007), 2007.

[18] M. H. C.W. Pyo, "Minimum Weight Routing based on A Common Link Control Radio for Cognitive Wireless Ad Hoc Networks", Proc. 2007 International Conference on Wireless Communications and Mobile Computing (IWCMC07), 2007.

[19] X. Huang, D. Lu, P. Li, and Y. Fang, "Coolest Path: Spectrum Mobility Aware Routing Metrics in Cognitive Ad Hoc Networks", in Distributed Computing Systems (ICDCS), 2011 31st International Conference on, june 2011, pp. 182 191.

[20] H. Yi Shi and Y.T., SAMER, "Spectrum Aware Mesh Routing in Cognitive Radio Networks", IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks (DySPAN), 2008.

[21] Kumari, N. V., & Ghantasala, G. P. (2021). Model for Rail Transportation System To Predicting the Capacity of Train Speed and Length. *INTERNATIONAL JOURNAL OF EDUCATION, SOCIAL SCIENCES AND LINGUISTICS*, *1*(1), 1-10.

[22] Kumari, N. V., Ghantasala, G. P., & Arvindhan, M. (2020). Compulsion for Cyber Intelligence for Rail Analytics in IoRNT. In *Securing IoT and Big Data* (pp. 59-83). CRC Press.

Modified Kinetic Gas Molecule Optimization for four fluids of Organic Rankine Cycle in shell and tube heat exchanger

Tallapureddy Subba Reddy *, Thimmasandra Venkataswamy Sreerama Reddy, Erappa Rajj Babu, Hosur Nanji Reddy Reddappa

Bangalore Institute of Technology, Bengaluru 560004, India

ARTICLE INFO

ABSTRACT

Organic Rankine Cycle (ORC) is applied in the shell and tube heat exchanger to enhance the efficiency of the exchanger. Existing methods involves in applying the optimization method in ORC in shell and tube heat exchanger to improve the performance. In this paper, the modified Kinetic Gas Molecule Optimization (KGMO) method is applied in four fluids to improve the performance of the exchanger. Four fluids such as R245fa, R134a, R290, and R600a were used to evaluate the performance of modified KGMO method. In KGMO, the worst learning particles affects the performance of the optimization in the convergence. The modified KGMO method involves in applying the feedback learning method to improve the learning performance of worst particles in KGMO. The proposed modified KGMO method is compared with existing methods of Bell-Delaware and KGMO. The proposed modified KGMO method has the enhancement factor of 2.8 and Bell-Delaware method has 1.51 enhancement factor.

© 2021 Elsevier Ltd. All rights reserved.
Selection and peer-review under responsibility of the scientific committee of the International Conference on Materials and System Engineering.

1. Introduction

Heat exchangers were widely used in industries for both heating and cooling processes for power generation. Heat exchanger operation is based on transferring the heat between two fluids at least that runs at different temperature. Various kinds of heat exchangers were developed for efficiency and capacity in large-scale industries namely, dynamic scraped surface, pillow plate, adiabatic wheel, plate fin, plate and shell and shell and tube etc. [1]. Moreover, the shell and tube heat exchangers were highly used in industries due to its efficiency in heat transfer. The cost of shell and tube heat exchanger is high and design optimization is required to apply to improve the efficiency. Various analysis shows that the baffles and tube configuration have the higher influences on the performance on this kinds of heat exchanger [2,3]. Instead of adding heat sources and supporting like oil coolers and intercoolers, the design optimization is performed for cost effective performance [4]. Various configurations of devices in various sizes were used in the exchanger like number of tubes inside and baffle. Heat transfers is carried out in tubes together with the shell side

through tube walls. Transfer rate is depending on various factors such as cutting spacing, baffle spacing, tube geometry, number of tubes, shell diameter, feed temperature and pressure [5].

The Organic Rankine Cycle (ORC) is a power cycle that provides heat source of low-grade to generate power based on an organic working fluid. The ORC can be applied in wide range of Waste Heat Recovery such as IC engines, heat exchanger and industrial processes. An appropriate working fluid is required to be selected to utilize the energy [6,7].

Many researchers applying the various formulations and methods for the optimization of equipment in waste heat recovery. Challenges in optimization involves in high thermal efficiency and cost represents an opportunity to improves the ORC performance [8]. The pressure drop and heat transfer are the important characteristics in the ORC working fluids and ORC design has significant impact on the characteristics. In this research, the modified KGMO method is proposed in four fluids of ORC in shell and tube heat exchanger to improve the efficiency. Four fluids such as R245fa, R134a, R290, and R600a were used to evaluate the performance of the proposed modified KGMO method. The modified KGMO method applies feedback learning method to improve the learning performance of worst particles in KGMO.

---

* Corresponding author.
E-mail address: phdsubbareddy@gmail.com (T.S. Reddy).

The paper is organized as literature survey of Organic Rankine Cycle (ORC) in shell and tube heat exchanger is given in section 2, the modified KGMO is given in section 3, the result is given in section 4 and conclusion is given in section 5.

2. Literature survey

Organic Rankine Cycle (ORC) is applied in shell and tube heat exchanger to utilize low-grade thermal energy. Existing methods applied optimization method to improve the efficiency of the shell and tube heat exchanger. Some of the recent researchers in ORC shell and tube heat exchangers were reviewed in this section.

Milcheva, et al. [9] applied Taborek version of Bell-Delaware method for shell and tube heat exchanger ORC optimization based on design parameters. The method is evaluated in the design of double-segmental baffle with single-phase flow. The simulated design is used to analyze the performance of the adaptive Bell-Delaware method. The R245fa fluid is used in the design to evaluate the performance of the adaptive Bell-Delaware method. Various design configuration of preheater is applied in the simulation model and analyzed the performance. The analysis shows that developed adaptive Bell-Delaware method has the higher performance in the design optimization.

Li, et al. [10] carried out the arrange form of thermo-economic performance of shell and tube heat exchanger subcritical ORC system. Mathematical model of shell and tube heat exchanger was developed to analysis the performance. Five hydrocarbons fluids were used to evaluate the performance of the method. Various design parameters were considered to evaluate the performance of the method. This method also analysis the optimal working conditions fluid and system parameters. The analysis shows that the developed method has the higher performance in terms of thermal and economic. The optimization efficiency of the method is low and need to be improved.

Zhang, et al. [11] analyzed the three types of heat exchanger such as plate type, shell and tube type and finned tube type in ORC configuration. The four ORC configurations were used to evaluate the performance of the developed method. Various parameters were considered for the analysis of the performance of the developed method. The analysis shows that shell and tube type, and plate type has higher performance compared to finned tube type. The developed model shows the cost-effective performance in the analysis. The optimization efficiency of the developed method is low and design parameters are need to be consider for optimization.

Li, et al. [12] analysis the thermo-economic performance of ORC system for interaction of the heat exchanger pressure drop. An iterative method is applied in design of thermo-economic performance in each case and resize the component until convergence. The developed method is compared with conventional method to analysis the efficiency of the method. The developed method has higher performance in terms of heat exchanger pressure drop. The optimized thermo-economic method improved the reliability and accuracy in the design. The optimization efficiency of the model is low and various fluids are need to be analyzed.

Erdogan, et al. [13] analysis the combine parabolic trough solar collector and ORC in shell and tube heat exchanger. The model was analyzed in various solar irradiation intensity to find the optimal parameter design. The difference method of logarithmic mean temperature for the detailed thermal model for shell and tube heat exchanger was analyzed. Various design parameters were analyzed for the optimization of shell and tube heat exchanger. The analysis shows that the baffle spacing is the important parameter in the analysis. The optimization efficiency is low and various design parameters are need to be considered for optimization.

3. Method

Shell and tube heat exchanger with ORC improves the efficiency of the exchanger based on Waste Heat Recovery. Existing methods applied the optimization methods to improves the performance of the method. In this paper, modified KGMO method is proposed in four fluids to improve the efficiency. The modified KGMO method applies the feedback learning method to improve the learning performance in the worst particles. Four fluids such as R245fa, R134a, R290, and R600a were applied to evaluate the performance of modified KGMO method. The overview of the method is shown in Fig. 1.

3.1. Tube side heat transfer coefficient

For considered load conditions, Reynolds number Re_D of the tubes should be higher than 10^4 value [9]. Heat exchanger correlation of tube side is considered to develop turbulent flow, as given in equation (1).

$$Nu_t = \left\{ \frac{\left(\frac{f}{8}\right) Re_D Pr}{1 + 12.7\left(\frac{f}{8}\right)^{\frac{1}{2}}\left(Pr^{\frac{2}{3}} - 1\right)} \right\} \left\{ 1 + \left(\frac{d_{in}}{L}\right)^{\frac{2}{3}} \right\} \left(\frac{pr_t}{pr_{tw}}\right)^{0.11}$$
$$\times Re_D \geq 10^4 \qquad (1)$$

where Prandtl number is denoted as Pr, Reynolds number is denoted as Re, and the D is diameter. The Konakov correlation is used in the friction factor f, denoted in Eq. (2).

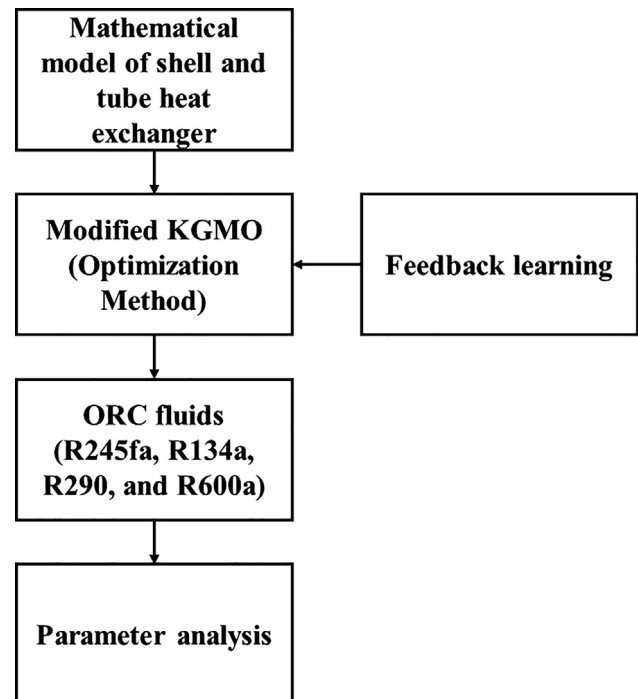$$f = (1.8 \log_{10} Re_D - 1.5)^{-2} \quad 10^4 \leq Re_D \leq 10^6 \qquad (2)$$

Fig. 1. The overview of the Modified KGMO method.

3.2. Shell side heat transfer coefficient

In this paper, heat transfer coefficient of average shell side is calculated based on Bell Delaware method [9]. The Bell Delaware general formula is denoted in Eq. (3).

$$h_s = J_c J_l J_r J_b J_s J_i \tag{3}$$

On a cross flow of tube bank, several effects are considered in Bell Delaware to diminishes the heat transfer coefficient h_i. The cross flow regime variations are considered in the forms of correction factors such as J_c, J_l, J_r, J_b, J_s. Eq. (4) denotes the ideal heat transfer coefficient h_i.

$$h_i = \frac{j_i C_{ps} G_s (\varphi_s)^n}{pr_s^{2/3}} \tag{4}$$

The Bell-Delaware basic equation structure method is not changed. The Bell-Delaware method is based on areas characteristic and tube number estimation.

3.2.1. Shell side cross flow area (SSCFA)

The heat exchanger is symmetry and flow division is equal for window right and left. Therefore, the sum of left and right cross flow areas $S_{m,l}$ and $S_{m,r}$ is denoted as SSCFA S_m. Eq. (5) calculate the SSCFA.

$$S_m = S_{m,l} + S_{m,r} = L_{bc}(bx - N_{tcf}d).2 \tag{5}$$

To calculate the half SSCF as $S_{m,l}$ or $S_{m,r}$, the cross flow region and central baffle spacing L_{bc} are multiplied. The $N_{tcf} \times d$ tube width is subtract from the entire width bx. To calculate the entire SSCFA S_m, the product is doubled.

3.2.2. Effective tube row number

To calculate the cross flow number of total tube row in N_{tcc}, overlapping regions of the number of tube rows $N_{tcc,l}$ and $N_{tcc,r}$ are added, as given in Eq. (6). The total number of right and left wing window $N_{tw,r}$ and $N_{tw,l}$ are added to measure the tube numbers wing window $N_{tw,w}$ as provided in the Eq. (7).

$$N_{tcc} = N_{tcc,l} + N_{tcc,r} \tag{6}$$

$$N_{tw,w} = N_{tw,l} + N_{tw,r} \tag{7}$$

3.2.3. Average values input parameters adaption

The wing baffle and central has various geometrical measures like baffle window number of tubes. Considering the left and right wing windows, the average window tube number is calculated in the Eqs. (8) and (9).

$$N_{tw}^{aver} = 0.5(N_{tw,w} + N_{tw,c}) \tag{8}$$

$$F_w = \frac{N_{tw}^{aver}}{N_t} \tag{9}$$

Where baffle window tube fraction is denoted as F_w that is measured by categorizing the total tube number N_i for categorizing the average window. Similarly, leakage areas of shell-to-baffle and tube-to-baffle are measured in the Eqs. (10) and (11).

$$S_{sb}^{aver} = 0.5(S_{sb,wb,l} + S_{sb,wb,r} + S_{sb,cb}) \tag{10}$$

$$S_{tb}^{aver} = 0.5(S_{tb,wb,l} + S_{tb,wb,r} + S_{tb,cb}) \tag{11}$$

3.3. Modified KGMO algorithm

The modified KGMO method is applied to optimize the shell and tube heat exchanger with ORC fluids. The gas molecules are considered as agents in search space in KGMO. The four characteristics of every gas molecule such as velocity, mass, position, and kinetic energy [14–17]. The velocity and position of the kinetic energy is used to identifies for each gas molecules. The gas molecules in KGMO search for the point of lowest temperature. The number of agents or gas molecules is denoted as N and i^{th} agent position and velocity are determined in the Eqs. (12) and (13).

$$X_i = (x_i^1, \cdots x_i^d, \cdots x_i^n), i = 1, 2, \cdots N \tag{12}$$

$$V_i = (v_i^1, \cdots v_i^d, \cdots v_i^n), i = 1, 2, \cdots N \tag{13}$$

Where velocity and position of ith agent in the dth dimension are denoted as v_i^d and x_i^d.

Boltzmann distribution is applied for the movement of the gas molecules in cylinder. The gas molecules velocity is inversely proportional to molecule kinetic energy. Eq. (14) defines the kinetic energy.

$$k_i^d(t) = \frac{3}{2} Nb T_i^d(t), K_i = (k_i^1, \cdots k_i^d, \cdots k_i^n), i = 1, 2, \cdots N \tag{14}$$

Where temperature is stated as $T_i^d(t)$, the number of gas molecules is denoted as N, and the Boltzmann constant is represented as b. The updated molecule velocity is provided in the Eqs. (15) and (16).

$$v_i^d(t+1) = T_i^d(t)w v_i^d(t) + C_1 rand_i(t)\left(gbest^d - X_i^d(t)\right)$$
$$+ C_2 rand_i(t)\left(pbest_i^d - X_i^d(t)\right) \tag{15}$$

$$T_i^d(t) = 0.95 \times T_i^d(t-1) \tag{16}$$

All the molecules prior best position is denoted as vector of $g_{best} = (gbest^1, gbest^2, .gbest^n)$ and the ith gas molecule prior best position is denoted as the $p_{best} = (pbest_i^1, pbest_i^2, .pbest_i^n)$. The gas molecular velocity limits of v_{min}, v_{max} is applied. If $|v_i| > v_{max}$, then $|v_i| = v_{max}$, the inertia weight is applied to slow the movement that is denoted as w. The uniform random variable in the range of [0, 1] is denoted as $rand_i(t)$ and the two acceleration constants are denoted as C_1 and C_2.

Every gas molecule mass m is a random number in range of $0 < m \le 1$. Dissimilar types of gases are provided by the random number in algorithm dissimilar execution. The molecule position is determined using the Eqs. (17) and (18).

$$x_{t+1}^i = \frac{1}{2} a_i^d(t+1)t^2 + v_i^d(t+1)t + x_i^d(t) \tag{17}$$

$$a_i^d = \frac{(dv_i^d)}{dt}, dv_i^d = \sqrt{\frac{2(dk_i^d)}{m}} \tag{18}$$

In the time interval Δt, Eq. (18) is rewritten as Eq. (19).

$$a_i^d = \frac{\sqrt{\frac{2(\Delta k_i^d)}{m}}}{\Delta t} \tag{19}$$

The molecule position is measured from the Eqs. (17) and (19), as given in Eqs. (20) and (21)

$$x_{t+1}^i = \frac{1}{2} a_i^d(t+1)\Delta t^2 + v_i^d(t+1)\Delta t + x_i^d(t) \tag{20}$$

$$x_{t+1}^i = \frac{1}{2}\sqrt{\frac{2(\Delta k_i^d)}{m}}(t+1)\Delta t^2 + v_i^d(t+1)\Delta t + x_i^d(t) \tag{21}$$

Eqs. (22) and (23) provides the minimum fitness.

$$pbest_i = f(x_i), iff(x_i) < f(pbest_i) \tag{22}$$

$$gbest = f(x_i), iff(x_i) < f(gbest) \qquad (23)$$

Conventional KGMO has the limitations of easily trap in the local optimum and lower accuracy in the solution. Feedback learning process is applied in the conventional KGMO method to improve the learning performance of worst particles. The individual fitness of *pworst* is improved in the feedback learning stage. Two individual higher difference increases the *pworst*. The feedback learning improves the individual *pworst* based on *pbest* feedback learning, as given in equation (24).

$$Feedback\ learning = \frac{f(X_i)}{diversity\ of\ pworst} \qquad (24)$$

4. Result

Shell and tube heat exchanger with ORC increases the efficiency of the exchanger and also reduces the cost. Various methods were applied for the optimization of shell and tube heat exchanger to improve its performance. In this research, Modified KGMO method is proposed for optimization of exchanger and analyzed in four fluids. Four fluids such as R245fa, R134a, R290, and R600a were used to evaluate the performance of the models. Enhancement factor is measured in four fluids to analysis the performance of the modified KGMO. The Heat Transfer Coefficient (HTC) and Reynolds number of the shell and tube side is shown in Table 1. The Relative Deviation Geothermal Fluid Outlet Temperature (RD-GFOT), Relative Deviation Fluid Outlet Temperature (RD-FOT), Thermal Water Mass Flow (MF-TW), Geothermal Water Outlet Pressure (OP-GW), Geothermal Water Inlet Pressure (IP-GW), Geothermal Water Outlet Temperature (OT-GW), Geothermal Water Inlet Temperature (IT-GW), Fluid Mass Flow (MF-F), Fluid Outlet Pressure (OP-F), Fluid Inlet Pressure (IP-F), Fluid Outlet Temperature (OT-F), Fluid Inlet Temperature (IT-F), Enhancement factor (J_x) were evaluated in performance analysis.

The Modified KGMO is applied in the optimization of shell and tube heat exchanger with ORC. The performance analysis of modified KGMO on R245fa fluid and compared with Bell-Delaware and KGMO is shown in Table 2. The feedback learning method is applied in the KGMO method to improve the learning performance of the worst particles. The Modified KGMO method has the higher enhancement factor compared to the Bell-Delaware method and KGMO. The modified KGMO method has 2.8 enhancement factor compared to KGMO has 1.88 enhancement factor.

The performance analysis of modified KGMO on R134a fluid and compared with KGMO method is shown in Table 3. The analysis shows that modified KGMO method has the higher performance compared to KGMO method. The modified KGMO method has the advantage of feedback learning improves the learning performance of worst particles in KGMO. The enhancement factor of modified KGMO is 1.93 and KGMO is 1.2 in the analysis.

The performance analysis of modified KGMO in R290 fluid and compared with KGMO is shown in Table 4. The proposed modified KGMO has the advantage of feedback learning to improve the learning performance of worst particles in KGMO. The modified

KGMO has the enhancement factor of 1.72 and KGMO has 1.02 in R290 fluid.

The performance analysis of modified KGMO in R600a fluid and compared with KGMO, as shown in Table 5. The proposed modified KGMO has the advantages of feedback learning to improve the learning performance of the worst particles in KGMO. The

Table 2
The Modified KGMO performance analysis on R245fa Fluid.

Operating point	Bell-Delaware method [9]	KGMO [18]	Modified KGMO
J_x	1.51	1.8864	2.8063
IT-F (°C)	19.9	19.9	19.9
OT-F (°C)	59.34	64.5239	64.2804
IP-F (bar)	5.48	5.48	5.48
OP-F (bar)	5.18	4.38	4.38
MF-F (kg/s)	85.55	88.3333	88.3333
IT-GW (°C)	66.64	66.64	66.64
OT-GW (°C)	47.77	52.1439	51.9004
IP-GW (bar)	15	15	15
OP-GW (bar)	15	4.38	4.38
MF-TW (kg/s)	58.1	61.1839	60.9404
RD-FOT (%)	0.38	0.3214	0.3214
RD-GFOT (%)	−0.19	−0.14	−0.14

Table 3
The modified KGMO performance analysis on R134a fluid.

Operating point	KGMO [18]	Modified KGMO
J_x	1.2329	1.9346
IT-F (°C)	19.9	19.9
OT-F (°C)	42.1741	44.3508
IP-F (bar)	5.48	5.48
OP-F (bar)	6.58	6.58
MF-F (kg/s)	67	67
IT-GW (°C)	66.64	66.64
OT-GW (°C)	27.5941	29.7708
IP-GW (bar)	15	15
OP-GW (bar)	17.3	17.3
MF-TW (kg/s)	38.3141	40.4908
RD-FOT (%)	0.4032	0.4032
RD-GFOT (%)	−0.26	−0.26

Table 4
The Modified KGMO performance analysis on R290 fluid.

Operating point	KGMO [18]	Modified KGMO
J_x	1.02	1.72
IT-F (°C)	17.08	17.08
OT-F (°C)	36.14	37.61
IP-F (bar)	5.1	5.1
OP-F (bar)	5.07	4.82
MF-F (kg/s)	57.01	57.21
IT-GW (°C)	58.48	58.48
OT-GW (°C)	22.12	22.17
IP-GW (bar)	15	15
OP-GW (bar)	12.3	12.21
MF-TW (kg/s)	32.31	32.51
RD-FOT (%)	0.3032	0.3032
RD-GFOT (%)	−0.21	−0.21

Table 1
The Heat Transfer Coefficient and Reynolds number of shell and tube side.

	$\alpha_{ss,min}$	$\alpha_{ss,max}$	$Re_{s,min}$	$Re_{s,max}$	$\alpha_{ts,min}$	$\alpha_{ts,max}$	$Re_{t,min}$	$Re_{t,max}$	$\frac{\alpha_{ts,max}}{\alpha_{ss,max}}$
Unit	(W/m2 K)	(W/m2 K)	–	–	(W/m2 K)	(W/m2 K)	–	–	–
R245fa	1204	1219	63,743	73,544	14,058	14,245	113,728	118,501	11.68
R134a	1162	1126	57,212	68,126	12,021	12,165	10,165	101,311	10.67
R290	1016	1021	5412	65,126	11,312	11,014	9046	9111	10.78
R600a	981	987	5216	64,165	10,213	10,361	9021	9100	10.49

Tallapureddy Subba Reddy, Thimmasandra Venkataswamy Sreerama Reddy, Erappa Rajj Babu et al.

Materials Today: Proceedings xxx (xxxx) xxx

Table 5
The modified KGMO performance analysis on R600a fluid.

Operating point	KGMO [18]	Modified KGMO
J_x	1.01	1.12
IT-F (°C)	19.9	19.9
OT-F (°C)	32.1	33.52
IP-F (bar)	4.1	4.1
OP-F (bar)	5.21	5.21
MF-F (kg/s)	56	56.2
IT-GW (°C)	58.67	58.67
OT-GW (°C)	21.1	22.16
IP-GW (bar)	12	12
OP-GW (bar)	16.2	16.2
MF-TW (kg/s)	26.32	27.12
RD-FOT (%)	0.32	0.32
RD-GFOT (%)	−0.28	−0.28

enhancement factor of modified KGMO is 1.12 and KGMO has 1.01 in R600a fluid.

The result shows that the proposed modified KGMO method has higher performance compared to existing Bell-Delaware and KGMO method. The R245fa fluid has the higher enhancement factor compared to fluids such as R134a, R290, and R600a.

5. Conclusion

Shell and tube heat exchanger with ORC improve the efficiency of the exchanger based on Waste Heat Recovery. Existing methods applied various optimization methods to improve the efficiency of the exchanger. In this research, the modified KGMO method is proposed for four fluids to improve the efficiency of the shell and tube heat exchanger. The KGMO worst particle learning affects the performance of the optimization in convergence. The modified KGMO applied feedback learning method to improve the learning performance of the worst particles in KGMO. Four fluids such as R245fa, R134a, R290, and R600a were used to evaluate the performance of the proposed KGMO method. The analysis shows that modified KGMO method has the higher enhancement factor of 2.8 and existing Bell-Delaware method has 1.51 enhancement factor in R245fa fluid. The future work of this method involves in applying the effective optimization method to improve the performance of the exchanger.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] M.H. Mohammadi, H.R. Abbasi, A. Yavarinasab, H. Pourrahmani, Thermal optimization of shell and tube heat exchanger using porous baffles, Appl. Therm. Eng. 170 (2020) 115005.
[2] A.A.A. Arani, R. Moradi, Shell and tube heat exchanger optimization using new baffle and tube configuration, Appl. Therm. Eng. 157 (2019) 113736.
[3] M. Mirzaei, H. Hajabdollahi, H. Fadakar, Multi-objective optimization of shell-and-tube heat exchanger by constructal theory, Appl. Therm. Eng. 125 (2017) 9–19.
[4] Z. Said, S.M.A. Rahman, M.E.H. Assad, A.H. Alami, Heat transfer enhancement and life cycle analysis of a Shell-and-Tube Heat Exchanger using stable CuO/water nanofluid, Sustainable Energy Technol, Assess 31 (2019) 306–317.
[5] A.A. Abd, M.Q. Kareem, S.Z. Naji, Performance analysis of shell and tube heat exchanger: Parametric study, Case Stud. Therm. Eng. 12 (2018) 563–568.
[6] J. Bull, J.M. Buick, J. Radulovic, Heat exchanger sizing for organic rankine cycle, Energies 13 (2020) 3615.
[7] M. Hojjat, Nanofluids as coolant in a shell and tube heat exchanger: ANN modeling and multi-objective optimization, Appl. Math. Comput. 365 (2020) 124710.
[8] C. Zhang, C. Liu, X. Xu, Q. Li, S. Wang, X. Chen, Effects of superheat and internal heat exchanger on thermo-economic performance of organic Rankine cycle based on fluid type and heat sources, Energy 159 (2018) 482–495.
[9] I. Milcheva, F. Heberle, D. Brüggemann, Modeling and simulation of a shell-and-tube heat exchanger for Organic Rankine Cycle systems with double-segmental baffles by adapting the Bell-Delaware method, Appl. Therm. Eng. 126 (2017) (2017) 507–517.
[10] J. Li, Z. Yang, S. Hu, F. Yang, Y. Duan, Effects of shell-and-tube heat exchanger arranged forms on the thermo-economic performance of organic Rankine cycle systems using hydrocarbons, Energy Convers. Manage.. 203 (2020) 112248.
[11] C. Zhang, C. Liu, S. Wang, X. Xu, Q. Li, Thermo-economic comparison of subcritical organic Rankine cycle based on different heat exchanger configurations, Energy 123 (2017) 728–741.
[12] X. Li, J. Song, G. Yu, Y. Liang, H. Tian, G. Shu, C.N. Markides, Organic Rankine cycle systems for engine waste-heat recovery: Heat exchanger design in space-constrained applications, Energy Convers. Manage 199 (2019) 111968, https://doi.org/10.1016/j.enconman.2019.111968.
[13] A. Erdogan, C.O. Colpan, D.M. Cakici, Thermal design and analysis of a shell and tube heat exchanger integrating a geothermal based organic Rankine cycle and parabolic trough solar collectors, Renewable Energy 109 (2017) 372–391.
[14] S. Moein, R. Logeswaran, KGMO: A swarm optimization algorithm based on the kinetic energy of gas molecules, Inf. Sci. 275 (2014) 127–144.
[15] P. Sreesudha, B.L. Malleswari, Performance Analysis of MIMO MC-CDMA System Using Optimization Algorithms, In Microelectronics, Electromagnetics and Telecommunications (2019) 535-543.
[16] G.R. Asha, An Efficient Clustering and Routing Algorithm for Wireless Sensor Networks Using GSO and KGMO Techniques. In Smart Computing Paradigms: New Progresses and Challenges (2018) 75–85.
[17] M. Gholamghasemi, E. Akbari, M.B. Asadpoor, M. Ghasemi, A new solution to the non-convex economic load dispatch problems using phasor particle swarm optimization, Appl. Soft Comput. 79 (2019) 111–124.
[18] T.S. Reddy, T.V.S. Reddy, Optimization of shell and tube heat exchanger design in organic Rankine cycle system using kinetic gas molecule optimization, Int. J. Intel. Eng. Syst. 12 (2018) 297–304.

The covid-19 in India- impacts on the economy and the automobile sector

MRS. LAVANYA P B[1], DR. SUBBA RAYUDU THUNGA[2], DR. N. Y. RAJU[3]

[1]Assistant Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India.
[2]Associate Professor, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India.
[3]Assistant Professor, RK College of Engineering, Vijayawada, Andhra Pradesh, India.
Email ID: ramslavanya@gmail.com, rayudu.thunga@gmail.com, raju.nyr@gmail.com

Abstract: This paper demonstrates the impact of lockdown in Indian economy particularly on automobile sector. The outcome proves that depending on the period of the lockdown, the Indian economy expected to face a loss of about 10-31% of its Gross Domestic Product and production loss is estimated on automobile sector is Rs 2300 crore per day. This study discusses the impact of covid-19 on economy, particularly on automotive sector. This is a secondary research work wherein aim is to study the potential impact of the novel covid-19 on automotive sector. The methodology adopted includes in-depth review and analysis of various reputed published journals, research works, articles, news paper reports and web sources. The study concludes that impact of corona virus is long term and adverse. It is the turn of Indian automotive industry to grab opportunities and flourish.

Keywords: Automobile Sector, Covid-19, Economic impact of corona virus, Gross Domestic product, lockdown.

INTRODUCTION

Corona Virus was first identified in Wuhan City of China and by the time the severity of the infectious disease made known to the world; it has spread and started showing its impact globally. India is now part of globalised economy and has great connectivity with rest of the world in terms of import and export of goods and services and people migrating in and out for various purposes. India is one among the 200 plus countries which are hit by the pandemic.

Inadequate medical facilities, larger population living in villages and remote locations away from minimum medical aids, less infrastructural facilities; the spread of contagious disease would have been more pathetic than anyone can imagine. In the given circumstances, Government of India was left with no option other than to opt for lockdown compromising on economic health for protecting people. The impact of pandemic and subsequent lockdown decision is very high on Indian economy. Various sectors like automotive sector, manufacturing, tourism, construction, trade, hotels, transport, financial services, agriculture, imports and exports, lives of economically marginalized workers, migrant labour and vulnerable sections of the society have been negatively impacted to note some. This paper demonstrates the overall impact of covid-19 on economic and automotive sector.

LITERATURE REVIEW

Richard Baldwin., et al. (2020) noted that Covid-19 to be both a supply as well as demand shock which will crash international trade in goods and services and the study concluded that there is a chance of permanent damage to trade system driven by firm's reactions and policy. Scott R. Baker., et al. (2020) was observed that Covid-19 strongly impact stock market due to various reasons i.e. it affects public health and economy, inter connection among economies. ShloloMaital., et al.(2020) found that the major impact of Covid-19 outbreak would be on supply side of the market, but the remedies being considered currently is mainly focusing on the demand side. The study also pointed that under reasonable current scenarios, a global recession is much likely to occur. Abiad.,A. et al.(2020) study estimates that covid-19 would affect global GDP by 0.1 to 0.4% or $77 billion to $347 billion. Mahendra Dev., S. (2020) analyzed measures such as lockdown, restrictions on global trade, closure of non-essential services, restriction on movement will adversely affect the financial health of the nation. Mishra., (2020) in his study the Covid-19 expected to affect all the sectors like international trade, Financial markets, unemployment, income, poverty and global trade.

Hypothesis Development
H_0= There is no impact of covid-19 on automobile sector performance
H_A= There is a impact of covid-19 on automobile sector performance

OBJECTIVES OF THE STUDY
Investigate the impact and economic losses of corona virus on Indian economy, analyze and discuss the impact of covid-19 lockdown on automobile sector and offer suggestions to strengthen automobile sector.

METHODOLOGY OF THE STUDY
The aim of this paper is to study the covid-19 in India: Impacts on the economy and automobile sector. The present study is qualitative as well as analytical in nature. The data sources are review and analysis of various literatures, reputed published journals, working papers, articles, news paper reports and web sources. For the study paired sample t-test was performed to study the affect of covid-19 on automobile sales with respect to four wheelers and two wheelers.

RESULTS AND DISCUSSION
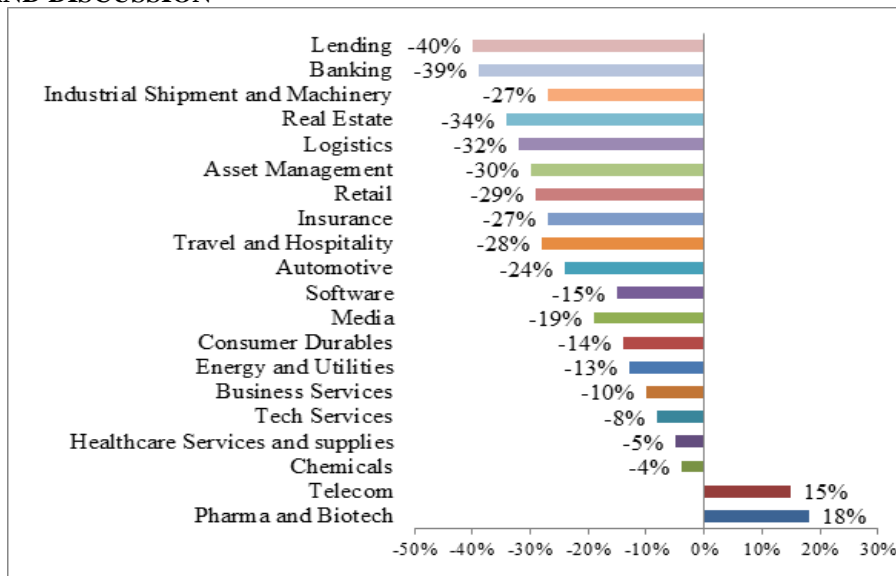
Fig.1: Estimated impact of covid- 19 on market capitalization of key sectors

The above figure represents the impact of covid- 19 on market capitalization of key sector performance in India. It is evident that market capitalization of lending is highly impacted with -40% followed by Banking -39%. On the other side only two sectors could record positive market capitalization, Pharma and Biotech with 18% and Telecom with 15%.
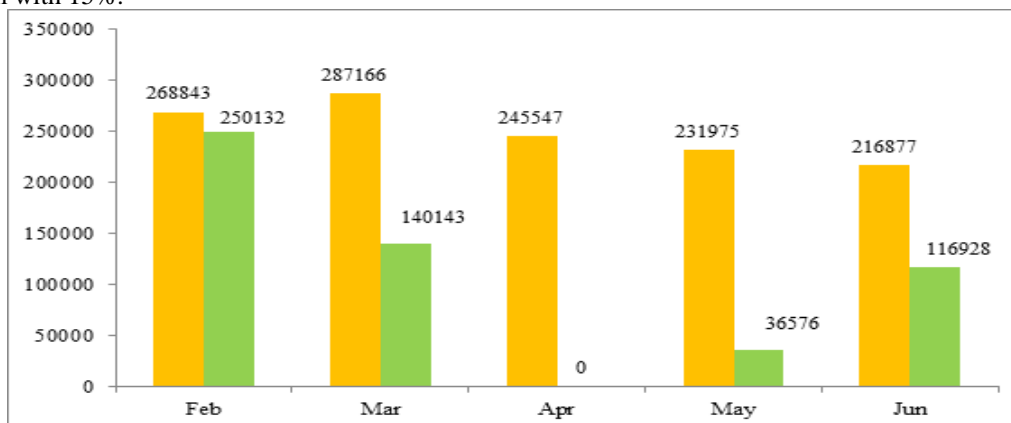
Fig.2: Estimated impact from the covid-19 on four wheelers sales (Pre & Post covid)

The above figure depicts the performance of four wheelers sales in India during pre and post covid-19 scenario against sales in financial year 2019-20 during the same period. On a whole four wheeler sales during 2020-2021 are comparatively less than the sales of 2019-20 for all the five months. The decrease in performance was at accelerated pace with -6.90%, -51.10% during February and March 2020. During April 2020, four-wheeler

reported zero sales. Even though, sales could gain momentum after April, they were still back with -84.20% and -46% during May and June 2020.

Formulation and Testing of Hypothesis

H_0= There is no impact of covid-19 on four wheeler sales performance

H_A= There is a impact of covid-19 on four wheeler sales performance

From the study it is clear that the critical value of paired t test is less than the calculated value at 5 percent level of significance and 4 degrees of freedom. Hence, the null hypothesis is rejected. We may conclude that there is an impact of covid-19 on four wheeler sales performance.
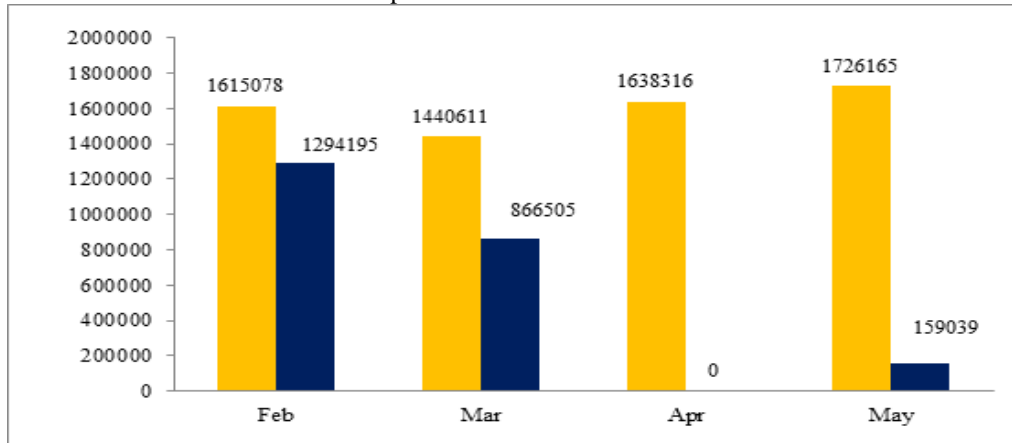
Fig.3: Estimated impact from the covid-19 on two wheelers sales (Pre & Post covid)

The above figure depicts the performance of two wheelers sales in India during pre and post covid-19 scenario against sales in financial year 2019-20 during the same period. The Two wheeler sales reported negative sign in its performance compared to previous year. The percentage of sales decrease reported at -19.80%, -39.80%, -100% and -90.70% during February, March, April and May respectively in 2020 against 2019.

Formulation and Testing of Hypothesis

H_0= There is no impact of covid-19 on two wheeler sales performance

H_A= There is a impact of covid-19 on two wheeler sales performance

From the study it is clear that the critical value of paired t test is less than the calculated value at 5 percent level of significance and 3 degrees of freedom. Hence, the null hypothesis is rejected. We may conclude that there is an impact of covid-19 on two wheeler sales performance.

ANALYSIS AND DISCUSSION

For the couple of years, countries across the world started facing economic slowdown. In the globalised economy countries are so well connected and dependent on each other that, the slowdown in one economy is impacting the performance of another economy too. Countries were in deep discussions for reviving their economies and brining structural changes. Unexpected pandemic, Covid-19 which was first detected in China has worsened the situations among 200 countries. Many were compelled to shut their economies and announce lockdown for protecting the life of their citizens.

In India, the wave of pandemic was seen around in the month of February, making the work of Government, Administrators and regulatory bodies challenging. Indian economy is diverse in its nature compared to other countries in the world. It has 130 billion populations with high density of population living in remote and village areas. It has inadequate infrastructural, medical facilities, insufficient masks, Personal Protective equipment, respiratory and life support systems during the initial days of pandemic hit. The government has taken decision to protect the health of the people at the cost of the economy and announced lockdown. These decisions made the economy to a standstill position for a period of more than 45 days from 25th March, 2020 to 13th May, 2020 unlock process started only from 01st June, 2020.

Lock down decision has heavily impacted Indian economy and on the performance of many sectors. Even India has reported a negative GDP for two consecutive quarters followed by lockdown decision. The impact was clearly evident on market capitalization of key sectors. Banking sector, Retail and Software which were operating as emergency services also got impacted negatively in terms of its Market capitalization with -39%, -29% and -15%. The other major sectors include lending -40%, Industrial Shipment -27%, Real estate -34%, Logistics -32%, Asset Management -30%, Insurance -27%, Travel and Hospitality -28%, Automotive -24%, Media -19%, Consumer Durables -14%, Energy and Utilities -13%, Business Services -10%, Tech Services -

8%, Health Services and Supplies -5%, Chemicals -4%. Only Pharma and Biotech and Telecom companies registered positive Market capitalization with 18% and 15% respectively.

Indian Auto industry is one of the well established and employment generating source and contributes for the GDP of the nation. Environmental consciousness and changing international standards have set new norms for auto players. In India, auto manufactures were informed of changes in emission standards from BS4 to BS6 and given 3 years of time from 2017-2020 for transition. During the three years span many players could not transform to BS6 standard and were left with more BS4 vehicles. Auto players had high expectations on clearing their BS4 vehicles during the first half of 2020 and announced huge discounts. But the reality turned differently with lockdown decision. During April month auto industry was completely shut and reported zero sales. Even though sales started registering in May 2020, they were far below the sales of 2019 during the same period. The Society of Indian Automobile Manufacturers (SIAM) estimated a production loss of Rs. 2,300 crore per day due to lock down decision.

The scenario of Indian auto industry could not have been something great without lockdown also. Auto manufacturers in India import components from China, Germany, US which are worst hit with pandemic. The Indian auto manufacturers maintain an inventory required for 2-3 months production capacity. According to ICRA Ltd., a rating agency, around 27% of components were imported in 2019 to India from Wuhan City (The first place affected with Covid-19 and lock down announced). The major disruption in the Supply chain in Wuhan, The "motor city" of China, a manufacturer and supplier of sensors, power and engine control units, motor and batteries could have impacted the production in India.

CONCLUSION
Indian automobile industry is one of the well established and ripest industries. It offers employment for more than 35 million employees working under permanent and temporary categories. It accounts for nearly fifty percent of manufacturing output in India. The Indian auto industry is facing several challenges for couple of years. On one side, the largest global auto markets are witnessing the flattened curve of performance and disruptions in the supply chain impacting sales of Indian automobile industry. On the other hand, environmental concerns of emission standards from BS4 to BS6 are already posing a challenge for clearing BS4 vehicles before 2020. Covid 19 has more worsened the situation of automobile industry with production loss, reduced sales, termination of employees and pay cuts. The Bailout package announced by Government of India could not really boost the industry in real time. The government can provide special bailout package exclusively for the automotive industry along with reduction in GST for some months and introduction of vehicle scrappage policy. These initiatives can revamp the Indian auto industry and strengthen the economy.

LIMITATIONS AND SCOPE FOR FUTURE STUDIES
The present study has certain limitations such as: it considered only secondary source of data and studied only on impact of covid-19 lockdown in Indian economy particularly to automobile sector in an analytical manner. So in future, researchers can consider primary data and can also consider other sectors such as manufacturing, retail, banking, pharmaceuticals, telecom, agriculture and software.

REFERENCES
1.   Ajay Kumar Poddar & Brijendra Singh Yadav (2020). Impact of covid-19 on Indian economy-A review. Journal of Humanities and Social Sciences Research, 2(S), 15-22
2.   Abiad,A., Arao, R.M., Dagli,S. (2020).The economic impact of the covid-19 outbreak on developing Asia, 2020, https://doi.org/10.22617/BRF200096
3.   Baldwin, R., Tomiura, E (2020).Thinking ahead about the trade impact of covid-19, Economics in the time of covid-19
4.   Baker, S., Bloom, N., Davis, S. J., Kost, K., Sammon, M., &Viratyosin, T. (2020).The unprecedented stock market reaction to covid-19. Covid Economics: Vetted and real-time papers, 1(3)
5.   Dev, S. M., & Sengupta, R. (2020). Covid-19: Impact on the Indian economy (No. 2020-013). Indira Gandhi Institute of Development Research, Mumbai, India
6.   file:///C:/Users/User/Downloads/gx-COVID-19-Impact-Automotive-Sector.pdf
7.   https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/M%20and%20A/Our%20insights/Indias%20post%20COVID%2019%20economic%20recovery%20The%20M%20a
8.   https://www.thequint.com/tech-and-auto/car-and-bike/auto-sector-on-recovery-post-lockdown-detailed-report-passenger-vehicle-pre-owned-cars-and-two-wheelers#read-more
9.   Kishore Kumar Das & Shalini Patnaik (2020). The impact of covi-19 in Indian economy-an empirical study. International Journal of Electrical Engineering and Technology, 11(3), 194-202
10. McKibbin, W., Fernando, R. (2020). The economic impact of covid-19. Economics in the Time of covid-19, 45

11. Narayana, Sudha (2020). Food and agriculture during a pandemic: Managing the consequence. https://www.ideasforindia.in/topics/agriculture/food-and-agriculture-during-a-pandemic-managing-theconsequences.html
12. Pankaj Chaudhary (2020). Impact of covid pandemic on Indian Automobile Industry. https://www.researchgate.net/publication/341344212_Impact_of_Covid_Pandemic_on_Indian_Automobile_Industry/link/5ebbbf7b458515626ca5aaa7/download
13. Pravakar Sahoo & Ashwani (2020). Covid-19 and Indian economy: impact on growth, manufacturing, trade and MSME Sector. Global Business Review, 21(5), 1159-1183
14. Ray, Debraj & Subramanian,S (2020). India's lockdown: An interim report. Working paper series, National Bureau of Economic Research (NBER), No. 27282, May 2020
15. Srivastava,P., (2020). Potential impact of novel covid-19 in Indian economy. International Journal of Advanced Research, 8(05), 711-716
16. Sengupta, Rajeswari and Harsh Vardhan (2020a). The pandemic and the package. Ideas for India, 4 June. https://www.ideasforindia.in/topics/macroeconomics/the-pandemic-and-the-package.html
17. Sengupta, Rajeswari and Harsh Vardhan (2020b). Policymaking at a time of high risk-aversion. Ideas for India, 6 April. https://www.ideasforindia.in/topics/money-finance/policymaking-at-a-time-of-high-risk-aversion.html
18. Sengupta, R (2020). Covid-19: Macroeconomic implications for India. Ideas for India, 24March.https://www.ideasforindia.in/topics/macroeconomics/covid-19-macroeconomic-implications-for-india.html
19. Tejal Kanitkar (2020). The covid-19 lockdown in India: Impacts on the economy and the power sector. Global transitions, 2, 150-156

The Purview of Blockchain Appositeness in Computing Paradigms: A Survey

Battula V. Satish Babu[1*], Kare Suresh Babu[2]

[1] JNTUH, CSE, Hyderabad 500085, India
[2] School of IT, JNUTH, CSE, Hyderabad 500085, India

Corresponding Author Email: satish@aliet.ac.in

ABSTRACT

Blockchain technology is getting more and more pertinent to solve most of the digital problems that we face today. Blockchain is notable for its prominent features like immutability, decentralization, consensus, privacy, and security. However, blockchain is still suffering from different barriers like quantum attacks, scalability problems, integration problems, incompetence to face bigdata, storage problems, and so on. The main aim of this study was to find out the scope, various problems raised, and the applicability of blockchain technology when integrated with different computing paradigms like cloud computing, edge computing, fog computing, osmotic computing, big data computing, and quantum computing. To conduct this study, we have surveyed different research articles in the combination of blockchain technology and computing paradigms. Based on this survey, we have mentioned the contemporary research works, challenges, and a list of possible research opportunities and solutions.

1. INTRODUCTION

As a part of the Bitcoin cryptocurrency, "Satoshi Nakamoto" introduced the concept of blockchain 1.0. In the year 2015, with the advent of smart contracts in the Ethereum blockchain platform made blockchain 2.0 unconfined to the Bitcoin cryptocurrency. Later, many top MNC companies like Google, IBM, Microsoft, FedEx, Facebook, etc. started investments in developing blockchain solutions.

At present, blockchain helps to solve many digital problems that we face in our daily lives. To understand the proliferation of blockchain, in the paper [1], we have listed nine application categories with a total of 88 identified different blockchain applications.

In that paper [1], we have identified that 88 applications were implemented in one of the computing paradigms like cloud, edge, fog, osmotic, bigdata, and quantum computing paradigms. So we started our literature survey by identifying the implications of adopting blockchain along with different computing paradigms.

2. RELATED WORK

To write this survey paper, we have almost referred to 147 research articles published in the combination of computing paradigms and the blockchain. Here Figure 1 represents the time order of the literature survey, and Figure 2 represents the number of journals and conference articles referred.

As a summary of Figure 1 and Figure 2, we can understand that research on integrating computing paradigms with the blockchain and its applications is gaining more interest in the research community, but still there are so many research gaps.

The main aim of writing this survey paper is to highlight contemporary research works, challenges, and to list out the research gaps and possible research opportunities regarding blockchain appositeness in computing paradigms.
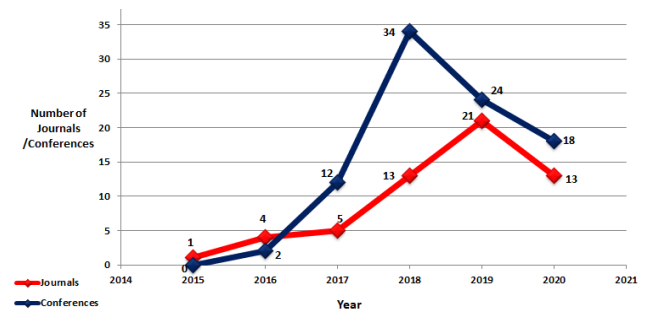
Figure 1. The time order of the literature survey
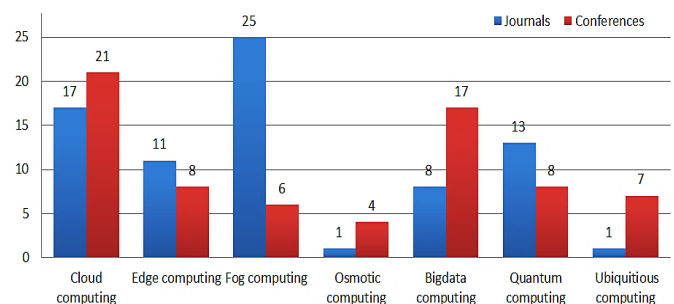
**Figure 2.** Number of journals and conference papers referred

In every section, we are going to mention contemporary research works, challenges, and list possible research opportunities. In Section 3, we have listed out different research works on the integration of the cloud and its services with blockchain. In Section 4, we have listed out some research works on the integration of edge computing with the blockchain framework. In Section 5, we discuss the feasibility

of integrating blockchain with the fog computing concept. Section 6 is about combining osmotic computing with blockchain. In Section 7, we have listed out different research works on combining blockchain with big computing. In Section 8, we have listed out some research works on combining blockchain with quantum computing and quantum attacks on blockchain. In Section 9, we explain the blockchain inappropriateness in particular cases. Section 10 includes the

survey analysis. Finally, Section 11 is about future work and the conclusion.

3. INTEGRATING BLOCKCHAIN WITH CLOUD

The comprehensive representation of blockchain applications in cloud computing are shown in Figure 3.
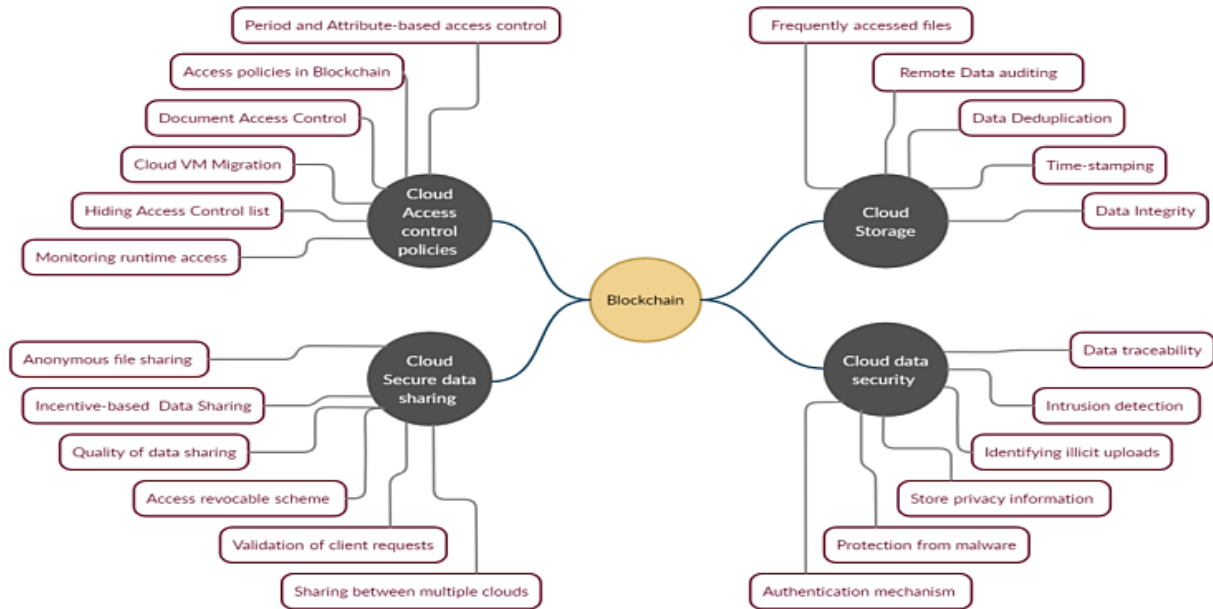
Figure 3. Comprehensive representation of blockchain applications in the cloud

When integrating blockchain with cloud, it is possible to overcome different cloud-related challenges like downtime, identifying data corruption, data security, limited access control, trust management issues, data sharing problems, and data privacy concerns.

Before integrating blockchain into the cloud, one should think of its characteristics and then decide its applicability to the cloud applications. Chan et al. [2] has given ten different characteristics and different requirement questions on the blockchain that can help anyone to decide about integration. These characteristics are immutable, data transparency, trust by smart contracts, individual identity, distribution of data, transactional system, permanent history of records, suitable for ecosystems and not for particular software, single backward-linked list, decentralized workflow architecture. But still, a few problems need to be addressed by research, among them

- Need designing of blockchain systems for the cloud that supports different data policies of different countries when cloud data moves from one country to another country data center.
- Need one common cloud blockchain IDE that supports the integration of cloud to different blockchain systems.

3.1 Blockchain combined with cloud storage

Centralized cloud storage is not secure and reliable for outsourced user data. Using a blockchain along with cloud storage will guarantee the security of user outsourced data. From the cloud storage perspective, blockchain is applied in different ways

1) Frequently accessed files: Shah et al. [3] suggested

using an adaptive algorithm through which we can identify frequently accessed files and maintain their metadata in the blockchain. This procedure will make them readily available. Additionally, the credit system is introduced to prioritize peer requests based on their previously provided file access services.

2) Remote data auditing: It is a process that allows the data owner to audit the outsourced data in cloud storage and to confirm the trustworthiness of the cloud service provider. Using a blockchain for data auditing involves all peer nodes as an association to verify the correctness of outsourced data. This proposed arrangement by Huang et al. [4] decreases the data owner's cost of verification.

3) Time-stamping: Time-stamping is very important when cloud data is about intellectual property rights. Zhang et al. [5] proposed a time-stamping mechanism using a blockchain, where the transaction with time-stamp will be created during the file creation in the cloud. It is not possible to change the time-stamp because the blockchain is immune to content modification.

4) Data Integrity: Blockchain is used as a perfect tool to verify the integrity of cloud data. Till now there are many proposed methods to protect the integrity of cloud data. One of them is the method proposed by Sharma et al. [6], which uses two Merkle trees to maintain owner and file information separately. This arrangement allows the verification of user request using blockchain

5) Data Deduplication: It is the process of removing the duplicated data in the cloud and reducing cloud resource costs. SP.Gochhayat et al. [7] has proposed a blockchain based tool called "Yugala", used to protect the integrity and de duplicates

the cloud data. Li [8] performed the deduplication of data from heterogeneous cloud datacenters. Here blockchain is used to maintain block indexes in the ledger.

Multiple data blocks with the same indexes will be considered as duplicates and removed from the cloud storage. But still, a few problems need to be addressed regarding the association of cloud storage along with blockchain, among them

- The problem of a byzantine node is still not addressed during the remote data audit for collaborative data verification
- In the blockchain network, every participating peer maintains the same copy of chained blocks. As time passes, the peer node may run out of storage if blockchain size increases. So there is a need for porting blockchain storage to a distributed storage solution.

3.2 Access control policies using blockchain

Controlling access to cloud assets is possible by defining the policies. There is a chance that a hostile cloud resource administrator or manager may tamper with these policies to grant illegitimate access and to pose unusual restrictions on legitimate users. Therefore, it is a dire need to protect these policies from such activities. Recently, the blockchain has emerged as a solution to protect these policies. Where policies are directly written into the blockchain. Some of the works on policy management using blockchain are listed below.

1) Cloud VM Migration: Uchibayashi et al. [9] placed policies in blockchain management host to manage cloud VM migration. This arrangement will remove restrictions on the source and destination host and speed up the migration process.

2) Document Access Control: Desai et al. [10] proposed a multi-user-based access control system. When the document is uploaded into the cloud, its encrypted link will be stored in the blockchain. Multiple clients who want to access cloud files should verify themselves and use the aggregate key to decrypt the link. Tseng et al. [11], used blockchain as a link to decrypt and encrypt the file location in the cloud, where the actual data is stored in the cloud.

3) Period and Attribute-based access control: In Wang et al. [12] method, the data owner is going to place ciphertext in blockchain and set the access period for the particular user. Users will be able to access ciphertext in blockchain only when the user provides the attributes and correct access period acceptable by access policy.

4) Access policies in Blockchain: Yang et al. [13] have proposed "AuthPrivacyChain", where access policies are written in the cloud blockchain. User access queries to access cloud data are always checked against policies in the blockchain.

5) Hiding Access Control list: Hoang et al. [14] proposed a blockchain based framework, where the data owner maintains a modifiable hidden access control list that contains consumer public keys with whom he or she wants to share the data. Additionally, smart contracts are deployed to control the location of share data located in IPFS. The consumer data retrieval request is also registered and controlled using smart contracts.

Apart from the above-mentioned methods, the research against the access control policy mechanism using the blockchain is still in the infancy.

3.3 Secure data sharing using blockchain

Data sharing through a cloud service provider is not entirely reliable and leads to different user privacy and quality issues. Choosing a blockchain is a considerable option to share data without the involvement of malicious third parties. Recent works that incorporated blockchain to share cloud data are

1) Signcryption: Liu et al. [15] used `signcryption` for the Internet of vehicles network data traffic sharing. The blockchain is used to maintain the vehicle's access control list. Data request from the client is validated against the blockchain ACL. On successful validation of client requests, smart contacts are used to send encrypted data storage addresses to the client. On receiving the encrypted data address, the client uses a symmetric key to get the required data.

2) Incentive-based data sharing blockchain: Shen et al. [16] proposed an incentive-based data sharing mechanism using a blockchain. When multiple clouds are involved in data sharing,**"Shapley value"** is used to determine fair incentive distribution and thereby increasing the quality of data sharing from multiple cloud participants.

3) Blockchain based academic paper sharing and peer review system: Zhou et al. [17] proposed a blockchain based academic paper sharing and peer review system. Hyper ledger Fabric platform is applied to maintain information regarding document access and reviews. For sharing documents, the blockchain is integrated with IPFS. In this method, anonymity is provided to both the reviewer and the author. This paper addressed the biased reviews using review metrics. Reviewers are automatically paid for their reviews by deploying smart contracts

4) User data-sharing categories: Shrestha and Vassileva [18] implemented incentive-based Ethereum blockchain for research data sharers users. Users need to register in a private network. A user participating in the network can describe data-sharing categories. Ethereum blockchain is used to share data among registered users. Policies regarding access and privacy are stored in the blockchain

5) Access revocable scheme: Hoang et al. [14] proposed access revocable scheme using predicate encryption, where the data owner is going to create a private key for every user that can be used for decryption. If the data owner finds malicious behavior on the user side, the data owner re-encrypts the data through a delegated storage node. After re-encryption, malicious users will become impotent to decrypt the data [19].

3.4 Achieving clouds data security using blockchain

Blockchain technology has become a promising alternative to confront different cloud data security issues because of features like immutability, distributed consensus algorithms, decentralized open ledger, using a hashing function. In this section, we are going to discuss a list of recent works that had incorporated blockchain for cloud data security:

1) Security: In the survey conducted by Xu et al. [20] and Tsai. et al. [21], have provided different solutions to secure cloud data using the blockchain. Among them

a. Public key cryptography and access control lists are used to safeguard cloud data privacy. We can use the blockchain and the public key cryptography to store data, smart contract to apply access control policies.

b. Monitoring runtime access: Smart contracts are used to specify access rights. Access logs will be collected from the cloud and compared against smart contracts to identify the

infringement.

c. Data traceability: It is possible to store cloud data access log operations in blockchain for efficient cloud data audit

d. Integrity verification: Original data will be store in cloud storage as an off-chain database. And the blockchain is used to maintain metadata like the address and hash of the cloud data. The data owners can investigate cloud data integrity using meta-data stored in the blockchain.

e. Anonymous file sharing using blockchain protect the privacy of data owners.

f.Identifying illicit uploads: A unique hash ID and other meta-data of upload files will be stored in the blockchain. Later on, this unique hash ID and authentication signatures can be used to identify illicit file uploads.

2) Kumar and Singh [22] has proposed Distributed intrusion detection using the blockchain. This method allows us to exchange log data with each other and decide the authenticity of logs from different cloud servers. If the blockchain network is growing large, then we need to face bigdata challenges.

3) Yan. et al. [23] suggested using a fuzzy algorithm based on searchable encryption through keyword. This method provides good searching results even in the case of typos in the keyword by the user. However, we can still improve this method by applying existing machine learning algorithms.

4) Albalawi and Azim [24] proposed a cloud-dependent enrollment and authentication mechanism for IoT devices using blockchain. Here blockchain is used to store IoT device-related data. However, if there is a large number of IoT devices, transactions lead to spun-out of the authentication process.

5) Malvankar et al. [25] proposed a method of restraint against malware in the cloud. Here, graph analytics are utilized to find the malicious node, and that information is shared with all other nodes that are part of the blockchain. Smarts contract is automatically applied to take appropriate action.

6) Westerlund and Jaatun [26] mentioned that using a blockchain to store privacy information does not concur with one of the GDPR privacy elements because of the immutability property of blockchain. But still, we need more research on storing and protecting user privacy data permanently in the blockchain.

4. INTEGRATING WITH EDGE COMPUTING

It was reckoned that the number of connected IoT devices would be increased to 25 billion by the end of the year 2030. Almost 130 new IoT devices per second are connected to the internet. As the velocity of data is increasing, the quantities of data that need to be processed and transferred are also increasing. Conventional centralized cloud servers can be used to store and process data originating from IoT devices. Using a centralized cloud server creates different problems.

- **Network latency from the cloud**: It is a consequential problem and critical for real-time IoT devices if there is a delayed response from the cloud, even for milliseconds.
- **Increased bandwidth**: It happens when a large volume of data is transferred with a high velocity between IoT devices and centralized cloud servers.

To overcome these problems, we can realize the distributed computing paradigm called "Edge computing". In edge computing, instead of entirely relying on cloud services, most of the data storage and computing operations are moved and performed in the proximity of the IoT device or in the IoT

device itself. When combined with the blockchain, we can even solve more problems related to edge computing. In this section, we are going to list out a few recent works on edge computing in the combination of blockchain:

1) Varghese et al. [27] has listed out different challenges regarding the integration of edge and blockchain

a. Blockchains are usually meant to store linear transactional data. But it is still obscure on how blockchain is going to handle complex data arrangements and queries that belong to edge market places.

b. It is still uncertain about the impact of different types of blockchain on edge computing models.

c. It is still uncertain about the impact of blockchains off-chain and on-chain storage on edge storage models.

2) Freitag et al. [28] proposed the community-based micro cloud over edge devices using blockchain. Here group Individual nodes part of the blockchain network denotes storage and computational resources to the edge devices. Individual nodes are going to get incentives based upon the participation in a micro-cloud service. Decentralized governance of all nodes is possible by using by materializing the blockchain.

3) Zhang et al. [29]. Used mobile edge computing to solve large intensive computational problems required for consensus. Blockchain is used to make data tamper-proof and to remove the dependency on a centralized trusted system.

4) Li et al. [30] raised the challenge that needs to be solved. Once the data is entered the blockchain, the blockchain is going to make that data immutable. But what about the protection of the same data in an edge device before it enters the chain?

5) Liu et al. [31] designed a model of blockchain and mobile edge computing to handle computationally intensive tasks related to video transcoding. Here blockchain is used to create a co-operative environment between video transcoders and provide incentives.

In their model, computationally intensive tasks are offloaded to edge devices provided with storage and computational resources. Additionally, they have introduced the concept of dynamic block size to handle different requirements of video transcoding.

6) Liu et al. [32] introduced the concept of caching the block hashes in blockchain deployed on the mobile edge computing devices. Block hashes are cached to speed the communication between edge nodes.

7) Xiong et al. [33] listed out open issues that are raised when blockchain is integrated with edge computing.

- There is a possibility of jamming attacks when the transactional data is in transit between wireless IoT devices and edger servers
- Efficient resource allocation methods are still needed when there are many resource requests from multiple IoT devices.

8) Zheng et al. [34] designed two different consensus protocols

- To improve performance of the system, message-based consensus protocol is proposed instead of hash-based consensus protocol.
- POE (Proof-of-Edge) consensus protocol is proposed to maintain consensus between edge computing nodes.

9) Xu et al. [35] proposed a resource management method. According to them, different edge devices are equipped with different levels of computational and network resources. Not all edge devices are going to afford the resources required to

maintain the blockchain. They have proposed two approaches for efficient resource utilization when dealing with bigdata on the edge. The possible solution is to develop a new mechanism that identifies the state, context, and requirements of edge devices by using some using unique identifiers.

10) The same kind of method is implemented by Seike et al. [36] in the management of ownership

● Transaction filtering: "Futile transaction theory" is applied to reduce the storage utilization of the blockchain. According to this theory, previous transactions are useless if their output is represented by the latest transactions.

● PoC (Proof of collaboration): It is a consensus protocol that requires less computational resources when compared to PoW.

11) Rahman et al. [37] proposed an anonymity scheme for each block in the edge blockchain using the open-source tool called **"tor"**. Because the address of the block is easily detectable in the public blockchain

12) Xu et al. [38] applied game theory to reduce potential attacks from edge servers. In this game, every edge server records the actions of other servers. These records are shared with the entire network. Every edge server is going to find out the Nash equilibrium value over received action records and applies a punishment scheme for identified malicious edge servers.

13) Kang et al. [39] for efficient data sharing they have implemented a consortium blockchain in a vehicular network with selected edge nodes. These prior selected edge nodes are responsible for reaching consensus.

14) Gauhar et al. [40] expounded the authentication mechanism between IoT devices installed in different places and working for variety of domains. They have created global and internal smart contracts to make them available for a variable number of users.

The synopsis of the above-mentioned recent works are listed in the Table 1.

Table 1. Recent works on Edge computing with Blockchain

| Author	Purpose	Synopsis
Varghese et al. [27]	Integration Challenges	● Handle complex data arrangements and queries ● impact of different types of blockchain ● Impact blockchains off-chain and on-chain storage
Li et al. [30]		● Protection of data in the dge device before it enters the chain
Xiong et al. [33]		● Possibility of jamming attacks ● Handling many resource requests from multiple IoT devices
Felix Freitag et al. [28]	Resource sharing and utilization	● Incentive-based storage and computational resources sharing
Xu. et al. [35]		● Resource utilization by identifying the state, context, and requirements of edge devices
Zhang et al. [29].	Intensive computational problems	● Blockchain used to make data tamper-proof
Liu et al. [31]		● Handling computationally intensive tasks related to video transcoding
Liu et al. [32]	Improving the performance of blockchain	● Caching the block hashes in blockchain
J. Zheng et al. [34]		● Message-based consensus protocol ● POE(Proof-of-Edge) consensus protocol
Seike et al. [38]		● Transaction filtering to reduce the storage utilization of blockchain ● Used proof of collaboration that requires less computational resources
Rahman et al. [36]	Improving the Security	● Anonymity scheme
Xu et al. [37]		● Using game theory to reduce attacks from other edge servers
Ali Gauhar et al. [40]		● Authentication mechanism between Edge devices
Kang et al. [38]	Data sharing	● Implemented a consortium blockchain for efficient data sharing

5. INTEGRATING WITH FOG COMPUTING

Fog computing is like a better version of edge computing. In edge computing, the storage and computational operations are carried out directly on edge devices. Edge computing has different cons like

- Huge amount of data generated on edge devices with less storage capacity
- Costly in terms of maintenance
- Need sophisticated infrastructure
- Security is at stake because data transferred to edge networks present outside
- Edge devices are used only for analyzing data
- Very little redundancy

Some of these problems can be solved using fog computing. Fog computing performs storage and computational operations on separate LAN-connected computers called Fog nodes. Fog nodes are equipped with more storage capacity and processing power when compared to edge devices. In turn, the

fog node is connected to the cloud. Figure 4 explains the concept of Fog Computing.
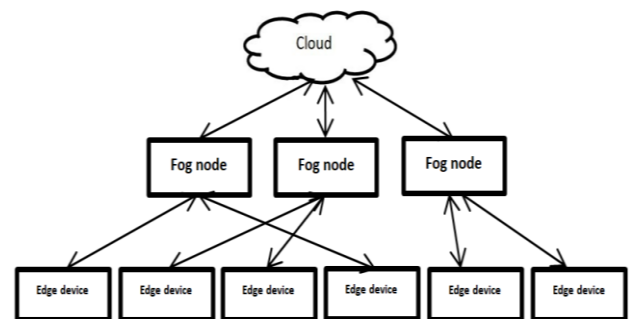
Figure 4. Fog and Edge computing

Fog computing is a solution provided by the CISCO company. Its name is given like that because fog lies just below the cloud and nearer to the ground (edge devices). When

combined with blockchain we can overcome security and privacy-related challenges. In the following section, we are going to list out a few recent works on the combination of fog computing and blockchain.

Table 2. Recent works on Fog computing with blockchain

Author	Purpose	Synopsis
Lei et al. [41]	Integration Challenges	• Need block parameters tuning to overcome scalability problems. • Computationally intensive Proof of Work (PoW) need to be addressed
Baniata et al. [50]		• Need more sophisticated security measures • Not suggested for time-critical IoT application • Lack of standardization • Problem with fast-moving clients
Yao et al. [42]	Authentication Mechanisms	• Introduced a lightweight and message-based authentication scheme using a blockchain for fast-moving vehicles
Almadhoun et al. [43]		• Proposed mutual authentication scheme between fog nodes in proximity.
Puthal et al. [53]		• Proposed lightweight blockchain consensus protocol "Proof of Authentication" for a fog node with resource constraints.
Debe et al. [45]	Reputation-based mechanisms	• Reputations of fog nodes are used either to distribute incentives and to penalize them for bad behaviour
Yu et al. [47]		• To identify and analyze storage and computing requirements
Cinque et al. [56]		• Instead of using reputation scores, fog nodes assign trust degrees to other nodes
Alshehri et al. [46]	Security	• Designed on-chain policies to control access to the data.
George et al. [48]		• Suggested using lightweight Elliptic curve cryptography
Wu et al. [49]		• Blockchain is used to store the access control list of fog nodes.
Ziegler et al. [51]	Simplifying Proof of Work (PoW)	• Creating side chains to decrease the load on blockchain caused due to PoW
Kumar et al. [52]		• Statistical-based matrix factorization is used to simplify PoW
Lee et al. [54]		• Delay Aware Tree (DAT) is constructed to free blockchain from PoW
Memon et al. [44]		• Maintained two fog layers in the system. Here the second layer is dedicated for mining operations related to PoW
Yánez et al. [55]	Data Management	• Calculated the rating of allotment (ROA) to decide on-chain data allotment for edge devices

1) Lei et al. [41] expounded problems related to fog computing like centralized and trust management and presented a solution called the blockchain. When combined with fog computing, they have suggested for block parameters tuning to overcome scalability problems of blockchain in the combination of fog computing.

Tuning block parameters like block size, block interval is going to influence blockchain properties like consistency as well as performance. The Blockchain Proof of Work is also heavy for a fog node. These problems still need to be addressed when fog computing is integrated with blockchain

2) Yao et al. [42] proposed a lightweight and one message-based authentication scheme using a blockchain for the fast-moving vehicles that are part of fog networks.

3) Almadhoun et al. [43] proposed a mutual authentication scheme carried out by fog nodes. Instead of involving IoT devices in hefty computation required for authentication and communication, we can use fog nodes that are present in near distance to IoT devices.

4) Memon et al. [44] suggested using two fog layers in the blockchain based IoT architecture. Here layer one contains a cluster of regular fog nodes that communicate with both cloud and IoT devices. Layer two contains fog nodes that are especially dedicated to performing mining operations for IoT devices that are part of the blockchain network.

5) Debe et al. [45] implemented a reputation-based mechanism using a blockchain to identify the reputation of a fog node either to distribute incentives or to penalize them for bad behaviour.

6) Alshehri et al. [46] resist the fog nodes from infringement data security. They have maintained on-chain policies to control access to the data. Every fog node is provided with an off-chain database of data files that are accessed often.

7) Yu et al. [47] applied a reputation based framework to identify and analyze storage and computing requirements of the fog node. They have divided fog node nodes into three categories: basic, light, and full-fog nodes based on computing power. For efficient storage methods, they have also identified users with two identities in two different fog nodes.

8) George et al. [48] suggested using a lightweight Elliptic curve cryptography scheme signing transactions in the blockchain in resource constraint IoT devices. But still, lightweight ECC needs some improvements like reducing bandwidth and energy consumption.

9) Wu et al. [49] used a blockchain to store the access control list of fog nodes. In their method, fixed blockchain length is maintained in a cluster of fog nodes to save storage space. A flake of a peer-to-peer network is created as a cluster that can work with less computing power available.

10) Baniata and Kertesz [50] mentioned a few challenges regarding the integration of fog and blockchain integration that are to be addressed.
 • Integration between them is not yet standardized
 • Decentralization property of blockchain along with fog computing needs more sophisticated security measures.
 • Their integration causes jitter, and it is not suggested for time-critical IoT application
 • PoW on fog node needs more computational energy
 • There will be complex situations due to fast-moving clients.

11) Ziegler et al. [51] proposed a scalable mechanism called the "Plasma framework" that can be used to integrate blockchain and fog nodes. This framework lets you create side chains from the parent chain. These side chains are used to maintain the transactions that are moved out of the parent

chain. Doing this will decrease the load on blockchain caused due to PoW and make it more suitable for fog nodes.

12) Kumar et al. [52] applied statistical-based matrix factorization to simplify "PoW". This method is used to easily obtain a solution with minimal memory and energy in a fog environment.

13) Puthal et al. [53] introduced a new lightweight blockchain consensus protocol "Proof of Authentication" for fog and IoT nodes with resource restrictions. In general PoW and other consensus protocols are applied to validate the blocks, whereas PoA is used to authenticate blocks.

14) Lee et al. [54] made a blockchain released from implementing PoW as it is computationally intensive. Here blockchain implementation is based upon the construction of Delay Aware Tree (DAT). After gathering certificates of IoT devices, now the system constructs DAT and selects as a fog device with less delay, i.e., a fog node near to the IoT device.

15) Yánez et al. [55] designed on-chain data allotment mechanism for edge devices using fuzzy logic. For every request, the method is to calculate the rating of allotment (ROA) based on different network-related parameters.

16) Cinque et al. [56] proposed a new trust management model. Instead of using reputation scores to decide the trust among nodes, this model allows every node to assign trust degree numbers (0 – No trust, 1 - Trust) to other nodes. These nodes may or may not belong to the same organization.

The synopsis of the above-mentioned recent works are listed in the Table 2.

6. INTEGRATING WITH OSMOTIC COMPUTING

Osmotic computing is a new computing paradigm inspired by the chemical osmosis process. In the chemical osmosis, process molecules move from a highly concentrated solution to a low concentrated solution to equalize the concentration of the entire solution.

Likewise, in osmotic computing micro services will be migrated to resource-constrained edge devices to the highly equipped cloud and vice versa is also possible [57].
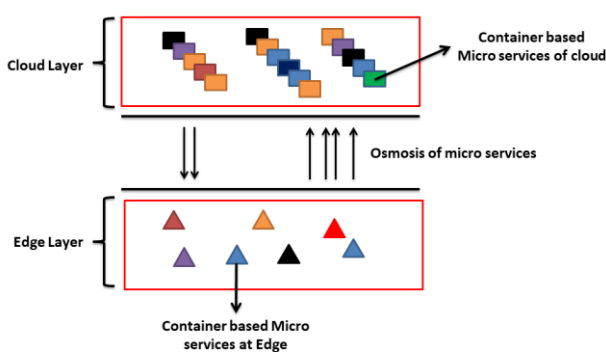

Figure 5. Osmotic computing between the edge, cloud

Osmotic computing is used to establish extensively federated and highly distributed environments in the cloud and edge. Micro services are deployed as virtualized containers using container-based technologies e.g Docker. It inherits all challenges and issues related to the edge and cloud environments. Osmotic computing is explained in Figure 5.

The following are the merits possible by integrating blockchain along with osmotic computing:

1) Supplemental analysis: Devices at the edge layer collect data from different sources and perform different types of operations on that locally stored data. The same data is transferred to the cloud layer for supplemental analysis.

2) Micro elements/Micro services: Buzachis and Villari [58] leveraged blockchain on software-defined membranes (SDMem). Micro elements/ micro services are transferred through this SDMem to enforce access control policies and to reach consensus during the osmosis.

Buzachis and Villari [58] implemented SDMem like Villari et al. [59] but with a private blockchain to ensure the integrity and ownership of data transferred and processed in micro services. A private blockchain is used to record all transactions related to micro services related to the cloud and edge.

3) Merits and challenges: Rasool et al. [60] expounded on the merits and challenges involved in the integration of blockchain. The following are the merits possible by integration.

- Openness
- Consensus-based Trust
- Smart contact-based reliability
- PoE along with access control list for privacy
- Semi-private blockchain for ownership

Challenges on integration:

- There is a dire need for research to discover the applicability of different types of blockchain in the presence of osmotic computing.
- Since Osmotic computing involves cloud, fog, edge layers, a new common consensus mechanism needs to be fabricated that requires the same level of computation resources in different layers
- Need research on possibilities of on and off-chain transactions
- Service management based on type of environments like cloud, edge, fog, IoT [61].
- Mirjana [62] stated that services would be categorized into macro services and micro services. Macro services are handled in a large cloud-based data center, whereas micro services are handled on resource-constrained IoT/Edge devices. To implement osmotic computing should have an insight into the following things.
  - Categorization of services into Macro or Micro
  - Estimating the different resource requirements for services and edge devices.

7. BIGDATA COMPUTING USING BLOCKCHAIN

Generally, the blockchain supports linear data with a small size. Recently, many scholars applied blockchain for securing bigdata in different ways like

- Bigdata Authentication
- Auditing to find interesting patterns
- Avoiding data skewness
- Data circulation in an autonomous way using blockchain
- Efficient sharing of Bigdata
- Bigdata privacy and trust
- Blockchain bloat

1) The challenges and requirements of bigdata authentication:

Abdullah et al. [63] has demonstrated the challenges and requirements necessary for bigdata authentication. The Bigdata tool Apache Hadoop uses Kerberos for the

authentication process. Already Kerberos systems are facing different challenges like

- Authentication based on password
- Having the chance of reply attacks
- Password guessed by brute-force attacks
- Exposure of session keys
- KDC (Key Distribution Center) as a single point of failure
- Time synchronization problems in a distributed environment
- Denial of service attacks

Prerequisites of bigdata authentication

- Decentralized authentication
- Anonymous and passphrase less environment
- Ignoring Session keys methods
- No single point of failure
- Immutable records

This entire list of requirements can be satisfied using a blockchain.

2) Subbiah et al. [64] proposed a querying algorithm based on blockchain technology. Traditional querying on bigdata is by using the MapReduce algorithm that causes data skewness.

To handle data skewness, the MapReduce-based querying method is replaced with a blockchain based querying method. In this method, the Map phase output is stored in the blockchain and uses caching to render the results.

3) Alexander and Wang [65] explained how blockchain 2.0 led to bigdata security in the following manner.

- Smart contracts lead to efficient bigdata circulation
- Decentralized storage of blockchain helps for efficient big data sharing
- Blockchain can be used to record the log of bigdata operations that can be used to audit.

4) Zheng et al. [66] said that when bigdata systems combined with blockchain, efficient data management schemes are possible. We can also perform data analytics on transactions of the blockchain to identify compelling patterns. (We need to check the applicability of parallel algorithms to analyze blockchain data)

5) Chen and Xue [67] stated that blockchain protects the data owner's copyrights and ownership rights by auditing the bigdata transaction logs of important documents present in the blockchain.

6) Yu et al. [68] implemented Data Auditing Blockchain (DAB), a different strategy to audit bigdata by collecting proofs of audits instead of blockchain transactions [69].

7) Karafiloski and Mishev [70] literature review suggested using access control list policies to maintain the privacy of big data. Shared encryption is applied to confidential data and sends the ciphertext to the off-chain "Distributed Hash Table" (DHT). Here blockchain is going to maintain a hash address as a link to that data.

8) Bandara et al. [71] compared blockchain storage against distributed storage and listed out a few shortcomings of blockchain.

- Blockchain storage is not that scalable when compared to distributed databases.
- It takes so much time to confirm the transaction.
- Less transaction throughput
- Lack of proper querying features
- Not suitable for big data sets

They have proposed the **"Mystiko"** blockchain-based storage built over a distributed database called Apache Cassandra. It is capable of handling big data and provides high transaction output.

Table 3. Recent works on Bigdata computing with blockchain

Author	Purpose	Synopsis
Subbiah et al. [64]		• Kerberos for the authentication process in Apache Hadoop • Data skewness • Bigdata privacy is a problem • MapReduce based querying method is not suitable.
Bandara et al. [71]	Integration Challenges	• Blockchain storage is not scalable when compared to distributed databases. • It takes so much time to confirm the transaction • Less transaction throughput • Lack of proper querying features • Not suitable for big data sets
Alexander et al. [65]		• Bigdata circulation
Smith et al. [72]		• Blockchain bloating (suggested using a tool called "Stroj")
Preece et al. [73]		• Placing confidential data in blockchain smart contracts is not preferable.
Zhou et al. [74]		• Suggested using holomorphic encryption to protect the privacy of big data.
Elena et al. [70]	Security	• Suggested using access control list policies and DHT in to maintain the privacy of big data
Zheng et al. [66]	Data Management and Auditing	• Data analytics on transactions can be performed to identify interesting patterns
Alexander et al. [65]		• Decentralized storage ledger of blockchain helps in bigdata sharing • Blockchain can be used to store bigdata log operations
Chen et al. [67]	Storage and Auditing	• Auditing the bigdata transaction logs to protect owner's copyrights
Yu et al. [68]		• Implemented Data Auditing Blockchain (DAB) that collects audit proofs
Bandara et al. [71]		• Proposed a blockchain tool **"Mystiko"** based on distributed storage.

9) Smith [72] suggested different methodologies to cope with blockchain bloating like using a tool called "Stroj" that makes use of Merkle tree and other method is by using Distributed network coded storage.

10) Preece et al. [73] suggested that blockchain smart contracts are generally available to everyone. Placing confidential data in smart contracts like a symmetric key in unencrypted format is not at all preferable.

11) Zhou et al. [74] explained the necessity of research on holomorphic encryption suitable for Quantum algorithms. Holomorphic encryption performs special mathematical calculations on encrypted data, where data can be verified without decryption. Holomorphic encryption can be applied to protect the privacy of big data.

The synopsis of the above-mentioned recent works are listed in the Table 3.

8. INTEGRATING WITH QUANTUM COMPUTING

Quantum computing is rooted in the concept of physics quantum mechanics. In quantum mechanics, particles like a photon have a quality of spin during their travel. The spin, in the vertical position and forward diagonal position, is used to represent the binary bit "1". And the spin, in horizontal position and backward diagonal position is used to represent the binary bit "0".

Sometimes the spin position of a photon represents both "1" and "0" at the same time. This position is called "qubit", and the property is called a "Superposition" of the photon. The same superposition property is used in quantum computing.

Traditional computers represent any data only by using 1's and 0's, whereas quantum computers represent data using 1, 0, and qubit. If we have "N" qubits, then we can represent 2^N bits. For example, if we have 300 qubits, then we can represent 2^{300} bits that are almost equal to the number of particles in the world.

This property makes quantum computers and quantum computing very powerful. We can use quantum computers to solve so many complex problems in polynomial time.

8.1 Quantum attacks towards Blockchain

Attacks carried out using quantum computers are called quantum attacks. The majority of the cryptographic primitives employed inside the blockchain are vulnerable to quantum attacks because they depend upon the "Finite Abelian Group" methods like factorization of integers and discrete logarithms e.g. The RSA and Elliptical curve based signatures. Those methods can be resolved in polynomial time on quantum computers by implementing Fourier transformations (Table 4).

1) Shor.[75] designed a hypothetical algorithm that works on quantum computers to expedite the calculations of integer factors and discrete logarithms and to break the blockchain security system. That algorithm can be used to drive the private key out of the public key and use that private key to sign illegitimate transactions.

2) In 1996, Grover. [76] proposed a search-based algorithm used to exploit two vulnerabilities in blockchain hashing algorithms.

- It is used to find out a new hash value by detecting hash collisions and replace the block hash with a new hash value without disintegrating the existing blockchain.
- It fastens the calculations of the PoW puzzle hash value called "Nonce", that can be used to make a block within less time. Proof of Stake (Pos) designed as an alternative for PoW is also vulnerable to P. Shor & L.K. Grover algorithms.

3) Suhail et al. [77] stated P.Shor algorithm can be used to break public-key cryptosystems like RSA, Diffie-Hellman, DSA, and Elliptical curve-based cryptosystems like Elgamal, ECDH, ECDSA. L.K. Grover algorithm is used to break

symmetric cryptographic schemes like AES and SHA-256. Finally, they expounded on the need for post-quantum cryptographic mechanisms.

8.2 Safeguard mechanisms towards quantum attacks

To safeguard blockchain against quantum attacks, it is essential to re-equip the blockchain with quantum-resistant cryptography mechanisms. In this segment, we are going to list out some of the research involved in developing anti-quantum methodologies.

1) Li et al. [78] mentioned that a few traditional cryptographic mechanisms are still viable to face quantum attacks. These mechanisms are Hash-based method, Code-based method, Multivariate method.

2) Yin et al. [79] proposed the first lattice-based cryptography scheme as an alternative for traditional public-key cryptographic mechanisms.

At present, lattice-based cryptography algorithms are mainly used as post-quantum cryptography to resist quantum attacks. At present, there are many variants of lattice-based signatures, like

- Short lattice algorithm
- Lattice-based blind signature scheme
- Bosai tree-based lattice etc.

3) Kiktenko et al. [80] suggested the concept of "Quantum key distribution inside the blockchain as a safeguard against quantum attacks.

4) Nanda et al. [81] stated that implementation of "Quantum Key Distribution (QKD)" is possible without the need for quantum computers. The QKD can be used for the secret sharing of keys with the help of qubits.

5) Jin et al. [82] incorporated the concept of "Quantum hashing" in the blockchain to defend against quantum attacks by increasing the uncertainty in hash values.

6) Yin et al. [83] stated that blockchain wallet bloat is going to happen by using lattice-based signatures. It is going to generate and store the number of private keys in the blockchain wallet from different seed keys.

In their paper, they have created a lightweight wallet based on bonsai trees and generated several private keys using a seed key.

7) Fernández-Caramés and Fraga-Lamas [84] suggested expanding the result size of the hash algorithms to face quantum attacks posed by Grover's algorithm.

8) Chalkias et al. [85] mentioned that blockchain-based solutions like Corda, Quantum resistant Ledger, and IOTA use post-quantum signatures schemes to limit the signature size and allow us the same key to sign multiple times.

9) Krendelev et al. [86] explained the required properties of the blockchain hash function to make it quantum resistant.

- Hash function should be able to define hash collision
- It should have more avalanche effect.

In their paper, they have described a quantum-resistant parametric hash function algorithm that generates hashes using a large number of parameters.

10) Suhail et al. [77] suggested the use of the "Hash-Based Signature (HBS)" scheme to defend against quantum attacks. Because HBS provides greater security with small-sized signatures and with fewer security specifications.

11) Ma and Jiang [87] proposed the smaller signature sized multi-signature approach using lattice-based cryptography and reduced memory requirements by using the aggregate public key in the place of several public keys.

Table 4. Recent works on integrating blockchain with quantum computing

Author	Purpose	Synopsis
Peter Shor.[75]		• Designed a hypothetical algorithm that drives the private key out of the public key
Grover. [76]	Quantum attacks on blockchain	• Designed a search-based algorithm to exploit vulnerabilities in blockchain hashing algorithms
Suhail et al. [77]		• Conducted survey on how Shor & Grover's algorithm affects different crypto systems
Chao-Yang et al. [78]		• Mentioned traditional methods to defend against quantum attacks
Kiktenko et al. [80], Nanda et al. [81]	Quantum Key Distribution	• Suggested the using of quantum key distribution without the need for quantum computers
Jin et al. [82]		• Uncertainty in hash values will defend against quantum attacks
Fernández-Caramés and Fraga-Lamas [84]	Quantum Hashing	• Increasing the result size of hash algorithm's will defend against Grover's algorithm
Krendelev et al. [86]		• Suggested the properties to make a quantum resistant hash function for blockchain
Yin et al. [79]		• Proposed lattice-based cryptography used as post-quantum cryptography to defend quantum attacks
Yin et al. [83]	Signature Based methods	• Proposed a method to deal with blockchain wallet bloat caused by lattice-based signatures.
Chalkias et al. [85]		• Limited the signature size and made the same key to sign multiple times.
Suhail et al. [77]		• Used Hash-Based Signature (HBS) method with small-sized signatures to defend quantum attacks
Ma and Jiang [87]		• Reduced memory requirements by using smaller signatures and aggregate key

Even though quantum computers are not real for now, by the year 2035, quantum computers may come into existence. By using quantum computers, one can fabricate and initiate different types of quantum attacks on cryptographic primitives belonging to the blockchain.

So there is a dire need for post-quantum cryptographic algorithms and techniques to prevent quantum attacks on the blockchain. Currently, there are very few works available on making blockchain quantum resistant.

9. INAPPROPRIATENESS OF BLOCKCHAIN

One should not prefer blockchain because of its hype or due to its prominent features like immutability. One should understand its appositeness from different functional requirements of the application.

In this section, we are going to list out possible scenarios where the blockchain is not appropriate [88, 89].

• It is not efficient for applications that deal with transactions that are huge in volume and less in profit.

• Blockchain is used to store a small amount of linear data, and it is still challenging for bigdata applications

• It is not suitable for time-critical applications. Because of the propagation delay and slow transaction confirmation.

• If your application depends on a compulsory third party, then blockchain is not a correct option.

• Blockchain is not a correct option if the application is not for storing the data related to the system state.

• It is not suitable for applications where only one node is going to act as a writer to the ledger

• It is not necessary for the applications where the identity of peers is already known and they completely trust each other.

Blockchain is not suitable for applications where validation of collected data is critical. Because using blockchain, we can make data immutable, but it doesn't guarantee the correctness of data.

10. SURVEY ANALYSIS

Based on the recent works mentioned in this survey paper,

we have taken synopsis points from Figure 3 and synopsis points from Tables 1-4 of different computing paradigms to identify the most appropriate computing paradigm with the blockchain
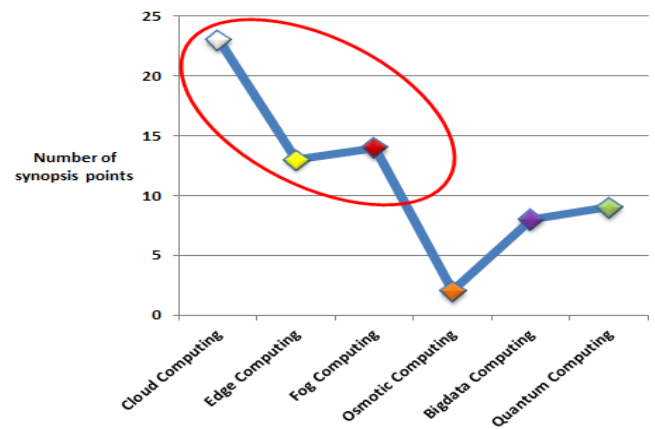
Figure 6. Mapping Computing paradigms with blockchain

Therefore, from Figure 6. We can identify that most of the research innovation of blockchain technology is done along with cloud, Edge, and fog computing paradigms. It is also identified that the suitability of inducing blockchain with different computing paradigms depends upon the context of the application and the type of framework we have selected to implement blockchain.

11. FUTURE WORK AND CONCLUSION

The main focal point of this survey paper is to identify the scope of the blockchain and its appropriateness and inappropriateness. In this paper, as a part of a literature survey, we have identified challenges and possible research opportunities involved in the integration of blockchain with different computing paradigms. In future work, further, we want to survey the role of blockchain in data management, access control policies and we want to address some of the challenges that we have mentioned in this survey paper.

REFERENCES

[1] Babu, B.S., Babu, K.S. (2020). Materializing block chain technology to maintain digital ledger of land records. In Proceedings of the Third International Conference on Computational Intelligence and Informatics, 1090: 201-212. https://doi.org/10.1007/978-981-15-1480-7_16

[2] Chan, K.C., Zhou, X., Gururajan, R., Zhou, X., Ally, M., Gardiner, M. (2020). Integration of blockchains with management information systems. In Proceedings of the 2019 International Conference on Mechatronics, Robotics and Systems Engineering (MoRSE 2019), 157-162). https://doi.org/10.1109/MoRSE48060.2019.8998694

[3] Shah, M., Shaikh, M., Mishra, V., Tuscano, G. (2020). Decentralized cloud storage using blockchain. In 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI), 48184: 384-389. https://doi.org/10.1109/ICOEI48184.2020.9143004

[4] Huang, P., Fan, K., Yang, H., Zhang, K., Li, H., Yang, Y. (2020). A collaborative auditing blockchain for trustworthy data integrity in cloud storage system. IEEE Access, 8: 94780-94794. https://doi.org/10.1109/ACCESS.2020.2993606

[5] Zhang, Y., Xu, C., Cheng, N., Li, H., Yang, H., Shen, X. (2019). Chronos$^+$: An accurate blockchain-based time-stamping scheme for cloud storage. IEEE Transactions on Services Computing, 13(2): 216-229. https://doi.org/10.1109/TSC.2019.2947476

[6] Sharma, P., Jindal, R., Borah, M.D. (2019). Blockchain-based integrity protection system for cloud storage. In 2019 4th Technology Innovation Management and Engineering Science International Conference (TIMES-iCON), 1-5. https://doi.org/10.1109/TIMES-iCON47539.2019.9024583

[7] Gochhayat, S.P., Bandara, E., Shetty, S., Foytik, P. (2019). Yugala: Blockchain based encrypted cloud storage for IoT data. In 2019 IEEE International Conference on Blockchain (Blockchain), pp. 483-489. https://doi.org/10.1109/Blockchain.2019.00073

[8] Li, L.J. (2019). Secured cloud storage scheme based on blockchain. In 2019 IEEE 2nd International Conference on Electronic Information and Communication Technology (ICEICT), pp. 137-142. https://doi.org/10.1109/ICEICT.2019.8846406

[9] Uchibayashi, T., Apduhan, B.O., Shiratori, N., Suganuma, T., Hiji, M. (2019). Policy management technique using blockchain for cloud VM migration. In 2019 IEEE Intl Conf on Dependable, Autonomic and Secure Computing, Intl Conf on Pervasive Intelligence and Computing, Intl Conf on Cloud and Big Data Computing, Intl Conf on Cyber Science and Technology Congress (DASC/PiCom/CBDCom/CyberSciTech), pp. 360-362. https://doi.org/10.1109/DASC/PiCom/CBDCom/CyberSciTech.2019.00073

[10] Desai, S., Deshmukh, O., Shelke, R., Choudhary, H., Sambhare, S.S., Yadav, A. (2019). Blockchain based Secure Data Storage and Access Control System using Cloud. In 2019 5th International Conference on Computing, Communication, Control and Automation (ICCUBEA), pp. 1-6. https://doi.org/10.1109/ICCUBEA47591.2019.9129015

[11] Tseng, M.H.R., Chang, S.E., Kuo, T.Y. (2019). Using blockchain to access cloud services: A case of financial service application. In 2019 Federated Conference on Computer Science and Information Systems (FedCSIS), pp. 565-568. https://doi.org/10.15439/2019F296

[12] Wang, S., Wang, X., Zhang, Y. (2019). A secure cloud storage framework with access control based on blockchain. IEEE Access, 7: 112713-112725. https://doi.org/10.1109/ACCESS.2019.2929205

[13] Yang, C., Tan, L., Shi, N., Xu, B., Cao, Y., Yu, K. (2020). AuthPrivacyChain: A blockchain-based access control framework with privacy protection in cloud. IEEE Access, 8: 70604-70615. https://doi.org/10.1109/ACCESS.2020.2985762

[14] Hoang, V.H., Lehtihet, E., Ghamri-Doudane, Y. (2020). Privacy-preserving blockchain-based data sharing platform for decentralized storage systems. In 2020 IFIP Networking Conference (Networking), pp. 280-288.

[15] Liu, J., Zhang, G., Sun, R., Du, X., Guizani, M. (2020). A blockchain-based conditional privacy-preserving traffic data sharing in cloud. In ICC 2020-2020 IEEE International Conference on Communications (ICC), pp. 1-6. https://doi.org/10.1109/ICC40277.2020.9148864

[16] Shen, M., Duan, J., Zhu, L., Zhang, J., Du, X., Guizani, M. (2020). Blockchain-based incentives for secure and collaborative data sharing in multiple clouds. IEEE Journal on Selected Areas in Communications, 38(6): 1229-1241. https://doi.org/10.1109/JSAC.2020.2986619

[17] Zhou, I., Makhdoom, I., Abolhasan, M., Lipman, J., Shariati, N. (2019). A blockchain-based file-sharing system for academic paper review. In 2019 13th International Conference on Signal Processing and Communication Systems (ICSPCS), pp. 1-10. https://doi.org/10.1109/ICSPCS47537.2019.9008695

[18] Shrestha, A.K., Vassileva, J. (2018). Blockchain-based research data sharing framework for incentivizing the data owners. In International Conference on Blockchain, 259-266. https://doi.org/10.1007/978-3-319-94478-4_19

[19] Yadav, D., Shinde, A., Nair, A., Patil, Y., Kanchan, S. (2020). Enhancing data security in cloud using blockchain. In 2020 4th International Conference on Intelligent Computing and Control Systems (ICICCS), pp. 753-757. https://doi.org/10.1109/ICICCS48265.2020.9121109

[20] Xu, H., Cao, J., Zhang, J., Gong, L., Gu, Z. (2019). A survey: Cloud data security based on blockchain technology. In 2019 IEEE Fourth International Conference on Data Science in Cyberspace (DSC), pp. 618-624. https://doi.org/10.1109/DSC.2019.00100

[21] Tsai, W.Y., Chou, T.C., Chen, J.L., Ma, Y.W., Huang, C.J. (2020). Blockchain as a platform for secure cloud computing services. In 2020 22nd International Conference on Advanced Communication Technology (ICACT), pp. 155-158. https://doi.org/10.23919/ICACT48636.2020.9061435

[22] Kumar, M., Singh, A.K. (2020). Distributed intrusion detection system using blockchain and cloud computing infrastructure. In 2020 4th International Conference on Trends in Electronics and Informatics (ICOEI)(48184), pp. 248-252. https://doi.org/10.1109/ICOEI48184.2020.9142954

[23] Yan, X., Yuan, X., Ye, Q., Tang, Y. (2020). Blockchain-based searchable encryption scheme with fair payment. IEEE Access, 8: 109687-109706. https://doi.org/10.1109/ACCESS.2020.3002264

[24] Albalawi, K., Azim, M.M.A. (2019). Cloud-based IoT Device authentication scheme using blockchain. In 2019 IEEE Global Conference on Internet of Things (GCIoT), pp. 1-7. https://doi.org/10.1109/GCIoT47977.2019.9058391

[25] Malvankar, A., Payne, J., Budhraja, K.K., Kundu, A., Chari, S., Mohania, M. (2019). Malware containment in cloud. In 2019 First IEEE International Conference on Trust, Privacy and Security in Intelligent Systems and Applications (TPS-ISA), pp. 221-227. https://doi.org/10.1109/TPS-ISA48467.2019.00036

[26] Westerlund, M., Jaatun, M.G. (2019). Tackling the cloud forensic problem while keeping your eye on the GDPR. In CloudCom, 418-423.

[27] Varghese, B., Villari, M., Rana, O., James, P., Shah, T., Fazio, M., Ranjan, R. (2018). Realizing edge marketplaces: challenges and opportunities. IEEE Cloud Computing, 5(6): 9-20. https://doi.org/10.1109/MCC.2018.064181115

[28] Freitag, F. (2018). On the collaborative governance of decentralized edge microclouds with blockchain-based distributed ledgers. In 2018 IEEE/WIC/ACM International Conference on Web Intelligence (WI), pp. 709-712. IEEE. https://doi.org/10.1109/WI.2018.000-7

[29] Zhang, X., Li, R., Cui, B. (2018). A security architecture of VANET based on blockchain and mobile edge computing. In 2018 1st IEEE International Conference on Hot Information-Centric Networking (HotICN), pp. 258-259. https://doi.org/10.1109/HOTICN.2018.8605952

[30] Li, Y., Shi, W., Kumar, M., Chen, J. (2018). Dycrem: Dynamic credit risk management using edge-based blockchain. In 2018 IEEE/ACM Symposium on Edge Computing (SEC), pp. 344-346. https://doi.org/10.1109/SEC.2018.00039

[31] Liu, M., Yu, F.R., Teng, Y., Leung, V.C., Song, M. (2018). Distributed resource allocation in blockchain-based video streaming systems with mobile edge computing. IEEE Transactions on Wireless Communications, 18(1): 695-708. https://doi.org/10.1109/TWC.2018.2885266

[32] Liu, M., Yu, F.R., Teng, Y., Leung, V.C., Song, M. (2018). Computation offloading and content caching in wireless blockchain networks with mobile edge computing. IEEE Transactions on Vehicular Technology, 67(11): 11008-11021. https://doi.org/10.1109/TVT.2018.2866365

[33] Xiong, Z., Zhang, Y., Niyato, D., Wang, P., Han, Z. (2018). When mobile blockchain meets edge computing. IEEE Communications Magazine, 56(8): 33-39. https://doi.org/10.1109/MCOM.2018.1701095

[34] Zheng, J., Dong, X., Zhang, T., Chen, J., Tong, W., Yang, X. (2018). Microthingschain: Edge computing and decentralized iot architecture based on blockchain for cross-domain data shareing. In 2018 International Conference on Networking and Network Applications (NaNA), pp. 350-355. https://doi.org/10.1109/NANA.2018.8648780

[35] Xu, C., Wang, K., Li, P., Guo, S., Luo, J., Ye, B., Guo, M. (2018). Making big data open in edges: A resource-efficient blockchain-based approach. IEEE Transactions on Parallel and Distributed Systems, 30(4): 870-882. https://doi.org/10.1109/TPDS.2018.2871449

[36] Seike, H., Hamada, T., Sumitomo, T., Koshizuka, N. (2018). Blockchain-based ubiquitous code ownership management system without hierarchical structure. In 2018 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computing, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld/SCALCOM/UIC/ATC/CBDCom/IOP/SCI), pp. 271-276. https://doi.org/10.1109/SmartWorld.2018.00081

[37] Rahman, M.A., Hossain, M.S., Loukas, G., Hassanain, E., Rahman, S.S., Alhamid, M.F., Guizani, M. (2018). Blockchain-based mobile edge computing framework for secure therapy applications. IEEE Access, 6: 72469-72478. https://doi.org/10.1109/ACCESS.2018.2881246

[38] Xu, D., Xiao, L., Sun, L., Lei, M. (2017). Game theoretic study on blockchain based secure edge networks. In 2017 IEEE/CIC International Conference on Communications in China (ICCC), pp. 1-5. https://doi.org/10.1109/ICCChina.2017.8330529

[39] Kang, J., Yu, R., Huang, X., Wu, M., Maharjan, S., Xie, S., Zhang, Y. (2018). Blockchain for secure and efficient data sharing in vehicular edge computing and networks. IEEE Internet of Things Journal, 6(3): 4660-4670. https://doi.org/10.1109/JIOT.2018.2875542

[40] Gauhar, A., Ahmad, N., Cao, Y., Khan, S., Cruickshank, H., Qazi, E.A., Ali, A. (2020). xDBAuth: Blockchain based cross domain authentication and authorization framework for Internet of Things. IEEE Access, 8: 58800-58816. https://doi.org/10.1109/ACCESS.2020.2982542

[41] Lei, K., Du, M., Huang, J., Jin, T. (2020). Groupchain: Towards a scalable public blockchain in fog computing of IoT services computing. IEEE Transactions on Services Computing, 13(2): 252-262. https://doi.org/10.1109/TSC.2019.2949801

[42] Yao, Y., Chang, X., Mišić, J., Mišić, V.B., Li, L. (2019). BLA: Blockchain-assisted lightweight anonymous authentication for distributed vehicular fog services. IEEE Internet of Things Journal, 6(2): 3775-3784. https://doi.org/10.1109/JIOT.2019.2892009

[43] Almadhoun, R., Kadadha, M., Alhemeiri, M., Alshehhi, M., Salah, K. (2018). A user authentication scheme of IoT devices using blockchain-enabled fog nodes. In 2018 IEEE/ACS 15th international conference on computer systems and applications (AICCSA), pp. 1-8. https://doi.org/10.1109/AICCSA.2018.8612856

[44] Memon, R.A., Li, J.P., Nazeer, M.I., Khan, A.N., Ahmed, J. (2019). Dualfog-iot: Additional fog layer for solving blockchain integration problem in internet of things. IEEE Access, 7: 169073-169093. https://doi.org/10.1109/ACCESS.2019.2952472

[45] Debe, M., Salah, K., Rehman, M.H.U., Svetinovic, D. (2020). Blockchain-Based Decentralized Reverse Bidding in Fog Computing. IEEE Access, 8: 81686-81697. https://doi.org/10.1109/ACCESS.2020.2991261

[46] Alshehri, M., Panda, B. (2019). A Blockchain-Encryption-Based approach to protect fog federations from rogue nodes. In 2019 3rd Cyber Security in Networking Conference (CSNet), pp. 6-13. https://doi.org/10.1109/CSNet47905.2019.9108975

[47] Yu, Y., Liu, S., Guo, L., Yeoh, P.L., Vucetic, B., Li, Y. (2020). CrowdR-FBC: A distributed fog-blockchains for mobile crowdsourcing reputation management. IEEE Internet of Things Journal, 7(9): 8722-8735.

https://doi.org/10.1109/JIOT.2020.2996229

[48] George, G., Sankaranarayanan, S. (2019). Light weight cryptographic solutions for fog based blockchain. In 2019 International Conference on Smart Structures and Systems (ICSSS), pp. 1-5. https://doi.org/10.1109/ICSSS.2019.8882870

[49] Wu, D., Ansari, N. (2020). A cooperative computing strategy for blockchain-secured fog computing. IEEE Internet of Things Journal, 7(7): 6603-6609. https://doi.org/10.1109/JIOT.2020.2974231

[50] Baniata, H., Kertesz, A. (2020). A survey on blockchain-fog integration approaches. IEEE Access, 8: 102657-102668. https://doi.org/10.1109/ACCESS.2020.2999213

[51] Ziegler, M.H., Großmann, M., Krieger, U.R. (2019). Integration of fog computing and blockchain technology using the plasma framework. In 2019 IEEE International Conference on Blockchain and Cryptocurrency (ICBC), 120-123. https://doi.org/10.1109/BLOC.2019.8751308

[52] Kumar, G., Saha, R., Rai, M.K., Thomas, R., Kim, T.H. (2019). Proof-of-work consensus approach in blockchain technology for cloud and fog computing using maximization-factorization statistics. IEEE Internet of Things Journal, 6(4): 6835-6842. https://doi.org/10.1109/JIOT.2019.2911969

[53] Puthal, D., Mohanty, S.P., Nanda, P., Kougianos, E., Das, G. (2019). Proof-of-authentication for scalable blockchain in resource-constrained distributed systems. In 2019 IEEE International Conference on Consumer Electronics (ICCE), pp. 1-5. https://doi.org/10.1109/ICCE.2019.8662009

[54] Lee, J.L., Kerns, S.C., Hong, S. (2019). A secure IoT-fag-cloud framework using blockchain based on DAT for mobile IoT. In 2019 IEEE 10th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), pp. 0213-0218. https://doi.org/10.1109/UEMCON47517.2019.8993056

[55] Yánez, W., Mahmud, R., Bahsoon, R., Zhang, Y., Buyya, R. (2020). Data allocation mechanism for Internet-of-Things systems with blockchain. IEEE Internet of Things Journal, 7(4): 3509-3522. https://doi.org/10.1109/JIOT.2020.2972776

[56] Cinque, M., Esposito, C., Russo, S. (2018). Trust management in fog/edge computing by means of blockchain technologies. In 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), pp. 1433-1439. https://doi.org/10.1109/Cybermatics_2018.2018.00244

[57] Villari, M., Fazio, M., Dustdar, S., Rana, O., Ranjan, R. (2016). Osmotic computing: A new paradigm for edge/cloud integration. IEEE Cloud Computing, 3(6): 76-83. https://doi.org/10.1109/MCC.2016.124

[58] Buzachis, A., Villari, M. (2018). Basic principles of osmotic computing: secure and dependable microelements (MELs) orchestration leveraging blockchain facilities. In 2018 IEEE/ACM International Conference on Utility and Cloud Computing Companion (UCC Companion), pp. 47-52. https://doi.org/10.1109/UCC-Companion.2018.00033

[59] Villari, M., Galletta, A., Celesti, A., Carnevale, L., Fazio, M. (2018). Osmotic computing: software defined membranes meet private/federated blockchains. In 2018 IEEE Symposium on Computers and Communications (ISCC), pp. 01292-01297. https://doi.org/10.1109/ISCC.2018.8538546

[60] Rasool, S., Saleem, A., Iqbal, M., Dagiuklas, T., Bashir, A.K., Mumtaz, S., Al Otaibi, S. (2020). Blockchain-EnaBlEd REliaBlE osmotic computing for cloud of things: applications and challEngEs. IEEE Internet of Things Magazine, 3(2): 63-67. https://doi.org/10.1109/IOTM.0001.1900101

[61] Carnevale, L., Celesti, A., Galletta, A., Dustdar, S., Villari, M. (2018). From the cloud to edge and IoT: a smart orchestration architecture for enabling osmotic computing. In 2018 32nd International Conference on Advanced Information Networking and Applications Workshops (WAINA), pp. 419-424. https://doi.org/10.1109/WAINA.2018.00122

[62] Maksimović, M. (2018). The role of Osmotic computing in Internet of Things. In 2018 17th International Symposium INFOTEH-JAHORINA (INFOTEH), pp. 1-4. https://doi.org/10.1109/INFOTEH.2018.8345538

[63] Abdullah, N., Hakansson, A., Moradian, E. (2017). Blockchain based approach to enhance big data authentication in distributed environment. In 2017 Ninth International Conference on Ubiquitous and Future Networks (ICUFN), pp. 887-892. https://doi.org/10.1109/ICUFN.2017.7993927

[64] Subbiah, S., Mala, S., Nayagam, S. (2017). Job starvation avoidance with alleviation of data skewness in Big Data infrastructure. In 2017 2nd International Conference on Computing and Communications Technologies (ICCCT), pp. 137-142. https://doi.org/10.1109/ICCCT2.2017.7972264

[65] Alexander, C.A., Wang, L. (2019). Cybersecurity, information assurance, and big data based on blockchain. In 2019 SoutheastCon, pp. 1-7. https://doi.org/10.1109/SoutheastCon42311.2019.9020582

[66] Zheng, Z., Xie, S., Dai, H., Chen, X., Wang, H. (2017). An overview of blockchain technology: Architecture, consensus, and future trends. In 2017 IEEE international congress on big data (BigData congress), pp. 557-564. https://doi.org/10.1109/BigDataCongress.2017.85

[67] Chen, J., Xue, Y. (2017). Bootstrapping a blockchain based ecosystem for big data exchange. In 2017 IEEE International Congress on Big Data (Bigdata Congress), pp. 460-463. https://doi.org/10.1109/BigDataCongress.2017.67

[68] Yu, H., Yang, Z., Sinnott, R.O. (2018). Decentralized big data auditing for smart city environments leveraging blockchain technology. IEEE Access, 7: 6288-6296. https://doi.org/10.1109/ACCESS.2018.2888940

[69] Zhang, F., Liu, M., Shen, W. (2017). Operation modes of smart factory for high-end equipment manufacturing in the Internet and Big Data era. In 2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC), pp. 152-157. https://doi.org/10.1109/SMC.2017.8122594

[70] Karafiloski, E., Mishev, A. (2017). Blockchain solutions for big data challenges: A literature review. In IEEE EUROCON 2017-17th International Conference on Smart Technologies, pp. 763-768. https://doi.org/10.1109/EUROCON.2017.8011213

[71] Bandara, E., Ng, W.K., De Zoysa, K., Fernando, N.,

Tharaka, S., Maurakirinathan, P., Jayasuriya, N. (2018). Mystiko—blockchain meets big data. In 2018 IEEE International Conference on Big Data (Big Data), pp. 3024-3032. https://doi.org/10.1109/BigData.2018.8622341

[72] Smith, T.D. (2017). The blockchain litmus test. In 2017 IEEE International Conference on Big Data (Big Data), pp. 2299-2308. https://doi.org/10.1109/BigData.2017.8258183

[73] Preece, J.D., Easton, J.M. (2018). Towards encrypting industrial data on public distributed networks. In 2018 IEEE International Conference on Big Data (Big Data), pp. 4540-4544. https://doi.org/10.1109/BigData.2018.8622246

[74] Zhou, X., Lin, P., Li, Z., Wang, Y., Tan, W., Huang, M. (2019). Security of big data based on the technology of cloud computing. In 2019 4th International Conference on Mechanical, Control and Computer Engineering (ICMCCE), pp. 703-7033. https://doi.org/10.1109/ICMCCE48743.2019.00163

[75] Shor, P.W. (1999). Polynomial-time algorithms for prime factorization and discrete logarithms on a quantum computer. SIAM Review, 41(2): 303-332. https://doi.org/10.1137/S0036144598347011

[76] Grover, L.K. (1996). A fast quantum mechanical algorithm for database search. In Proceedings of the Twenty-Eighth Annual ACM Symposium on Theory of Computing, 212-219. https://doi.org/10.1145/237814.237866

[77] Suhail, S., Hussain, R., Khan, A., Hong, C.S. (2020). On the role of hash-based signatures in quantum-safe internet of things: Current solutions and future directions. IEEE Internet of Things Journal. 8(1): 1-17. https://doi.org/10.1109/JIOT.2020.3013019

[78] Li, C.Y., Chen, X.B., Chen, Y.L., Hou, Y.Y., Li, J. (2018). A new lattice-based signature scheme in post-quantum blockchain network. IEEE Access, 7: 2026-2033. https://doi.org/10.1109/ACCESS.2018.2886554

[79] Yin, W., Wen, Q., Li, W., Zhang, H., Jin, Z. (2018). An anti-quantum transaction authentication approach in blockchain. IEEE Access, 6: 5393-5401. https://doi.org/10.1109/ACCESS.2017.2788411

[80] Kiktenko, E.O., Pozhar, N.O., Anufriev, M.N., Trushechkin, A.S., Yunusov, R.R., Kurochkin, Y.V., Fedorov, A.K. (2018). Quantum-secured blockchain.

Quantum Science and Technology, 3(3): 035004. https://doi.org/10.1088/2058-9565/aabc6b

[81] Nanda, A., Puthal, D., Mohanty, S.P., Choppali, U. (2018). A computing perspective of quantum cryptography [energy and security]. IEEE Consumer Electronics Magazine, 7(6): 57-59. https://doi.org/10.1109/MCE.2018.2851741

[82] Jin, M., Yoo, C.D. (2009). Quantum hashing for multimedia. IEEE Transactions on Information Forensics and Security, 4(4): 982-994. https://doi.org/10.1109/TIFS.2009.2033221

[83] Yin, W., Wen, Q., Li, W., Zhang, H., Jin, Z. (2018). An anti-quantum transaction authentication approach in blockchain. IEEE Access, 6: 5393-5401. https://doi.org/10.1109/ACCESS.2017.2788411

[84] Fernández-Caramés, T.M., Fraga-Lamas, P. (2020). Towards post-quantum blockchain: A review on blockchain cryptography resistant to quantum computing attacks. IEEE Access, 8: 21091-21116. https://doi.org/10.1109/ACCESS.2020.2968985

[85] Chalkias, K., Brown, J., Hearn, M., Lillehagen, T., Nitto, I., Schroeter, T. (2018). Blockchained post-quantum signatures. In 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), pp. 1196-1203. https://doi.org/10.1109/Cybermatics_2018.2018.00213

[86] Krendelev, S., Sazonova, P. (2018). Parametric hash function resistant to attack by quantum computer. In 2018 Federated Conference on Computer Science and Information Systems (FedCSIS), pp. 387-390.

[87] Ma, C., Jiang, M. (2019). Practical lattice-based multisignature schemes for blockchains. IEEE Access, 7: 179765-179778. https://doi.org/10.1109/ACCESS.2019.2958816

[88] Wüst, K., Gervais, A. (2018). Do you need a blockchain? In 2018 Crypto Valley Conference on Blockchain Technology (CVCBT), pp. 45-54. https://doi.org/10.1109/CVCBT.2018.00011

[89] Nofer, M., Gomber, P., Hinz, O., Schiereck, D. (2017). Blockchain. Business & Information Systems Engineering, 59(3): 183-187. https://doi.org/10.1007/s12599-017-0467-3

Comparative analysis of nutritive and non-nutritive content of *Shatavari* – A commercial Indian herbal medicine

P. Harika[a,b], G. V. Ramana*[c] and B. Haribabu[d]

[a]Research Scholar, Department of Chemistry, Jawaharlal Nehru Technological University Kakinada, Kakinada-533 003, Andhra Pradesh, India

[b]Department of Chemistry, Andhra Loyola Institute of Engineering and Technology, Vijayawada-520 008, Andhra Pradesh, India

[c]Department of Chemistry, Andhra Loyola College, Vijayawada-520 008, Andhra Pradesh, India

[d]Department of Chemistry, Acharya Nagarjuna University, Guntur-522 510, Andhra Pradesh, India

E-mail: gvramanachemistry@gmail.com

Shatavari is a plant based product used for treating infertility and improving vitality and immunity in women. The present study was aimed to compare the total phenolic, flavonoid, steroidal saponin and antioxidant activity of *Shatavari* aqueous and methanol extracts which were prepared by agitation extraction (AE) and ultra-sonication extraction (UE) and also to determine the variation of nutrients and heavy metals content of marketed *Shatavari* herbal products in India. Antioxidant activity of *Shatavari* aqueous and methanol extracts were assessed against DPPH and ABTS spectrophotopmetrically. Compared to the aqueous, methanol extracts significantly increased the yields of total phenolic and flavonoid contents, and steroidal saponin. Antioxidant activity was effective by using ABTS compared to DPPH with low IC_{50} values. Among all the samples SH1 has revealed highest total phenolic and flavonoid contents and antioxidant activities. No significant differences were noticed between the two extraction techniques. Studies unveil that samples SH1 and SH2 were found to be rich source of nutrients. Heavy metal contents in the analysed samples were likely to be of negligible concern. In all herbal samples mean concentration of heavy metals were within the limits stated by WHO guidelines for human consumption.

Keywords: Ultra-sonication, anti-oxidant activity, *Shatavari*, heavy metals, nutrients.

Introduction

Now a days, marketing of Ayurvedic medicine has been tremendously increased through exports and online business to meet their demand global level. Traditional plant based medicine exert greater importance due to healing, rejuvenation and lack of side effects.

Most of the women across the world are suffering from infertility[1]. *Shatavari* is a famous Ayurvedic formulation for improving cellular vitality and immunity[2] and widely used for the treatment of stress related immune complaints and hormonal imbalances in women and promotes lactation[3]. *Shatavari* root powder or extract was highly effective in female reproductive disorders, avoiding premature birth and utilized as uterine tonic[4]. *Shatavari* has various nutritive, therapeutic and preventative properties contributed by its various chemical constituents. *Asparagus racemosus* is the major constituent of *Shatavari* products. Their identification was difficult, because roots are in similar shape of *Stemona* plant roots[5]. There is a chance that *Stemona* plant roots may be mistaken for *Asparagus racemosus*.

The activity of *Shatavari* is strongly swayed by both natural and human activities. To enhance its therapeutic activities manufacturers were adding various plant based products with different chemical composition and marketed with different commercial names[6]. The quality of herbal medicine was quantified by presence of phytochemicals, minerals and heavy metal content[7]. Concentrations of the essential elements and heavy metals in plant samples alters the chemi-

cal structure and composition of plant material used in the preparation of herbal medicines. Extraction efficiency was also essential for the preparation of herbal products to maximize health benefits. Therefore, the standardization of herbal formulations is mandatory. Moreover, a lot of survey has been found on phytochemical and therapeutic usage of *Shatavari*, but as per our knowledge no study has been conducted on total phenolic and flavonoid content, steroidal saponin, and antioxidant activity of aqueous and methanol extracts of *Shatavari* products prepared from agitation extraction (AE) and ultra-sonication extraction (UE), and there were no information of nutrients and heavy metal content of selected *Shatavari* products marketed in India[8,9].

Keeping above information in mind, the present study aimed to compare the total phenolic and flavonoid content, steroidal saponin, antioxidant activity of *Shatavari* aqueous and methanol extracts prepared by AE and UE techniques. Antioxidant activity was studied using DPPH and ABTS spectrophotometrically, and moreover, evaluation of minerals and heavy metal content of regularly prescribed and highly marketed *Shatavari* products in India.

Materials and methods

Samples:

Shatavari products SH1, SH2, SH3, SH4 and SH5 are commercially available herbal medicines purchased from local markets in Vijayawada, Andhra Pradesh, India.

Extract preparation:

Agitation extraction:

10 g of dried powder of selected poly-herbal formulations were extracted individually in 100 mL of water and methanol for 8 h at room temperature using shaker in 150 rpm speed and the residue was again extracted twice and centrifuged. The combined filtrate was concentrated on a rotary evaporator under reduced pressure at 40°C to obtain the crude extract. The extract was then dried in a vacuum freeze dryer (Martin Christ freeze dryer; Model: Gamma 2-16 LSC) for 24 h, weighed and stored at 4°C. 50 mg of the each extract was dissolved in respective solvents and diluted to 25 mL and used as stock solution for analysis.

Ultra-sonication extraction:

10 g of dried powder of samples were extracted with 100 mL of water and methanol individually by using electronic ultrasonic bath at room temperature for 8 h set to 35 kHz and

filtered. The residue was re-extracted twice. The resultant filtrate was concentrated using rotary evaporator and freeze dried for 24 h. 50 mg of each extract dissolved in water and methanol solvents and diluted to 25 mL and stored for further use.

Determination of total phenolic content:

Total phenolic content (TPC) of the extracts were assayed by modified spectrophotometric method using Folin-Ciocalteu reagent[10–12]. TPC was estimated using a standard curve prepared with gallic acid and expressed as mg of gallic acid equivalent (GAE) per gram of the sample extract. 500 µL of each extract was mixed individually with 500 µL of Folin-Ciocalteu reagent (50% v/v) and the mixture was allowed to react for 5 min, 2000 µL of sodium carbonate (10% w/v) solution was added to the resultant mixture and finally diluted to 10 mL with distilled water. After 30 min of incubation, the absorbance was measured at 760 nm against distilled water as blank using UV-Visible spectrophotometer. The determination of total phenolic compounds in all the sample extracts were carried out in triplicate and the results were averaged.

Determination of total flavonoid content:

Total flavonoid content of sample extracts were determined using spectrophotometric method of earlier studies with slight changes[10,13]. The concentration of total flavonoid was assayed using a standard rutin curve and expressed as mg of rutin equivalent (RE) per gram of the sample extract. 1000 µL of extracts each mixed with 500 µL of aluminium chloride (10% w/v) and 500 µL of sodium nitrate (5% w/v) solutions allowed to stand for 10 min at room temperature. Then 2000 µL of 1 *M* sodium hydroxide was added. Finally the mixture was made up to 10 mL with distilled water. The absorbance was measured at 510 nm against distilled water as blank using UV-Visible spectrophotometer. Flavonoid contents in all the sample extracts were determined in triplicate and average results were considered.

Determination of total steroidal saponin:

Water and methanol extracts of *Shatavari* were washed with diethyl ether and re-extracted with n-butanol, finally washed with 5% aqueous sodium chloride. The remaining solution was evaporated and dried for constant weight to obtain crude saponin[14]. Further the extract was acid hydrolysed for 3 h at 90°C to deglycosylate and the resultant steroidal sapogenin was dissolved with ethyl acetate and made

up to 10 mL of which 2 mL of aliquot was added to one mL of 0.5% anisaldehyde in ethyl acetate (v/v) and one mL of 50% sulphuric acid in ethyl acetate (v/v). The resulting mixture was stirred and maintained at 60°C in a water bath for 20 min to develop chromophore and then allowed to cool at room temperature. The absorbance of the coloured solution was measured at 430 nm against ethyl acetate as blank using UV-Visible spectrophotometer[15]. The steroidal saponin concentration were calculated from standard curve of sarsasapogenin and expressed as mg sarsasapogenin equivalent (SE) per gram of crude extract.

Evaluation of antioxidant activity:

2,2-Diphenyl-1-picryl-hydrazyl method:

The radical scavenging activity of samples were determined by the spectrophotometric method[16,17] using ascorbic acid as standard. 2000 μL of 0.08 mM of DPPH in methanol was mixed with 2000 μL of different concentrations (200, 500, 1000, 1500 and 2000 μg/mL) of extracts and allowed to stand at room temperature for 1 h. Finally the absorbance of each sample was measured at 517 nm. Mixture of 2000 μL of DPPH solution and 2000 μL of methanol was taken as control. 50% Inhibitory concentration (IC 50%) was calculated by linear regression analysis. The results were compared with that of ascorbic acid, the standard antioxidant.

2,2-Azino-bis(3-ethylbenzothiozoline-6-sulfonic acid):

The antioxidant activity of sample extracts were evaluated by ABTS radical cation reduction method[17,18]. ABTS reagent with an absorbance of 0.700±0.02 at 734 nm was prepared by mixing 7 mM of ABTS, 2.45 mM of potassium persulfate and finally diluted with 0.1 M potassium phosphate buffer (pH 7.4). 10 μL of various concentrations (200, 500, 1000, 1500 and 2000 μg/mL) of extracts were added to 2990 μL of ABTS reagent and the mixture incubated for 30 min at room temperature. The absorbance was measured at 734 nm and the results were expressed in terms of IC_{50} values.

Determination of elements:

Each sample of *Shatavari* 100 mg were digested with a mixture of concentrated nitric acid and hydrogen peroxide (9:1 v/v) at room temperature for overnight. The contents were heated on hot plate at 100–150°C, until a clear solution obtained and filtered, finally diluted to 100 mL with distilled water and stored for further use. Essential elements and heavy metal content of acid digested *Shatavari* samples were determined using Inductive Coupled Plasma-Optical Emission Spectrometer (I-CAP-6500, Thermo scientific company-UK). Operating conditions as described[19,20]. By using standard calibration curve, the concentration of metals in the studied samples were determined. Blank solution spiked with standard metal at a lower concentrations were used to determine the limits of detection (LOD) of elements.

Statistical analysis:

All determinations were carried out in triplicates. Experimental data was subjected to ANOVA test and statistical significance was obtained at $p < 0.05$. Finally, the data was expressed as mean ±SD.

Results and discussion

The total amount of phenolic and flavonoid contents present in *Shatavari* samples were quantified as gallic acid equivalent (GAE) and rutin equivalent (RE) were shown in Table 1. Methanol extracts had significantly higher amounts of total phenolics and flavonoids than the aqueous extracts. Both extraction techniques (AE and UE) were effective. There is no considerable variation were observed between the two extraction techniques. SH1 had exceptionally higher amounts of phenolic and flavonoid contents, whereas, SH3 sample

Table 1. Total phenolic and flavonoid contents of different brands of *Shatavari* sample extracts expressed as mg of GAE/g of extract and mg of RE/g of extract (n = 3)

Sample	Total phenolic contents				Total flavonoid contents			
	Aqueous (mg/g)		Methanol (mg/g)		Aqueous (mg/g)		Methanol (mg/g)	
	AE	UE	AE	UE	AE	UE	AE	UE
SH1	6.19±0.14	6.05±0.04	14.64±0.9	15.73±0.18	3.85±0.02	3.81±0.1	13.43±0.32	13.11±0.45
SH2	2.51±0.01	2.76±0.05	4.01±0.07	3.98±0.11	1.46±0.02	1.22±0.16	3.96±0.15	4.18±0.03
SH3	2.58±0.02	2.99±0.01	4.58±0.1	4.78±0.03	1.50±0.01	1.69±0.05	4.25±0.11	4.36±0.05
SH4	1.49±0.02	1.44±0.02	2.59±0.03	2.44±0.01	0.56±0.01	0.98±0.02	0.78±0.01	0.69±0.01
SH5	5.23±0.05	5.37±0.08	3.97±0.05	4.06±0.06	2.23±0.05	2.17±0.02	3.92±0.26	4.01±0.13

showed lower concentrations among the studied samples. The concentrations of total phenolic and flavonoid in the *Shatavari* methanol and aqueous extracts obtained by both techniques were noticeably higher than those previously reported[21,22] for plant raw material. According to the earlier results[11], the serial dilutions of *Shatavari* plant raw material showed higher phenolic and flavonoid contents. The phenolic content varied widely among the samples in methanol and aqueous extracts ranged from 15.73–2.44 mg/g of extract weight and 6.19–1.44 mg/g of extract weight whereas, flavonoid content ranged from 13.43–0.69 mg/g of extract weight and 3.85–0.56 mg/g of extract weight.

The steroidal saponin was determined by using sarasasapogenin standard curve. In the present study, we observed a considerable amount of steroidal saponin in the studied samples as shown in Table 2. Among all these samples, SH1 had revealed highest steroidal saponin content in both aqueous and methanol medium. SH4 had shown least steroidal saponin content. The order of steroidal saponin content of aqueous extracts obtained from both AE and UE techniques as SH1 > SH2 > SH5 > SH3 and SH4. In case of methanol extracts the order as SH1 > SH5 > SH3 > SH2 and SH4.

Table 2. Steroidal saponin concentration of aqueous and methanol extracts of *Shatavari* samples expressed as mg of SE/g of saponin extract (n = 3)

Sample	Steroidal saponin			
	Aqueous (mg/g)		Methanol (mg/g)	
	AE	UE	AE	UE
SH1	26.60±0.6	25.04±1.4	38.89±0.27	38.18±0.02
SH2	20.59±0.02	22.67±1.23	25.62±0.33	26.55±0.86
SH3	17.58±0.53	17.98±0.8	26.01±0.25	27.19±0.74
SH4	13.61±0.40	12.11±1.59	20.66±0.54	18.61±0.16
SH5	19.72±0.01	20.45±0.77	28.67±0.11	27.88±0.63

Antioxidant activity:

The sample extracts are very multifaceted mixture of many distinct compounds of different plant materials with various activities. Therefore, more than one method was essential to estimate antioxidant activity. The scavenging capacity of extracts against DPPH radical was evaluated by determining the decrease in absorbance by increasing the concentration. DPPH scavenging ability of methanol and aqueous extracts of commercial samples which were prepared by both techniques (AE and UE) were listed in Table 3. The methanol extracts had significantly shown lower IC_{50} values with higher activity than the aqueous extracts. Among the methanol extracts the highest antioxidant activity was demonstrated by SH1 followed by SH2, SH5, SH3 and SH4. While the aqueous extracts followed the order of SH1, SH2, SH3, SH5 and SH4 in both the techniques. Previous studies[12,23] reported comparatively low activity with high IC_{50} value in aqueous extracts. Former studies[11] of serial dilution of raw material had shown high antioxidant activity with low IC_{50} value. The ability of sample extracts to scavenge ABTS radical by donating active hydrogen and convert them into more stable products was listed in the Table 3. The methanol extracts are effective towards ABTS radical compared to aqueous extracts. The highest ABTS radical scavenging activity by SH1 in methanol and aqueous extracts. In contrast SH4 shown lowest scavenging ability in methanol and aqueous.

Essential elements and heavy metals:

A wide range of variation in the nutrients and heavy metals content of different commercially available *Shatavari* samples were noticed. The traditional use of samples due to the presence of phytochemicals and nutrients composition. The concentration of macronutrients calcium, potassium, magnesium, sodium and phosphorous were given in the Table

Table 3. The IC_{50} values of aqueous and methanol extracts of *Shatavari* samples in DPPH and ABTS assay

Sample	DPPH assay				ABTS assay			
	Aqueous (μg/mL)		Methanol (μg/mL)		Aqueous (μg/mL)		Methanol (μg/mL)	
	AE	UE	AE	UE	AE	UE	AE	UE
SH1	265.93±1.4	249.67±4.2	193.80±2.4	189.1±0.8	70.23±1.9	72.77±0.9	30.74±0..5	33.45±1.1
SH2	446.67±5.9	449.01±2.5	331.94±4.6	337.5±5.2	173.05±2.1	166.56±1.3	44.56±2.2	43.61±0.8
SH3	511.45±7.8	509.2±1.8	398.12±5.4	400.87±1.5	165.12±3.6	158.32±3.4	58.90±3.7	56.76±1.5
SH4	747.19±8.5	760.11±7.6	535.55±4.9	542.33±2.4	220.90±3.1	212.85±4.9	116.66±2.4	109.39±1
SH5	541.88±8.1	534.6±4.1	356.61±1.1	351.8±2.2	104.20±5.6	103.47±0.5	47.85±1.6	45.17±1.9

Table 4. Macro-nutrients concentration (mg/kg) of *Shatavari* samples (mean), n = 3

Sample	Calcium	Potassium	Magnesium	Sodium	Phosphorous
SH1	8011.50±1.31	9658.99±2.18	1774.29±2.66	2011.93±1.45	1679.45±0.67
SH2	10366.69±2.75	2676.22±5.30	5685.13±1.28	1702.96±0.45	418.06±0.79
SH3	1039.82±0.89	6184.47±1.74	709.06±0.65	396.18±0.49	2386.02±1.25
SH4	693.62±0.67	162.75±0.11	268.83±0.29	1372.74±0.93	190.02±0.95
SH5	1604.38±0.58	1760.65±0.30	510.33±0.13	1786.85±1.53	336.79±1.20
LOD	1.73	0.45	1.18	4.62	2.86

4. Calcium was essentially prime for bone health, the maximum concentration of calcium were noticed as 10366.69±2.75 mg/kg, 8011.50±1.31 mg/kg in SH2 and SH1 respectively. The minimum concentration was reported as 693.62±0.67 mg/kg in SH4. From the earlier reports[24] calcium content of *Shatavari* leafs and roots in the range of 961.0±0.6 to 2115.0±3.2 mg/kg lower than SH1 and SH2. All the samples exhibited higher potassium content except SH4 (162.75±0.11 mg/kg). Potassium was very useful for transmission of nerve impulses and building muscles. In the analysed samples magnesium was detected at high concentration in SH2 (5685.13±1.28 mg/kg) and low concentration in SH4 (268.83±0.29 mg/kg). The concentration of sodium was ranges from 396.18±0.49 mg/kg to 2011.93±1.45 mg/kg. The high concentration of phosphorous in SH3 (2386.02±1.25 mg/kg) and relatively low concentration in SH4 (190.02±0.95mg/kg). Phosphorous plays important structural role in nucleic acids and cell membranes.

The concentration of micronutrients (cobalt, iron, manganese, nickel and zinc) was given in Table 5. Cobalt was detected in SH1 and SH5 only at the concentration of 0.74±0.01 and 5.92±0.17 mg/kg respectively. Manganese was an essential cofactor for many enzymes. Iron was involved in oxygen transport. Both manganese and iron are the nutrients that exhibited the higher concentrations in SH1

as 53.49±0.63 mg/kg and 1981.03±1.81 mg/kg compared to other samples. Various enzymes synthesis was dependent on the concentration of zinc in the human and animal body. Lack of zinc can inhibit the growth and well-being[25]. SH4 showed high concentration of zinc 193.73±0.13 mg/kg than the concentration reported previously. Nickel is used for increasing iron absorption in the body. Nickel concentration ranges from 2.92±0.02 mg/kg to 14.49±0.80 mg/kg.

The concentration of arsenic, cadmium, chromium, mercury and lead in the samples are present in the Table 6. Arsenic consumed in lower dose for a long period cause vascular toxicity, respiratory, liver toxicity and hypopigmentation[25]. Higher concentrations of arsenic noticed in SH2 (1.98±0.01 mg/kg) and SH3 (1.84±0.02 mg/kg) samples which were lower than the maximum permissible limit of 5 mg/kg. Cadmium intake exert toxic effects on kidneys, the respiratory system and the skeletal system[26]. It has ability to substitute the other metal ions like Ca^{2+}, Zn^{2+} and Cu^{2+} leads to negative effect on enzymatic systems. The elevated levels of cadmium was noticed in SH1 of concentration 0.21±0.03 mg/kg whereas, cadmium concentration was within the maximum allowable limit (0.3 mg/kg). Chromium is an essential trace metal in carbohydrate metabolism and protein synthesis. When chromium concentration is higher than 2 mg/kg in herbal medicine, it may cause skin problems

Table 5. Micro-nutrients concentration (mg/kg) of *Shatavari* samples (mean), n = 3

Sample	Cobalt	Iron	Manganese	Nickel	Zinc
SH1	0.74±0.01	1981.03±1.81	53.49±0.63	14.49±0.80	169.33±0.89
SH2	ND	1180.03±3.67	41.08±0.24	7.62±0.24	146.03±0.28
SH3	ND	213.81±0.58	11.37±0.02	2.92±0.02	51.07±0.81
SH4	ND	832.44±0.32	11.69±0.01	13.60±0.13	121.95±0.19
SH5	5.920±0.17	1273.41±0.55	25.52±0.24	6.30±0.08	193.73±0.13
WHO	0.14–0.48	261–1239	44.6–339	1.63	–
LOD	0.10	0.63	0.03	0.26	0.75

Table 6. Heavy metals concentration (mg/kg) of *Shatavari* samples (mean), n = 3

Sample	Arsenic	Chromium	Cadmium	Mercury	Lead
SH1	≤ 1.1	ND	0.21±0.03	≤ 0.1	9.23±0.27
SH2	1.98±0.01	1.33±0.01	0.07±0.02	≤ 0.1	7.46±0.16
SH3	1.84±0.02	0.04±0.01	ND(0.05±	≤ 0.1	4.38±0.03
SH4	≤ 1.1	0.03±0.0	0.09±0.02	≤ 0.1	6.78±0.11
SH5	≤ 1.1	0.02±0.0	0.09±0.01	≤ 0.1	3.96±0.23
WHO	5	2.0	0.3	0.1	10
LOD	1.1	0.01	0.08	0.1	1.5

and damages liver, kidneys, circulatory nerve tissues and respiratory problems[27]. Chromium content was detected only in sample SH2 at level of 1.33±0.01 mg/kg. Lead has adverse effects on various body systems such as reproductive, digestive, cardiovascular and immunological systems[28,29]. Lead was present at concentration ranging from 3.96±0.23 to 9.23±0.27 mg/kg which were lower than the maximum recommended limit 10 mg/kg by WHO[30]. Mercury was not observed in all the examined samples and this may be due to the presence of mercury at lower concentration than its detection limit (0.1 mg/kg). The concentration of heavy metals in the studied samples were below the permissible limits of WHO. These findings revealed that the concentrations of the essential elements and heavy metals vary considerably from sample to sample due to differences in plant species environmental conditions and cultivation process, which accordingly alters the constituents of the plant material used in the preparation of herbal medicines.

Conclusion

From this study, SH1 sample displayed more pronounced antioxidant potential than the remaining commercially available samples. Some samples showed linear correlation between phenolic compounds and antioxidant activity, some did not. Both AE and UE techniques were effective for phytochemical extraction. No significant variation was observed between the two extraction techniques. Presence of total phenolic and flavonoid contents, steroidal saponin, antioxidant activity and nutrients contribute a good basis for understanding the curative effects of the samples. The concentration of heavy metals indicated that there was no anthropogenic inputs of the metals in any of the samples. Thus, results of the present study proposes monitoring the levels of heavy metals in herbal medicines was mandatory for manufacturers.

References

1. S. Patra and S. Unisa, *Glob. J. Med. Public. Health.,* 2017, **6**, 1.
2. N. K. Satti, K. A. Suri, P. Dutt, O. P. Suri, M. Amina and G. N. Oazi, *J. Liq. Chromatogr. Relat. Technol.,* 2006, **29**, 219.
3. R. K. Sharma and B. Dash, "Charaka Samhita", Chowkhamba, Varnasi, India, 2003, **5**, 129.
4. Atreya, "Ayurvedic healing for women", York: Sauel Weiser, Inc., 1999.
5. Y. Kumeta, T. Maruyama, D. Wakana, H. Kamakura and Y. Goda, *J. Nat. Med.,* 2013, **67**, 168.
6. S. Parasuraman, G. S. Thing and S. A. Dhanaraj, *Phcog. Rev.,* 2014, **8(16)**, 73.
7. M. Rajani and S. K. Niranjan, "Bioactive Molecules and Medicinal Plants", 2008, Chap. 19, 349.
8. S. Alok, S. K. Jain, A. Verma, M. Kumar, A. Mahor and M. Sabharwal, *Asian. Pac. J. Trop. Dis.,* 2013, **3(3)**, 242.
9. A. K. Singh, A. Srivastava, V. Kumar and K. Singh, *The Natural Products J.,* 2018, **8**, 32.
10. S. Kaur and P. Mondal, *J. Microbiol. Exp.,* 2014, **1**, 23.
11. M. I. Hossain, F. A. Sharmin, S. Akhter, M. A. Bhuiyan and M. Shahriar, *Int. Curr. Pharm. J.,* 2012, **1**, 250.
12. L. Taepongsorat and S. Rattana, *Phcog. J.,* 2018, **10**, 1129.
13. L. Subedi, S. Timalsena, P. Duwadi, R. Thapa, A. Paudel and K. Parajuli, *J. Tradit. Chin. Med.*, 2014, **34**, 584.
14. B. O. Obadoni and P. O. Ochuko, *Glob. J. Pure. Appl. Sci.,* 2001, **8**, 203.
15. J. C. Baccou, F. Lambert and Y. Sauvaire, *Analyst*, 1977, **102**, 458.

16. K. Devendra, D. kiran, V. Ritesh, B. Satyendra and K. Abhishek, *J. Phcog. Phytochem.,* 2013, **2**, 116.

17. G. Marinova and V. Batchvarov, *Bulgarian. J. Agric. Sci.*, 2011, **17**, 11.

18. E. A. Shalaby and S. M. M. Shanab, *Indian. J. Geo-Marine. Sci.*, 2013, **42**, 556.

19. K. Puspendra, J. Shivesh and N. Tanveer, *Int. J. Drug Dev. & Res.*, 2015, **7(1)**, 23.

20. A. Giacomino, O. Abollino, C. Casanova, C. L. Gioia, E. Magi and M. Malandrino, *Micro. Chem. J.*, 2015, **120**, 6.

21. K. Devendra, D. Kiran, V. Ritesh, B. Satyendra, Kmar. Abhishek, *J. Phcog. Phytochem.*, 2013, **2(4)**, 116.

22. S. Velavan, K. Nagulendran, R. Mahesh and V. H. Begum, *Phcog. Mag.,* 2007, **3**, 26.

23. G. V. Jayashree, P. Rachitha, K. Krupashree, K. H. Kumar and F. Khanum, *Phcog. J.,* 2015, **7**, 183.

24. J. S. Negi, P. Singh, G. J. Nee Pant, M. S. M. Rawat and H. K. Pandey, *Biol. Trace. Elem. Res.,* 2010, **135**, 275.

25. N. K. Singh, A. S. Raghubanshi, A. K. Upadhyay and U. N. Rai, *Ecotoxicology and Environmental safety,* 2016, **30**, 224.

26. N. V. V. Jyothi, P. C. Mouli and S. R. J. Reddy, *J. Trace Elem. Med. Biol.*, 2003, **17**, 79.

27. S. Wilbur, H. Abadin, M. Fay, D. Yu, B. Tencza, L.Ingerman, *et al.*, "Agency for Toxic Substances and Disease Registry", Toxicological Profiles, Department of Health and Human Services, US, 2012.

28. M. Jalili MD and R. Azizkhani MD, *West J. Emerg. Med.*, 2009, **10(4)**, 244.

29. S. Tokalioglu, *Food Chem.,* 2012, **134**, 2504.

30. WHO, "Guidelines for assessing quality of herbal medicines with reference to contaminants and residues", World Health Organization, Geneva, Switzerland 2007.

Sentiment Classification through Convolutional Neural Network Based Quick Sentiment Analysis

Kota Venkateswara Rao[1,2], M. Shyamala Devi[1]
[1]Department of Computer Science and Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai, TamilNadu, India.
[2]Department of Computer Science and Engineering, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Andhra Pradesh, India

.ABSTRACT

Sentiment Analysis (SA) is characterized as the region of study to analyze individuals' Sentiment, surveys, and mentalities from various languages or from web remarks. SA has spread to each conceivable space like budgetary, medicinal services, online items, internet business to get-togethers, media transmission, political causes and decisions. In the manuscript, a computerized framework, which forms a huge dataset of analysis for viewpoint based decisions is proposed. The sentiments are gathered by Natural Language Processing (NLP) and afterward it is assigned positive, impartial and negative. As the quantity of web information is exponentially expanding, it turns out to be increasingly imperative to create models to investigate the content information consequently. The text may contain different labels, for example, age, gender, nation, sentiment, review etc. Utilizing such labels may carry advantages to some modern fields, such huge numbers of investigations of classification of texts have showed up. As of late, the Convolutional Neural Network (CNN) has been utilized for the process of classification of text and has obtained better results. In the manuscript, Convolutional Neural Network based Quick Sentiment Analysis (CNN-QSA) is proposed for the assignment of sentiment classification. The most main reason for to utilize CNN in SA is that CNN can extract features from global data, and it can think about the relationship among these features. CNN has a convolutional layer to extract data by a larger part of text with convolutional neural system. The proposed CNN-QSA method is compared with the traditional methods and the results show that the proposed method is better than the traditional methods like SVM and Naive Bayes strategies.

Key words : Sentiment Analysis, Natural Language Processing, Textual Data, Text Classification, Convolutional Neural Network, Feature Extraction.

1. INTRODUCTION

Sentiment Analysis and Opinion mining is almost comparative one anyway there is slight assortment between them for example opinion mining separates and investigate individuals' conclusion about a substance while Sentiment analysis search for the slant words/articulation in a book and after that analyze it. Opinion mining is additionally represented as the mining that expects to choose the conclusion unrevealed about a content noted in regular language. This perceives and chooses the natural data from the quality materials [1]. Opinions uncovered in a gathering of source records regarding a text document are extricated with opinion mining. This is finished by picking the characteristics of an item from the client assertions and chooses whether the remarks are ideal or disappointing [2]. For instance, the items salespersons are focused more on each client singular remarks in web based with respect to the items and administrations. These client remarks have high significance in the assessments of different buyers. Establishments and business keep watch on these buyer remarks to know the method for items perceived [3] [4]. Although analyzing these things is one of the uncertain employments on the grounds that there are accessible sources that contain spacious information.

Assumptions indicate the sentiments; Sentiments are the thoughts of people for the particular item. Assumption investigation of sentiment mining is extremely a complex task. There are numerous confusions like characteristic language processing for automated extricating of features, ordering and editing Sentiments which are communicated in on the web. Opinion Analysis is an investigation that is practiced by different associations for recognizing client input about the items. This makes different clients for knowing the ideal determination of their supported item. Sentiment Analysis using machine learning methods is ordinarily utilized in opinion mining for knowing notions, subjectivities also delicate states in online reviews and opinions[5-8]. The procedure was practiced on product assessment by sorting out the items qualities. Right now, estimation and analysis of sentiments is used in a broad scope of areas like E-Commerce and health care applications. By using CNN, the process of performing sentiment analysis is depicted in Figure 1.
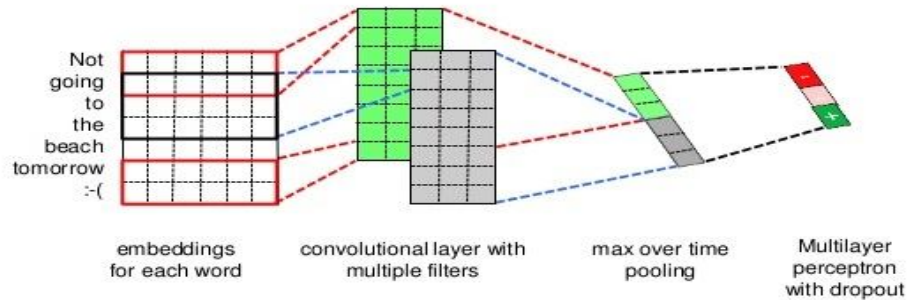
Figure 1: Process of Sentiment Analysis using CNN

In the web, numerous text information exists and it very well may be sorted out roughly into two most significant orders: truth and assumption. The fact of the matter is the target declaration though Sentiments are the emotional articulations. Sentiments are singular conclusions, emotions, assessments, and mentalities related with the particular item or product. The significant part of the sentiment analysis on text information has been engaged with respect to mining from truth based information, for example, online products, recovery of data, content gathering, content classification, and so on. Accessible numerous quantities of sentiment based sources and all may additionally have an enormous measure of Sentiment based informations using machine learning approach for attaining better results. Customer's expressions are generally occupied with broad discussion posts and sites for survey. It is badly arranged for the clients to blueprint such sources, finding right Sentiment articulations, understand them, and convert them into positive and negative assessments [9].

Sentiment Analysis focuses on the determination of user's perspective regarding explicit subject. The perspective includes appraisal, sensitivity or even passionate stages [10]. The most prime activity in opinion examination is the order of the extremity of explicit content at the degrees of features, archives, sentences and so forth. After text divisions are arranged, keen stages like „happy", „angry" and „sad" are likewise recognized [11]. The arrangements of text divisions is the principle task in sentiment mining and it occurs at the hour of a segment of content expressing a Sentiment on a solitary issue that is classified as one among the two incompatible assessments. Hardly any models for extremity characterization are „like" versus „dislike" or „thumbs up" versus „thumbs down". This grouping likewise finds the favorable circumstances and damages of explanations in online surveys and helps with making the evaluation of items progressively solid. Another type of paired sentiment classification is understanding recognition of sentiments analyzed [12].

Sentiment Analysis is one of the unpredictable techniques that comprise of five significant stages for looking at inclined information. The sequence of Sentiment Analysis process is appeared in Figure 2. The stages incorporates, I. Gathering Reviews, ii. Preparation of data, iii. Performing review analysis, iv. Sentiment classification, v. Generating Results.
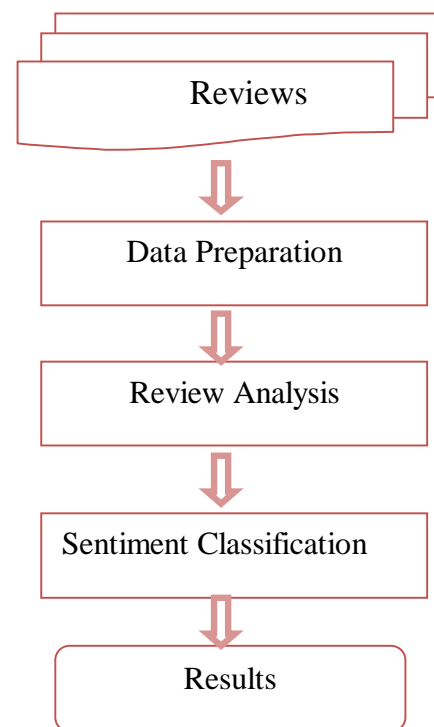
Figure 2: Sequence of Sentiment Analysis

The explanations that are chosen are examined and the explanations that are with a conclusion are protected though the other outstanding assertion. This undertaking can be conveyed in different levels or states, one term, whole sentence or entire record with commonly applied methodologies [13]. These procedures incorporate as follows:

- ➢ Unigrams
- ➢ N-grams
- ➢ Lemmas
- ➢ Negation
- ➢ Opinion words

Machine learning methodology is considered for getting accurate results in the process of sentiment analysis and for accurate classification of text based on sentiments identified and rating the products [14].

2. LITERATURE SURVEY

Y. Han et al. [1] introduced a independent feature extraction from the web information. This method portrays the KnowItAll framework. This framework is another structure thought, featuring its novel ability to infer the data without any hand-marked organized models. This framework focuses to computerize the standard procedure of determining the massive determination of realities, for instance, names of extraordinary pioneers or researchers from the web in an area free, solo and versatile way. So as to upgrade the frameworks review and inferring rate, there are three particular ways for assessing its exhibition; they are design learning, subclass extraction and rundown extraction. Sentiment model learning finds the explicit inferring decisions so that there are additional inductions that are likewise conceivable.

Z. Nasim et al. [2] handled parallel characterization utilizing the SVM and accomplished 71.6% exactness for Twitter data, where they embraced two sorts of target-autonomous features (e.g., twitter text highlights and supposition vocabulary features). Z. Xiangyu et al. [3] utilized the quantity of positive words and the quantity of negative words as features and accomplished 82.3% precision for double grouping with Twitter reviews. M. H. Krishna et al.[4] joined unigram features and their own Twitter-explicit features and acquired 80% precision for double characterization utilizing the SVM classifier. P. Yadav et al. [5] characterized the number supposition things as an element and joined the component with unigrams. They accomplished 75.2% precision for ternary arrangement utilizing the SVM.

D. V. N. Devi et al. [8] examined about finding assessments naturally on client conclusions. By exploring the assessments of the items from the clients, it is conceivable to separate the items which are missing and which are solid. This can be found with the assistance of sentiment examination. This makes to develop a model that can determine the Sentiment words consequently and find their extremity with the assistance of a lexicon. This limits the hand-worked exertion of dissecting these assessments and to assess them. It additionally depicts the significance of utilizing unstructured content in the spot of preparing information that are costly. A strategy is discovered that relies upon rules in which the item remarks are considered from reviews containing destinations and investigation is finished. Subsequently an individual should ready to know whether a particular item review is positive or negative or neutral.

The procedure for SA by means of R. Hegde et al. [9] depended on deep NLP of the sentences, using a part parsing as a advancement. Assessment Propagation is completely founded on the SA calculation that acknowledged that each semantics component is a kind of an issue. They showed a gathering of syntactic-based measurements that intended to cover a significant bit of the thought putting nature conveyed by content. They anticipated Associate in nursing information representation structure during which they expected to filter through numerous information questions or to contextualize the information with the objective that just the data essential to a customer request is given the impression to the customer.

K. Han et al. [10] have shown a much customized framework for fine-grained Storm Troops on the sub sentence level, merging shifted supposition vocabularies and neighborhood and furthermore online review relations. They use Andrei Markov rule to facilitate furthest point scores from changed evaluation word references using data in regards to relations between neighboring segments. Their results incontestable that the utilization of fundamental features expanded the exactness of furthest point estimates achieving precision scores up to 69%.

S. Jebbara et al. [11] use the phonetic examination to explore the idea in sentence level with the nearness of product review rates. This technique is introduced to infer the conclusions identified with the sentence or expression. Sentiment Analysis has been attempted for the most part for records regularly a Sentiment or another item. Conjunctions have a broad impact on the total sentiment of a sentence, along these lines, it discover a method for nuclear assessments of independent expressions incorporate with each other in the presence of conjuncts to decide the total sentiment of a sentence. The word conditions are used to inspect the sentence builds and along these lines, the outcome got about 80%. It additionally analyzes the impact of WordNet on the yield precision.

Ghiassi et al. [12] contemplated that in numerous past works, item highlight and determining assessments are treated as two separate errands. Right now, are converged with each other by utilizing probabilistic models. This respects the trouble of item qualities and supposition extraction as a succession marking task and chooses the restrictive arbitrary field's models to accomplish this. A computational strategy is created to assemble area explicit assessment dictionary by incorporating semi-organized supposition with general notion vocabulary that helps with finding the notion directions of Sentiments. The adequacy of the proposed approach is appeared with the test results on two genuine world datasets.

Balazs et al. [13] studied about the conclusion mining and assumption investigation.

This overview portrays the strategies and methodology which guarantee to allow Sentiment focused data looking for frameworks straightforwardly. This focuses on these methodologies that mean to mark the new challenges raised by assumption mindful applications when contrasted with the one that exist already in a much broad truth based investigation. This includes the material on the portrayal of evaluative content and on more extensive issues concerning control, security and financial impact that the advancement of supposition arranged data procures administrations emerges.

Chaturvedi et al. [14] proposed an assessment investigation utilizing Support Vector Machine. For Feature extraction, this proposed approach utilizes N-grams, diverse weighting plans and furthermore investigates Chi-Square weight features. This Chi-Square weight gives a huge improvement in arrangement exactness. The assessment of the results in

film related area shows conspicuous outcomes. AUC on unigram approach is 0.917, though AUC on bi-gram approach is 0.728. Text arrangement utilizes preparing and testing informational index from Pang Corpus, which has film surveys gathered from IMDb.

C.R.Bharathi et al. [15] proposed a multilayer perception model for Sentiment analysis and selection tree-based component positioning is proposed for feature determination. The author likewise proposed a crossover calculation, in view of differential development and genetic calculation for weight streamlining calculation to improve multilayer perceptron neural system is proposed. The technique is assessed on IMDb dataset. A multilayer perceptron is a feed-forward neural system; it can have at least one concealed layers alongside information and resultant layers. A multilayer perceptron has numerous node layers, where every node is neuron with non-direct enactment work in layers other than the information layer[16-22].

3. DISADVANTAGES OF EXISTING SYSTEM

With the advancement of internet based life, reviews on the web and its conversations, sentiments, proposals, gathering, criticisms and postings are utilizing in the media to make goals by people and associations. In like manner the total foundation extremity or client assumptions in regards to not many traits are sorted out utilizing Sentiment Analysis. The order is found as a significant test in Sentiment Analysis and the review can comprehend the item, assessment of item or evaluation of an item that can be a choice, record or quality which is gathered into positive or negative. Due to the communication of various locales in the web, it is difficult to watch and decide the destinations of client perspectives and determining the data. In the spots of long online journals and gatherings, all locales incorporate not many sentiment

sentences and it very well may be comprehend with no troublesome.

The destinations relating the specific thing was found and determining, inspecting the perspectives is urgent through utilizing a normal human peruser. In these conditions, the arrangement of SA is essential. Right now, opinion analysis is the mandate at the convergence of NLP and recovery of data and furthermore parts the numeral of features other than with different procedures that incorporate perceptive examination, computational etymology, content mining, data extraction.

A review made by the client concerning unmistakable substances, occasions or articles, and its features is alluded as realities. Additionally, an expression that portrays the person's Sentiment, assessments and the presentation examination with respect to elements, items, occasions and its characteristics is alluded as sentiment. Regularly Sentiments can be passed on everything that might be an individual, item, specific theme or business enterprises. This determines, the most opinions are passed on features that are having own components and attributes.

4. PROPOSED METHODOLOGY - CONVOLUTIONAL NEURAL NETWORK BASED QUICK SENTIMENT ANALYSIS (CNN-QSA)

Convolutional neural networks are the neural system that is utilized for handling information that has realized framework like topology. Natural language preparing task is utilizing convolutional neural systems, abuse the 1D structure of text information for accurate estimation. A convolutional neural system gives prevalent characterization precision as a result of the non-linearity of the system just as the capacity to effectively incorporate pre-prepared word embeddings. The text is classified from the sentiments using CNN is depicted in Figure 3.
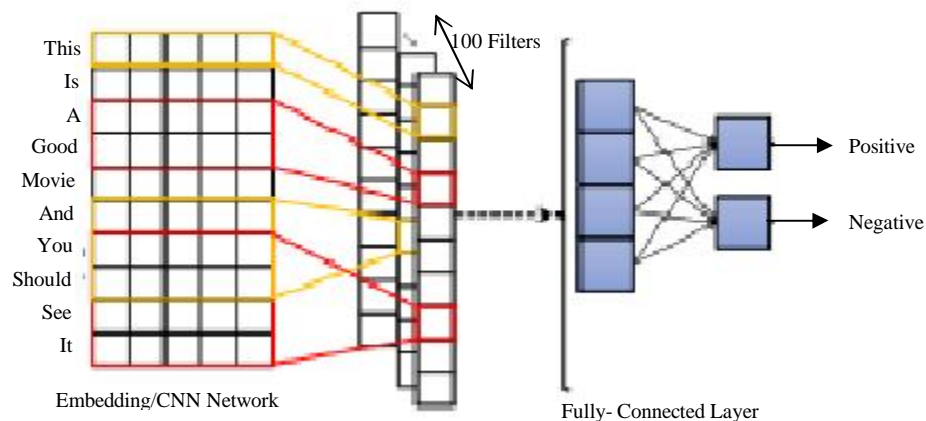
Figure 3: Text Classification using CNN

Convolutional neural systems are systems with convolutional and pooling layers, which are helpful for order undertakings, for example, assessment arrangement and so forth. At convolutional neural systems, convolutional and pooling

designs are applied to text. Convolution is a specific sort of direct activity and pooling is an activity in convolutional neural systems. The convolution activity is done as

$$C(t) = (M * w)(t) \qquad (1)$$

Here, $*$ is the Convolutional operation $C(t)$ – referred to as feature map, M is referred to as input w is referred to as the function such as kernel. The proposed Neural Network based Quick Sentiment Analysis (CNN-QSA) works as follows
When a low dimensional vector is fed to the convolutional neural network to predict the sentiment is represented as.
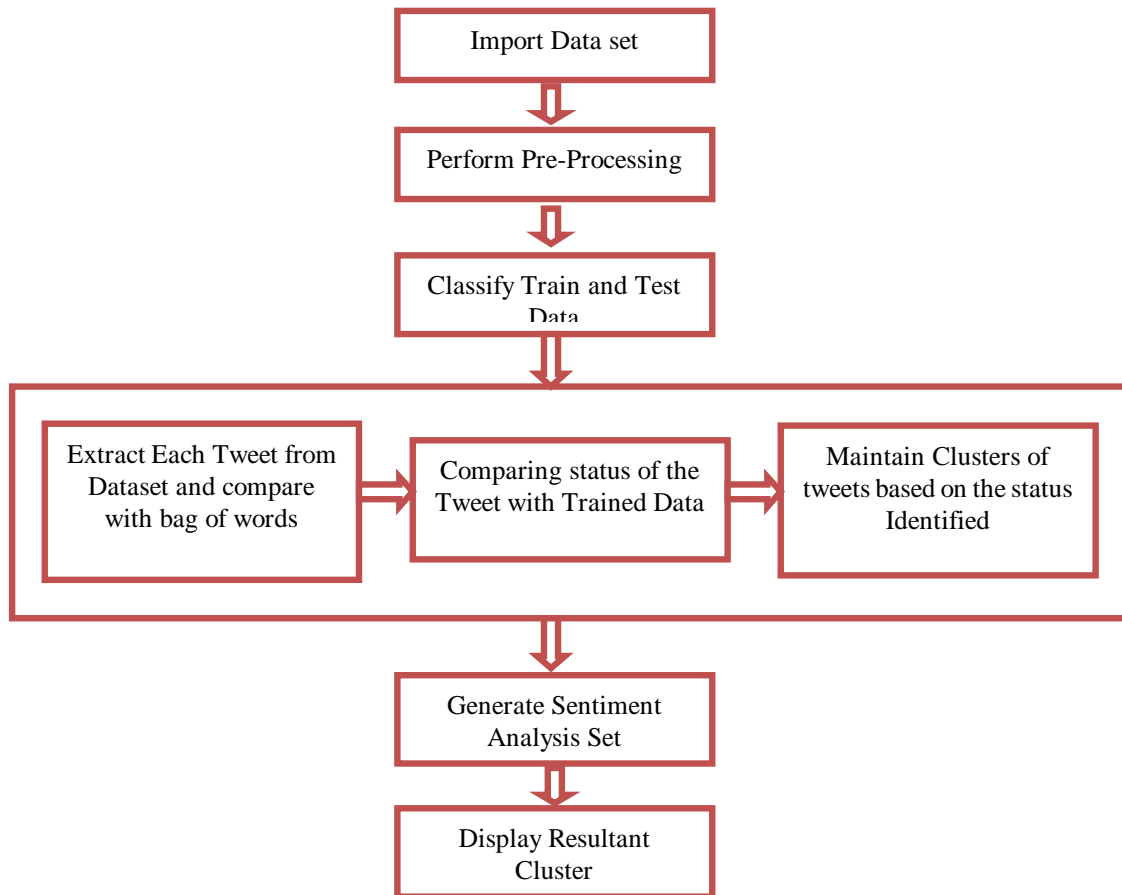
$$S(t) = dW_1 = f(wx + T) \qquad (2)$$

$$\hat{dW} = max(d_1, d_2, \ldots, d_n) \qquad (3)$$

$$\hat{s} - f(wx) - softmax(W\hat{d} + T) \qquad (4)$$

$d_1, d_2, \ldots, d_n$ - Convolution, T- Bias vector, $\hat{d}$- pooling layer to generate one vector as the output of the filter layer.

The proposed work framework is depicted in Figure 4.

Figure 4: Over all Architecture of Proposed CNN-QSA

For Text classification, the input document or sentences was classified into two or three class classification. The output of the predicted sentiment of the document Di is represented as follows:

$$Di = f(wx) = \sigma(W.r_{vi}(x) + T) \qquad (5)$$

The proposed CNN-QSA model performs sentiment analysis on the given data using the algorithm given
In the proposed algorithm Tr(DS) is the Dataset considered having trained and test data that is given as input, q is the initial tweet considered from the dataset given. C(i) is the cluster set starting from initial record i.
Input: Dataset Tr(DS)
Output: Given Tweets status is displayed in clusters
    [1]. Initialize Bag of words, i=1

    [2]. For each tweet q, do
        Apply Pre processing
            Eliminate Hashtags
            Eliminate Stop words
            Eliminate Special characters
      end for
    [3]. Consider Selected token set TS
    [4]. foreach q $\in$ Tr(DS) do
            C(i) ←q.tweet where qε Tr(DS)
          Where q is the tweet considered from the given dataset Tr(DS)
         foreach t C(i)ε Tr(DS) do
              C(i+1) = q.sub('#Bag of words)
           Where C(i+1) is the sequential tweets considered.
        end for

[5]. I = str.compare(C(i), Tr(Ds).Status. Positive
    if (I==0)
        C(i).Status =
    q.sentiment('Positive');
      end if
[6]. I = str.compare(C(i), Tr(Ds).Status. Negative
    if (I!=0)
        C(i).Status =
    q.sentiment('Negative');
       else
        C(i).Status =
    q.sentiment('Neutral');
      end if
[7]. Display Tweets status cluster sets C(i)ε Tr(DS) that represents positive, negative and
    neutral tweets.

5. MATHEMATICAL MODELING OF CNN-QSA

The proposed CNN-QSA have fast learning speed and improved execution of speculation. It can't to adjust the underlying parameters of concealed layer about each nonlinear undertakings are expressed as covered neurons. Thus, N discretionary particular examples {(pi, qi)|pi ∈ R n , qi ∈ R m , i= 1,..., N} in the resultant work with L covered neurons is given as

$$f_L(p) = \sum_{i=1}^{L} \omega_i \, hl_i(p) = hl(p)\omega$$
(6)

in which, $\omega = [\omega 1 , \omega 2 , \ldots .]$: indicates the result vector among the L neurons and the resultant neuron of concealed layer, $hl(x) = [hl1(p), hl2(p), \ldots . hlL(p)]$: shows the resultant vector of information as of information space. So as to limit the preparation inaccuracy and to upgrade the presentation of speculation in neural system, it is conceivable to limit the preparation inaccuracy and the loads in a similar time and it is given by

$$minimum \, (\|H_\omega - T\|, \|\omega\|)$$
(7)

Right now, set of s channels is applied to a sliding window of length h over each sentence. Let S[i:i+h] mean the connection of word vectors si to si+h. A component CIi is produced for a given channel R by:

$$CI_i := \sum_{k,j} (S_{[i:i+h]})_{k,j} \, R_{k,y}$$
(8)

There is a filter which parameterized by the weight matrix WM with region size S; the sentence matrix $A \in \mathbb{R}^{s \times d}, A[i: j]$ is the sub-matrix of K from row i to row j. The output $o \in \mathbb{R}^{s-h+1}$ can be calculated

$$K = \pi r^2 o_i = WM.A[i: i + S - 1]$$
(9)

In the formula i=1…s-h+1 is the dot product between sub-matrix and the filter. Same as other neural network model, bias $b \in \mathbb{R}$ and activation function f have been added to o_i and the feature map $c \in \mathbb{R}^{s-h+1}$ for

$$c_i = f(o_i + b)$$

The basic n-gram language model is used to assign a probability P(t) to every possible word sequence W i.e. the feature derived are represented as:

$$P(t) = \sum_{i=1}^{v} (w_i \,|w_{i-1}) + cl + K$$
(10)

$$WBOW(f_-,f_2,\ldots,f_k) = \frac{1}{\sum_j^k w_i} \sum_i^k v(f_i) - P(t) + k$$
(11)

Consequently O(p) is the output function and is represented as

$$O(p) = [k(p,p_1),\ldots k(p,p_N)](M+k)^{-1}$$
(12)

On the off chance that attribute Ai with values {v1,v2,.....vN } is utilized for tree root, at that point it sub separates P into {P1, P2 ,..... PN }, in which Pi determines the classes in T that have esteem vi of Xi. Expect Ti involves ai classes of O(p); bi classes of WBOW and ci classes of P(t), at that point the mediator data which is required for the sub-tree for Ti are I(ai ,bi), I(bi ,ci) and I(ai ,ci). The L anticipated data required for the decison tree with Ri as the (L (Xi)), is set up as a weighted normal are given as follows:

$$L(X_1) = \sum_{i=1}^{N} . \frac{a_i + b_i}{a + b} I(a_i, b_i)$$
(13)

6. RESULTS & DISCUSSIONS

The proposed method for performing sentiment analysis is done using ANACONDA SPYDER and dataset that is utilized for assessing the evaluation is available at http://www.cs.cornell.edu/individuals/pabo/film audit information and movie review dataset used is the recently proposed Stanford Sentiment Treebank (SSTb). The dataset organizer have „txt_sentoken" which are the 2000 processed down-cased content documents that are used in Pang/Lee ACL and there are two subdirectories that are "pos" and "neg", it determines the genuine review of the segment records dependent on the proposed programmed rating classifier and results are clearly depicted. The original training set contains 1.5 million tweets that were automatically labeled as positive/negative using emoticons as

noisy labels. The datasets considered and the tweets considered for training and testing are represented in Table 1.

Table 1: Trained and Test Tweets

Dataset	Set	Tweets	classes
Film Audit Dataset	Train	96521	5
	Test	2541	5
SSTb	Train	85247	3
	Test	1556	3

An assessment metric is used to quantify the value of sentiment analysis frameworks and to clarify the theoretical and useful advancements of these frameworks. It contains measurements which trails the general unrevealed procedure of assessment. Not many of the measures that are chosen with the end goal of assessment are Recall, Precision, and the F-Measure. The performance of the proposed classifier is contrasted with the traditional methods and are depicted in Table 2.

Table 2: Performance levels of Various Classifiers

Classifier Model	Precision	Recall	F-Measure
SVM	0.56	0.62	0.72
LSTM	0.68	0.57	0.76
CART	0.85	0.72	0.82
CNN-QSA	0.97	0.95	0.93

The predicted values are depicted in Table 3. The Trained and Test dataset parameters data is clearly depicted specifying positive, negative and neutral tweets.

Table 3: Levels of Predicted Values

Predicted Value	Positive Category	Negative Category	Neutral Category
Trained dataset	21365	12352	568
Test dataset	8652	3657	103

For better use of this proposed technique for the proficient characterization of reviews with mining, it needs the estimations of these measures to be determined. The estimations of measures are resolved based on True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN) with the decision of customer review

classification. The examination of ROC is utilized to figure the classifier accuracy. The flat and vertical pivot of ROC curve is
given as $x = 1 – specificity\ (t)$ and $y = sensitivity\ (t)$.

Figure 5 outlines the partition with the cut-off point for best explicitness and affectability. The proposed model to the preparation information and produces the client survey information. It is discovered that the pace of affectability of estimation examination for the proposed approach is about 93% and explicitness pace of 90%. The ROC curves levesl of the proposed method is compared with the traditional LSTM (longshort-term-memory) and SVM method.
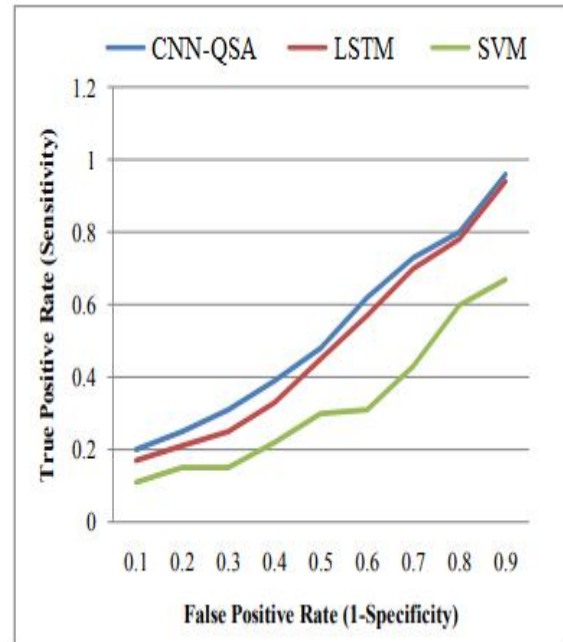
Figure 5: ROC Curve Levels

The precision evaluates the number of reviews that are to be categorized as Positive (Negative or Neutral) is actually Positive (Negative or Neutral) using the equation:

$$precision = \frac{True\ Positive}{False\ Positive + True\ Positive} \quad (14)$$

The recall specifies the numbers of reviews of Positives (Negatives or Neutrals) classes actually are categorized. The accurate classification percentage of Positives (Negatives or Neutrals) is specified using recall. It is also identical to Sensitivity:

$$Recall = \frac{True\ Positive}{False\ Negative + True\ Positive} \quad (15)$$

F-Measure integrates the precision and recall and it is considered as the harmonic mean of precision and recall:

$$F - Measure = \frac{2(Precision \times Recall)}{Precision + Recall} \quad (16)$$

Accuracy evaluates the weighted percentage of reviews Positive, Negative and Neutral which are categorized accurately.

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN} \times 100 \quad (17)$$

The time levels of the proposed method is depicted in Table 4. The proposed method takes less time in analysis of the sentiment tweets.

Table 4: Time Level Parameters

Classifier Model	Product Tweets Count	Training Time levels (hrs.min)	Testing Time levels(in milliseconds)
SVM	36524	4.37	19
LSTM	38981	3.23	16
CNN-QSA	45867	1.09	8

The processing time of the proposed CNN-QSA method is very low when compared to traditional methods. Figure 6 represents the processing time levels.
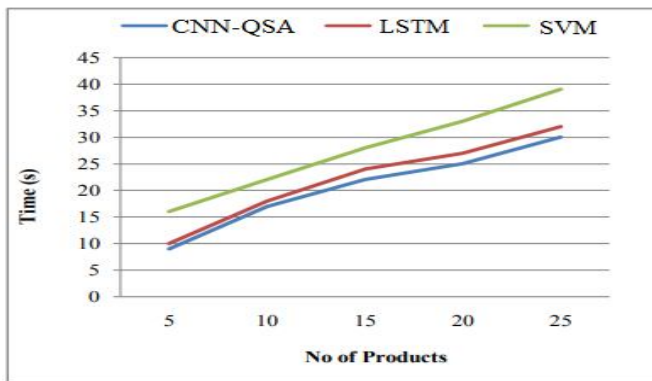
Figure 6: Time levels for Processing Sentiments

The accuracy, sensitivity and specificity of the proposed method and traditional methods parameters are depicted in Table 5.

Table 5: Performance Parameters

Classifier Model	Accuracy	Sensitivity	Specificity
SVM	87	83	80
LSTM	93	91	86
CNN-QSA	96	94	90

The comparison of accuracy, sensitivity and specificity of the proposed method is compared with the traditional methods and the results depict that the proposed method exhibits better performance. Figure 7 represents the comparison levels.
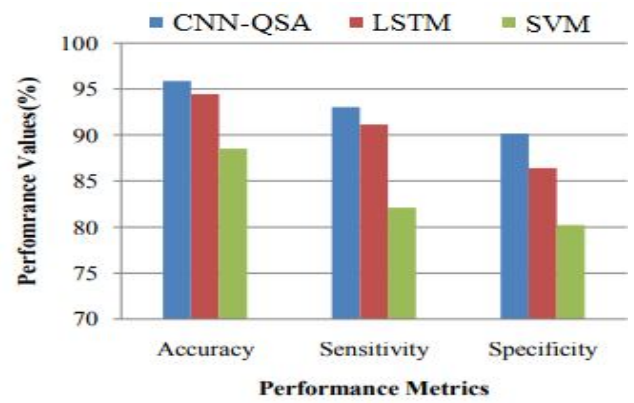
Figure 7: Comparison Levels

The comparison of precision, recall and F-measure of the proposed method is compared with the traditional methods and the results depict that the proposed method exhibits better performance. Figure 8 represents the comparison levels.
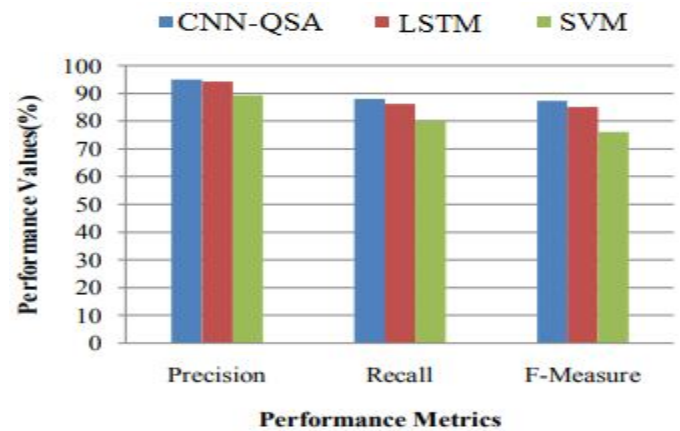
Figure 8: Comparison Levels of the Parameters

The training accuracy levels of the proposed method with positive, negative and neutral words are depicted in Figure 9.
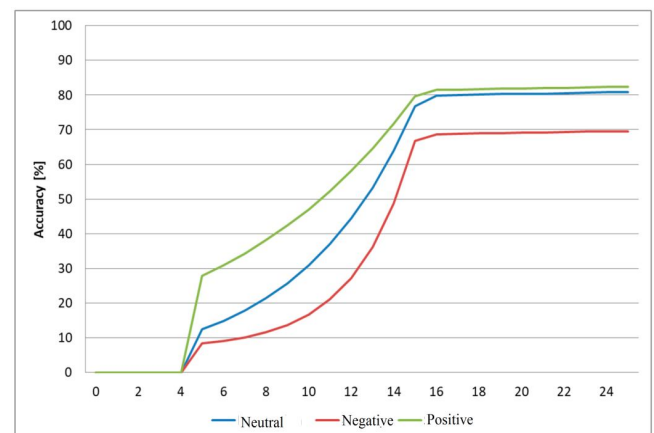
Figure 9: Training Levels

The testing accuracy levels of the proposed method with positive, negative and neutral words are depicted in Figure 10.
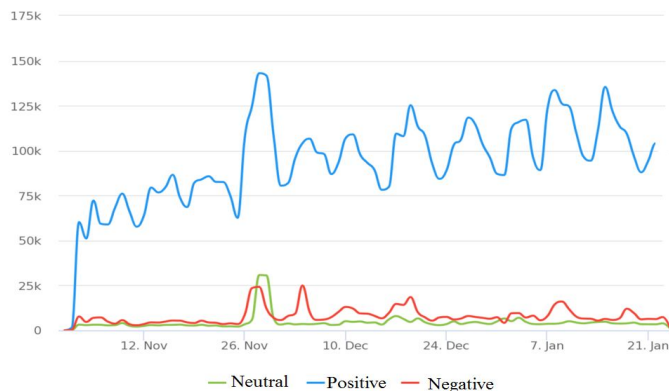
Figure 10: Testing Levels

The proposed CNN-QSA algorithm is compared with the existing LSTM and SVM methods and the accuracy of the models are depicted in Table 6.

Table 6: Accuracy Levels

Algorithm	Accuracy
CNN-QSA	93%
LSTM	84%
SVM	76%

7. CONCLUSION

Sentiment Analysis using machine learning methods is ordinarily utilized in opinion mining for knowing notions, subjectivities also delicate states in online reviews and opinions. The procedure was practiced on product assessment by sorting out the items qualities. A convolutional neural network model joins the qualities of keen words to manage the issue of Sentiment analysis. A keen word lexicon coordinating the features of the useful words into the word vector when preparing the word vectors, finally a convolutional neural system strategy was familiar with performing Sentiment analysis. The word vector joins the qualities of adoring words was input, and the result was the extremity of the remark data. Contrast with the conventional strategy, this technique improves execution. Be that as it may, there are still spaces for development, the measure of preparing information is little which may cause model preparing be inadequate This methodology hence can be considered to join information on the morphological structure of sentences, with the inducing intensity of CNNs. In future work, investigating the impact of different mixes of part-of-speech labels and other linguistic structures, on expectation accuracy should be possible.

REFERENCES

1. Y. Han and K. K. Kim. **Sentiment analysis on social media using morphological sentence pattern model,** *IEEE 15th International Conference on Software Engineering Research, Management and Applications (SERA),* London, 2017, pp. 79-84, 2017.

2. Z. Nasim, Q. Rajput and S. Haider. **Sentiment analysis of student feedback using machine learning and lexicon based approaches**, *International Conference on Research and Innovation in Information Systems (ICRIIS),* Langkawi, 2017, pp. 1-6, 2017.

3. Z. Xiangyu, L. Hong and W. Lihong. **A context-based regularization method for short-text sentiment analysis**, *International Conference on Service Systems and Service Management*, Dalian, 2017, pp. 1-6, 2017.

4. M. H. Krishna, K. Rahamathulla and A. Akbar, **A feature based approach for sentiment analysis using SVM and coreference resolution**, *International Conference on Inventive Communication and Computational Technologies (ICICCT)*, Coimbatore, pp. 397- 399, 2017.

5. P. Yadav and D. Pandya. **SentiReview: Sentiment analysis based on text and emoticons**, *International Conference on Innovative Mechanisms for Industry Applications (ICIMIA),* Bangalore, pp. 467-472. 2017.

6. M. Trupthi, S. Pabboju and G. Narasimha. **Sentiment Analysis on Twitter Using Streaming API**," *IEEE 7th International Advance Computing Conference (IACC),* Hyderabad, 2017, pp. 915-919, 2017.

7. K. Liu, Y. Niu, J. Yang, J. Wang and D. Zhang. **Product Related Information Sentiment-Content Analysis Based on Convolutional Neural Networks for the Chinese Micro-Blog**, *International Conference on Network and Information Systems for Computers (ICNISC),* Wuhan, 2016, pp. 357-361, 2016.

8. D. V. N. Devi, C. K. Kumar and S. Prasad. **A Feature Based Approach for Sentiment Analysis by Using Support Vector Machin**e, *IEEE 6th International Conference on Advanced Computing (IACC)*, Bhimavaram, pp. 3-8, 2016.

9. R. Hegde and Seema S.**Aspect based feature extraction and sentiment classification of review data sets using Incremental machine learning algorithm**. *Third International Conference on Advances in Electrical, Electronics, Information, Communication and BioInformatics (AEEICB)*, Chennai, 2017, pp. 122-125, 2016.

10. K. Han, K. Youngsub, Y. Kim, and Jin-Hee Song. **Building Sentiment Lexicon for Social Media Analysis using Morphological Sentence Pattern Model**, *Advanced Science and Technology Letters,* 136, pp. 103-106, 2016.

11. S. Jebbara and P. Cimiano. **Aspect-Based Sentiment Analysis Using a Two-Step Neural Network Architecture**," *Communications in Computer and Information Science*, vol 641, 2016.

12. Ghiassi, M.; Lee, S. **A domain transferable lexicon set for Twitter sentiment analysis using a supervised machine learning approach.** *Expert Syst*. Appl. 106, 197–216, 2018.

13. Balazs, J.A.; Velásquez, J.D. **Opinion mining and information fusion: A survey**, *Inf. Fusio,* , 27, 95–110, 2017.

14. Chaturvedi, I.; Cambria, E.; Welsch, R.E.; Herrera, F. **Distinguishing between facts and opinions for sentiment analysis: Survey and challenges**. *Inf. Fusio*, 44, 65–77, 2018.

15. C.R.Bharathi, Vejendla. Lakshman Narayana , L.V. Ramesh, " **Secure Data Communication Using Internet of Things**, *International Journal of Scientific & Technology Research*, 9(4), pp:3516-3520, 2020.

16. Evgeniy Ivanovich Trubilin, Svetlana Ivanovna Borisova, Vladimir Ivanovich Konovalov, Mikhail. **Experimental Studies of Parameters of Pneumatic Slot Sprayer**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

17. M. Shyamala Devi, Shefali Dewangan, Satwat Kumar Ambashta, Anjali Jaiswal, Nariboyena Vijaya Sai Ram, **Backward Eliminated Formulation of Fire Area Coverage using Machine Learning Regression**, *International Journal of Innovative Technology and Exploring Engineering*, 8(12), pp.1565-1569, 2019.

18. M. Shyamala Devi, Ankita Shil, Prakhar Katyayan, Tanmay Surana. **Constituent Depletion and Divination of Hypothyroid Prevalance using Machine Learning Classification**, *International Journal of Innovative Technology and Exploring Engineering*, 8(12), pp. 1607-1612, 2019.

19. Hennadii Khudov, Irina Khizhnyak, Fedor Zots, Galina Misiyuk, Oleksii Serdiu. **The Bayes Rule of Decision Making in Joint Optimization of Search and Detection of Objects in Technical Systems**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

20. JKR Sastry, M Trinath Basu, **Multi-Factor Authentication through Integration with IMS System**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

21. M. Shyamala Devi, Shefali Dewangan, Satwat Kumar Ambashta, Anjali Jaiswal, Sairam Kondapalli. **Recognition of Forest Fire Spruce Type Tagging using Machine Learning Classification**, *International Journal of Recent Technology and Engineering*, 8 (3), pp. 4309 – 4313, 2019.

22. M. Shyamala Devi, Usha Vudatha, Sukriti Mukherjee, Bhavya Reddy Donthiri, S B Adhiyan, Nallareddy Jishnu, **Linear Attribute Projection and Performance Assessment for Signifying the Absenteeism at Work using Machine Learning**, *International Journal of Recent Technology and Engineering*, 8 (3), pp. 1262 – 1267, 2019.

Performance Analysis and Identification Malicious nodes in the MANET using Trust Based and Auditor Based Methods

Lankapalli V. Ramesh[1*] , Chettiar R. Bharathi[2]

[1]Dept. of Computer Science and Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu. & Dept. of Computer Science and Engineering, ALIET, Vijayawada, A.P, India.

[2]Dept. of Electronics and Communication Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India.

Figure 1: MANET sample model

ABSTRACT

In this communication, we have analyzed the performance of MANET network by adopting the trust based and the auditor based mechanisms with this we are able to identify the malicious nodes in the network. With the incorporation of performance improved watchdog in the MANET, overall network performance is improved in terms of security and the energy effectiveness. The two mechanisms are involved in the performance improved watchdog to identify the malicious nodes in the network, i.e., in primary level we have combined one-hop with auditor node and in the secondary level we have placed an active watchdog. Because of this to level mechanism all the malicious nodes in the MANET are effectively identified and the security of the system is improved.

Key words: MANET, watchdog, WSN, malicious nodes, auditor node.

1. INTRODUCTION

MANET has emerged into many wireless communication applications because of its great ability and potential. MANET topology is complex in nature since the mobile nod s interconnected across multihop communication paths wher e mobile nodes determine the topology[1-4]. Because of MANET topology dynamic nature the probability of malicious nodes is very high. The primary challenges in the MANET is improving the energy effectiveness and improving the network security.
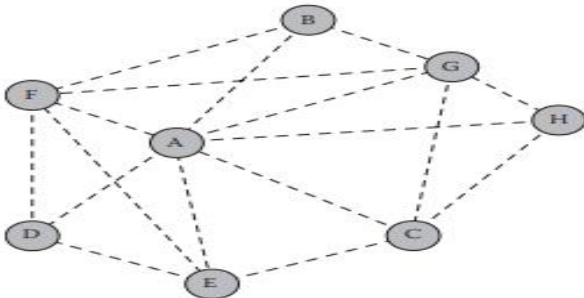
MANETs are especially susceptible to numerous forms of attacks and threats to security due to maximum sovereignty of the user nodes and absence of any centralized infrastructure. The integration of credibility- and trust-based structures into MANET will help overcome these problems. In a MANET, both nodes may be local, because there is no n etwork connectivity or network back-haul. The network energy effectiveness and security primarily depends on the how effectively we can identify the malicious nodes in the topology. There are so many mechanisms like trust based, audit based and credit based. Active watchdog comes under trust based mechanism to identify the malicious nodes in the network.

In promiscuous mode,watchdog overhears themessage sent b y its neighbors. If it finds any data transmitting anomalies or a malicious data from a neighbor, it may identify the neig hbor as misbehaving.

Condition is generated by taking an extra hop of traversal in which the hostile nodes appear to drop their own packet s while the auditor node attempts to key out nodes that are hostile contributing to their eventual removal. Wireless con nections may be prone to erratic node motions in Mobile A d Hoc Networks (MANET), contributing to regular bond er rors and unexpected topology adjustments. Maintaining the network connection in MANETs can therefore be diffi cult.Mobility control is a significant problem in ad hoc mobi le networks (manets), owing in part to rapidly evolving to pologies of the network[5-8].

A monitor that detects misbehaving nodes and a pathratin g system that allows routinprotocols to stop certain nodes.Th e two methods used to identify and minimize routing misbeh avior are Monitor and Path rate.

The Watchdog identifies nodes that are misbehaving by hold ing a buffer of packets that have just been received. The Deb ugger then tries to check if the next node has already trans mitted a packet by overhearing the adjacent nodes transmiss ions.The Monitor extracts the packet from its buffer as it c oncludes that the next node has forwarded the packet[9-12].

The safeguard system consists of multiple modules, each monitoring module having a different role. The larger t henumber of modules, the greater the amount of resource on

thenode. A likelihood distribution is believed to obey the cr   edibi-lity equation.
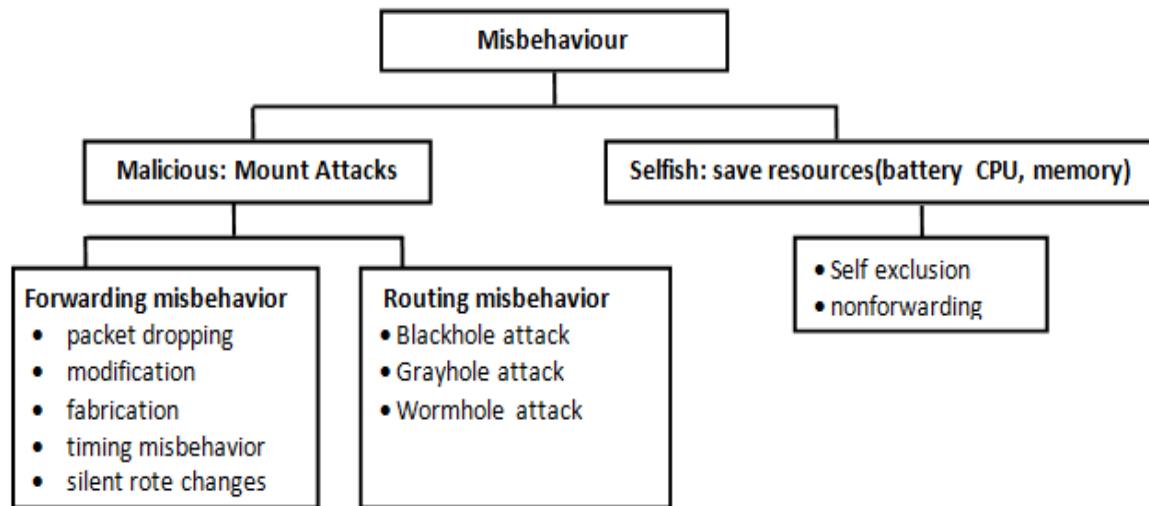
Figure 2: Node's misbehavior in MANET.

2. RELATED WORK

The Watch dog technique is a critical building block for several confidence schemes built to protect wireless sensor networks (WSNs). Unfortunately, this form of procedure requires a great deal of energy and thus effectively reduces WSN's lifetime. The comparison of a transaction is not clear in the case of credibility schemes for MANETs because of the restricted observability and detectability of a mobile node. To track misbehaviour, nodes promiscuously overhear their neighbours conversations.

The part used for this form of monitoring is named Watchdog[9], Monitor [10], or Neighbour Watch[11-12]. Wireless channel instability and energy conservation are the key problems for watchdog systems. Every monitor is located so close to its goal node that communications require minimal resources.   In the other hand, mission frequencies are chosen according to the trust worthiness of the goal nodes. the lower frequency of the activities is appropriate when the goal nodes are secure. This saves electricity by cutting back on transmission numbers. The findings also shown effectively that our watchdog optimization strategies will save at least 39.44 percent of energy without losing any reliability (less than 0.06 in terms of confidence precision and robustness), including in certain instances improving safety against some assaults. Several monitoring issues have been found in, such as the challenge of unambiguously detecting that a node is not transmitting packets in the face of collations or in the cases of insufficient transmission capacity.

The   watchdog function in CORE is focused on the promiscuous style of wireless node device operations. Moreover, by ranking the end-to-end link the nodes will determine the outcome of a transaction. CONFIDANT utilizes passive acknowledgement not only to check that a node can forward packets, but also as a way of detecting when a packet has been illegitimately changed before forwarding. Marti et al.[13] suggested watchdog and path ratter components for minimizing routing misbehaviour. They found improved performance in MANETs by complementing the DSR protocol with a watchdog for detecting rejected packet forwarding and a path rate for confidence management and routing procedure, ranking any path used.

This makes any node on its routing path to stop malicious nodes. Watchdog measures a node's wrong doing by copying packets to be transmitted to a buffer and tracking the adjacent nodes actions against such packets. Promiscuously the inspector snoops to verify whether the nearby nodes forward the packets without alteration. If the snooped packets fit those in the control node buffer, they will simply be discarded. The packets that persist past a specified among of time in the control node buffer are marked as having been dropped or charged. The node responsible for transmitting the packets would then be identified as a suspect node. If a specified threshold value increases the amount of such failures to forward packets, the guilty node would be marked as a malicious node. Knowledge regarding hazardous nodes is forwarded to the feature pathrater for use in path evaluation [14].

3. PROPOSED METHOD

The proposed framework utilizes the Active Watch dog methods for MANET. This procedure is utilized to adjust vitality proficiency and security as far as trust exactness. In this powerful Watch dog enhancement strategy the data sends from source to destination node in the way huge numbers of the nodes are accessible. The neighbour or closest node is considered for data

transmission that is selected Active Watch Dog node with the goal to decrease the consumption of power and increasing security. This Watch dog is called as a Active Watch dog as it continuously monitors all the nodes transactions during data communication.
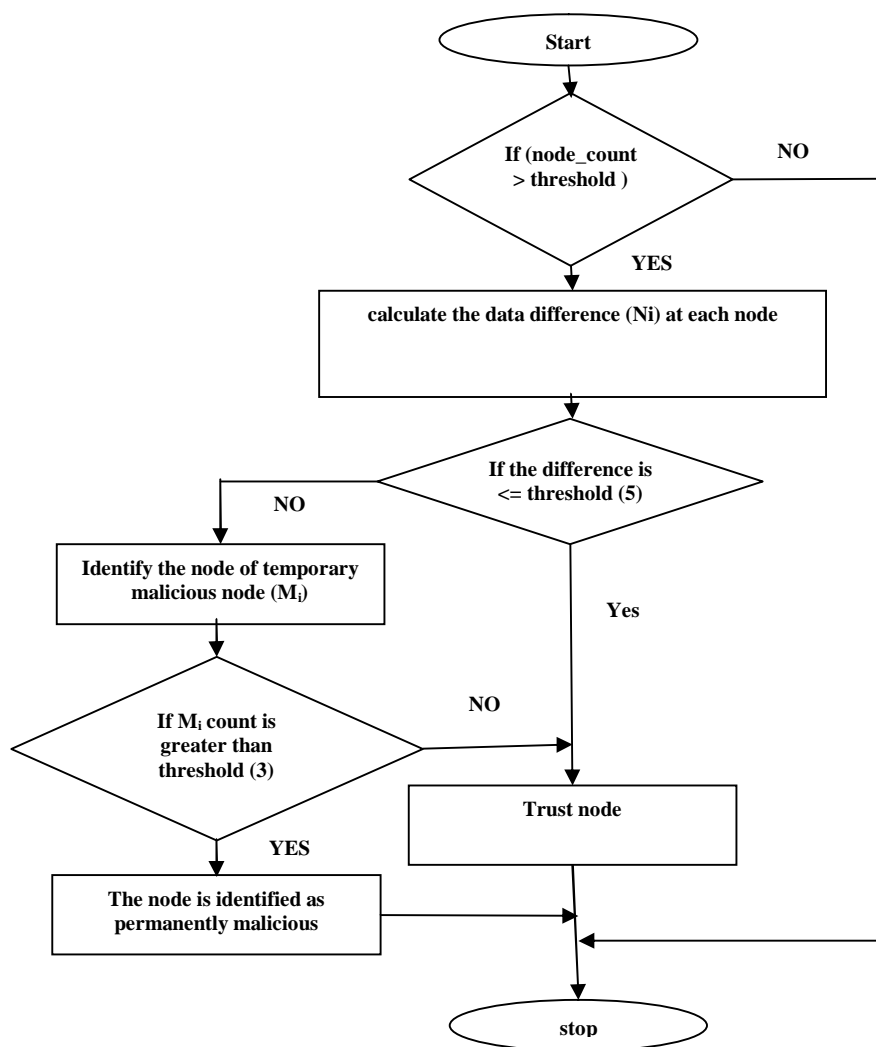
Figure 3: performance improved active watchdog algorithm flowchart.

Initially when a MANET is established, the nodes in the network are dynamic in nature and then the administrator nodes are selected for key generation and maintenance. Among the nodes initially a node having high computational power and energy efficiency is considered as Active Watchdog node and when the communication is initiated, the node will calculate the data packets received by the node and send to neighbor nodes as

Data Transferred (N_i) = Data Received – Data Send to Neighbor node. (1)

Here N_i represents specific node i.
If there is any change in the data transferred level, the node is marked as malicious node and the remaining nodes are certified as trusted nodes. A node whose data transferred rate is less than '5' is certified as trusted nodes. After the communication is completed, the network marks all nodes as trusted or malicious nodes.

The Active watchdog node will be dynamically changed for every transaction and the data maintained by the Active watch dog node should be transferred to the new Active Watchdog node before leaving the MANET. The watch dog node records the malicious activities caused by several nodes and those nodes are not considered from next communications. Extreme objective is to lessen the power consumption by Watch dog.

4. RESULTS AND DISCUSSIONS

4.1. Auditor based

The test was performed in the simulator at NS2. A distincti on was made between the approaches introduced and the pro cedures used during the audit. The findings are illustrated gr aphically below based on the research which focuses on the packet distribution ratio. In the experiment,three approaches were analysed. It includes; Normal Auditor Process process Auditor & One Hop (AOH) system.
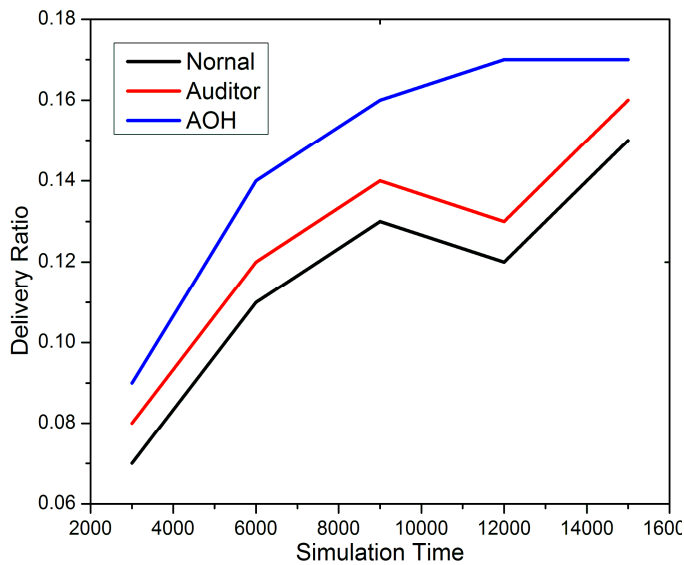
Figure 4: Delivery ratio: 10% malicious nodes.
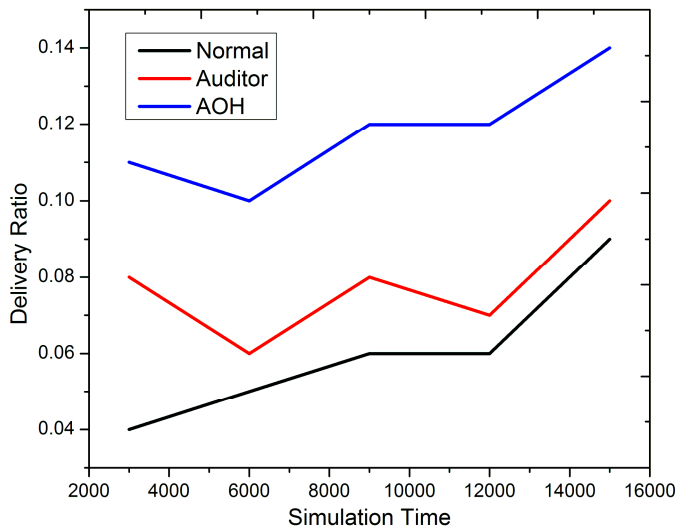
Figure 5: Delivery ratio: 20% malicious nodes.

The distribution ratio is the percentage of the message transmitted to the message produced.

$$Delivery\ ratio = \frac{Number\ of\ messages\ delivered}{Number\ of\ messages\ created}$$

(2)

In Figure 3 and Figure 4, the three strategies are compared

and contrasted respectively with 10 percent and 20 percent malicious nodes. With the rising amount of malicious nodes, the amount of packet droppings is growing. The AOH approaches thus demonstrates significantly improved distribution efficiency than other approaches. In the proposed AOH process, the pause in data transmission between the nodes is minimized and is shown in the figure below.
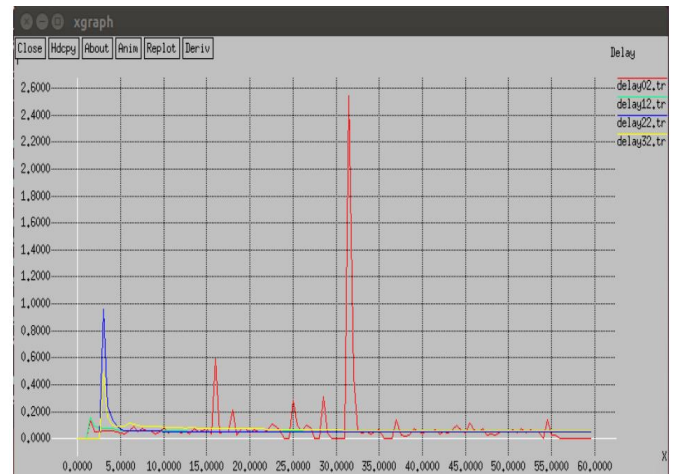
Figure 6: Delay in data transfer.

The two mechanisms are involved in the performance improved watchdog to identify the malicious nodes in the network, i.e., in primary level we have combined one-hop with auditor node and in the secondary level we have placed an active watchdog. The approach suggested eliminates the failure of the packets during contact. Any node essentially has the auditor and one hop method if it has forwarded the packets to next nodes without any miscellaneous intervention. Reduction of packet loss rate is seen in the figure below.

Figure 7: Packet loss reduction.
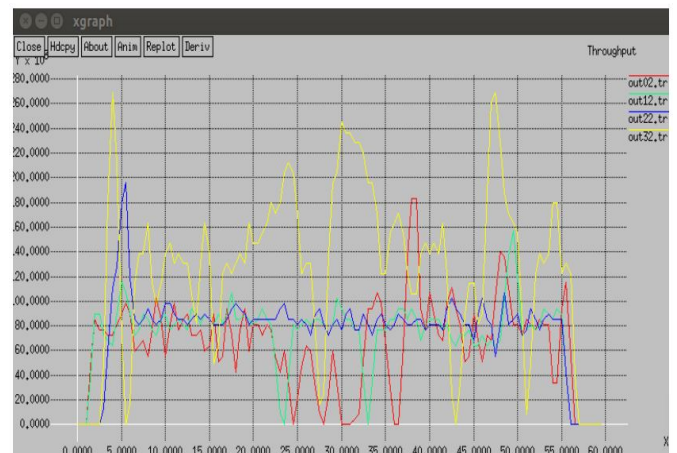
Figure 8: Throughput level.

The suggested system efficiency is higher than the current methods. The findings indicate that the AOH approach suggested demonstrates greater and better efficiency than conventional methodologies.

4.2. Trust based

The proposed method is implemented in NS2 and the proposed watchdog method is implemented which provides security to the data and identifies the malicious nodes in the MANET for secure data transmission. The parameters used for establishing a MANET is depicted in Table 1.

Table 1: Experimental Parameters

PARAMETER	VALUES
Simulation time	5 mins
Topology size	1000 X 1000
No. of nodes	10
No. of clusters	2
Node mobility	0 to 20m/sec
Routing Protocol	DSDV
Frequency	11 MHz
Traffic type	CBR
MAC	IEEE 802.11
Mobility model	Random Waypoint
Max. no. of packets	10000
Pause time	10sec

The overall communication overhead of the proposed active watch dog method is compared with the traditional watch dog method and the results are depicted in figure 9.
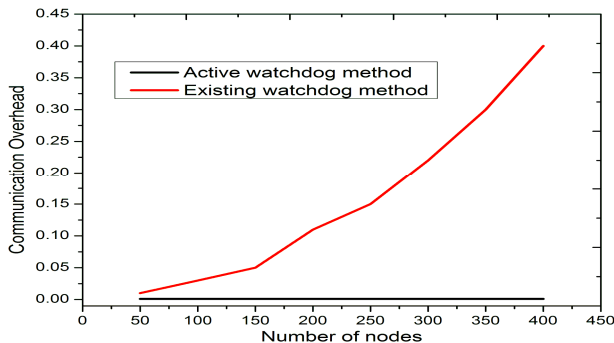
Figure 9: Communication Overhead levels.

After the MANET is established and the watch dog node is selected, the identification rate of the malicious nodes are depicted in Figure 10.
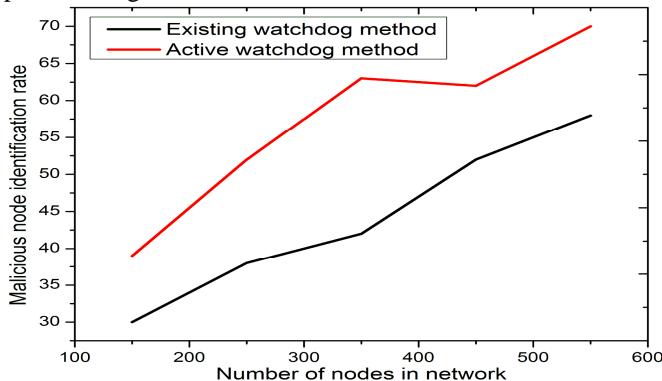
Figure 10: Active Watch dog system identification rate.

The proposed active watch dog method effectively identifies the malicious nodes in the network. As all nodes are trusted nodes, the packet delivery rate in the proposed method is high as shown in Figure 11.
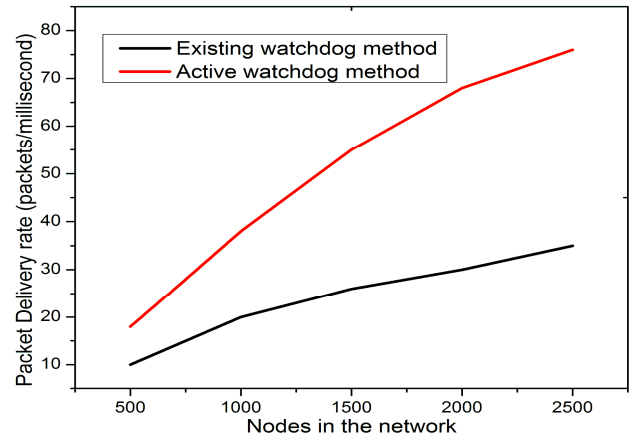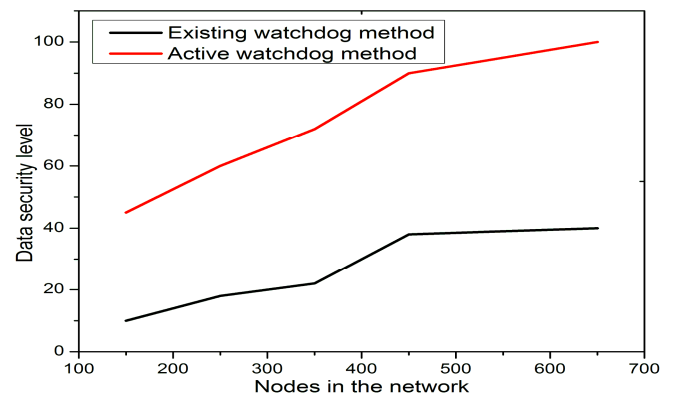

Figure 11. Packet Delivery Ratio.

The energy consumption rate of the proposed method is very less when compared to traditional methods. The energy consumption rate is depicted in Figure 12.
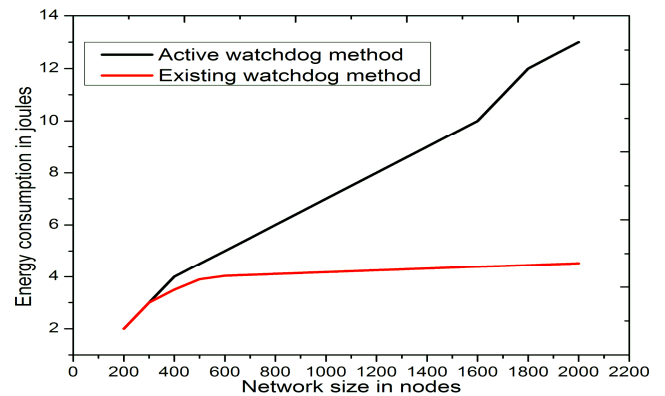
Figure 12: Energy Consumption Ratio.

The data security level of the proposed method is illustrated in Figure 13.

Figure 13: Data Security Level.

5. CONCLUSION

we have improved the watchdog performance in the MANET network which is able to identify the malicious nodes in the network. With the incorporation of performance improved watchdog in the MANET, overall network performance is improved in terms of security and the energy effectiveness. The two mechanisms are involved in the performance improved watchdog to identify the malicious nodes in the network, i.e., in primary level we have combined one-hop with auditor node and in the secondary level we have placed an active watchdog. Because of this to level mechanism all the malicious nodes in the MANET are effectively identified and the security of the system is improved.

REFERENCES

1. Anto Ramya S.I, **Mobile ad-hoc Netwoek Topology and its Algorithms**, *International Journal of Trend in Research and Development*, 2(5), Pp 16-21, 2015.

2. Narendra Reddy .P, Vishnuvardhan C.H, Ramesh.V, **Routing Attacks in Mobile ad-hoc Networks**, 2(5), pp 360-367, 2013.

3. O.Kachirski, R. Guha, **Effective Intrusion Detection Using multiple sensors in Wireless ad-hoc Networks**, *International Conference on System Sciences*, 2003.

4. S. Marti, T.J. Giuli, K. Lai, and M.Baker. **Mitigating routing misbehavior in mobile ad hoc networks,** *6th MobiCom, Boston*, Massachusetts, 2000.

5. Evgeniy Ivanovich Trubilin, Svetlana Ivanovna Borisova, Vladimir Ivanovich Konovalov, Mikhail. **Experimental Studies of Parameters of Pneumatic Slot Sprayer**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

6. Karti kumar Srivasta, Avinash Tripathi, Anjnesh kumar Tiwari, **Secure Data Transmission in MANET Routing Protocol,** *International Journal of Computer Technology& Applications*, 3(6), pp 1915-1921, 2012.

7. R. Bhuvaneshwari, G. Nalina keerthana, A. Rachel Roselin, **Improving Selfish Node Detection In MANET Using A Collaborative Watchdog**, *International Journal of Advanced Research Trends in Endineering and Technology*, vol 3, No 15, pp 17-21, 2016.

8. Harold Robinson, M. Rajaram, E. Golden Julie, S. Balaji. **Detection of Black Holes in MANET Using Collaborative Watchdog with Fuzzy Logic**, *International Journal of Computer and Information Engineering*, Vol 10, No 3, pp 622-628, 2016.

9. Sun B, Guan Y, Chen J, Pooch U. **Detecting black hole attack in mobile ad hoc networks**, *IEEE Transactions on Vehicular Technology*, 490-495, 2003.

10. Buttyan L, Hubaux JP. **Stimulating cooperation in self organizing mobile ad hoc networks**. *ACM/Kluwer Mobile Netw*. PP-579-592, 2003.

11. Zhong S, Chen J, Yang YR. **Sprite: A simple cheat-proof, creditbased system for mobile ad-hoc networks**. *In Proc. IEEE INFOCOM Conf* , PP-1987- 1997, 2003.

12. Balakrishnan K, Deng J, Varshney P. **TWOACK: Preventing selfishness in mobile ad hoc networks**. *In Proc. IEEE Wireless Commun. Netw. Conf* , pp: 2137-2142, 2005.

13. Hennadii Khudov, Irina Khizhnyak, Fedor Zots, Galina Misiyuk, Oleksii Serdiu. **The Bayes Rule of Decision Making in Joint Optimization of Search and Detection of Objects in Technical Systems**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

14. JKR Sastry, M Trinath Basu, **Multi-Factor Authentication through Integration with IMS System**, *International Journal of Emerging Trends in Engineering Research*, 8(1), 2020.

A Distributed Environment with Rough Set Theory Based Image Processing Approach for Analysis of Facial Disorders for Better Cosmetic Product Recommendation

Pakalapati Manikya Prasuna[1*], Yellasiri Ramadevi[2], Arramraj Vinaya Babu[3]

[1] Department of Computer Science & Engineering, Jawaharlal Nehru Technological University, Hyderabad 500085, Telangana, India
[2] Department of Computer Science & Engineering, Chaitanya Bharathi Institute of Technology, Hyderabad 500075, Telangana, India
[3] Department of Computer Science & Engineering, Stanley College of Engineering and Technology for Women, Hyderabad 500001, Telangana, India

Corresponding Author Email: prasunamanikya@gmail.com

ABSTRACT

Producers and Consumers are getting progressively open to the use of cosmetic beauty care products. This can be found in them utilizing an assortment of regular Cosmetic resources and materials. This reality is additionally upheld by the pattern of natural and health awareness. This experience can be found inside both the Producers and Consumers behavior. Fast development of beauty care products industry, the improvement of new advances and the style for wonderful and youthful skin caused that fashion became basics for present day society. As the growth of cosmetic industry increases, the number of cases related to side effects of the products are also getting increased. According to Central Drugs Standard Control Organization, nearly 8% of the customers are facing side effects because of unsuitable products. There is no proper model used by the cosmetic product producers to suggest suitable cosmetic product to the customers. To reach the requirements of the various customers, the cosmetic industry needs to manage enormous features of skin, extract from the face images of the customers, out of which not many are required to recognize the skin issues and fundamental item stimulation. The proposed work mainly concentrates on designing a model for better cosmetic product suggestions to the customers to reduce the side effects and to have a healthy and shining skin. Advanced image handling and examination of clinical face images can successfully strengthen medical diagnosis with important plans including automatic prediction and analysis, image segmentation and estimation of obvious features in images. Rough set theory is one of numerous techniques that can be utilized to break down and analyze images, less regular than progressively customary strategies for probability, statistics and set theory. In this manuscript a distributed environment with rough set theory based image processing method is used for analysis of facial disorders for better cosmetic product recommendation that cannot cause any harm or disorder to the customer with use of cosmetic products that improves the safety of the customers. The proposed model performs product recommendations based on local and global features based on the customer locality. The proposed method is compared with the traditional methods and the results show that the proposed method exhibits better accuracy in prediction of skin disorders in cosmetic industry.

1. INTRODUCTION

The usage of Cosmetic items and the markets manufacturing such products are increasing in recent decades as customers are taking very much care about their beauty in present lifestyle. Customers purchase beauty care products for purging, improving or changing the appearance, skin, hair and nails especially face tone improving products. Cosmetic items incorporate excellence arrangements, for example, make-up and face cream products that helps, for example, cleanser and antiperspirant [1]. At the point when herbs are utilized for their fragrant and cosmetic usage in makeup, they are known as home developed or green entity consideration items.

The historical backdrop of cosmetic products has experienced radical changes during the previous decades. The worldwide cosmetic market was around 590 billion USD in 2019 and it is assessed to arrive at 750 billion USD by end of 2020, developing at a rate of 20 percent [2]. The Beauty advertisements has developed by 15 percent a year on a normal with a yearly development rate running from 8 percent to 10 percent. During the 20th century, India built up a fabrication procedure to replace the scent, cosmetic products made by regular and with chemical techniques [3].

The Indian cosmetic industry experienced quick development rate since the monetary Liberalization in 1991. All through the main decade of 21st century, the offer of Cosmetic products became consistently arriving at the degree of 9 percent Compound Annual Growth Rate (CAGR) in the

primary half and 10 Percent (CAGR) in the later half. The excellence business was influenced in 2010 and recovered in 2018 because of the improvement of worldwide economy [4]. The Cosmetic business is presently a multibillion-dollar industry. India is the second biggest exporter of moderate beautifiers to the world market after China [5]. The Indian cosmetic industry has seen a quick development throughout the most recent few decades when the Indian contenders began fabricating items so as to meet the expanded needs of both the Indian and the global markets [6]. Huge numbers of the world's mainstream Cosmetic brands entered the Indian market in 1990s so as to satisfy the solid need for the corrective items in India [7]. The facial disorders caused due to the usage of cosmetic products that causes reactions are depicted in Figure 1.

Figure 1. Cosmetic product reaction

As the utilization of cosmetic products are increasing day by day, manufacture companies have to take much care in producing the cosmetic products that best suits the customers and satisfy their requirements. Because of the usage of various chemicals and herbs, a lot of care need to be taken as the product should not cause any harm or any reaction to the users. In India, there is 4 percent of cases that represents the reactions caused to customers especially face disorders or facial reactions [8]. As the research in the field of cosmetic industry is a growing field, researchers have to provide platforms for suggesting cosmetic products to the customers only after analyzing the skin behavior [9]. In India, many research organizations are performing several experiments on this area and still many customers are facing facial or skin disorders that is a worrying issue [10]. In the proposed work, a distributed environment with rough set theory based image processing approach for analysis of facial disorders for better cosmetic product recommendation is introduced that helps the customers to provide their face as input and check which cosmetic product best suits their skin that does not cause any harm or reaction to them.

Customer purchasing behavior is the total of a buyer's perspectives, inclinations, aims, and choices with respect to the product manufacturer history in the commercial center when buying an item [11]. The investigation of customer conduct draws upon sociology orders of human studies, brain research, social science, and financial matters. Taste and tradition of the general public have changed because of expanding familiarity with the western world and excellence patterns and more productive employments [12]. Accordingly women from such social layers are currently increasingly aware of their appearance and is happy to spend additional cash on it further. The adjustment in Cosmetic and healthy skin item utilization is seen today because of ascend women population, particularly from the employees having increasingly flexible cashflow. This really has improved development in certain item classifications in the market that was seen before [13]. The beauty care products and sun care items that have demonstrated development paces of 51% and

16% individually in the recent years [14].

The scope of Cosmetic items in India has broadened hugely in recent years [15]. Cosmetic item makers in India have for the most part been obliging the extraordinary interest for products that fall into the low-or medium priced classes as the best interest in India consistently spin around financially estimated items [16]. The segment has chiefly been driven by improved buying interest and rising style based on the Indian populace. Besides, to attract customers the marketing agencies are promptly spending on the special exercises [17]. The product recommendation method strictly identifies the customer's skin condition by applying image processing technique and extracting features from the skin and comparing the features with the existing data of cosmetic reactions data and suggesting customers the best product that will not cause any harm or reactions to users [18]. Taking such care on the customers will definitely improve business levels and also the customers show their interest in buying cosmetic products without any uncertainty or fear thus improves the customer needs [19].

2. LITERATURE SURVEY

Sigma Research Indonesia conducts research on 1,200 ladies matured 15-55 years. From these investigations they identified that there are a few elements for ladies in buying corrective items. The greatest factor is the rate coordinates facial skin, trailed by enduring items, lightweight chemicals fit, with rate cost by considering brand also. Patty et al. [1] introduced a proposal framework is a model utilization of the aftereffects of perceptions on the conditions and reactions on the client. In this way, a framework requires a model of exact suggestions that were suggested as per the desires of clients, just as empowering clients to take the correct choice in figuring out which item will be utilized.

Ekstrand et al. [2] discovered huge distinction between the use and disposition of the groups of customers. This investigation came about into the development of three clusters viz. medium self-coordinated, substantial other-coordinated changing attributes. Furthermore, brand inclination for customer products was found to change by group and brand inclination for face wash, shaving cream and face cream as multiple clusters. Shockingly, substantial other ingredients were accounted for to be the least spenders while incidental users were the most impacted.

Sharma and Gera [3] asserts the more extensive phases of a purchaser's dynamic procedure that incorporates issue ID, data search, evaluation of choices, outlet determination and buying selected products and post-buy activity (fulfillment). With respect to facial healthy skin, the variables that impact the purchaser would include: convictions in product property, natural concern, segment and individual trademark which initiate the shopper to buy the facial skin health management product.

Yasir et al. [4] directed an investigation and arrived at a resolution that ladies who go through uncertainty and are on edge and need certainty about them. Cosmetic items contain different unsafe or poisonous synthetic substances fit for making hurtful impacts on the skin. Makers of Cosmetic items don't just utilize manufactured fixings yet in addition common items, for example, Shea margarine, Rose concentrate, and natural sweetener which are manageable, modest and less harmful to the customer. Skincare items, for example,

fragrances, make up, nail cleaners and so on, stay on the skin for a more drawn out timeframe and can cause unsafe impacts like hypersensitive responses. Moisturizers increment the hygroscopic properties of the skin especially when utilized in high fixation. It can cause inconvenience and peeling on the skin.

Schneider et al. [8] recommend that a multi-dimensional methodology of understanding excellence is increasingly suitable, instead of the single dimensional methodology of alluring-ugly utilized by analysts to assess people groups view of magnificence for suggestion of products. Portugal et al. [9] talks about how advertising utilization of appealing individuals in promoting for an exchange with customers has strongly affected purchasers impression of their own facial excellence.

Robertson et al. [11] proposed a framework model with utilization of the aftereffects of perceptions on the conditions of the client. In this way, a framework requires a model of exact suggestions that were suggested as per the desires of clients, just as empowering clients to take the correct choice in figuring out which items will be best suitable.

Rinaldi [12] made a suggestion to buy the beauty care products. In this investigation utilizing Content Based Filtering is suggested for product selection. The motivation behind this investigation is to build up an arrangement of Cosmetic proposals for customers who will purchase facial products that suit your necessities as indicated by skin shading and skin type. Content Based Filtering is done dependent on regular methodologies by analyzing skin conditions. At that point the similitude of the product profiles and customer profiles utilizing the Cosine Similarity is done and a product is recommended.

According to Central Drugs Standard Control Organization (CDSCO), the cosmetic products are increasing from year to year by 20% and customer satisfaction rate is decreasing every year by 15%. Nearly 8% of the users are facing side effects because of unsuitable products and 3% of them have serious skin problems. Based on the literature survey done, there is no proper model for suggesting customers with suitable products. The proposed model concentrates on designing a distributed model for customers of different regions to suggest a suitable cosmetic product by analyzing the skin conditions. The proposed model concentrates on the safety of the customers who are interested in using cosmetic products.

3. PROPOSED METHOD

The proposed method is designed using rough set theory based image processing approach for analysis of facial disorders for better cosmetic product recommendation. The proposed method initially converts the face images into a set of basis functions which essentially are the principal components of the face images that seeks directions in which it is more efficient to represent the data into numeric format for better analysis. This is mainly useful for decreasing the computational effort. Image processing method is primarily used here to convert image pixels into binary values. Converting the pixels into binary values are helpful for quick analyzing and for accurate training. This process of converting image pixels to binary values improves the accuracy levels. The proposed method reduces the number of features to a more manageable number because face is represented by a large number of pixel values. The features extracted from face

images for the identification of a normal pixel and effected pixel are pixel contrast, correlation, entropy, uniformity, pixel energy, face shape, eyes position, nose position, pixel intensity. The proposed model performs training of features which contain normal face images and skin images having side effects. Based on the trained features, if new set of features are applied then side effects can be analyzed. The products are initially used by the customers and their facial features are extracted for training the model.

Each of the new dimensions is a linear combination of pixel values, which form a face template. The linear combinations obtained are an order set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels. The pixel extraction process from the image given as input is done as

$$
\text{IDS}(I(x,y)) = \sum_{x=1}^{N} \text{mean}(x) + \sum_{y=1}^{N} \text{mean}(y) + {}^{M}\sum_{n=0} s(i_x - i_y)2^N
\tag{1}
$$

where, i_x and i_y corresponds to the value of the center pixel (x_n, y_n), $S(i_x)$ and $S(i_y)$ represents to the value of eight surrounding pixels, function f(x) represents the pixel values as 1 if required and 0 if not required that is defined as:

$$
f(x) = \begin{cases} 1 & if\, x >= 0 \\ 0 & if\, x < 0 \end{cases}
\tag{2}
$$

By looking at the extracted rationality vectors of images, a proximity measure is proposed that predicts the relevant and irrelevant pixels in an image. The comparability measure between two image pixels x and y is considered with the parameters:

$$
I(diff(x,y)) = \sum_{i=1}^{N} |\alpha_j - \alpha_j'|(X) + |\beta_j - \beta_j'|(Y)
\tag{3}
$$

where, α and β are the color levels of the image that represents dark and light colored pixels. On the basis of color histogram, some statistics to reflect the characteristics of the image pixels are calculated. Mean reflects the average gray values of an image that is calculated as:

$$
M(I(x,y)) = \sum_{i=0}^{N} x\, H(y) * i + f(x)
\tag{4}
$$

H represents the histogram value. Variance reflects the gray value pixels of an image on the numerical discrete distribution, variance is a measure of the width of the histogram, the difference between the average and gray levels of pixels that are extracted.

$$
\sigma^2 = \sum_{i=0}^{L-1} (i - \mu)^2 H(i)
\tag{5}
$$

Here μ represents the gray level value of the pixel. Fourier transform model is used to transform the image convolution operation for getting the frequency domain characteristics of the image. For the P × Q original image I(x, y), its

corresponding Fourier spectrum can be expressed as f(x,y) and the numerical representation of the image is represented as:

$$I(P \times Q) = \begin{bmatrix} -\dfrac{d_x + d_y}{\alpha n_x} & -\dfrac{n_x^2 + n_y^2}{\alpha n_x} & 0 & 0 & 1 \\ -\dfrac{d_x h_{(x)} + d_y h_{(y)}}{I_\beta n_x} & -\dfrac{d_x + d_y}{I_\beta n_y} & 0 & 0 & 0 \\ -1 & -H(x) & 0 & n_x & 0 \\ 0 & -H(y) & 0 & 0 & n_y \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad (6)$$

Rough Set Theory (RST) which created in mid-1980's, which is having its noteworthiness to data acquirement and gathering through AI techniques, Feature extraction systems etc. One of the most important use of RST is that it needn't disorder data with any kind of preliminary information about the model data assortment for instance probability allocation, estimated probability task, etc. Rough Set Theory is one of the data mining methodologies which reduce the features from huge amounts of data that when applied on cosmetic data can extract only relevant features to suggest the best product to the customers for avoiding reactions to face when applying cosmetic products.

The face disorders of several customers are trained using the representations.

$$I(X, Y) = \sum_{i=0}^{N-1} H(i)\text{-}similarity(i_x - i_y) + K \quad (7)$$

Every Image 'I' from the dataset is considered I ε Image Set (IS), H is the histogram range and K is the Threshold brightness value to be considered for extraction.

The pixels from the image are extracted and forms a cluster C based on relevant and irrelevant data.

Consider C1, C2 ,…,C(N) be the N clusters formed with $|C_i| \leq |C_j|$ and W is initialized as 1 for starting pixel. For each pixel extracted from the image, weights are assigned to every pixel for establishing similar cluster set. Weights W are calculated as:

$$W(I(x,y)) = \frac{1}{\sum_i^N W_i} \sum_i^N |x_i - y_j|^2 + \sum_{j=1}^N \sum_{i=1}^M |x_i^{(j)} - y_j^{(i)}|^2 \quad (8)$$

For rotating the images for maintaining same angle θ in the range $(-\lambda,)$ of the inverse tangent function of the slope of the line connecting the two points for fixing the pixels in a particularangle. The pixel rotation is done as:

$$\theta = arc\tan\left(\frac{y_2 - y_1}{x_2 - x_1}\right) \quad (9)$$

The facial image considered undergo segmentation process to extract pixels quickly by considering parts of image that is useful for extracting face disorder pixels only. The process is done as:

$$I_\sigma(I[i_x, j_y]) = \sqrt{\sum_i^N (W - I_m(I(x,y)))^2 \times K} \quad (10)$$

where, W is the weight and K is the threshold value. A model for assigning the weights for the image pixels are used which assigns the weights for the pixels as:

$$W_{x,y} = exp\left(\frac{-(I_i(x) - I_n(y))^2}{\left(\frac{\beta^2}{2}\right) * \theta}\right) \quad (11)$$

From the facial image given as input, features are extracted only that forms facial template from a relevant sub image is that is calculated as:

$$FS(I(x,y))_N = \sum_{i=1}^N \left\{ \frac{||X_j - V_i||}{||X_j - V_K||} \right\}^{-\frac{2}{m}-1} + W(I) * I(x,y) \quad (12)$$

X and y are the pixel coordinates, m is the sub image position, w is the weight of the pixel in the facial template.

After extracting the facial template features, the classifier is trained with the existing facial disorders for better product suggestion for the customers that may not cause any harm or disorder to them. The training process is depicted below.

Algorithm Skin_Disorder_Training
```
{
Input: FS (fs1,fs2,……fsM), fsMθ // Relevant Threshold
for eachx=1 to Mdo // where m is the total features
considered
for each y= x+1 to M do
if (x,y ε FS) && (fs<θ)
        PR← ΔTree(FS, x, y,W,PID,DISID)
 if (x< y) && (x,y ε FS) && (fs <θ)
 Insert the node at left position and continue the process of
inserting
 if (x>y) && (x,y ε FS) && (fs <θ)
 Insert the node at right position and continue the process of
inserting
    if FS<θ
        if (f i ε FS(M)) && (f i <θ) && (x<y)
        search for product id and disorder id in left positions
else
    PR← ΔTree(FS, x, y,W,PID,DISID)
    end if

foreach p ∈ FS(p) do
W(P) = Count(left (DISID)) / Count(left(PID)
Display W(P), FS
}
```

where, FS is the feature set, x,y are pixel co ordinates, W is the weight of the feature set and PID is the product id, DISID is the disorder ID. Based on the disorder ID, the products are categorized as recommended or not recommended. When a customer needs any recommendations for a cosmetic product, they need to provide their facial image as input. The classifier then analyze the facial pixels and based on the trained experience, best product that does not cause any disorder will be suggested to the customer who belongs to any nation or locality.

3.1 Global and local rule setting by central authority for distributed model

As the proposed application is recommended for better cosmetic product suggestion, there is a chance for this

application to be useful for all regions and nations of people which is very much helpful to avoid skin disorders and to suggest a suitable product based on analyzing their skin condition. The skin conditions, features of people are different but, the proposed method has to suggest the products to local as well as global level customers. To perform this task, local and global rule setting for feature extraction and product recommendation becomes a challenging task. The proposed method imposes some local and global rules on the images provided for customers for getting better product suggestions. There is less complexity in setting local rules for the skin conditions of the users where as global rule setting is a complex task. The local rule setting on the images are performed and the local rules are analyzed by the central authority. Different cosmetic products are available at different regions and each system applies its rules and then the local rules are applied.

To perform local and global distribution, the proposed model needs to be trained with the features of customers of different regions. The proposed model initially provides an option for the user to select for local or global product suggestion. The proposed model is trained with the local features like customer facial shape, color, contrast, pixel intensity, brightness level, facial edge pixels. The proposed model is also trained with customers of different regions to provide a distributed approach also. The main idea of the proposed model is to recommend cosmetic products to customers at different regions in the world. Facial features of customers will change from region to region. The proposed model should be trained with different datasets of different regions considering normal skin features and infected skin image features. This allows the model to suggest a better cosmetic product for the customers. The customer can select either local or global model based on the locality of the user.

The image given as input undergo the process of preprocessing and feature selection and then, the facial template is fixed by setting the property moving as:

$$FT \in_{mv} = \sum_{i=\{\frac{FS}{2}\}+1}^{N} \binom{\theta}{i} I(x,y) \in^i (1-\pounds)^{N-i} \qquad (13)$$

where, FS is th feature set, θ is the angle of the input image, x and y are pixel coordinates, £ is the value fixed for balancing the pixels for every customer that depends on the facial template pixels intensity. The local rules are imposed for balacing the image angle, intensity, sub image position and grey levels. The Grey Level Parameter Balancing (GRPB) is done as:

$$GRPB(y) = \sqrt{\frac{\sum_{i=1}^{N} \cdot (I_{proj} - x_{orig})^\theta}{Total(FS)}} \qquad (14)$$

$$GRPB(x) = \sqrt{\frac{\sum_{i=1}^{N} \cdot (I_{proj} - y_{orig})^\theta}{Total(FS)}} \qquad (15)$$

The intensity values for the images are balanced as:

$$I(P(I)) = argmin_W(\sum_i^N \theta \, FS(I(x,y)) - (I_j(x) - I_i(y))^\theta \qquad (16)$$

where, $FS(I(x,y))_{ij}$ is the correlation between the ith and the jth individual pixel at any angle θ.

As different users from different locations needs cosmetic product recommendations, all this cosmetic product suggestion features selection data has to be monitored and analyzed. To perform data analysis of local product suggestions, a central authority need to be established which has to analyze all the collected local product suggestion features and need to be applicable to global rules so that customers can get better product recommendation. The process of gathering local data by the central authority and setting of global rules is depicted in Figure 2.
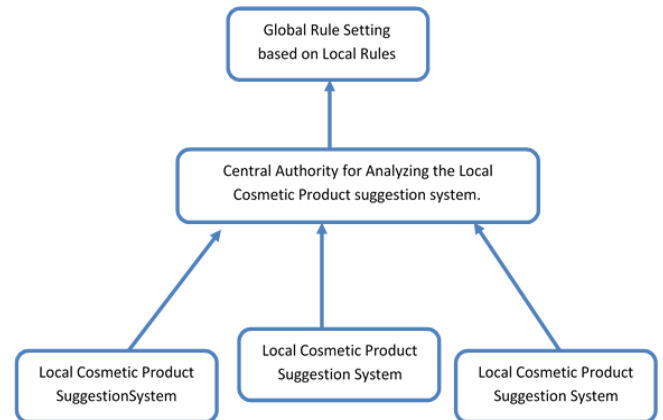
Figure 2. Framework for analyzing local rules and setting global rules

The process of analyzing the local rules by the central administrator is clearly illustrated. Initially the features selected from every product recommender system has to be transferred to the central administrator. The central administrator gathers relevant features trained data and arranges accoringly as data clusters. The process of clustering is done as:

$$CS^{LD} = \sum_i^N Fs_{i+j}(R(i)) + \log\{ P(ID)(N)\} * W(P) \qquad (17)$$

Here CS is the cluster set generated based on local data LD, Fs is the features used in the local data, P(ID) is the product ID and W is the weights assigned to products locally. All local features are grouped based on the selected feature weights and local rules are grouped together to improve the product suggestions by applying global rules. The weights are newly correlated in the global data cluster set as:

$$CS^{GD} = \sum_i^N \sum_j^M (W - mean(P(i,i+1)))^N + (j(x) + i(y) + L \qquad (18)$$

Here CS is the cluster set generated based on global data GD. N is the maximum local rules and M is the global rule count. W is the weight of the feature and P is the Product ID. I and j are the relevant features in the subset. L is the constant for balancing the global rules. The images given as input when compared to local regions is easy to process when compared to global regions.The central authority will finally group all the local rules to make the rules available globally, suchthat every user at any location can use the product recommender system. The central authority finally groups all the local rules as:

$$CS(GR) = \sum_{i}\sum_{j}\frac{W(P(ID)) + mean(\text{i}(x) - \text{i}(y)}{1 + W(i - j)} \quad (19)$$

The global regions are then processed after completing and applying local rules as global rule setting concentrates on features extracted and facial template fixing and arranging it same for all kinds of users. The global rule setting model extracts some more features from the images such that every customer at any region can get best product recommendations.

The optimum weight of an image OW^I is calculated for extracting more relevant features and excluding irrelevant features from the given input image is done as:

$$OW_N^I = \frac{\sum_{i}^{N}\sum_{j}^{M}\left|x_i^{(j)} - y_j^{(i)}\right|^2}{\sum_{i}^{N}\sum_{j}^{M}W_{kj}^{\theta} + \left|\beta_j - \beta_j'\right|} + \sum_{i=1}^{N}\left|\alpha_j - \alpha_j'\right| \quad (20)$$

The sigmoid function for balancing the facial template structure is balanced as:

$$Sig(I(x,y)) = \frac{1}{1 + e^{-10\sum_{i=0}^{L-1}(i-\mu)^2 H(i)(H_i^n - 0.5)^\theta}} \quad (21)$$

where, H_i^n, $H(i)$ are calculated for identification of similarity levels of the global and local images. The image pixels are balanced for all kinds of images for allowing customers at different regions to support distributed environment.

4. RESULTS

The Proposed method is implemented in ANACONDA SPYDER platform that takes the input from the customer and analyze the image by performing feature extraction and identifying disorders on the face and training the model with the disorder levels and suggesting the best product to the customer that does not cause any reaction based on the comparisons done with the trained data. The proposed method is compared with the traditional methods and the results show that the proposed method product suggestion is accurate that does not cause any disorders to the customer. The proposed is compared with traditional methods in terms of customer causing disorder rate by using the products, time for analyzing the disorders on the skin. The facial disorder datasets are considered from the link https://archive.ics.uci.edu/ml/datasets/dermatology. The proposed method identifies the number of cases caused by the usage of cosmetic products and reduces the cases by suggesting suitable products to the customers.

The disorders caused from the cosmetic products is considered and analyzed from the customers and depicted in Table 1.

The proposed method is used to train the model based on the available trained data of facial and skin disorder caused by several products. Based on this data, the model suggests a product by analyzing customer's skin using rough set based image processing approach by extracting features that reduce the chances for causing skin or facial disorders that satisfies the customer requirements. As the proposed model supports distributed environment, group of users can use the model for getting best product recommendations. The time levels for analyzing the facial disorders of the customers in the proposed method is compared with the traditional Computer Vision Based Method (CVBM) and the results are depicted in the Figure 3.

Table 1. Customer facial disorder percentage

Age Group (in years)	Annual amount spent on Cosmetic products (in Rs:)	Product Type	Percentage of cases identified
>15	Less than 2,000	Skin moisturizer product	12%
20-25	2,000 to 4,000	Facial beauty product	18%
26-30	2,000 to 5,000	Facial and skin beauty product	22%
30-45	Less than 3,500	Facial beauty product	16%
45-55	Less than 5,000	Skin rash avoiding products	21%
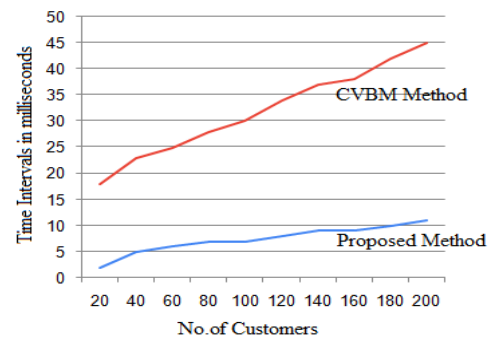
Figure 3. Facial disorder analyzing time intervals
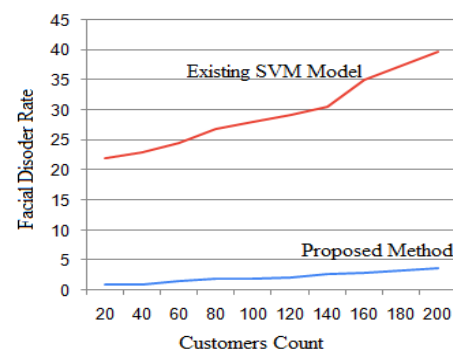
**Figure 4.** Facial disorder rate after product recommendation

The facial disorder rate of the proposed method is compared with the traditional SVM classifier for product suggestion that causes facial disorders is depicted in Figure 4. The proposed model analyzes the facial features of the customer completely and then identify the exact problem depending on pixel value comparison and similarity. Based on the analysis, the proposed model recommends a suitable product to the customer that reduces the side effects and improves the safety levels of the customer.

Table 2. Accuracy levels

| Model	Product type	Percentage of customers	Allergic Reaction	Chemical reaction	Distributed Platform	Accuracy
Existing SVM Model	Facial Cosmetic Products	19%	Yes	Yes	No	68%
Proposed rough set based image processing method	Facial Cosmetic Products	25%	No	No	Yes	91%

As the proposed model performs conversion of pixel values into binary format, the comparison and analysis of features will become easy and then suggest a cosmetic product that best fits the skin condition. In this way the facial disorder rate of the proposed model is very low. The accuracy rate in suggesting the cosmetic product to the customers for better results with the proposed method is compared with the traditional methods and the accuracy rate of proposed and traditional methods are depicted in Table 2.

The accuracy levels of the proposed and traditional methods are depicted in the Figure 5. The accuracy of the proposed method is high when compared to traditional methods and the proposed method also available globally as n number of users can request for product recommendation.
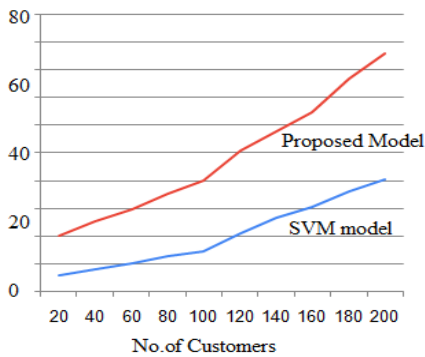
Figure 5. Accuracy level

The proposed model recommends a best cosmetic product that improves the safety levels of the customer. The proposed model analyzes the complete facial features and its dissimilarities and then recommends a product that fits the skin condition. This allows the customer to have a safe condition to avoid side effects. The safety levels of the proposed model are compared with the traditional methods and the results show that the proposed model provides high safety levels. Figure 6 depicts the skin safety levels of the proposed and traditional methods.
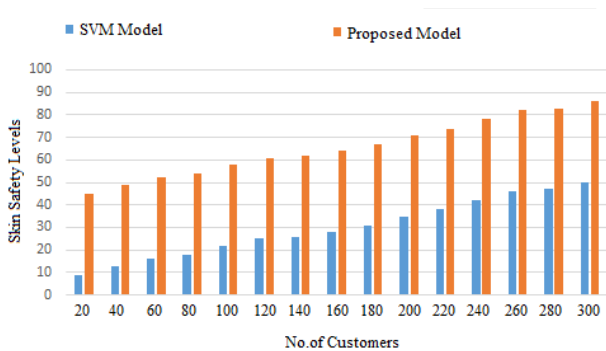
Figure 6. Skin safety levels

5. CONCLUSION

Manufacturers of skincare products should lay emphasis on the Research Department for avoiding skin disorders to the customers using those products. Since, the Customers are progressively aware about the symptoms brought about by skincare items. As the utilization of cosmetic products are increasing day by day, manufacture companies have to take much care in producing the cosmetic products that bests suits the customers and satisfy their requirements. The Cosmetic items may introduce disorders and repetitive unfriendly impacts are ascribed to the harmful substances generally found in their definitions. The proposed distributed platform is introduced using the roughest theory and utilizing image processing techniques for recommendation of a product that best suits the skin condition of the customers. The framework is designed as it can be used in any location by predefining and training the model with existing facial disorders caused by several products. The model segments the facial image and analyze the features for recommending a product. The proposed model improves the safety of the customers by reducing the cause of side effects. The proposed model is trained with the local and global features of customers of different regions and then analyze the features and recommends a best product. The model can be used by the customers at local level or in global level for getting better recommendations of the cosmetic product that best suits the skin condition. The proposed method accurately suggests the best cosmetic products to the customers that does not causes any harm to the customers. In future the training time need to be reduced as the proposed model concentrates on local and global features. The number of dataset samples can also be increased to improve accuracy levels also.

REFERENCES

[1] Patty, J.C., Kirana, E.T., Giri, M.S.D.K. (2017). Recommendations system for purchase of cosmetics using content-based filtering. International Journal of Computer Engineering and Information Technology, 10(1): 1-5.

[2] Ekstrand, M.D., Riedl, J.T., Konstan, J.A. (2011). Collaborative Filtering Recommender Systems. Foundations and Trends® in Human—Computer Interaction, 4(2): 81-173.

[3] Sharma, L., Gera, A. (2013). A survey of recommendation system: Research challenges. International Journal of Engineering Trends and Technology (IJETT), 4(5): 1989-1992.

[4] Yasir, R., Nibir, M.S.I., Ahmed, N. (2015). A skin disease detection system for financially unstable people in developing countries. Global Science and Technology Journal, 3(1): 77-93.

[5] Ghazanfar, M., Prügel-Bennett, A. (2010). Building

switching hybrid recommender system using machine learning classifiers and collaborative filtering. IAENG International Journal of Computer Science, 37(3).

[6] Bhatia, L., Prasad, S.S. (2015). Building a distributed generic recommender using scalable data mining library. 2015 IEEE International Conference on Computational Intelligence & Communication Technology, Ghaziabad, pp. 98-102. https://doi.org/10.1109/CICT.2015.129

[7] Draelos, Z.D. (2015). Cosmetics: The medicine of beauty. Journal of Cosmetic Dermatology. 14(2): 91. https://doi.org/10.1111/jocd.12146

[8] Schneider, G., Gohla, S., Schreiber, J., Kaden, W., Schomock, U., Lewerkuhne, H.S., Kuschel, A., Petsitis, X., Pape, W., Ippen, H., Diembeck, W. (2001). Skin cosmetics. Ullmann's Encyclopedia of Industrial Chemistry, Germany: Wiley VCH, 6: 24-29. https://doi.org/10.1002/14356007.a24_219

[9] Portugal, I., Alencar, A., Cowan, D. (2018). The use of machine learning algorithms in recommender systems: A systematic review. Expert Systems with Applications, 97: 205-227.

[10] Akay, B., Kaynar, O., Demirkoparan, F. (2017). Deep learning based recommender systems. 2017 International Conference on Computer Science and Engineering (UBMK), Antalya, pp. 645-648. https://doi.org/10.1109/UBMK.2017.8093489

[11] Robertson, J., Fieldman, G., Hussey. T.B. (2008). Who wears cosmetics?" Individual differences and their relationship with cosmetic usage. Individual Differences Research, 6(1): 38-56.

[12] Rinaldi, A. (2008). Healing beauty? More biotechnology cosmetic products that claim drug-like properties reach the market. EMBO Reports, 9(11): 1073-1077. https://doi.org/10.1038/embor.2008.200

[13] Dooms-Goosens, A. (1993). Cosmetics as causes of allergic contact dermatitis. Cutis, 52(5): 316-320

[14] Donsing, P., Viyoch, J. (2008). Thai Breadfruit's heartwood extract: A new approach to skin whitening. Srinakharinwirot Science Journal, 24 (1): 9-23.

[15] Sattar, A., Ghazanfar, M.A., Iqbal, M. (2017). Building accurate and practical recommender system algorithms using machine learning classifier and collaborative filtering. Arabian Journal for Science and Engineering, 42(8): 3229-3247.

[16] Nigam, P.K., Saxena, A.K. (1988). Allergic contact dermatitis from henna. Contact Dermatitis, 18(1) :55-56.

[17] Durmazlar, S.P., Tatlican, S., Eskioglu, F. (2009). Localized hypertrichosis due to temporary henna tattoos: Report of three cases. Journal of Dermatological Treatment, 20(6): 371-373. https://doi.org/10.3109/09546630802691945

[18] D'Arcy, P.F. (1982). Fatalities with the use of henna dye. Pharmacy International, (3): 217-218

[19] Johansen, J.D., Andersen, K.E., Rastogi, S.C., Menne, T. (1996). Threshold responses in cinnamic-aldehyde-sensitive subjects: Results and methodological aspects. Contact Dermatitis, 34(3): 165-171. https://doi.org/10.1111/j.1600-0536.1996.tb02167.x

AUTOMATED COLLEGE TIMETABLE GENERATOR

Dr. Rajendra Babu .Chikkala [1], Manasa. M [2] , Khamurunnisa. P [3]

Department of Computer Science and Engineering, Andhra Loyola Institute of

Engineering and Technology, Jawaharlal Nehru Technological University – Kakinada

chikkalarajendra@gmail.com, maradamansa99@gmail.com

khamurunnisapatan@gmail.com

ABSTRACT :

The automated timetable generator system simplifies the process of scheduling timetable for the departments .The proposed system takes the faculty information along with the number of subjects they dealing with , number of classrooms for each department and number of courses in the college .This system generates all possible timetables for all courses in such a way that there will be no crash in timeslots of any faculty in the department .The college authority now does not need to perform permutations and combination.

Keywords:

Automatic college timetable generator, Managing time ,ASP .Net ,SQL server ,Visual Studio ,Time table

I. INTRODUCTION

Time table scheduling has been in human requirements since they thought of managing time effectively. It is widely used in schools, colleges and other fields of teaching and working like crash courses, coaching centres, training programs etc. In early days, time table scheduling was done manually with a single person or some group involved in task of scheduling it with their hands, which take lot of effort and time.

While scheduling even the smallest constraints can take a lot of time and the case is even worse when the number of constraints or the amount of data to deal with increases. In such cases perfectly designed time table is reused for whole generation without any changes, proving to be dull in such situations. Other cases that will cause problem when the number of employers/workers are weak, resulting in rescheduling of time table or they need to fill on empty seats urgently.

1. Existing and Proposed System:

Normally timetable generation done manually. As we know all Institutions or organizations have its own timetable, managing and maintaining these will not be difficult. Considering workload

with this scheduling will make it more complex. As mentioned, when Timetable generation is being done, it should consider the maximum and minimum workload that is in a college. In those cases, timetable generation will become more complex. Also, it is a time consuming process. Automatic Timetable manger is a DotNet Framework based software used to generate timetable automatically. It Will help to manage all the periods automatically. Proposed system will help to generate it automatically also helps to save time. There is no need for Faculty to worry about their period details and maximum workload. It is a comprehensive timetable management solution for Colleges which helps to overcome the challenges in current system.

The Existing system for timetable generation is still manual due to the inherent difficulties it contains.

This old method of generating timetable is not only the waste of time but also the loss of effort and not easily modifiable if required .

Proposed system :

Carter M W, Laporte G [1] Several techniques have been developed for automated timetable generation.

Schaerj A [7] One of the popular technique is based on graph coloring algorithms

2. DESIGN METHODOLOGY:

"Automation College Time Table Generator" is to improve on how lecture table is being generated by school for the usage by the students.

The study is considered of great importance in that it examines the impact of computer introduction in developing an automated timetable generator.

This one may confidently state that the introduction of computer system to computer science for development of the generator timetable would bring about improvement in the management in terms of time and resources involved.
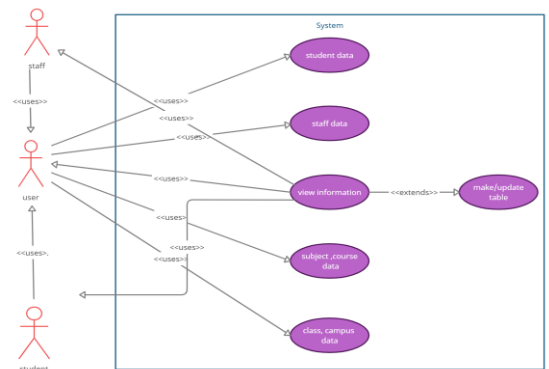
Fig 1. UML diagram for project interaction of timetable

The above figure is a class diagram that depicts all the actors and the actions

performed by them that are present in the system.
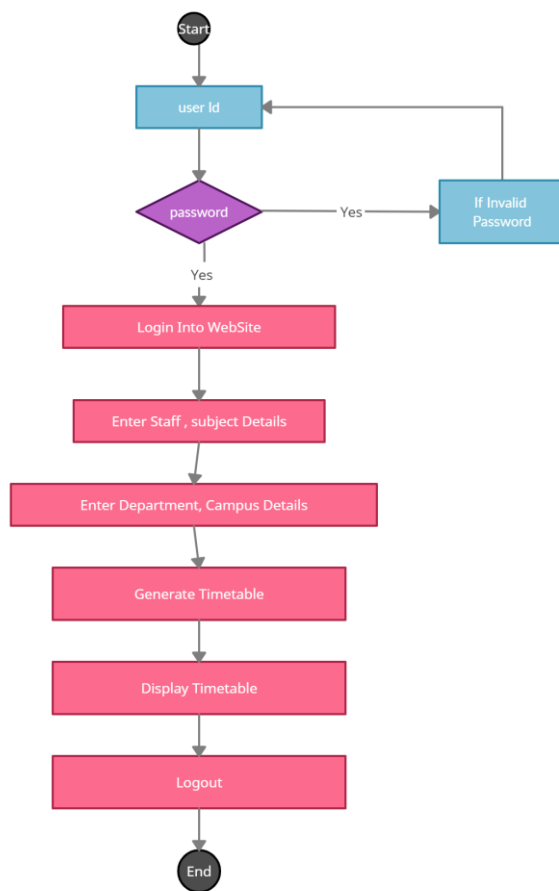
Fig 2. *Activity diagram*

Above activity diagram shows the working flow of the system i.e., the mechanism of the system and the subsequent events that occur in the system.

3. LITERATURE SURVEY :

i. Carter and Laporte[6] (1998) considered different categories to solve the timetabling problem. They are – Cluster method, Sequential method, Meta-Heuristics and Constraint Based

method. Meta Heuristics is a higher level procedure which is used to provide good enough solutions for optimization problems by Barkha Narang, Ambika (2013)

ii. Genetic Algorithms (GA) was invented by John Holland [4] and has described this idea in his book "Adaptation in natural and artificial systems" in the year 1975. Genetic Algorithms are inspired by Darwin's evolutionary theory. GA comes under the class of Evolutionary algorithms that use the principle of natural selection to derive a set of solutions towards the optimal solution.

iii. To Finding a feasible lecture/tutorial timetable in a large university department is a challenging problem faced continually in educational establishments. This paper presents an evolutionary algorithm (EA) based approach to solving a heavily constrained university timetabling problem Om Prakash Verma, Rohan Garg, and Vikram Singh Bisht,(2011) [5] .

II. OBJECTIVES :

Identify a software tool which can:

✓ *optimize the use of time.*

- ✓ *respect the pedagogical needs of the course.*
- ✓ *change schedules to integrate new professors without intensive manual effort.*
- ✓ *Store accurate information on when individual professors are available to teach.*

III. SYSTEM ARCHITECTURE :

- It is the system architecture where this project going to be implemented using the login credentials and implemented modules like add course ,add department details ,add staff details ,add subject details, and generate time table .
- In this system architecture the entered details are storing into the database automatically.
- Whatever the details stored and any updates done in the web sites can be monitored in database and then module for exit we can use a module logout.
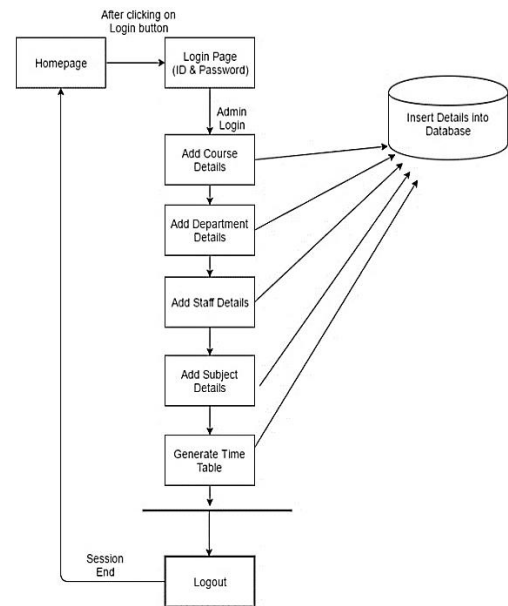
Fig 3. System Architecture

IV. PROJECT IMPLEMENTATION :

The Project is loaded in Visual Studio 2010. We used Visual Studio for Design and coding of project. Created and maintained all databases into SQL Server 2008, in that we create tables, write query for store data or record of project.

V. RESULTS AND OBSERVATIONS :

A) METHODOLOGY :

- ★ Scheduling timetable contains of teachers, numbers of students, and classroom into a fixed number of periods.
- ★ An optimal schedule would be where no students, teacher or

classroom is used more than once at any given time.

★ The problem of the timetable can describe as finding a schedule where the classroom, teachers, and student's combination within the same period have a minimal number of overlapping elements.

★ Even the perfectly designed time table is reused for whole generation without any changes, proving to be dull in such situations.

★ Other cases are caused because the problem is the number of employers or workers keeps changing, this result in rescheduling of time table urgently.

★ However, their schedule should meet the requirement of new course addition and newly enrolled students to fresh batches with class room number are allotted.

B) RESULTS :

➢ *Login Page:*
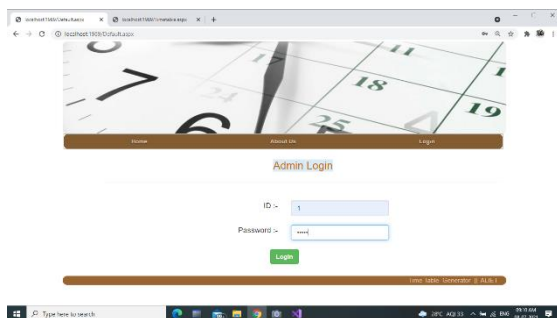
Fig 4. *Login page*

The above picture represents the login site for admin to login into the website while providing the inputs like ID and PASSWORD.

➢ *Add Course:*
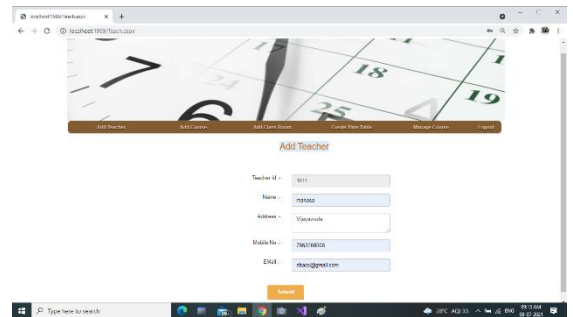
Fig 5. *Add Course*

In Add Course page we can add new course requirements like no of subjects in that course ,allotted teachers for that and priority of those subjects in the course.

➢ *Add Teacher:*
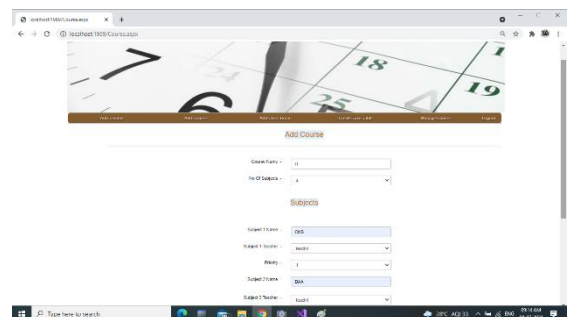
Fig 6. *Add Teacher*

In Add Teacher module we can add new teacher into the database by providing so information according to particular teacher.
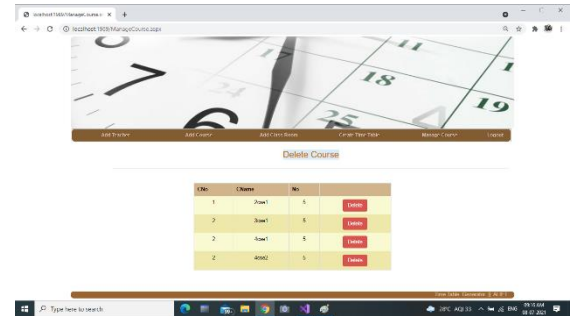
> *Add Classroom*
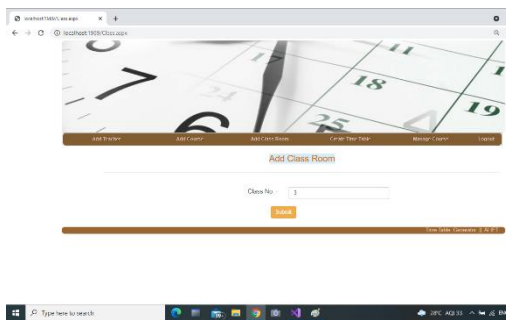
Fig 7. *Add Classroom*

In Add Classroom module we can allot one classroom for one course of students without merge.
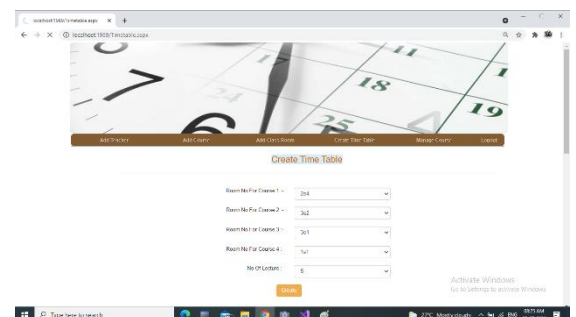
> *Manage Course:*

Fig 8. *Manage Course*

In Manage Course module we can monitor the no of courses present in database and if we to delete any one of the course we can delete it.

> *Generates Time Table:*

Fig 9. *Generate time table page*

Choosing the number courses we need to create timetable.

Fig 10. Generated Time table result page

In Generates Time Table module we can able to see some of feasible solutions of timetable.

➢ *Logout:*

This redirects to the home page.

ACKNOWLEDGMENT

We are pleased to present "Automated College Timetable Generator" project and take this opportunity to express our profound gratitude to all those people who helped us in completion of this project.

CONCLUSION

★ This software is used to maintain the details of staff and student's Time Table details and college Time Table details. **Visual Studio** is used as front end that is used to design the user interface. **Microsoft SQL** is used as back end and used to design the database and stores the details.

★ The tables used here are Course Details, Department details, Staff Details, Time Table Allocation details, Subject Details.

★ The project is more user-friendly so that anyone have minimum computer knowledge can access and handle the software without having any complexity. This system provides security to the users by providing proper login.

REFERENCES

[1]. http://www.doc.ic.ac.uk/~nd/surprise_96/journal/vol1/hmw/article1 .html

[2]. http://jgap.sourceforge.net/doc/gaintro.html

[3]. Barkha Narang, Ambika Gupta, and Rashmi Bansal, "Use of Active Rule and Genetic Algorithm to Generate Automatic Time-Table," in

International Journal of Advances in Engineering Sciences Vol.3 (3), July, 2013.

[4]. Tahir Afzal Malik, Hikmat Ullah Khan, and Sajjad Sadiq, "Dynamic Time Table Generation Conforming Constraints a Novel Approach," in ICCIT 2012.

[5]. Om Prakash Verma, Rohan Garg, and Vikram Singh Bisht, "Optimal Time-Table Generation by hybridized Bacterial Foraging and Genetic Algorithms," in International Conference on Communication Systems and Network Technologies, 2012.

[6]. Michael W. Carter, Gilbert Laporte "Recent developments in practical course timetabling" Springer publications volume 1408,2006.

[7]. A. Schaerj "A Survey of Automated Timetabling" Springer publications April 1999.

[8]. Dipti Srinivasan Tian Hou Seow Jian Xin Xu "Automated timetable generation using multiple context reasoning for university models", 2002 IEEE conference

[9]. Antariksha Bhaduri "University Time Table Scheduling using Genetic Artificial Immune Network" 2009 International Conference on Advances in Recent Technologies in Communication and Computing

[10]. AnujaChowdhary,PriyankaKakde, ShrutiDhoke, Sonali Ingle, RupalRushiya, Dinesh Gawande "TIMETABLE GENERATION SYSTEM" A paper published in IJCSMC Vol. 3, Issue. 2, February 2014.