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Editorial

There were the glory days during eighties and nineties that the engineering education was preferred by the talent across India. Any country's prosperity depends on higher education (HE) system and its technological development. Why many engineering institutions are closed or at the verge of closure? Many more institutions are just functioning with small number of student's strength. Is it due to dearth of job opportunities to engineers? Answer is certainly "No". There are plenty of job opportunities for creative engineers across the world. For an employment, young engineering graduates need to have skills in emerging areas like big data, artificial intelligence (AI), data science, machine learning, robotics, cyber security, mobile and cloud, etc.

According to the information available, in India 38.52 lakh students were enrolled in approximately 6200 engineering education institutes and nearly 15 lakhs are graduating every year. Unfortunately, less than 20% only are getting jobs in their core domain due to lack of required skills. Some of the reasons for not able to produce employable technical graduates include lack of infrastructure and facilities, substandard quality of teachers, ineffective teaching-learning process, no knowledge or exposure on current requirement of skills, faculty unaware of technology advances in their domain, lack of communication skills, and so on….. In many institutions, faculties are compelled to concentrate only on producing better result in university examinations rather than producing employable engineering graduates.

Engineering institutions sometimes have their vision statement with a big ambition, but truly speaking such institutions do not have a real vision. Any technical education institute without research facilities can only produce mere engineers with limited practical knowledge. These engineers fail to compete with creative and innovative engineers. In modern sense, particularly engineering education without skills of innovation is incomplete.

It is the time for restructuring the non-performing private technical institutions by renovating the laboratories, replacing the old and malfunctioning equipment, converting the conventional classrooms into virtual or digital classrooms. Also, the success of any engineering institution depends on other parameters which include highly qualified and trained teaching faculty, 24x7 library with pleasant reading area, research and innovation centre, internal quality management system (IQMS) for quality assurance, successful functioning of training and placement department with active team, collaboration with industries/ reputed institutions and research organizations, adopting better teaching- learning practices rather than following age old chalk and talk method, facilities to provide value added courses, finishing schools, hygienic hostels/canteens with quality food and good dining facilities, sports complex with necessary facilities, health care centre, etc.

This edition of IJTE contains articles on "An Innovative Blended Educatinal Lerning and Augmented Training Model (BELATM) for Engineering and Vocational Education", "Design and Analysis of 4-Port MIMO Antipodal Vivaldi Antenna for Sub-6 GHz 5G Applications", "5G Dual Connectivity with LTE as Default Technology", "Study on Value of Material Science in the Field of Industr", "Practical Analysis of Implementation of New Education Policy" and "Multiscale Based Joint Histogram Equalization for Nearly Invisible Natural Images" etc.

We take this opportunity to thank all those contributors, reviewers in making this issue an unforgettable one. Suggestions and feedback from our readers are welcome for the overall improvement of quality.

New Delhi **Editorial Board**
31st March, 2022

AN INNOVATIVE BLENDED EDUCATIONAL LEARNING AND AUGMENTED TRAINING MODEL (BELATM) FOR ENGINEERING AND VOCATIONAL EDUCATION

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ABSTRACT

Due to the Industrial Revolution (IR-04), the technologies are extensively used globally because of their potential to increase productivity, in almost all engineering industries, business establishments, etc. The cutting-edge technologies have way left behind the Indian academia of engineering and vocational education from fulfilling the need of new Generation 'Z' for IR-04. Appropriate pedagogical integration of increasing power of computing technology, Information and Communication Technology (ICT), and advancement in software technologies can augment the contemporary education system to meet the emerging labor market needs. Therefore, a blended education system, augmented with different technological resources and industrial practices will promote intensive learning experiences for learners to suit the present industrial revolution. Wherein, Virtual Reality (VR) and Augmented Reality (AR) technologies can prepare graduates with simulated practical experiences similar to a real industrial environment. This paper discusses an innovative 'Blended Educational Learning and Augmented Training Model (BELATM)' for the engineering and vocational education system of India based on the Problem Based Learning (PBL) curriculum development approach. The 'BELATM' would be a way to transform the present higher education system through blended educational learning, virtual reality, and augmented reality technologies followed by industrial experience in equipping the students of the future. This paper is conceptual paper based on the authors' specialization in the area of online education and training.

Keywords: Blended Educational Learning and Augmented Training Model (BELATM), Virtual Reality, Augmented Reality, Blended learning, flipped learning, Industry Revolution 4.0, Academic Revolution 4.0, Generation 'Z'

1. INTRODUCTION

The Industry Revolution 4.0 (IR-04) and Generation 'Z' has brought the technical and vocational education system of the country India at a crossroad. The policy-makers in the Ministry of Education (earlier MHRD), Government of India, and academia are rightly addressing the emerging challenges faced by INDIA by revamping of all key aspects of educational policies and aligning them to aspirational goals of the 21st century. The National Policy of Education (NPE)-2020 released recently on 29th July 2020; has suggested an integrated higher education system including professional/

technical and vocational education for meeting future challenges. [13pt10.13pp 36]. Now, to cater to the needs of IR-4 of Indian industries; the engineering education system of the country is expected to roll out undergraduate degree programs of either 3 or 4-year duration having multiple exit options to the students and progressively year-wise certifying them similar to the vocational education system. Thus, equipping them with specialized cutting-edge technologies such as the Internet of Things (IOT), Artificial Intelligence (AI),3-D machining, big data analysis, and machine learning skill, autonomous robots, etc. thus increasing their employability opportunities.

NPE-2020 has also recommended an increased thrust and inclusive learning through Online education, Open Distance Learning (ODL), facilitating learning resources to students of Higher Education Institution (HEI) – is preferably blended mode [13 pt11 p34,35].

This paper is a concept paper that proposes an innovative model to transform present-day engineering and vocational education by re-engineering the teaching-learning process through blended educational learning, virtual reality, and augmented reality technologies, along with laboratory/ workshop practices with industrial experiences. This is named as 'Blended Educational Learning and Augmented Training Model (BELATM)' for engineering and vocational education. The undergraduate program will be developed based on Problem Based Learning (PBL) curriculum development approach. The PBL approach will develop a real-world problem-solving ability in the passing out, students. This will be contrary to contemporary curriculum practices of the content structured approach.

2. Industry Revolution 4.0 vis-à-vis Academic Education 4.0

2.1 Industry Revolution 4.0 (IR-4.0)

Industry 4.0 stands for the fourth industrial revolution mainly characterized by digitization, extensive, use of sensors, automated production, etc. Saurabh Vaidya et al. (2018) states nine pillars of Industry 4.0 as follows:

i) Big Data and Analytics

ii) Autonomous Robots

iii) Simulation

iv) System Integration: Horizontal and Vertical System Integration

v) The Industrial Internet of Things

vi) Cybersecurity and Cyber-physical Systems

vii) The Cloud

viii) Additive Manufacturing

ix) Augmented Reality

The above nine new technologies adopted by the industries have presented a real challenge to the engineering and vocational academia. This would require a thorough re-engineering of present-day academic education in line with IR-4.0 requirements.

2.2 Academic Education 4.0 vis-à-vis Industry Revolution 4.0

Thomas Wallner et al. (2016) in their paper, emphasizes the need for rethinking by academia towards Academic Education 4.0 (AE-4.0) in line with Industrial Revolution 4.0 facing the world just as Work 4.0 or Healthcare 4.0, etc. The authors highlight "Academic education is now more than ever torn between the conflicting requirements of pursuing the Humboldtian model on one hand and providing vocational training resulting in "employability" on the other." (according to FHStG, 1993, § 3). According to Savvina O.V.,-Humboldt's university in Berlin (1810) was based on a model of higher education which could be called a democratic model.

But, today in this modern world of IR-4.0, not all students desire to be scientists; many of them just want to learn a profession and to fulfill the demand of the labor market resulting in employability.

In the above scenario, this Industrial Revolution-4.0 has a serious impact on the education system of this country India to pursue or adapt to the changing pattern of global Academic Education-4.0 (AE-4.0). The establishment first of

its kind Shri Vishwakarma Skill University (SVSU), Gurgoan, India, and Vocationalization of engineering education points to changes towards AE- 4.0. In India; the B.Voc. and D.Voc. programs offered by UGC approved Universities/ Colleges and 1063 AICTE approved engineering colleges in different states of the country are believed to accelerate the growth of India's economy *(AICTE List of Vocational Course, AY 2018-19, UGC Portal List of BVoc Degree Colleges/Universities)*. In this context, it is also important to refer to the NPE-2020 of India.

2.3 National Education Policy (NPE) - 2020

In Pt.16.5 of new NPE 2020)[13] it is mentioned that – "by 2025, at least 50% of learners through the school and higher education system shall have exposure to vocational education." The Pt.16.6 of NPE highlights "Vocational education will be integrated into all school and higher education institutions in a phased manner over the next decade. Focus areas for vocational education will be chosen based on skills gap analysis and mapping of local opportunities".

The NPE-2020 has also now suggested to award certificates progressively to the passing-out students of technical education as done in the vocational education system. The proposed pattern is awarding – a 'Certificate' after completing 1-year or a 'Diploma' after 2 years of study and finally a 'Bachelor's degree' after completion of a 3-year program. The 4-year multidisciplinary Bachelor's Programme, however, shall be the preferred option. [13,pt11.9pp37].

The Industrial Revolution 4.0 now, is forcing academia for re-engineering the educational system according to Academic Education 4.0 needs of the labor market for a technology-savvy generation/ group of people called – Generation 'Z'.

3. Generation 'Z'

Anna Dolot (2018), identified five generations of people in the modern world; the youngest – called Generation Z- is born after 1995 (Cillers, 2017 pp.189-190) and raised in completely different circumstances than other older generations. "Generations are defined as an identifiable group that shares birth years, age location, and significant life events at critical developmental stages" (Kupperschmidt, 2000, p.66).

According to Shilpa Gaidhani (2019), some of the characteristics of Generation 'Z' students are:

- Technologically sophisticated generation
- Informal, individual, and very straight way of communicating, and social media is a vital part of their lives.
- They are a Do-It-Yourself generation
- Have acquired attention deficit disorder with a high dependency on technology and a very less attention span, individualistic, self-directed, more demanding, acquisitive, materialistic, and entitled generation so till now, etc.
- Acquainted with Real and Virtual Worlds.

In the above scenarios of IR-4.0, the technology is a common influential factor in AE-4.0 as ever been for the new Generation- 'Z' students. Therefore, in this paper, the author further emphasis the suitability of the use of emerging technologies such as Virtual, Augmented realities, and blended online learning as well, for the native students born in technologies.

4. Emerging Technologies For Education

This new generation 'Z' students entering into higher education have significant computing knowledge, handling of mobile technologies, and are with higher expectations. It is, therefore, necessary, that the academic institutes introduce to them emerging technologies such as Virtual Reality, Augmented Reality for creating near to real industrial experience. These technologies can transform laboratories and workshop practices of engineering education into augmented learning.

4.1 Virtual Reality

Virtual Reality (VR) or immersive technology is an experience generated by the computer, where a user gets immersed in a simulated environment with technologies, manipulating them with handheld devices, and feels real. It attempts to emulate a physical world through the means of a digital or simulated world, thereby creating a sense of immersion. Today, this technology is extensively

used globally in the aerospace industry for manufacturing and training, automotive medical training, military training, entertainment (Nooriafshar, et al., 2004) and automotive premium industries, etc.

To make the pass out students capable to work in the above modern industries, it important to make them familiar with such technologies. This is possible by using virtual reality technologies as an educational and training tool. There are numerous advantages of VR being - safe, cost-effective, time-saving, usability, improved quality, and fully controllable as compared to several real-world laboratory and workshop experiences. Due to the interactivity and near to real feel, virtual reality environments enhance significantly the learning experience. According to the research findings of Mehryar Nooriafshar (2004) of the University of Southern Queensland, Australia; the visual feature, the advancement in immersive technologies to interact with the near-real world have a noticeable impact on various styles of teaching and learning and easing conventional teaching and learning processes. The Virtual Reality or VR -simulated environment created using of ICT gives a 3D viewing or 360^0 experience and gives an enhanced realistic interactive ability to the student.

Technologies for Virtual Reality Systems

- The VR Headsets or Head Mounted Displays (HMD) for viewing.
- Computer-generated virtual environment and 3-dimensional objects.
- Sensory accessories enhancing the interactivity/ participation levels of VR action.

In the project on virtual reality done by Abulrub A.G. et al. (2011), has cited the following benefits:

- "features such as 3D visualization, photorealistic, interactive, and immersive (sense of existence) to improve tangible learning outputs.
- Develop autonomous problem-solving skills for real-life challenges.
- Share complex technical information with team members and professionals both verbally and in writing.
- Examine the engineering problem in diverse modes; close inspection of an object or as a part of a whole system.
- Support creativity as it provides a chance for insight based on innovative technology.
- Encourage and develop effective communication skills among team members
- Apply knowledge and logic to conclude sound engineering opinions and decisions.
- Encourage to consider and propose different business solutions to achieve a specific task in practical terms for engineering problems."

4.2 Augmented Reality

Integrating Augmented Reality (AR) along with educational content provides an augmented environment with a unique combination of the physical and virtual world. Mehmet Kesim et al. (2012) in their paper mention, "Augmented Reality allows the user to see the real world and aim to supplement reality without completely immersing user inside a synthetic environment". This technology augments virtual information on top of the real world with full user control and interactivity. It's a combination of augmented reality interfaces with educational content changing perception and interaction with the real world in 3D space.

Technologies for VR/AR Systems

Virtual reality and augmented reality share the same technologies such as computer-generated virtual environments, 3D Objects, and handheld sensory devices for interactions. The main difference between them is that virtual reality replaces the real world and augmented reality supplements the real world. The main devices in AR are displays, computers, input, and tracking devices. The two types of displays are as follow:

i. Head-Mounted Displays : This kind of display is put on the head as a helmet and has a display in front of each eye. This display is of two types- See-through for VR and handheld displays for AR. In the case of See-through displays, the images of the real and virtual environments are placed over both eyes as shown in Fig. (1).

Fig. 1 : Headset display device

ii. Handheld Displays : The handheld devices for AR have a display that the user can hold in their hands. In this video-see technique, the hand-held device uses graphics to overlay the real object/environment. Handheld displays such as smartphones, personal device assistants, cameras, tablets, etc. handheld devices are held all the time over the real object/environment as shown in Fig,(2).

Fig. 2 : Handheld Display Device

iii. Input and Tracking Devices : Augmented Reality provides flexibility, where students can interact with the virtual world with hand tracking devices also. A hand glove used in AR/VR Technology is shown in Fig.(3).

Fig. 3 : Hand Glove for AR/VR Technologies

Now, these cutting edge technologies can transform the classroom, laboratory, and workshop situations in engineering colleges. The author in this paper further explains innovative blended learning and training model using the above AR/VR technologies for implementing an engineering/vocational program.

5. 'BLENDED EDUCATIONAL LEARNING AND AUGMENTED TRAINING MODEL(BELATM)

The author proposes an innovative 'Blended Educational Learning and Augmented Training Model (BELATM)'. This model is a combination of:

- **'Blended Educational Learning' and**
- **'Augmented Training Methodology'**

(Augmented Training is a method practiced by the Seabury Group, Spain)

The author believes that 'BELATM' will bring about revolutionary changes in the technical education system. The curricula of the program could be designed in a modular approach engaging the students to develop a real-world problem-solving ability in each year of certification. This proposed model has four steps of learning. It is as shown in Fig. (4).

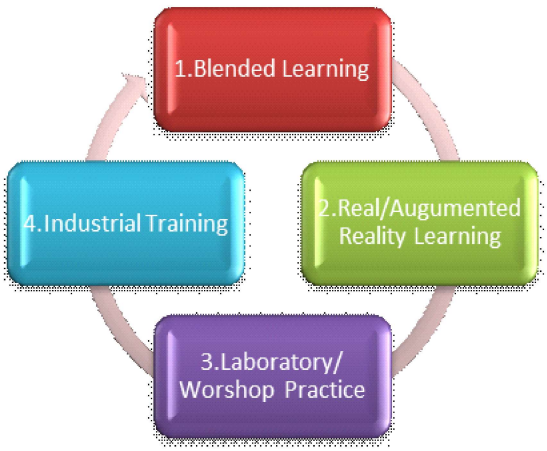

Fig.4 : 'BELATM' Four Learning Steps

'BELATM' is an advanced educational methodology in which 'Blended Educational Learning' is 'Augmented with emerging technological resources', for near to real

experiences in Laboratory or Workshop, followed by 'industrial practice'. This will promote the students for intensive practice.

It is a dynamic and flexible model, which allows teachers to easily manage the program, allowing students to learn online at their own place, pace, and time in their virtual learning space. The key to the program design approach must be the Problem Based Learning (PBL) curriculum Development Approach.

5.1 Problem Based Curriculum Development Approach

The curriculum of engineering or vocational education is suggested to be designed on Problem Based Learning curriculum development and instructional system approach. This will simultaneously develop both; problem-solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem-solvers confronted with an ill-structured problem that mirrors real-world problems. The course contents will be organized around problems and sub-problems. The teacher as facilitator, guide, and coach teaches the theoretical knowledge to the students through a blended and flipped learning approach. The students by confronting the real-world problem in the curricula learn in small groups. After learning the theoretical part of the curricula, the students undergo training through engineering experiences or practical's designed using virtual reality and augmented reality technologies. Wherein they undertake different engineering experiences as per curricula. Subsequently, the students complete their prescribed laboratory and workshop experiences and industrial practices. The student progresses, once they develop the problem-solving ability given in each module of the course curricula, which guarantees a higher level of achievement.

5.2 Blended Educational Learning

'Blended Educational Learning' is a personalized methodology that combines both traditional classroom-based methods and learning using online educational materials, listening to video lectures, attempting quizzes, and submission of online assignments. It has some elements of student control over time, place, path, or pace. The online teaching-learning methodologies used are blended and flipped learning in a smart classroom equipped with technologies.

A Blended Educational Learning environment will enable the teacher to complete the theoretical part of the curriculum. This includes the conceptional and procedural knowledge which are required to perform a practical or task in the laboratory or workshop situation.

5.3 Smart Classroom for Content Delivery

The smart classroom is a well-furnished air-conditioned room with a sitting arrangement of say 30-40nos. of learners as shown in Fig. (5).

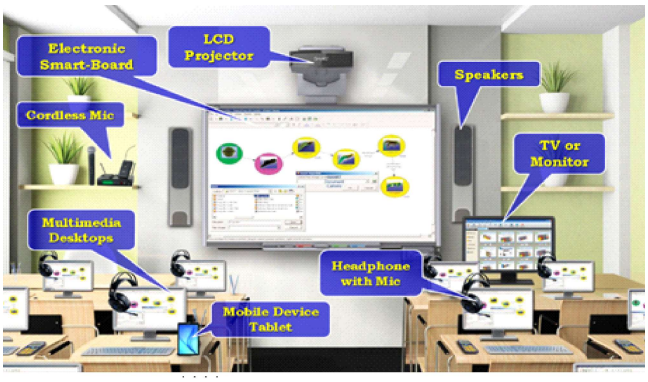

Fig. 5 : Smart Classroom

It is equipped with Computer systems, LCD projectors, television, electronic smart-boards, High definition Camera, UPS, etc. for information presentation by teachers. Each learner in the classroom has access to a multimedia desktop, laptop, a mobile device such as a tablet, etc. with headphones, cordless mike, microphones on a network. The learner in the smart classroom will access uploaded contextual content materials related to the sub-problem.

5.4 Blended learning and flipped learning

The two methods Blended and Flipped learning have some components which are overlapping and a common objective as shown in Fig.(6). The two are used to create a full, inclusive learning experience.

The online mode of learning can be accessed from anywhere using the internet through a learning management system (LMS). The difference between the two is discussed herewith.

Fig. 6 : Blended Educational Learning -1 (Theoretical Knowledge)

5.7 Blended Learning

Blended learning involves online Technology Enabled Learning (TEL) and face-to-face classroom instruction (often referred to as "traditional learning"). The teacher gives learners links to online resources that complement or supplement the problem/topic under discussion. This broadens the understanding of the topic. The teacher further asks them to complete an online group project. In the case of blended learning, online materials complement face-to-face instruction. They truly "blend" giving an enriched online learning experience to students to solve the problem(s).

5.8 Flipped Learning

Flipped learning is at times also known as a flipped classroom. Flipped classrooms refer to technology-enabled teaching and learning processes in which readings of e-content and listening to video lectures occur outside the *classroom* while learners in-person in the class focus on problem-solving. A learner watches an eLearning video / participates in online learning exercises before coming to the class. In the classroom, the problems related to that new material are explored at length, discussed, and solved. In most cases, the applied knowledge is done in class, and an understanding of a concept is done online.

5.3 Augmented Training Methodology

The "Laboratories are designed to improve the student ability to investigate and solve engineering problems with appropriate levels of independent thought and create and also to demonstrate suitable levels of reporting technical information (Abulrub A.G.et al. 2011)". In the same way, virtual reality and augmented reality can also be used for providing laboratory and workshop experiences to enhance the student's practical skills. The student gets actively involved in applying their knowledge in performing a task. The Virtual Reality and Augmented -a simulated environment created using of ICT gives a 3D viewing or 360^0 experience, gives an enhanced realistic industrial interactive ability to the student.

The students after performing engineering practices using AR/VR simulated environment, they can further perform practices in laboratory and workshop situations. Finally, the students after completing their industrial practice as a part of the curricula, can be awarded a certificate of completion. The completion certificate of the program would be as per the proposed pattern of awarding – a 'Certificate' after completing 1-year or a 'Diploma' after 2 years of study and finally a 'Bachelor's degree' after completion of a 3-year program. The 4-year multidisciplinary Bachelor's Programme, however, shall be the preferred option. This 'Augmented Training Methodology' is shown in Fig. (7).

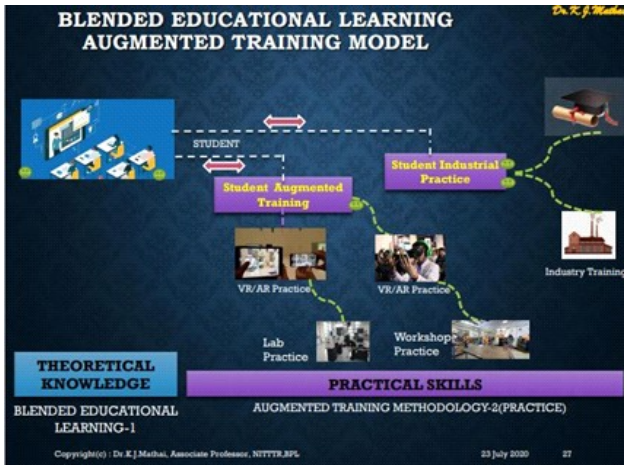

Fig. 7 : Augmented Training Methodology-2 (Practical Skills)

6. CONCLUSION

The policy-makers and academia are addressing the increasing challenges because of Industry Revolution 4.0 and Generation 'Z' by the Vocationalization of curricula. The author has proposed KJMathai's innovative 'Blended Educational Learning and Augmented Training Model (BEATM)'. This would require re-engineering of teaching-learning processes according to Problem Based Curriculum Development (PBL) approach through blended educational learning, virtual reality, and augmented reality technologies with industrial experiences

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★★★★★

DESIGN AND ANALYSIS OF 4-PORT MIMO ANTIPODAL VIVALDI ANTENNA FOR SUB-6 GH_Z 5G APPLICATIONS

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ABSTRACT

A low profile 4-Port Multiple Input and Multiple Output (MIMO) Antipodal Vivaldi Antenna (AVA) for Sub-6 GHz 5th Generation (5G) Mobile Applications is proposed. Initially, the AVA is designed and further it is enhanced by incorporating MIMO technique in order to improve the antenna parameters. The size of the proposed MIMO AVA is 156 x 35 mm2 and it is designed using a low cost FR4 substrate with thickness of 1.6 mm and loss tangent of 0.02. Sub-6 GHz band is chosen in order to provide better outdoor to indoor coverage for mobile applications. The antenna parameters in terms of gain, efficiency and isolation among the antenna elements were studied. The proposed antenna has better isolation of < -13 dB, better gain of 8.4 dB and radiation efficiency of 90%. The antenna performances demonstrate that it is a good candidate for 5G Mobile applications.

Keywords : *Antipodal Vivaldi Antenna (AVA), Multiple Input Multiple Output (MIMO), Sub-6 band 5G Antenna.*

1. INTRODUCTION

Compared with the current and previous generations (4G-1G), fifth generation is expected to have abundant bandwidth and data rate. When the number of users on a cellular communication network rises, the frequency provision becomes inadequate due to limited channel bandwidth [1]. Within the same frequency band, the number of users cannot exceed a certain limit. Furthermore, as the number of users rises, co-channel interference rises. The capacity of sending and receiving large files is limited in 3G and 4G channels. Hence, there is a need of having large bandwidth and faster communication channels [2]. Next generation after 4G is 5th Generation technology which uses Sub-6 GHz (3.4 GHz – 3.8GHz) and millimeter (mm) wave bands (24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 GHz and 66-71 GHz). One of the greatest advancements in 5G technology is the usage of MIMO technology which will improve the communication capacity. MIMO uses multiple antennas at the transmitter side and multiple antennas at the receiver side. If the signal gets transmitted from the transmitter side, it will get spatially divided and will be received multiple times at the receiver side. In case, any one of the signals is not properly received by the receiver due to path loss or fading, the signal will be received at the receiver since the signal recombination takes place [3]. MIMO antennas play a critical role in meeting high data rates. In the existing literature, planar MIMO antennas are designed for both mm wave and sub-6GHz frequency bands. However, the MIMO based Antipodal Vivaldi Antennas are very

limited, especially for sub-6GHz frequency range. In [1], MIMO antipodal Vivaldi antenna is designed and to avoid mutual coupling between the antennas, the spiral slots have been incorporated in the ground plane. Likewise, several mutual coupling reduction techniques such as neutralization lines, Ground slots, EBG structures, metamaterials are used in between the antennas [5].

Millimeter waves can provide higher bandwidth and high data rate but it suffers from various disadvantages such as signal attenuation, penetration loss, path loss and foliage losses. Moreover, in mm waves the Non-Line of Sight (NLOS) paths cannot be predicted as the signal itself gets scattered when it gets hit by the buildings, trees and other tall structures. It also needs a higher-end RF module for deployment which requires more power for operation [6],[7]. Further, for the 5G mm-wave communications, the small towers must be deployed by replacing the existing 4G towers. In an overall comparison with mm waves, the sub-6 GHz band is capable of sending large amounts of data over long distances in Rural and Urban areas as it has a larger wavelength, the NLOS paths can be easily predicted. It can propagate through longer distances, requires less power for transmission, can propagate inside buildings, less foliage loss etc.,[8]. The signal will be more consistent and sub-6 GHz can work by updating the existing LTE module itself without the deployment of smaller towers.

A sub-6 GHz band MIMO AVA is designed in this paper. The paper is organized as follows, design procedure for the antenna is given in section II. The results and analysis in terms of return loss, VSWR, gain and radiation characteristics are given in section III. Finally, the conclusion and future scope is provided in section IV.

2. ANTENNA DESIGN

The design of MIMO AVA is carried out in HFSS. The design is initialized by creating a taper to stretch a structure of curved flares to create AVA. The feed is designed as a base and the flares are designed by placing two ellipses and intersecting them. The AVA is designed on the top and bottom side of the readily available FR4 Substrate which has a dielectric constant of 4.3, a loss tangent of 0.02 and a thickness, 'h' of 1.6 mm. The flares are placed at the top and bottom sides of the substrate. The designed AVA is shown in Fig.1.

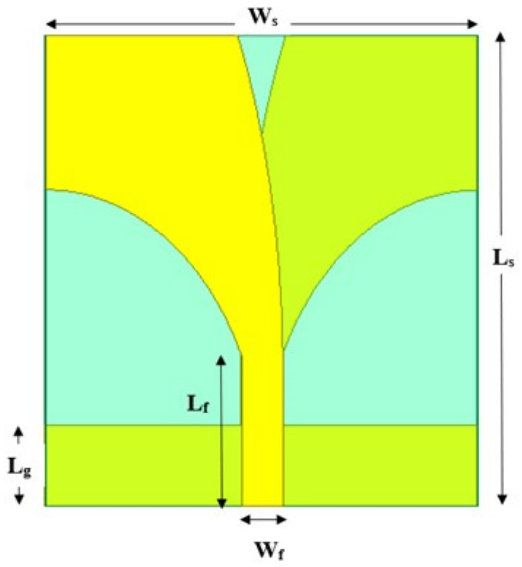


Fig.1 : Antipodal Vivaldi Antenna

Here, W_f and L_f are the width and length of the feed. G_l is length of the ground.

The design equations are given below [10],

$$f_{min} = \frac{c}{2W_s\sqrt{\varepsilon_{eff}}} \quad (1)$$

Where f_{min} is the minimum frequency, W_s is the width of the antenna and ε_{eff} is the effective permittivity and also effective dielectric constant.

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left(1+\frac{12h}{W_s}\right)^{-0.5} \quad (2)$$

The exponential flare of the AVA is constructed by two ellipses using the following equations [11],

$$a_1 = \frac{W_s - W_f}{2} \quad (3)$$

$$a_2 = 1.68 b_2 \quad (4)$$

$$b_1 = 0.48 \quad (5)$$

$$b_2 = \frac{W_s}{2} \quad (6)$$

where a_1 and b_1 are the minor and major axis of the first ellipse (i.e.) the first ellipse (big flare) and

a_2 and b_2 are the major and minor axis of the second ellipse (i.e.) the cut down portion below the flare respectively. The antenna dimensions are given in Table 1.

Table 1 : Design Parameters of AVA

Parameter	W_s	L_s	W_f	L_f	L_g
Dimensions (mm)	32	35	3.1	11.5	6

Based on the dimensions mentioned in Table-1, the design of AVA is carried out.

The single AVA is modified to a 4 port MIMO antenna in order to improve the antenna characteristics and to improve the link reliability, as MIMO technique is incorporated mainly to provide better user experience with faster data rate with minimal delay. All the 4 antenna elements are placed with the centre to centre spacing of λ/2 in order to avoid mutual coupling. The design of MIMO AVA is shown in Fig.2. The overall size of the antenna is 156 x 35 x 1.6 mm^3.

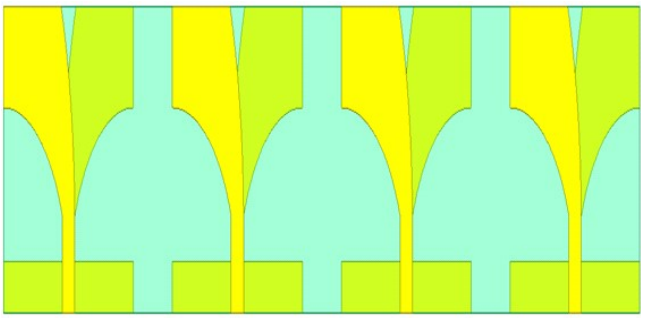


Fig.2 : MIMO AVA

The AVA has been designed and enhanced by incorporating MIMO technique. The antenna parameters such as, return loss, gain, bandwidth, radiation characteristics are obtained. In the discussion Sii denotes the reflection coefficient of 'i'th port. Sij denotes the transmission coefficient from port 'j' to 'i'. In the proposed MIMO antenna, there are 4 antennas. Hence, 'i' and 'j' vary from 1 to 4.

3.1 Antenna Parameters

1) Return loss (S_{ii} in dB): The 'S_{ii}' plots of the designed 4 port MIMO AVA is shown in Fig. 3. S_{ii} denotes the amount of power reflected from the source due to mismatch between the source and load. It is generally measured in dB. From the S_{ii} graph, it can be seen that the antenna resonates at 3.6 GHz. which is the mid-band of 5G Sub-6 GHz frequency band from 3.4 GHz - 3.8 GHz.

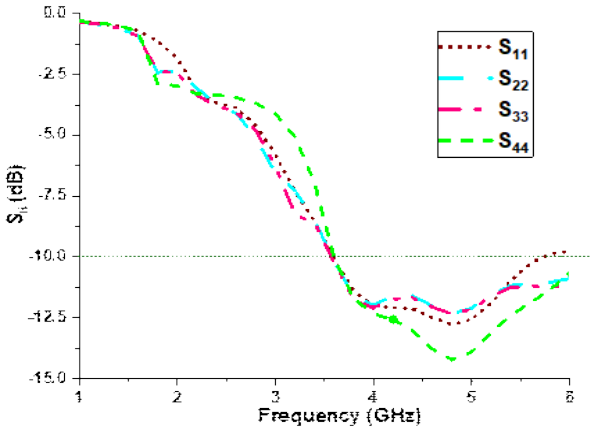


Fig.3 : Return loss plot of MIMO AVA

2) Isolation (S_{ij} in dB): It denotes the strength of power coupled from one antenna to another antenna when the antennas are closely spaced. The isolation of < -12 dB is considered to provide less mutual coupling. It can be inferred from transmission coefficients 'S_{ij}'. Fig. 4 denotes the Isolation plot for the MIMO AVA. All the 4 antennas provide better isolation < -13 dB. It indicates that there is negligible mutual coupling between the antennas.

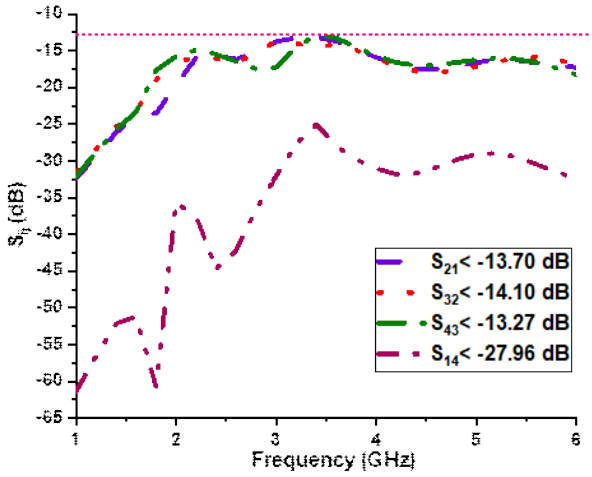


Fig.4 : Isolation plot of MIMO AVA

3) VSWR: The VSWR of the designed MIMO AVA's is < 1.5 which denotes the better matching condition of the source and load.

4) Gain: The gain of the designed AVA is found to be 4.8 dB. After incorporating MIMO technique, the gain got increased to 8.4 dB. Thus, the gain is enhanced compared with the single AVA. The gain plot for AVA and MIMO AVA is shown in Fig-5.

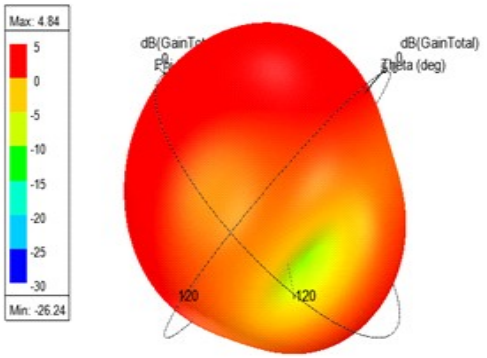
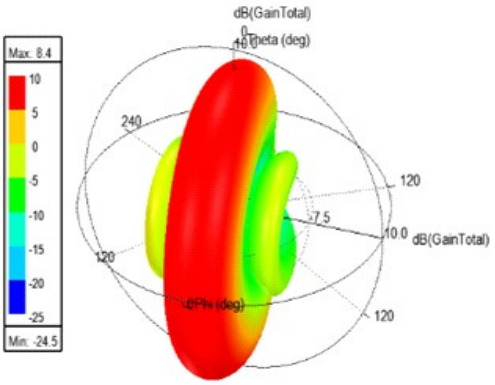


Fig.5(a) : Gain plot of AVA



(b) : Gain plot of MIMO AVA

5) Radiation characteristics: The radiated power for the AVA with inclinations is 34.7 dBm at 3.6 GHz. The radiation efficiency is 90%.

4. CONCLUSION

Antipodal Vivaldi Antenna is gaining importance in all wireless devices since it provides better gain, Ultrawide bandwidth, and better return loss. The designed antenna provides a better gain of 8.4 dB at 3.6 GHz. The VSWR is also lesser than 1.5 which denotes a perfect matching condition. Further, the isolation between the antennas is also good. The MIMO technique has many advantages over the single antenna technique by providing a high data rate and better link reliability. As mentioned in Section I, on using sub-6 GHz band, the signal can penetrate without any loss and will be more consistent. The designed 5G sub-6 GHz MIMO AVA can be used for 5G wireless applications. The future work could be designing of the compact MIMO AVA.

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BRAIN TUMOR DETECTION FROM MRI IMAGES USING MACHINE AND DEEP LEARNING TECHNIQUES : A REVIEW

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ABSTRACT

Detection of brain tumor is a difficult task that entails identifying malignant tissues from different and diffuse brain medical imaging. This is a crucial stage in computer-aided diagnostic (CAD) systems, as cancerous areas must be identified for viewing and analysis. Image segmentation and classification of brain tumors have to be automated. The principle of this work is to provide an overview of the Magnetic Resonance Imaging (MRI)-based approach for brain tumors detection. Deep learning-based techniques, which automatically create multilevel and separated from unprocessed data, have made significant progress in brain tumor detection recently. These techniques outperformed traditional machine learning techniques that employed handmade characteristics to explain the distinctions between sick and healthy tissues. We provide a complete summary of modern advances in deep learning-based approaches for brain tumor detection (BTD) from MRI in this study. Furthermore, we address the most typical issues and provide potential remedies.

Keywords : *Brain tumor detection, deep learning, classification segmentation.*

1. INTRODUCTION

Brain tumor is an uncontrolled proliferation of abnormal cells in the body. A brain tumor is a lump in the brain that is made up of a cluster of these aberrant cells. Tumors are classified as malignant or benign. Tumors are classified as primary, secondary, or metastatic depending on their origin. The term “type of tumor” refers to cancer that originates in the brain. Brain cells, meninges, nerve cells, and glands can all produce them. The metastatic tumor can spread cancer cells to different parts of the body. Glioma and meningioma are the most prevalent kinds of malignant tumors. Adult gliomas are the most common malignant tumor. It begins in glial cells and spreads throughout the body [1]. Gliomas affect children aged 5 to 10 years, as well as adults aged 40 to 65 years, according to the World Health Organization (WHO) [2]. Furthermore, these tumors report for 81% of the total malignant brain tumors and 45% of the total primary brain tumors [4]. WHO has classified and rated over 120 tumor types (World Health Organization). According to the WHO, brain tumors are graded from grade I through grade IV. The tumor’s classification and grading system aid in predicting the tumor’s nature and stage, which may aid in diagnosis. Complex cell structure, diverse distribution of strength, tumor dynamic position, and tumor artifacts, for example, can all impact diagnosis. Heterogeneity in cancer cell proliferation provides significant hurdles in the development of cost-effective and efficient behavior strategies.

Positron emission tomography (PET), X-ray, and computed tomography (CT) are examples of biomedical imaging modalities. MRI is a most important technique for brain construction study because it provides high-contrast images of soft muscles as well as great spatial resolution. The MRI image pre-diagnosis method involves frequent image sequences T1, T2, T1ce, and FLAIR. Fig. 1 shows the images of dissimilar sequences.

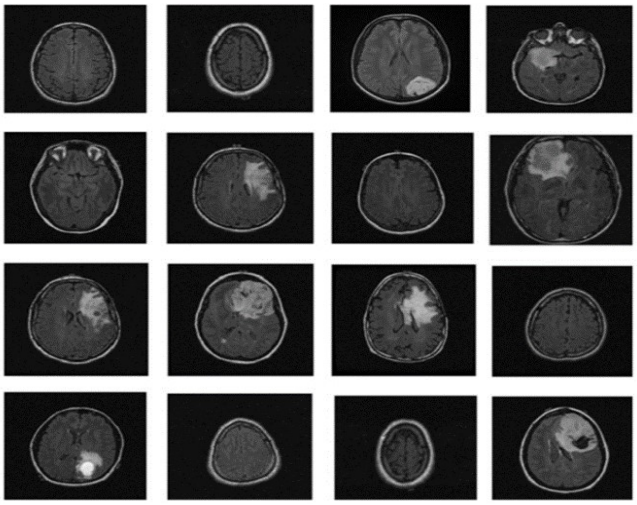

Fig.1 : Sequences of MRI images

2. LITERATURE SURVEY

In the last two decades, several approaches for brain tumor detection have been planned to identify the position of tumors at a prior stage for a greater survival probability. The most important goal is to distinguish and emphasize the various aberrant brain images using the distinct feature set. Many researchers use a machine and deep learning approaches to detect brain tumors, as follows:

When compared to further machine learning techniques, the KNN, or K nearest neighbor method, finds Euclidean distance the label-based, resulting in excellent accuracy. However, it falls short in terms of runtime performance. To accomplish classification, an ANN, or artificial neural network, employs numerous nodes and hidden layers, as well as weights. When comparing the desired output to the weights, the error factor is reduced [6].

In [7], a novel SVM method was proposed that extracts flexible decision edges based on region processing. This method makes it simple to comprehend nonlinear data. When compared to fuzzy clustering, the final findings reveal a better output. The distinction between different types of cancers was studied using a probabilistic neural networks (PNNs) paired through least-squares features transformation (LSFT) in [8]. The model had achieved a level of accuracy of over 95%. For categorizing normal and Alzheimer's brains, orthogonal DWT paired with intensity histograms [9] achieved a high accuracy of around 100%. [10] proposed an adaptive neuro-fuzzy interface system (ANFIS) for brain tumors recognition using a neural network (NN) and a fuzzy filter. This was tested on 80 normal photos and 40 aberrant images. The auto seed selection technique showed promising accuracy of 81.7% in the experiment. [11] proposed SVM for dimensionality reduction, and this experimental resulted 98% accuracy with extremely selective features. This also emphasizes the significance of selecting the right features. The author of [12] addresses the use of unsupervised machine learning to cluster comparable MRI images. This work was based on detecting important classes by plotting similar pixel vectors. Some of the most widely studied unsupervised algorithms is fuzzy c-means algorithm, k-Means clustering algorithm, SOM (self-organized map), and PCNN algorithm. [13] describes advances in the classification phase of Brian tumors identification. The Feed-Forward neural network (FFNNs) with K-Nearest Neighbors (KNNs) classification methods is discussed by the author.

Concentrating on these categorization algorithms resulted from inaccuracy of 97 and 98%, respectively. It was also suggested that this technology be applied to a variety of MR pictures. In [14] the widespread approval of Deep Learning (DL) in this diligence is discussed. Deep Learning (DL) is used in a variety of fields, including breast cancer, tuberculosis, and brain tumors studies. CNNs (Convolution Neural Networks) the deep learning techniques that have been developed for recognizing and classify brain tumors. When Deep Learning approach is backed up by additional

techniques, their accuracy soars to new heights. In [15] they proposed a Deep Convolution Neural Network (DCNN)-based solution to tackle the problem of over-fitting. The author suggests max-out with drop-out layers and tests the method using the BRATS_2013 dataset. The model was trained with an 80:20 train with test ratio and sensitivity, specificity, and dice similarity coefficients (DSC). In [16], proposed Fuzzy c-means for segmentations T2-W MRI images were classified using a combination of discrete wavelet transform (DWT) and a DNN (Deep Neural Network). Normal, glioblastoma, sarcoma, with metastatic-bronchogenic-carcinoma tumors, were all included in the classification. The algorithm's performance in a classification rate of 96.97%.

Within a year, [17] [18] discussed an enhanced version of DCNN. Tumor multiplicity adds to the complexity and necessitates greater precision. [19] multimodal-based segmentation with Random forest classification was discussed. Gabor characteristics are taken from each supermodel and used to train Random Forest. Using multimodal images from the BraTS datasets, each supermodel is classified as healthy or tumor. The results are presented in terms of sensitivity and dice score, which are 86% and 0.84%, respectively. Mohsen et al. [20] proposed using a Deep Neural Network to divide brain MRIs into four categories: normal, sarcoma, metastatic bronchogenic carcinoma tumors, and glioblastoma. The discrete wavelet transform (DWT) with principal component analysis (PCA), an effective feature extraction method, were used with the classifier. When the suggested model was compared to other classifiers, such as KNN when k = 1, k = 3, LDA, and SVM, it got the highest AUC score of 98.4% when DWT was employed on CNN. Chang et al. [21] introduced a Fully Convolutional Residual Neural Networks (FCRNNs) based on linear identity mappings, a basic medical picture segmentation approach. The FCR-NN system uses a fully convolutional image segmentation architecture that effectively caters to low-level and high-level picture information. For tumor segmentation, the machine employs two distinct networks: one to segment the entire tumor and the other to segment subregion tissues. The FCR-NN sequencing architecture goes beyond state-of-the-art approaches with validation, and both have been trained for the proposed model. Complete tumor 0.87, core tumors 0.81, and enhanced tumors 0.72 are DSC.

Raja et al. [22] presented a brain tumor classification model hybrid deep autoencoder uses through a Bayesian fuzzy clustering technique for brain tumor segmentation. Initially, during the preprocessing stage, non-local mean filtering is used for denoising purposes. The BFC(block-based fast compression) method is employed in the segmentation brain tumors. They use information-theoretic measurements such as the Wavelet Packet Tsallis Entropy (WPTE) from each brain image with Scattering Transform (ST) approaches after segmentation. The brain tumor classification, a hybrid system comprising the DAE (Deep autoencoder)-based JOA (Jaya optimization algorithm) and softmax regression is applied. According to the results of the BraTS_2015 database, the proposed technique provided high classification accuracy (98.5%).

Kumar et al. [23] proposed employing a Deep Wavelet Autoencoder Neural Networks (DWADNNs) strategy for picture segmentation, which was evaluated and compared to a variety of different classification methods, including the DNN, AEDNN, and others. In broad data distribution, an autoencoder can be thought of as an optimal strategy for extracting and learning principal components. DWA-DNN has been proven to be more accurate than the other exit approaches. It also enables the use of an image classification method for cancer detection that is both reliable and simple. The original encoded image is treated using a Daubechies wavelet of order two via a Discrete Wavelet Transformation (DWT), which bypasses low-pass and high-pass filters to generate estimate and detail coefficients. Sensitivity, specificity, and F1-Score, as well as accuracy results of 93, 94, 92, and 93%, respectively.

3. METHODOLOGY

Computer-aided diagnostic (CAD) for brain tumor detection steps various machine and deep learning techniques uses, the block diagram illustration in shown in fig.2.

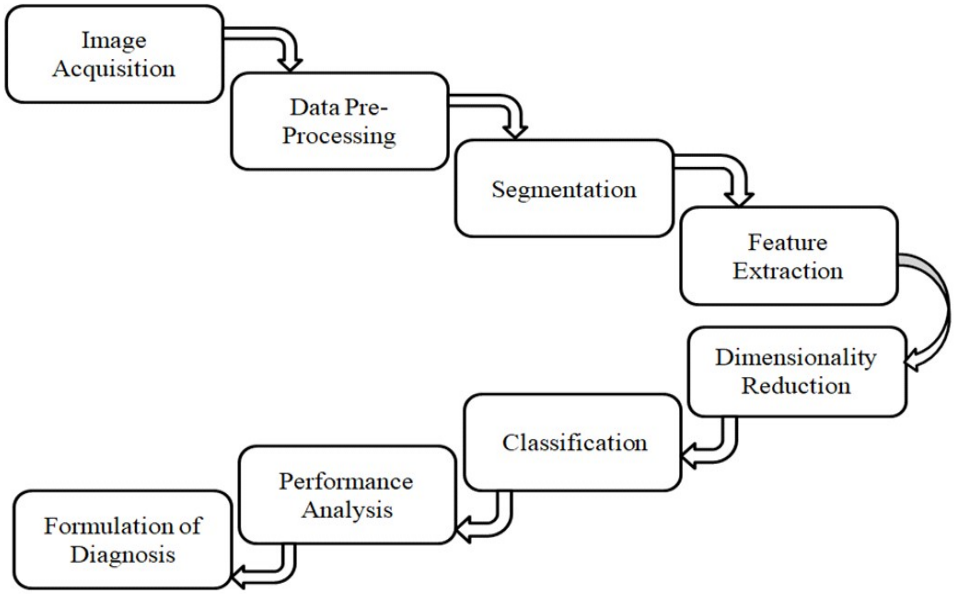

Fig.2 : Computer-aided diagnostic (CAD) systems for brain tumor detection

Collect historical images for training the algorithm. This is the first phase of the Brain Tumor recognition system. The dice coefficient of Internet Brain Segmentation of Repository (IBSR) segmented dataset, and Brain Web with Medical School Harvard Some of the most usually used datasets for brain tumors detection are BraTS [5]. Researchers encountered numerous limitations as a result of a requirement of data for precautions reasons. Data cleaning and data improvisation occur after the data has been collected during the data preprocessing step. The amount of noise in images makes it difficult to distinguish between normal and diseased cells. The segmentation phase is a crucial step in determining the analytical region of interest. Following segmentation, feature extraction extracts features such as texture and intensity with edges. Reduction of dimensionality: PCA (Principal Component Analysis) aids in the reduction or elimination of non-classifiable features. Later, utilizing the collected features, classification models are employed to classify the types of brain tumors.

4. DATASETS

Brain Tumor Detection (BTD) uses Machine and Deep Learning Techniques are brain tumor datasets publically available as shown in Table 1.

Table 1: Publically Brain tumor Datasets

Sl. No.	URL Address	Datasets Name
1	https://www.cancerimagingarchive.net/	TCIA
2	https://www.smir.ch/BRATS/Start2012	BRATS
3	https://brainweb.bic.mni.mcgill.ca/	Brain Web
4	http://www.oasis-brains.org	OASIS
5	http://www.med.harvard.edu/AANLIB/	Harvard Medical School
6	https://imaging.nci.nih.gov/ncia/	NBIA
7	https://www.cancerimagingarchive.net/	TCIA
8	https://www.smir. ch/	ISLES

5. EVALUATION PERFORMANCE

The evaluation performance is precision, recall, accuracy, and F1-score are used to measure the real and expected classes that have previously been expressed in equations 1, 2, 3, and 4, individually, to validate the proposed model. Different metrics may be constructed from a confusion matrix to reflect the performance of classifiers, unique to each tumor type, using each performance metric's mathematical notation. The important measures of accuracy, precision, recall, and F1-score are computed using the following equations.

$$AUC = \frac{TP + TN}{TP + TN + FP + FN} \quad (1)$$

$$PRE = \frac{TP}{TP + FP} \quad (2)$$

$$REC = \frac{TP}{TP + FN} \quad (3)$$

$$F1\ SCORE = 2 \times \frac{Precision \times Recall}{Precision + Recall} \quad (4)$$

Where,

TP used for True Positives, TN used for True Negatives, FP used for False Positives, and FN used for False Negatives

6. DISCUSSION AND FUTURE DIRECTION

Deep Learning algorithms are gaining traction as the demand for AI and automation grows. Automatic systems are currently a prominent focus of research. This review focuses on the various deep learning algorithms that are currently in use, as well as a discussion of the approaches for segmentation of brain tumor utilized. Deep learning-based segmentation of brain tumors are detection in this paper. We examine it from two perspective. The deep learning is a first of the perspective technology and the second is from the perception of tumor types. From a technical aspect, we seem at network building, post-processing, pre-processing, loss function, multimodality, and post-processing. The tumor segmentation approach deep learning-based is concise from two perspective: types of the tumor and procedural architecture. The modern methods are mostly utilized to correctly segment tumors and compensate for the lack of training data. When given adequate training data, deep learning can efficiently segment tumors, and all three approaches are based on the following three perspectives: Remove infrared portions from the image and segment with set limits to provide additional data for pixel categorization. As a result, a large number of networks have been proposed, and the article includes detailed comparison introductions. However, because neural networks require large amounts of data by their very nature, the current methods for compensating for a lack of data are partial, and the most popular ones rely on modify the training technique. Based on the aforesaid situation, we have identified four potential research areas for future: Some of the techniques used include 3D image compression model, segmentation, classification, and transfer learning an overfitting solution.

Although the deep learning-based tumor segmentation method has yielded promising results so far, there are few relevant research approaches and development points. Based on the method's reasoning, this study evaluates the methodology from the perspective of tumors kind and network architecture. This review contains some important information for researchers and others interested in learning more about this topic quickly.

7. CONCLUSION

This research looks at a variety of methodologies and tools for developing automatic brain tumor detection algorithms. Despite major advancements in the discipline, deep learning methodologies are still in their infancy. Tumor segmentation techniques based on deep learning are gaining popularity. This article looks at the state-of-the-art technique from two perspectives: tumors type and network building, and technical considerations. The majority of the strategies are based on supervised learning, which necessitates manual ground truth labeling. Because there aren't enough datasets, different strategies for dealing with

data or class imbalance issues should be investigated. 3D image transfer learning, model compression, segmentation, classification and an overfitting solution are all areas that will be investigated in the future.

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A WIDEBAND METAMATERIAL - BASED MICROWAVE ABSORBER

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ABSTRACT

A thin metamaterial-based microwave absorber with twin concentric rings and a single split on the top surface is presented in this paper for wideband applications with more than 90% absorptivity. A substantial amount of study has been conducted on the metamaterial unit cell structure such as the incident electromagnetic wave's angle, the dielectric substrate thickness, and both the top and bottom layer surface current to achieve the enhanced absorption characteristics. The enhanced structure exhibits 6.82 GHz broadband absorption from 8.98 GHz to 15.8 GHz. The peaks of absorption for this metamaterial absorber for the normal incidence of EM wave appear at 9.40 GHz, 11.20 GHz, and 14.95 GHz as 99.75 %, 99.93 %, and 99.88 %, respectively. The broadband characteristics enable the structure for a broad range of applications such as stealth devices, radar cross-section reduction, electronic cloaking devices, military equipment, and for improvement of the electromagnetic compatibility of devices.

Keywords : *Metamaterial, Microwave Absorber, Broadband Absorber.*

1. INTRODUCTION

A new era of microwave absorbers started with the metamaterial absorber structure proposed by Landy *et al*. [1]. The popularity of metamaterial-based absorbers has increased in recent times because of their compact structure where unit cells are arranged periodically and can be easily fabricated at a minimal cost. The structure of the unit cell generally comprises the top conductive layer, dielectric substrate layer in the middle and, the bottom ground layer. The metamaterial absorber structure's reflectance and transmittance should be minimal for near-unity absorption. This is achieved by matching the effective input impedance of the absorber structure to free space impedance for a low reflection and introducing a high loss structure for low transmittance.

Previously, investigations have been conducted on several single bands [2]-[5], dual-band [6]-[9], triple-band [10]-[12], and multi bands [13]-[14] absorbers. Recently, more focus is given to broadband metamaterial-based absorbers [15]-[18] because of their wide applications in various fields. Achieving broadband absorption is challenging because of the structure's high electric and magnetic resonance [19]. The use of a double-layered structure can be observed in Wang *et al* [19] to obtain broadband absorption. In [20], the utilization of circular split rings has been reported for x-band applications.

A single-layered metamaterial absorber structure with applicability in -band and - band frequency ranges are proposed in this work. The structure comprises a periodic arrangement of unit cells with twin concentric rings with a single split at the top surface. The rings' dimensions have been tuned such that the structure has a bandwidth of 6.82 GHz and absorptivity of more than 90% between 8.98 and 15.80 GHz. The proposed structure is also studied using 3D EM simulator HFSS under oblique incidences of the EM waves showing that up to 45º incident angle, the structure provides wideband absorption.

2. DESIGN OF THE UNIT CELL STRUCTURE

The unit cell top view, as well as the incident EM wave direction along with the electric and magnetic field, are presented in Fig. 1. The top layer consists of twin concentric rings with a single diagonal split which are made up of copper (conductivity of 5.8×10^7 S/m). The structure's bottom layer is entirely made of copper. A single FR-4 dielectric substrate layer of thickness of 2 mm with dielectric loss tangent (*tanδ)* of 0.02 and relative permittivity (ε_r) of 4.2 has been used as the middle layer. All the copper layers of the structure are 0.035 mm thick and the other design parameters of the structure are: w = 0.4 mm, r_1 = 1.65 mm, r_2 = 1.05 mm, s = 0.4 mm, and l = 3.75 mm. The absorptivity can be obtained as $A(\omega)$, where

$$A(\omega) = 1 - |S_{11}(\omega)|^2 - |S_{21}(\omega)|^2 \qquad (1)$$

Here, the incident EM wave's transmitted power and reflected power with angular frequency ω is denoted by $|S_{21}(\omega)|^2$ and $|S_{11}(\omega)|^2$ respectively. As the proposed metamaterial structure has a bottom layer entirely made of copper, the transmitted power will be zero i.e. $|S_{21}(\omega)|^2 = 0$. Hence, the eq. (1) can be modified as,

$$A(\omega) = 1 - |S_{11}(\omega)|^2 \qquad (2)$$

Therefore, the maximum absorptivity is achieved by minimizing the reflected power for the proposed structure.

3. RESULT AND DISCUSSION

Ansys HFSS was used to simulate the proposed structure, comprising twin concentric rings with a single split with the use of periodic boundary conditions for normal EM wave incidence.

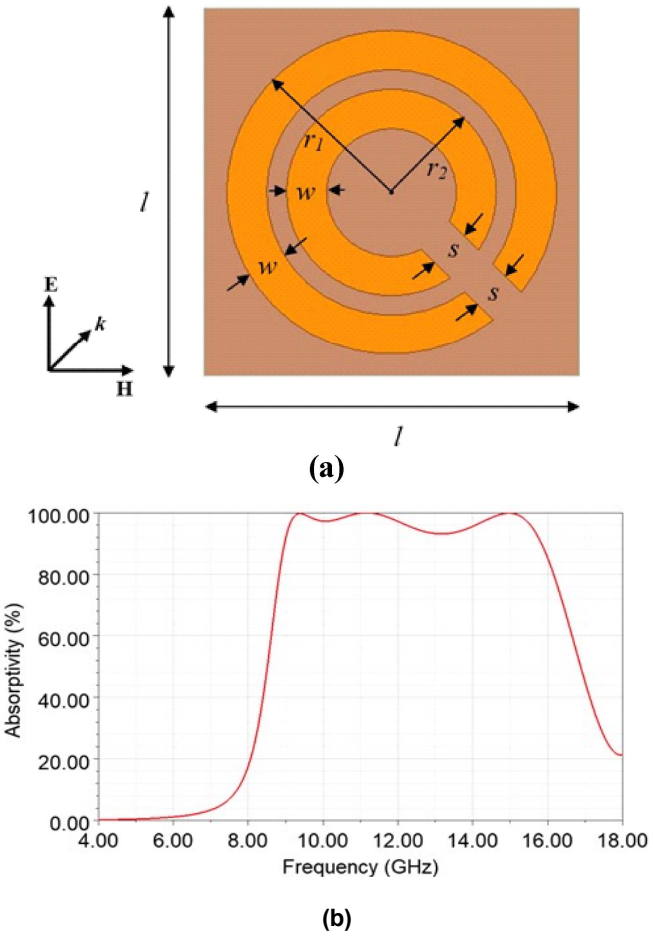


Fig.1 : The proposed twin split ring metamaterial absorber (a) Unit cell structure and (b) Absorptivity plot.

The percentage absorptivity is shown in Fig.1. From 8.98 GHz to 15.80 GHz frequency range, the absorption bandwidth of 6.82 GHz with an absorptivity of over 90% can be observed. For the normal incidence of EM wave, the peaks of absorption for this metamaterial absorber are obtained as 99.75% at 9.40 GHz, 99.93% at 11.20 GHz, and 99.88% at 14.95 GHz frequencies.

The proposed structure's surface current distribution is also analyzed. Surface current distributions are observed at different frequencies. The top and bottom layers' surface current distributions are given in Fig. 2 at 9.4 GHz, 11.2 GHz, and 14.95 GHz.

Subsequently, different parametric variants of the absorber structure have been observed. The variation of ring width and radius of the inner ring r_2 and outer ring r_1, along with the contributions of the inner and outer split rings which are shown in Fig. 3. When a parameter is varied, other parameters are kept constant. An increase in length of provides a shift of absorptivity curve towards the lower frequencies. Similarly, smaller shifts the absorptivity plot to higher frequencies. The proper selection of and provides wideband absorption for the structure. These observations helped to come up with an optimized structure.

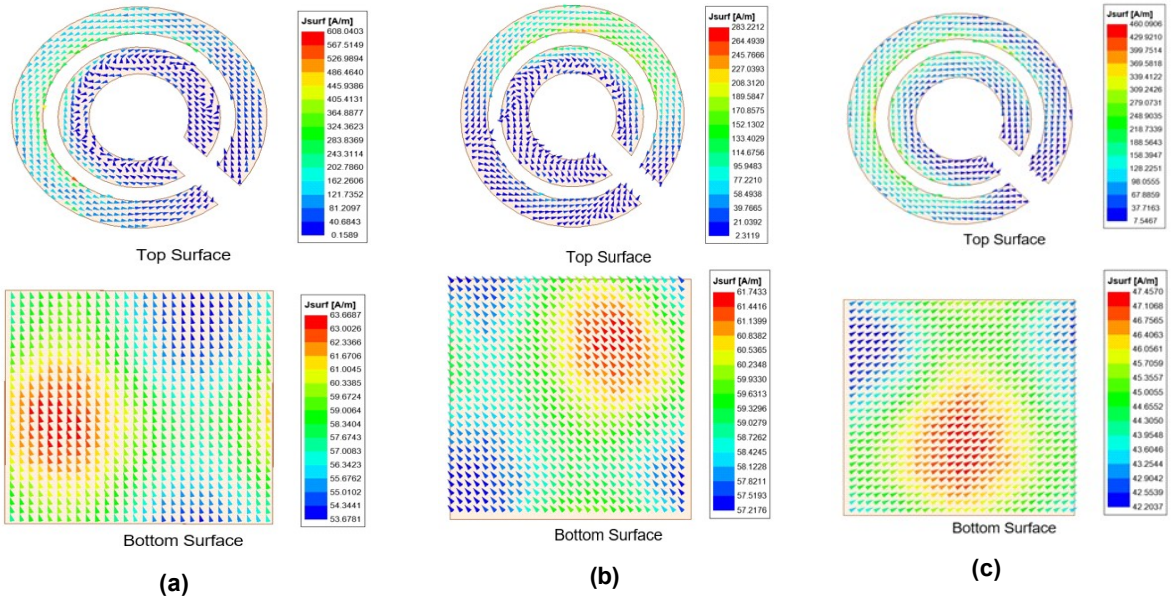
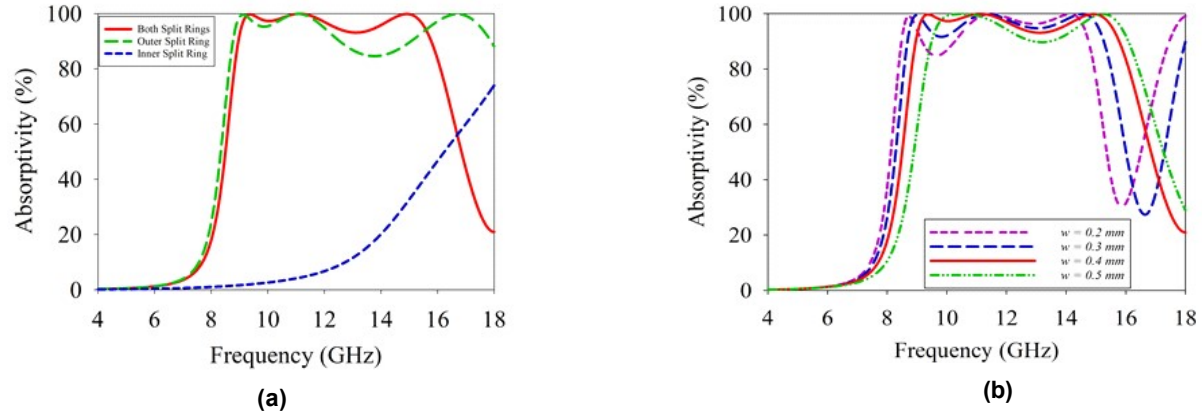
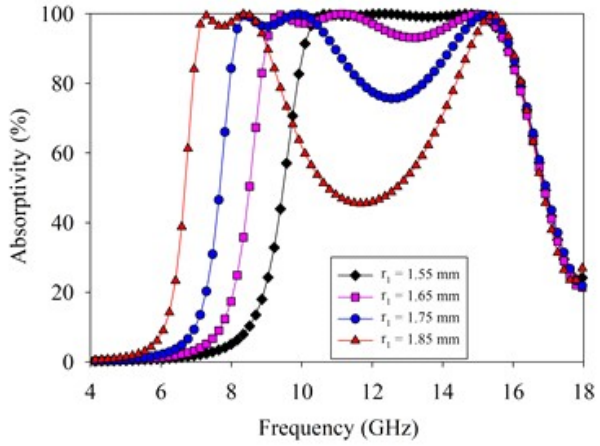


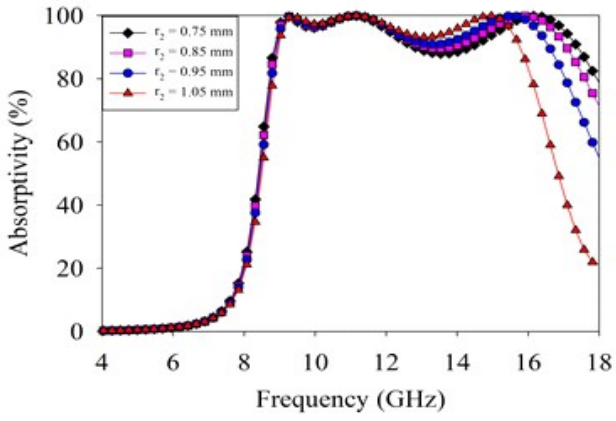
Fig. 2: The proposed metamaterial absorber's surface current distribution at (a) 9.40 GHz, (b) 11.20 GHz and (c) 14.95 GHz frequencies

Equation (3) is used to compute the change in normalized impedance with frequency, as shown in Fig. 4. At 9.40 GHz, 11.20 GHz, and 14.95 GHz, the normalized impedance for broadband absorbers is 1.05 + 0.08j, 0.96 + 0.03j, and 0.93 + 0.02j, respectively, indicating that the suggested absorber structure has minimal reflectance owing to perfect impedance matching with free space.





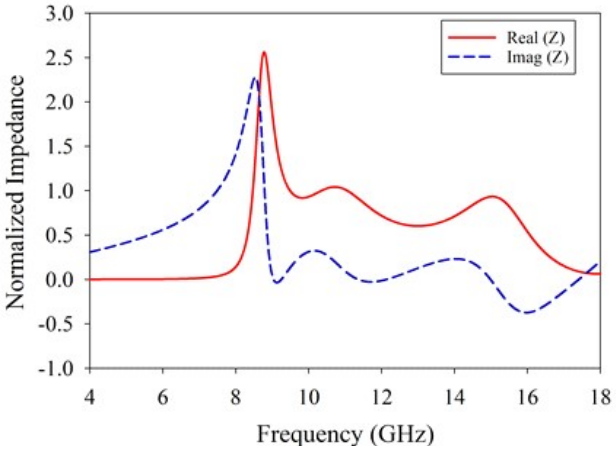
(c)



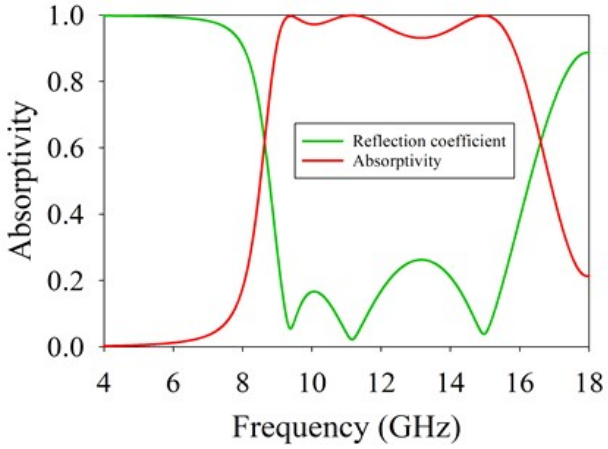
(d)

Fig.3 Simulated absorptivity for (a) comparison of only inner and outer split ring with proposed structure, (b) variation of w, (c) variation of $r_{1,}$ and (d) variation of $r_{2.}$

$$Z = \sqrt{\frac{(1+S_{11})^2 - S_{21}^2}{(1-S_{11})^2 - S_{21}^2}} = \frac{1+S_{11}}{1-S_{11}} \qquad (3)$$



(a)



(b)

Fig.4 : Plot for (a) the fluctuations of normalized impedance with frequency along with (b) reflection coefficient for proposed absorber.

As illustrated in Fig. 5, the proposed absorber structure's polarization behavior was investigated at various polarization angles ranging from 0º to 45º. The simulated plot shows a gradual decrease in absorptivity with a higher polarization angle and reaches a minimum for $\phi = 45^o$.

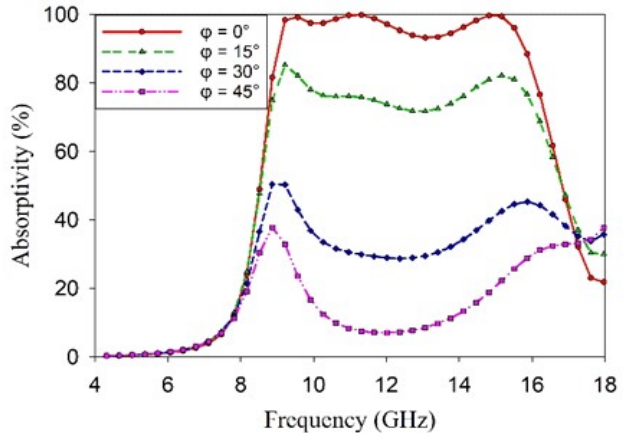


Fig.5 : Absorptivity plot for different polarization angles

4. CONCLUSION

A broadband metamaterial structure with twin concentric single-split rings is presented. The proposed structure's radii and width of the rings are optimized for broadband absorption of x-band and K_u- band. From the 8.98 GHz to 15.80 GHz frequency range, the absorption bandwidth of 6.82 GHz with an absorptivity of over 90% can be observed. The peaks of absorption for normal incidence of EM waves from this proposed structure are observed to be 99.75%, 99.93%, and 99.88% at 9.40 GHz, 11.20 GHz, and 14.95 GHz frequencies, respectively. The comparison with previously proposed absorbers with the same substrate is presented in Table 1, and a significant improvement in bandwidth can be observed for the proposed absorber with almost the same thickness. The metamaterial absorber structure shows wideband absorption characteristics for oblique incidence angles up to 45º.

As the substrate thickness is only 2 mm, it helps the structure be less bulky and more suitable for a broad range of microwave applications.

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Table 1

Absorber	Dielectric Substrate	Thickness (mm)	Unit cell size (mm)	Range (GHz)	Bandwidth (GHz)	Polarization insensitive
Agarwal et al [17]	FR-4, $\epsilon_r = 4.4$ tanδ = 0.02	2	18	7.46-8.83 and 11.5-12.93	1.37 and 1.43	Yes
Ghosh et al [20]	FR-4, $\epsilon_r = 4.2$ tanδ = 0.02	2	7.1	7.85-12.25	4.4	No
Gu et al [21]	FR-4, $\epsilon_r = 4.6$ tanδ = 0.025	2	11.65-13.15	9.05-11.4	2.35	-
Goyal et al [22]	FR-4, $\epsilon_r = 4.4$ tanδ = 0.02	2	10	6.9-9.6	2.7	No
Sen et al [23]	FR-4, $\epsilon_r = 4.4$ tanδ = 0.02	1.9	5.5	8.86-15.5	6.64	No
Proposed structure	FR-4, $\epsilon_r = 4.2$ tanδ = 0.02	2	3.75	8.98-15.8	6.82	No

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5G DUAL CONNECTIVITY WITH LTE AS DEFAULT TECHNOLOGY

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ABSTRACT

The 5G networks are designed to provide unprecedented performance in mobile networks. MmWaves are considered as a major enabler for these performance improvements, especially the ultra-high throughput due to the massive amounts of available bandwidth. Nevertheless, the mmWaves suffer from high isotropic path loss and a smaller coverage area. Dual Connectivity (DC) is one of the best techniques to overcome these problems and make the mmWave networks more reliable. In this paper, we investigated and compared between Long Term Evolution (LTE) and 5G. Moreover, we proposed a Dual Connectivity (DC) method where the LTE connection is the default Radio Access Technology (RAT). The proposed method will help reduce connection complexity and energy consumption by reducing the number of handovers and the reliance on high frequencies. The extensive simulation comparison is performed using the NS-3 mmWave module.

***Keywords** : 5G, mmWave, LTE, Dual Connectivity*

1. INTRODUCTION

Mobile applications and mobile internet, enabling us to be connected anywhere and anytime, are changing the day-to-day lives of people. Popular mobile Internet services include mobile social networking, online multimedia streaming, interactive gaming, and so on. Those were the leaders to the explosive mobile traffic growth in recent years. Based on statistics, mobile data traffic is expected to increase by 27% per year between 2019 and 2025 [1]. The 5G network should address the increased traffic demand and the growth of connected devices. One of the most important enablers of the ultra-high throughput is the mmWaves. However, mmWaves present several issues that should be addressed like (i) high isotropic path loss; (ii) weak penetration capabilities (blockage caused by buildings and even humans); (iii) attenuation from rain, tree leaves, and even heavy fog [2]; (iv) processing power consumption [3]. The 5G DC was introduced to overcome the low Signal to Interference and Noise Ratio (SINR) and even the outage in coverage that the User Equipment (UE) can suffer from using the stand-alone 5G network [4]. In traditional DC, the number of handovers increases and the UE will keep searching constantly for both networks even though one of them may not be available. This means increasing the connection complexity and energy

consumption. This paper proposed a DC method where LTE is the default used RAT. The purpose of this method is to use the LTE network solely when there is no need for ultra-high data rates. This means saving the resources of the 5G network and decreasing energy consumption. In other words, this paper aims to determine the threshold where LTE is not anymore capable of providing the needed services. In order to evaluate the benefits of this proposal, an exhaustive simulation was carried out on both LTE and 5G networks using the NS-3 mmWave module. Based on the performance measures a suitable threshold is proposed for handover. The distinctive characteristics of the mmWave frequencies have different effects on the protocol stack. For instance, the utilization of highly directional beams affects the Media Access Control (MAC) layer and increases the complexity of cell search, synchronization, initial access, and control signals, which in turn affects the robustness and delay [5].

NS-3 is an open-source discrete-event simulator aimed to provide a developed tool for educational use, development, and research [6]. However, NS-3 doesn't support mmWaves simulations. Therefore, several researchers worked on developing a module that can simulate mmWave 5G networks with the partnership of New York University (NYU) [7]. The NYU mmWave Module for NS-3 is the first open-source framework that supports the simulation of 3GPP-style mmWave cellular networks. Its architecture builds upon the LENA (LTE-EPC Network simulator) module [7]. Therefore, the NS-3 was chosen for the simulations conducted in this paper.

2. PERFORMANCE EVALUATION FOR ONE USER WITH MULTIPLE SPEEDS

The conducted simulation aims to compare the values of latency and throughput of both LTE and 5G under the same scenario (UE location, UE speed, buildings distribution, start, and endpoints, etc.). Therefore, it was based on the mctwoenbs.cc example which is found in src/mmWave/examples [8]. This example originally simulated a 5G mmWave DC scenario. A detailed description of the module can be found in [9].

2.1 Simulation parameters

The abovementioned example was modified to simulate an LTE connection only or a 5G DC connection. The simulated LTE is the standard LTE, without using the DC configuration. Moreover, the default module parameters were used [8]. The main parameters are listed in Table 1 and the mobility model is the constant mobility model. The conducted simulation was done on a PC using a core i5 @2.80 GHz processor, 16 GB of RAM, and operated by Ubuntu 18.04. The simulation scenario parameters are:

Table 1 : Main Parameters

Parameter name	5G DC	LTE
Access technology	OFDMA	OFDMA
Duplex	TDD	FDD
Bandwidth	1 GHZ	25 MHZ
Number of UE antennas	16	1
Number of eNB antennas	64	1
Number of UEs	1	1
Number of LTE eNBs	1	1
Number of mmWave eNBs	2	none
Velocity model	constant	constant

- The UE start point coordinates (80, -5, 1.6);
- The UE end point coordinates (120, -5, 1.6);
- Buildings: 8 buildings with random distribution.

These values can be changed easily and were selected randomly. The simulation was performed multiple times where the downlink data rate and/or the UE speed were changed in each iteration. The main purpose is to identify the saturation point of each technology and the effects of UE speed on the latency and throughput.

2.2 Simulation results and discussion

Nine different simulations were performed where in each one the positions of the (evolved Node Base) eNBs and/or the speed of the UE was changed. The main purpose of these simulations is to study the effects of different speeds on throughput. The results are listed in Table 2.

The presented throughput is the Packet Data Convergence Protocol (PDCP) layer throughput. It is calculated by sampling the PDCP Packet Data

Units (PDUs) each 5 ms then summing the received packets to get the number of received bytes $B(t)$. Then the throughput $S(t)$ is calculated as $S(t) = B(t) \cdot 8/Ts$. Where $Ts = 5ms$, and the average throughput is calculated by averaging these samples over the total simulation time [4].

TABLE 2 : LTE & 5G Maximum Throughput Values

UE speed (m/s)	Max LTE throughput (Mbps)	Max 5G DC throughput (Mbps)
1	74.77	381.74
2	74.33	416.55
3	73.91	407.79
5	73.16	320.18
10	71.59	397.79
15	70.27	359.71
20	69.33	375.42
25	68.48	222.85
30	67.75	212.38

It is observed from Table II that the LTE network throughput is affected by the UE speed. The relation between the UE speed and the throughput is inversely proportional (the faster the UE, the lower the throughput). The overall variation is around 7 Mbps only (9%). This is due to the fact that the coverage area of the LTE is bigger, which means fewer handovers. Also, to the fact that the LTE radio channel is more stable than the mmWave one [10]. While in the 5G mmWave the effect of the speed is higher, and the relationship is not inversely proportional. This can be explained by the mmWave radio channel vulnerability and rapid quality variations [11]. The maximum throughput varied between 416.55 Mbps and 213 Mbps, meaning that the throughput dropped by around 50%.

Another two scenarios are considered in the simulation to check the effect of both i) the relative distance between the UE and base stations; ii) different building distributions; without the effect of movement speed. In the first scenario, the first mmWave Next Generation NodeB (gNB) is located at the point with the coordinates (5,70), and its altitude is 3 m, while the second mmWave gNB is located at the point (150,70) and its height is also 3 m. In the second scenario, the coordinates of the first mmWave gNB are (5,70) and its height is 3 m while the seconds are (170,70) and its altitude is also 3 m. In both scenarios, the LTE eNB is co-located with the first gNB. The UE movement starts at (80,70) and ends at (120,70), and its altitude is 1.6 m. When the locations of the gNBs change, the buildings distribution can also change since random distribution is used. The results of this simulation are illustrated in Fig 1. As the figure shows, there are almost no changes in the LTE throughput while the 5G is much more affected. The main reason behind these results is the fact that the coverage area of the LTE eNB is bigger than the one of the mmWave gNB. Also, from the fact that mmWave signals are more susceptible to blockage [10]. Moreover, it shows the importance of the signal strength and quality to maintain the high performance of the mmWave network.

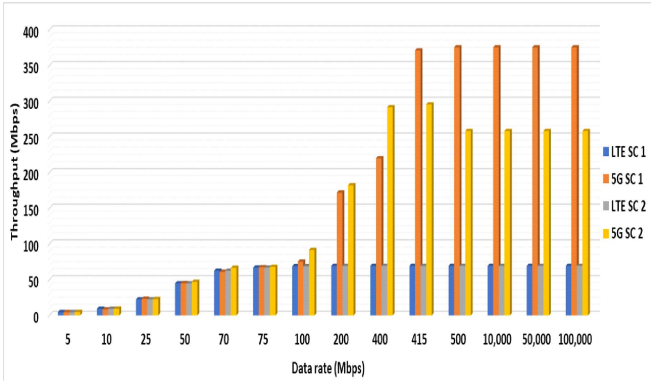


Fig 1 : The throughput of both LTE and 5G DC networks in two scenarios using same UE speeds and different BS distributions

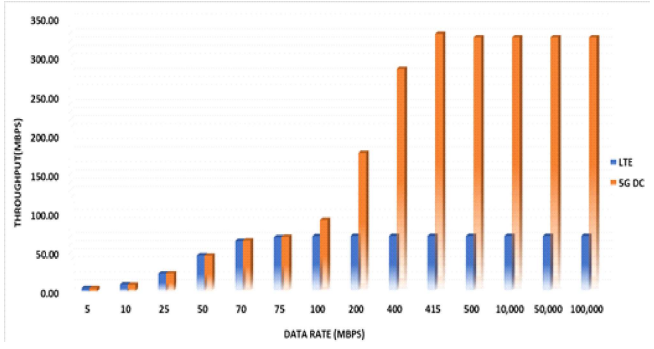


Fig 2. : The average throughput of both LTE and 5G DC networks under different data rates

a) Overall throughput: The main aim of the simulation is to compare the performance of the LTE and the mmWave 5G networks under the same circumstances. The obtained results are averaged in a conventional way and are illustrated in Fig. 2 and Table 3.

Fig 2 shows the throughput values of both networks. It is noticed that the values till 75 Mbps point are almost identical. However, after this value, the LTE network gets to its saturation point and the throughput values do not increase. While in 5G the values keep going up and reach their maximum throughput at around 350 Mbps. This shows the performance variations in the ideal case between the two networks, and how much higher data can be transmitted using 5G.

b) Average latency: The latency is measured from the time each packet leaves the PDCP layer of The NB to when it is received successfully at the PDCP layer of the receiving UE. This means it is the latency of the packets received correctly only. Moreover, the forwarding latency on the X2 link, the queuing time in the RLC buffer, and the handover latency are included [4].

Table 3 : LTE & 5G Maximum Latency Values in ns

Mbps	LTE (ns)	5G DC (ns)
5	3,499,925	4,534,812
10	3,499,884	41,310,777
25	3,500,135	25,225,352
50	3,533,036	2,798,737
70	3,536,302	3,965,737
75	3,601,796	6,348,963
100	868,389,580	52,404,041
200	1,393,512,805	191,215,889

The latency values of both networks under different data rates values are averaged. Similarly, to the throughput case, the latency values of the LTE network are stable with almost no differences till the 75 Mbps data rate point. However, the 5G values vary enormously. Below the 75 Mbps point, the 5G network delay values vary and present high delay values sometimes (ex: 10Mbps point), this can be caused by the high error rate values due to interference and low SINR. Above the 75 Mbps point, the latency values of the LTE network soar and rise to around 500 times the values less than the 75 Mbps point as can be seen in Table III. This is mainly caused by the buffering in the LTE network. So, in both cases (throughput and latency) the turning point is the 75 Mbps data rate since after this point the 5G network performance is much better in both cases.

3. PERFORMANCE EVALUATION FOR MULTIPLE USERS WITH MULTIPLE SPEEDS

In the previous section, the performance of both LTE and 5G mmWave DC networks were simulated using one UE. Despite the importance of this simulation to see the limits and ideal performance of the networks, it does not reflect a realistic indicator of the performance. Many factors are not taken into consideration while simulating for one UE only, like self-interference, high data rates, and control messages. Furthermore, the transportation parts will be highly affected when using a high number of users [9]. Therefore, in this section, several simulations will be performed using different numbers of UEs to examine the impact of increasing the number of UEs on throughput and latency. The simulation parameters are similar to the ones in section 3 with the main difference in the number of UEs used. A representation of the initial state of the simulation with the location of all UEs, buildings, and base stations can be seen in Fig 3.

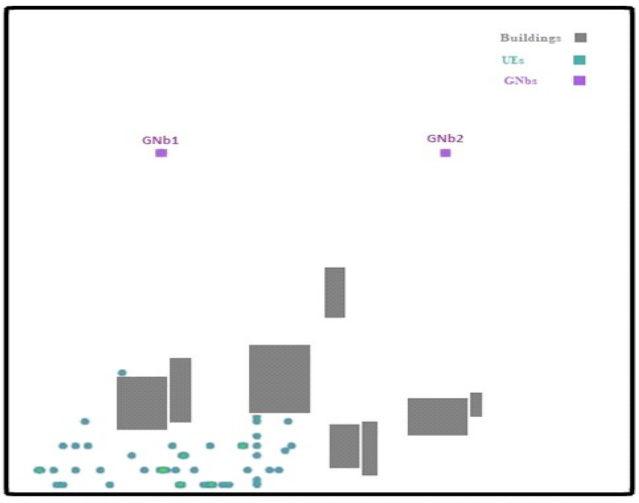
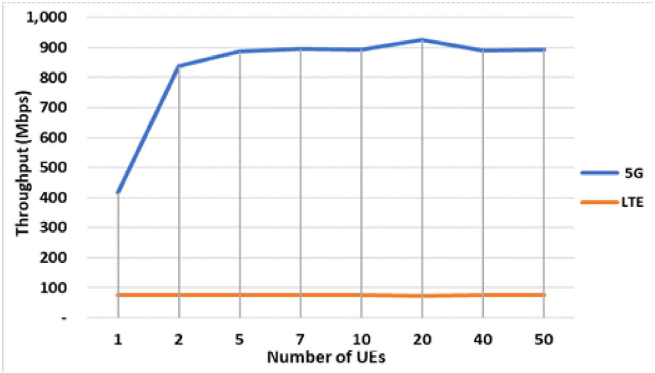


Fig.3 : The initial state of the simulation scenario

3.1 Simulation parameters

Different number of users were simulated (from 1 to 50 UEs) under the same scenarios in both networks to observe the performance variation of each network and each UE. We selected the 50 UEs to be the maximum number of UEs because we believe that in actual networks this number represents the maximum number of UEs that could be active simultaneously in this size of an area. Based on the previous simulation, the 1 Gbps data rate was selected since it is more than the max throughput. Moreover, since mobility affects performance [12], both the high and low mobility cases were simulated to see whether similar effects on both technologies will occur or not.



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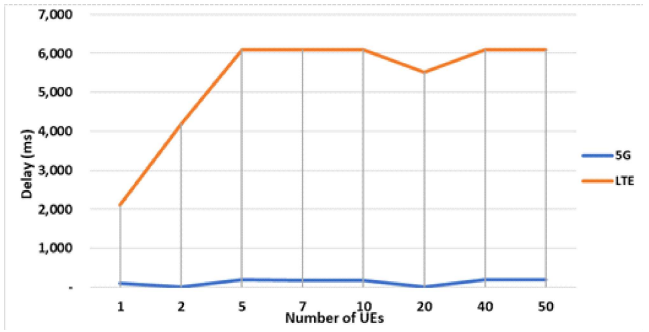


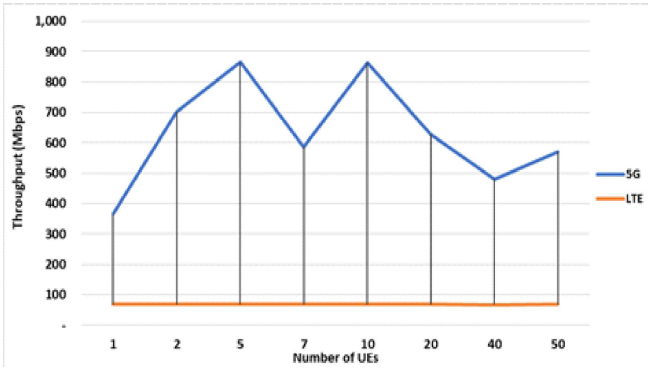
(b)

Fig. 4. : The throughput and delay of both LTE and 5G DC networks for different users (speed 1m/s)

3.2 Simulation results and discussion

In this simulation, the throughput and latency of both networks will be investigated and compared. Also, the effects of the number of users and UE speed will be checked.

a) Case 1 (Low mobility): For the low mobility, 1 m/s speed is used. The results for both latency and throughput are obtained. The results are as follows: The overall performance is similar to the case of one user in very high data rate cases as can be seen in Fig 4. Where the 5G network outperforms the LTE in both latency and throughput. Here, it is more obvious since the 5G network throughput reached much higher levels (double) than in the case of one user. This is due to the fact that the network resources and capacity are divided among a number of users. So, any limitation from the UE side will not affect the whole network performance. On the mobile station level, there might be some decline in the throughput value due to congestion or/and interference, but on the network level, the throughput will not change. From Fig. 4(b) it is observed that the latency of the LTE network becomes much worse because the LTE network is not designed to handle big amounts of data (around 1 Gbps). Which causes more buffering, data loss and data retransmissions.



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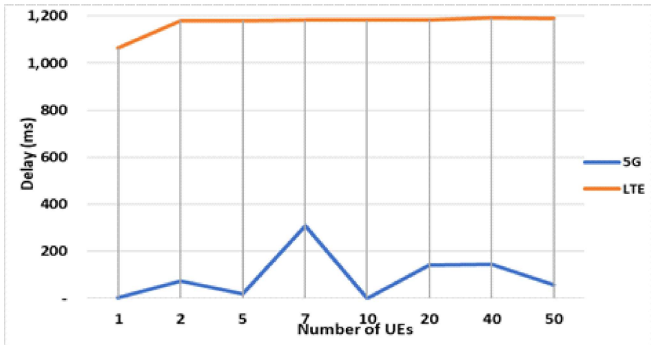


(b)

Fig. 5 : The throughput and delay of both LTE and 5G DC networks for different users (speed 25m/s)

b) Case 2 (High mobility) : in the high mobility case, the 25 m/s speed is used. The throughput results are demonstrated in Fig 5(a) and the latency in Fig 5(b). From the two Figures 5(a) & 5(b) it is also noticed that the 5G superiority above LTE network is obvious in terms of latency and throughput.

In case of a high number of users (5 and more). There is no direct relation between the number of users, the overall latency, and the throughput of the two networks as shown in figures 4 & 5. In the LTE network, the overall performance is stable in all cases with almost an overall variation of about 0.5 Mbps between the best and worst case in throughput and around 500 ms in latency. While in 5G the performance fluctuates randomly in both the latency and throughput which can be explained by the radio channel vulnerability for any obstacle.

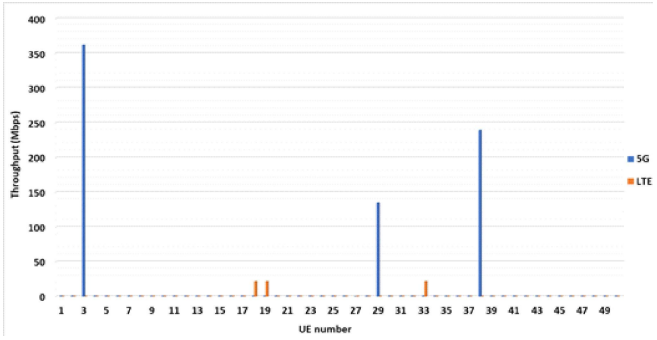
c) Case 3 (Fixed number of users): The case of a fixed number of users (20 UEs) with random UE movement speeds was also simulated. The results are illustrated in Table IV. It is easily noticed that the LTE is almost not affected by the speed. However, 5G is highly affected and this agrees with the previous results from the high and low mobility scenarios.

Table 4 : Throughputs for 20 UES with Different Movement Speeds

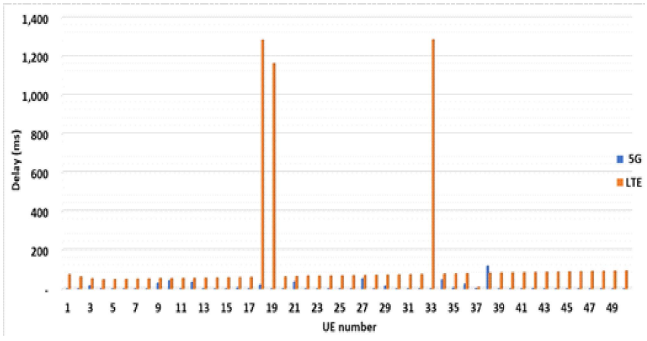
Scenario	LTE (Mbps)	5G DC (Mbps)
1	74.4	942
2	74.3	830
3	74.3	973
Average	74.3	915

Performance per user: All the simulations performed earlier are the network's performance for multiple users. The results show that the 5G network is much better, and this is expected since that is the reason behind designing it. However, we extracted the performance values of each user among the 50 users moving at a speed of 25 m/s to see the individual performance of each UE under different RATs (the scenario parameters were the same in both cases). The results are shown in Fig. 6.

d) From Fig 6(a) it is seen that although the 5G network throughput is higher than the LTE one. There are minimum 3 cases (users 18, 19, 33) where the UE using the LTE network has higher throughput. This is due to several factors like SINR, UE capacity, and UE requirements. Also, there are only 3 users (3, 29, 38) who used 95% of the total throughput. This means that these three users needed this kind of very high throughput while the rest 47 users did not (their throughput is very small compared with the 3 with the very high throughput but it is not zero). So, using the 5G technology is not needed and the LTE would be sufficient. Also, in the latency, there is a case where the UE under the LTE network coverage has a smaller latency value compared with a UE using the 5G network (UE 38). This can occur in rare cases where the 5G network suffers from very bad signal strength or quality. While the LTE's signal is much better



(a)



(b)

Fig. 6 : The 2 systems throughput and delay values for 50 users when the UE moves at a speed of 25 m/s.

4. COMPARISON WITH SIMILAR WORK

The authors in [13] made also a comparison between different DC schemes and between LTE and 5G. However, there are major differences between our work and the work conducted by them. The parameters and numerologies are abbreviated in Table 5.

Not only many parameters and numerologies are different, also the methodology used. They have done two types of simulations. First, they made the data rate used fixed to 150 Mbps, and increased the file size up to only 100 Mbyte to observe the delay values. This values actually are not enough and will not reflect the real networks behavior because: (i) the data rate is considerably low and this value is supported by the already used LTE DC networks; (ii) the file size is small and the required time to fully transmit it is small which will not allow us to observe the real network performance.

Second, they fixed the file size to 66 Mbyte, and increased the data rate up to 350 Mbps. Also, the values here are small and will not allow us to exploit the full potentials and capabilities of both networks.

And in both simulations, they used only one stationary UE with one BS, which means no handovers or radio channel quality variations, hence it will not show the actual network and UE behaviors.

While in the work done by us, we used multiple moving UEs with two mmWave gNBs and one LTE eNB. We also varied the data rate used and make it up to 100 Gbps with continuous data streaming (not only a small size file) which will show more realistic behavior.

5. CONCLUSION

In this paper we have performed a deep and thorough comparison between the performance of the LTE and 5G networks. A less thorough comparison has been done in [13]. As a results of the performance simulation, 5G network proved its superiority above the LTE network and outperformed it in terms of throughput and latency, especially in the case of multiple users. However, this supremacy on the network level does not mean that all the UEs using the 5G technology will have better performance than the ones using the LTE network. The UEs with normal day-to-day utilization like browsing, chatting, video streaming, and any other usage which is not very high data consuming do not need a 5G connection. In fact, supporting all the users (with low and high data demand) is a very time, money, and effort consuming process. Also, the high number of users will affect the ones with the real need for the high data rates negatively and

Table 5 : Comparison Between Our Work and The Work in [13]

	Our work	The work in [13]
Module	NS3 NYU	NS3 NYU
Scenario	Street Canyon	Not mentioned
X2 Latency	500 μs	20 ms
P2P Delay	10 ms	20 ms
Bandwidth	1 GHz	1 GHz
Center frequency	28GHz, 73 GHz	28GHz, 73 GHz
LTE Bandwidth	20 MHz	20 MHz
DC	LTE-mmWave	LTE-mmWave & mmWave-mmWave
HARQ	Enabled	Enabled
RLC AM	Enabled	Enabled
UE Speed	Varying	No movement
Data amount	Unlimited	Limited
Number of UEs	Up to 50	1
Protocol	UDP	UDP

will reduce the available resources for them, while the regular users can use the resources of the LTE network which is already deployed and capable of satisfying their needs.

Therefore, and based on the simulations results, it is suggested to divide the UEs based on their categories, requirements, and SINR values (all of these are reported to the network periodically). Based on these divisions, the network decides the preferred RAT for each UE. The LTE network should be the default and preferred network for all devices with usual daily needs (data rate requirements lower than 75 Mbps), low 5G SINR and good LTE SINR and use the Fast Switch (FS) in case of a need for a higher data rate to perform a handover to the 5G network. This will increase connection reliability, reduce energy consumption and help avoid 5G network congestion, especially in early deployment stages.

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STUDY ON VALUE OF MATERIAL SCIENCE IN THE FIELD OF INDUSTRY

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ABSTRACT

The name pig iron originated in the early days of iron ore reduction when the total output of the blast furnace did sand and cast in to pigs-a mass of iron roughly resemble a reclining pig. Pig iron produced in blast furnace is the first product in the process of converting iron ore in to use full metal. It has following composition approx. carbon 3-4%, Phosphorous 0.3-1.7%, and silicon 1-35, sulphur less than 1.0% manganese 0.1 to 1%, and iron remainder mm$^{2.}$ Pig iron partly refined in a cupola produce various grades of cast iron, by puddling orshotting processes, wrought iron is produced from pig iron. Steel is produced from pig iron by various steel making processes such as Bessemer, Open Hearth, Oxygen; Electric furnace etc. Carbon is free form that is as graphite imports softness and course crystal structure to metal. Carbon is combined form that is as cementite and pearlite makes the metal hard and gives fire grained crystalline structure. In this study, we look into the production process of pig iron, wrought iron and cast iron, their properties and their wide range of application in the industry.

Keywords: *Pig iron; Wrought iron; Cast iron; Furnace*

1. PIG IRON

1.1 Production of Pig iron

To separate pig iron from its ore following three operations are done on iron ore.

a. Dressing of iron ore.

b. Roasting and Calcination.

c. Smelting.

- For dressing of iron ore, it is first broken in to small pieces 2-5 cm. After that a strong stream of water is applied on broken ore so that the impurities in the ore such as sand, clay, sand particles etc. to be separated out.
- These impurities are in the category of gangue materials.
- Then this ore is passed through magnetic separators so that the other impurities like small iron pieces are separated out. Thus, the process needed to separate out the impurities is known as concentration.
- After completion of concentration, the roasting and calcination of ore is done. During this process, the iron ore is seated to a temp below its MP in presence of air so that the

impurities like sulphur, arsenic etc. are separated in to its oxides.

- Like this, gaseous substances and volatile materials are separated. In the end smelting of iron ore is done and pig iron is separated out. The furnace used for separation of pig iron from its ore is known as blast furnace.

1.2 Blast furnace plant

The following units are included in blast furnace plant (Figure 1): -

- Blast furnace
- Appliance for charging iron ore, coke and flux on the top of furnace.
- Blowing engine for sending blast of air.
- Stores for heating of air.
- Pumping devices for pumping water for cooling of furnace walls.
- 6 -Appliances for cleaning blast furnace gas.
- Plants for generating electric power from blast furnace gas.
- Appliances for disposal of pig iron and slag from ores.

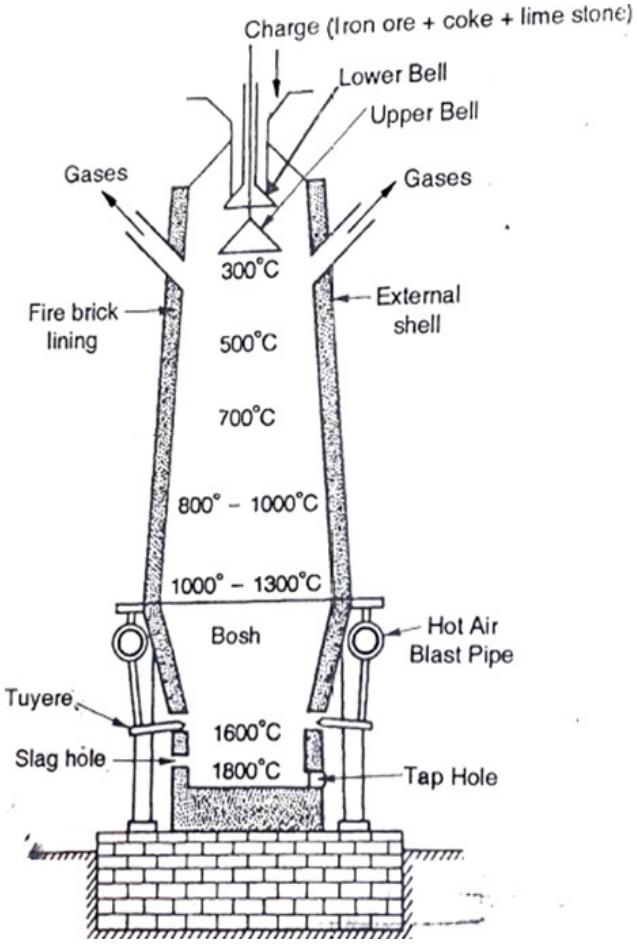
1.3 Working of Blast Furnaces

- The charge [iron ore + coke + flux] is prepared in a proper ratio and it is charged into furnace by a double cup and core arrangement.
- The charge delivered through head of furnace falls slowly into stack.
- The hot air in the furnace is supplied through tuyeres and it is used for combustion of coke. Thus, the furnace is lit. The temp developed in the bottom of the furnace varies from 1350°-1600° Centigrade.
- The carbon present in coke acts like a reducing agent and reacts with iron ore.

The following chemical reaction completes the reaction of iron ore: -

$$3Fe_2O_3 + C = 2Fe_3O_4 + CO$$

$$Fe_3O_4 + 4C = 3Fe + 4CO$$



- The CO gas produced further reacts with iron ore by following chemical reactions: -

$$3Fe_2O_3 + CO = 2Fe_3O_4 + CO_2$$

$$Fe_3O_4 + 4CO = 3Fe + 4CO_2$$

- The charge admitted through top of furnace gets melted while travelling down in the furnace.
- The molten iron and slag are collected in the bottom zone.
- The slag is collected over the molten iron being lighter than molten metal.
- The slag is taken out through its opening.
- The molten iron is taken out of the furnace through its tapping hole and is used to prepare castings.

1.4 Flow Diagram of Production of Pig Iron

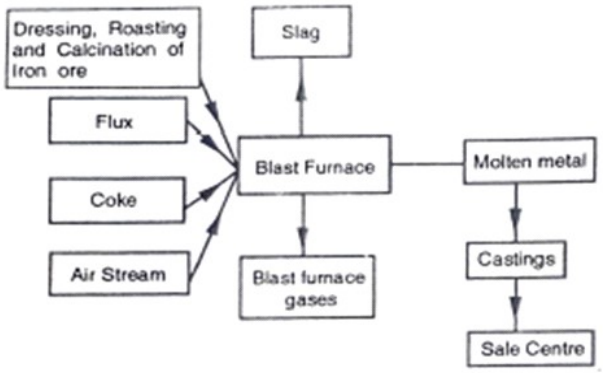


Fig 2: Flow of production of Pig Iron

2. CAST IRON

The cast iron is obtained by melting pig iron with coke, lime stone and steel scrap in a furnace known as cupola. It is primarily an alloy of iron and carbon. The carbon percentage varies from 1.7 to 4.5 %. It also contains small amount of silicon, manganese, phosphorous and sulphur.

2.1 Properties

- It is brittle.
- It is weak in tension so it cannot be used for making bolts and machine parts which are liable to tension.
- It is having low cost.
- It has good casting characteristics
- High compressive strength.
- High wear resistance.
- Excellent machinability.
- Tensile strength 100-200 MPa.
- Compressive strength 400-1000 MPa.
- Density 6.8 to 7.8 gm/cm^3
- Melting point is 1150^o to 1200^o C.

2.2 Effect of constituent on Cast Iron

1. Carbon : It reduces the melting point. Pure iron has melting point of about 1500^o C but iron with 3.5% carbon has melting point of about 1350^o C. When carbon is in free form that is as graphite the resulting cast iron is known as grey cast iron. When carbon is in combined form, the cast iron will be hard and known as white cast iron.

2. Silicon: It helps to reduce the shrinkage in cast iron.

3. Manganese: It reduces the harmful effects of sulphur by forming compound manganese sulphide which is not soluble in cast iron. Manganese also helps the carbon to remain in the combined form.

4. Phosphorous: It increases the brittleness and reduce the strength of cast iron when content is above 0.3%. It affects the fluidity as well as shrinkage.

5. Sulphur: It hardens cast iron thereby counteracting the softening influence of silicon. It decreases the strength fluidity and increases brittleness. It promotes oxidation of cast iron. Hence, it is desired to keep sulphur content as low as possible.

2.3 Manufacturing of Cast Iron

The principle of working is same as of blast furnace.

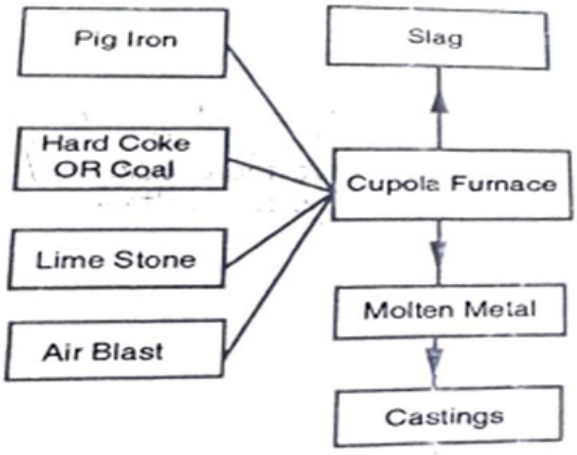


Fig 3 : Flow diagram of manufacturing of cast iron

- First of all, combustion of coke in cupola starts from its bottom and with the strong stream of air this combustion takes place. Thus, some quantity of coke is burned before the charge is dropped into furnace.
- The oxidation of impurities in pig iron takes place by strong stream of air. By complete

combustion of coke, a high temperature and heat is produced.

- The hot gases rise up and heat of hot gases is used to melt the pig iron.
- Within a period of 10 minutes pig iron starts melting and molten metal is collected at the bottom of the furnace. The temp of molten metal varies from 1200° -1400° C. The temp in cupola varies from top to bottom. It is more in melting zone (1550° C – 1650° C)

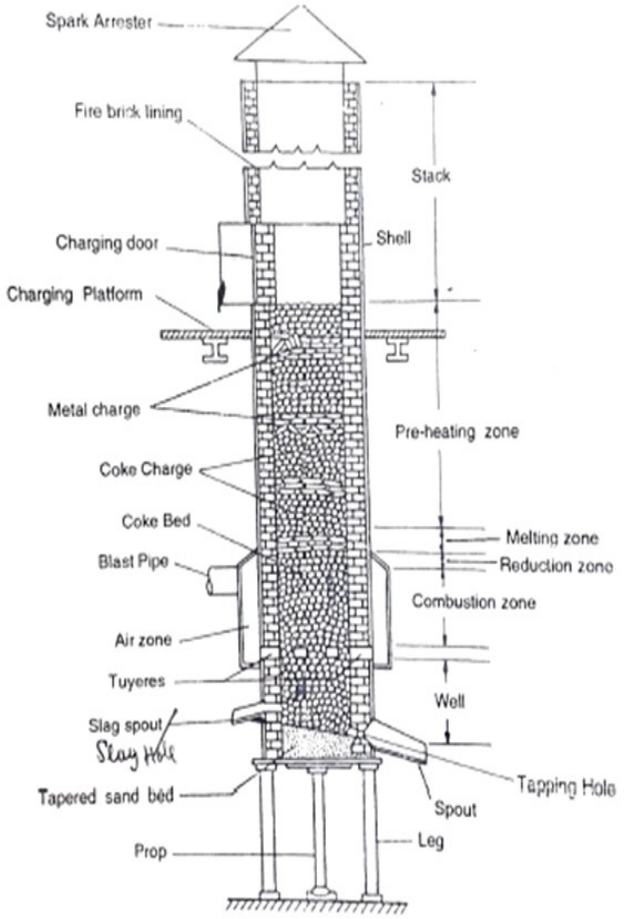


Fig 4. Cupola Furnace

3. Description of Cupola Furnace

1. **Shell:** Shell is vertical and cylindrical in shape. It is made with steel sheet 6 to 12 mm thick and lined inside with refractory bricks and clay. Refractory bricks and clay used for cupola lining consists of silica (SIO_2) and Alumina (Al_2O_3). Cupola diameter varies from 1 to 2 metres and the height is 4 to 6 times the diameter.
2. **Foundation:** The shell is mounted either on a brick works foundation or on steel columns. The bottom of the shell consists of a drop bottom door, through which debris consisting of coke, slag etc. can be discharged at the end of a meeting.
3. **Tuyers:** Air for combustion of fuel is delivered through the tuyers which are provided at the height of between 0.6 to 1.2 metres above the working bottom.
4. **Wind belt:** The air is delivered to the tuyers from a wind belt which is a steel plate duct mounted on the outer shell of the cupola.
5. **Blower:** A high pressure fan or blower supplies the air to the wind belt through a bast pipe.
6. **Slag hole**: It is located at a level about 250 mm below the centres of the tuyers. It is used to remove the slag.
7. **Charging Door**: It is situated 3 to 4 metres above the tuyers. Through this hole, metal, coke and flux are fed into the furnace.
8. **Chimney or Stack:** The shell is usually continued for 4 metres to 5 metres above the charging hole to form a chimney.

3.1 Zones in Cupola

The entire section of cupola is divided into the following zones:

1. **Crucible Zone**: It is between top of the sand and bottom of the tuyers. The molten metal accumulates here. It is also called the 'well'.
2. **Combustion or Oxidizing Zone:** It is situated normally 150 to 300 mm above the top of tuyers. Heat is evolved in this zone because of the following oxidation reactions:

$$C + O_2 \rightarrow CO_2 + Heat$$

$$Si + O_2 \rightarrow SiO_2 + Heat$$

$$2Mn + O_2 \rightarrow 2MnO + Heat$$

$$Fe + O \; FeO + Heat$$

3. **Reducing zone**: This zone starts from the top of the combustion zone and extends upto the top of the coke bed. In this zone, the reduction of CO_2 to CO occurs and temperature drops to about 1200° C.

$$CO_2 + C(coke) \rightarrow 2CO - Heat$$

4. **Melting zone**: The zone starts from the top of the coke bed and extends upto a height of 900 mm. The temperature in this zone is highest approx. equal to 1600° C.

$$3Fe + 2CO \rightarrow Fe_3C + CO_2$$

5. **Preheating Zone or Charging Zone**: It starts from the top of the melting zone and extends upto the charging door. Charging materials are fed in this zone and get preheated.

6. **Stack zone:** It starts from the charging zone and extends upto the top of the cupola. The gases generated within the furnace are carried to the atmosphere by this zone.

4. Types of Cast Iron

a. Grey cast iron

- It is basically an alloy of carbon and silicon with iron.
- Contains 2.5 to 3.8% C, 1.1 -2.8% Si, 0.4-1% Mn,0.15% P and remaining iron.
- It is marked by the presence of flakes of graphite.
- Graphite flakes occupy 6-10% of the metal volume.
- Molten fractured grey cast iron gives grey appearance.
- It has a solidification range of 2400°-2000° F.

Mechanical Properties:

- High compressive strength 600 to 750 N/ mm^2.
- Low tensile strength and high rigidity.
- Hardness ranges from 150-240 BHU.
- Low tensile strength, High rigidity,
- Hardness ranges from 150-240 BHN.

Casting properties:

- Possesses high fluidity and hence it can be casted into complex shapes and thin sections.
- It has lowest melting point of ferrous alloys (1130°-1250° C).

Machinability:

- Better machinability than steel. Produces discontinuous chips.

Special properties:

- Possesses high vibration dumping capacity. Good anti friction properties

Applications:

- Machine tool structure.
- Gas or water pipes for underground purposes.
- Man hole covers.
- Piston rings.
- Transformer electric motor.
- Cylinder blocks and heads for IC Engine.

b. White cast Iron

- White cast iron derives its name from the fact that its freshly broken surface shows a white fracture.
- It is very hard and brittle hence machining can't be done easily. [400 to 600 BHN].
- Possesses excellent resistance against wear
- Solidification range 2550-2065 F
- The flow ability of molten metal is low, so it takes more time in filling of moulds.
- Unlike grey cast iron, white cast iron has almost all its carbon chemically bonded.

Composition

- Iron 94%
- Graphite carbon=0.5%
- Combined carbon=3.5%
- Other impurities=2%

Application

- For producing malleable iron castings.
- For manufacturing those component parts which require a hard abrasion resistant material.

c. Mottled Cast Iron

- It is a mixture of two types of cast iron.
- The grey cast iron and white cast iron both are found in it.
- It's strength and hardness depend upon the ratio of free carbon and combined carbon.
- The rust formation in it is lesser then grey cast iron.
- It is hard and brittle.

Composition

- Iron =93.5%
- Graphite carbon=1.75%
- Combined carbon=1.75%
- Other impurities=3%

Application

- It is used for hardware
- In the production of man hole covers and pipe.

d. Malleable cast iron

- It can be hammered and rolled to obtain different shapes.
- It is obtained from hard and brittle white iron through a controlled heat conversion process.
- It possesses high yield strength.
- It has high young modulus and low coefficient of thermal expansion.
- It has a solidification range of 2550 -2065 F.
- It has low moderate cost. It contains 2-3%C, 0.6-1.3% Si, 0.2-0.6% Mn,0.15%P and 0.10% S.
- It possesses good wear resistance and vibration damping capacity.
- It has a tensile strength of approximate 3800 kgf/cm2.

Applications

- Automobile industry
- Tractor springs
- Gear case
- Universal joints
- Automotive crankshaft

e. Modular cast iron (Ductile cast iron)

- Unlike long flakes as in grey cast iron, graphite appears as rounded particles or modules or spheroids in modular cast iron.
- Ductile cast iron possesses very good machinability.
- It contains 3.2-4.2% C, 1.1 TO 3.5% Si, 0.3-0.8% Mn, 0.08%P and 0.25 S.
- It possesses damping capacity intermediate between cast iron and steel.
- It possesses excellent castability and wear resistance.
- If small quantity of magnesium is added to cast iron the graphite content the graphite content is converted in to modular spheroidal form.

Applications

- Paper Industry machinery
- Internal combustion engine
- Power transmission equipment
- Valves and fitting
- Steel mill rolls and mill equipment

f. Mechanite cast iron

- It is essentially a grey iron containing free graphite which is graphitized in a controlled manner in the ladle.
- Calcium silicide acts as a graphitizes.
- The basic grey iron which is graphitized to obtain mechanite metal possesses low

silicon content and moderate carbon content 2.5 to 3%.

- Mechanite metal possesses certain highly desirable engineering properties.
- Mechanite can retain a high proportion of its strength from 32° F and 752° F and thus can be used in installations involving the use of superheated steam or hot gases.
- The machinability of mechanite is one of its most valuable property.
- Machinability of mechanite castings may be improved by lower high temperature annealing.
- Internal stresses developed in mechanite castings due to varying cooling rates during solidification in the mould may be relieved by annealing.

g. Alloy cast iron

- A large number of alloy cast iron have been developed to overcome deficiencies in ordinary cast iron and to give qualities more suitable for special purposes.
- Alloy are added to improve strength, corrosion resistance and ability to withstand shocks.
- The most important alloying elements are nickel, chromium, molybdenum and vanadium.

Nickel

- Nickel up to 5% is added to cast iron to increase hardness and strength.

Chromium

- Chromium up to 3% is added to cast iron to promote the formation of carbide and inhibits the formation of graphite. It also increases corrosion resistance.
- The metal structure becomes graphitized by nickel and carbides are formed by mixing chromium.
- By mixing molybdenum the small spheroidal particles of graphite are formed and size of grains becomes fine resulting in increase of strength and hardness.

3. Wrought iron

- Wrought iron is virtually pure iron, containing a large number of minute threads of slag lying parallel to each other, thereby giving the metal a fibrous appearance when broken.
- It practically contains no carbon and therefore does not harden when quenched in water

a. Composition

C = 0.02 – 0.03%

P = 0.05 – 0.25%

Si = 0.02 – 0.10%

S = 0.008 – 0.02%

Mn = 0 – 0.02%

Slag = 0.05 – 1.5%

Iron = remainder

b. Properties

- Wrought iron is never cast. All shaping is accomplished by hammering, pressing, forging etc.
- It is noted for its high ductility and for the ease with which it can be forged and welded.
- It has high resistance towards corrosion.
- It possesses the property of recovering rapidly from overstrain, which enables it to accommodate sudden and excessive shocks without permanent injury. It has high resistance towards fatigue.
- Structurally, wrought iron is a composite material; the base metal and the slag are in physical association, in contrast to chemical or alloy relationship that generally exists between the constituents of other metals.
- Melting point 1510° C

3. MANUFACTURE OF WROUGHT IRON

The production of wrought iron involves more labour and it is a costly process. The following four operations are required in its production.

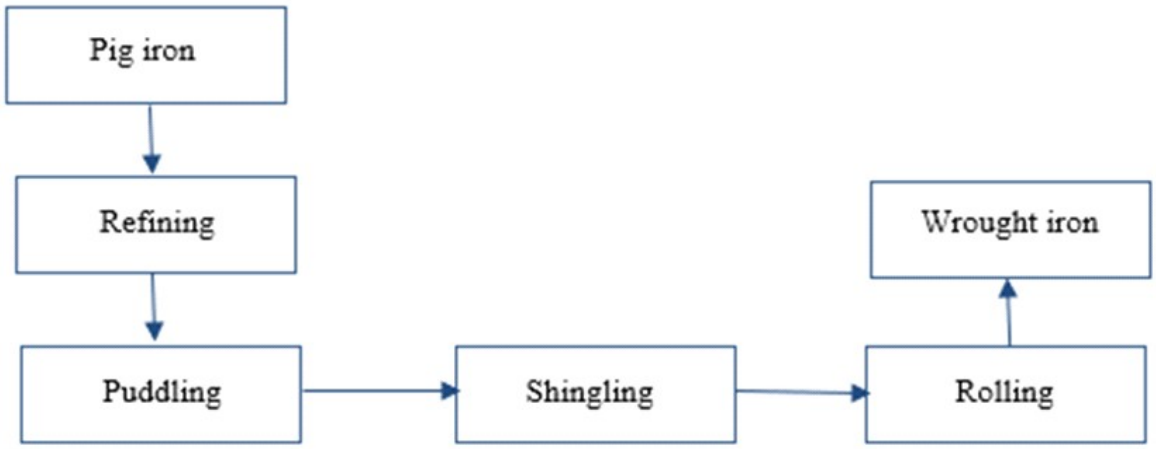


Fig 5. Flow diagram

- Refining
- Puddling
- Shingling
- Rolling

Applications

- Building Construction: Underground service lines and electrical conduct.
- Public work: Bridge railings, drainage lines, sewer, outfall lines
- Industrial: Condenser tubes, heat exchangers, acid and alkali process lines.
- Rail road and marine: Diesel exhaust and air brake piping, tanker heating coils etc.

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★★★★★

PRO-ACTIVE LEARNING SYSTEM FOR RAPID RESPONSE EMERGENCY VEHICLES

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ABSTRACT

In transportation domain, rapid response emergency vehicles are prone to delay due to distance from target emergency site and traffic on roads. According to various surveys, many time-critical patients die every year due to the delay in their transportation to hospitals; infrastructure, valuable resources as well as human lives are lost due to delay in arrival of rapid response vehicles like fire trucks, ambulances and police vans to emergency sites. Conventionally, the delay may be reduced or overcome by constructing special emergency lanes reserved for these emergency vehicles, but the solution will be infeasible in under-developing countries like India due to additional space required, costs involved as well as under-utilization of emergency lanes most of the time. This work primarily focuses on delay issues faced by rapid response emergency vehicles and existing as well as proposed solutions to overcome these issues.

Keywords : *Alerting system, Emergency vehicle, Pro-active.*

1. INTRODUCTION

The transportation of people, services, and goods to/from emergency sites requires availability of rapid response Emergency Vehicles (EVs). These emergency vehicles are usually delayed due to distance from target emergency site and traffic on roads. Based upon existing surveys, it is observed that many time-critical patients die every year due to the delay in their transportation to hospitals; infrastructure, valuable resources as well as human lives are lost due to delay in arrival of EVs like fire trucks, ambulances and police vans to emergency sites.

The delay may be reduced or overcome by constructing special emergency lanes reserved for these emergency vehicles, but the solution will be infeasible in under-developing countries like India due to additional space required, costs involved as well as under-utilization of emergency lanes most of the time. A much viable solution in use is installation of sirens, flashlights, labels and unique colors for these emergency vehicles to alert other vehicles on road about their presence and immediate passage requirement to reach some target emergency site or destination without delay or with minimum possible delay. The success of this solution depends upon the attentiveness and willingness of other vehicle drivers, time available

to free lane and amount of traffic on road. Most of the time, normal vehicle drivers remain unable to hear sirens from distance, and fails to quickly free lane for EVs even they are willing to cooperate. Sometimes, traffic police persons or other people try to help EVs to pass through the traffic with minimum delay, but it is not always an efficient and reliable solution.

Some technology based systems are also present that offers priority passage to EVs on traffic lights or congestion detection for route optimization, but are not much viable and delay reducing as required. In order to overcome the problem of delay in time-critical emergency transport services, there is a need to develop a system and method for delay reduction in rapid response EVs.

2. BACKGROUND

Kapileswar Nellore et al. [1] proposed an emergency vehicle scheduling approach, while vehicles are in traffic. This approach is combination of distance measurement between the intersection and emergency vehicles through methods of visual sensing, counting of vehicles and time-sensitive alerting transmissions within the sensor networks. The calculation of distance between intersection and emergency vehicle for comparison is performed with the help of Canberra, Manhattan and Euclidean distance techniques.

Shuvendu Roy et al. [2] proposed another approach to detect the EV from CCTV footage of the road. The CCTV camera takes images on regular intervals i.e. every second for on road vehicle detection. The detected vehicle is classified as emergency vehicle or regular vehicle. A system notification can be sent to concerned traffic police staff or some autonomous device to provide quick passage to the emergency vehicle. The proposed system produced better results with image dimension 64 × 64.

In another work, a multi-objective optimization evaluation model is proposed by Cai Wenxue et al. [3] to select optimal route considering the minimal cost, minimum travel time, and smallest traveling risk probability. TSP is used to solve path selection problem for the emergency vehicles. Different mathematical models are also provided to solve the problems of economy, safety and timeliness.

Fahad Memon et al. [4] classified two communication systems: Vehicle-to-Vehicle(V2V) and Vehicle-to-Infrastructure(V2I). The initial route selection offers are provided for vehicle depending upon congestion on route alternates available at initial level. The safe, easy and smooth passage of emergency vehicle is with the selection of optimal route having low congestion. For assistance during emergency and rescue operations, the emergency vehicle selection is made using sensors-based monitoring.

Lennéet et al. [5] examined the Advance Warning Device (AWD) effects on driver interactions. The prime intention of the work is to make provision of an AWD system for emergency vehicle drivers within small radius of few hundred meters, and audio video warnings whenever in range. A combination of different scenario types like turning across, adjacent lane, warning condition control and car following is considered.

Sumiet et al. [6] introduced an IoT and VANET fusion framework for prioritization of emergency vehicles to provide safe passage on road. The real-time information of traffic is used to find the best possible (nearest) path to destination for emergency vehicles like ambulances.

Jordanet et al. [7] evaluated and tested another strategy that enables the navigation of emergency vehicles through congested intersections in an efficient manner. A strategy involving V2V communication is used for sending messages for alerting on road vehicles through specific instructions to give earlier passage to emergency vehicles on intersections. The work claims reduced travel time for emergency vehicles intersections with signals having congestion.

Mooreet et al. [8] examined the localization issues of emergency vehicles. A combinatory approach to provide different auditory cues sequence to drivers along with in-cabin alerting is used whenever another emergency vehicle comes closer. It reduces spatial ambiguity of present frequency siren tones, while two-way alerting-

external and internal is provided to the drivers of emergency vehicles. The drivers gain awareness of incoming emergency vehicle and prompt response with sufficient sound localization.

3. PROPOSED SYSTEM

The proposed work relates to the delay reduction method for transport of rapid response emergency vehicles like police cars, fire trucks and ambulances. The delay reduction method comprises the installation of LED displays and sirens on road side poles, activating relative displays pro-actively, displaying real time emergency vehicle information like distance and probable amount of time to reach there, and sirens sound with different intensity depending upon the emergency vehicle distance from respective pole. Figure 1 illustrates a block diagram of system and method.

The proposed alerting system consists of three key sections: Rapid Response Vehicle, Centralized Control Room and Emergency Alerting System (on road). The on road system nodes are not limited to motor vehicles only. There can by people on walk or bicycles.

The rapid response vehicle (or emergency vehicle) may be an emergency vehicle transferring some patient from one place i.e. home, hospital or accident site to another place i.e. hospital or relief camp. It may be also a fire truck, police car or similar vehicle which wants to go through the existing road traffic with minimal possible delay.

The emergency vehicle is equipped with a transceiver to communicate with server, and a touch screen panel to activate/deactivate emergency service, choose optimal route out of routes provided by server, and communicate with central control room as and when required.

The centralized control room consists of a server and LED Display and Siren Controller. The server runs entire application to provide communication with emergency vehicle driver to know its emergency service status, provide optimal path support, and support whenever required.

LED Display and Siren Controller takes information from server to control and monitor the LED displays and sirens installed on road. It takes the emergency vehicle driver's chosen path information from server, and activates respective LED displays and sirens on the relevant path through the Master Node.

In proposed system, the LED display and siren master node controls multiple LED display and siren nodes connected to it. It is a powerful node as compared to normal nodes that only display data receiver from master node on LED displays and change intensity of sirens. There are multiple master nodes installed on roads to cover different paths as well as control multiple normal nodes simultaneously.

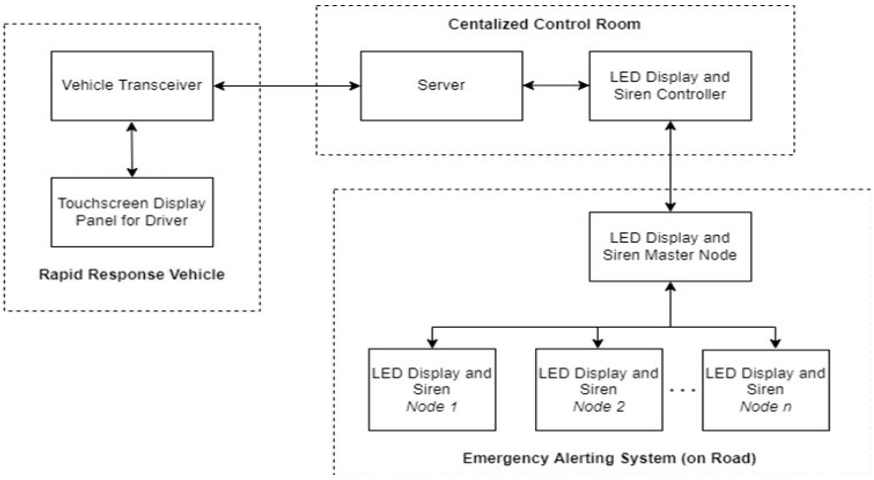

Fig.1: Block Diagram of Proposed Emergency Alerting System

The normal LED display and siren nodes are used to display the information to drivers of vehicles and people on road. It actually alerts them to free the emergency lanes for faster passage of emergency vehicles.

4. FUTURE TRENDS

A pro-active alerting system and method for rapid response emergency vehicles like police cars, fire trucks and ambulances, and alerts drivers of other vehicles on road to free the emergency lanes well in time based upon the time displayed on LED displays and siren sound intensity for easy and minimal delay passage to emergency vehicles carrying time-critical patients as well as services to emergency sites. The system consists of transceiver devices and touch panels installed in the emergency vehicles, server and controller installed at central office, and LED displays, sirens and microcontrollers installed on roads. The server keeps checking status of emergency vehicles, which activates their emergency service transceiver(s), to provide optimal route choices, and controls the on road infrastructure to alert other vehicle drivers. It gives quick passage to the emergency vehicles, therefore, saves a lot of valuable time, lives, resources and infrastructure. In future, the proposed system may be integrated to smart cities having advanced infrastructure on road to provide smart transportation.

5. CONCLUSION

In this paper, issues faced by present transportation domain specifically related to transportation of rapid response emergency vehicles are discussed. Various solutions to ease traffic through reduced congestion and congestion warning and reduction have been proposed by researchers. Still the unintentional delay due to last minute alerts to drivers of other vehicles where they are unable to provide quick passage to emergency vehicles due to present traffic on road. A pro-active alerting system is proposed to overcome delay through installation of LED displays and control via smart IoT devices to reduce delay upto maximum possible values. The proposed system is a suitable candidate for future implementations of smart cities.

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TWEAK MYOCARDIAL INFARCTION (MI) PROGNOSIS METHODOLOGIES USING RFGS OPTIMIZATION FOR MACHING LEARNING AND HYPER-PARAMETERS

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ABSTRACT

Machine learning algorithms are commonly utilized in healthcare to forecast chronic conditions. The goal of this work is to use the Random Forest Grid Search technique (RFGS) to construct a model for predicting myocardial infarction and compare its performance to that of many other approaches. The model will generate better results if the hyper-parameters are tweaked. We presented the Random Forest Grid Search (RFGS) method for successful hyper-parameter tuning, and this model analyzes enormous volumes of medical data using supervised grid search principles. Over-fitting is avoided by using appropriate features for prediction and hyper-parameter fitting. We also compare the proposed model's accuracy to that of various grid and non-grid models including decision trees, logistic regression, K nearest method and support vector machines. The proposed model has a precision of 98.65%, which is higher than existing models.

Keywords : *Myocardial Infarction (MI); Random Forest Grid search models; non-Grid search models; Machine learning.*

1. INTRODUTION

Cardiovascular disease is the most severe and life-threatening condition that humans can suffer from. Globally, rising incidence of high-mortality cardiovascular disease pose considerable risks and costs to healthcare systems. Men are more likely than women to develop cardiovascular disease, especially in middle-aged and older persons [1] and [2], however, some youngsters suffer from similar health issues [3] and [4]. According to WHO figures, cardiovascular disease is the leading cause for one-third of all fatalities globally. Every year, roughly 17.9 million people die from cardiovascular disease around the world, with a significant prevalence in Asia [5], [6]. According to the European Society of Cardiology (ESC), there are 26 million adults incidence of heart cause of death worldwide, with 3.6 million new cases

identified every year. Half of all heart disease patients die within one to two years of being diagnosed, and heart disease treatment accounts for about 3% of overall healthcare expenditures [7]. Deaths from heart disease increased by 3527 percent in Bangladesh between 1986 and 2006, but deaths from dysentery and respiratory infection decreased by 79 percent and 86 percent, respectively [13]. Predicting cardiac disease necessitates the use of several diagnostics. Inaccurate projections can result from a lack of experience among healthcare specialists [8]. It can be difficult to conduct an early inquiry [9]. Surgical management of heart disease is difficult, even for experienced healthcare providers. Emerging countries lacked the necessary test equipment to properly diagnose and treat heart disease patients [10]. Accurate heart failure risk assessment can help patients avoid serious heart attacks and improve their overall safety [11]. When trained with exact data, machine learning algorithms are effective in recognizing diseases [12]. For cardiac disease prediction, researchers have used a variety of strategies to construct hybrid models and classifiers [14], [15]. Inadequate medical datasets, improper feature selection, Machine Learning algorithms, and a lack of in-depth inquiry are all difficulties that may obstruct reliable prediction of heart disease. This research suggests that using Random Forest with Grid Search (RFGS) algorithms to predict heart disease is a good idea. The suggested technique guards against model over-fitting and erroneous feature selection. Hyper-parameter tuning improves forecast precision substantially. Finally, we evaluated the proposed RFGS prediction model's performance to that of other supervised grid search models such as Decision Tree, Logistic Regression, Random Forest, Support Vector Machine, and K-nearest neighbour. In terms of heart prediction accuracy, the proposed RFGS model beats previous supervised grid search approaches, according to the findings.

The following is the paper's structure: The literature review is included in Section II. Section III contains the proposed model's details, whereas Section IV contains the proposed model's experimental results. The summary of the paper comes to a close in Section V.

2. LITERATURE SURVEY

To forecast cardiac disease, several machine learning and artificial intelligence approaches are used. Inaccurate prediction is caused by inappropriate feature selection for training a model and a lack of preprocessing procedures. Because of the increased precision and efficacy of forecasting, artificial intelligence and machine learning algorithms have been increasingly popular in recent years [16]. DNN and ANN were proposed by A. K. Garate-Escamila et al. [17], with statistical model utilized for predictions. Hungarian-Cleveland datasets were utilized by Harvard Medical School [18] to predict cardiac disease using different machine learning classifiers and PCA for dimensionality reduction and feature selection. Zhang et al. [19], proposed the AdaBoost classifier, which uses a PCA combination as feature extraction and improves prediction accuracy. To extract the key elements of prediction, Singh et al. [20], used the Fisher technique and generalized discriminant analysis with binary classifiers. Chen et al. [21], as a subset of stratified feature clustering, subspace feature clustering was used, and the features of the clusters generated were then decreased. Yang and Nataliani [22], offered a fuzzy c-means clustering technique that could be used with a number of feature weighted approaches and reduced features.

Kumar [23] Predictions were made using a diversity of machine learning methods, and the accuracy of the predictions was compared. For prediction, Rajagopal and Ranganathan [24] presented a mix of probabilistic neural network classifiers. In order to classify clinical data,, Zhang et al. [25] employed a Support vector machine. In this study, Khan and Quadri [26] look at how diverse unstructured data may be analyzed using various data mining approaches. For ECG, Negi et al. [27] PCA was used to demonstrate uncorrelated linear discriminant analysis. To improve accuracy, Dun et al. [28] used a combination of deep learning and ensemble approaches. Guidi et al. [29] Leveraging neural networks, SVM, a fuzzy system technique, and a Random Forest classifier, researchers created a clinical decision support system to predict heart failure. For cardiac disease prediction,

Santhanam and Ephzibah [30] employed regression approaches with PCA in several versions such as PCA1, PCA2, PCA3, and PCA4. Amma [31] trained with a genetic algorithm and classified by neural networks. For extracting key characteristics and classification purposes, Parthiban and Srivatsa [32] employed Naive Bayes and SVM. The cardiac disorders in coal mines were the main focus of Srinivas et al. [33], to classify them, decision trees, Naive Bayes, and neural networks were used. To attain improved accuracy, Das et al. [34] combined SAS-based software with several ensemble approaches. For feature reduction and classification, Asl et al. [35] employed extended discriminant analysis and SVM. For feature analysis, feature extraction based on cardiac murmur frequency was combined with time representation frequency and PCA by Avendano-Valenciaetal [36]. Guyon et al. [37] Book on efficient feature extraction. Many ML and Deep learning benchmark results were based on the UCI Machine Learning Repository [38] dataset.

3. MATERIALS AND METHODS

Data analysis involves automating the development of analytical machine learning models. This field of artificial intelligence is predicated on the notion that computers can learn data, find similarities, and form opinions with little or no manual intervention.

Hospitals now use machine learning to improve administrative procedures, map and treat infectious diseases, and tailor medical treatments. It can also be used to demonstrate and educate patients about disease processes and the ramifications of different treatment options. It's a visual depiction of healthcare machine learning. Machine learning helps diagnose disease and speeds up the research of genetic abnormalities in health informatics. Heart disease detection can be thought of as a binary classification task because there are only two classes: those who have heart disease and those who do not. The classifier will need training data in this case to understand how the input variables relate to the class. The classifier can be used to determine if a patient has heart disease after proper training.

Machine learning algorithms are now trained using three primary methodologies. Learning can be classified into three categories: supervised, unsupervised, and reinforced.

3.1 Supervised Learning

The model is trained by using labelled data-set. It has the input data and its results. Classification and regression are examples of such measures.

3.2 Unsupervised Learning

Data used for training is neither classified nor tagged in the data-set. The aim is to find hidden trends within the data. The model is trained to build models. It can effortlessly foresee covered up patterns for any modern input data-set, but upon investigating information, it draws conclusion from datasets to portray covered up designs. In this procedure, no reactions within the data-set are seen. The clustering strategy is an illustration of an unsupervised learning method.

3.3 Reinforcement Learning

It doesn't utilize named data-set nor are the outcomes related with information, in this manner model gains from the experience. In this strategy, the model further develops its show dependent on its relationship with environment and figures out how to examine its shortcomings and to get the right result through appraisal furthermore, testing different possibilities.

Classification algorithms are often used under supervision of learning techniques to mitigate the likelihood of cardiac illness incident. A block schematic of machine learning algorithms for predicting heart disease is depicted in Fig 1.

3.4 Data Collection

The system's aspects associated with obtaining data, for that we use the UCI repository data-set, which has been exhaustively tested by a number of researchers and the UCI authority. There are 303 instances and 75 attributes in all, however only 14 numerically valued attributes are analysed. There are different aspects of output, with 0 indicating no heart disease and 1 indicating cardiac ailment.

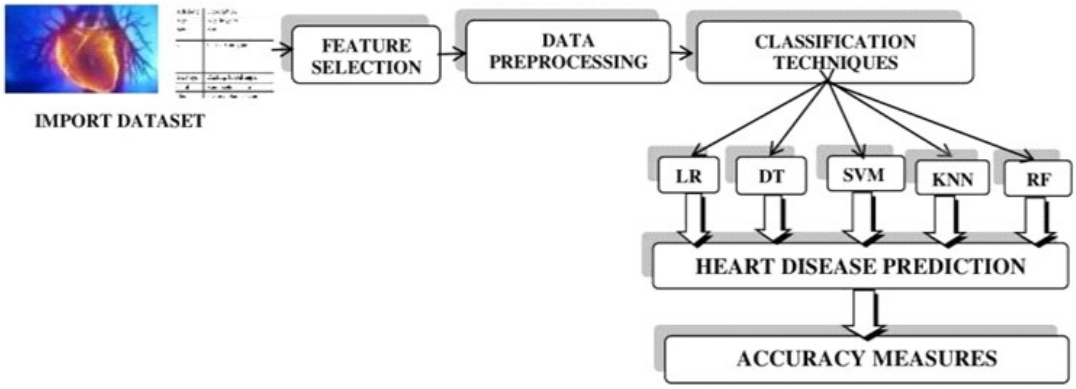

Fig. 1 : Heart Disease Prediction using Machine Learning Algorithms

3.5 Preprocessing of Data

Data that has been pre-processed in order to prepare it for initial processing or further analysis. When numerous steps are required to ensure data for the user, the terminology can be extended to any first or preceding pre-processing phase. Data scaling is a numerical feature pre-processing step. In this scenario, standard scalar is used to generate a standardised distribution with a mean of 0 and a standard deviation of 1. (Unit variance). It standardises features by subtracting the feature's mean value and dividing the result by the standard deviation of the feature. It can be calculated as

$$g = (a - v)/sd \qquad (1)$$

Where data which has been scaled usually represented by the symbol g, a indicates scaled data and the mean of training set is v. The standard deviation of the training samples is signified as sd.

3.6 Categorization of Machine Learning

The study looks at the first and second stages of heart disease prediction. The traditional heart disease prediction system was presented without the use of a hyper-parameter tweaking machine learning algorithm.

The classification venture is used for prediction of subsequent instances depending on beyond information. The knowledge of classification in statistics is vast, and several classification methods can be used based on the data set. The following are five of the most common machine learning algorithms.

3.6.1 Logistic Regression (LR)

To forecast the likelihood of categorical dependent variables, a machine learning classification approach called logistic regression is used. This is an extension of the classification problem for linear regression models. Unlike linear regression, which provides continuous numbers, logistic regression generates probability values that can be translated to two or more discrete classes using a logistic sigmoid function.

The binary finding acquired by assessing independent criteria and categorizes the results into one of two groups. The dependent variable is always categorical, regardless of whether the independent factors are numeric or categorical. It's written like this:

$$Pr(Yo = \frac{1}{X}) \; or \; Pr(Yo = \frac{0}{X}) \qquad (2)$$

Given the independent variable X, it determines the probability of the dependent variable Yo.

3.6.2 Decision Tree (DT)

The decision tree is a categorization technique that can be used to categorize both numerical and category data. A decision tree is a structure that looks like a tree. Decision trees are a simple and widely used approach to medical data analysis. Data from a tree is easy to process and analyze. The three nodes form the basis for the analysis of the decision tree model.

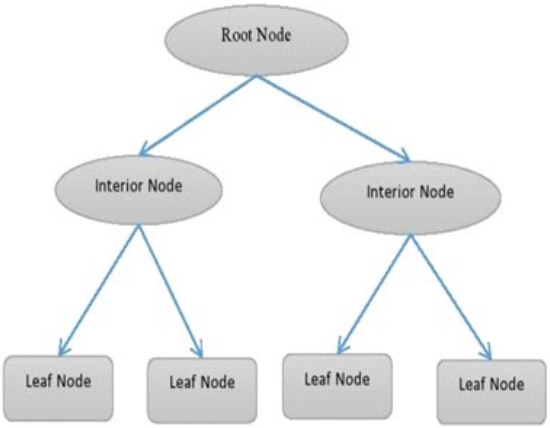

Fig. 2 : Decision Tree

It is a supervised technique that predicts the target class using a tree structure. Leaf nodes are referred to as decision nodes in the tree model, whilst inner nodes represent features, and each branch represents a test result.

Based on the most crucial indicators, this algorithm divides the data into two or more equivalent sets. Each attribute's entropy is determined, and the data is separated into predictors with the most information gain or the lowest entropy:

$$E(S) = \sum_{i=1}^{c} -\text{Pi} \log 2 \text{ Pi} \qquad (3)$$

Where E(S) denoted as Entropy, in our data, the frequent probability of an element/class i is simply 'Pi.' For the sake of simplicity, let's say we just have two classes: a positive class and a negative class.

$$I(S,a) = E(S) - E(S/a)z \quad (4)$$

Where I(S, a) indicates the information gain for the data-set S for the random variable a, E(S) indicates the entropy for the data-set before any change (stated above), and E(S | a) symbolizes the conditional entropy for the data-set given the variable a.

3.6.3 K-Nearest Neighbor (KNN)

The supervised classification technique k-nearest neighbour (k-NN) uses training datasets to find the k closest relatives in future situations. When you use k-NN to train the classifier, you calculate to place it in the category of its closest neighbour. If k = 1, it will be classified correctly closest to 1. A plurality referendum of its neighbors classifies K.

3.6.4 Support Vector Machine (SVM)

By varying the difference between the measured points and the hyper plane, this classifier seeks to create a hyper plane that can divide the classes as much as feasible. The hyper plane is determined depending on a number of kernels. This analysis used four kernels: linear, polynomial, radial basis function (RBF), and sigmoid (this could be used as a stand-in for neural networks). The most common type of kernel function is RBF. Because it's limited, it has a finite response along the entire x-axis.

The kernel functions return the scalar product of two points in a particularly prescient feature space. Thus, even in the situation of very high-dimensional spaces, by establishing a notion of likeness with a low computational cost.

$$\text{K(X)} = \begin{matrix} 1 & if||X|| \leq 1 \\ 0 & \text{otherwise} \end{matrix} \qquad (5)$$

3.6.4.1 Linear Kernel

The linear kernel is used when the data is linearly separable, that is, when it can be split using only one line. It is one of the most extensively consumed kernels. It is most generally utilized when a data set contains a rich set of features. When training an SVM, a Linear Kernel is quicker than any other Kernel.

L(X,Xj) = sum((X.Xj) (6)

Where X, Xj signify the features you're trying to categorize.

3.6.4.2 Polynomial Kernel

The polynomial kernel is a kernel role that enables nonlinear models to be trained by comparing vectors (training samples) in a feature space to polynomials of the original variables. It's commonly utilised with support vector machines and kernelized models (SVMs).

P(X, Xj)= (X.Xj+1) ^d) (7)

The degree is denoted by d, and the dot product of both values is shown by '.'.

P indicates the decision boundary when splitting the given classes (x, xj).

3.6.4.3 Gaussian Radial Basis Function (RBF)

In SVM, it's one of the most well-known and widely-used kernel functions. It's typically used with non-linear data. When there is no prior knowledge of data, it aids in proper separation.

$$G(X, Xj) = \exp(-\text{gamma} * ||X - Xj||^2) \quad (8)$$

The gamma value ranges from 0 to 1.

3.6.4.4 RANDOM FOREST (RF)

The supervised learning strategy is widely used by Random Forest, a well-known machine learning algorithm. In machine learning, this can be applied to both regression and classification issues. Ensemble learning is a method for integrating many classifiers to solve a tough problem and increase the performance of the model. A Random Forest is a classifier that improves the estimated accuracy of a data set by averaging the results of multiple decision trees on various subsets of the data set. Rather than depending on a single feature, the random forest evaluates each tree's prognosis and forecasts the final outcome based on the democratic majority of projections. The forest becomes more exact as the number of trees increases, and the problem of over-fitting is avoided.

4. PROPOSED METHODOLOGY

4.1 Overview

Because hyper-parameters govern the entire behaviour of a machine learning model, fine-tuning them is critical. Each model of machine learning will take a different h. This work emphasizes the evaluation of machine learning models based on hyper-parameter fit. Hyper-parameter setting refers to selecting a set of optimal hyper-parameters for a learning algorithm. A hyper-parameter is a model conflict with a value defined before the learning progress begins. The key to automatic learning algorithms is hyper-parameters.

4.2 Model Selection

Scaling features are a must have in algorithmic modeling with datasets. As a result, the records as an entire have many one-of-a-kind dimensions and sizes. The modeling of a data-set is harmed through one-of-a-kind sizes of records capabilities.

Model tweaking's major goal is to discover the best values or characteristics for the greatest results. Any model can be affected by hyper-parameters. Sklearn is the library that was utilized to automate the process. Among the methods adopted were Logistic Regression Classifiers, K Neighbors Classifiers, Support Vector Classifiers, Decision Tree Classifiers, and Random Forest Classifiers. In the proposed model, the Grid search is used to discover the optimal hyper-parameters. After the hyper - parameters were fine-tuned, the categorization models were created.

4.3 Random Forest with Grid Search

The suggested model's design is shown in Figure 3, and it uses data from the UCI repository. Then the model does preprocess and feature selection processes. The essential features elicited are given to the input of the model. Finally, hyper parameter tuning was employed to increase the precision. For accurate cardiac disease prediction, the model executes the actions outlined in the Algorithm.

Algorithm:
Input: Training Data (D), Hyper parameter (Hp).
Output: Best model with greater accuracy.

1. From D, create the subset of random decision trees. Then vote all the output of the training random decision tree. The majority voted tree is the output of the Random Forest algorithm.
2. Apply the various hyper parameters criteria to the model, such as max_depth, max_features etc. It prevents the model from over-fitting and improves the learning process.
3. Fine-tune the hyper parameters to check for bias and variance errors, which will increase the model's accuracy.
4. The best model with the best hyper parameters is returned by RTGS.

To predict the heart disease, the model employed 13 prediction characteristics including 'age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach', 'exang', 'oldpeak', 'slope', 'ca' and 'thal'. Initially, the model performs the normalization process using standard scalar. It converts all the feature values from 0 to 1 and it is calculated as follows:

Let TD= {No_of_training_samples (n), No_of_prediction_features},

$$\beta = \frac{TD-\mu}{\sigma} \qquad (9)$$

Where, mean$(\mu) = 1/n \sum_{k=1}^{n}(TD)$,

standard deviation$(\sigma) = \sqrt{1/n \sum_{k=1}^{n}(TD-\mu)^2}$.

The second step is to reduce the model complexity, avoid over fitting, speed up the model training and eliminate the generalization error by eliminating inappropriate features using feature importance techniques. Feature importance arranges predictor variables in descending order and eliminates the predictors having the least values. The important predictor variables for prediction such as 'age', 'trestbps', 'chol', 'restecg', 'thalach', and 'oldpeak' which is input to the Random Forest with Grid Search method. The next step is to perform the above steps shown in an algorithm. The hyper parameter criteria for RFGS shown in Table.1

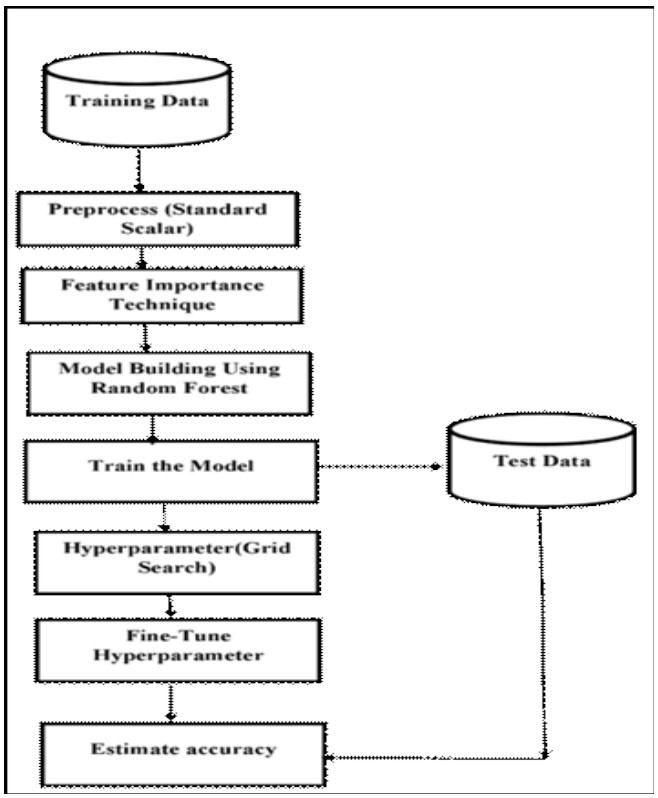

Fig. 3 : RFGS: proposed system

5. RESULTS AND ANALYSIS

Three tactics were tested using different machine learning algorithms, which were then fine-tuned to assess how much of an impact they had when compared to the data. The first technique gathers a normal data set with appropriate structure for classification, whereas the second strategy treats data using feature selection and detects no outliers. The obtained results are highly promising, and the data set was normalised while adding outliers and feature selection in the third technique; the produced results are significantly superior to the preceding procedures, and our results are quite promising when compared to other study levels of accuracy. The analytical action is performed in the pre-processing phase to eliminate or minimize missing data, and to find the optimum, least, means, and standard deviation from each extracted features.

A histogram of categorical response aspects was again built for easier and more effective analysis. Statistical graphs depict the structure and density distribution of categorical observations. Figures 4, 5, 6, and 7 demonstrate a distribution study that shows how often each trait is. It can aid in the recognition of statistical trends and the impression of feature distribution.

While using the machine learning model for testing and training, we observed that the Random Forest with Grid Search is dramatically more accurate than some other techniques. The accuracy of each algorithm should be calculated using hyper-tuning, as shown in Fig.9, and Fig.8, which exhibits a machine learning technique without hyper-tuning. When adopting the first strategy, Logistic Regression is 78 percent accurate, Decision Tree

Table.1 : Hyper-parameter Criteria-RFGS

Sl. No	Training parameter Name	Values	Description
1.	Bootstrap	True, False	Maximum samples
2.	Max_depth	40,50, None	Longest path between root and leaf node.
3.	Max_features	Auto, Sqrt, Log2	Max-Features in the tree.
4.	Min_samples_leaf	1,2	In each leaf node, there must be a minimum amount of samples.
5.	Min_samples_split	2,5	Splitting a minimum amount of samples from any node.
6.	N_estimators	200, 400	Model performance
7.	Max_leaf_ node	1,2	Minimum number of samples present in leaf node.

is 79 percent accurate, Support Vector Machine is 83 percent accurate, Random Forest is 85.2 percent accurate and KNN is 87 percent accurate. RFGS has a higher precision of 98.65 accurate, which has been achieved by use of grid search to discover the perfect features determining whether or not such a person is diseased. Each attribute's significance and contribution to the data-set may determine errors.

Fig. 4 : Heart Disease Histogram Analysis Prediction focusing on various features

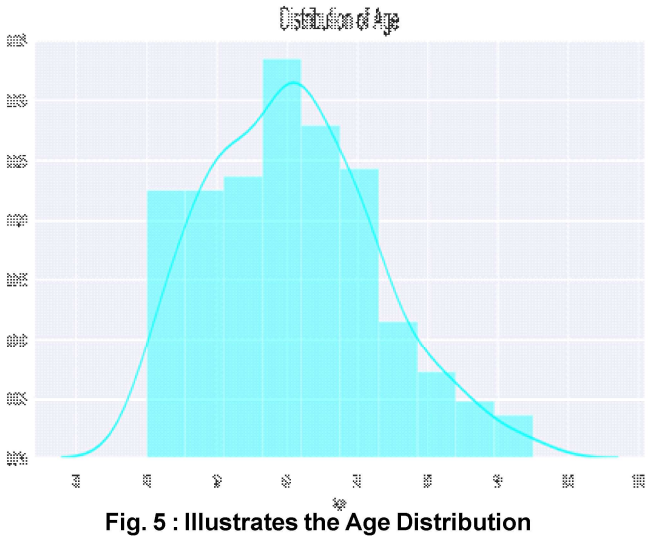

Fig. 5 : Illustrates the Age Distribution

6. CONCLUSION

Algorithmic accuracy is one of the metrics used to quantify algorithm efficiency because the heart is a crucial and sensitive organ in the body, and the prediction of cardiac disorders is also a huge concern for individuals. The datasets used for training and testing ensure that ml algorithms are efficient. When we examine the methodologies that used datasets with the characteristics described in Table.1 with grid search, we conclude that RFGS is the optimum. The classical and proposed algorithms have been used to predict Cleveland cardiovascular disease statistics in this

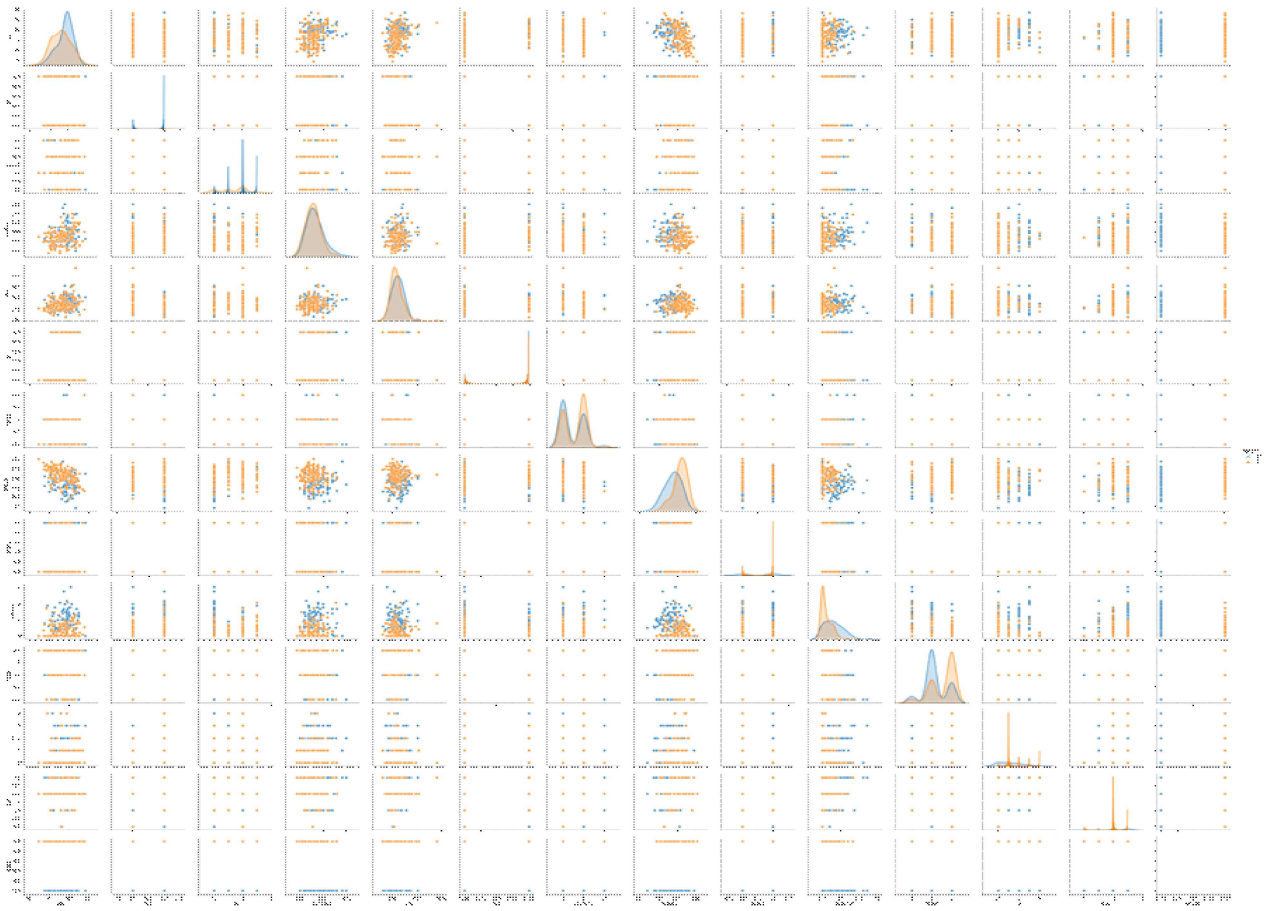

Fig. 6 : Automating graphical analysis for heart disease prediction

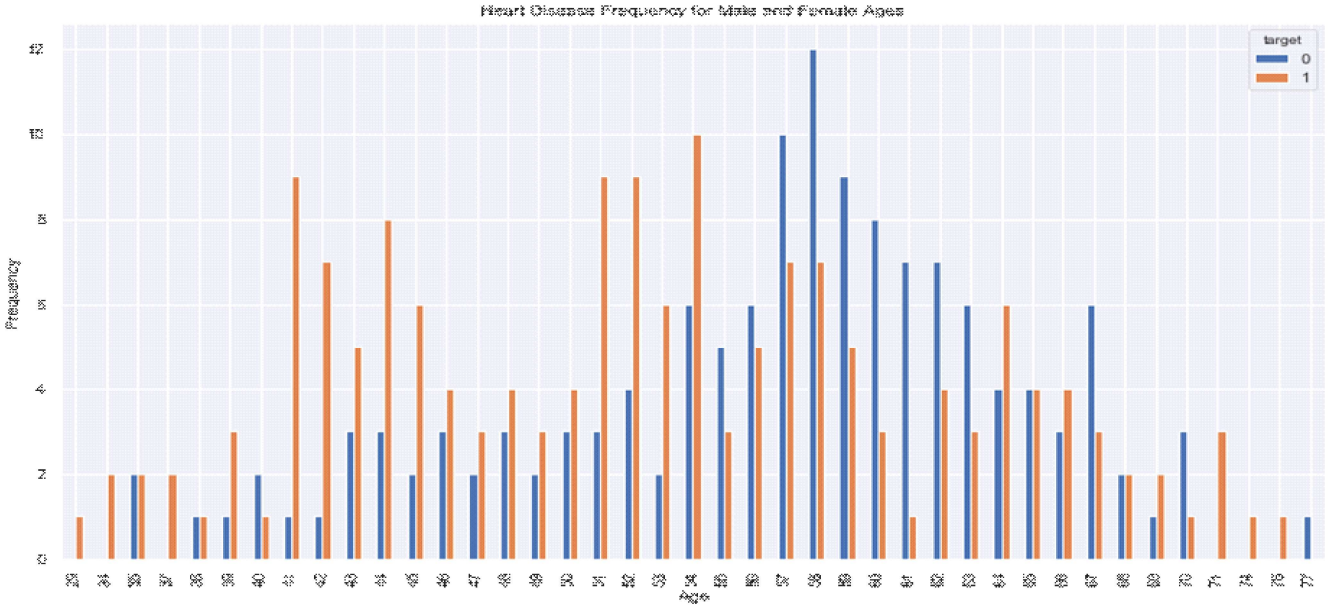

Fig. 7 : For each target class, there is indeed a range of ages

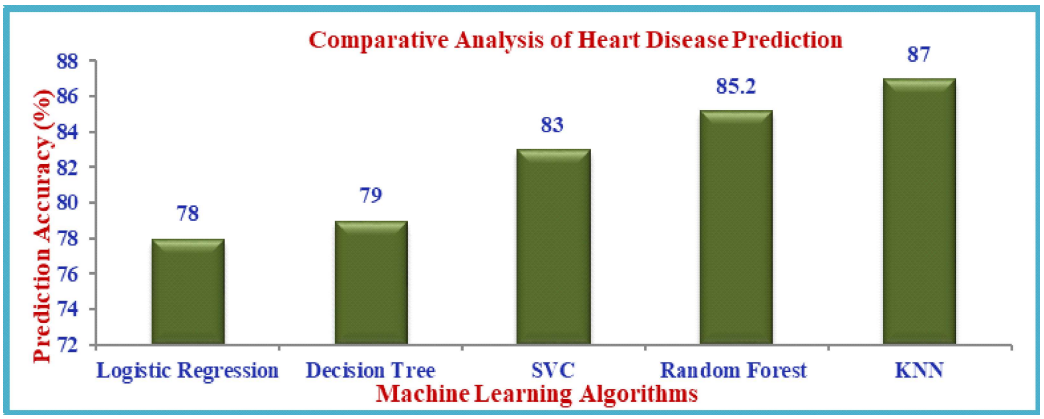

Fig. 8 : Algorithm for Machine Learning without Hyper-tuning

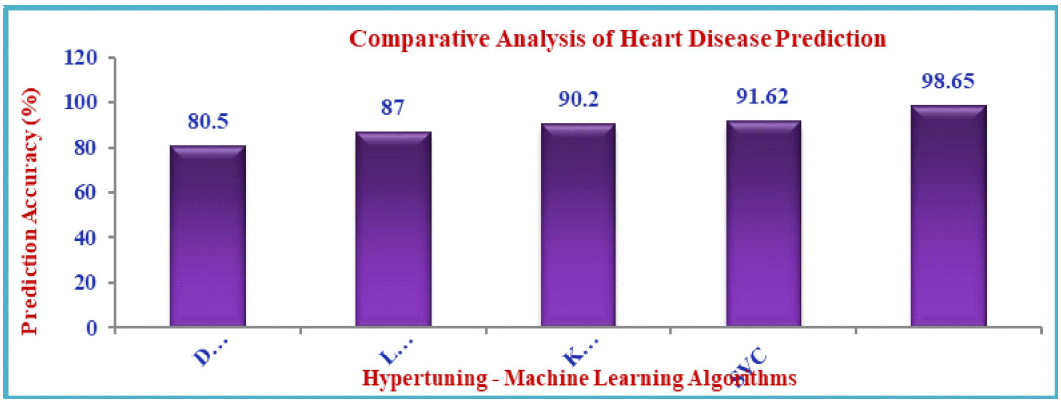

Fig. 9 : Hyper-tuning Machine Learning

work. Techniques for machine learning include LR, DT, SVM, RF, and KNN are implemented to build the automated diagnostic model in both instances. These models essentially consist of 5 phases, but the proposed model distinguishes from the classic system as a result of hyper - parameters tweaking. The LR, DT, SVM, RF, and KNN classifiers, on the other hand, yield accuracy rates of 78 percent, 79 percent, 83 percent, 85.2 percent, and 87 percent, respectively, without hyperparameter tweaking. The DT, LR, KNN, SVM, and RF classifiers in the refined set, on either paw, exhibit prediction accuracy of 80.5 percent, 87 percent, 90.2 percent, 91.62 percent, and 98.65 percent, respectfully, whilst using the hyper - parameters tuning strategy. As a result of research observations of measuring performance on the cardiac datasets, it may be deduced that the proposed approach is more efficient and can better predict cardiovascular risk.

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PRACTICAL ANALYSIS OF IMPLEMENTATION OF NEW EDUCATIONAL POLICY

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ABSTRACT

The new education policy comprises of many novel and innovative schemes to usher India into a developed nation. This paper discusses the effect on this new policy on technical education in India. With increasing globalization and competition from other developed countries, more flexibility is required in education. Advantages and disadvantages of this flexibility are discussed in detail.

Keywords : *New Educational policy, Flexibity, Implementation*

1. INTRODUCTION

The last education policy was brought out in 1986 and the world has changed drastically since then the United States of America and the Soviet Union was the only two super powers in the world at that time. During the last 30 years, especially since the last 10 years, globalization has forced all countries to adapt or perish. In line with this situation. The new education policy was ushered in during the year 2020 just before the start of COVID. While COVID has certainly pushed the whole world backwards, it is really heartening to know that India has come bouncing back faster than most other countries in the world. This is due to the inherent nature of Indian people to absorb shocks and help each other in times of crisis. This again stems from our ancient cultural concept of Vasudeiva Kutumbakam, which means that the whole world is one family. In this paper,I would like to discuss some of the salient points of our new education policy, its advantages and disadvantages.

2. LITERATURE

The first education policy in India was framed in 1968 and the second in 1986.The 1986 policy was reframed in 1992.A ten member commission headed by Dr.S.Radhakrishnana was constituted in 1948 on educational plocies.[1]An analysis of higher education was done by Aithal et al.[2]Our current vice President Shri Venkiah Naidu has also talked at length on the new education policies.[3]A critical study of the issues in our education and the new education policy have been carried out by Venkateshwarulu.[4]This study done by the authors is a detailed extension of the previous studies and contains their original views on the subject.

3. MAIN ASPECTS OF NEP AND COMMENTS

- New Policy aims for Universalization of Education from pre-school to secondary level with 100 % GER in school education by 2030.

A very ambitious step, but worth trying out to the full.100 % education levels are a dream for every developed country and I am sure that by 2030,India will be among the most developed countries in the world. Already, the world is looking at Indian Universities in a more respectable light compared to what used to be the case earlier.

- NEP 2020 will bring 2 crore out-of-school-children back into the mainstream-

This idea is a very noble idea and the originator of this idea should be commended. However, due to the COVID situation, many school children throughout the country have been affected and some have dropped out. So, it is going to be a real challenge for the Government and society as a whole to rise to the occasion. I feel that wherever individuals see school drop outs, they should educate them and maybe even sponsor the child's education. Society as a whole should be involved in this endeavour.

- New 5+3+3+4 school curriculum with 12 years of schooling and 3 years of Anganwadi / Pre-schooling.-

Again it is going to be a big challenge and no easy task. People generally resist change, even if it is for the better and I feel that the benefits of this scheme should be marketed by Government agencies in a big way.

- Emphasis on Foundational Literacy and Numeracy, no rigid separation between academic streams, extracurricular, vocational streams in schools; Vocational Education to start from Class 6 with Internships.

I am not too sure that this idea is practical, though it seems to be very innovative. Of course, early specialization will help children from poor and lower middle class families to quickly get their children into jobs. So, if the target class for this idea is the poor and lower middle class, the idea is really good, but implementation could be a problem and monitoring the implementation should be done strictly.

- Teaching up to at least Grade 5 to be in mother tongue/ regional language.

Again, I am not very sure about the practicality of this idea and I feel that subjects could be taught in English only with emphasis on the local language/ mother tongue. Otherwise, teaching in many languages throughout India may reduce learning of the English language. Being an Indian, I would welcome all languages, but as the common language used in India is already English, which in some ways is unifying the country, this idea of teaching in local languages till grade 5 should be looked into very carefully.

- Assessment reforms with 360-degree Holistic Progress Card, tracking Student Progress for achieving Learning Outcomes.

A very ambitious and holistic step. This is already happening in some reputed colleges ,where mentors maintain 360 degree progress. Holistic education should include yoga, meditation and sports,in order to wean away students from bad habits like drugs and alcohol, which have become a big problem among students in this generation. Mentors play a vital role in correcting/rectifying dangerous situations and the mentor should be seens as a friend and not an elder. Students confide their problems more among friendly people.

- GER in higher education to be raised to 50 % by 2035; 3.5 crore seats to be added in higher education.

This step is possible when we invite and allow foreign Universities to open campuses in India and also encourage reverse brain drain, that is attract Indians and foreigners abroad to come to India and work/study here.

- Higher Education curriculum to have Flexibility of Subjects.

Again and again, the new education policy's thrust on flexibility is very clear and it is similar to what the United States of America has been pursuing. Considering the current improvement in

friendship with the United States, in future we may expect more of credit transfers to American Universities and vice versa. Already, NPTEL courses are being considered for credit transfer in good Universities in India and abroad.

- Multiple Entry / Exit to be allowed with appropriate certification.

This point, I feel will be a bit tricky because though it might have been thought of to improve flexibility, misuse and confusions are possible during implementation.

- Academic Bank of Credits to be established to facilitate Transfer of Credits.

A good scheme with long term benefits and again in line with the policies on flexibility.

- National Research Foundation to be established to foster a strong research culture.

The United States of America has a National Science Foundation, which funds basic research. India can do much better considering the variety of languages and ancient literature available with us, which have been lost or forgotten during the last 1000 years or so.

- Light but Tight Regulation of Higher Education, single regulator with four separate verticals for different functions.

This step makes a lot of sense since too many regulators create confusion in the minds of the faculty and staff in colleges and Universities. Both the AICTE and the UGC have been doing a very good job in the past, but sometimes some regulations have a chance of being misinterpreted .Similarly, we have NAAC and NBA for accreditation and many times, there is duplication of work and faculty members face a lot of mental stress while preparing laborious documents as proof for their work and research.

- Affiliation System to be phased out in 15 years with graded autonomy to colleges.

Again a very practical step and the reasons being similar to the previous point. Affiliation involves a lot of documentation and faculty spend a lot of time and effort preparing these documents.

- NEP 2020 advocates increased use of technology with equity; National Educational Technology Forum to be created.

Increased use of technology has become a must ,especially if India's rural areas are to develop. High speed internet to rural areas is one point which should be given top priority.

- NEP 2020 emphasizes setting up of Gender Inclusion Fund, Special Education Zones for disadvantaged regions and groups.

Disadvantaged regions and groups have been suffering for long due to discrimination and this step is welcome.

- New Policy promotes Multilingualism in both schools and HEs; National Institute for Pali, Persian and Prakrit, Indian Institute of Translation and Interpretation to be set up.

Ancient India had a lot of advancements, which were lost during the last 1000 years or so. Hence, studies in ancient languages like Pali, Prakrit, Persian and Tamil would be very useful in order to retrieve a lot of lost ancient treatises and valuable information. I would add here that study of Sanskrit has to be given utmost importance.

4. CONCLUSION

The new education policy is greatly forward thinking and most of the points are ambitious and set a very high standard. Unless we set very high standards, it is not possible to grow to be a super power in the world, which India should rightly strive for. The problems lie in the implementation and all sections of society should co-operate with each other to develop India to a developed nation category. Especially, centre state relations should be smooth in order to uplift India as a whole in the future.

5. FUTURE TRENDS

India is marching towards its rightful place in world history and it is only apt that educational policies should be modified to suit current trends. It is expected that in future, educational policies

should be revised at least once in five years, though not on such a massive scale. In future, educational Institutes and Industry could play a more synergic role in modifying educational policies, with more inputs from students too.

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AN EXPLORATION OF COMPUTER, INTERNET AND DATABASE LITERACY SKILLS OF THE UNIVERSITY STUDENTS

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ABSTRACT

This paper explores on the use of computer, internet and database literacy skills of university students under different elements. The findings explore that out of total population under study, majority (85.83%) of students' access internet on daily basis and 59.45% of them use computers regularly that shows the best use and value of computer and internet in compelling their academic/research tasks. Further, it is noted that university students have better computer literacy skills as out of defined 8 skills components, 6 skills components ratio is above 50%. The data further reflects that students possess not only the basic internet skills but also advanced skill to use internet. In addition to this, 73.23% university students are well acquainted with Database Literacy. As a part of honing the internet search skills, use of instruction, preferred sources and smart phone by the university students were also studied.

Keywords: *Information & Communication Technology, Literacy Skills, University Students*

1. INTRODUCTION

'Industry 4.0' equipped with modern and advanced technologies knocks the door for the academicians to express their research and innovation activities for the well-being of the society. The extensive development in all the disciplines make impact to adopt and use different sorts of literacy's like computer/internet, health and finance by the academicians. Accordingly the lifelong, self-explanatory and survival skills of information literacy/ e-information literacy need to be implemented and used. Acquiring ICT (Information and Communication Technology) knowledge, especially about the computer and communication technology with its auxiliary system is the essential pre-requisite in today's mobile computing digital world as of most of the services/facilities are in online tune. To handle smart technology, there is demand for smart skills in line with computer, internet and database skills.

2. REVIEW OF LITERATURE

To ascertain the computer literacy level of medical students, Achampong and Pereko [1] in their research showed that, 89.9% of respondents had some average to advance knowledge of computer and in the use of basic computer software (windows, word, excel, PowerPoint, database,

internet and email). However, the knowledge and use of database was observed low (62.5%) as compared to other programs. Kumar and Mahajan [2] determines levels of computer literacy with demographic variables of postgraduate and research students of the selected Indian universities. The study discovered that among the respondents less than half reported that they had acquired adequate computer competency to search for information from varied e-resources, however no significant differences were found for computer skills with respect to students having different demographic characteristics. A further, significant difference was noted between the academic use of internet and students varying age groups. Markulin and others [3] made a comparative survey of three group (generation) of medical students against the use of Internet.

The comparison of the results of all three surveyed groups have shown an increase in the use of the Internet (62% in 2000 vs. 98% in 2010 and 2012 groups) and e-mail communication (67% in 2000 vs. 96% and 98% in 2010 and 2012 groups respectively). More than a half of the respondents used the Internet for entertainment and searching of general information, only 4% of the respondents in 2010 and 2012 groups used the Internet for learning and exam preparations. Farajollahi and others [4] investigated the effect of a Distance Education (DE) system on the computer literacy of postgraduate students, the findings states that DE has a more significant impact on concepts of IT, internet and presentation regarding computer literacy than the other traditional educational tasks. Herzog [5] in the book 'Data Literacy: A User2 s Guide' narrates about auxiliary areas of 'data literacy' contents with practical, illustrated approach in simple language by focusing on data analysis methods/tools including database managers such as Microsoft Access, MySQL and standalone statistical programs such as SPSS, SAS and R. etc. Ajani [6] emphasis on different angles of 'data literacy' as an innovative learner-centered, experiential approach like data, internet of things and cyber security etc. by describing an on-going effort to create, develop and teach an innovative introductory data literacy course with college-wide appeal. Mansour [7] surveyed digital information literacy (DIL) among the academic library and information professionals with their demographic variables. It reveals that, there is a significant relationship between all the respondents' professional characteristics; particularly their discipline, followed by job title, work experience and DIL. Further, regarding the level of respondents' knowledge of the types of computers, knowledge of using mobile devices, followed by PCs, workstations, portable media players/digital audio player and personal digital assistant was, 'at the least', 'high' that too the use of different output devices and the application software's.

Weber and others [8] in their experimental study resulted that there was significantly increased in the use of academic databases and cited more articles from scholarly journals by the students of a German university after given academic search tasks to them. The study further predicts that teaching digital information literacy is essential and feasible, but it is no panacea for increasing the academic quality of students' work. Enakrire [9] investigated the usefulness of data literacy (DL) for teaching and learning in higher education institutions (HEIs), the findings indicates that DL is crucial in HEIs. The investigation further directs for different types of data collection methods applied in various higher institutions such as rating scale, reporting, questionnaire, interview, observation, checklist, project, registration, assignment and performance test etc. by applying different types of skills and abilities to search, analyze, adopt and share data in HEIs. Bieza [10] studied thoroughly various sources of information regarding the concept of digital literacy, its application in today's context and come out with better comprehend wide range of digital literacy definitions after reviewing several sources considered for this study. Huang and others [11] measure and validate the junior students internet literacy scale by applying psychometric method that includes development of an 18 item scale using exploratory and confirmatory factor analyses specified under five subscales, viz. Knowledge and Skills for the Internet (KSI), Internet Self Management (ISM), Awareness and Cognition of Internet (ACI), Internet Interactions (II) and

Autonomous Learning on the Internet (ALI) to prove the stated hypothesis under study. Further, the study concludes that the developed internet literacy scale will help students to facilitate unified research in the field of interest. Soroya and others [12] in their research explored the level of Internet literacy skills of undergraduate first-year students; the results revealed that the respondents possess very good knowledge to identify legal and illegal activities and information on the Internet. Further the study come out with a theoretical model that may be useful to design an efficient and effective Internet literacy module/subject to help students to increase their Internet use-related skills. A scientometric study of Digital Literacy, ICT Literacy, Information Literacy and Media Literacy were undertaken by Park and others [13] against the three parameters as keywords, co-authorship and cited publications on these literacy areas. The findings concludes that the digital literacy is a multidisciplinary field which widely embraces the domains like literacy, ICT, the Internet, computer skill proficiency, science, nursing, health, and language education etc. by suggesting the need to cultivate understanding of the social impact of exploiting technology and computational thinking of the users.

After reviewing it is noticed that no study was made in conglomeration of computer, internet and database literacy with its allied areas against the university students' population hence, to fill this gap the present survey was made.

3. OBJECTIVES OF THE STUDY

The basic objectives of this study are:

a. To know the regularity and access point in the use of computer and internet by the university students for their academic purpose.

b. To study the Computer and Internet Literacy Skills with different skills parameter along with use of web browser software and email service provider by the university students.

c. To know the use of instruction, preferred sources and smart phone by the university students for honing the internet search skill

d. To explore the Database Literacy Skills of the university students.

4. METHODOLOGY

For this study, descriptive method of research and online pre-tested, structured questionnaire as a data collection tool were applied. The scope is limited to both Post Graduate (PG) and Research students enrolled at Shivaji University Kolhapur Maharashtra, India from 37 different post graduate academic departments' which falls in four faculties' viz. Humanities, Science and Technology, Inter-Disciplinary Studies and Commerce and Management. The online questionnaires were distributed randomly to 351 university students of the Shivaji University Kolhapur, out of which 254 (PG: 133, Research: 121) students responded to the questionnaire (72.36%). The response rate is high enough, hence considered for the present study.

5. RESULTS AND DISCUSSION

5.1 Regularity and Access Points in the use of Computer and Internet

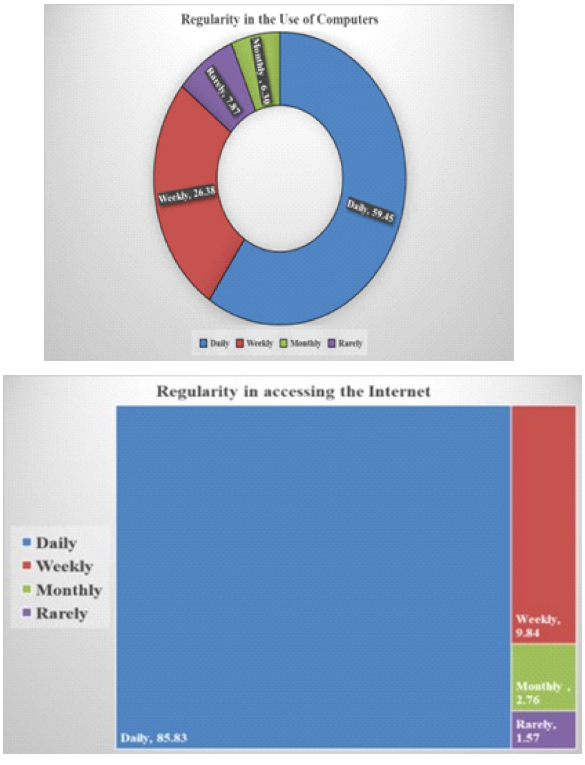

Fig. 1 : Regularity in the use of Computer and the Internet

- It is observed from the above figure 1 that out of total population under study, 151 (59.45%) university students use computers on daily basis followed by weekly 67 (26.38%), rarely 20 (7.87%) and monthly by 16 (6.3%) students. Further, 85.83% university students access internet on daily basis, 9.84 % students' access internet weekly, 2.76% of students on monthly basis and remaining 1.57% use/access internet rarely.
- Table 1 below denotes about the places/ venues to use and access the computer and internet, which clears that the most favored place to use and access the computer/ internet is the Internet Hall (68.50%) and the least access venue is Library/KRC (19.29%). The other places identified are at department/ laboratory (55.12%), at home/hostel and internet café with equal quantum of response (23.62%).

Table 1: Places to access Computer/Internet

Places to use and access Computer/Internet	No. of Students	Percentage (%)
Department/Laboratory	140	55.12
Internet Hall	174	68.50
Library/KRC	49	19.29
Home/Hostel	60	23.62
Internet Café	60	23.62

b. Computer Literacy Skills

The response related to various aspects/components of Computer Literacy Skills is mapped in the following Table 2

Table 2 : Computer Literacy Skills

Sl. No.	Components of Computer Literacy Skills	No. of Students	Percentage (%)	Rank
1	Knowledge about different types/specification of computer/laptop	207	81.50	**1**
2	Knowledge of hardware/software's/operating system/ programming languages etc.	140	55.12	**5**
3	Knowledge about office software's like Word, PowerPoint, Excel, Access etc.	185	72.83	**2**
4	Knowledge about different file formats (pdf. doc/docx. jpeg, HTML, XML, Text,Mp3/4 etc.) and Multimedia components, Media Players etc.	144	56.69	**4**
5	Knowledge about storage system with cloud applications	123	48.43	**7**
6	Knowledge of installing the system, uploading, downloading and printing of the resources	151	59.45	**3**
7	Knowledge about sharing the devices for quick retrieval of data/information	130	51.18	**6**
8	Undergone computer training/course to gain computer knowledge	90	35.43	**8**

- It explores that 81.50% university students have knowledge about different types/ specification of computer/laptop. Further 72.83% university students have better knowledge about different office software's like Word, PowerPoint, Excel, Access etc. 59.45% students have competency for installing the system, uploading, downloading and printing of the resources. 56.69% of students knows different file formats (pdf. doc/docx. jpeg, HTML, XML, Text, Mp3/4 etc.) and Multimedia components, Media Players etc. Knowledge of hardware/software's/ operating system/ programming languages etc. is acquired by 55.12% students. 51.18% students know about sharing the devices for quick retrieval of data/information. Knowledge about storage system with cloud applications is occupied by 48.43% of students and 35.43% students' undergone computer training/course to gain more computer knowledge. Thus, the university students have better computer literacy skills as out of 8 skills components, 6 skills components ratio is above 50%.

c. Internet Literacy Skills

The analysis against internet literacy skill is represented in following Table 3.

- It reflects that, 76.38% university students have knowledge to setup internet connection, manage its settings and use of bookmarks etc. 70.47% of students have knowledge of internet tools like WWW, URL, domain names, IP addresses, Web browsers and navigation techniques. Further 68.11% of students' use mobiles, internet on it for their academic/training tasks and virtual learning etc. 53.54% students have knowledge of different Internet tools, its services and launching of website etc. 38.58% university students have knowledge to differentiate between secured and non-secured websites, security system etc. Like this, 34.25% of students have knowledge about webpage design, network technology, database, data leakage and its security etc. and very meager quantum of students i.e 22.44% undergone web training/course to gain more internet/web technology related updated knowledge.
- In addition to this, it is learnt from figure 2 below that, 99.21% of students use Google Chrome as one of the most preferable web browser software to access internet followed by other web browser software's such as Internet Explorer (65.35%), Mozilla Firefox (55.51%), Opera (35.83%), Safari (8.27%),

Table 3: Internet Literacy Skills

Sr. No.	Internet Literacy Skills	No. of Students	Percentage (%)
1	Knowledge about setup of internet connection, manage settings and use of bookmarks	194	76.38
2	Knowledge of WWW, URL, domain names, IP addresses, Web browsers and navigation techniques	179	70.47
3	Knowledge of Internet tools, services and launching of website	136	53.54
4	Knowledge about webpage design, network technology, database, data leakage and its security	87	34.25
5	Knowledge to differentiate between secured and non-secured websites, security system etc.	98	38.58
6	Use of mobiles/internet on it for academic/training tasks, virtual learning etc.	173	68.11
7	Undergone web training/course to gain more internet/web technology knowledge	57	22.44

Netscape (7.48%) and UC browser (0.39%). Further, it is apparent that majority of the university students (98.82%) prefer G-Mail services of Google as a part of their email service provider. Other email services are least preferred by the university students like Rediffmail (15.75%), Yahoo mail (14.17%), Hot mail (6.3%), Indiatimes mail (2.76%) Sancharnet mail (2.36%) and Outlook express (0.78%).

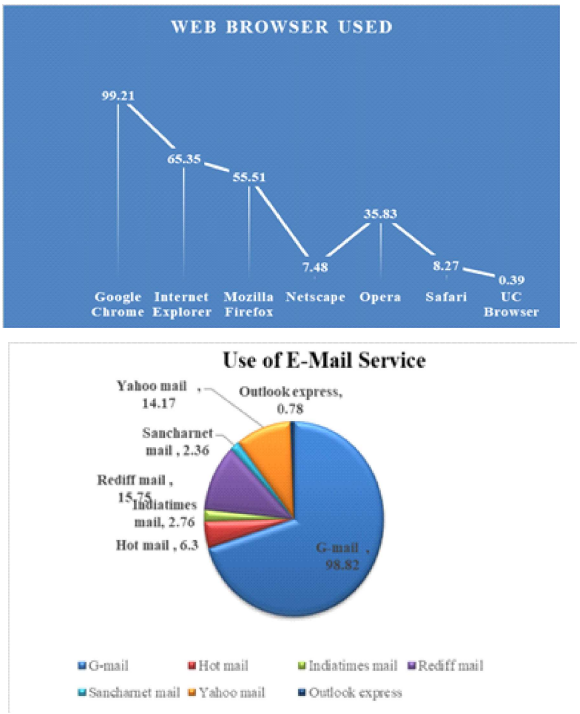

Fig.2 : Use of Web browser software and E-Mail Service Provider

- Table 4 below represents use of preferable instructions/skill that was displayed on Internet while accessing the internet by the surveyed university students as a part of internet literacy skill. From the analysis, it is clear that, 72.44% university students use Bookmarks/ Favorites service. The use of the rest of the internet instructions/skills and response received on it are use of Language (61.02%), links [blue underlined words] (50.79%), scrolling and dragging service (50.39%), drop down menu (40.16%), use of options like skip to content/navigation, screen reader etc. by 35.83% of students and pick and choose option by 31.89% university students.
- It is clear from the below Table 5 that students use different preferred sources for honing the internet search skills, 73.23% university students prefer the internet source for attending seminar/workshop in their basic field of interest followed by other sources such as for self-search /self-study, trial and error and users guide (64.96%), for formal education/training (59.45%), use of other medias like newspapers, phone, mobile, smart watch, digital devices etc. (58.27%), students/colleagues assistance (57.48%), help from teachers/guide/experts by (52.36%) and guidance/training from Library (University)/library staff/librarian [Director, KRC] (45.67%).

Table 4: Use of Internet Instructions/Skills

Internet Instructions/Skills	No. of Students	Percentage (%)
Bookmarks/Favorites	184	72.44
Drop down menu	102	40.16
Language	155	61.02
Links (blue underlined words)	129	50.79
Pick and choose	81	31.89
Scrolling and dragging	128	50.39
Use of options like skip to content/ navigation, Screen Reader etc.	91	35.83

Table 5: Use of Preferred Sources

Use of Preferred Sources	No. of Students	Percentage (%)
Attending seminar/workshop	186	73.23
Formal Education/Training	151	59.45
Guidance and Training from Library (University) / Library staff /Librarian (Director, KRC)	116	45.67
Other medias like Newspapers, Phone, Mobile, Smart watch, Digital devices etc.	148	58.27
Self-search /self-study, trial and error and Users guide	165	64.96
Students /Colleagues	146	57.48
Teachers/Guide/Experts	133	52.36

- Along with internet skill, it is also surveyed the use of smart phones/mobiles for internet access against the information needs of the university students. From the below figure 3, it explores that out of total population under study, 87.01% students use smart phone for E-mail purposes. 79.13% for Chatting-Whatsapp/Face book etc. on mobiles. For entertainment purpose by 61.81% students, online shopping by 48.82% and for other purposes like online banking, digital marketing (digital dukan)/business, e-learning and research task by 1.57% of university students.

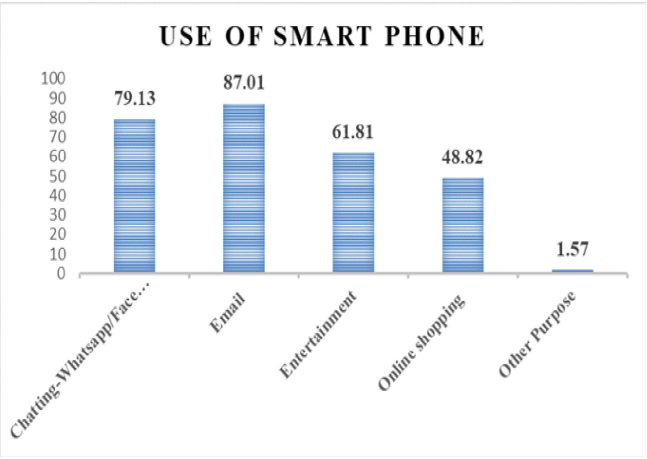

Fig.3 : Use of Smart Phone

d. Database Literacy

- It is noticed that 186 (73.23%) of university students acquainted with Database Literacy against the open-ended question on it.
- The different criteria's of database literacy and the response received from the students are expressed in the following Table 6 below which states that, out of total population 71.26% of university students are well acquaint with data analysis/ visualization tasks followed by the rest of criteria's of database literacy's viz. Data sharing (70.47%), database tools (46.46%), formatting and documentation of data and its techniques (42.91%), preservation and curation of data (33.46%), normalization of data (29.92%), metadata(24.80%) and acquaintance with Relational database management system by 24.41% of university students.

6. ADDITIONAL FUTURE STUDIES

This computer, internet and database literacy skills of the university students may be mapped with their category, gender, department, faculty and age group wise categorical variables in comparison with the other university students.

7. CONCLUSION

It is the need of the hour to grasp the knowledge and skills of computer, internet and mobile technology as they are changing rapidly with a base towards disruptive technology. Considering its great applicability, it pushes towards use of e-learning for the academic sector in this virtual wireless environment.

Table 6: Database Literacy

Database Literacy	No. of Students	Percentage (%)
Data analysis/visualization	181	71.26
Data sharing	179	70.47
Database tools	118	46.46
Formatting and Documentation of data and its techniques	109	42.91
Metadata	63	24.80
Normalization of data	76	29.92
Preservation and curation of data	85	33.46
Relational Database Management System	62	24.41

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MULTISCALE BASED JOINT HISTOGRAM EQUALIZATION FOR NEARLY INVISIBLE NATURAL IMAGES

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ABSTRACT

Histogram equalisation (HE) reduces the amount of gray levels in an image, which results in information loss and an unnatural appearance. Edge detail-based mutual histogram equalisation is used in this study to enhance contrast while conserving information details. In order to accomplish this, a gradient filter is employed on multi-resolution images, which provides information on the pixel values that are present on the boundary of the image. Combined occurrence of the detail information and the pixel values of the low contrast image are computed to generate the probability distribution function. This distribution function is transferred to a homogeneous distribution to result in an improved image. The suggested method is experimented on the CSIQ database and the effectiveness of the technique is examined using a variety of performance metrics, including standard deviation (SD), contrast improvement index (CII), normalised entropy (DEN), and discrete entropy (DE). In comparison to available strategies described in the literature, the suggested method outperforms on quantitative metrics. The Kullback-Leibler (KL) distance is used to determine the degree of uniformity in a distribution. The proposed strategy achieves a better degree of homogeneity than the existing techniques.

Keywords : *Joint histogram equalization, edge information, multiscale-analysis,KL-distance.*

1. INTRODUCTION

Despite advances in imaging technology, captured images have limited dynamic range and uneven intensity distribution, resulting in low contrast images [1]. Intensity values are modified to bring out the image's invisible elements via contrast enhancement (CE) [2]. It enhances the image's visual richness, helping to differentiate desired things from their background. It is a pre-processing technique applicable for many computer vision applications. Generally, contrast-enhanced photographs suffer from information loss and unnatural appearance, etc. Many algorithms are developed to improve images, nevertheless designing an algorithm free of artefacts is difficult in low-level image processing [3].

Histogram equalisation (HE) is a popular and straightforward spatial domain method for enhancing contrast. However, it suffers from over-enhancement as a result of spikes, average luminance shifting as a result of grey level stretching, and information loss as a result of intensity value merging during transformation [4]. Many histogram-based approaches have been developed in the

literature to address the aforementioned issues. These methods can be classified into two types based on histograms: one-dimensional (1-D HE) and two-dimensional histogram based methods (2-D HE). Along with contrast enhancement, 1-D HE methods are developed for preserving mean brightness in order to eliminate the visual artefacts caused by display devices. 2-D HE approaches are designed to boost contrast while keeping the information structure of a low-contrast image.

The majority of one-dimensional histogram equalisation approaches split the histogram into two portions, to equalise each section separately, and are referred to as bi-histogram equalisation [5]. The histogram is divided according to the statistical criterion that contributes to the preservation of the average luminance [6]. To optimise the efficiency of bi-histogram equalisation, the histograms are recursively divided to maintain the average intensity and then equalised. However, these recursive division-based approaches are limited in their ability to optimise the number of divisions [7]. If the number of divisions is more then, they generate the same low contrast image as output.

The algorithms described previously are largely concerned with maintaining the average brightness. By limiting the occurrences of intensities into their transformation function, further bi-histogram algorithms have been designed to minimise excessive enhancement [8]. These cutting limits are statistical characteristics generated from the low contrast image's histogram. Following that, the cutting limits are adaptively determined to increase the algorithm's robustness in terms of controlling the enhancement rate [9]. Although bi-histogram based approaches are employed to maintain the average brightness and minimise over-enhancement. However, the algorithm's primary objective of boosting contrast is obscured by its inefficient usage of a dynamic grayscale.

Methods based on 2-D HE make use of the co-existence of pixel values and their spatial location. Two-dimensional histogram equalisation (2DHE) enhances contrast by utilising contextual information. Contextual information is defined as the frequency with which gray levels occur in an image as a function of the intensities of the adjacent pixels. The goal of this strategy is to boost the image's contrast by consistently dispersing the gray level disparities between the intensity and its neighbours within a neighbourhood [10].

The spatial entropy-based contrast enhancement (SECE) method is introduced to solve the problem of size of the neighbourhood and histogram specification in 2DHE. To compute the distributions of pixel values inside the grids, the low contrast image is partitioned into non-overlapping grids. The spatial entropy of the spatial distribution is determined in order to determine the discrete function that will be utilised to define the mapping function [11]. The primary disadvantage of this technology is that it lacks control over the augmentation rate, which results in an over enhanced output image.

To address the above-mentioned issue, residual entropy-based contrast enhancement (RESE) employed a non-linear mapping function. This method preserves the image's mean brightness by taking into account the spatial relationship of the image's gray levels, which makes the process computationally challenging [12]. Due to the retention of average brightness, RESE leads in a loss of contrast in the output image and may be unable to exploit the entire dynamic range.

Joint histograms can be calculated in a variety of ways based on the existing research. A joint histogram indicates the amount of pixels in an image that are described by a specific blend of feature values. A joint histogram is a k-dimensional vector that holds the number of pixels in an image, represented by a k-tuple of feature values for each entry. Joint histograms enlarge the size of histogram without affecting each feature. This preserves the robustness of each feature while boosting the histogram space's capacity. Color, texture, edge intensity, gradient, and rank are examples of local properties within related images. Joint histograms are mostly employed in image retrieval and segmentation applications.

Sanjai Agarwal et al. suggested that JH may be employed to enhance contrast [13]. Joint Histogram Equalization (JHE) was developed to

reduce computational complexity by utilising a joint histogram (JH). The JH finds the joint occurrences of pixel values and neighbourhood information. The joint histogram is obtained by averaging information from the spatial neighbourhood [14]. A cumulative distribution function was constructed based on the joint histogram in order to discover the equivalent intensities using a mapping function.

The primary purpose of the proposed approach is to boost contrast while minimising artefacts, preserving edges, reducing over-enhancement. The following are the paper's main contributions:

1. By extracting picture information at various levels, the proposed contrast enhancement method employs multi-resolution analysis.
2. A filter detects crucial visual information and prioritises pixel variations with in their neighbours.

The remainder of the paper is structured as follows. Section II discusses the suggested contrast enhancement approach. Section III provides the outcomes of several bi-histogram and joint histogram-based approaches, as well as the validation of methods using various performance measures in comparison with the suggested algorithm. The conclusion of this work is provided in Section IV.

2. METHODOLOGY

Each step in the process of improving contrast by applying gradients is subdivided into a discrete function enumeration followed by a mapping function to determine an equalised histogram. The gradient image is created using the following two measures:

1. To get edge information, a filter is applied to the low contrast image at several scales.
2. Edge information is created by calculating the geometric mean value of multiscale filtered images.

The Gaussian pyramid is employed to decompose the low contrast input image I. The input image has the dimensions $H \times W$. The decimation method is used in each successive image by halving the sample rate. A series of multiscale images, including the original image, will be provided for each decomposition [15].

$$w_m = [0.25 - 0.5a, 0.25, a, 0.25, 0.25 - 0.5a]$$

$$w_m(0) = a; w_m(1) = w_m(-1) = 0.25; \quad (1)$$

$$w_m(2) = w_m(-2) = 0.25 - 0.5a; \quad (2)$$

where value of a is 0.375. The two dimensional mask coefficients are generated by

$$w_m(i,j) = w_m(i).w_m(j) \quad (3)$$

Convolution of the 2-D coefficients and decimation by a factor of 2^{m-1} yields the next level image $(m-1)$. As a result of this, multiscale image is generated and it is indicated by:

$$A_{m-1} = \sum_{p=-2}^{2} \sum_{q=-2}^{2} w_m(p,q).A_m(i+p, j+q) \quad (4)$$

Sobel operator is used to extract the edge information from the image sequences in the pyramid.

$$S_x = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} S_y = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \quad (5)$$

where S_x and S_y represents the mask in x and y-direction. Convolution of these masks with given image results in gradient magnitude and direction.

The gradient image is obtained by convolving the image with the mask.

$$G_x(x,y) = A_m * S_x$$

$$= \frac{1}{w \times w} \sum_{i=-w/2}^{w/2} \sum_{j=-w/2}^{w/2} A_m(x+i, y+j) \quad (6)$$

$$\times S_x(i,j)$$

$$= \frac{1}{w \times w} \sum_{i=-w/2}^{w/2} \sum_{j=-w/2}^{w/2} A_m(x+i, y+j) \times S_y(i,j) \quad (7)$$

$$G_m(x,y) = \sqrt{G_x^2 + G_y^2} \quad (8)$$

where x varies from $1 \le x \le H$ and varies from $1 \le y \le W$. $G_x(x,y)$ and $G_y(x,y)$ are represented as gradient images of x and y direction respectively. $G_m(x,y)$ is a gradient image which is used to calculate the combined histogram. The edge information is calculated by combining the filtered outputs using the geometric mean.

$$G_U(x,y) = \left(\prod_{i=1}^{m} \max\left(U\left(G_m(x,y)\right), \varepsilon\right)\right)^{1/m} \quad (9)$$

where $U(.)$ up samples the filtered images by an amount of 2^{m-1}. The combined occurrence of the pixel values is calculated by considering the unique intensities of the low contrast input and the edge information.

$$JH = \{JH(k,l); 1 \le k \le K, 1 \le l \le L\} \quad (10)$$

where K and L denotes the total number of pixel values avilable in the low contrast and the detail image, respectively.

$$JH(k,l) = \{count; for I(x,y) = k, G_U(x,y) = l\} \quad (11)$$

From the JH, the probability distribution function and cumulative distribution function (CDF) is calculated as

$$F(k,l) = \sum_{i=0}^{k} \sum_{j=0}^{l} JH(i,j) \quad (12)$$

where $F(k,l)$ represents the CDF.

$$JH_{tr}(k,l) = \left\lfloor \frac{((L1-1) \times (F(k,l) - F(k,l)_m))}{(H \times W) - 1} \right\rceil \quad (13)$$

where $\lfloor . \rceil$ uses the closest integer to round the data, $JH_{tr}(k,l)$ indicates an intensity values that is equivalent to the specified value for the equivalent $I(x,y) = k, G(x,y) = l$, $F(k,l)_m$ represents the lowest value of the cumulative distribution function.

The transformation function results in the improved output, which is represented as:

$$JHE = \{JH_{tr}(k,l); 1 \le k \le K, 1 \le l \le L\} \quad (14)$$

All equivalent intensities based on possible input and edge information, combined occurrences are substituted for JHE's specified intensities, producing an enhanced image.

3. RESULTS AND DISCUSSION

To evaluate the performance of the contrast enhancement algorithms in terms of both qualitative and quantitative, the techniques have been implemented on categorical subjective image quality (CSIQ) database [18].

The CSIQ database contains thirty original photos having dimension of 512×512, each of which has been deformed using one of six different types of distortions at four to five different levels of distortion. Additive pink Gaussian noise, Gaussian blurring, global contrast decrements, and jpeg compression are used to create the six distinct forms of distortions. Here contrast adaptive histogram equalization (CLAHE) [19], edge enhancing bi-histogram equalization (EEBHE) [20], JHE and structure revealing low light image enhancement (STRU) [21] methods are evaluated with the proposed contrast enhancement method using qualitative and quantitative analysis.

Qualitative analysis is based on visual examination and provides information regarding

bothersome artifacts, and over enhancement [22]. Performance measurements such as contrast improvement index (CII), discrete entropy (DE), standard deviation (SD), normalized discrete entropy (DEN) and Kullback-Leibler distance (KL) are used for quantitative evaluation. This section discusses qualitative and quantitative analysis, as well as the outcomes.

a) Qualitative Analysis

I1, I2, I3, I4, I5 and I6 have been selected from CSIQ database to observe the effect of image enhancement achieved by the algorithms on distinct pictures. The first column of Fig. 1 depicts the input images; the second to fifth columns depict contrast-enhanced images of CLAHE, EEBHE, JHE, STRU and the proposed approach, respectively.

The second column of Fig. 1 depicts the enhanced images produced by the CLAHE algorithm. There is a slight improvement in the enhanced image when compared to the input image. CLAHE subdivides the entire image into small neighbourhoods and evens out the intensities within each neighbourhood. This could be due to a failure to utilise the entire dynamic gray range provided by CLAHE.

In order to improve edge information, the EEBHE approach has been proposed. As can be seen in the third column of Fig. 1, the EEBHE method creates enhanced images with improved boundary details as a result of the directed filtering that is utilised in the process. However, the complete grayscale is not utilised and the uneven distribution restrict the amount of enhancement in the resulted image. JHE produces a high contrast image, as shown in fourth column of Fig. 1. It employs the entire grayscale range. However, because the transformation employs mean value of the neighbourhood information, the intensities are unevenly dispersed, and the resulting image is smoothed.

The improved pictures produced by STRU are denoted in fifth column of Fig. 1. The enhanced photographs demonstrate that while the overall luminance of the image has been increased, the contrast between the various items in the scene is modest, resulting in a foggy effect in the resulting images.

The sixth column of the Fig. 1 illustrates the enhanced images produced by the proposed approach. It generates an image with higher contrast and no loss of information data due to the use of multiscale analysis. The improved image retains the edge information which is observed in the artifact-free edges of the improved photos. In comparison to other approaches described in the literature, the proposed technique generates artifact-free enhanced images, according to the qualitative review.

b) Quantitative Analysis

With the use of quantitative analysis, the qualitative analysis is numerically evaluated. Table II summarises the quantitative metrics employed in this study. The suggested method intends to boost the contrast while keeping the image's edge information intact. The local and global contrast enhancement that meets the objectives are calculated using the CII and SD metrics, respectively. The preservation of information details is calculated by DE and DEN. The even distribution of intensity is measured using the KL-Distance. Table III through Table VI list the values of the quantitative metrics for the sample photos, with the highest acceptable values underlined for each measure.

The contrast improvement index is used to quantify the improvement in local regions in the resultant image.The local enhancement enables the objects to be distinguished from one another. Table II contains the CII values. As seen in the table, the proposed method produces a higher CII value than the other techniques. This shows that the contrast enhancement aids to differentiate various objects in the image.

Fig. 1: Contrast enhanced images from CSIQ database. First column: low contrast images(I1, I2,...I6), enhanced images: second column: CLAHE, third column: EEBHE, fourth column: JHE, fifth column: STRU, sixth column: Proposed method.

Table 1 : Various Quantitative Metrics

S. No	Measures	Mathematical representation	Highlights	Range
1	CII [16]	$CII = \frac{M(C_{loc}(J))}{M(C_{loc}(I))}$	Enhancement in local regions	More than the original image.
2	SD [16]	$SD = \sqrt{\sum_{k=0}^{L-1} \left(\hat{I}_k - M(\hat{I})\right)^2 \times pdf(\hat{I}_k)}$	Global contrast enhancement.	More than original image.
3	DE [17]	$DE = \lvert E(I) - E(J) \rvert$	Preservation of information content.	Maximum value:8 bits/symbol.
4	DEN [10]	$DEN = \frac{1}{1 + \frac{\log_2(256) - E(\hat{I})}{\log_2(256) - E(I)}}$	Amount of information loss.	0-1.
5	KL [10]	$KL(p,q) = \sum_{\forall k} p(y_k) \log_2\left(\frac{p(y_k)}{q(y_k)}\right)$	Measure of uniform distribution	0-1.

Table 2 : CII values of contrast enhancement techniques

Methods/ Images	CLAHE (2014)	EEBHE (2019)	JHE (2019)	STRU (2018)	Proposed
I1	2.69	1.09	5.27	1.07	**5.32**
I2	1.67	1.02	2.32	1.04	**6.62**
I3	1.63	1.10	2.62	1.05	**3.62**
I4	2.53	1.09	2.65	1.03	**3.09**
I5	2.77	1.01	3.03	1.02	**3.48**
I6	2.14	1.08	2.30	1.06	**4.35**

Table 3 : SD values of contrast enhancement techniques

Methods/ Images	CLAHE (2014)	EEBHE (2019)	JHE (2019)	STRU (2018)	**Proposed**
I1	29.44	17.86	63.12	12.30	73.57
I2	33.08	13.18	69.12	11.25	70.12
I3	32.4	19.01	70.15	22.35	73.2
I4	54.08	24.25	72.13	21.58	73.50
I5	52.99	34.02	70.98	22.41	73.6
I6	41.06	37.50	69.5	24.83	72.17

Table 4 : DEN values of contrast enhancement techniques

Methods/ Images	CLAHE (2014)	EEBHE (2019)	JHE (2019)	STRU (2018)	**Proposed**
I1	0.66	0.78	0.43	0.48	**0.96**
I2	0.57	0.55	0.50	0.47	**0.65**
I3	0.58	0.54	0.43	0.48	**0.63**
I4	0.82	0.81	0.89	0.56	**0.97**
I5	0.79	0.85	0.54	0.41	**0.98**
I6	0.62	0.78	0.51	0.44	**0.93**

Table 5 : KL-Distance values of contrast enhancement techniques

Methods/ Images	CLAHE (2014)	EEBHE (2019)	JHE (2019)	STRU (2018)	**Proposed**
I1	1.13	2.18	2.71	2.50	0.06
I2	4.44	6.54	7.94	6.72	4.27
I3	4.69	6.75	6.27	6.75	4.64
I4	0.42	1.86	0.21	1.64	0.06
I5	0.34	1.33	3.99	1.81	0.04
I6	1.28	2.22	6.13	2.34	0.5

Table 6 : DE values of contrast enhancement techniques

Methods/ Images	Input	CLAHE (2014)	EEBHE (2019)	JHE (2019)	STRU (2018)	Proposed
I1	5.7	6.86	5.81	5.76	5.49	**7.93**
I2	1.91	3.55	2.45	2.91	1.27	**3.72**
I3	1.66	3.30	2.24	1.68	1.24	**3.35**
I4	6.03	7.57	6.13	7.78	6.35	**7.95**
I5	6.67	7.65	6.68	6.7	6.18	**7.96**
I6	5.24	6.71	5.77	6.08	5.65	**7.43**

Table III contains the standard deviation (SD) data. A high contrast image is produced by a dispersion of intensities that span the whole gray scale. It is quantifiable using the statistical term SD. According to the table, the proposed technique gives a higher SD value compared to other techniques.

Table IV contains the DEN values for all of the sample images. From the table, it is observed that compared to the other approaches, the proposed method provides the highest DEN, due to the use of spatial neighbourhood in the generation of the joint histogram.

The Kullback-Leibler distance (KL) for the sample images determined using the representative and proposed approaches is listed in Table V. A high contrast image should have a uniform histogram with pixel values that span the whole dynamic range. The KL distance can be used to determine the equal dispersion of pixel intensities in the processed image. A small KL-distance indicates that the distribution is more uniform. From the Table 6, the suggested approach produces a low KL value, indicating that the even dispersion of the intensities in the processed image compared to the other methods.

Table VI contains the discrete entropy values for the test photos. The proposed method produces a greater entropy value than the existing associated methods. This is related to the use of joint histogram equalization in the discrete function formulation.

In Fig. 2, the average value of the various metrics is depicted. The entire database was used in all approaches considered, including the proposed approach, in order to obtain a more accurate analysis.

The results demonstrate that the suggested method provides improvement in contrast, edge detail preservation, and information preservation when compared to the existing methodologies described in the literature.

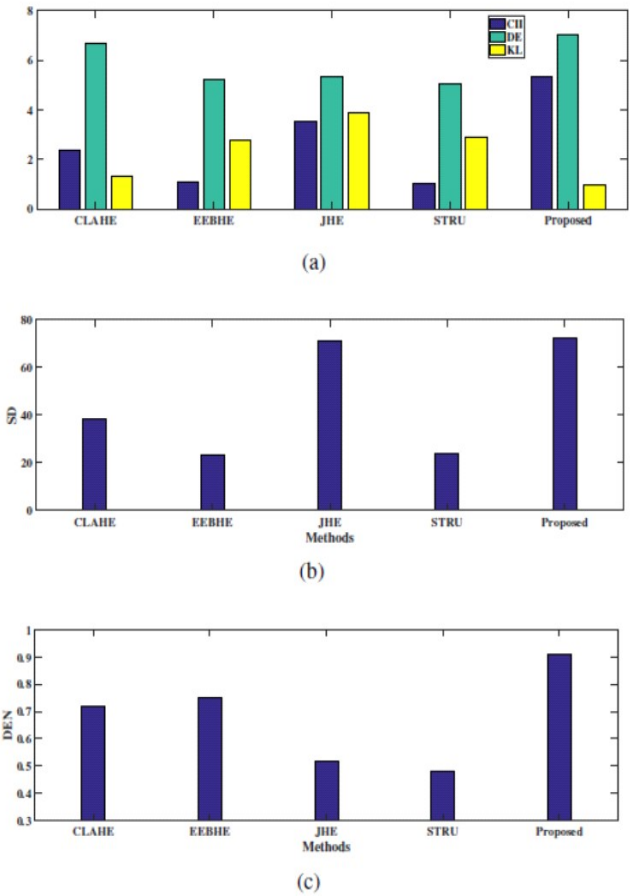

Fig. 2 : Comparison plot of performance measures: (a) CII, DE and KL-distance, (b) SD, and (c) DEN

4. CONCLUSION

In this paper, a global contrast improvement method is presented which uses the combined occurrence of pixel values and detail information obtained from the spatial neighbourhood to result in an artifact-free enhanced image. The combined occurrence enables the transformation function to disperse the pixel values evenly across the whole dynamic grayscale. It has been demonstrated statistically that the proposed approach increases an image's contrast while reducing histogram peaks and valleys to produce improved images. The method performs well in terms of contrast enhancement, information loss prevention, and structural information preservation. The simulation results indicate that the suggested approach is suited better for images with a low dynamic range.

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