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C. Ram Kumar
S. Karthik *Editors*

Translating Healthcare Through Intelligent Computational Methods

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Our sincere thanks to the Almighty for the blessings, guidance, love and support in all stages of life. We are thankful to our beloved family members for standing by us throughout our career and also helping us advance our careers.

We would also dedicate this to the people impacted by the book or featured in it. Last but not least, we'd like to thank our readers, who gave us their trust, and we hope our work inspires and guides them. Also we would like to thank the Almighty God for protecting and giving us the strength and courage to stand tall in this challenging time of COVID-19 pandemic.

Preface

This book intends to provide an insight on unease of traditional medicine, evolution of healthcare techniques in prognosis diagnosis, and therapy. It discusses emerging soft computing techniques in healthcare and technologies in cancer research and also provides insights on artificial intelligence and telecommunication in future medicine.

The book is organized into 10 parts. The first and second parts address difficulties in conventional medicine which in turn paved way for modern techniques. The first part proposes the various difficulties and complications in traditional medicine. The third part talks about augmenting medicine using computer-based intelligence. Computer-based intelligence can give clinical choice help to radiologists and work on the conveyance of care to patients. Concerning picture handling, DL calculations can help select and separate elements from clinical pictures as well as assist with making new highlights. The fourth part provides the computer systems which are used extensively in medical sciences. Common applications include diagnosing patients, end-to-end drug discovery and development, improving communication between physician and patient, transcribing medical documents, such as prescriptions, and remotely treating patients. Part IV "Evolution of Healthcare Techniques" includes artificial intelligence, telemedicine, big data analytics immersive technology and block chain. Part VI "Novelty in Emerging Soft Computing" presents techniques which are the new paradigm of problem solving. It involves evolutionary and swarm intelligence and algorithms and bio-inspired computation. Part VII "Precise Healthcare Technologies Serving in Cancer Research" includes surgery, radiation therapy, chemotherapy, hormonal therapy, immunotherapy, adjuvant therapy, targeted-growth signal inhibition, drugs that induce apoptosis, nanotechnology, RNA expression and profiling, and the latest being CRISPR. The next part discusses the telemedicine; encompasses the diagnosis, treatment, monitoring, and education of patients; and provides convenient, site-independent access to expert advice and patient information. Finally, part IX "Future of Medicine and Computational Techniques in Healthcare" affords people healthier and longer life. The future of medicine is bright thanks to advancements in quality improvement, inventions to combat motion loss, and efforts to address excessive prescription costs.

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Part I
Introduction

Introduction to Translating Healthcare Through Intelligent Computational Methods

T. Gophika, S. Sudha, and M. R. Ranjana

1 Introduction

The main objective of healthcare is to pay attention towards each individual at different stages of life. “Health is wealth” is the proverb to describe the importance of health. Blessed life is possible with good health. The “Universal Declaration of Human Rights” says that people with good health can be more productive. Every country needs to maintain good and efficient healthcare system.

1.1 Role of Technology in Healthcare

Technology plays a very important role in creating a major transformation in healthcare sector.

1.1.1 Electronic Health Records

It is a digitized version of patient health records. This information can be shared among different healthcare sectors for introducing innovations and new treatment plans. It may contain information like age, gender, medicines consumed, previous database, laboratory results, discharge and summary reports, billing information

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and so on. A federal law called the Health Insurance Portability and Accountability Act (HIPAA) establishes control over who can view the database [1].

1.1.2 Telehealth

Information and communication technologies are utilized to provide efficient healthcare services remotely. Separate online portals are maintained for individual patient and are accessed using digital devices. Maintenance of insulin level, food logs, medications, dosing, review of BP and sugar level by healthcare providers, online medicine ordering are some of the ways in which telehealth services are helpful. People living in isolated community will also get benefited due to this technology. This technology helps to offer service in different ways like (1) fixing virtual appointments with doctor from different locations (2) to maintain online patient database portal with detailed history of previous treatment procedures and reports (3) Doctors can talk with other expert doctors at different locations to get clarification, appointments, general and research related discussions and to plan treatment procedures to their patients.

1.1.3 Personalized Treatment and Surgical Technology

Effective translation and integration of technology enables doctors and scientific community to provide better results. Personalized medicine separate people into different groups and offer better diagnosis, treatment and care system (Fig. 1).

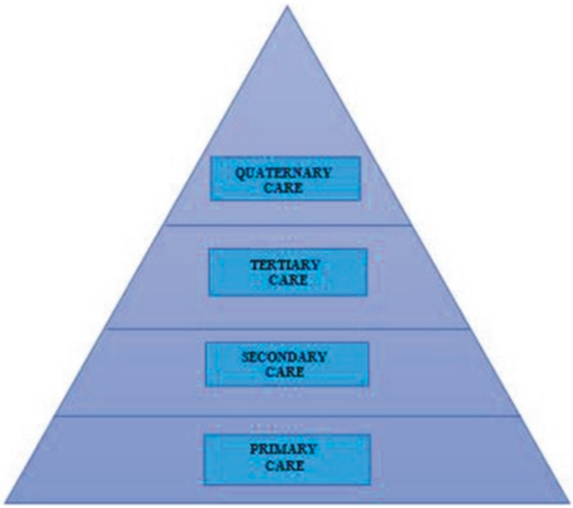

Fig. 1 Classification of healthcare

Surgical robots, 3D printing system and new imaging modalities are some of the roles played by technology. Nearly 3% of surgical procedures are done by robots. In the United States, around 15% of operations are performed with robotic assistance or assistance from any device. Technology integrated into the healthcare systems can be evidenced from following innovations like: (a) minimally invasive surgical procedures (b) 3D printing (c) surgical robot (d) diagnosis using live modules (e) telehealth (f) telemedicine [3].

1.2 Primary Healthcare

It deals with taking care of basic symptoms of disorders and respective medical concerns. It can be categorized under basic care services. Doctors, nurses and healthcare assistance can be under this primary system. Both inpatient and outpatient care services can be under primary healthcare services. General practitioners can take care, and types of disorders which can be treated without any major hospital care can be under this. Disorders like stomach virus, less severe injuries, sore throats, hypertension, and other healthcare service like vaccination can also be included.

1.3 Secondary Healthcare

Health issues that need to have specialized care for patients come under secondary healthcare. Experts need to be associated with patients to provide special attention. We have different systems in our body like respiratory system and cardiac system. If any special attention and care need to be provided for any of these systems, then secondary healthcare services are required. These kinds of healthcare services can also be called as “post-acute care” system. Constant attention is needed for patients but they need not stay in hospital for special care. Care providers can be categorized as cardiologist, orthopaedic and ophthalmologist [4].

1.4 Tertiary Healthcare

Patients who need hospitalization will come under this system. Specialized equipment and experts are needed to treat individuals. Specialized intensive care unit, advanced diagnostic centres, well-equipped laboratories and modern medical facilities are basic requirements. Congenital malformations and pituitary tumours are some of the issues which come under tertiary care [2].

1.5 Quaternary Healthcare

It is the extended version of tertiary healthcare system. Regional- and national-level monitoring systems are needed. Surgical procedures and diagnostic procedures that are not common services come under this healthcare system.

2 Problems Faced in Utilizing Healthcare

During pandemic, healthcare issues were prominent at different levels. There was a need to build a strong healthcare system. Every sector faced a lot of issues during this period. A small evolution of healthcare industry happened during the twenty-first century. Due to rapid growth in health industry, there is a need for updating the skills and knowledge of people who are engaged in healthcare-related services [5–11].

Healthcare-related issues are faced in rural areas compared to urban areas. Due to lack of facilities in rural areas, government-sponsored schemes are formulated to improve and provide good quality services to poor people. To address the absence of medical coverage in rural areas, the National Rural Health mission was established in 2005. Significant improvement is needed in this industry with available infrastructure and labour. Transformation in healthcare can be done using different types of intelligent systems which are available in the market. This helps even an individual in rural area to get secured healthcare services [12].

3 Intelligent Computational Methods

Intelligent computational techniques can also be categorized as "smart techniques", which help to develop various sectors. These techniques are developed by getting inspired from nature and integrating different biological behaviours at various developmental stages of technologies. In today's world, there is a high demand for incorporating technology into different healthcare systems. For example, nowadays due to pandemic and series of lockdowns, even the patients who need to have regular health check-ups could not visit clinics and hospitals. Only technology helped to bridge this gap [13].

A great transformation in healthcare industry in terms of telemedicine and telehealth came to play dominant role. Patients had online consultation with doctors to clarify their issues and doubts. Several online tools and platforms are available and a few new tools evolved. Online platforms offered these opportunities to the users. Because of the availability of these online tools, everyone was able to communicate and even people living in remote places also got benefited. Using these computational techniques, several new algorithms have been framed. Many complex and diverse problems are solved using these techniques. Problems are identified and optimized solutions are provided by these systems. Biologically and linguistically motivated computational paradigms are developed by applying computational techniques at different levels likes design, application and development stages [14]. Three main concepts of computational intelligence include

- Evolutionary computation.
- Neural networks.
- Fuzzy systems.

Evolutionary Computation: It is a sub-field of computational intelligence. The applications of evolutionary computation include design of robots, decision tree creation, training neural networks, tuning data mining algorithms and optimization algorithm solving. It provides a methodology for solving optimization problems where classical numerical methods fail to find suitable solutions [15].

Neural Networks: It is a network or circuit of neurons or is composed of artificial neurons or nodes. It is used for solving problems of artificial intelligence. Function approximation, classification, novelty detection, data processing, medical diagnosis, financial applications, data mining, visualization and e-mail spam filtering are some of the applications using neural network.

Fuzzy Systems: They are structured based on fuzzy techniques. The functional block of fuzzy system consists of following basic blocks: fuzzifier, knowledge base, fuzzy inference engine and defuzzifier. Defined fuzzy sets and numerals can be used as an input to the system. It has an excellent ability to process inaccurate information. Fuzzy logic can be stated as a computing technique which is based on the degree of truth. Fuzzy system can also be defined as a set of values which is characterized by membership function.

From Fig. 2, it is inferred that computational intelligence have few subsets or subclassification:

- Artificial immune system.
- Fuzzy sets.
- Artificial neural networks.
- Evolutionary computing.
- Swarm intelligence.

Even these subclasses are further classified. Biomedicine, data analysis and computer science engineering are some of the applications of computational intelligence. Artificial intelligence, machine learning, deep learning, computational intelligence and nature-inspired computations are some of the widely used computational intelligent techniques. Translation of healthcare industries using these techniques plays a very important role to enhance the infrastructure of current healthcare industry with modern technological tools. Characteristics associated with intelligence in human behaviour are exhibited by these tools.

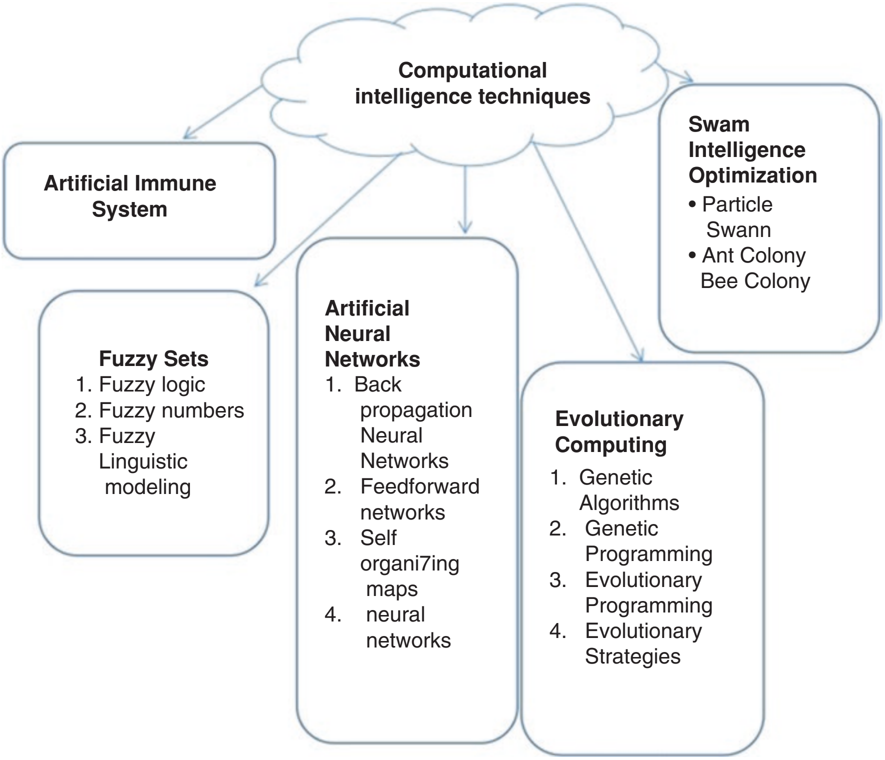

Fig. 2 Types of computational intelligence

4 Healthcare Through Intelligent Computational Methods

Different approaches for healthcare using different techniques are available which play a very vital role in transformation of healthcare sector by technology [16].

4.1 Healthcare Approaches Using Deep Learning

Complex data analysis can be simplified by deep learning algorithms. More accurate and on-time predictions can be performed, and identified abnormalities are prioritized more precisely. Convolutional neural networks (CNNs) help professionals in medical field to diagnose and provide accurate measures according to the identified health issues of their patients [2].

4.1.1 Data Analytics

Structured and unstructured data including clinical database, diagnosis report, prescription, medical history and test results are stored in the form of electronic health records (EHR). Deep learning models will analyse these records at faster speed and high degree of accuracy. Wearable devices and other medical devices connected with mobile phone provide easy way to monitor the condition of patient. Medical risk factors can be analysed and monitored using mobile applications for deep learning models [17].

4.1.2 Chatbots for Mental Health

Chatbots are natural language processing based frameworks which interact with humans. The interaction will be in the form of spoken language, visual language and written communication. They play a potential role among people who struggle to communicate due to mental health problems. Happify, Moodkit, Woebot and Wysa are some of the AI-based mental health apps with chatbots.

4.1.3 Personalized Medical Treatments

Models built based on deep learning help to maintain personalized database of each and every patient. Better patient care is possible as patient can have earlier diagnosis, optimal treatment and better risk assessment at low cost [18].

4.1.4 Response to Patient Queries

Various intelligent computational tools are used in healthcare which involves NLP applications that can understand and classify documents. Data collection, analysis and documentation according to patients' medical history need assistance from recent technologies as huge database needs to be maintained and processed. Standalone communication tools are integrated into practice which include electronics medical report (EMR) or practice management system (PMS). This system helps the patient to plan their schedule with the doctor and records can also be maintained efficiently. Many sites use a protected internet patient portal as a part of an EMR, PMS and other similar applications to receive and respond to various queries integrating machine learning, deep learning and AI-related techniques. Chatbots are used in most of the applications [19].

4.1.5 Prescription Audit

Through this, deep learning models can be designed and errors in prescription, health records and diagnostic reports can be identified.

4.1.6 Health Insurance

Offers are provided to consumers by insurance companies on basis of powerful predictive analysis based on new deep learning models. Fraud insurance claims are also identified by designed models [20].

4.1.7 Research and Development

Research and development play a major role in translating healthcare through different computational methods. Artificial intelligence, machine learning and deep learning-related algorithms are integrated into different domains of research due to their efficiency. Real-world problems can be easily solved using these methods. Research activities are carried out at different stages in the medical field for early diagnosis of disorder, classification of stage or category of disorder, correlating and examination and storage. One of the best known application fields of these methods includes computer-aided diagnosis (CAD). Different image-processing algorithms are also designed to improve the clarity of image and remove the noise segments in CT, MRI, PET and SPECT images. Image-guided surgeries are also one of the emerging R & D activities.

Providing proper care for the patients admitted to intensive care unit (ICU) is very important. Details and records need to be generated and stored from time to time to evaluate their health conditions. Very large electronic health record (EHR) will be created through ICU. A timeseries ICU patient database obtained from Medical Information Mart for Intensive Care is shown in Fig. 3. Different deep learning and nature-inspired algorithms are incorporated to generate and maintain different databases. Deep learning algorithms like long short-term memory (LSTM) and long short-term memory-attention (LSTM-AT) were used.

4.2 Intelligent Systems and Computational Methods in Medical and Healthcare

In recent years, intelligent systems and artificial intelligence (AI)-integrated applications in the medical field are very high. Health and medical industries are promoted by these technologies. Recent clinical decision-support systems are developed by these tools. Different AI techniques can be used to generate datasets related to

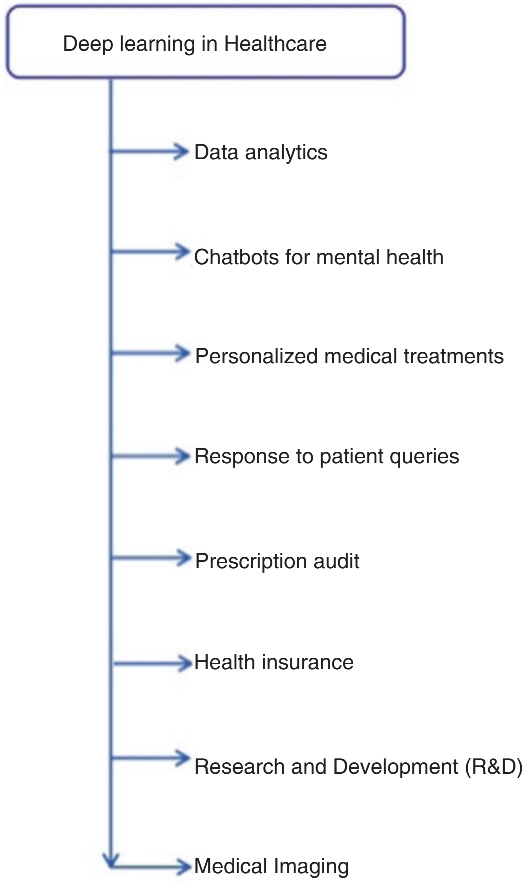

Fig. 3 Role of deep learning in healthcare

process of examination, transformation and loading [3]. Even molecular-level analysis can be done using these modern technologies.

Electronic medical database comprising diagnosis, medications and laboratory results can be maintained. Block chain technologies, artificial intelligence, internet of things, big data analytics, fog computing, deep and machine learning techniques, mobile computing and wearable computing are recently incorporated advanced technologies which are taking the medical field into a new era of technological world. Intelligent and quick recovery systems are needed as the world emerges out into a new era. Also, the need for advanced medical care service and non-invasive methods and emerging telemedicine and telemetry systems also play a very important role in healthcare industry. Figure 4 shows the computational intelligence and integrated systems in the medical and healthcare sector. They have become more powerful tool in terms of performance and computational capabilities [21].

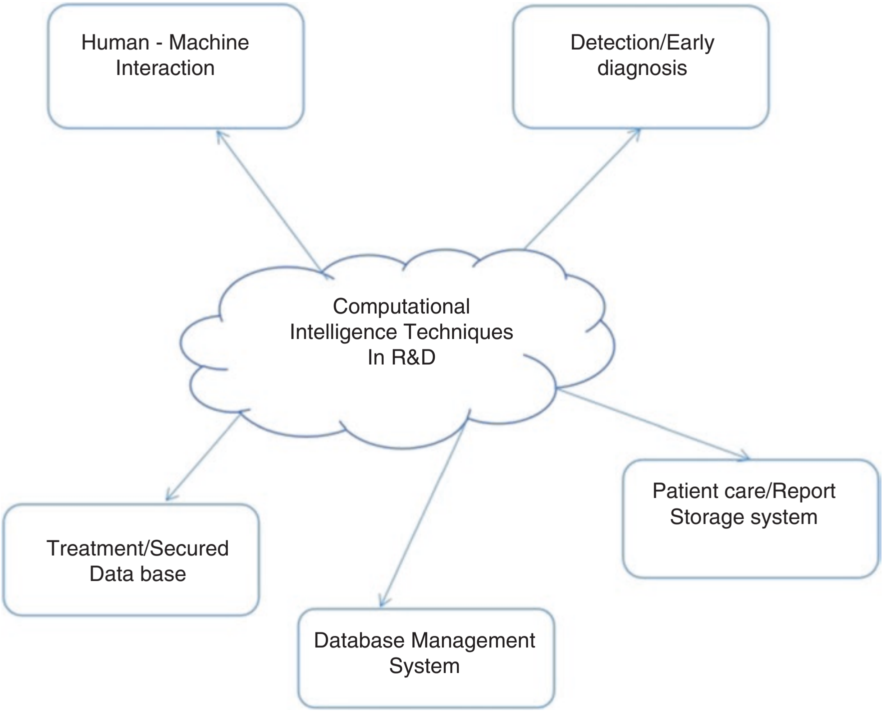

Fig. 4 Computational intelligence and integrated systems

4.2.1 Role of AI in Healthcare

An exponential growth of AI in health sector provides an estimation that by 2026 it may cross 150 billion dollars. It assists healthcare industry by providing surgeries assisted by robots, virtual nursing assistants, better diagnosis and so on.

4.2.2 Virtual Nursing Assistants

This is a much-required service which needs to be provided round the clock. Patient needs to be monitored and accessibility level will be improved by virtual nursing assistant services provided by AI. It converses with patients, registers the issues, fixes appointments with doctor and monitors the condition of the patient round the clock [24].

4.2.3 Wearable Technology and Robotics

Variety of health issues can be tracked and prevented by this technology. Smart health monitoring wearable devices and mobile applications assist people to make self-examinations, i.e. diagnosis and treatment. A best example for this technology is smart watches, which help the doctors to remotely monitor and assist the health condition of their patient.

Robots integrated with AI help to perform surgery with more flexibility and precision. Intelligent prompts are provided by chatbots to users which hold medical databases and ease the process of query. Superior healthcare services are offered by them [22].

4.2.4 Data Management and Diagnostics

Huge number of datasets related to patients need to be managed efficiently in healthcare sector. Integrating AI into healthcare assists various medical organizations to access the medical database within a fraction of seconds. Best patient care can be offered by this system. It also facilitates insurance and pharma companies to provide suitable healthcare plans for needy people by accessing various available medical records. The major role in the healthcare sector of artificial intelligence is shown in Fig. 5.

Image-based diagnosis plays a very important role. Integrating AI helps to diagnose more precisely and accurately. Treatment plans can be formulated and better healthcare services can be offered to patients. Diagnosis reports on different stages of monitoring process or treatment procedures are stored which help healthcare organizations to apply cognitive technology to power diagnosis [23].

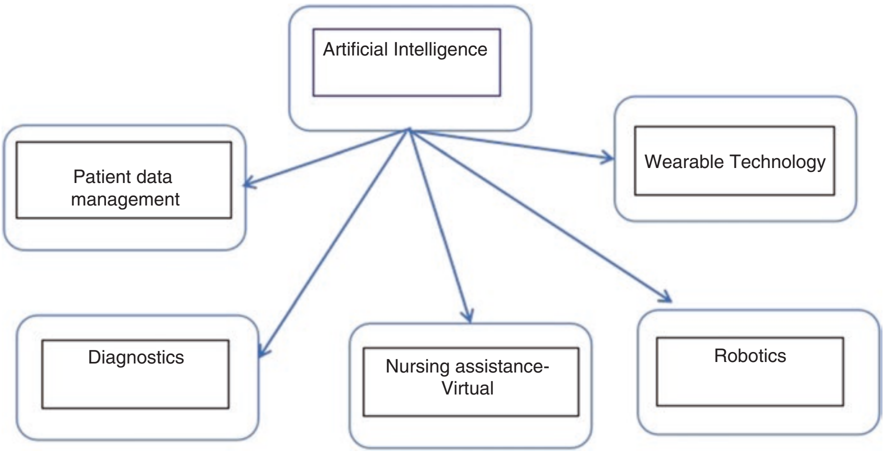

Fig. 5 Major role of AI in healthcare sector

4.2.5 Healthcare Industry Services

There are a variety of issues faced by healthcare industry even after new technologies-integrated services are provided to end users. Need for more reliable and secured services are increasing every day. Cloud-based platforms are utilized for efficient storage of data. Cloud and big data have great impact in healthcare industry. By integrating various resources available, patients, healthcare service providers, financial resources, research community, doctors, drug makers, network providers and hospitals, an expanded healthcare system can be constructed. In the twenty-first century, three major revolutions in healthcare industry took place [1]:

- The internet revolution
- The omics revolution
- Artificial intelligence revolution.
- Also, P9 concepts [1] are included which can be categorized as.
- Personalized
- Predictive
- Preventive
- Participatory
- Pervasive
- Precise
- Preserving privacy
- Protective
- Price reasonably

To provide safe and secured domain, these P9 concepts need to be included in each of the module designed using computational intelligence techniques [25]. Figure 6 shows the expanded section of healthcare system.

5 Conclusion

Due to the exponential development of technology, various services are integrated together to offer better service. Every industry utilizes the technology-integrated services to obtain better lifestyle. Nowadays, due to growing population, increasing demand for resources, less invasive procedures, lack of time to wait for appointments, reserved pre-booked slots according to availability of doctors, stored

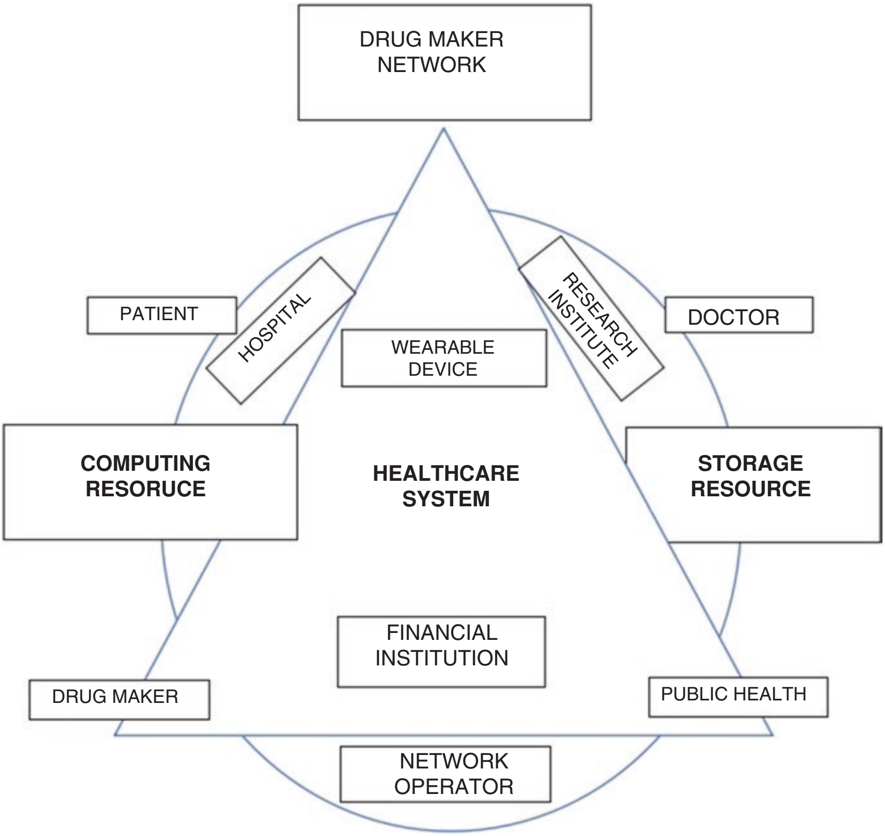

Fig. 6 Illustration of expanded healthcare system

database like medical history, database, medications, lab records, reports, patients and doctors keep themselves in a comfort zone to avail services efficiently. All these are possible by the integration of computational techniques into healthcare sectors. This brings a greater transformation in the medical or healthcare systems. Based on survey, it can be noted that advanced technologies like block chain technologies, artificial intelligence, internet of things, big data analytics, fog computing, deep and machine learning techniques, mobile computing and wearable computing are recently incorporated into current medical field to offer better healthcare services [26].

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Healthcare Administration and Management in Current Scenario

A. V. R. Akshaya, Punita Kumari, S. G. Charulatha, and C. Ram Kumar

1 Introduction

The main objective of healthcare is to pay attention towards each individual at different stages of life. "Health is wealth" is a proverb to describe the importance of health. Blessed life is possible with good health. The "Universal Declaration of Human Rights" says that people with good health can be more productive. Every country needs to maintain a good and efficient healthcare system [1–3].

Healthcare is delivered by the healthcare system, which includes services provided to a single person or a population by various health and health-related agencies. The healthcare system, on the other hand, includes management of the health sector and its organizational structure. Many elements, like food, lodging, apparel, cleanliness and disinfection, way of life, contamination and environment, can influence the soundness of an individual and population. The special covers and passes the understanding of India's healthcare system, the function of a hospital's supporting department, hospital administration, and hospital services.

Any medical clinic has five primary targets:

- Patient history (signs and side effects of infection) and examinations
- Treatment
- Avoidance and post-release direction
- Rehabilitation
- Data

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Some decision cycle tools determine if it is reliable, significant, or even legal to test on humans, with human resources (HR) constantly seeking out the best option to complete productive enrolment based on interest variables [4].

Hospital management is defined as management of aspects in the hospital and coordination of elements of the hospital. This might go from patient consideration to record keeping to stock of medicines and neatness. Hospital management professionals should take care of all elements of the hospital [5].

2 Attributes of Hospital Management

Coordination is the soul of hospital management. Having ergonomic hospital architecture with trend-setting innovation in medical care offices requires a high coordination, synchronization and incorporation. Strengths and complementing skills or sub-specialities Attributes to a distinctive person and his distinct region or department in hospital management. For example, a person who is skilled in intensive care will be assigned to an internship for a departmental person skilled in inventory management of medical supplies. With this, medical professionals put the knowledge of skills into practice and need to be trained to handle each of these areas.

The role of hospital professionals should be flexible, and this is a very important factor in hospital management. During their scholastic temporary positions and training, the vast majority of emergency clinic board experts have openings to a multitude of capacities. Function and works are rotated as well as shuffled in hospitals for all departments and carried out in a fixed period of time and shifts. In this method, the hospital management professional would have worked in every department and area of management. Technology plays an important and big role in helping professionals. These professionals should also be efficient in carrying out and managing the various functions of the hospitals. The final and most important requirement of hospital management is to ensure the data of hospitals are up to date.

3 Human Resources Management

Human resources not only exist to handle employee issues but also contribute to the organization's overall success. The human resource management's role is to keep up with successful administrations, drawing in capable representatives and advancing a positive, proficient climate and working environment security [7].

In order to be successful and to retain good workers, we should understand the practices of human resources and their implementation in our business. A well-thought-out human resource management strategy will organise and classify HR-related difficulties, prioritise recruiting quality employees, and advance your company's top priority.

3.1 HRM in the Hospital Industry

The human resource management in hospital has several roles. HRM maintains employee payroll and benefit; it also checks whether the new hires have required qualification for the particular job. Current personnel of employee are evaluated along with subject matter specialists who perform [6].

- *Human resources planning*: Through vital preparation and investigation of work, including the vision for future business, organizations usually investigate the short- and long-term staffing needs and the essential capacities to address those issues.
- *Work analyses and results*: Job investigations are used in characterizing the assignments and results engaged with each work and to decide the capabilities needed for effective satisfaction. The set of responsibilities are the essential records.
- *Recruitment*: Various strategies are used for attracting the perfect candidates required for the workplace.
- *Selection*: This is one such process of employing the best individuals into the best positions for which they are generally fit.
- *Orientation*: Creating a positive initial feeling with a basic orientation for the new employees leads to good results in work.
- *Training and development*: A new employee should have capacities to improve themselves with information, abilities and mentalities needed for staff to act in their present position as well as to plan ahead for their future.
- *Compensation, benefits and recognition*: The healthcare industry needs to provide suitable levels of compensation and motivation, including wages, formal advantages and perquisites (incentives).
- *Performance management*: Work performance and support can be improved by providing reviews to representatives on their work execution. Performance management is also improved by guidance. Progressive discipline is a corrective process for expected job execution.
- *Termination*: A good organization should deal with the businesses related to termination due to sudden emergencies or due to poor progressive discipline.

3.2 The Importance of Human Resources in the Healthcare Sector

An organized team is more important for every great system, especially in the healthcare industry. The major role of HR (human resources) is to recruit employees, train staff and implement safety measures in the workplace, effectively providing orders and facility to training staff with most accurate and up-to-date factors. Hospital staff provide outstanding service to their patients and are more satisfied in their roles with the help of the high-quality HR management program. Staff training is the most crucial task faced by healthcare facilities. So, providing high-quality training is more important in healthcare facilities [8].

4 Recruitment and Selection in the Healthcare Sector

The first step for achieving highly skilled employees for the organization is the recruitment. The more successful the recruiting strategy, the stronger the employees. Recruitment strategies include advertisements on newspaper and on job websites. Recruiting internal applicants is also one of the strategies followed by the organization as they understand the values of the organization and possess desired skills for the organization needs.

Selection is the next step in staff processing, where they identify the applicants with excellent knowledge, skills, attributes and other important factors that are necessary for an organization. This process is a challenging one; hence a legally defensible selection system is a crucial part for the success of the organization. Interviews and application forms are some of the selection tools used to assess the candidate's skills [9].

4.1 Recruitment and Selection Issues Faced in the Industry Recently

To complete the given tasks and duties, every employee should require a basic skill set. The staff should be quick learners, flexible, easily adaptable and transformable. The employer will choose the people who can work independently with more creative aspects for the job. High staff turnover and limited focus on upgrading and training are some of the common issues that are found across the industries. One of the common problems faced is skill gaps. It is the difference between the market demand and the current skills supplied by the organizations. Recruiting a low-skilled employee will increase the cost of training and the time period. So, this encourages companies to recruit temporary workers and also reduces the cost of training since they have the required skills.

4.2 Hard Versus Soft Skills

Skills are of two types namely hard and soft skills. Hard skills refer to the training and educational experience, usually called technical skills. Soft skills refer to a person's behavioural skill, aptitude and their values. The recruiters prefer candidates who are good in both hard skills and soft skills. Problem solving, self-management, decision-making skills, cognitive skills and so on are very important. The organizations also give more importance for the soft skills from a candidate.

4.3 Psychometric Testing in the Selection Process

There is always confusion between personality traits and soft skills. The existing aspect of one's genetics that is developed through life experience is the personality trait, whereas skills that are learned through experience are called soft skills. Hence psychometric tests are done in the selection process in order to test the personality, aptitude and skills of the applicant for a better analysis.

5 Importance of Training in the Healthcare Sector

A job without training would be challenging for a new employee, which is more complicated in the case of the healthcare sector. So, the employee has to be provided with accurate and up-to-date training. In healthcare environment, the work is often fast-paced. Hence, it is more important to adapt to the workflow. Better training will also improve the knowledge and experience of the staff.

5.1 Training Healthcare Teams Online

Online training is also one of the effective ways of training. Many online courses are available for new and established staff from basic subjects to more specific topics on health and medicine. Many online platforms provide free training for new employees in order to improve their skill sets. The current pandemic situation also demands online training rather than offline training.

5.2 Benefits of Managing Training Online

Managing training online seems difficult for the HR team. We know that healthcare workers are always busy and it is difficult to arrange physical training sessions. But when it comes to online training, healthcare staff find free time among their priorities because of its advantages like accessibility to attend from any location and time.

5.3 Eliminating the Skill Shortage Gap

A staff with inadequate skills cannot be hired. So online training is a big plus for the hospitals and HR team to make sure their employees are accruing a good skill set and knowledge. So, this is helpful for the human resources department to focus on other important priorities [10].

5.4 Excellent Form of Continuing Education

Every individual will be continuously seeking knowledge, new skills and perspectives to improve their career. This can be achieved by online training and can assure that the staffs are up to date with the latest technology and information.

5.5 Ease of Communication

Easy flow of communication can be achieved by managing online training for the healthcare staff in a very efficient way. There are a lot of course providers outside the country that may contain good contents, which would be very easy for the employees. It is just about employees completing the courses.

5.6 Better Versatility for Both HR and Hospital Staff

Since there are so many self-learning online courses available nowadays, which allow the HR and the hospital staff to access their materials anywhere, there is a greater possibility for the employees to succeed in the course [11].

5.7 Online Training Can Also Assist Employees

Online training can also help employees with

- Personal and technical development
- Patient care
- Decision making
- Work–life balance
- Ethics in workplace

Overall, when the staff meet their personal needs, they usually provide high-quality care to patients and more importantly the standard of care will be high.

6 The Importance of Performance Management in Healthcare Sector

Work–life balance is the toughest in healthcare industry, and unhappy employees are also high except for the satisfaction of being in the recovery part of the patients. But many organizations do not treat the staff properly, which is important in the workplace. Thus, there is need for healthcare performance management.

- *Performance management*: In every organization, there are goals which are expected to be fulfilled within a certain period and of course it is possible only with the work of employees. Performance management is also one such process of observing and encouraging the staff for their constant completion of their tasks. Performance management can also be done through software nowadays.
- *Employee problems in the healthcare industry*: Healthcare professionals require more energy for managing the patients, the admin, and so on. There are only a few people who are efficient for this kind of work and workplace atmosphere. Employee satisfaction statistics rate also plays a major role in persuading the youth to learn about the healthcare industry. And that is where the performance management plays its role.
- *Performance management affects healthcare workers*: If the healthcare industries have efficient performance management, then all the problems faced by the employees can be fixed. If the healthcare workers feel comfortable, they would be happy that their career choice will again enhance the effect of work. And they would possibly be happy to work long hours.
- *Importance in healthcare*: Healthcare industry is very important in saving people's lives and this can be achieved by high-performance management in which high standard of care is given to the patients. A hospital cannot be run without the coordination of healthcare professionals. Therefore, performance management is important in healthcare.
- *How to implement performance management practices*: If a performance management system is absent in an organization, then certain goals should be fixed and should be brought into practice. The goals should be distributed and achieved with the help of all the employees. Every work should be appreciated. Every employee's performance assessment with reviews should be given, which will enhance the amount of work by the employees because of getting appreciated. Performance management is a very important aspect which will protect the healthcare workforce.

6.1 Top Performance Challenges Faced in the Health Industry

Healthcare is one of the fastest growing industries. The quality care given to patients, devoted clinical experts and cost-saving clinical techniques play an important role. Other than specialists, the intensive care unit requires support staff – people who are engaged with the front end to back end on value-based tasks. Some of the performance management challenges that have affected the performance of institutions lately are as follows:

- *Limited performance improvement opportunities*: Half percent of medical care experts face the absence of professional success openings in their job. Absence of preparation stops their ability in improvement and vocation development. Denying the preparation and advancement openings leaves the emergency clinic staff disappointed, discouraged and unfocused [12]. Reports recommend that clinical experts feel miserable because of restricted educational openings and dullness in their positions. Preparing is never simple and it is critical to further develop worker execution; yet in addition it guarantees that the representatives get freedom to foster abilities, push forward in vocation and feel fulfilled consistently.
- *High employee turnover due to work pressure*: Increasing work pressure rate is somewhat a big challenge for healthcare organizations. Due to high work culture, responsibility, non-payment of remunerations and absence of innovation development to accelerate processes, employees feel like quitting the job. Lack of appreciation and recognition for the staff results in being lethargic in work and high employee turnover.
- *Lack of standard procedures to measure performance*: Dealing with the staff's performance in healthcare is usually more vital. Since providing patient with required services and intensive care is important, this job requires certain commitments and goals. It is hard for auditing the execution to utilize the right arrangement of qualities.
- *Absence of measurable goals*: Many organizations are not proactive in setting performance goals. So, the staffs are unaware of their tasks. Setting performance goals is the first step for measuring the performance in healthcare industry. But it should not pressurize the staff. These usually improve the performance levels and provide improved quality of services.
- *Reviews on inconsistent performance*: Following employee performance in the absence of goals is a tough task. Performance evaluation is done and real-time review is given to the workers, which will improve every individual and develop them [14].

6.2 Performance Management: A Tool to Build High Performing Workforce

Performance management helps in developing the performance of the employees, which in turn helps in creating a high performing workforce with high-quality services production. With a well-distinguished approach, the medical activities of the healthcare institution can be managed in an organized manner which would increase service quality. Data-high tools can be useful in the deciding process, streamline processes, building more performing workforce and improving the quality of patient-centric services. Designing a set of defined performance goals for the medical staff will improve the performance rate. Using a performance tracker, the achievements of the medical staff and patients can be monitored. Making simple ways to manage the performance like setting goals, developing skills and appreciating top performers will improve service quality and form an engaged workforce that provides quality healthcare service.

7 Compensation and Retention Strategies for Healthcare Sector

To sustain in today's world, healthcare institutions should provide competitive compensation and carry out proposed action to recruit and retain the talented workers and professionals. To retain the top performers of the institute, impressive incentive plans and retention policies are being introduced and executed successfully.

The organization uses strategies to administrate and govern their pay and benefit programs successfully. The benefits are designed for developing the organization's strategies [13].

7.1 Build Up a Compensation Strategy for Executive Talent

Remuneration is a vital component of the all-out remunerations procedure to draw in and hold the best initiative, and medical services frameworks ought to foster a pay structure that incorporates:

- Base pay
- Short-term motivations
- Long-term motivations
- Retention motivations

7.1.1 Base Salary

Base compensation is a fixed remuneration that normally doesn't change as per execution or hierarchical outcomes. It pays for experience, information and individual execution. It isn't unexpected practice to build up and keep a compensation organization program with two goals: furnishing base remuneration that is serious with the market and controlling fixed expenses. Furthermore, the program ought to guarantee that the pay is impartial when contrasted with comparative situations inside the association. Practically speaking, not all pay rates will be equivalent to the objective and there are various substantial justifications for why compensations might change from the objective. Pay targets in the compensation organisation programme enable leaders to decide pay rates by assessing factors that incorporate individual experience, market rates, length of administration and business needs.

7.1.2 Momentary Incentives

Top-performing associations configure momentary motivation plans, to grant motivators utilizing an even handed and restrained methodology. The arrangement ought to build up the way of thinking that leaders are associated with authoritative outcomes; it ought to inspire and drive proper practices and convey rewards that are in arrangement with hierarchical achievement and development.

7.2 Long-Haul Incentives

Long-haul motivation plans are becoming as significant parts in remuneration methodologies for medical care frameworks as the plans demonstrate the importance in holding and enlisting top ability. As associations search for long-haul execution-based remuneration arrangements, there is an assortment of choices to consider [15]. One arrangement that is famous is an exhibition-based long-haul motivating force plan that grants cash towards the finish of a multi-year execution period dependent on the accomplishment of foreordained objectives. Another methodology that is turning out to be more normal is the "execution-based" SERP. This choice offers serious long-haul remuneration, accepting sufficient degrees of supported yearly execution.

The choices of long-haul motivation plan shift, as well, between for-benefit and non-benefit medical services associations. Revenue-driven medical care frameworks can incorporate some kind of "value" grant in the all-out pay bundle for leaders. Chiefs in the non-benefit, charge-absolved medical services climate do not have the chance of genuine "possession". Measuring long-haul esteem is considerably more significant with a duty-excluded association on the grounds that the "investors" are citizens and individuals from the local area. Long-haul plans are just momentary measurements over a multi-year time frame. The pattern has moved and long-haul or worth-centred measurements power a more key or visionary perspective on future guideposts for progress. While monetary outcomes stay significant, associations are including more measures that emphasize on development, portion of the overall industry, local area effect, and manager brand [16].

7.2.1 Maintenance Incentives

One part that has seen critical development is the execution of maintenance remuneration. The medical services industry specifically has been on the front line because of the new and anticipated future union of clinics and medical services frameworks.

Regularly, maintenance motivators happen on occasions of an expected exchange which requires coherence to execute change designs and keep up with the continuous worth of the endeavour. It tends to be fundamental to guarantee that key ability is held, working capacities are held flawless, and connections are kept up with during a huge change. The design of maintenance plans shifts as certain associations might decide to join maintenance benefits inside individual business arrangements, while others make standard arrangements or approaches for gatherings of professionals and experts.

7.3 Plan and Implement an Effective Compensation Strategy

The medical services industry is going through critical change and organizations must have all around planned leader remuneration programs with maintenance systems to select and hold top ability. Planning and executing compelling plans require:

- Taking an all-out remuneration and absolute pay for arrangement in regular intervals.
- Aligning the pay plan with the mission and systems of the association.
- Creating and keeping up with conditions that are good for conveying cutthroat pay.
- Designing maintenance techniques that adjust the interests of the chiefs to the partners.

8 Hospital Information System

A hospital information system (HIS) is a sector of health informatics that chiefly centres on the management needs of the clinics. HIS is a set of frameworks formed to deal with every area of the hospital's activity like clinical, managerial, financial, and law issues and the comparison handling of administration services. Hospital information system is also called the executive programming or medical clinic board framework.

Hospital information systems are the source of information about a patient's history or a doctor's schedule timing. Since everything is software based, it's easy to access the patient's health history including the visual reports such as x-ray. HIS is communicated using portable devices and includes laboratory information system (LIS), policy management system, radiology information system (RIS) and communication system.

8.1 Potential Advantages of Hospital Information Systems

- Following the clinical guidelines, efficient organization of money and diet plans for patients assist in emergency clinic development.

- Monitoring the observation of medication use and its investigation leads to decrease in unfriendly medication connections while using more efficient drugs.
- It improves data integrity, reduces duplication errors and lessens transcript errors.
- Hospital programming is very easy to utilize and eliminates errors.

8.2 Safety and Quality of Healthcare

Intensive care provided by the healthcare industry ensures safety and quality. This kind of healthcare provides more care and less harm for the patients [17].

- *Safety*: The avoidance of potential injury from medical facilities, anticipated harm from the patient's care, or avoidance of the environment in which such care is provide.
- *Quality*: The probability of people receiving good health services of desired outcome with current expert information; safety and quality are always important when it comes to health system.
- *Improving safety and quality*: Every organization aims in improving safety and quality of health care. We must focus on efforts at the national level, state or territory level, service level, and clinical level or specific areas of health care.

8.3 Standards and Accreditation

Safety and quality standards showcase the percent of care that the consumers expect from a particular healthcare service. Protecting public from harm (ACSQHC 2019b) and the second edition of NSQHS standard are examples of standards. Health services are evaluated and relate to these standards to become recognized (ACSQHC 2019b). State and territory health departments help in determining the evaluation against the NSQHS standards. There are various other areas of explicit principles that apply in healthcare administration associations like:

- National Safety and Quality Primary Health Care Standards.
- National Safety and Quality Standards for Digital Mental Health Services.
- Clinical Care Standards [18].

9 Biggest Issues Facing Healthcare Today

9.1 Challenges, Obligations and Opportunities

- *Costs*: Executing strategies to face the development of medical and drug expenses and the effect of quality of care.

- *Experience of consumer*: Tending to and ensuring that all client participation and results are straightforward, favourable, ideal medical care prosperity fits regularly into the "presence stream" of each and every individual, families and networks.
- *Delivery system transformation*: Beating the social determinants of medical services is accomplished by functionalizing, coordination and conveyance framework change of clinical and non-clinical benefits through joint efforts to improve results.
- *Data and analytics*: Using different advanced technologies, software and new resources, health outcomes can be improved and administrative burdens can be reduced.
- *Interoperability/consumer data access*: One of the probably greatest issue is chipping away at the exchanging part of payer, patient, provider data and work cycles to bring the collected data and getting to it when required.
- *Individual health*: Distinguishing and working on the patient's general medical care and financial, social, lifestyle and ecological prosperity for frictionless and associated medical services.
- *Next-generation payment models*: Creating coordinated functional foundations for a more collaborative and even-handed way to deal with all the upgraded quality results in the progress.
- *Accessible points of care*: The wearable computerized gadgets, digital medical devices, home care, small medical clinics; and acknowledgment of these drives more attention for people nearer to home and office.
- *Healthcare policy*: Managing the alteration of medical care strategy, rules and regulation, political threat and absence of a restrained administrative cycle are taken care of by healthcare policies.
- *Privacy*: Consumer trust can be enhanced by maintaining the privacy of the medical service data by using cyber security.

9.2 Turning Challenges into Opportunities

While there are numerous motivating forces to keep medical services' costs high, "Foreseeing cost in the customary health care coverage climate is incredibly perplexing", says Nathan, the CEO and the organizer of Zipari. The best chance to reduce the healthcare costs for payers, shoppers and framework is by having a good payer–buyer relationship. Payers have the data buyers need to settle on better choices about their well-being and accounts. When a payer demonstrates that they can make important and confident proposals, the customer can settle on the choices that won't just prompt better well-being results but result in decreased expense of care.

10 Conclusion

Nowadays, we are seeing more changes in the 2020 Healthcare Executive Group Top 10 than we had earlier and all things considered. Medical services executive group part associations express that the interest for and speed of progress and development are speeding up as medical care has moved to all important focal points in the public discussion. It shouldn't be astounding that expenses and straightforwardness are at the first spot on the list alongside customer experience and conveyance framework change. "Information, investigation, innovation, and interoperability are as yet progressing difficulties and openings. Simultaneously, leaders should be careful, as individual wellbeing, customer access, protection, and security are on-going difficulties that likewise need to stay as needed".

With the frequent development in the accommodation business, organizations are looking for people who can perfectly fit the job. Psychometric testing will be a common tactic in the choosing cycle, so the employers must consider completing the test dependent on legitimate examination to ensure the job while undergoing investigation from a common freedoms point of view [19].

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Part II
Unease of Conventional Medicine

An Insight into Traditional and Integrative Medicine

D. Sophia, V. K. Gopalakrishnan, C. Ram Kumar, and B. Vijayalakshmi

1 Introduction

Ever since the dawn of human civilization the herbs and plants play a major component as medicines. According to history there were about 350,000 species (which includes plants, herbs, bryophytes and fungi) which were used as traditional medicine. Traditional system of medicine is considered to be the progenitor of modern medicine as it play a significant role in curing various chronic diseases. There are different ways of interactions between the herbal and modern drug, one such is few drugs originate from the plant sources. Every single traditional medicine will have a long history with considerable progress. The World Health Organization supports the Member States for developing their own traditional medicine constraints and limitations.

According to the reference of World Health Organization (WHO), a conventional medicine is characterized as the aggregate of information, expertise and practice in view of the hypothesis, conviction and experience to various societies, regardless of whether reasonable, utilized in the support of wellbeing as well as in the counteraction, diagnosis, improvement or treatment of physical and psychological

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maladjustment. Traditional medicine comprises the knowledge systems that were developed over years by the ancestors before the introduction of modern medicine. When a traditional medicine is adopted from another country it will be named as an alternative or complementary method of traditional medicine [1].

WHO has stated that about 80% of people started using traditional medicine because of its traditional healing beliefs and the affordable cost compared to conventional medicine. Traditional medicine follow health practices based on knowledge, and beliefs by incorporating plant, animal and mineral based medicines, spiritual therapies, and other manual techniques to prevent ailments and maintain wellbeing [2].

Since traditional medicine was developed based on the society, culture and habitat of the place, it has various types which are shown in Fig 1. They are

- Indian traditional medicine
- Chinese traditional medicine
- African traditional medicine
- European traditional medicine
- Korean traditional medicine
- Arabic traditional Medicine

Fig 1 Types of traditional medicine

2 Indian Traditional Medicine

Indian traditional medicines are well known for meeting global healthcare needs. The system of Indian traditional medicine represents a healthy way of living with established principles and concepts based on medical philosophies to prevent diseases and promote natural health. The Indian medical system includes mainly Ayurveda, Yoga, Unani, Siddha, and Homeopathy, which is represented by an acronym AYUSH.

2.1 Ayurveda

Ayurveda is one of the oldest and well-defined theoretical framework which is befitting throughout the ages, and it is found to be more effective than modern therapies in a few cases. Unlike modern therapies, it first determines the physiological framework and then the therapeutic practice which is a classic feature in the medical field. Ayurveda precisely means the "science of human life" [3]. Atharvaveda, Sushruta Samhita, and Astanga-Hridaya were the major treatises of Ayurveda. These three were popularly known as "Brihat Trayess" (the big or major three). These three treatises covered all forms of complications of a vast body of literature which had information from more than 1500 years.

The treatments are of different types:

- Shodhana therapy (purification treatment)
- Shamana therapy (palliative treatment)
- Pathya Vyavastha (appropriate diet activity)
- Nidan Parivarjan (avoids situations leading to disease aggravation)
- Satvajaya (psychotherapy)
- Rasayan (immunomodulators, anti-stress, and rejuvenation drugs)
- Dipan (digestion)
- Pachan (assimilation)

Ayurveda lays incredible emphasis on the eating routine guideline. As per Ayurveda ideas, food has incredible impact over physical, fickle, and mental advancement of a person. The food is the essential material for the development of the body- and life-supporting indispensable matter known as rasa. The rasa is changed over to body parts and supports a wide range of life exercises. It also gives importance to maintaining harmony with nature [4, 5].

2.2 Yoga

Yoga is a mindful practice which helps in improving strength and physical balance and provides strength with flexibility. It helps us relax and get better sleep. Yoga is considered to be a physical practice which is helpful with mental health like reducing aggression, depression, and anxiety.

2.3 Medical Yoga

Clinical yoga is described as the usage of yoga practices for the evasion and anticipated treatment of diseases. Clinical yoga helps in appropriate breathing systems, care, thought, and self-reflection/study to achieve the most outrageous benefits. Medical yoga is not only individualized for the patient but also for his family as a treatment plan.

Yoga tunes the autonomic sensory system into a good arrangement by invigorating the parasympathetic sensory system. It is initiated when our body feels undermined or worried. This results in vasoconstriction, causing diminished blood flow. One's heartbeat and circulatory strain increase, the circulatory system configuration changes, inciting lessened stomach-related structure development and diminished pee yield. The parasympathetic system has a profound influence on circulation to the stomach-related structure, frontal cortex, uttermost focuses, and sexual organs. Yogic practices work by reducing physiologic fervour and quieting down this consistent play of the autonomic structure. The therapeutic effect of yoga has positive effects on pregnancy, prenatal and postpartum depression, stress, etc. [6].

2.4 Unani

Unani medicine had its birth and source from Greece. It is believed that Unani was established by the great physician Hippocrates (460–377 BC). Galen (130–201 AD) contributed to its further turn of events. Aristotle (384–322 BC) set down the establishment of anatomy and physiology. Dioscorides – the eminent doctor of the first century AD – has made huge contributions in improving pharmacology, especially plant origin drugs. The following period of advancement occurred in Egypt and Persia (Iran). The Egyptians had all around developed drug storage pharmacies.

It is theoretically said that six essentials are the basic requirement for maintaining a healthy state. They are

- Air
- Food and drink
- Bodily movements and reaction
- Psychic development and rest

- Sleep and alertness
- Evacuation and maintenance

Unani system of medicine believes that the body is composed of four basic elements. It has a simple and complex organ system with varying temperatures [7]. In Unani, we diagnose a disease through examination of pulse rate, and it is treated by employing four types of therapies as follows:

- *Regimental therapy* – It usually consists of drug-less therapy like exercise, massage, bath, etc.
- *Diet therapy* – It is based on a patient-specific dietary regimen.
- *Pharmacotherapy* – It involves the contribution of drugs to correct the cause of the disease.
- *Surgery* – It takes place in case of failure of parts of the patient.

The Unani system was introduced in India in the early eighth century, and it has been recognized by the Indian Government for clinical practice and research. The products like ointment, herbal powders, oils, and tinctures were synthesized from plant-based formulations.

2.5 Siddha

The word Siddha is a Sanskrit word meaning attainment of perfection or fulfilment. Siddha medication is quite possibly one of the most ancient clinical frameworks of India and very similar to Ayurveda. Siddha is the mother medication of antiquated Tamils/Dravidians of peninsular South India. The word Siddha implies truth. The people who were related with building up such thoughts were known as Siddhars. They recorded their spiritualist discoveries in medication, yoga, and astrology in Tamil. Five elements (Aimpootham) and three forces/faults (Mukkuttram) are regarded as the major principles in the system of Siddha medicine. Siddha also follows and utilizes the eight methods of examination (Envakai Thervukal) to decide analysis, aetiology, treatment, and anticipation. Several lines of evidences suggest that Siddha medicine can treat a lot more extremely normal and uncommon infections. Siddha medicine system focuses on safely grown herbal and herbo mineral treatment for various skin disorders namely psoriasis, skin inflammation, alopecia, diabetic ulcer, vitiligo, pemphigus, and pompholyx. Siddha system also includes an individual's physical, physiological, and psychological well-being as well as the patient's surroundings. Minerals, metals, and to some extent some medicinal plants in their original form are formulated through various procedures and are used in the treatment of diseases [8, 9].

2.6 Homeopathy

Homeopathy depends on the organization of cures where dynamic constituents are weakened so that no distinguishable trace of them remains in the eventual outcome. However, it is viewed as a dubious treatment and is generally polished to treat different infections [2].

The main five principles of homeopathy are described as follows:

- *Principle of similia*: This is the fundamental law in homeopathy. It is also referred to as treat like by likes. Treating sufferings in the patient by administration of homeopathic remedies will have the potency to cause small sufferings in a relatively healthy person.
- *Principle of individualization*: Principle of individualization states that each remedy is tailored as per the needs of the individual.
- *Principle of using single remedy or minimum dose*: According to this principle, a patient should be treated using simple as well as a single remedy at a shot. Homeopathic medicine is prepared by a process called dilution method where only trace amount of the active constituent is found in the medicine given to the patient.
- *Principle of potentialization*: Greater the dilution, greater the potency. It is believed that side effects and harmful reactions of the medicine could be reduced if quantitative reduction and qualitative enhancement are followed.
- *Principle of healing by nature*: Homeopathic treatments are generally safe and serious adverse side effects are believed to be negligible. As per the homeopathic treatment, the milder illness should not be progressed to major or severe illness.

3 Chinese Traditional Medicine

Like conventional Indian medication, customary Chinese medication is additionally one of the most antiquated in this living tradition. As per the arrangement of Chinese conventional medication, man is viewed as a radio wire among space and natural components. In the antiquated Chinese way of thinking, the world is viewed as a solitary unit and its development leads to two fundamental contradictory angles, yin and yang [3]. The term yin and yang allude to positive and negative individually, together it is intended to be “opposite”. Yin and yang ought to be controlled for the ordinary working of the human body. Chinese savants trust that the four real humours (qi, blood, dampness, and substance) and inside organ frameworks (zang fu) assume a significant part in keeping up with the equilibrium between yin and yang in the body. Moreover, it is also believed that when “yin reduces, yang raises, or yin raises, yang reduces”. Dysregulation and awkwardness of these energies lead to the improvement of infections. This standard is considered by the doctors for treating patients. Restorative plants and medications have the property to adjust yin and yang in the body [10, 11].

3.1 Acupuncture

Acupuncture is a form of treatment which involves inserting thin needles through a person's skin at specific points on the body, to varying differential depths. This form of treatment benefits in curing several neurological problems.

3.2 Tai Chi

Tai chi is a combination of gentle movements, mental focus, breathing, and relaxation. This method helps in improving the balance and stability and improves the quality of life in people with heart failure and claims to manage mental stress in a gentle way [12].

3.3 Chinese Herbalism

Chinese herbal products are still considered to be unique as they focus mainly on homeostasis of the body. It involves the use of plant products that are used to treat certain medical problems like stroke, heart disease, mental health issues, migraine, insomnia, neurodegenerative diseases, and respiratory diseases significantly with limited side effects [13].

4 African Traditional Medicine

In Africa, the customary medication framework is of incredibly helpful potential. The customary clinical specialists and healers have a fundamental influence on its social history. African clinical professionals dominate in more than one practice. Regardless of the impact of Western development, more noteworthy populace in Africa utilizes home-grown solutions for their essential medical care. In the event of any genuine or ongoing sickness, independent of the societal position held or the religion followed by the individual, they even look for otherworldly treatments as one of their mending rehearses. Africa's multi-layered customary information in medication joins numerous worldwide and nearby components. Customary medication in Africa, made for the most part out of therapeutic plants, has been contended to be connected to social and financial reasons [14, 15].

The traditional medicine system in Africa includes a diverse range of health practices. They are as follows:

- *Psychotherapists*: Traditional healers of Africa are good psychotherapists. Psychological basis of an illness is diagnosed and treated before prescribing herbal medicines to treat the symptoms.
- *Herbalism*: In herbal medicines, whole herbs, herbal decoctions, and their preparations that contain active constituents of the herbs are used.
- *Spiritualism*: Spiritualism is considered to be one of the holistic approaches in the African traditional system. Consulting the spiritual world by diviners, invocation, incantation, and animal sacrifices to God supreme force/deity are part of their spiritual belief.
- *Therapeutic occultism*: It is a prevalent thought in the African community that diseases could be due to supernatural causes like ancestors' curse, evil/angered spirits, or witchcraft. In such cases, the practice of exorcism, magic, and magic spells to heal illness is also practiced to heal the diseases. The objects like talisman, amulets, and stones engraved with figures or symbols are believed to cast miracles and break spells [16].

5 Korean Traditional Medicine

The standard Korean medicine possibly has its establishments in Chinese and Japanese drugs. There is verification of the importation of Chinese aesthetic sciences into Korea around the tenth 100 years. The portrayal of Korean prescriptions was known since the twelfth 100 years. Over the most recent 700 years, Korean medication fostered its restorative regimens – primarily entire, individual-driven Sasang-protected grouping and Saam needle therapy techniques. By the seventeenth century, conventional Chinese and Korean medications were underdeveloped as Saam needle therapy rehearsals were being used.

Sasang constitution types depend on physical qualities, disposition, and different attributes of a person.

Each individual can be classified into any of the four sacred sorts:

- Tae-Eum
- So-Yang
- So-Eum
- Tae-Yang

Every constitution type is explicit for appearance, character qualities, illness inclination, drug reactions, and physiological characteristics of the person. Treatment depends on constitution type, rather than manifestations. The Buddhist priest, Saam propounded needle therapy which usually depends on the five components – earth, metal, water, wood, and fire, and six kinds of qi (energy). He proposed that the five components have either supporting or smothering connections. The Saam strategy depends on 12 meridians, addressing every one of the physiological cycles. Every organ has a prevailing component and energy type [17, 18].

Korean needle therapy also referred to as Korean acupuncture is considered to be one of the natural needle therpaies. In this needle therapy, professionals utilized home-grown herbal concentrates or diluted honey bee toxin to treat various skin diseases, inflammation, autoimmune disorders, neurological disorders, etc. Although the Korean medication has been established in Chinese medicine, today it is an autonomous clinical framework with its own standards, theory, and practices. One more contributing variable to the development of Korean medicine is the acknowledgment of ideal models and variety. Korean medicine specialists reviewed their traditional medicine systematically and scientifically, which helped in the improvement of numerous clinical disciplines [19, 20].

6 European Traditional Medicine

In the dawn of Western Roman Empire, knowledge based on medicine and health was surviving based on Greek and a Roman text which was preserved.

Hippocratic Medicine The main component of Hippocratic philosophy based on the literature is "healthy mind in a healthy body". According to Hippocratic medicine, conventional medicine should be based on thorough observation, reasoning skills, and experiential knowledge for diagnosis and treatment [21].

Temple Healing The Greeks believed in numerous folk-healing practices and medicines including temple healing through visions, dreams, and incantations. The concept of temple healing in Europe can be traced back to second century BC. The temple of Asclepius at Epidaurus, believed to be the God of medicine in Greek, was worshipped by thousands of people for mental and physical health [22].

Pagan and Folk Medicine Most of the medical practice in the Middle Ages reflects the context of pagan practices in which it is rooted. Pagan folkloric traditions are based on the faith in practicing magic with the assistance of most powerful entities other than humans [23].

Monasteries Monasteries were considered to be spiritual centres for the sick and downtrodden. It was built in a secluded place and developed not only for spiritual healing, but also for intellectual studies and medical practices. Many sick people believed monasteries to be the place for both spiritual and conventional healing practices [24].

Medieval Medicine Medieval medicine and surgery trace back to the Greek tradition. According to its tradition, the elements fire, water, earth, and air control four humours of the body: yellow bile, phlegm, black bile, and blood. It is believed that an imbalance of these four body humours causes diseases and other ailments. The practitioners of medieval medicine focussed on balanced diet in the treatment of diseases. Medieval medicine and surgery strongly believed in the quote of Hippocrates, “Let food be thy medicine and medicine be thy food.”

Medieval Surgery Medieval surgeons were considered to be expertise in external surgery like treating external injuries and wounds and cataracts but were not able to perform surgery in the internal organs, as surgery was regarded as a practice of dangerous procedure. But later, the surgeons were taught that the knowledge of human physiology and balanced diet is important to treat the patients. In this way, surgery gained its importance and was no longer considered as a dangerous act.

7 Arabic Traditional Medicine

Arabic traditional medicine, which especially involves herbal medicine, can be seen throughout the Middle East countries for culinary and medicinal purposes. Literature studies report that around 250 plants and their species are still in use in traditional Arab medicine. Spiritual healing which is practiced till now is based on the Islamic religious texts and their worship [25].

The development of hospitals in the Arab world was regarded as one of the most important innovations in medical practice. Pharmacy has started its professional existence with the Arabs due to the advancements in Arabic chemistry and arrival of abundance of precious drugs from Middle East countries. The achievements and developments in pharmacy and medicine by the Arabic science were translated and exchanged with other nations. This paved the way for a greater interest and further accomplishments in surgery. Arab scholars translated Greek texts into their language and made significant scientific investigations. They also made original scientific and technological advances which made a breakthrough in the field of medicine. They introduced many features like medical charts and protocols, use of alcohol as an antiseptic, and techniques such as distillation and crystallization that we make use of even now for drug synthesis [26, 27].

8 Osteopathic Medicine

The beginning of osteopathic medication traces back to over 130 years. Osteopathic medication focuses on the whole body, not restricted to explicit parts or harmed portions of the body. This medication depends on the way that our natural framework is interrelated. The guideline behind osteopathic medication is that the body can recuperate itself with the right change in the real stances/spine or joint control and in this manner assists with reinforcing the outer muscle structure of the body without the utilization of medications or prescriptions. As of now, osteopaths consent to rehearse their medication inside logical biomedical norms. Notwithstanding the absence of examination and solid randomized clinical preliminaries, osteopathy has acquired public consideration. The significant parts of a treatment impact are the nature of the connection between the expert and patient along with a self-influenced consequence.

9 Alternative Medicine Versus Conventional Medicine

The alternative medicine interfering with the practice of conventional medicine has been reduced after the exhaustion of conventional treatments. Due to this, there is a strong belief among the patients that alternative medicine may help them in a better way than conventional medicine [28].

Regardless of whether a remedial treatment is Eastern or Western, flighty or standard, or includes mind–body procedure like yoga or contemplation or atomic hereditary qualities, authentic purposes and culture assume a huge part in the field of helpful cycle. Most of the modern medical professionals believe in the benefits of various types of integrative medicines. In the alternate manner, numerous elective prescriptions are denied by specialists rehearsing ordinary arrangements of medication because of the absence of twofold visually impaired randomized preliminaries [29]. Although traditional and integrative medicine is more prevalent nowadays, always there is a prerequisite for more convincing data on its prosperity and medicinal ampleness in a more imperative level.

10 Conclusion

Medical care is amidst a thrilling season of revelation, when a proof-based way to deal with medical care conveyance brings openings for the fusion of the most ideal choices from all wellsprings of care, be it customary medication or CAM. The test is to stay away from parochial inclination and to move toward every chance with a proper level of wariness or conviction. At that time will it be really feasible to guarantee that educated, contemplated and information-based choices are being made?

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Heart Disease Prediction Desktop Application Using Supervised Learning

V. Pattabiraman and R. Parvathi

1 Introduction

The coronary heart is the organ that pumps blood, with its lifestyle giving oxygen and nutrients to all of the tissues of the body. If the pumping movement of the coronary heart becomes inefficient, essential organs like the mind and kidneys suffer. If the heart stops running altogether, dying takes place in a minute. Heart sickness has been considered as one of the most complicated and lifestyle-deadliest human illnesses in the world. Life itself depends absolutely on the green operation of the heart. Symptoms of coronary heart sickness include shortness of breath, weak spots in the body, swollen feet, and fatigue. Heart disease prognosis and treatment are very complicated, mainly in developing countries, because of the nonavailability of diagnostic equipment and different assets that have an effect on the right prediction and treatment of coronary heart patients. This makes coronary heart sickness a prime difficulty to be dealt with. But it's far more difficult to identify coronary heart sickness due to numerous contributory hazardous elements, which include diabetes, high blood pressure, high cholesterol, ordinary pulse rate, and other different elements. Invasive-based strategies to the diagnosis of coronary heart sickness are primarily based on the evaluation of the affected person's clinical history, body examination, and evaluation of involved signs via health workers. Often there's a delay in the prognosis because of human errors. Due to such constraints, scientists have become particular toward current methods like data mining and machine learning (ML) for predicting sickness.

Data mining is important in developing a sensible model for a clinical device to detect coronary heart disease by utilizing a dataset of patients that includes risk

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factors related to the illness. Medical practitioners might also offer to assist with the detection. Researchers proposed several software program and algorithms for developing a powerful clinical selection guide gadget.

2 Related Works

To ensure decision making in the domain of health care, different mining algorithms are surveyed to find the most frequent diseases in the local environment. Using the *K*-means algorithm, a prototype application is created for assessing temporal views and generating yearly and monthly periodic common patterns [1]. Remote health study (RHS) systems are both cost effective and successful in terms of disease reduction. In this study, it is suggested that Wanda cardiovascular disease (CVD) for monitoring women's heart health by coaching them with healthy lifestyle instructions and getting back the feedback using a smart phone is proposed in [2]. Different platforms, such as mobile phones and television, can be used to anticipate disease and educate illiterate people about the condition. In [3], the study demonstrates how to deal with cardiac sickness-hidden designs in a planned and concealed manner. The framework employs data mining techniques such as ID3 algorithm. Increasing public knowledge of the ailment and reducing the number of deaths from this ailment would benefit everyone involved. Reference [4] discusses MAFIA (maximal frequent item set algorithm) and *K*-means clustering and explains the categorization that is vital for determining the prognosis of an illness. Categorization accuracy based on MAFIA and *K*-means is obtained. Unfortunately, the bulk of the data currently accessible is uneven when it comes to the level and kind of coronary heart disease that is prevalent in society. As a result, the system's performance suffers. The authors of [5] consider the issue of data imbalance while presenting an intelligence system for assessing the severity of coronary heart disease in the patient population. The researchers' findings indicated that, on average, the proposed system exhibits 80.1% sensitivity. In [6], an effective method for predicting cardiac disease was developed. A neural network is trained using the learning vector quantization technique, which is fed data from a set of 13 clinical variables. It indicates whether or not a person has cardiac disease. To increase the prediction system's performance, it is trained using varying numbers of neurons and training epochs. When compared to other systems, the findings reveal that our method has the greatest accuracy of 85.55%. Rather than lowering heart disease risk, certain unsaturated fatty acids and other dietary suggestions may actually increase the risk of cancer and other disorders in some people. Exercising is beneficial to everyone, not just those at risk of heart disease, yet only a small percentage of individuals in the United States exercise at the recommended level. Diet, genetics, and exercise all have a role in the development of heart disease [7], which has to be considered while building a prediction model. As per the report in [8], 6.5 million Americans get cardiovascular disease globally. Enhancing self-care mechanisms through mobile applications can help in building quality lifestyle of patients. In [9], a sophisticated self-care system through a mobile application is created. Whenever a patient sends in their blood test results, an expert system will decide whether or not the condition is life threatening. It is possible that the intelligent system will provide treatment and advice in noncritical situations. If not, it will instantly contact the patient's doctor to discuss the best course of action. In addition, patient data will be regularly incorporated into the expert system. Machine learning algorithms were used in this work to categorize a dataset of SCD patients. The logit Boost algorithm produces the best results, with 99.5984% accuracy. A self-monitoring system is constructed in [10] with the KNN algorithm for diagnosing heart disease in patients, which provides an accuracy of 97.4%. In [11], machine learning technologies such as naive Bayes and decision tree classifiers are used to detect heart disease. This study examines information mining procedures that are critical for medical data mining, specifically for locating locally prevalent disorders such as heart disease, lung cancer, and breast cancer. It also employed information mining to examine and identify heart illness by extracting data with the goal of discovering inactive cases. In the naive Bayes algorithm, Bayes theorem was used. There are almost 500 patients in the dataset. Weka was used, and the categorization was done with a 70% split. Naive Bayes has an accuracy rate of 86.419%. A deep learning-based, one-of-a-kind smart healthcare framework for heart disease prediction was developed in [12]. Precision for the suggested framework was 0.99. The combined technique of machine learning and data mining for predicting premature ventricular contractions is presented in [13]. The authors of [14] discuss the identification of key variables and data mining strategies for predicting cardiac disease. Reference [15] discusses the detection of cardiac disease using a multikernel recommendation system with adaptive neuro-fuzzy inference. Reference [16] demonstrates that, among the numerous prediction models available, neural networks and Gini index prediction models predict heart attacks with the highest degree of accuracy. Some discretization procedures, such as voting, are known to produce more precise decision trees. For detecting cardiac illness, decision trees may be used to their fullest extent, and examines how various methodologies can be used on various aspects of decision trees in order to improve execution. Artificial intelligence (AI) and data science both rely heavily on deep learning technology, which is explained in detail in [17]. Deep learning tasks and how they are used in different contexts were mapped out in a taxonomy. Machine learning techniques are used to develop an analytical method for disease prediction and are discussed in [18]. Patients and healthcare providers can use health recommendation systems to help them make better fitness decisions. A few examples of the recommendation described in [19] include food suggestions, prescription recommendations, health status predictions, physical fitness proposals, and guidance from a healthcare practitioner. A fuzzy expert framework in view of molecule swarm streamlining was made in MatLab to analyse cardiovascular diseases and sound circumstances. On the test set, our proposed technique could accomplish an arrangement precision of 93.27%.

Machine learning predictive models such as *K*-nearest neighbor (KNN), support vector machine (SVM), and random forest algorithm are used to predict whether or not a person has coronary heart disease. However, clinical records are regularly constricted to smaller units of observations than what's usually desired to permit for enough education and trying-out the use of machines to learn algorithms. Heart disorder might also arise as a result of a bad way of life, smoking, alcohol, and high consumption of fats, which might also cause hypertension. A healthy way of life and early detection are the most effective ways to protect yourself from coronary heart disease. The principal venture in today's health department is the allocation of the best high-satisfactory offerings and correct verification. Data from a large set of scientific statistics created with the help of scientific specialists are available for observation and extraction of valuable expertise. Data mining strategies are the way of removing precious and private records from the large quantity of statistics. Mostly, the scientific database includes discrete records.

Hence, selection through the use of discrete statistics is a complicated and hard task. Machine learning (ML), a subfield of data mining, efficiently handles large, well-formatted datasets. In the scientific field, device studies may be used for identifying, verifying, and forecasting numerous illnesses. The principal intention of this report is to discover coronary heart disorder at an early stage. This, in turn, will assist in offering a powerful remedy to sufferers and keep them away from severe results. ML performs a completely vital task in discovering the private, discrete styles and thereby examining the given statistics. After this evaluation of statistics, ML strategies assist in coronary heart disorder forecast and pre-identification. This article presents an overall presentation evaluation of numerous ML strategies such as KNN, SVM, and random forest for forecasting coronary heart disorder at a first level.

3 Methodology

The goal of this investigation is to identify whether or not there is a potential for heart discomfort as a cause for a computer-based cardiac sickness prediction tool that will benefit both medical professionals and ordinary people alike. In order to achieve this objective, we studied the usage of different machine learning algorithms for dataset analysis. This research also highlights specific personality attributes that are crucial for gaining more accuracy than others. This might save money in numerous patient studies since all the features would not contribute to the result in the same way. In this module, three different (random forest, support vector machine, and KNN) models are compared and the accuracy and prediction of the bulk amount of different user data are verified. We utilized data from the Heart Disease Dataset from the Machine Learning Repository in Kaggle to finish our study as given in Fig. 1. There are a large number of examples of real-world data with various features such as blood pressure, the kind of chest pain, and electric cardiograms. In this study, three algorithms were used to identify cardiovascular causes and build a model that is as precise as feasible.

Sr. no.	Attribute	Representative icon	Details
1	Age	Age	Patients age, in years
2	Sex	Sex	0 = female; 1 = male
3	Chest pain	Cp	4 types of chest pain (1—typical angina; 2—atypical angina; 3—non-anginal pain; 4—asymptomatic)
4	Rest blood pressure	Trestbps	Resting systolic blood pressure (in mm Hg on admission to the hospital)
5	Serum cholesterol	Chol	Serum cholesterol in mg/dl
6	Fasting blood sugar	Fbs	Fasting blood sugar > 120 mg/dl (0—false; 1—true)
7	Rest electrocardiograph	Restecg	0—normal; 1—having ST-T wave abnormality; 2—left ventricular hypertrophy
8	MaxHeart rate	Thalch	Maximum heart rate achieved
9	Exercise-induced angina	Exang	Exercise-induced angina (0—no; 1—yes)
10	ST depression	Oldpeak	ST depression induced by exercise relative to rest
11	Slope	Slope	slope of the peak exercise ST segment (1—upsloping; 2—flat; 3—down sloping)
12	No. of vessels	Ca	No. of major vessels (0–3) colored by fluoroscopy
13	Thalassemia	Thal	Defect types; 3—normal; 6—fixed defect; 7—reversible defect
14	Num(class attribute)	Class	diagnosis of heart disease status (0—nil risk; 1—low risk; 2—potential risk; 3—high risk; 4—very high risk)

Fig. 1 Heart disease attributes and their details

3.1 K-Nearest Neighbor

KNN classification and regression is a supervised learning technique. It is used to fill in missing values and resample datasets. *K*-nearest neighbor estimates a new data point's class or continuous value using *K* neighboring data points (neighbors). The algorithm learns this way. Model-based techniques, on the other hand, employ weights to predict output based on training data; in this case, the entire training set is utilized. Models aren't trained on new data until a prediction is needed; this is called "lazy learning." There is no built-in mapping function in KNN that may be used. The Euclidean distance [3] is used to calculate the distance of an attribute. Several ways of forecasting the dataset can be applied after the missing values have been provided. Improved accuracy may be achieved by combining multiple versions of these algorithms. It is simple to use the KNN approach without having to create a model or make any extra assumptions. The method may be used to categorize, regress, and search for data. Although KNN is the most basic approach, it is influenced by noisy and irrelevant data, which reduce its accuracy.

Suppose there are two classes, i.e., class A and class B, and we've got a brand new record factor of x1; this record factor will lie in one of those categories. To clear

Fig. 2 Before KNN

up this sort of problem, we want a KNN algorithm. With the assistance of KNN, we easily become aware of the class or magnificence of a specific dataset as given in Figs. 2 and 3.

3.2 *Support Vector Machine*

When dealing with classification and regression problems, it is possible to use a supervised machine learning approach known as SVM (support vector machine) for assistance. This locates a high energy in the spatial domain that differentiates the categorization classes. The attribute selection is represented by an SVM model as values in the spatial domain, which is done in such a way that components in the feature vector representing a variety of categories are separated by as vast a range as possible, as given in Fig. 4.

3.3 *Random Forest*

A random forest is a multidecision tree expert system that may be used for analysis as well as categorization. The findings might include feedback on correctness and parameter significance. A random forest is a filter made up of *n* number of tree-structured learners, where *n* stands for individually generated, cumulative distribution function random trees, but every random tree represents a piece of judgment for

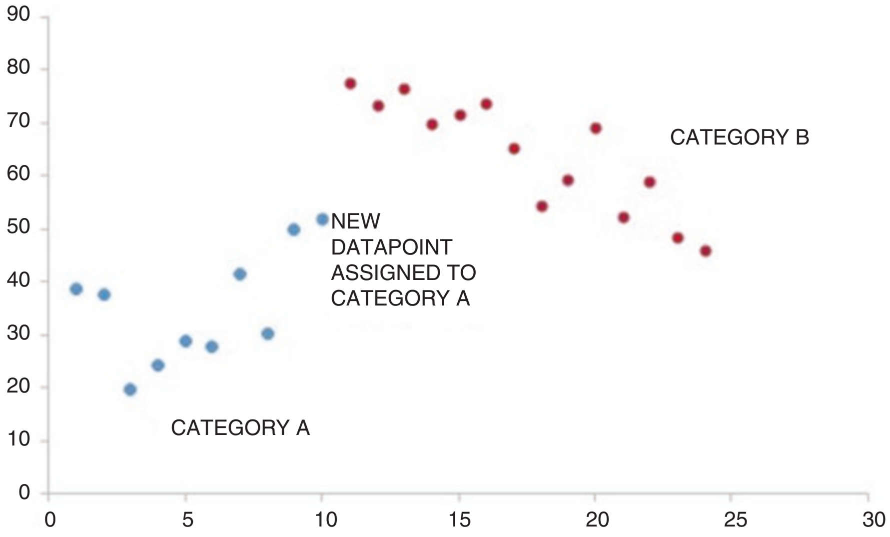

Fig. 3 After KNN

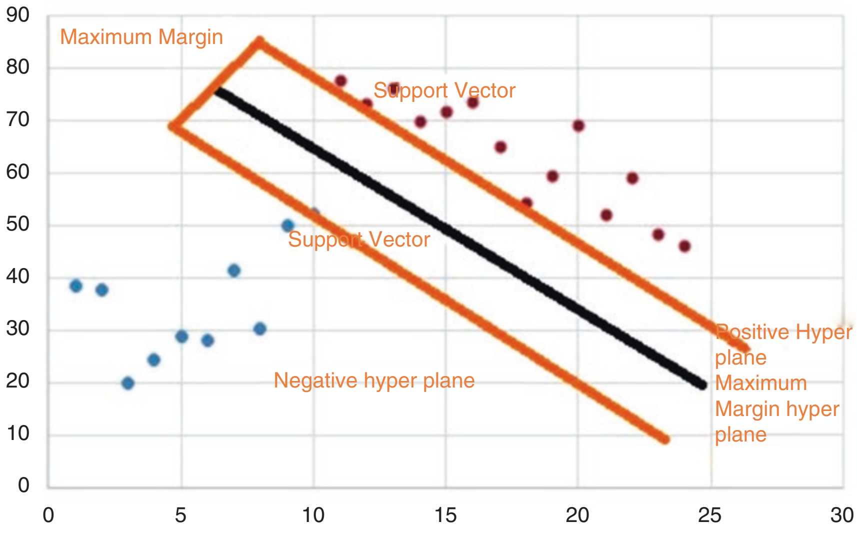

Fig 4 SVM record factor

data categorization. The random forest categorizes and determines the result class in each tree using the Power spectrum.

As given in Fig. 5, the conclusion category inside each tree is merged and determined by the model parameters to obtain the desired classifier. The random forest

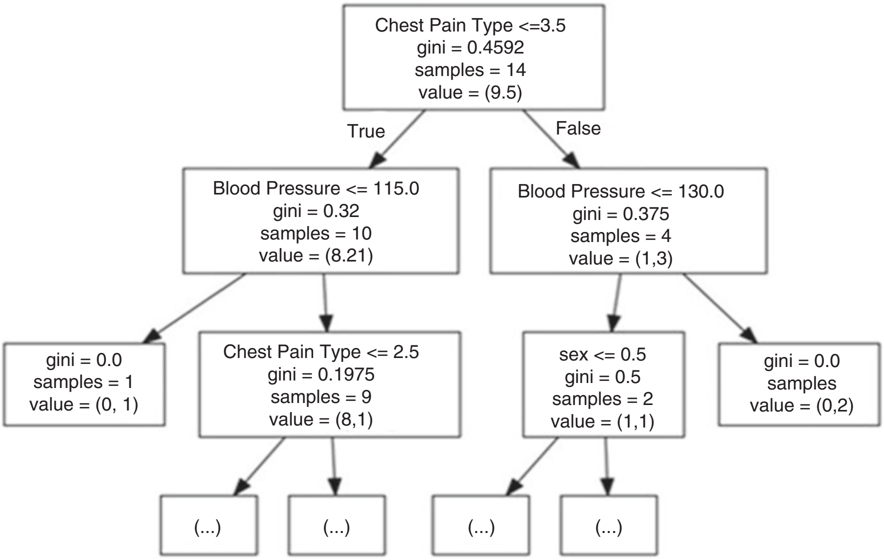

Fig. 5 Random forest example

algorithm works by generating a suitable sample that picks out a group of data from the original. Final classification is done through the majority voting mechanism.

4 Experimental Evaluation

The Heart Disease Prediction Desktop Application Using Supervised Learning was created to combat the general disease at an earlier level. Machine learning was developed to battle illness at an earlier stage. As we all know, in today's competitive world of economic progress, humanity has grown so preoccupied with its own well-being that it has forgotten about its own health. According to statistics, 40% of individuals ignore general sickness, which eventually develops into dangerous sickness.

4.1 Evaluation Metrics

Accuracy Accuracy is the most important evaluation metrics used in many classification algorithms. The formula for accuracy is given in Eq. 1:

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}} \tag{1}$$

where TP, TN, FP, and FN are true positive, true negative, false positive, and false negative, respectively. The accuracy is the ratio of the number of correct predictions and the total number of predictions.

Precision Precision explains how many accurately anticipated instances have really turned out to be right, which is explained by the precision factor *n* as given in Eq. 2:

$$\text{Precision} = \frac{\text{True positive}}{\text{True positive} + \text{False positive}} \tag{2}$$

Recall (Sensitivity) The recall factor illustrates how many of the real positive cases we were able to anticipate accurately using our model after running the simulation as given in Eq. 3:

$$\text{Recall} = \frac{\text{True Positive}}{\text{True positive} + \text{False Negative}} \tag{3}$$

***F*1 Score** It is a harmonic mean of precision and recall and it is given in Eq. 4:

$$F1 = 2.\frac{\text{Precision X Recall}}{\text{Precision} + \text{Recall}} \tag{4}$$

Specificity It is a measure of accurately negative classified instances, with all of the examples being healthy in real-world situations, and is given in Eq. 5:

$$\text{Specificity} = \frac{\text{True Positive}}{\text{True Negative} + \text{False Positive}} \tag{5}$$

In this module, the three different classification algorithms were compared (random forest, support vector machine, and KNN) and the accuracy of the algorithm was analyzed with different user data. The accuracy of the random forest algorithm was higher and good enough when compared to some other algorithms, and it is the best algorithm that fits this kind of problem. A sample screenshot of the input and accuracy analysis is given in Fig. 6.

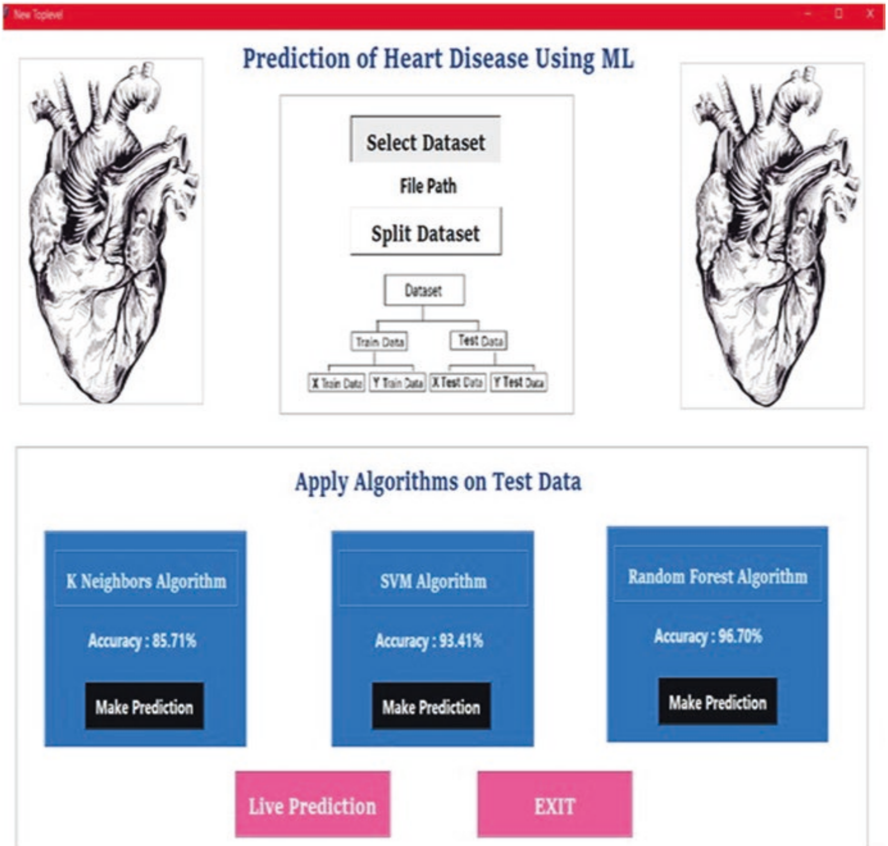

Fig. 6 Prediction of heart disease using ML

4.2 Live Heart Disease Prediction Module

In this module, users can predict whether they have heart disease or not by entering all their attributes' values into the interface and getting the prediction from the best algorithm, which was random forest, where we achieved a 96% accuracy. The training accuracy of the models is overfitted, and due to that, the testing accuracy of the models is 96%. Heart disease prediction module results are given in Fig. 7.

5 Results and Discussions

After execution, the accuracy of the algorithms (SVM, KNN, and RF) was calculated. The accuracy outputs are shown in Table 1.

Fig. 7 Live heart disease prediction module

Table 1 Algorithm accuracy

Algorithm used	Performance metrics accuracy
SVM	93%
KNN	85%
Random forest	96%

Figures 8, 9, and 10 show the accuracy, precision, recall, and $F1$ score of the SVM, random forest, and KNN, respectively. The objective of this examination is to fabricate a work area program that can foresee whether a patient will obtain coronary illness later on. AI grouping strategies, e.g., support vector machine, arbitrary timberlands, and K-closest neighbor, were utilized in this review, which was directed under the Machine Learning Repository (MLR). In the review, an Intel Core i7 eighth era CPU with a clock speed of up to 2.8 GHz and 16 GB of RAM was utilized. The information was utilized to build a preparation set and a test set.

```
>> Train Result:
********************************

>> Accuracy : 93.14%
----------------------------------------------------------

>> CLASSIFICATION REPORT:
                0       1  accuracy  macro avg  weighted avg
precision    0.94    0.92      0.93       0.93          0.93
recall       0.91    0.95      0.93       0.93          0.93
f1-score     0.92    0.94      0.93       0.93          0.93
support    193.00  230.00      0.93     423.00        423.00


>> Testing Result:
********************************

>> Accuracy : 93.41%
----------------------------------------------------------

>> CLASSIFICATION REPORT:

               0       1  accuracy  macro avg  weighted avg
precision   0.94    0.93      0.93       0.93          0.93
recall      0.91    0.95      0.93       0.93          0.93
f1-score    0.93    0.94      0.93       0.93          0.93
support    82.00  100.00      0.93     182.00        182.00
```

Fig. 8 Accuracy scores of KNN

Information is preprocessed, and controlled order calculations like support vector machine, *K*-closest neighbor, and arbitrary woods are utilized to accomplish the precision. Precision score is calculated for the training and testing data using Python programming. Table 1 compares the cardiovascular prediction accuracy score of the difference classification model with the percentage accuracy scores for other approaches.

The accuracy scores of KNN, SVM, and random forest are 93.14, 85.58, and 100, respectively, for the training dataset and 93.41, 85.71, and 96.70 for the testing dataset. The parameters like precision, recall, *F*1 score, and support were analyzed for the training and testing datasets for KNN, SVM, and random forest algorithms.

6 Conclusion and Future Work

The ultimate goal is to develop a variety of data mining approaches that can help with precise cardiac disease prediction. Our goal is to create a desktop prediction tool that is efficient and trustworthy while requiring fewer features and tests. In total, we focused on 14 crucial factors in our research. Random forest classification, *K*-nearest neighbor, and support vector machine were utilized. The data were

```
>> Train Result:
**********************************

>> Accuracy : 85.58%
------------------------------------------------------------

>> CLASSIFICATION REPORT:
                0      1  accuracy  macro avg  weighted avg
precision    0.85   0.86      0.86       0.86          0.86
recall       0.82   0.88      0.86       0.85          0.86
f1-score     0.84   0.87      0.86       0.85          0.86
support    193.00 230.00      0.86     423.00        423.00


>> Testing Result:
**********************************

>> Accuracy : 85.71%
------------------------------------------------------------

>> CLASSIFICATION REPORT:

               0      1  accuracy  macro avg  weighted avg
precision   0.88   0.84      0.86       0.86          0.86
recall      0.79   0.91      0.86       0.85          0.86
f1-score    0.83   0.87      0.86       0.85          0.86
support    82.00 100.00      0.86     182.00        182.00
```

Fig. 9 Accuracy score of SVM

preprocessed and used in the models. The algorithms that produce the greatest outcomes in these circumstances include *K*-nearest neighbor, support vector machine, and random forest. We discovered that the random forest had the highest accuracy after executing it three ways (96%). This research could benefit from the use of various machine learning approaches, grouping and association rules, vector machine assistance, and evolutionary algorithms. As demonstrated by the study's limitation, more intricate and interconnected models are required in order to improve the accuracy of early cardiac disease prediction.

Using the system to get to know the idea, a newly educated dataset may be used for an excellent greater-than-average correct prediction system. Accounts may be created for every consumer, after which, by means of referring the patients beyond desire, records of the patients' coronary heart circumstance may be monitored to determine if there's any development or if the circumstance has deteriorated. In this study, we developed a desktop program that is suitable for real-time coronary heart

```
>> Train Result:
*********************************

>> Accuracy : 100.00%
-----------------------------------------------------------

>> CLASSIFICATION REPORT:
                0      1  accuracy  macro avg  weighted avg
precision    1.00   1.00      1.00       1.00          1.00
recall       1.00   1.00      1.00       1.00          1.00
f1-score     1.00   1.00      1.00       1.00          1.00
support    193.00 230.00      1.00     423.00        423.00


>> Testing Result:
*********************************

>> Accuracy : 96.70%
-----------------------------------------------------------

>> CLASSIFICATION REPORT:

               0      1  accuracy  macro avg  weighted avg
precision   0.97   0.96      0.97       0.97          0.97
recall      0.95   0.98      0.97       0.97          0.97
f1-score    0.96   0.97      0.97       0.97          0.97
support    82.00 100.00      0.97     182.00        182.00
```

Fig. 10 Accuracy score of random forest

disease prediction for patients suffering from coronary disease. It is capable of doing prediction on every stage, unlike many other one-of-a-kind systems. Machine learning algorithms can be used to forecast coronary artery disease. However, the findings are extremely reliant on the characteristics of the sickness dataset. We utilized an amplified pulse sensor and an Arduino suite microcontroller to send the statistics to the cell, which was incredibly low cost compared to the equipment. This gadget has been designed to monitor the client's heart rate and sound an alarm if it climbs above the normal range. In order to demonstrate the value of the tool, we used well-known algorithms such as KNN, SVM, and random forests. Following the completion of a holdout check, the random forest algorithm was used in an attempt to increase the accuracy of the suggested tool to 96% using the existing neural network-based classification model. It is believed that human activity recognition will play an important part in human-to-human interaction and interpersonal relationships since it delivers difficult-to-extract information or insight into a person's identity, personality, and psychological condition.

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Part III
Mutating Medicine Using Artificial Intelligence (AI)

Healthcare Revolution and Integration of Artificial Intelligence

S. Saranya and S. Priya

1 Introduction

1.1 Healthcare Revolution in the Past Century

Though technological revolution dates back to the decade revolving around 1860, it was not until 1895, that it found a foothold in healthcare with the discovery of X-rays [1]. Since then, the quality of medical diagnosis has seen an accelerated improvement including the notable lifesaving technologies for cardio-pulmonary assistance that were invented in the 1950s. Following the hardware revolution, the invention of computers and the vision of connecting computers to share information were evident in the 1970s. Clinical database management systems collectively called hospital information or medical information systems were initiated by individual hospitals to handle patient-centric data [2]. These series of revolution since the first publication in the domain of AI in biomedicine in 1958 have sowed the seed for the present-day artificial intelligence (AI)-driven healthcare [3].

With the advent of computers, healthcare entered the digital era as a process driven by need. The beginning of the twenty-first century has recognized the role of computer technology to evaluate the clinical processes prior to which it was predominantly used for hospital administration. In the next 10 years, computers became physician's best friend. The volume of data in healthcare is massive, but its potential

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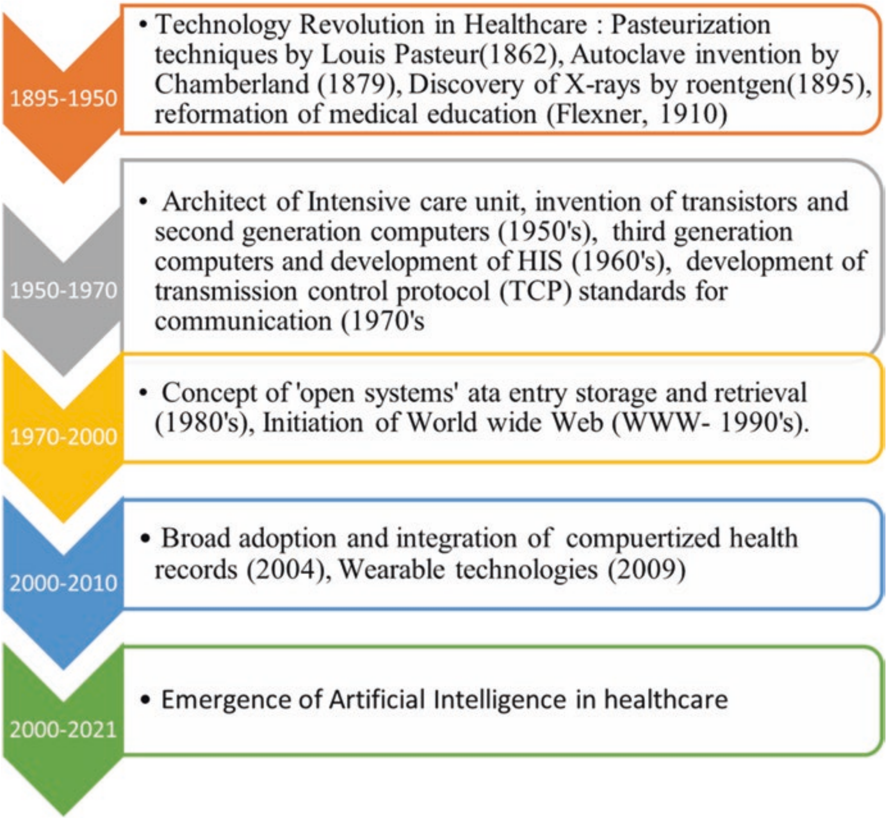

Fig. 1 Timeline of events pertaining to healthcare revolution

to provide insight into patient care was still in its infancy. In 2004, the United States included a goal for broad adoption of computerized health records. These are essentially a digital version of a patient's health record to avoid medical errors and to provide cost-effective healthcare and improved patient care [4]. The timeline of events that led to healthcare revolution is shown in Fig. 1.

Furthermore, the growth of data-intensive medical specialties, wearable technologies, and electronic health records has provided a wide array of real-world data. Early years of last decade saw multiple sources contributing to big data in large amounts, but it was difficult to collect, organize, and analyse the data. With access to continuous digitized data streams the potential for a personalized, precise, and a proactive form of healthcare decision support system was necessitated [5]. Since then, scientists have curated knowledge for the development of machines with intelligence capable of performing tasks analogous to the complex human brain leading to the development of AI.

1.2 Artificial Intelligence: A Transformation in Healthcare Delivery

Artificial intelligence learns from a vast amount of data using algorithms to do a specific task. Specific to healthcare, it is the process of applying artificial intelligence to mimic human cognition in discovering, analysing, presenting, and comprehending complex medical and healthcare data. It plays a key role in decision support for clinical interventions aiding in diagnosis, treatment planning, and health management. This capability is creating waves of change, as AI in healthcare proves to be a critical component in many aspects. First, the superpower of these AI systems is to automate diagnosis by building powerful models using accumulated healthcare data [6]. Second, they also enable tailor-made highly precise patient-specific treatments [7].

Simply put, they make use of large amounts of data and select right information/predictions that clinicians may miss or do not have direct access to. The rate of growth of AI market in healthcare as rightly predicted by Frost and Sullivan [8] shows a drastic increase (Fig. 2) in less than 10 years. Section 2 discusses in detail how AI and its components are applied in healthcare.

2 Artificial Intelligence in Healthcare

Artificial intelligence powered by enormous availability of healthcare data and sophisticated analytic techniques has brought a paradigm shift to healthcare. Some of the major use cases are, but not limited to, the discovery of diseases/disease patterns especially cancer, neurology, and cardiology [9]; early diagnosis, prediction, and treatment of medical conditions; personalized medicine and patient monitoring;

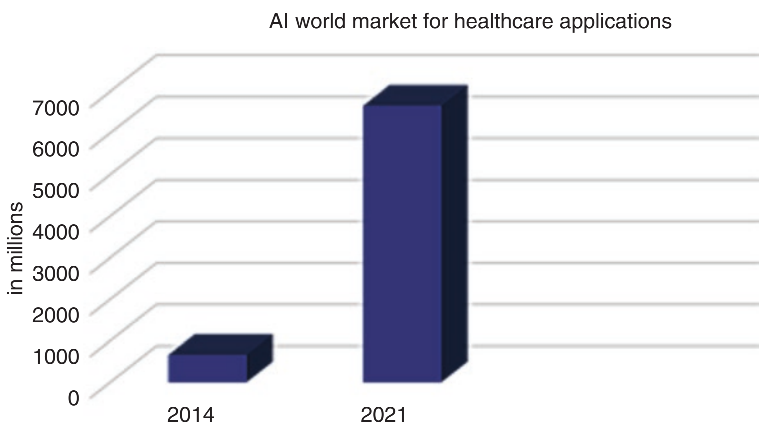

Fig. 2 Growth prediction of global AI healthcare market (2014, 2021)

understanding and explaining complex conditions to medical experts and patients which otherwise would be complex to comprehend or conclude [10]. Healthcare data can be either structured or unstructured and AI can be effectively applied to either of these. While support vector machine and methods like neural networks (NN), fuzzy logic, and evolutionary computing grouped under computational intelligence techniques are popular learning methods considered for structured data; modern deep learning and natural language processing are more predominantly used for unstructured data. The broad application areas of AI in healthcare include image analysis, rule-based systems for encoding clinical guidelines and protocols using electronic health records, predictive analytics, etc. [10].

2.1 Components of Artificial Intelligence

Artificial intelligence covers a multitude of technologies, and some of the major components that AI revolves around are shown in Fig. 3. The upcoming subsections discuss each of these components and their significant role in healthcare.

2.1.1 Machine Learning

Machine learning (ML) can be considered as one of the most popular forms of AI applications in healthcare. Machine learning refers to the ability of the machines to learn and perform on par with human intelligence and enables the machine to learn by experience without explicit programming with massive amount of data [11].

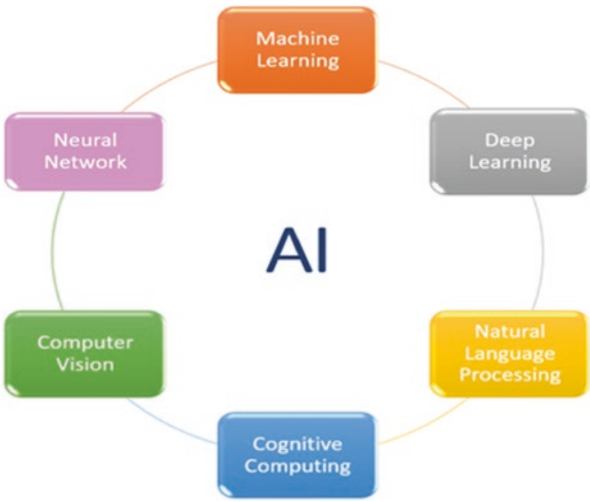

Fig. 3 Pictorial description of AI and its associated components

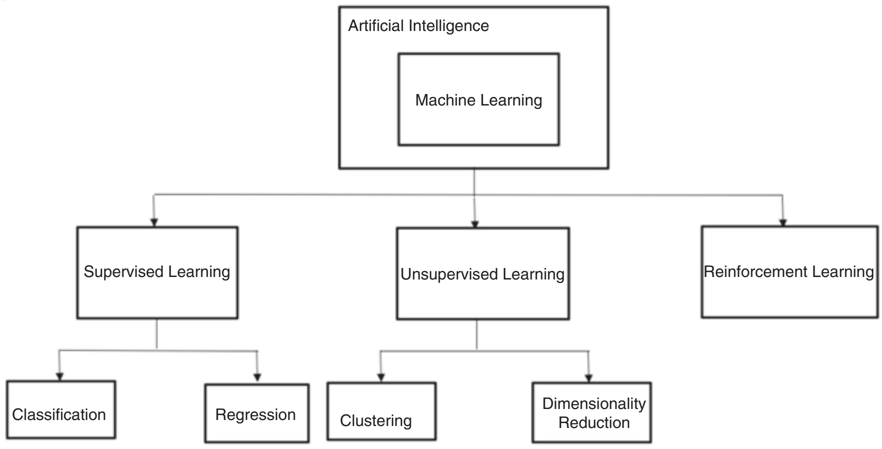

Fig. 4 Types of machine learning approaches

Contrary to the traditional approach where the model acts as an input to the machine, ML approach is data driven and the output is a model used in the analysis of new data. The five major processes involved in the ML pipeline are data acquisition, pre-processing, feature extraction, feature selection, and learning (supervised/unsupervised/reinforcement) task. The choice of the learning method is based on the amount of human intervention and the way in which a machine learns. The various subsets of machine learning are shown in Fig. 4.

In supervised learning, the ML algorithm learns on a labelled dataset, i.e., a certain degree of ground truth is available for performing the expected task. This is further classified into classification and regression based on the task to be performed.

On the other hand, in unsupervised learning, the algorithm deals with unlabelled data and tries to extract features and patterns on its own. They can be further classified into clustering and dimensionality reduction. Reinforcement learning is typically a trial and error method with feedback for learning from new situations using an interactive environment. The notion is to maximize rewards that are provided for favourable outputs. In this work, clustering, an unsupervised ML, as well as classification, a supervised ML technique, are further explored through experiments.

Feature engineering is one of the challenges in traditional ML methodologies. This requires intensive human effort to translate raw patient data into higher level feature representations usable for interpretations. Clinical data types obtained from radiology (X-rays, CT, MRI, PET, SPECT, and photographic images), biosignals including ECG, EMG, EEG, EOG, EGG, etc., and unstructured data from electronic health record (EHR) are some of the most common data types used by ML for diagnostic predictions [12]. Prediction of patient-specific treatment procedures based on their health conditions and genetic makeup is a huge leap forward and seems to be promising for many healthcare organizations.

2.1.2 Computational Intelligence

Computational intelligence (CI) encompasses a number of nature-inspired computational methodologies that can be classified into three main categories namely artificial neural networks (ANN), fuzzy logic, and evolutionary algorithms such as swarm intelligence, genetic algorithms, and their hybridization for addressing real-world problems. CIs are preferred to specific problems to which conventional modelling cannot be used, due to reasons such as complexity, existence of uncertainties, and the stochastic nature of the processes. The discussion in this section is limited to a very popular CI method, the ANN, which uses artificial neurons that depict the biological neurons of the human brain through which learning is made possible to solve AI problems. The technique is an extension of linear regression and unfolds the complex and non-linear input–output relationship.

ANN is multi-layered with a number of hidden layer combinations that determine the associations between the output and the input layer. The layers are made of a predefined number of neurons interconnected by weights between them. The goal of ANN is to develop a model to estimate the weights between the layers from input through output that satisfies the criteria of minimizing the average error between the actual target and predicted output. ANN is one of the initial techniques that gained popularity in AI-related healthcare applications and the advanced version of which is the present-day deep learning networks. Applications of ANN started off with disease diagnosis, monitoring, and classification. These included processing of biomedical data involving image analysis, clinical diagnosis, drug development [13], and speech processing [14]. However, their applications extended to informing healthcare management decisions. Particularly, in the years spanning 1994–2003, cancer diagnosis, prognosis, and guided therapy using ANN-based decision support systems were reported emphasizing the need for rigorous methodologies [15]. It is also noteworthy to mention that the use of ANN for clinical diagnosis based on classification and prediction majorly spans the areas of cardiovascular, telemedicine, and organizational behaviour [16].

2.1.3 Deep Learning

As a subset of ML, deep learning (DL) is an extension of classical ANN with many layers and with a capability of exploring more complex non-linear patterns in data. The two most widely used DL techniques are convolutional neural networks (CNN) and recurrent neural networks (RNN). Deep learning was introduced to overcome the hiccups faced by classical ML algorithms in handling the issue of data with more dimensions and with many traits. For instance, the DL models perform better in scenarios that employ images as input where the dimensions are naturally high due to pixels as traits. CNN can take the normalized pixel values on the images as input and processes it by alternatively weighting and sampling in the convolution and subsampling layers, respectively. This results in a recursive function which is

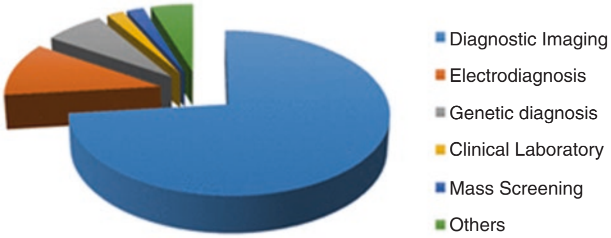

Fig. 5 Major applications of deep learning in medicine

the output of the weighted input values. As in the case of ANN, the weights are trained to minimize the average error between predicted and the actual outcomes [9].

Deep learning is also used for speech recognition which is popularly known as natural language processing (NLP), a promising application in healthcare. One major limitation of DL models is the difficulty in interpreting the features arrived as they usually have little or no meaning for delineating manually. Figure 5 shows various applications of DL in medicine most common being diagnosis, screening, and imaging.

2.1.4 Natural Language Processing

Natural language processing is a method by which useful and insightful information is extracted from textual data. In healthcare, electronic health records and clinical data are in the form of unstructured written records or reports. Examination reports, laboratory reports, operative notes, and discharge summary are inexplicable for the computer program. NLP is capable of extracting information from these unstructured texts aiding in clinical decision making. NLP pipeline generally comprises the following processes: (1) text processing and (2) classification. Text processing enables the identification of a series of relevant keywords based on the available clinical databases. This is followed by examining a subset of relevant keywords and the effects on normal and abnormal case classification are deduced. The validated keywords now serve as a structured data support in clinical decision making [9].

Speech recognition or text analysis followed by translation is one of the common processes followed by NLP systems. The major application of AI in healthcare using NLP application involves a method of understanding and classifying clinical documentation. These unstructured clinical notes give a promising insight for clinicians to better diagnose and understand treatment quality, improving the process and providing better results for patients. NLP also assists in creating alert systems during treatment arrangements, monitoring adverse effects, etc., which form a key role in clinical decision making [9].

2.1.5 Cognitive Computing

The thin line of difference between cognitive computing (CC) and AI is that the former works to replicate or mimic the human way of solving problems while the latter creates alternate ways to solve problems and potentially outperform humans. Hence CC aims at creating automated systems to solving problems without human intervention. These techniques perform a sort of data mining operation using a variety of data from appropriate streams of information. These systems follow a process of continuous knowledge acquisition and fine-tune their methods of pattern matching and data processing. This makes them capable of predicting new problems and modelling suitable solutions. To simply put, these are self-made systems based on continuous learning by incorporating techniques such as data mining, pattern recognition, and NLP thus mimicking the human brain. Cognitive computing forms a part of AI application that includes but not limited to natural language programming, expert systems, neural networks, virtual reality, and robotics to name a few [17].

In healthcare, cognitive computing paves way for the development of AI systems capable of augmenting the role of physician by providing virtual assistance to patients. This will in turn help improve telemedicine and personalized medicine. With the increasing access to clinical data through EHR it is possible to build such systems that are cost effective, accessible, and with improved care outcomes. The CC system processes large amount of varied data almost instantly based on an intelligent query response approach to make customized recommendations. From areas of advanced personal training to patient-specific treatment, clinical trial matching to individual treatment plans for cancer treatments, cognitive computing transforms the way in which organizations impact health and wellbeing [17]. Cognitive computing in healthcare provides an interface between machine and man where both brainstorm to improve clinical decision making [18].

2.1.6 Computer Vision

Computer vision is a part of AI that focuses on understanding and interpreting visual data using trained intelligent algorithms without being explicitly programmed. In healthcare, about 90% of the input data is in the form of images, thus providing numerous opportunities to improve patient care. The automated image recognition process can surpass the need for manual interpretation of clinical staff, enabling the human workforce to focus on more complex problems [19]. Computer vision technique has been quite welcoming in the areas of predictive analytics, therapeutic, and surgical procedures. Technologies like three-dimensional (3D) modelling and rapid prototyping have driven the rapid development of medical imaging modalities like CT and MRI which have been widely used in recent times in the field of medicine [20]. Furthermore, computer vision is also extensively used in various healthcare domains like radiology and oncology to track tumour progression, early diagnosis of cancer, bone fractures detection; in cardiology for vascular imaging, artery highlighting, automated cardiac pathology, and anomaly detection to name a few; and for automated lab tests in which blood analysers powered by computer vision are capable of either taking images of blood samples or receiving pictorial inputs of blood-stained slides [19].

Thus, AI has paved way for solving many complex healthcare problems. Each AI component has been widely used in various healthcare domains for different types of input data. A summary of different biomedical data types preferred for AI-based applications in healthcare is shown in Table 1 [11, 12].

3 Impact of AI in Medicine

Undoubtedly AI has the potential to transform healthcare delivery with increased productivity and efficiency. The technological advances in medical science have increased life expectancy with demands being driven by population ageing, lifestyle changes, newly emerging diseases, and changing patient expectancy. The pandemic in late 2019 gave the world a lesson to work towards a shift from a care-based healthcare management to a more proactive and focused healthcare philosophy to cater to the complex needs. AI definitely seems promising to address the challenges outlined above, with better care outcomes and a learned decision support system. This section discusses how AI will impact current medical practices.

Table 1 Biomedical data types and preferred AI approaches

Data types	Subtypes	Preferred AI models
Multi-omics data	Genomics Proteomics Transcriptomics Epigenomics Microbiomics	Integration using ML: Data-based and model-based DL, CC
Clinical data	Images EHRs Physiological signals	Supervised ML, DL, CC Computer vision DL, NLP,CC ML, DL, CI
Behavioural data	Social media data Voice data Mobile health data	Unsupervised ML
Environmental data	Pollution data, metallic reactions, etc.	Supervised/unsupervised ML
Pharmaceutical data	Chemical compounds, clinical trial data, drug interaction reports	ML graph-based approaches

3.1 AI and Traditional Medicine: Combining Impact

Artificial intelligence has set its mark in the healthcare domain with its high-performance computing and superior learning algorithms using huge medical data resources. With the current pandemic impact faced globally, the need for understanding the disease forms, its prognosis, design and development of new drugs has become the prime focus. The rich resources of traditional medicine and its practical references needs to be sufficiently exploited and rejuvenated to address the global crisis faced during the COVID-19 pandemic. Prior to AI, drug development strategies focused on drugs designed to react only with the proteins involved in a particular disease reducing side effects; but can still react with unintended targets thus missing on a multi-targeted approach. AI technologies in the areas of bio and chemical informatics, pharmacology systems, and computational biology when properly linked with traditional medicine can lead to successful implementation of computer-assisted drug design technology with low-cost, high-speed precise solutions to combat disease management and treatments. The various stages of drug design and development where AI can play an integrated role is shown in Fig. 6.

In recent times, big data has extended its application in drug design and discovery. AI-based computer programs can predict how people with different genetic and physiological characteristics react to new therapeutic drugs using a virtual human body. It will enable more chemical combinations to be tested, reducing the number of superfluous trials. One such research led by the research team of Bio-Synergy Research Project has developed CODA (context-oriented directed associations)

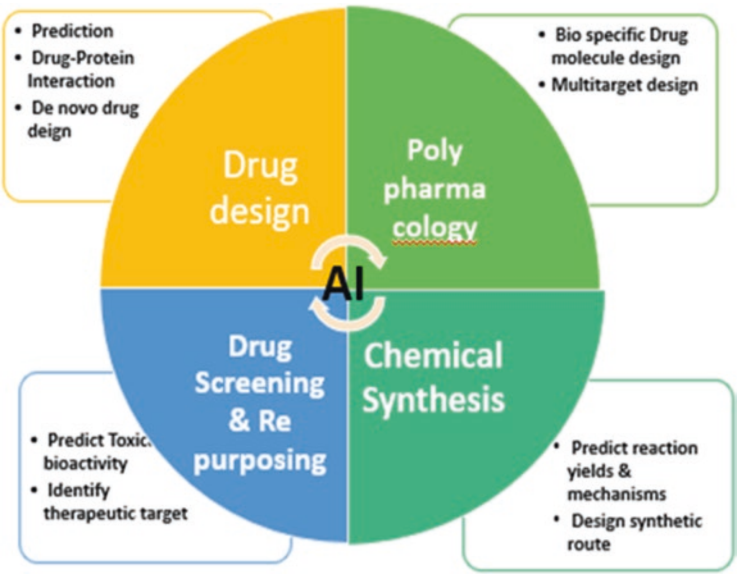

Fig. 6 Role of AI in drug design and development cycle

software to test the therapeutic potential of chemical compounds found in traditional medicines [21].

The researchers first developed an AI-based intelligent program to represent biological interactions. Then voluminous resources from public databases and scientific literature were collected to construct a network of potential interactions between chemicals, proteins, and genes within, and between organs. With this AI has enabled safe, cost-effective, and precise patient-specific drug development methods to combat new disease forms that pose a challenge to survival of mankind.

3.2 Future Role of Physicians

Quantity and quality of data is the basis of any AI system to be effective in learning and making accurate judgements. To simply put, it requires humans to collect data and teach them what to do, so that they learn. AI has a promising role to augment/assist the efforts of clinicians for much faster and less expensive at the same time more accurate decision making. High computational power intelligent systems can search and read through countless medical data, a capability that far exceeds a human physician [22]. A fatigued physician may not recollect the allergies and past symptoms of a particular patient, but that cannot be the case in an AI-based system. Not only limited to diagnosis, surgeries assisted by augmented reality can be provided by AI systems so that, the surgeon can perform a remote surgery with precision and with decreased blood loss due to tactile feedback [23]. AI-based systems can analyse and learn from millions of data in a considerable timeframe. This is particularly advantageous in the fields of radiology, pathology, dermatology, and ophthalmology [24]. In 2018, researchers at Harvard's SEAS in association with Massachusetts General Hospital (MGH) reported that in diagnosing intracranial haemorrhages, an AI-based system was equally accurate as trained radiologists. In 2019, researchers from academic institutions in conjunction with Google, reported an AI-based lung cancer detection system which had 94% accuracy with fewer instances of false positives and negatives compared to the decisions of six radiologists [25].

With AI taking most of the burden, it certainly will minimize the waiting time for appointments and also provide more time for clinicians to spend with patients. All said, an AI-based system will work hand in hand with physicians augmenting their capability and is less likely to interfere with the patient–physician relationship [8].

3.3 Explainable AI

AI solutions, specifically machine learning models, are considered as black box making it difficult to comprehend and interpret the results of the ML models. This has led to the evolution of explainable AI (XAI). XAI is the process of making ML models more explainable as well as a means to testing its reliability and causality with respect to its features. Especially in the field of medicine, it is important for the clinicians to understand why a particular result is obtained and trust the model output in order to help them assist in the treatment of patients. Thus, XAI has gained popularity in recent times.

XAI aims at producing explainable ML models without compromising on the high-level learning performance and accuracy in decision making. This provides an understanding towards how feature engineering is performed within ML, thus making it more reliable [26]. By doing so, it enables trustworthiness of the AI solutions and makes use of the powerful AI solutions in solving the real-world healthcare problems.

3.4 Risks and Safety Challenges

With more and more recognition towards AI's potential value, there is equal concern towards its potential risks. The quality of data is paramount for any AI-based healthcare delivery as "bad data" may put a patient's life to risk. Poorly designed AI systems trained on culturally biased data will incorporate blind spots that lead to misdiagnosis/treatment when applied universally. Having said, the costs of doing it wrong might cost a life. Therefore, both the potential and challenges of AI are equally big. With changing demands and healthcare complexities, AI-based systems require constant fine-tuning to enhance quality, efficiency, safety with reduced health discrepancies and elevated care coordination. A significant number of years may be required to rightfully believe that AI works right for healthcare encompassing a broad range of medical tasks and surpassing the need for physicians.

4 Conclusion

The impact of integration of AI in healthcare is phenomenal, facilitating quality and precision in diagnosis, patient care, and management. AI has integrated the world together by providing a common platform to address healthcare needs. It is undoubtedly a boon which has solutions to all unanswered complexity involved in the identification and treatment of certain deadly diseases.

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Logistic Regression-Based Machine Learning Model for Mutation Classification in the Discovery of Precision Medicine

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1 Introduction

Machine learning models are basically classified into supervised learning models [1] and unsupervised learning models [2]. Supervised learning models function based on the training data. The training data is fed to the model and the model undergoes training. Once the training of the model becomes successful the model is tested with new unknown data in order to understand the quality of the model. The model's quality assessment is performed by testing data; if the model is trained well with the training data, then it performs well with testing data too. The quality of the model is assessed with a few well-known metrics like accuracy, precision, recall, F1-score, and ROC [3]. If the machine learning method is the classification method, then precision, recall, F1 score, etc., are the metrics to assess the quality of the model. If the machine learning model is a regression model, then the mean absolute error (Eq. 1) and the mean squared error (Eq. 2) are the metrics to assess the quality of the model. It represents the fitness of the model on the dataset.

$$\text{Mean absolute error} = \frac{1}{n} \sum_{j=1}^{n} \left| y_j - y'_j \right| \tag{1}$$

$$\text{Mean squared error} = \frac{1}{n} \sum_{i=1}^{n} \left| y_i - y'_i \right|^2 \tag{2}$$

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In the area of precision medicine, the medicine should be precise and personalized for individual patients. In order to prescribe the medicine specifically, patient gene, variation, and mutation details should be analysed properly. The machine learning classification algorithms which come under supervised learning are useful in identifying the relationship between gene and mutation-based medical data [4, 5].

The proposed method analyses the attributes gene and variation and then classifies the tuples into different classes based on these attributes. Machine learning-based logistic regression is used in order to predict the classes. The training data is given to the model with the attributes gene, variation, and class. Once the model is trained then the model is ready to take the input to classify or predict the relevant class. If the variation attribute in the dataset is about mutation, then it supports mutating the medicine. The performance of the logistic regression-based model is compared with the state-of-the-art classification models like decision tree classification, random forest classification, SVM classification [6], and naïve Bayes classification to prove its accuracy [7, 8].

2 Literature Survey

Lee et al. (2018) [9] proposed a method using deep learning in order to identify mutation–gene–drug relations. Molecular biomarkers take vital role in the precision medicine for cancer patients. Genes with specific mutation play important role in fixing the problem of medication and support precision medicine. The method which the paper proposed used biomedical entity search tool (BEST) and machine learning classification and performed better in finding the gene–mutation–drug relation. Random forest classifier is involved in the above context as a machine learning classifier. Random forest algorithm can be used as a classification by combining *n* number of decision trees.

Each decision tree acts as a classifier. To improve the performance of classifier in random forest algorithm, *N* number of decision trees are used; the outcome is decided based on voting. Entropy is the measure used to identify which attribute should hold the root node and other nodes.

Convolutional neural network in deep learning is also taking place in the classification. CNN is mostly suitable to deal with image-based datasets. Here CNN contributed well in gene–mutation–drug relation. The proposed method proved efficiency through the F1 score and accuracy when compared with existing methods.

Leung et al. (2015) [10] reviewed the application of machine learning in genomic medicine. The main objective of genomic medicine is to propose precision medicine by understanding the variations in DNA. The study stated that all types of supervised machine learning algorithms are useful in genome interpretation. Supervised learning algorithms like linear regression, logistic regression, and SVM take vital roles in genome interpretation. They can be used to perform genome interpretation to a large extent.

The main behaviour of the supervised machine learning algorithm is it takes the training data and does the prediction or classification based on the training data. Once the machine learning model is perfectly trained with the data then for all upcoming new data the model can predict without the help of medical experts.

Wood et al. (2018) [11] proposed a method to discover somatic mutation using machine learning algorithms. Detailed information about somatic mutation takes a crucial role in prescribing precision medicine for most cancer patients. The specific machine learning approach Cerebro proposed by the author was used to identify somatic mutation in a patient's cancer cell. Cerebro performs better and accuracy is proved. The accuracy of Cerebro was compared and validated with six other existing methods. The method Cerebro when compared with existing techniques has been proved to have an accuracy of 98% while the two existing approaches had an accuracy of 92% and 32%, respectively.

Qu et al. (2020) [12] proposed an NLP-based machine learning approach to understand the protein–protein interaction. Due to mutation, proteins are affected, and the interaction of one protein with other protein is called protein–protein interaction. In order to improve the treatment by understanding the biological effect, information about the protein–protein interaction is highly essential and useful. Natural language processing-based machine learning approach is used to extract the information on protein–protein interaction of affected proteins by mutation.

In machine learning or deep learning, natural language processing can be implemented in various ways. The primary way of implementing NLP is using an artificial neural network (ANN). ANN may provide good results for NLP but it consumes a high cost.

The recurrent neural network (RNN) is the next possible advancement of the NLP. RNN works fine and is valuable in keeping the text used in the network long back. The short-term memory problem is the drawback of RNN.

In order to solve the short-term memory problem of RNN, the LSTM was introduced. LSTM's hidden state and cell state maintain long-term memory and solve the problem associated with RNN. So, the models ANN, RNN, and LSTM are highly associated with NLP. The above techniques are very useful in NLP-based applications. GRU is another NLP-based deep learning method. GRU is the lightweight method of LSTM and supports NLP to a large extent.

The machine learning methods and deep learning methods never accept word input. They accept and process only the numerical inputs. Converting words into numerical data is a challenging task. The words are text data that can be converted into numerical data by the one-hot encoding method. One-hot encoding is the easiest and simple way of converting a word to numerical data but it never establishes a relationship between one word to another word; it decreases the quality of the NLP model. The solution is word embedding. Word embedding is the method that establishes the relationship among words; it enhances the quality of the NLP model. The models' performance is measured by the metrics precision, recall, and F1-score. The model validation was successful based on the metrics precision, recall, and F1-score.

Le et al. (2021) [13] proposed machine learning-based method for predicting EGFR and KRAS mutations in non-small cell lung cancer. Genetic algorithm and XG Boost classification are involved in prediction. Genetic algorithm is mostly used to solve optimization problems. Genetic algorithm is used when a high-quality solution is essential for the problem. Genetic algorithm functions based on natural selection. XG Boost algorithm is also called extreme gradient boosting. XG Boost works based on decision tree. In decision tree condition is checked in every non-leaf node. The leaf node contains labels or classes. Which attribute holds the top level of the tree and which attribute holds the low level of the tree is decided by the measure entropy. Minimum entropy is always better. The attribute which is having maximum entropy should not occupy the higher level of the tree in order to construct an optimum decision tree. XG Boost and genetic algorithm both bring efficiency in prediction.

Yang et al. (2021) [14] proposed a machine learning model to identify disease genes. Identifying disease genes is a critical task in medicine. The machine learning framework did the identification of disease genes in an effective way. A semi-supervised machine learning method [15] is used to identify disease genes. The supervised machine learning algorithm or method takes training data and trains well in order to do the prediction or classification well. The unsupervised learning algorithm does not depend upon the training data. Clustering methods or clustering algorithms come under the category of unsupervised learning. Here in order to find the disease gene semi-supervised algorithm is used.

The proposed method map gene is used to identify the disease gene related to diabetes mellitus. Parkinson's disease is a brain-related disease. The patients affected by the disease miss the balance in walking and miss the coordination in handling something with the hand. Diabetes mellitus is a disease that affects the body with insufficient insulin. The performance of the method is compared with state-of-the-art existing methods and accuracy is proved to a large extent.

3 Logistic Regression

Logistic regression is a statistics-based well-known machine learning model for classification. Logistic regression is the extension of linear regression. The output of linear regression is in the range of $-\infty$ to ∞. The output of logistic regression is in the range of 0 to 1. When the range is limited, the classification can be performed without hassle. In linear regression of the machine learning, the model gets trained based on the training data set using Eq. 3.

$$\gamma = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i \tag{3}$$

where.

γ = dependent variable.

β_0 = intercept.
β_i = slope for X_i.
X_i = independent variable

The objective is to find the dependent variable y using one or more independent variables X_i, intercept β_0, and slope of the independent variable $x_1, x_2, \ldots, x_n$. The gradient descent algorithm supports in the prediction of y. The input of x_i may be one dimension or n-dimension. If it is one dimension the linear regression type is simple linear regression when it is n-dimension the linear regression type is multilinear regression. In all the cases the output y is in the range $-\infty$ to ∞. When the range of y is too large, using the linear regression for classification is difficult.

Logistic regression solves this problem of simple linear regression and multilinear regression associated with the classification. Logistic regression introduces the function sigmoid (Eq. 4). The sigmoid function takes major role in logistic regression. It takes input from the linear regression model and transforms that into a value in the range 0 to 1. When the output is represented between 0 and 1, then classification is easy.

$$\text{Sigmoid}(x) = \frac{1}{1 + \mathrm{e}^{-x}} \tag{4}$$

Sigmoid (x) is the sigmoid function and e is the Euler's number.

The classification is such that if the output is greater than 0.5 it belongs to class 1 otherwise class 0 when it is binary classification.

4 Logistic Regression on Mutation Classification

The data which is used for training and testing contains the attributes ID, Gene, Variation, and Class. Here Class is considered as a dependent variable. Gene and Variation are considered as the independent variables. The logistic regression model was created for the classification. Then the model is fitted with training data of both independent and dependent variables. Once the model gets trained with the training data then the model is ready to predict the Class for Gene and Variation.

The classification in mutation data is automated using the machine learning technique logistic regression based on the attributes Gene and Variation. The attribute Gene represents where this genetic mutation is located. Variation is the attribute that represents the amino acid change for these mutations.

5 Logistic Regression-Based Model for Mutation Dataset

The attributes of training data Gene, Variation, and Class are applied on the proposed logistic regression-based model for mutation dataset (LRBMM). Once the training has been done the model is tested with the testing data. Based on the model's performance with the training data, the model's validation is carried out. The model has been validated by the measures confusion matrix, accuracy, and precision.

The confusion matrix is the measure that represents the number of tuples classified and the number of tuples classified in a wrong way. It represents how many class 1 is predicted as class 1 in an incorrect way and how many class 1 is predicted as class 2, class 3 up to class *n* in a matrix format. It gives the complete idea and performance of the model.

Accuracy is the measure that has been used to assess the quality of the model. Accuracy is calculated by companion's test data and predicted data (Eqs. 5 and 6).

$$\text{Accurancy} = \frac{\text{Number of correct predictions}}{\text{Total number of correct predictions}} \tag{5}$$

$$\text{Accurancy} = \frac{TP + TN}{TP + TN + FP + FN} \tag{6}$$

where TP is true positive, TN is true negative, FP is false positive, and FN is false negative.

True positive and true negative are the correct predictions. False positive and false negative are the wrong predictions. Precision and recall can be calculated with the above functions using Eqs. 7 and 8.

$$\text{Precision} = \frac{\text{Number of true positives}}{\text{Number of true positives} + \text{Number of false positives}} \tag{7}$$

$$\text{Recall} = \frac{\text{Number of true positives}}{\text{Number of false negatives} + \text{Number of true positives}} \tag{8}$$

Figure 1 represents the functioning of the LRBMM model on mutation data. The training data containing gene, variation, and class is given to the LRBMM model and the model gets trained. Classification and prediction are performed for the testing data and the predicted classes are identified. In Fig. 2, the validation of the model is done by giving new data to the model in order to do prediction.

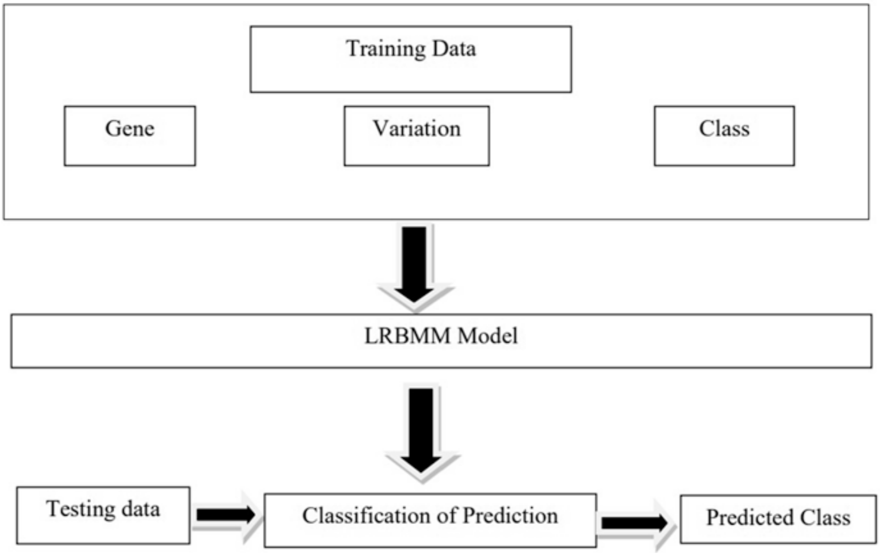

Fig. 1 Functioning of LRBMM model on mutation data

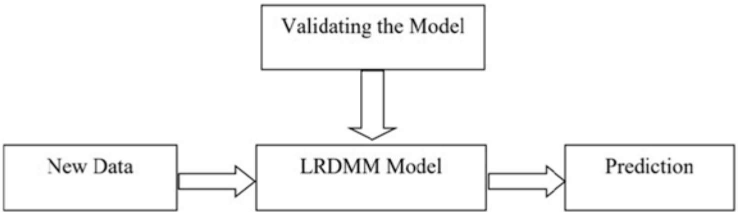

Fig. 2 Functioning of LRBMM model on new input

6 Experimental Analysis

Gene, Variation, and Class are the major attributes of the dataset; They are mentioned in Fig. 3. All the attributes Gene, Variation, and Class are categorical attributes. Machine learning-based linear regression model or logistic regression models are unable to progress with categorical data; in that case categorical data need to be converted into numerical data. Two ways of converting categorical data into numerical data are one-hot encoding and label encoding. One-hot encoding makes the dataset bigger by having new attribute for each category in the attribute. So, one-hot encoding is not suitable for the mutation data. Label encoding has been chosen as the correct option to convert categorical data into numerical data. In label encoding, a numerical value is assigned for each category in all the attributes. The data will be imported to the python environment using pandas. Read-csv function in pandas supports the import operation.

	ID	Gene	Variation	Class
3316	3316	RUNX1	D171N	4
3317	3317	RUNX1	A122*	1
3318	3318	RUNX1	Fusions	1
3319	3319	RUNX1	R80C	4
3320	3320	RUNX1	K83E	4

Fig. 3 Sample data before label encoding

Fig. 4 Sample data after label encoding

	ID	Gene	Variation	Class
0	0	85	2629	0
1	1	39	2856	1
2	2	39	1897	1
3	3	39	1667	2
4	4	39	1447	3

```
import pandas as pd
import numpy as np
mudatafile = pd.read_csv("mutation.csv")
mudatafile.head()
```

Pre-processing is the conversion of categorical data to numerical data by the package pre-processing from sklearn. The sample data after label encoding is shown in Fig. 4.

```
from sklearn import preprocessing
le = preprocessing.LabelEncoder()
a=le.fit(mudatafile.Gene)
encoder = preprocessing.LabelEncoder()
categorical_features = mudatafile.columns.tolist()
for each in categorical_features:
mudatafile[each]=encoder.fit_transform(mudatafile[each])
```

The independent variable and dependent variable are separated. X is considered as independent variable and contains the attributes Gene and Variation. The dependent variable y contains the attribute Class.

Both X and y means independent variable and dependent variable are split into training data and testing data, using train_test_split function of sklearn. It is also a part of pre-processing.

```
# split X and y into training and testing sets
from sklearn.model_selection import train_test_split
X_traindata,X_testdata,y_traindata,y_testdata=train_test_
split(X,y,test_size=0.25,random_state=0)
```

Based on the train_test_split function 75% of the dataset is used as a training set and 25% of the dataset is considered as testing set. The 75% data and 25% data are split in random fashion as shown in Figs. 5 and 6.

The logistic regression model has been created and training data fitted into the model using fit function. Sklearn python library is used to create the model and for pre-processing.

from sklearn. linear_model import Logistic Regression

```
logreg  model=Logistic  Regression  (multi_class='multinomial',
solver='lbfgs', penalty='l2', C=1.0)
logreg model. fit(X_train data, y_train data)
y_preddata=logreg model.predict(X_test data)
```

The accuracy of the model is tested with the metric confusion matrix (Fig. 7).

The quality of the model is also assessed with the metrics accuracy, precision, and recall. Table 1 represents the precision, accuracy, and recall for LRDMM model.

Figure 8 represents the quality assessment of the model. Table 2 describes the performance of LRDMM by comparing it with decision tree-based approach, random forest-based approach, SVM-based approach, and naïve Bayes-based approach.

Figure 9 and Table 2 show that based on accuracy the LRDMM model performs better than other models in prediction.

Fig. 5 Sample training data contains independent variable

	Gene	Variation
3050	130	1281
2622	31	2336
2320	123	379
3021	130	428
951	180	1341

Fig. 6 Sample testing data contains independent variable

	Gene	Variation
3028	130	1673
2874	32	297
1772	261	599
989	254	1588
2507	31	409

```
array([[ 49,  0,   0,   0,   0,   0,   0,   0,   0],
       [  0,  48,  0,   0,   0,   0,   0,   0,   0],
       [  0,  0,  14,   0,   0,   0,  15,   0,   0],
       [  0,  0,   0,  85,   0,   0,   0,   0,   0],
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       [  0,  0,   0,   2,   0,   0,   5,   0,  53]], dtype=int64)
```

Fig. 7 Assessing the quality of the model using confusion matrix

Table 1 LRDMM model's quality assessment

Name of the metrics	LRDMM performance
Precision	0.9189
Accuracy	0.96158
Recall	0.96158

7 Conclusion

The strategic relapse-based AI model is utilized to distinguish the change class in light of the information quality and variety. The quality and variety are the free factors and class is the reliant variable. The strategic relapse-based model prepared with the preparation named information and the expectation or order of change class is distinguished. To demonstrate the nature of the model, it is contrasted and the contemporary cutting-edge order methods Naïve Bayes, Decision Tree, Random Forest, and SVM grouped. Toward the finish of the examination of the exactness, F1 score, accuracy, and review are great with the proposed technique when contrast with the current strategy.

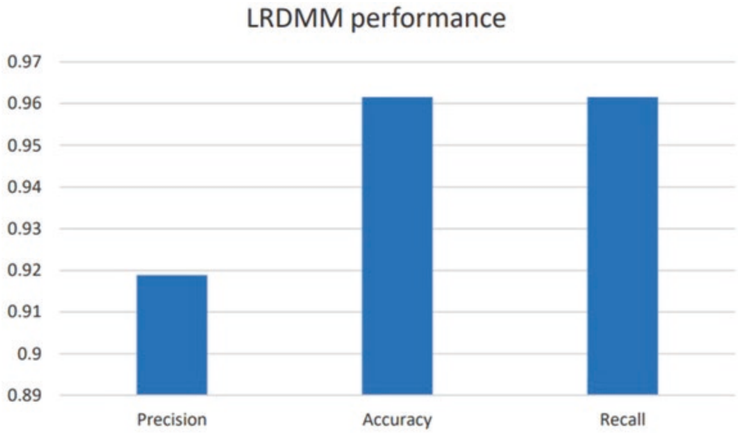

Fig. 8 Histogram of LRDMM model's quality assessment

Table 2 Performance analysis of LRDMM by comparing with other methods

Name of the methods	Precision	Recall	Accuracy
Decision tree	0.84	0.81	0.91
Naïve Bayes	0.78	0.75	0.83
Random forest	0.68	0.77	0.71
SVM	0.83	0.87	0.81
LRDMM (proposed)	0.91	0.96	0.96

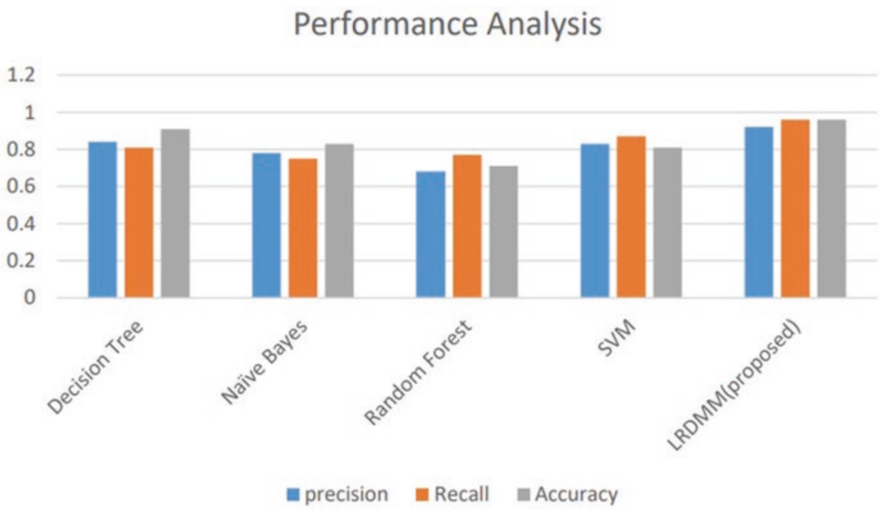

Fig. 9 Performance comparison chart of LRDMM

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Part IV
Evolution of Healthcare Techniques (Prognosis and Diagnosis)

The Revolution in Progressive Healthcare Techniques

R. Manju, S. Anu Roopa Devi, J. Jeslin Libisha, Sapna S. Gangolli, and P. Harinee

1 Introduction

Technological revolution has exhibited exceptional changes in the areas to enhance health maintenance and patient effects, including antibiotics, drugs and other anti-infective drugs that target diseases like cancer and its therapies, cardiac rhythm monitors, imaging and diagnosis, non-invasive surgery, algiatry control and other health technology services [1].

Measures, activities and methods for enhancing health, living and its immediate surroundings as well as rights gained through health insurances are included in healthcare. Proper functioning of healthcare involves coordinated, public or personal efforts to help people in improving general public health as well as preventing ailments and impairment. Health services are present countrywide and these devices are set up where establishments fulfil multipurpose goals of the population's diverse health needs. Healthcare for people and the community encompasses a wide variety of preventive and healing techniques and it relies closely on versatile medical examiners. The dimensions of the population will have an effect on the specifications of the diseases and issues handled at multiple levels. The first tier of a healthcare organization is the professional (medical) care which is the "first contact" of a person with a fitness-care provider that is supplied in unfamiliar environments by using certified fitness experts (general practitioner–GP, circle of other health practitioners or nurses) while an affected person provides sure sign symptoms or signs most commonly seen for the first time.

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For harder issues that could not be handled by well-known practitioners or number one expert care, there is a "specialist physician". Sub-specialist care, which includes fairly unique treatment, is furnished at the tertiary degree of care. It can be supplied by using notably specialized health experts and sub-specialists which include neurosurgeons, plastic surgeons, nephrologists, cardiologists and others in establishments or via terminal health professionals. Secondary and tertiary healthcare complement primary care by offering technologically advanced diagnosis, treatment and rehabilitation [2]. Secondary and tertiary care should be more clearly served and supported in most member states, according to the WHO. Figure 1 shows the progress of healthcare and their regions of governance. The following should be the primary goals of every national health system:

- Popular to get entry to an extensive range of scientific offerings.
- Selling countrywide by setting health targets.
- Signs of fitness-reputed improvements.
- Geographical and socio-demographic fairness in getting a right to entry and pleasant care.
- Monetary sufficiency, as well as cost minimization and useful resource performance.
- Client and number one care as per provider's choice.
- Company satisfaction and referral alternatives.
- Advantages such as portability, moving jobs or houses.
- Authority's management or stringent laws.
- Advertising of advanced provider quality.
- Comprehensive in terms of primary, secondary and tertiary care.
- Well-developed tracking and information systems.

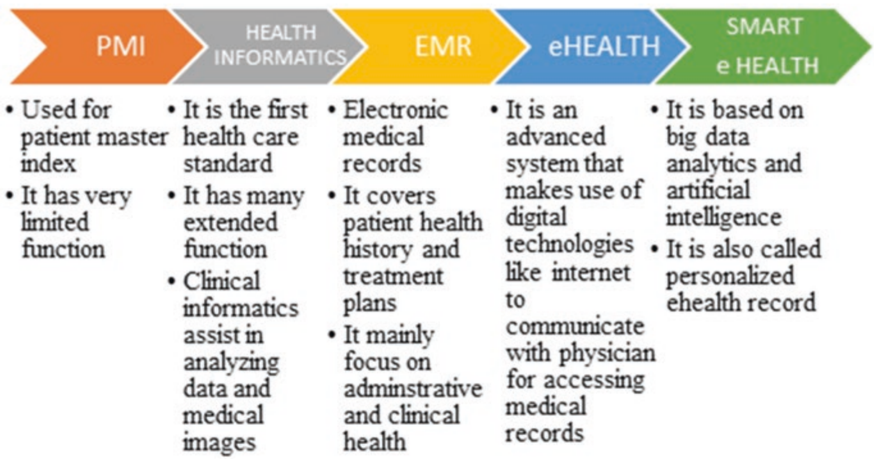


Fig. 1 Schematic showing the progress of healthcare and their regions of governance

- On-going policy and management assessment.
- Promoting of professional education, training and research standards.
- The delivery of services by means of authorities and the non-public region.
- Community participation and decentralized management [3].

2 Evolution of Primary Healthcare

The origins of outpatient treatment can be traced back to the sixteenth century where medical care, which had formerly been organized typically via affected patient facilities related to churches and monasteries, started out to shift and fall under the control of the nation. WHO emphasized the significance of outpatient care and government obligations for enhancing the fitness and overall health status of their very own at the ancient conference on primary fitness care in Alma Ata in 1978 based on the centre of concepts for primary fitness care formulated within the Alma Ata statement: Commonplace based on need, health fairness as part of development orientated to social justice [4].

Primary healthcare is critical for patient care that is made extensively to be given to people and families within the community using techniques which are suitable to them and at a fee that is of low cost to the community. Primary healthcare incentives consist of expanding programs and services that have an impact on kids and teenagers for their healthy development and hygiene. To increase community participation at both the government and community sectors enhance their network fitness. To improve fundamental fitness, care offerings are handed out [4].

The tip to ensure the primary healthcare services are to be given in a time-efficient and inexpensive manner inorder to guide the implementation of public health regulations. To use accountability concepts in expert activities, primary fitness care teams keep constraints of available assets, to inspire the delivery of complete, included and evidence-based primary fitness care are the major goals covered. A primary healthcare team is made up of a diverse set of healthcare specialists who work together to provide basic healthcare to a specific group of individuals or demographic. The framework for primary healthcare is based on four essential elements. These pillars serve as a foundation for providing safe healthcare and are shown in Fig. 2.

The four predominant pillars of number one fitness care are as follows:

- Network participation
- Inter-sectorial coordination
- Appropriate technology
- Assist mechanism made available

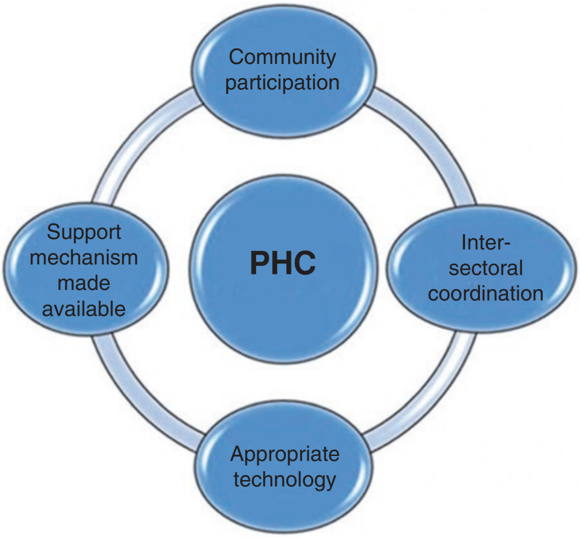


Fig. 2 Flowchart representing the constituents of primary healthcare (PHC)

2.1 Community Participation

Community contribution is a technique for including community individuals in arriving at conclusions about their own well-being.

- It is a social system to feature the community's medical care needs.
- Community cooperation involves the support of community individuals in surveying the preparation, sorting out, deciding and executing well-being programmes [5].

2.2 Inter-sectoral Coordination

- Inter-sectoral coordination is fundamental for executing various practices in the movement of prosperity organizations.
- It is essential to incorporate explicit associations, the business region and the regulative region to additionally foster prosperity workplaces.
- Inter-sectoral coordination will guarantee that different areas interface and work together to address individuals' medical services prerequisites [6].

2.3 Appropriate Technology

Reasonable clinical consideration propels, described as "advancement that is coherently strong, adaptable to local necessities, and palatable to the people who apply it and to whom it is applied, and that can be stayed aware of by people themselves concerning the rule of autonomy with resources the local area and country can bear", are a critical strategy for chipping away at the availability and transparency of clinical consideration organizations [7].

2.4 Support Mechanism Made Available

- The importance of aid mechanism to one's fitness and quality of life cannot be overstated.
- An approach aimed towards improving first-class life is the help mechanism in fundamental healthcare.
- Human being acquires non-public, bodily, intellectual, religious and instrumental help to fulfil primary healthcare desires as a part of the guide mechanism.

Primary fitness care is the most important element that causes and emphasizes a country's health. The primary vehicle for promoting fitness in the healthcare system is the most crucial component, spanning from the periphery to the core, and serving as a fundamental driver of social and economic growth in the United States. It is going to expect exceptional shapes relying on the political, financial, social, cultural and epidemiological styles in the United States. One of the most fundamental elements of the number one fitness care approach is the hyperlink between patient care and public fitness features [7].

3 Teleological Healthcare Systems

Teleological ethics (from Greek telos, "end", and logos, "science") is an ethical quality hypothesis that determines liability or honest conviction based on what is great or attractive as an objective to be sought after. In numerous nations today, the issue is to arrive at the whole populace with adequate medical care benefits and guarantee that they are utilized [8].

Telemedicine can possibly close this hole, yet it is anything but a fix. Both specialists and patients have an elevated degree of pessimism. Telemedicine may (and should) be used to give medical care to underserved regions in non-industrial nations and nations with restricted framework. The World Health Organization stated that the Covid illness 2019 (COVID-19) flare-up a pandemic on March 11, 2020, referring to north of 720,000 cases kept in more than 203 nations as of March 31, 2020. To bring down the risk of transmission, telemedicine, especially video interviews, was supported and increased here [9].

4 Artificial Intelligence in Healthcare

Artificial intelligence has been an integral part of the healthcare evolution as it serves as the most widespread utilization of modern healthcare business. AI typically represents the dominant approach for a range of intelligent processes and computational algorithms with emerging changes in the lifestyles of people, and a lot more of the chronic illnesses have become the deadliest drawbacks in healthcare technology. Addressing the above, artificial intelligence, machine learning, IoT, telemedicine and big data have set standards in the evolution of healthcare technologies. AI technology can be used as a powerful tool to heighten the care for patients in various aspects of clinical transformation [10].

AI has surpassed partnership with machine learning and deep learning. Prediction of treatment procedures in prior is likely to be favourable and successful with the help of artificial intelligence framework in numerous healthcare organizations. The precision application of healthcare technology will feature significant benefits in the health recording systems. AI-based E-healthcare and M-healthcare owe the data-enrichment approach to attain the target and demand of healthcare management and diagnosis consequently. Many researches are evolving in their trend in enveloping their part with healthcare computational techniques. AI is the way forward of connecting devices to the computational network by increasing their efficacy and quality care.

Overall, AI has incorporated healthcare evolution diagnosis and will enhance the decision-making administrative endeavours associating patient care and providing superior experience and an intelligent framework for expanding assessment to healthcare service [11].

5 Machine Learning Prediction in Healthcare

Machine learning is a widespread approach on healthcare informatics as it supports diagnosis of many clinical illnesses along with artificial intelligence and big data science. ML data has estimated the success rate of numerous complex algorithm patterns based on certain serious diagnostic techniques in healthcare informatics. It also serves as the most challenging and effective computational techniques of various tests for reliable prediction results.

ML is renowned for its workflow, output and relevant data source implementation for the clinical decisions and algorithmic development. ML provides healthcare feasibility to overcome chronic illness by incorporation with AI diagnosis. All those computational techniques act as the digital health coach to halve the mortality survey rate. Machine learning and artificial intelligence in healthcare informatics serve as the bot system to make the duration of treatment feasible. Given below is the use of this technology enabling healthcare integrated with AI and IoT [12].

5.1 Identification of Disease

There are a enomorous peak of physiological diseases due to the various etiological causes, of which one of the most uncurable diseases being cancer are hard to detect. ML detects many of these diseases at their primary stages by providing a quick diagnosis. It also predicts the reaction to a treatment of depression and improves diagnosis. 30 million people among which adults and elderly are being diagnosed with diabetes every day. The algorithm of machine learning includes KNN, decision tree and naive Bayes methods since they are the primary basis for building a novel computation system.

Liver forms a major function in metabolism for the human physiology's efficient working. Diseases like chronic hepatitis, cirrhosis and liver cancer are being effectively diagnosed with ML. ML makes the difficult task of predicting the earlier stages of liver disorders by collecting large amounts of medical data. Major advancements strike a huge part in the field of healthcare management. The algorithms like classification and clustering are causing a major impact in machine learning. Maintaining and managing health records continues to be a major inconvenience in the medical industry.

It has become a lot faster today but continues to siphon a lot of time. There are numerous records available today and they can be differentiated into vector machines and OCR (optical character recognition techniques) working on ML (Fig. 3).

Support vector machines (SVM), clustering and logistic regression (LR) are the most commonly used methods in machine learning. These models are highly appreciated in classifying and diagnosing chronic diseases and are expected to become more important in the medical industry in the near future [13].

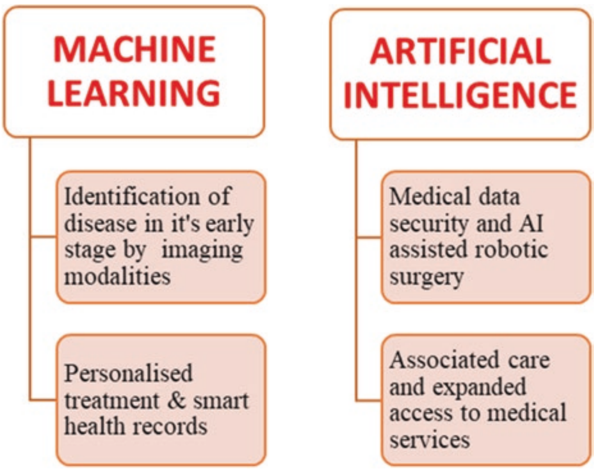


Fig. 3 Schematic showing ML vs. AI

6 IoT in Health Informatics

The internet of things has been exploited in excess in the field of medical health informatics. Many researchers have reported remarkable development in studying on-board status of monitoring clinical management. Advancement in the internet of things has delivered a significant path in the field of healthcare management. Significant evolution of healthcare technologies serves in receiving advancements taking into consideration the treatment faculties available. It serves a huge grass-roots network on data handling and healthcare resource management [14].

Different applications of IoT have a time-requirement factor and a structural big data type which aid in further time processing of computational processes. A mobile-enhancing wearable healthcare technology uses IoT for non-invasive procedure and can be designed by incorporating reliable sensors where actuators and software are used to globally develop the configuration in which it plays a predominant role in the field of medical science. Hence it solves a large number of healthcare issues. The application of IoT has enhanced the independence of big data analysis on humans to interact with the global environment.

The basic topology of the healthcare – Internet of Things – mainly composes of three components:

- Publisher
- Broker
- Subscriber

The publisher serves as a network of integrated sensor connections and other additional medical devices that might work individually to capture the patient's vital information. The publisher cannot send any data via network to the broker. The broker process is stocking of data in the cloud in which the subscriber monitors continuous information recording of the patient's health and can be visualized using a wearable device. Later the data can be stored, retrieved or sent to the doctor using telemedicine technology for prescription (drugs and treatment required) [15]. Figure 4 shows the various segments of the population used in IoT.

7 Wave of Wearables in Clinical Management

Across the treatment continuum, modern healthcare relies on technology. Incentives for value-based care are allowing even further penetration into consumer health. Because of the widespread use of digital health, there are more chances to collect patient data outside a medical facility. The patient health record (PHR) is one strategy for coordinating patient well-being information across numerous areas. The data given by the subset of customer hardware are known as wearable gadgets and are turning into a wellspring of information. Numerous wearable healthcare devices can connect remotely to different gadgets, working with data stream, trade and

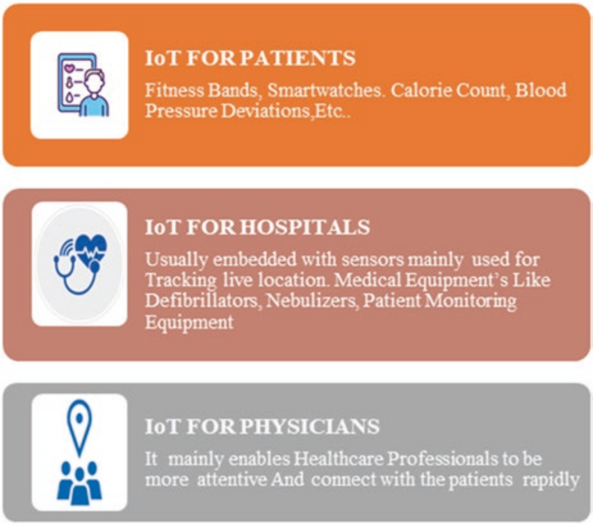
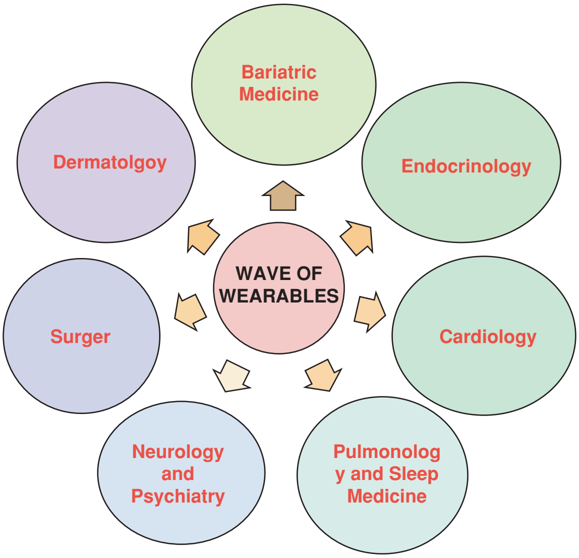


Fig. 4 Schematic showing IoT used by various segments of the population

Fig. 5 Schematic of the areas covered in wearables market



characterizing these gadgets as a component of the Internet of Things (IoT) [16]. Figure 5 represents the areas covered in wearables market over the current scenario.

Integration of wearable data into an electronic health record (EHR) is clearly beneficial to physician workflow. The cell phone is the most widely recognized direct-to-buyer wearable gadget. Cell phones are quite possibly the most expected devices for versatile well-being intervention, with billions of other devices installed, and software programs promising to enhance or track prevalent health metrics are immensely popular. Health-related applications promise faster weight reduction, better sleep and lower primary care expenditures ranging from action trackers that track steps, calories consumed and hours spent sitting each day and use of telemedicine stages that permit clients to take part in video conferences for minor and major concerns [17].

8 Direct to Consumer

The cell phone is the most well-known direct-to-customer wearable gadget. Cell phones are versatile for well-being intervention, with billions of devices installed, and software programs promising to enhance or track prevalent health metrics are immensely popular [18].

8.1 Cardiology

In the light of new administration of heart disease patients, remote observing of patient physiology has demonstrated to be an important apparatus. ECG recording innovations have become more convenient. The overall mass and prominence of checking gadgets present issues for patient's fulfilment and consistency. Currently, Holter screens are being a backbone in the work-up of new beginning such as detecting arrhythmias, notwithstanding the general mass and prominence of observing gadgets.

Nonetheless, outside clinical exploration, studies with extra mediations and conventions, there is a scarcity of writing researching these cases. It is as yet questionable whether the utilization of the customer free of clinical oversight or the board, significantly affects the results or financial matters. With upgraded structure factors and sweeping information stockpiling and transmission abilities, current buyer wearable devices give a valuable chance to assemble some clinically helpful data.

The exactness of pulse observing by monetarily accessible wearables has been assessed, with pulse estimation very still being more dependable than other different modalities of activity; however, photoplethysmography, which estimates light ingestion during and after throbs of blood through skin, was viewed as consistently less precise than customary electro-physiologic checking in each setting.

To observe the survey of healthcare devices in heart rate monitoring, roughly 10,000 patients took on a distant partner study, as surveyed by Apple Watch Photoplethysmography, that were viable with the physiology of atrial fibrillation (AF). Additionally with a standard 12-lead ECG, the Apple Watch pulse-based identification technique was additionally less contact and being explicit. This impact is not clinically huge while surveying for fundamental dysrhythmias like AF, however it may prompt missed irregularities or misdiagnosis of more inconspicuous anomalies.

8.2 Bariatric Medicine

Weight reduction has for some time been a famous objective for cell phone applications, wearable devices and other advanced customer innovation. A few overviews have uncovered the usage of cell phone applications that help in exercise regimen and nutritional chart.

8.3 Endocrinology

Patients should invest tremendous effort and regard for tracking, deciphering and follow-up on a wide scope of information (from blood glucose levels to insulin spikes to complex dietary data) to successfully oversee diabetes mellitus (DM).

Glycaemic control has been connected to the ability of treatment regimens and adherence to them. The limit of programming and wearables to gather and sort out close to home DM information has provoked the curiosity of scholastics hoping to further develop patients' and doctor's capacity to adequately deal with the sickness [19, 20].

9 Devices Used or Managed by Clinicians

Wearable gadgets have the potential to transform how doctors practise and manage patients in both inpatient and outpatient settings, in addition to direct-to-consumer technologies. The following discussion focuses on gadgets that are utilized in a variety of disciplines to increase access to expert opinions, provide alternate procedural functionality and organize clinical and personal health data [21].

9.1 Cardiology

Wearable gadget applications in interventional cardiology have been depicted notwithstanding electrophysiology. At point, creating augmented experience through a gadget that projects three-layered processed tomographic angiography of hindered coronary conduits onto a wearable PC to help with percutaneous revascularization.

9.2 Dermatology

As other clinical subspecialties, Dermatologists, have less stock as a result of conflicting geographic scattering which is a foreordained number of getting ready occupations and a developing populace. Telemedicine has been suggested as a solution for addressing healthcare challenges, with wearable devices being utilized to facilitate remote care. Research has demonstrated the use of hands-free Google Glass technology for video consultations and image sharing with dermatologists in a clinical setting.

9.3 Neurology and Psychiatry

The brain activity can be measured in an assortment of ways, as indicated by the researchers. Patients with epilepsy problems is a gathering with one or more constant conditions that can be hard to control, with seizure recurrence being especially capricious and connected to serious horribleness as some of the integrated problems in the measure of neural activity. The biometric information gathered by wearables is considered to check whether early seizures and actions discovered could be estimated.

Seizure identification accelerometry device when reviewed was found – inadequate, but calculations made from a blend of wearable healthcare device and electrodermal information gave an impression of being promising. HUDs have additionally been tried as a telemedicine apparatus for neuro rehabilitation and exercise-based recuperation, and computer-generated reality frameworks like the Oculus Rift have stated interest as modalities for treating patients with intense and constant torment in diverting and focusing their consideration [22, 23].

9.4 Pulmonology and Sleep Medicine

Many commercially available smartphone applications and wearable devices claim to be able to measure sleep quality indicators. Most hardware uses technology such as accelerometry to monitor movement, with a device determining the periods of low-level movements associated with sleep. When it comes to identifying complex sleep habits or stages of sleep, such technology is restricted. Software methods combining other biometric data, such as breathing and heart rate fluctuations, have been integrated with wearable pulse oximetry sensors to detect episodes of obstructive sleep apnoea in smartphone-based platforms (OSA). Despite advancements, wearable sensors as an accurate and granularity of data to be supplied by polysomnography, the gold standard in sleep medicine.

9.5 Surgery

Inside the surgical subspecialties, heads-up display (HUD) has been broadly explored as a means for working with far-off conferences and help specialists, just as an offering for expanded or increased diagnostic reviews. Verification of this idea has been directed to be tested on Microsoft's HoloLens in neurological procedures, vascular medical procedures, orthopaedics and plastic surgery. While Google Glass has been tried in paediatric surgery, relocation surgeries have been among the different fields it has been used in. These "tweaked" HUDs have been utilized as an added active method for fundoscopy in the field of ophthalmology, giving a portable and savvy option in contrast to conventional operative viewing methods. Healthcare works has kept it from zeroing in on to being the effective utility of HUDs showing increase in augmented reality (AR) conditions and as instructive devices for careful learners.

Computer-generated reality has for quite some time been perceived as a method for procuring task-based capability, and work has kept on zeroing in on the utility of HUDs showing increased or augmented reality conditions as instructive devices for careful learners. HUDs, like Google Glass, have been utilized by teachers for assessment as well as supporting direct learning [24, 25].

10 Role of Big Data in Healthcare

Big data assumes a significant part in medical care. Utilizing big data in medical services covers advancement, business understanding, data investigation, data planning, data demonstration, and data assessment. It deals with volume, assortment, and speed and is essentially named as the 3v's of big data. Volume shows the construction of data. It shows whether it is organized, unstructured, or semi organized. Speed demonstrates the on-going speed and close to time speed and close to time stream of the data across a channel. Big data is possibly costly and challenging to execute [26].

To catch harmonious connections of assorted added substances and events of this sort of convoluted framework, a biomedical or natural test generally accumulates measurements on a more modest or a less confounded part. Subsequently, it requires two or three worked-on tests to create an immense course of a given physiological peculiarity of interest. This shows that the more noteworthy the insights we have, the higher we secure these cycles. With this idea, present-day systems have been created at a wonderful speed. An illustration of the potential of big data can be seen in the utilization of advanced technologies such as next-generation sequencing (NGS) and genome-wide association studies (GWAS) to analyze human genetics, resulting in a vast amount of measurements being generated. NGS relies on data that provides information at previously unprecedented depths. The advantages of big data can be summarized as follows:

- Genome mapping
- Retrieval of real-time data
- Better way of diagnosis

10.1 Big Data in Health Records

Utilizing big data in medical services initially predicts the issue looked by the patient. Next its investigates the medical care data by utilizing electronic health records (EHR). Electronic well-being record involves the general soundness of the patients. The expression "big data" has arisen as a renowned field all through the globe in current years. Practically each zone of examination, whether it relates to big business or scholastics, creates and reads up huge data for various purposes.

The greatest intense endeavour concerning this gigantic store of realities that might be ready and chaotic is its administration. Given the truth that enormous data is unmanageable in healthcare records, the utilization of the traditional programming programs need actually predominant bundles and programming programs that can utilize quick and cost-effective computational strength for such errands. Execution of artificial intelligence (AI) creates a vital utilisation of big data science [27].

10.2 Deriving Big Data from Omic Studies

Omics data types like genomics, epigenomics, transcriptomics, proteomics, and metabolomics are called as complex heterogeneous data. These data are analysed using big data and grouped into separate categories as represented in the schematic in Fig. 6. Healthcare calls for a robust integration of biomedical information from numerous assets to offer faster remedies to affected people. These possibilities are

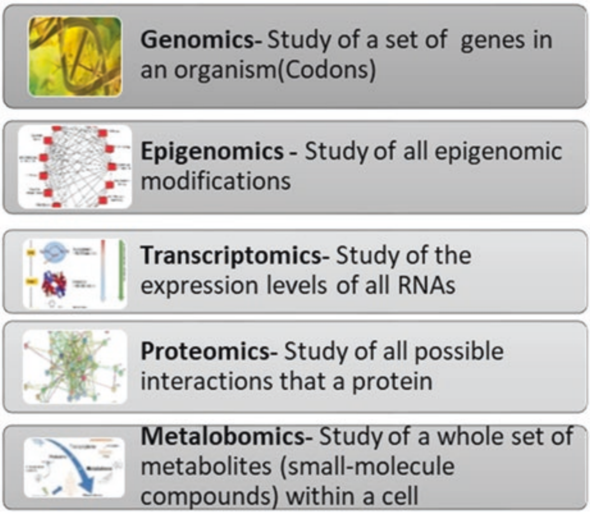


Fig. 6 Schematic of various omics data types studied

so interesting that despite the fact that genomic statistics from sufferers could have many inconsistencies industrial groups are already making use of human genome information to assist the companies in making personalized scientific decisions. This may become a game-changer in the future of healthcare [27].

11 Conclusion

Customer wearable contraptions, auxiliary innovation, and, virtual applications increased the truth are quickly developing as there is evidence in the worldwide market around the world. This is making a pivotal and an inexorably significant resource for present-day medical care. The capacity of these devices to re-enact clinician connection, work with constant disease on the board, and gather enormous measures of well-being data has for quite some time been praised, and the picture of future medical care IoT environment conveys customized and excellent therapy while bringing down expenses of other famous instruments.

The enormous volumes of data produced by buyer might be advantageous when handled by complex calculations that take into consideration. Expanded design distinguishing proof and clinical choice help, the two of which are turning out to be progressively pertinent thinking about in setting of the superior working. On the off chance that wearable advances are to be depended on for giving early advance notice of issues, the patient should be given the important data to take into account a heightening in treatment. Additionally, data may be shipped off to doctors early to take into consideration faster emergency and asset task. Clinical choice helps with regard to wearable advances have not been widely explored excessively so far. In spite of these disadvantages, wearables vow to stay as a functioning and intriguing innovative work area with consistently expanding functionalities. Obscuring the lines between customary embedded clinical gadgets and wearable gadgets, collaboration with arising informatics advances will undoubtedly occur in 10 years.

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Epocalypse Telepathy of Objects Using Brain Force

S. Hema Priyadarshini, T. David Simon, N. Hanumanthappa, and C. Ram Kumar

1 Introduction

Moving objects using our cerebral signals has always been a mythical theory or idea expressed by various scientists and critics. The signals from the brain are recorded through electroencephalograph (EEG), EEG was discovered by a German psychiatrist Hans Berger in 1929 [1], which was a breakthrough in medical history. Understanding the neural connections of our brain fell in a domain of wonders, where every new thing discovered had a bright, innovative side, just like the discovery of the EEG recorder. Ancient history supported the idea of telepathy through mythical creatures [1]. People believed controlling other objects was an inherited superpower and was genetic only.

Richard Caton's discovery of "current in the brain" led to EEG and electroencephalograph equipment. In 1875 [2], he presented his discovery of electrical phenomena of the exposed cerebral hemispheres of rabbits and monkeys. He placed the electrodes on the exposed brain and saw the fluctuating oscillations of the brain activity, which led to the conclusion of cerebral or brain waves. The investigation of the spontaneity of brain electrical activity was also published [2].

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EEG is a non-invasive method of recording the electrical changes of the brain. It is the macroscopic activity recorded underneath the brain's superficial layer. The electrodes are placed on the scalp of the head to extract the brain's electrical signals non-invasively [3]. The cerebral signals can also be extracted using the invasive method called intracranial EEG, which is complex but accurate. EEG measures the voltage fluctuations resulting from the ionic current within our brain's neurons. It records the brain's spontaneous activity in different stages (e.g., sleep, active, deep sleep, and relaxed) concerning time. The subject followed through a "stimulus onset" or "button press" event to record responses to various fields of the state of the brain [4].

Disorders such as sleep disorders, epilepsy [11], coma, encephalopathies, and brain death plights can be easily identified from EEG, which helps make further diagnoses [5]. EEG signals were later analyzed through a wave format in the frequency domain called brain waves. Hence any alterations which don't fall in the normal range of the EEG wave pattern are addressed to be abnormal [6].

EEG was used to identify tumors, stroke, and other focal brain-related disorders before the advent of the MRI, PET, and CT machinery equipment. EEG is still in use for the acquisition of brain signals and research purposes since it is deemed a mobile technique with the millisecond-ranged temporal resolution that sets it apart from MRI, PET, and CT equipment [7].

EEG has two major derivatives, evoked potential (EP) [8] and event-related potential (ERP) [13], both time-locked and analyzed. Evoked potential involves averaging the EEG activity to the presentation of a stimulus (visual, somatosensory, or even auditory); likewise, the ERPs are used to average EEG signal responses to much more complex processing stimuli. Event-related potential was used in cognitive psychology, psychophysiology, and other studies related to cognitive science and research [8].

These EEG signals, which are electrical signals, can be used to move objects or perform certain activities just like any other signal. To get into the picture, we need an interface between the brain and a programmable computer, and thus, the BCI concept was introduced. BCI, also known as BMI or HCI [17, 25], is the brain–computer interface or brain–machine interface. It is a communication channel between the brain's electrical activity and an external device, usually a PC or a robotic structure [9].

This BCI interaction can be improved and enhanced with machine learning and artificial intelligence, emerging technologies. This interaction is named "telepathy over objects" [30].

The signals collected from the brain's frontal lobe (cerebral wave) can be classified into different mental states [15], i.e., relaxed, focused, plain, or neutral [4].

"Disability need not be an obstacle to success," said the great physician Sir Stephen Hawking [12]. Though mobility was completely hindered, his ability to showcase his talent and achievements to the world was not an obstacle. The human body is affected by various conditions affecting mobility and contact. These diseases can be temporary or for a lifetime, sometimes with no cure and forcing us to adapt and thrive to the existing technology or medical equipment, increasing the dependency on others.

Some diseases are losing a limb or damaged nervous system or paralysis, which affects the host body to look into a new way of adapting and living. Our functioning cerebro headset can help regain the lost part, which helps in object movement using cerebral signals extracted, analyzed, and promoted into moving an object. For instance, a patient sitting in a wheelchair, being unable to move, can move his wheelchair to achieve movement and momentum [10, 21].

The cerebro headset has an insulating shield enclosing the device's core, the Arduino, and motion sensors. Electrodes are placed over the visual cortex to ensure the extraction of the alpha cerebro-visual signals. The processing of the recorded signal is done using Arduino and given as an input to our application, a toy car [24, 25].

The mobility-affected host patient will be trained with cognitive training, i.e., to focus and improve visualization and to have a calm and relaxed mind. This is because the cerebral signals being extracted are of a specific frequency of 8–12 Hz. In this way, a motionless or affected person can gain mobility. In short, it is the moving of objects using just our brain signals. Therefore, this device can be a revolution for providing movements using brain signals.

These days, many fictitious series convey the revelation of human beings' superpowers. One of them is telepathy. Telepathy is the transmission of communication without any known sensory channels. Our device comprises a wireless headset that works with two sensors [18, 32] (advancement three, motion-sensing detector) and a Bluetooth shield, which helps control devices through the cerebral waves.

Cerebral signals from our brain communicate by sending electrical and chemical signals, called neurotransmitters. They do not emit simultaneously, but when focused on one central activity/region of our brain, specific signals of various frequencies are emitted. These signals are recorded through electroencephalogram [2]; a device that emits and transmits brain wave of certain frequency from various regions of our brain.

Due to pandemic, there are many patients whose movement and contact are restricted on a day-to-day basis. Keeping this in mind, we decided to build a cerebro enabling mobility for the affected one. It is a well-equipped headset, with an insulating shield enclosing the core of the device, the Arduino, and motion sensors. Electrodes are placed over the visual cortex to ensure the extraction of the alpha cerebro-visual signals, which are sent to the Arduino to process and forward the output as an input to our application, a toy car.

These cerebro signals [14] are of different frequencies; namely, the beta (β) frequency band is in the range of 12–35 Hz, which is emitted during dominant anxiety, active/external attention, or a relaxed state. Likewise, there are five primary brain-signaled frequencies that are emitted and are responsive to specific stimuli daily. They are alpha (α), beta (β), gamma (γ), theta (θ), and delta (δ) as shown in Table 1 [14].

Dependency has become a bane to oneself, but this might be overcome with our brain force headset. Our headset works on the principle of electroencephalogram (EEG). This device can help us understand medical conditions such as epilepsy and sleeping disorders [14]. Our project, which monitors our subject's EEG signals, requires an input signal (EEG) of 8–12 Hz only to move our application, a

Table 1 The various frequency bands of EEG

Frequency Band	Frequency (Hz)	Physiological state of brain
Alpha (**α**)	8–12	Very relaxed, passive attention
Beta (**β**)	12–35	Anxiety dominant, active, external attention
Gamma (**γ**)	>35	Concentration
Theta (**θ**)	4–8	Deeply relaxed, inward-focused
Delta (**δ**)	0.5–4	Sleep

wheelchair. With more advancement, we will be able to upgrade this device with a motion-sensing detector that will detect the twitching of the cheek muscle or raising of our eyebrow and will give these actions as an input to the application, say, a toy car or a wheelchair. Usage of the EEG cerebro headset helps control the objects around through telepathy [16]. The cognitive training provided during the process of mastering the cerebro headset can ensure a relaxed and focused mind to the subject or the patient [20].

1.1 Benefits

- Technology in healthcare has made a significant positive impact on society. Brain control devices may reduce human resources and increase independence in any physical activity. BCI reaps importance and is significant in healthcare and therapy centers. With more understanding and acceptance, people can achieve mobility and privilege in taking a step forward to change societal norms.
- Getting to know more about cerebral and machine interface flashes light on various possibilities such as controlling prosthetics and an inanimate object through the art of object telepathy.
- A headband created by Arduino microcontroller would pick up the EEG signal from the scalp [19]. The visual cortex will yield a good source of information in understanding mental states in medical research and diagnosing certain medical conditions such as epilepsy and sleep disorders.
- People have started harnessing EEG as a way to control technology and devices. EEG headsets have been used to help amputees control high-tech prosthetic limbs and avoid dependency on people.
- Usage of EEG helps to control the objects around us through telepathy and cognitive training of our brain to stay more relaxed and focus more effectively [20, 22].
- In the medical industry, this device helps in monitoring brain activity to determine areas of damage following a stroke or head trauma, epileptic activity, and brain death in patients [5].
- Emerging healthcare technologies give an overall view of the benefits mentioned here [23]:

– Enhanced monitoring and active care.
– Improved standard of living.
– Increase in life expectancy rate.
– Minimizing human resources.
– Quality.
– Connectivity and affordability.
– Reduced dependency over others.

2 Materials and Methods

The main objective is to apply the BCI technique to access objects, to control them using the cerebral signals alone and gain mobility in healthcare and technology. ADS1292R is a multichannel signal detector of 24-bit that can convert analog signals into digital data. In our model, we use this device to read the waves emitted from the brain when the subject attains a focused state. It starts reading when brain waves are between 8 and 12 Hz and gives this signal input to the Arduino board [34]. HC-05 Bluetooth module is a wireless device that communicates based on Bluetooth protocol. This has a single-chip Bluetooth IC that works using standard protocols and supports USB interfaces; this model plays a significant role in transmitting commands between the two microcontroller boards. They play a vital role in sending and receiving data.

The L293D motor driver is an IC that has 16 pins and used for motors. This device can run two DC motors simultaneously and control the direction independently, and the motors should have less than 36 V [34, Wikipedia]. This microcontroller board is based on ATMEGA328P and has 14 pins, including an input and output jack. It has a USB connection, a power jack, and a reset button. It contains what every microcontroller needs to process data. The input is given through the signal wave detector, the brain waves. If the wave's frequency is 8–12 Hz, the board considers it a command and creates a command to move the motor driver forward.

We also use another Arduino board on the wheelchair to make the wheelchair move forward; the transmission of commands is done through Bluetooth. The readings processed in the headset are sent directly to the second board. If the command orders to move them forward, this board then commands the motor driver to start, and the wheelchair moves forward. We all know that the great physicist Sir Stephen Hawking communicated just by twitching his cheeks; this applies here to move the wheelchair in our desired direction. We attach the muscle sensors to the cheekbones (near the temporal plane of the head). When the subject twitches his right cheek, there will be a motion detection, which is taken as an input and makes the wheelchair move to the right. It is directed toward the left if the subject twitches the left cheek [27].

Our brain houses about 100 billion neurons, nerve cells that enable us to react to stimuli. These cells work in a synchronized manner. A brain–computer interface (BCI) provides a pathway for direct communication between the brain and an external computer. The BCI is aimed at acquiring or repairing human cognitive or sensory-motor functions. Our headset works on the BCI principle and has two circuits, i.e., a headband circuit and an application circuit (wheelchair) [29]. These circuits consist of Arduino microcontrollers, ADS1292R shield, muscle sensors, Bluetooth modules, electrodes, motor drivers, DC motors, jumping wires, and two batteries.

EEG (electroencephalogram) is the core principle. Alpha waves are the ones that are in core use. These lie in the frequency region of 8–12 Hz [27]. The BCI calculates this frequency's spectral density. To enhance or bring about these signals, one has to stay relaxed or close eyes and avoid distractions [28]. Once the signals are extracted through the brain's active nerve extremities, it is provided as an input to the wheelchair application. With an upgrade of a motion-sensing detector, the application is partially controlled by the EMG (electromyogram) signals from twitching of the cheek or raising of the eyebrow or blinking of an eye [31], for the left and right motions. The application vehicle moves through the visualization of the optical effects video by the subject. The forward and backward movement can be brought into action through imagination or visualization.

The signals from the scalp of the subject's brain over the visual cortex are given as inputs to the brain force headset. The headset consisting of microcontrollers and sensors analyses, performs, and evaluates if the power of the signal is greater than the threshold, i.e., when the frequency of the brain waves is above 8 Hz and below 12 Hz; during this process, the patient's brain is in an active state. This creates an output that lets us control the application. The headset has three electrodes that pick up the signal from the scalp of the subject. Look at Fig. 1. The right signal can be monitored when the patient is in a relaxing and focused state of mind [26, 27]. This selected signal comes in the range of 8–12 Hz, also called alpha waves of the brain.

2.1 Construction

The front box of the headset contains the core elements, i.e., Arduino microcontroller, handled by the switch and the shield, protected by an insulating sheath and a metal casing. A battery is used to power up the circuit, and a Bluetooth module is used to make it seem wireless and stand away from the personal computer. For better results, the subject will be given cognitive training before wearing the headband. The subject wears the headband consisting of electrodes and sensors and is made to concentrate and focus by simply displaying a video in front of them or making them perform a mathematical calculation so that the subject's brain attains a focused state which leads to the emission of alpha waves from the brain.

This alpha wave, which is in a range of 8–12 Hz, will be taken as an input signal by the Arduino UNO microcontroller that is connected to the electrodes consisting of EEG sensors and then the input signal is processed by the Arduino UNO board to check if the signal coming from the brain is between 8 and 12 Hz [35, 38].

Fig. 1 Electrodes placed over the scalp to extract EEG signals

Once the Arduino microcontroller confirms the signal meets the criteria, then the command is generated by the Arduino board, i.e., to move the application. Then the command signal is transmitted to the other Arduino microcontroller embedded in the application (wheelchair) for the application to move. The command is sent to the second circuit present in the application wirelessly through a Bluetooth module. Figure 2 shows the methodology of BCI.

The main operation of the headset is to diagnose or receive the wave signals that are emitted by the brain and process the signal; the process is to check whether the signal is in the range of 8–12 Hz; this circuit is also connected to a myometric sensor which detects movement of muscles in the face. If the myometric sensor detects movement, the electrode picks up the signal attached to the cheek of the subject and processes it to the microcontroller board; the microcontroller analyses the signal given by the sensor and gives the command to the motor driver that is embedded in the application to move right side or to change its direction from straight to the right and the same happens when the subject twitches his left cheek [27].

The other circuit is built in the application using another Arduino microcontroller board that receives the command transmitted by the headset circuit. It processes the data again to check whether the signals are in a range of 8–12 Hz. If the signal meets the criteria, the board sends a command signal to the motor driver to

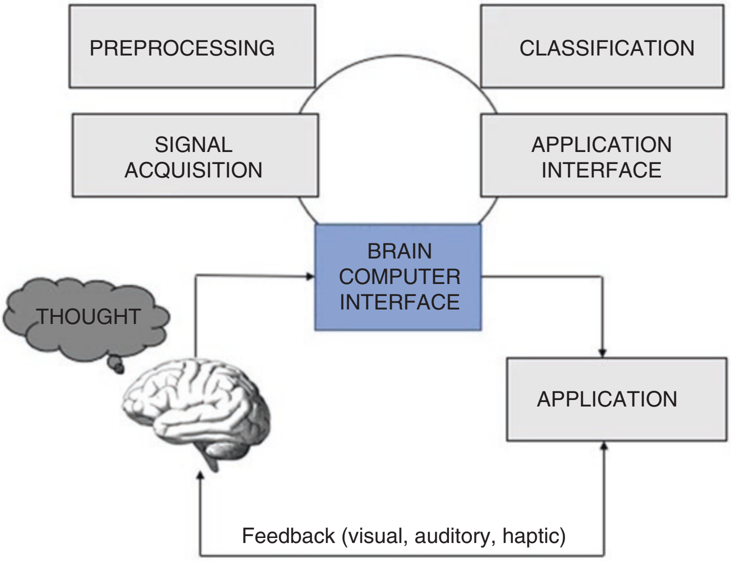

Fig. 2 Methodology of BCI

start and move the application, i.e., wheelchair forward, thus attaining mobility [37]. It stops when the frequency from the brain signals is decreased or when the subject is distracted; hence the subject is given cognitive training to stay in the active state of the brain signal to achieve mobility of the wheelchair [36]. The direction commands are given to the motor when the subject twitches any one side of his cheeks, thereby making the wheelchair move in a possible desired condition of the subject; in this way, any physically impaired person can move around independently through their brain activity.

2.2 Discussion

The human body is affected by various conditions affecting mobility and contact. Some of the diseases result in losing a limb or damaged nervous system or paralysis involving the host body to look into a new way of adaptation and living. These diseases can be temporary or for a lifetime. Sometimes, having no cure and forced to adapt and thrive to the existing technology or medical equipment increases the dependency on others.

Our functioning cerebro headset can regain the activity of the lost part, which helps in the movement of objects using cerebral signals that are extracted, analyzed, and processed into moving an object. For instance, a patient sitting in a wheelchair, being unable to move, can move his own wheelchair to achieve movement and momentum. It is a well-equipped headset, with an insulating shield enclosing the device's core, the Arduino, and motion sensors. Electrodes are placed over the visual cortex to ensure the extraction of the alpha cerebro-visual signals, which are sent to the Arduino to process. The output is forwarded as an input to our application, a toy car. The cerebro signals extracted are of a specific frequency, 8–12 Hz. The mobility-affected host patient undergoes cognitive training, i.e., focusing and improving visualization and having a calm and relaxed mind. In this way, a motionless or affected person can gain mobility. Therefore, the social well-being of the disabled subject is improved.

2.3 Article Highlights

Researchers worldwide are experimenting and trying out various possibilities related to BCI in the realm of science fiction. One such and most widely explored is telepathy. The devices or inventions use different brain signals and signal processing techniques along with recording methods searching for a scientific-practical explaining device. They can operate on different devices ranging from a cursor to a screen to a robotic arm and wheelchair [28]. Our motive was to get our hands to a device that helps disabled people to gain control over their decimated or defected physically voluntarily controlled organ or part of their body. A few are already using BCI for essential communication and management and for real-world accessibility. With excellent signal acquisition, reliable hardware techniques and methods, and effective software clinical validation, an innovative device in the area of BCI can come into existence, being an efficient control technology for people around, prioritizing medical needs. Using the principle of EEG and signal processing, BCI can usually be achieved using any type of brain signal. For our device, we mainly focus on the alpha waves in the frequency range of 8–12 Hz. These are measured from the scalp of our brain using electrodes where the lead connects the scalp externally over the visual cortex to acquire the thought-processed alpha signals from the brain. The main sequential processes in BCI system are (1) signal acquisition from the scalp of our brain (cortex), (2) extraction of signal, (3) signal analysis, and (4) device output/application movement [33]. These components act as a controlling protocol for the device.

Brain–computer interfaced controlled devices can replace and restore the functions of differently abled and neuromuscular affected parts/disorders and to remotely function under pressure for technicians and physicians while operating a surgery [29], flying an airplane, or to remotely access information from any source that cannot be hand touched by man or which might not be accessed easily.

3 Simulation Results

The main focus of this study was to identify how objects can achieve displacement with the help of cerebral signals. Different techniques such as averaging the extracted EEG signals to understand the evoked potential (EP) and event-related

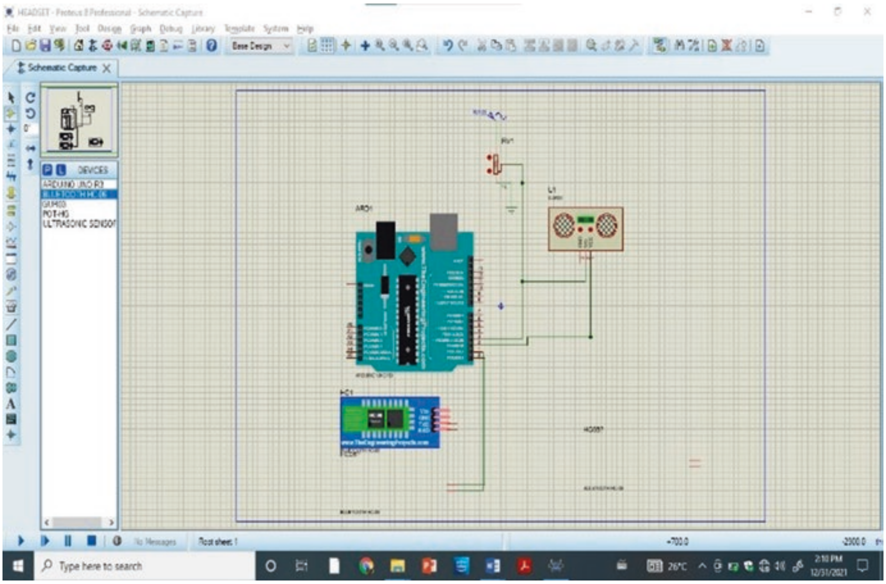

Fig. 3 Simulation of headset circuit in proteus professional

potential, which is cognitive psychology, were applied. An experimental virtual setup is used to demonstrate the movement of the wheelchair.

Our device has two main circuits, i.e., headset circuit and wheelchair circuit. The main working principle of the headset circuit is EEG signal acquisition and processing. The headset simulation in Fig. 3 receives the cerebro signals and validates if they are in the range of 8–12 Hz. When met with the input criteria, the Arduino board sends a commanding signal to the wheelchair circuit.

In Fig. 4, simulation of wheelchair, we can comprehend that the input is received by the electrodes, which transmit the signals to the microcontroller; then the microcontroller processes and checks whether the signals meet the criteria and if the input meets the criteria, then the output is given through a Bluetooth module through pin 13. The Bluetooth transmits the command signal to the wheelchair circuit and then the command signal processes it and sends another command to the motor driver, and then the motor driver starts moving forward. Therefore, we can move a wheelchair just by using our brain waves as an input.

4 Conclusion

An assessment toward the end of this project showed us the simulation result of the working cerebro headset and the achieved mobility of the wheelchair using just the cerebro signals of our brain. An effective cognitive training plays a vital role to have a steady and focused mind in controlling the device. In the light of this project, we

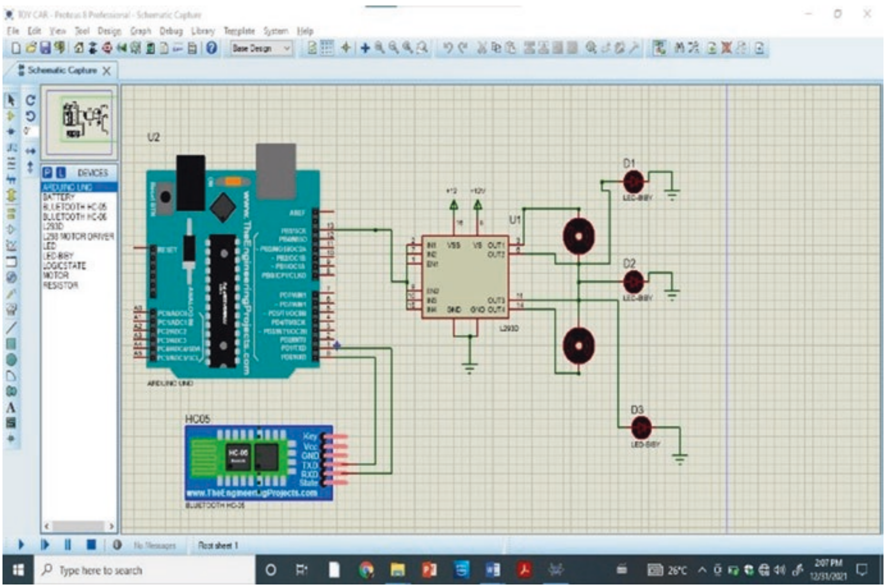

Fig. 4 Simulation of wheelchair circuit in proteus professional

have planned on further upgradation under the canopy of Epocalypse, to work on moving a specially designed pen using the cerebro headset for people affected by dysgraphia, physically disabled, and even amputees who lack the ability to write. We, henceforth, are working on to bring the virtual abilities into reality with a thrilling vision of development and safety toward mankind.

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Automatic Hybrid Deep Learning Network for Image Lesion Prognosis and Diagnosis

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1 Introduction

Liver is the biggest part in the abdominal region. Liver cancer is one of the subtypes of hepatocellular carcinoma (HCC). HCC is the major cause for primary liver cancer and leads to major health issues. Early stage of HCC prognosis and diagnosis is more benefited to patients to attempt earlier treatment and to live peacefully. HCC can be caused by non-alcoholic fatty liver disease, steatohepatitis, alcoholic liver disease or hepatitis B and C. During the course of disease, tumours from the breast, pancreas and colon can readily spread into the liver.

Manual segmentation of liver cancer in the radiological images is a time-consuming process. Deep learning combined with image processing techniques can be used to detect tumours automatically. The tumour usually originates in the other parts of the image and spreads to the liver. Tumour usually is the abnormal growth in the liver. Tumours can be cancerous or non-cancerous part.

The main goal of liver segmentation is to classify the pixels into two groups: the pixels which belong to the liver and the remaining pixels which belong to non-liver parts. Based on the conventional approach, other ways are employed to segment the liver, such as level sets or deformable models, clustering, region growing, graph cuts, probability atlases, statistical shape models and deep learning methods. Figure 1 depicts the details of abdominal CT image and various internal parts are

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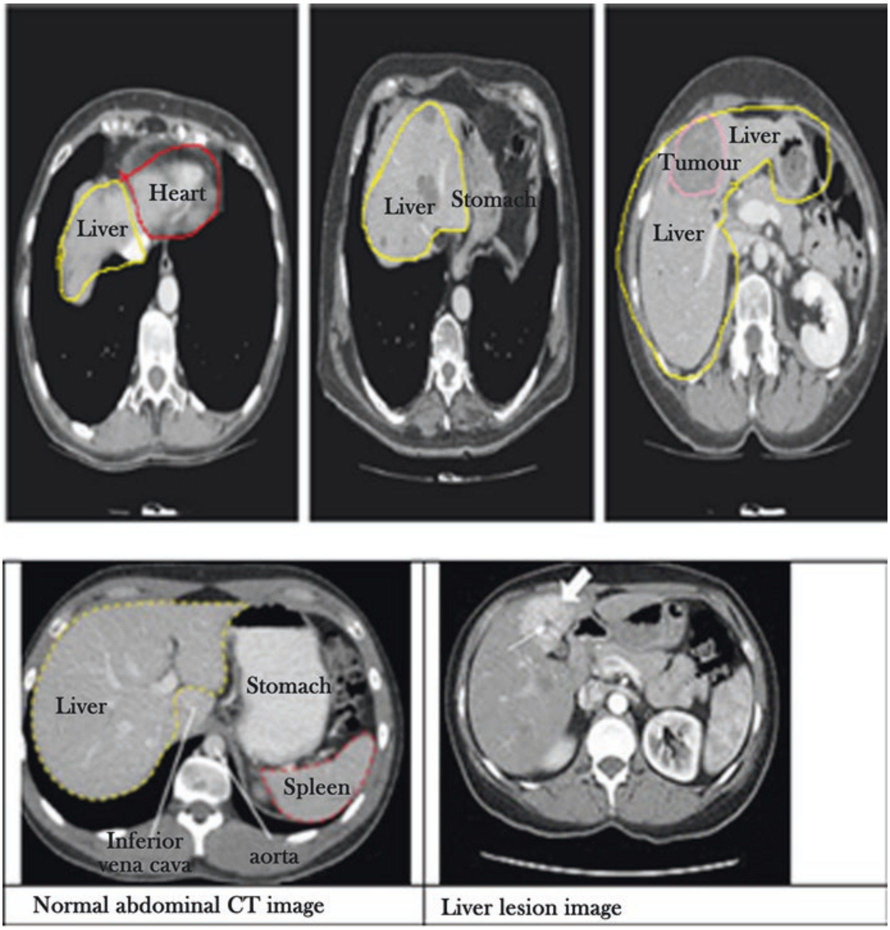

Fig. 1 Liver, heart, stomach and tumour in CT slice and presentation of normal and lesion image

marked. Also, this figure represents the CT image of liver in normal and lesion cases. Table 1 explains the different stages of liver cancer. Various stages are stage 1, 2, 3 and 4 based on the penetration of tumours into the inner human body parts. From the given dataset or data acquisition, the liver part is segmented using morphological operations or with efficient image segmentation algorithm. Then from the segmented liver lesion/tumour features are extracted. Then the various performance measures listed in Table 2 are computed and evaluated.

Generally, the liver image segmentation applies various algorithms and is explained as follows. In spatial and geometric shape model, prior knowledge provides the statistical shape model. This method creates a probabilistic model with prior knowledge. Local image features can be extracted using B-spline transformation. Grey-level method is utilized for intensity distribution. Morphological filters and intensity distribution are utilized for extracting pattern features. Also, graph cut

Table 1 Various stages of liver cancer

Various stages of liver cancer	
Stage 1	Primary tumour not grown into any blood cells
Stage 2	Primary tumour grown into blood cells Several small tumours are present Tumours' diameter less than 5 cm Not spread to nearby lymph nodes or distant sites
Stage 3	Stage 3A Several tumours were present with more than 5 cm Not spread to nearby lymph nodes or distant sites Stage 3B Several tumours were present At least one tumour is growing into a branch of the portal vein or the hepatic vein Not spread to nearby lymph nodes or distant sites Stage 3C Tumour has grown into the outer covering of the liver Not spread to nearby lymph nodes or distant sites
Stage 4	Cancer has spread to nearby lymph nodes and may have grown into nearby blood vessels

Table 2 Evaluation parameters

Parameters	Formula
Accuracy	(true positive [TP] + false positive [FP])/(true positive [TP] + false positive [FP] + true negative [TN] + false negative [FN])
Specificity	True negative [TN]/(true negative [TN] + false positive [FP])
Sensitivity (recall)	True positive [TP]/(true positive [TP] + false negative [FN])
Precision (Pr)	True positive [TP]/(true positive [TP] + false positive [FP])
F-score	2 (precision (Pr) × recall)/(precision (Pr) + recall)
Dice similarity coefficient (DSC)	DSC (A, B) = (2 × $\|A \cap B\|$)/($\|A\|$ + $\|B\|$) × 100% A is the segmentation result, B is the ground truth
Volume overlap error (VOE)	VOE (A, B) = 1 − $\|A \cap B\|$ $\|A \cup B\|$

methods help to separate background and liver. K-means clustering and region growing segmentation methodologies were applied over the image followed by contouring algorithm in semi-automated method and the parameters (liver, heart, stomach and tumour) of CT slice and presentation of normal and lesion image.

After segmenting the liver, the following step is to segment any tumours that may be present in the image. The current research work contains a summary of several liver tumour segmentation methods, which are described as follows. Thresholding method is an effective tool used to separate tumour and background. Histogram analysis method is used for thresholding. Spatial regularization method depends on the morphological operations. Level set method is applied with numerical computations to segment various tumour shapes. Graph cut method, watershed segmentation, Bayesian classifier, SVM, fuzzy C-means clustering and hidden Markov models are used in the semi-automated method.

The paper is coordinated as follows. Section 2 portrays the connected works connected with liver disease anticipation and analysis. Section 3 presents the proposed technique. Section 4 makes sense of the outcomes and conversation of the proposed work with correlation of the new examination works. Section 5 presents the results and future improvements of the proposed work.

2 Objectives

The major contribution of the proposed work is given as follows:

- Hybrid liver image segmentation for lesion detection is proposed with morphological segmentation operation and two-fold cascaded CNN networks for liver and lesion segmentation.
- Morphological operations provide the effectiveness in liver segmentation from the abdominal CT and MRI images.
- In the cascaded FCN U-net architecture is experimented to reach the faster computation.

3 Methods

Men et al. [1] have worked on the 3D computer tomography images and avoided the time-consuming manual interpretation. But this method is less effective for multiple lesions. A fully automated fully convolutional network was experimented for 20 patients and received 0.86 and 0.6 true positive rate and false positive rate, respectively, with three-fold cross-validation [2]. Vivanti et al. [3] developed a convolutional neural network with a robust classifier for the detection of liver tumours. With global CNN, this approach generates high-scoring examples while discarding low-scoring cases. Multi-scale candidate generation with residual network [4] was applied with liver tumour segmentation. Initially U-network segments the liver and fractal residual network segregates the tumour. Finally, contour method refines the tumour refinement. A semi-automatic segmentation [5] of liver was performed by Voronstov et al. This work combines both deformable model and machine learning algorithm for segmentation. Support vector machine classifier precisely classified and validated the metastatic liver tumour for 27 tumours. A two-fold multi-voxel-based liver tumour segmentation was implemented using the method proposed by Conze et al. [6]. Random forest technique is applied for multi-voxel-based feature discrimination and hierarchical multi-scale fashion to deal with heterogeneity. Jiang et al. [7] have discussed a cascaded network for liver localization, segmentation and tumour identification on 3D datasets. This cascaded network outperforms the existing U-net and Res-net for various datasets. Hierarchical convolutional and deconvolutional network-based live tumour prognosis and diagnosis method was implemented by Yuan [8]. This model was experimented over LiTs 130 training datasets and the best Jaccard function was calculated. Two different fully convolutional layers are applied separately for liver and lesion classification [9]. The performance of these two FCN layers outperforms the single FCN network. Bellver et al. [10] implemented cascaded stages of network for liver segmentation and lesion detector. Here the segmentation network operates in pixel-wise manner. The lesion detector applies constraint-less detection. Pancreas cancer detection is implemented on PET/CT images. Linear iterative clustering method is implemented for pancreas segmentation. Then principal component analysis is applied for feature extraction. This method was finally evaluated over public datasets which include 82 three-dimensional CT images. Deep neural network with combined networks [11] of U-net for long-range concatenation and short-range residual network was proposed in this methodology. This DCNN has the limitation of long computation time for lesion detection. Larsson et al. [12] introduced a macro architecture based on self-similarity without residuals. This architecture includes sub-paths of various lengths. The majorly contributed fractal networks show better performance on CIFAR datasets. This deeper network brings quick answer with more accuracy. Trivizakis [13] has extended the 2D CNN architecture to 3D and achieved improved performance for MRI liver datasets. This architecture includes 2048 neurons with ReLu activation function with softmax binary classifier. Hu et al. [14] has applied three-dimensional CNN deep learning methods for detecting the liver. Here deep learning is trained to extract probabilistic map. This method is validated on 42 CT images. Lu et al. [15] developed a fully automatic method for liver segmentation. This combines graph cut and deep learning procedure. Deep learning method extracts liver surface. Refinement method [16] uses graph cut technique to map the liver probability map. Christ presents an automatic fully connected CNN for segmenting liver and its lesion. HU windowing/N4 bias correction method is applied in the pre-processing step. Then from the abdominal images liver part is segmented with FCN.

4 Proposed Work

The proposed work depicted in Fig. 2 uses the public dataset 3DIRCADSET and CIFAR set. The liver image is converted into luminance (Y) channel and then the artifacts are removed using median filter. Then the liver image is segmented using morphological operation including erosion and dilation operation.

Next from the segmented liver image the tumour is detected using fully connected convolutional layer together with deeper U-net architecture which enhances the classification accuracy. The experimentation is tested over the computer tomography image slices and MRI images as shown in Figs. 3 and 4.

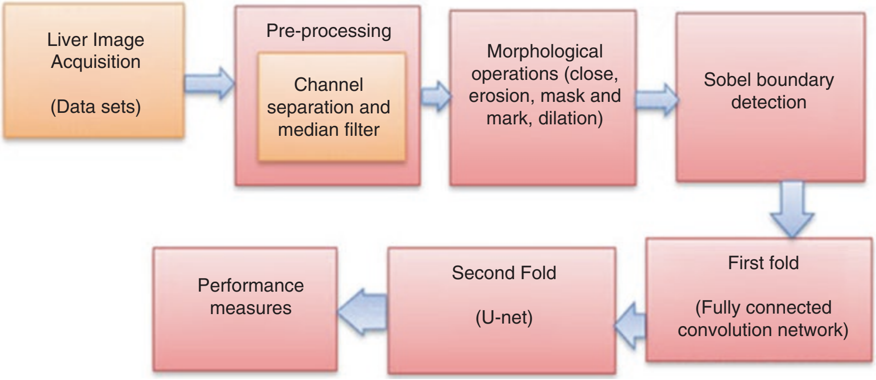

Fig. 2 Block diagram of the proposed work

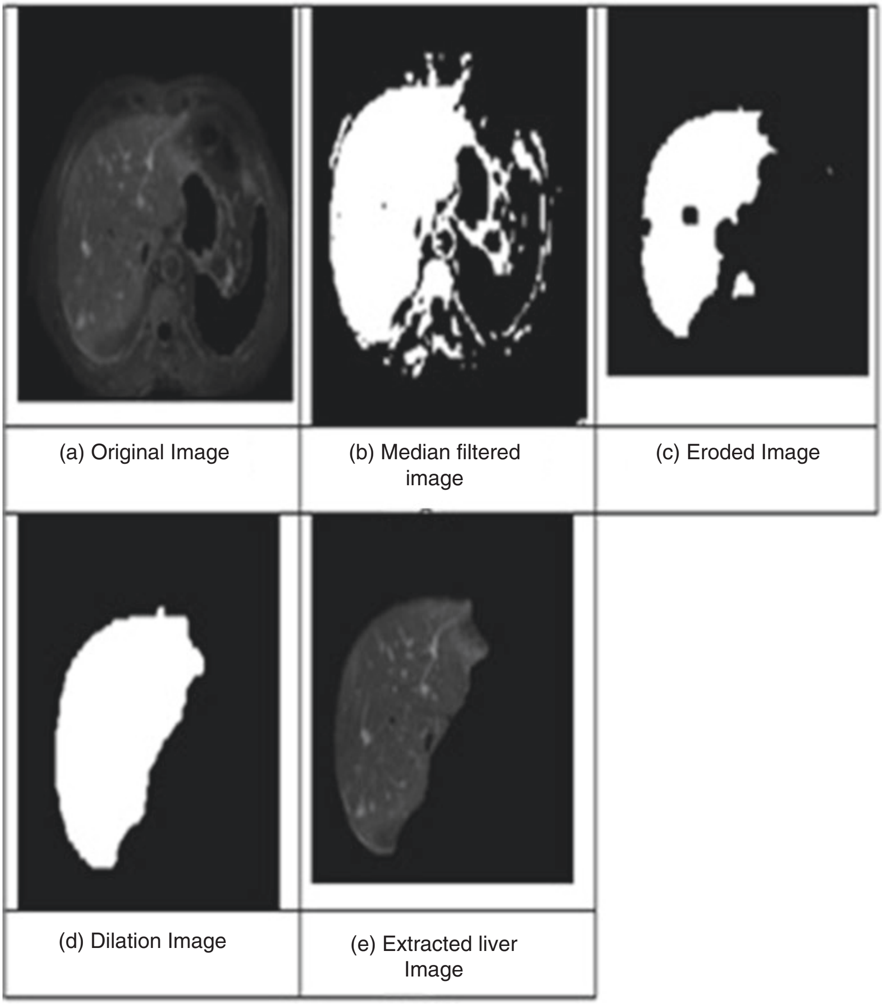

Fig. 3 Liver segmentation using morphological operations (**a**–**e**)

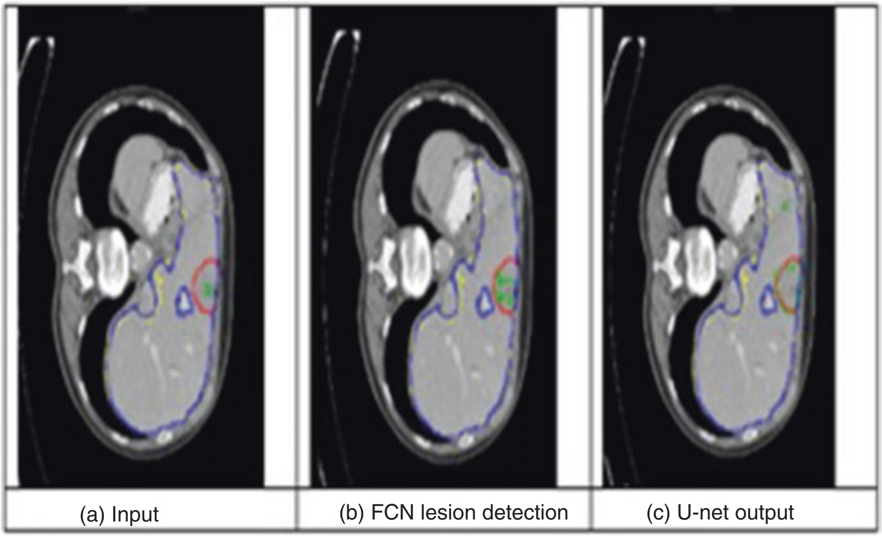

Fig. 4 Blue colour is the lesion ground truth, red colour indicates the tumour ground truth, yellow represents the predicted liver and green represents the lesion detection

Table 3 Performance measures comparison of the proposed method with existing methods

Performance measures			
Methods	DSC %	Precision %	Recall %
Adaboost	74.62	80.22	74.26
RF	79.37	91.37	74.11
SVM	79.77	83.53	81.06
Proposed	80.05	82.79	84.34

5 Results

The proposed method applies morphological operation for the liver segmentation from the abdominal images and the performance measures of various parameters for MRI Images are shown in Table 3 and Fig. 5. Then the two-fold lesion segmentation for lesion classification is further enhanced using fully convolutional network with U-net architecture. The proposed hybrid method enhances the sensitivity and true positive rate with highest value compared to the existing methods. The evaluation can be extended for 3D slices in the future.

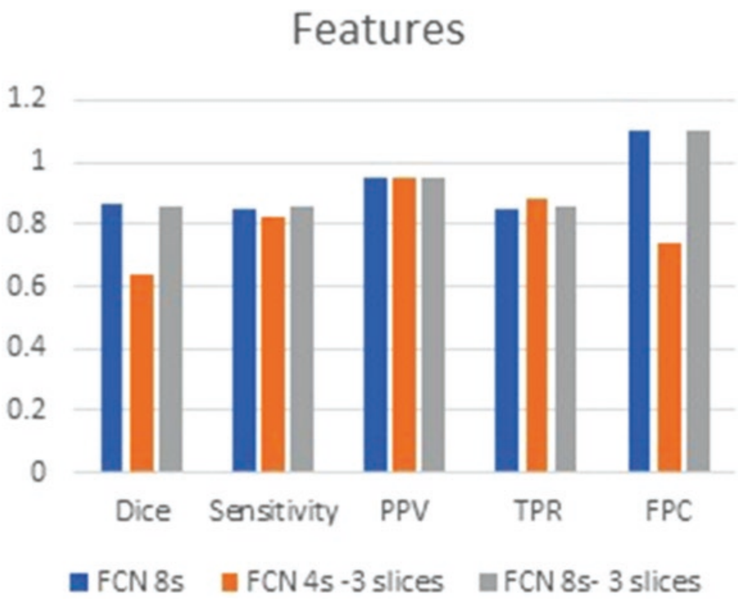

Fig. 5 Performance measures of the various parameters for MRI images

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Comparison of Cardiac Stroke Prediction and Classification Using Machine Learning Algorithms

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1 Introduction

Cardiac disorder [1] usually refers to extraordinary functioning of the heart. This usually occurs in the elderly; however, these days it is not unusual among people of all ages. Newborn babies are also affected by this disorder, which is known to be hereditary. One of the most important organs in the human body is the heart. The functioning of our heart leads to the functioning of our life. The impact of the non-proper functioning of the heart may lead to the failure of other parts of the body. If the heart does not function properly, it will have an impact on other human body parts such as the brain and kidneys. The heart/cardiovascular system merely comprise a pump that circulates blood throughout the body. If the body's blood supply is insufficient, numerous organs, including the brain, suffer, and if the heart stops working, the internal mind dies. Life throws a lot of obstacles in the way of the

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ability of the heart's to function properly. The term heart disease refers to a disease that affects the cardiovascular system. Examine your family's history of heart disease for the following habits or symptoms: smoking, poor habits, unusual pulse, cholesterol, high blood cholesterol, obesity, etc.

The signs and symptoms of the condition differ from one person to the next. Mostly, there are no early signs or symptoms and the condition is only detected later on. Heart disease [2] manifests in a variety of ways.

- Pain in the chest (angina pectoris).
- A pain in the regions of neck, chest, and shoulders such as tightness or burning.
- Chest problems.
- Symptoms to watch for include sweating, light-headedness, dizziness, and breathing issues.
- Growth of pain during exercising that stretches between the chest to the arm and neck.
- A cough.
- Abeyance of fluids.

Although the causes of heart disease remain unknown, age, sex, case records and ethnic background have all been suggested as possible reasons in numerous studies. The major factors that are associated with the escalation of developing heart disease include irritating behaviors, hypertension with varying stress and strain levels, deep fried oily foods, lack of exercise, saturated fat abnormality in the body, environmental contamination, overweight of the body, abnormal glucose levels. Most illness occurrence is documented in adults between the ages of 50 and 60 years, according to cardiac studies.

Owing to the development of the latest technologies, new algorithms and methods have been developed for the prediction and diagnosis of the disease. One such efficient method of the predications and classification is based on machine-learning techniques. Machine learning (ML) [3], is a substantial multidisciplinary correction that draws on values from applied technological know-how, facts, scientific subjects, engineering, optimization theory, and a variety of other mathematics and science fields. Various gadget learning applications are available, but records management is the most important. The two major classifications of machine-learning algorithms are unsupervised learning and supervised learning.

Machine learning [4–8] without supervision will not be able to make inferences from datasets that comprise the documents without label, or in other words, unsupervised learning does not provide preferred output. Supervised device learning challenge approaches to understanding the relationship between input attributes (unbiased variables) and a given aim (structured variables). Methods that are supervised can be divided into two categories: category and reversal. The output variable in reversal accepts continuous values, whereas the output variable in category takes class labels. Machine-learning techniques are a type of programming that mimics many aspects of human thought, allowing us to quickly solve extremely tough issues. As a result, gadget learning holds much promise for enhancing the performance and accuracy of smart PC software. Concept mastering and category learning are two aspects of machine-learning awareness. Classification is a commonly used machine-learning awareness of an approach that entails separating data into discrete, non-overlapping pieces. As a result, classification is the process of identifying a set of ways to define and distinguish the data object. Mobile gadgets, such as smart phones, smartcards, and sensors, as well as hand-held and automotive computer systems, can all benefit from machine learning.

Mobile terminals (such as Laptops, Tablets, PCs, and other digital assistants) and mobile networks (such as a global system for mobile communications, 3G+, wireless networks, and Bluetooth) have supported progress. Cell devices benefit from machine-learning approaches such as C4.5, Naive Bayes (NB), and decision tree (DT). Classification is a data-processing (machine-learning) technique for predicting group membership in data examples. Although there are a multitude of strategies for system mastering, there are a few that are most commonly employed. Classification is a difficult task in system awareness, especially in future planning and knowledge discovery.

Researchers in the fields of machine learning and information processing aid the classification of a collection of fascinating investigated problems. Classification is a well-known strategy for learning about gadgets, but it has drawbacks, such as dealing with a lack of facts. Missing values in a data set can cause issues at both the educational and the classification level. Non-access of report acknowledgments owing to erroneous impressions, records diagnosed irrelevant at the time of entry, records removed owing to discrepancies with other documented records, and gadget failure are just a few of the possible explanations for missing facts.

Data miners can delete missing records, replace all missing values with a private global standard, replace an omitted price with its characteristic recommendation for the current class, manually review samples with missing values, and insert a possible or likely price. We will concentrate our attention on a few main classification strategies in this diagram. The following are the types of strategies [9] that a machine can learn:

Supervised Learning: A classified dataset is used to train the model developed. The document is entered, as well as the results. Data are categorized and separated into two datasets: schooling and checking. The accuracy of the learning model is ensured by the testing data set attributes and the basic training performed by the training dataset. The output of the algorithms will be based on the training data, which will be an example of classification and regression models.

Unsupervised Learning: The dataset contains no classification or labeling of the data utilized to produce it. The objective of the unsupervised models is recognizing the patterns hidden in the data based on the conditions provided. For any data set given in the input, this learning model makes decisions on the patterns hidden in the input and explores the data. The collection technique is one of the examples and this unsupervised method has no effects on the data set provided in the input.

Reinforcement Learning: This learning method learns the information based on the conditions provided and no connected information about the data set is known to the learning. Using this strategy, the description enhances its presentation by tying it to a specific area and identifies an optimized output by evaluating and experimenting with variable inputs.

It is hard to detect heart disease owing to a number of causal threat elements similar to diabetes, excessive pressure, excessive cholesterol, unusual pulse, and plenty of different elements. A type of strategy in information processing and neural networks is working to seek not in the harshness of heart disease in humans. The severity of the disease is identified using several approaches such as DT, K-Nearest Neighbor Algorithm (KNN), NB and Genetic Algorithm. People with heart ailments complications should be dealt with proper analysis and predictions. The attitude of medicinal technology is to discover and treat different types of metabolic syndromes. The machine learning and information processing plays a vital role in heart disease identification research.

The major purpose of these investigations is to improve the detection accuracy of cardiac problems. Several investigations have been conducted that have resulted in mixture of algorithmic techniques with performancer. In an assessment, the hybrid random forest with linear model (HRFLM) technique uses all functions with feature choice. This behavior experiment will use a hybrid technique to find a system's structures by observing a set of rules. In comparison with earlier methodologies, the findings of this research indicate that our suggested hybrid technique has a higher potential for predicting heart disease. HRFLM data pre-processing experimentally followed by, classification modeling, and performance measurement.

The paper is organized as Sects. 1 and 2 presentation with the target of the work and the survey of the framework. Section 3 examines the proposed framework of the proposed algorithm and examined with models in Sect. 4. Section 5 discuss about the execution and results of the proposed method with the examination results. Finally, Sect. 6 concludes the paper.

2 Literature Review

Yan et al. [10] in their research fostered a framework for diagnosing innate heart problems. The framework also utilizes back-propagation neural networks, which depend on data and heart disease signs and side effects. The innovation has a 90% precision rate. Newman et al. [11] made a framework that utilizes a fake neural network, which is normally used for prediction in the clinical field. This study looks at the promotion advantages and disadvantages of artificial intelligence (AI) calculations such as support vector machines (SVM), NB, and neural networks.

Lu et al. [12] fostered a technique for distinguishing educational quality subsets utilizing correlation feature selection methodology, which used as a heuristic pursuit strategy to consider the space factors, and the subset weight was determined utilizing these estimations. The exactness of the SVM approach was 76.33% on data obtained for 52 patients out of 4726 cases. Priyanka and Kumar [13] laid out a strategy for foreseeing heart issues utilizing data-mining procedures, DT and NB, and showed that the DT were more precise than NB for a dataset applicable to heart infections gathered from the University of California, Irvine.

Jaidhan et al. [14] fostered a strategy for identifying false Mastercard exchanges utilizing an AI procedure called the random forest calculation, which displayed a 0.267% increment in effectiveness over standard models. Utilizing data mining techniques, Palaniappan and Awang [15] fabricated a model called the Intelligent Heart Disease Prediction System. The examples and cooperations between clinical boundaries related to coronary illness are utilized to anticipate coronary illness. Utilizing data mining methods, for example, NB, DT calculation, KNN, and neural networks, Thomas and Princy [16] recommended a framework for anticipating cardiovascular issues. This examination shows that having a larger number of characteristics prompts a more significant level of exactness.

The initial segment included making a dataset with 13 credits, which was then used to run arrangement calculations utilizing DT and random forest algorithms. Finally, the exactness of the two is not set in stone. Subsequently, it tends to be shown that in the prediction of heart illnesses, random forests outperform DTs.

Gavhane et al. [17] made an application that can foresee the weakness of a cardiac infection in view of essential side effects such as age, sex, pulse rate, and different variables. The AI calculation of neural networks has been demonstrated to be the most exact and solid method. Esfahani et al. [18] utilized crude data on cardiovascular patients from the University of California, Irvine. Design acknowledgment procedures, for example, DTs, neural networks, rough sets, SVMs, and NB are tried in the research center for precision and prediction.

Gandhi and Singh [19] featured various ways of dealing with information by utilizing data-mining techniques, which are currently being utilized in heart disease prediction research. Data-mining approaches such as NB, neural networks, and DT calculations are analyzed using calculations on clinical data sets. Nahar et al. [20] utilize the UCI Cleveland dataset, an organic database, and the three rule age calculations – a priori, predictive a priori, and tertius – to reveal these causes utilizing affiliation data mining, a computational insight strategy. Women are accepted to have a lower chance of coronary issues and heart disease than men, in light of data accessible on debilitated and healthy people and involving certainty as a pointer.

There were various elements that highlighted both solid and perilous conditions. Asymptomatic chest problems and exercise-instigated angina are believed to predict the presence of heart disease in all kinds of people. A typical or high resting ECG and a level slant (dextrocardia) are possible high-risk pointers for women. Just a single rule, communicating a high resting, not set in stone to be determinant in men. This suggests that the resting ECG condition is a vital differentiator in foreseeing heart disease. If the slant is up, the quantity of shaded vessels is zero, and the old pinnacle is not exactly or equivalent to 0.56 while contrasting the soundness of people it is more predicted towards the heart disease.

3 Proposed Method

The architecture of the future version for calculating cardio/coronary heart disease is shown in Fig. 1. Two of the 13 features in the facts set, relating to age and communication, are used to calculate the patient's non-public indicators. The final features are kept for critical consideration because they contain essential clinical information. Clinical data are essential for predicting and understanding the severity of an aerobic/heart problem. It gathers information and implements taxonomy procedures, including the HRFLM algorithm. Later on, the variety of the final results may be predicted, and accuracy will be taken into account.

3.1 Data Flow Diagram

A bubble chart is another name for a data flow diagram. It is a genuine graphical formalism for addressing a machine concerning an information report to the gadget, different handling allotted in these insights, and consequently the result records are created by this technique. One of the main demonstrating devices is the data flow diagram, as seen in Fig. 2. Mimicking the framework additives is standard.

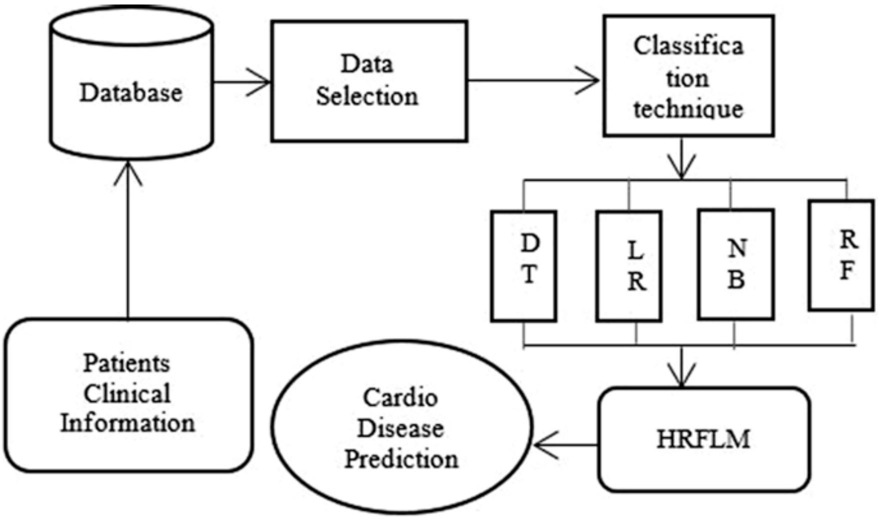


Fig. 1 System architecture

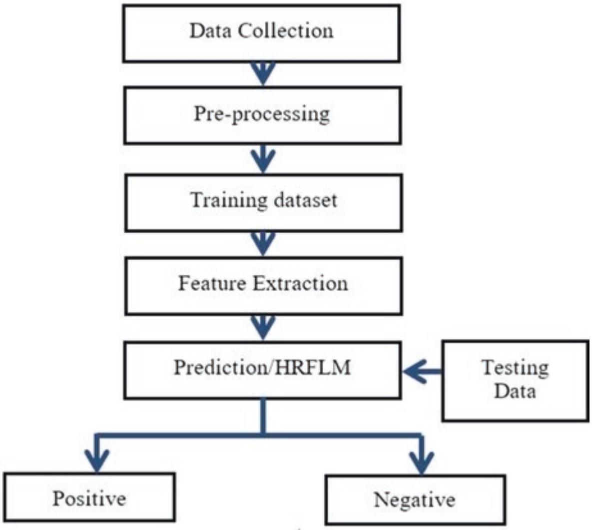


Fig. 2 Data flow diagram

3.2 UML Diagrams

In the domain of computer programming, the unified modeling language (UML) is a predictable, broadly useful display language. The UML is a basic part of article, situated for improvement in the product progression process. To address the plan of programming projects, the UML utilizes graphic documentation.

The following are the primary goals [21] of the UML design:

- To provide customers with an easy-to-use, expressive visual modeling language so that they can expand and trade major trends.
- To provide methods for extendibility and specialization.
- To be self-contained in terms of programming languages and the development process.
- To provide a solid foundation for understanding how to use the modeling language.
- To encourage higher-level enhancement concepts such as partnerships, frameworks, styles, and components.
- To incorporate best practices.

3.3 Sequence Diagram

In the UML, a sequence diagram (displayed in Fig. 3) is a type of cooperation diagram that shows how cycles associate with each other. It comprises a message sequence diagram. Occasion diagrams, occasion situations, and timing diagrams are terms used to describe arrangement diagrams [22].

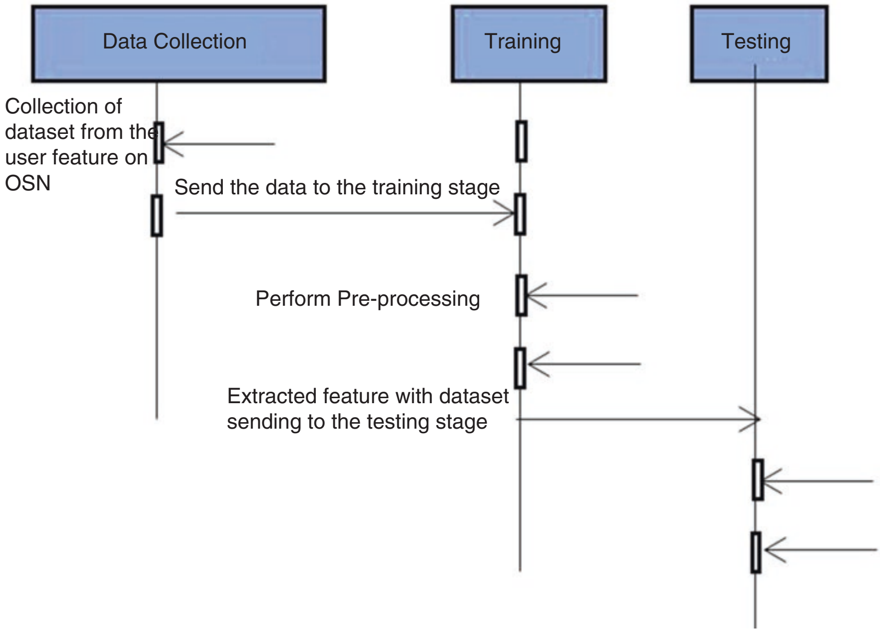


Fig. 3 Sequence diagram

4 System Implementation

The following modules are present in the proposed method:

- Data collection
- Data preparation
- Model selection
- Analysis and prediction

4.1 Data Collection

This is the primary step towards the improvement accumulating records. This is a crucial step to cascade and relate to how the original model will be. If the records obtained are better and high, the output will be accurate. There are several strategies like net scraping and guide interventions etc., for acquiring the statistical data. The Cleveland Heart Disease dataset from the UCI repository will be used in this project. The dataset is made up of 303 unique facts. The dataset [23] contains 13 rows, which are shown in Table 1.

Table 1 Data set

Facts	Description
Sex	The gender is displayed using the following format: 1 denotes a male and 0 denotes a female
Chest-pain type	Displays the individual's type of chest discomfort in the following format: 1 = typical angina; 2 = atypical angina; 3 = non-anginal pain; asymptotic = 4
Resting blood pressure	Displays the gender using the following format: 1 = male; 0 = female
Serum cholesterol	The serum cholesterol level is displayed in milligrams per deciliter (mg/dl) (unit)
Fasting blood sugar	The fasting blood glucose cost of a person with 120 mg/dl is compared. If fasting blood sugar >120 mg/dl then: 1 (real) else: zero (fake)
Resting ECG	Shows resting electrocardiographic outcomes 0 = regular; 1 = having ST-T wave abnormality; 2 = left ventricular hypertrophy
Max cardio/heart rate achieved	Displays the maximum cardio/heart rate achieved by a person
Exercise induced angina	1 = yes, 0 = no
Peak exercise ST segment	1 = up-sloping, 2 = flat, 3 = down-sloping
ST depression induced by exercise relative to rest	Displays the value, which is an integer or a float
Number of major vessels (0–3) color by fluoroscopy	Displays the value as an integer or a float
Thalassemia	Displays the thalassemia: 3 = normal; 6 = fixed defect; 7 = reversible defect
Diagnosis of cardio/heart disease	Displays whether or not the individual has cardio/heart disease: 0 = absent; 1 = present

4.2 Data Preparation

Data Must be clean and no redundant when it is used for any analysis. Randomization of records, eradicate the consequences of the genuine request inside, which is accumulated as well as in some other case. Picture records are splitted into tutoring and evaluation units.

4.3 Model Selection

Random forests are one the most famous system learning algorithm. They are so successful because they provide predictive performance, low over-fitting, better interpretability etc. This interpretability is given by using the fact that it is simple to derive the importance of every variable on the tree selection. In other words, it is straightforward to compute how much each variable is contributing to the selection.

Feature choice using random forests comes under the category of embedded strategies. They are carried out using algorithms that have their own built-in feature choice methods.

4.4 Collaboration Diagram

Collaboration diagrams describe interactions among classes and associations. Here, as shown in Fig. 4, all through this venture the collaboration diagram incorporates the flow that gathers the information set from the user function on the output sequence number and sends the information to the education level, performs pre-processing, and teaches the dataset and extract feature by sending the dataset to the test stage. Subsequently, admin views the information and upload documents as per that requirement.

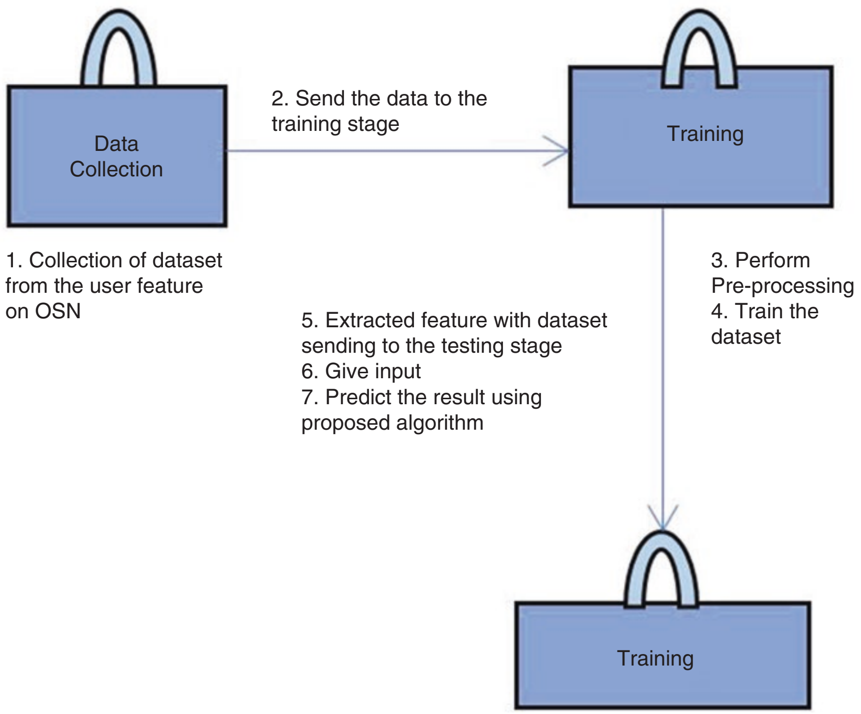


Fig. 4 Collaboration diagram

5 Analysis and Prediction Results of HRFLM

5.1 Parameters used for analysis

The parameters used for the analysis and prediction of heart disease [24, 25] are as follows.

True positives: people who self-identify as having a condition truly have it; in other words, the true positive represents the number of people who are unwell and self-identify as such.

$$\text{True Positive} = \frac{\text{Number of cases correctly identified as positive for disease}}{\text{Total number of observations}} \tag{1}$$

True negatives: people who say that they do not have the condition are actually discovered to be free of it; in other words, the true negative represents the number of people who are healthy and say that they are healthy.

$$\text{True Negative} = \frac{\text{Number of cases correctly identified as negative for disease}}{\text{Total number of observations}} \tag{2}$$

False positives: people who claim to be afflicted with the sickness are actually discovered not to be afflicted. In other words, the number of persons who are healthy but are incorrectly diagnosed as being ill are represented by the false positive.

$$\text{False Positive} = \frac{\text{Number of cases incorrectly identified as positive for disease}}{\text{Total number of observations}} \tag{3}$$

False negatives: people who are afflicted with the disease are anticipated not to be afflicted with the condition. The false negative, on the other hand, shows the number of persons who are ill but have been mislabeled as healthy.

$$\text{False Negative} = \frac{\text{Number of cases incorrectly identified as negative for disease}}{\text{Total number of observations}} \tag{4}$$

Accuracy: accuracy is a great measure while the goal variable classes in the data are almost balanced. Accuracy is a relevant measure for a binary classifier. For a binary classifier that classifies instances into positive (1) and negative (0) times, any single prediction can fall into one of four terms below:

$$\text{Accuracy} = \frac{\text{True Positive} + \text{True Negative}}{\text{True Positive} + \text{True Negative} + \text{False Positive} + \text{False Negative}}. \tag{5}$$

Sensitivity: the number of true-positive instances identified as such is referred to as sensitivity (or true positive). Sensitivity is also known as recall. It indicates that the number of actual good circumstances that are incorrectly categorized as bad will rise (and, thus, could also be termed false negative). It can also be described as a false negative rate. 1 would be the sensitivity-to-false-negative-rate ratio. Let us look at the process for determining whether or not someone has the disease. Sensitivity refers to the percentage of patients who were accurately diagnosed with the condition. In another sense, the sick individual was expected to get sick. Sensitivity is calculated using the following formula:

$$\text{Sensitivity} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}. \tag{6}$$

The true-positive value is higher and the false-negative value is lower as sensitivity increases. The true-positive value is lower and the false-negative value is higher as the sensitivity decreases. In the health care and banking industries, very sensitive models will be desired.

Specificity: specificity is characterized as the quantity of true negatives that were recognized as negatives. Thus, more true negatives will be seen as positives, bringing about false positives. This proportion is otherwise called the false-positive rate. The amount of particularity and false-positive rate is generally 1 in this situation. How about we investigate the system for deciding if somebody has the condition? The negligible proportion of people who are not impacted by a precisely anticipated sickness is known as specificity. Specificity is likewise useful:

$$\text{Specificity} = \frac{\text{True Negative}}{\text{True Negative} + \text{False Positive}}. \tag{7}$$

The higher the specificity, the lower the false-positive rate and the higher the true-negative rate. The higher the specificity, the lower the true-negative value and the greater the false-positive value.

The specificity of a test is characterized in various ways. For example, specificity being the capacity of a screening test to recognize a true negative, being founded on the true-negative rate, appropriately distinguishing individuals who do not have a condition/sickness, or on the other hand, if 100%, distinguishing all the patients who do not have the infection from those individuals testing negative. The prediction models are created using 13 features, and the various parameters for the various techniques are calculated and displayed in Table 2. The table compares parameters such as precision, sensitivity, F-measure, and accuracy. With the suggested prediction approach, the parameters are compared with several current methods. In comparison with existing approaches, the suggested HRFLM classification method achieves the maximum accuracy, sensitivity, and F-measure, as shown in the comparison graph.

Table 2 Comparison of various algorithms against different parameters

Algorithms	Accuracy	Sensitivity	F-measure	Precision
Logical regression	84.8%	89.92%	85.4%	81.24%
Decision tree	85.4%	84.9%	84.6%	83.1%
Random forest	86.9%	84.9%	86.1%	86.4%
Naïve Bayes	74.8%	78.9%	77.8%	80.3%
Support vector machine	75.4%	82.4%	80.3%	82.1%
Ensemble classifier	89.1%	88.3%	86.8%	89.1%
Hybrid random forest with linear model (proposed)	89.9%	90.02%	87.1%	88.7%

The UCI dataset is additionally grouped into eight styles of datasets upheld by arrangement rules. Each dataset is additionally grouped and handled by Rattle in RStudio. The outcomes are produced by applying the order rule for the dataset.

Combining the properties of random forest and linear method, the proposed hybrid HRFLM technique is applied. As a result, it was found to be quite accurate in predicting heart disease. The accuracy rate for a dataset is expressed as a percentage of correct predictions. According to this method, if we have a machine learning model with a 90% accuracy rate, we can anticipate having 90 accurate predictions out of every 100. Compared with existing models, machine learning approaches focus on the best performing model. The HRFLM is the model that predicts heart/cardio disease with high accuracy and low classification error, which is shown in Fig. 5.

5.2 *Simulation Model for Prediction of the Disorder*

The home web page shown in Fig. 6 includes the identity of the challenge with branding records and the brand of the venture. The intention of the homepage is not to be a library of textual content and content material but alternatively to characterize the manual in the direction of the pages that have the desired statistics.

Admin login may be a set of credentials accustomed to authenticating a consumer, as shown in Fig. 7. Most frequently, those contain a username and password. They are a protection measure designed to stop unauthorized access to personal facts. When a login fails (i.e., the username and password aggregate does not fit a consumer account), the user refused access. The Uploading and transmission of a file from one computing system to a one that has an upload option, as shown in Fig. 8, generally a large, computerized statistics processing device to add a document is to send it to a different PC.

A statistics view might be a gadget or visible representation of facts that differs from physical facts. The sample statistical data view of the uploaded image is shown in Fig. 9. Views are frequently created to form records that are more applicable, readable, and thrilling for human consumption. The shape or the visualization of information always differs from an information repository.

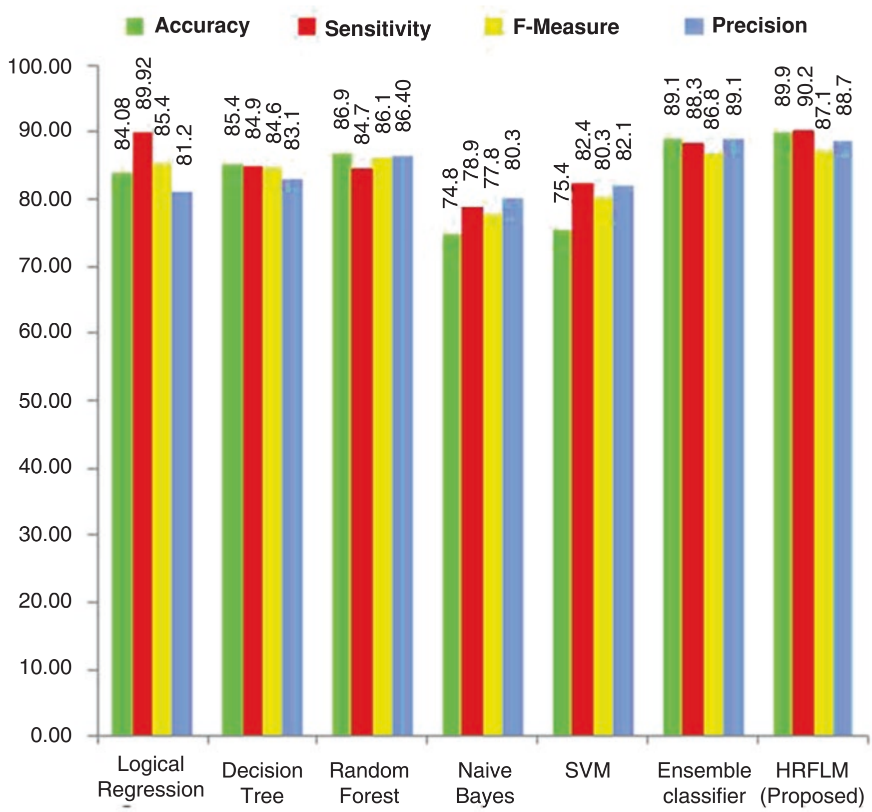


Fig. 5 Comparison of algorithms versus parameters

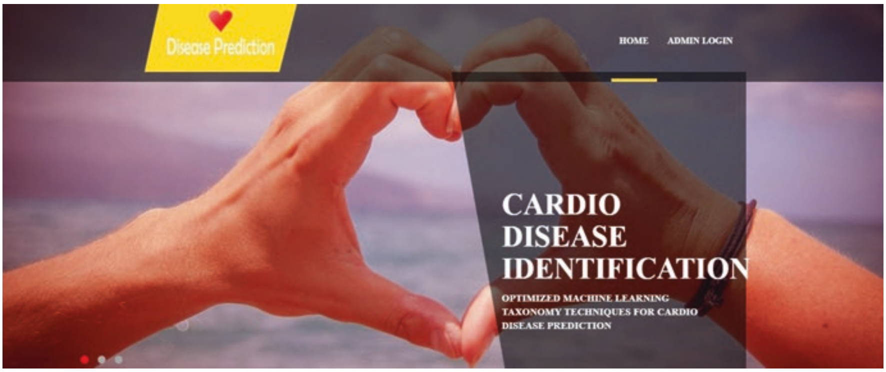


Fig. 6 Home page

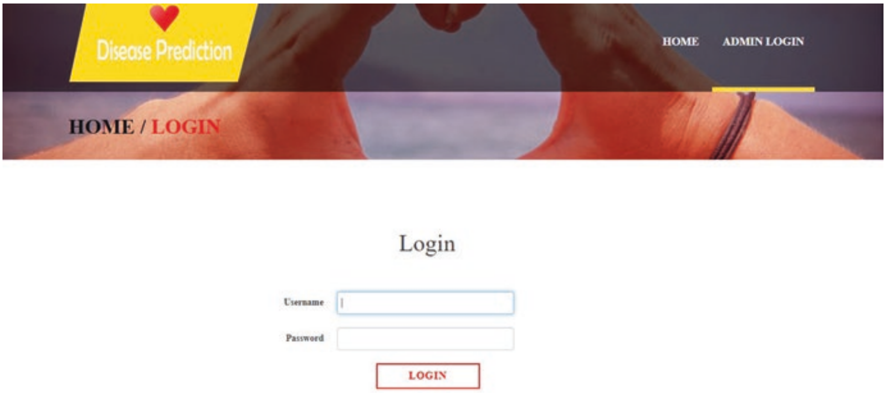


Fig. 7 Admin login page

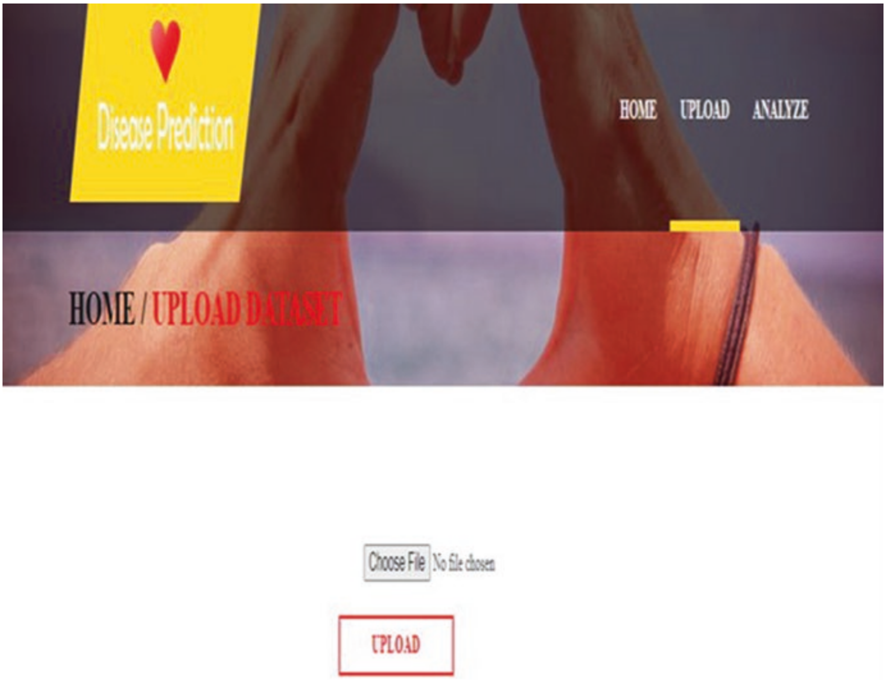
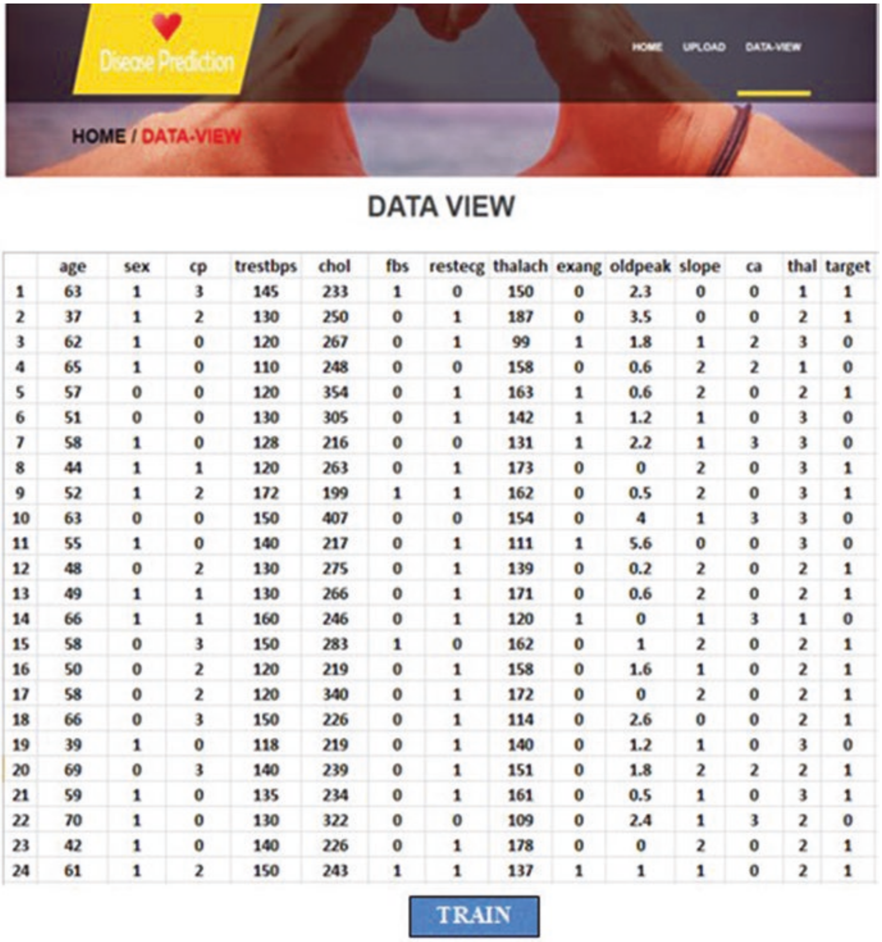


Fig. 8 Upload file page



	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
1	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
2	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
3	62	1	0	120	267	0	1	99	1	1.8	1	2	3	0
4	65	1	0	110	248	0	0	158	0	0.6	2	2	1	0
5	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1
6	51	0	0	130	305	0	1	142	1	1.2	1	0	3	0
7	58	1	0	128	216	0	0	131	1	2.2	1	3	3	0
8	44	1	1	120	263	0	1	173	0	0	2	0	3	1
9	52	1	2	172	199	1	1	162	0	0.5	2	0	3	1
10	63	0	0	150	407	0	0	154	0	4	1	3	3	0
11	55	1	0	140	217	0	1	111	1	5.6	0	0	3	0
12	48	0	2	130	275	0	1	139	0	0.2	2	0	2	1
13	49	1	1	130	266	0	1	171	0	0.6	2	0	2	1
14	66	1	1	160	246	0	1	120	1	0	1	3	1	0
15	58	0	3	150	283	1	0	162	0	1	2	0	2	1
16	50	0	2	120	219	0	1	158	0	1.6	1	0	2	1
17	58	0	2	120	340	0	1	172	0	0	2	0	2	1
18	66	0	3	150	226	0	1	114	0	2.6	0	0	2	1
19	39	1	0	118	219	0	1	140	0	1.2	1	0	3	0
20	69	0	3	140	239	0	1	151	0	1.8	2	2	2	1
21	59	1	0	135	234	0	1	161	0	0.5	1	0	3	1
22	70	1	0	130	322	0	0	109	0	2.4	1	3	2	0
23	42	1	0	140	226	0	1	178	0	0	2	0	2	1
24	61	1	2	150	243	1	1	137	1	1	1	0	2	1

Fig. 9 Statistical data view

Figure 10 shows data analyzed from the statistical information. The data evaluation is the process of accumulating and organizing records so as to draw helpful conclusions from them. The approach to fact evaluation makes use of analytical and logical reasoning to realize statistics.

The positive predictive value is the chance that patients with a positive screening test genuinely have the disease. The positive predictive value definition is similar to the sensitivity. However, positive predictive value and sensitivity are more beneficial to the doctor. Positive prediction will also provide the probability of someone having a disease, as shown in Fig. 11.

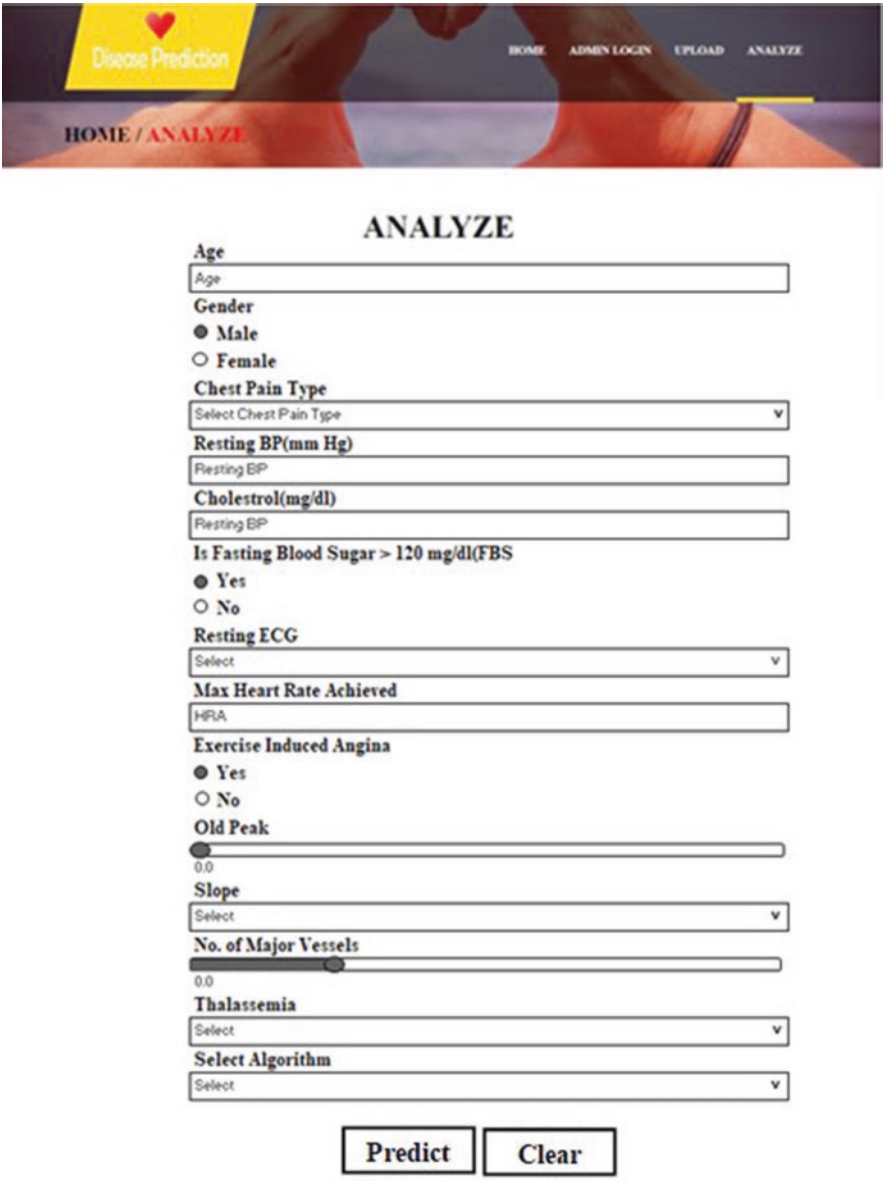


Fig. 10 Data analysis

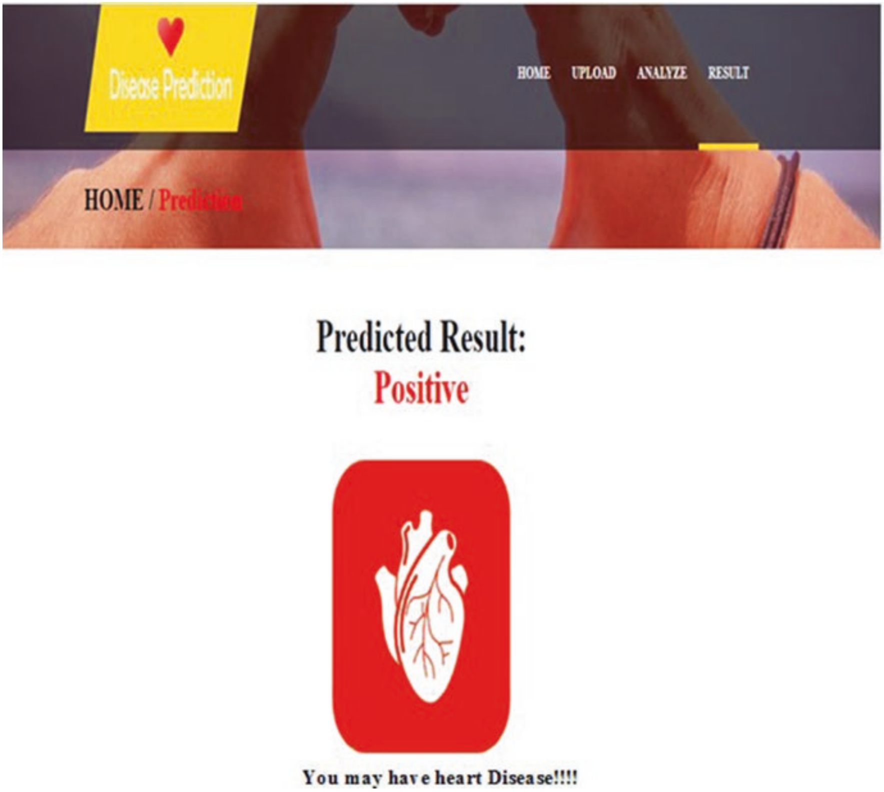


Fig. 11 Positive predictive value result

Figure 12 shows the negative predictive value, which represents the chance that an individual would not have a disease or circumstance, i.e., the negative predictive value represents the percentage of people with a negative test who are efficiently identified or recognized.

6 Conclusion

The prognosis for cardiovascular diseases using data mining methodologies when contrasted with past methodologies, HRFLM gives further developed exactness and improvement in all boundaries. The discoveries of the correlation show that when contrasted with the other individual calculations, the random forests strategy delivers improved results. As far as foreseeing cardio/heart disease, the HRFLM was demonstrated to be genuinely precise. The recommended approach joins random forests and with a direct model, and developed execution. The underlying algorithm utilizes the attributes klike age, orientation, CP, Tresbps, Chol, fbs, Restecg, Thalach, Exang, oldpeak Slope, Ca, Thal Target etc., for result prediction.

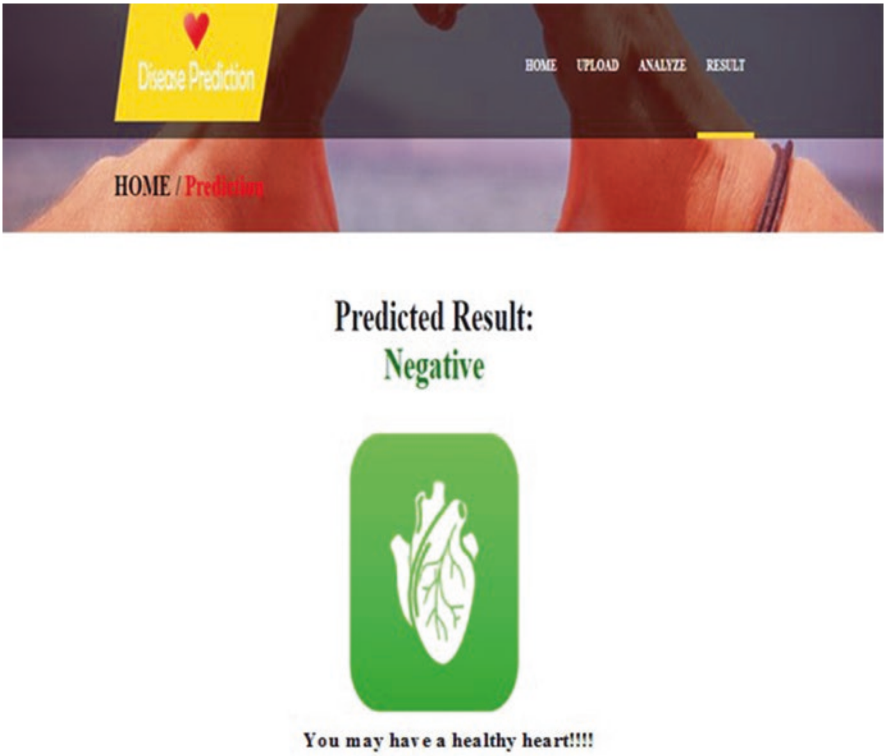


Fig. 12 Negative predictive value result

The future objective of this examination is to further develop prediction calculations by utilizing different combinations of machine learning algorithms. Later on, this exploration can be done utilizing different blends of AI calculations to further develop prediction strategies. Moreover, new component selection methods could be created to improve the heart disease prediction.

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Technologies and Therapies for Disease Diagnosis and Treatment

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1 Introduction

The human body is a sophisticated machine working as a single entity by exploiting the interdependent functioning of its organs. Attempts to formulate a definition of health date back to ancient times, as when the Greeks believed health to be the unity of soul and body or the balance established between a human and his/her habitat. The Indians and Chinese considered health to be the harmonious functioning of the organs [1]. These beliefs were further ascertained by various philosophers and biologists. With the passage of time, in 1948, the World Health Organization (WHO) defined health as "a state of complete physical, mental, and social wellbeing and not merely the absence of disease or infirmity". Here, disease refers to the pathological conditions whose influencing factors are external agents quite different from the sickness, illness or disorder, with each implying a different set of symptoms in an

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individual. Diseases are studied by their aetiological factors or causes that lead to the abnormality or pathogenicity observed [2].

A number of therapeutic techniques and applications were developed with progress in research on diseases and the factors associated with them. Rational therapeutics, developed after the boom in appropriate diagnostic techniques, successfully replaced irrational treatment elixirs. The accuracy and precision rendered by advancements in prognostic and diagnostic techniques enhanced the quality of treatment received by the patient [3]. An initial understanding of human physiology helped fabricate tools that could be used as potential diagnostic agents. Traditional prognostic tools used for measuring vital signs proved to be better empirical predictors of certain diseases and malfunctions even during their onset. Further, enhancement of these diagnostic instruments with sensors led to more accurate analyses of various disease types. Meanwhile, diagnostic technique improved drastically with the emerging trends in biotechnological strategies. Consideration of the optimal physiological conditions of the human body for molecular-level functioning resulted in a proper mapping of the biomolecules associated with specific malfunctions. Molecular diagnostics achieved a milestone in terms of understanding many genetic abnormalities that could not be usually deciphered with conventional procedures. Nowadays, it serves as a confirmatory step for many human infections, certain organ dysfunctions and several types of cancer [4]. The physiology of an organ is found to be deeply correlated with the potentials or charges associated with it. It serves as a base for the functioning of the nervous system, because of which even a minor impairment to it might lead to a variety of neuronal disorders associated with the brain and spinal cord. It helps in the diagnosis of many psychic disorders that do not have any relatable clinical symptoms [5]. Medical imaging benefited from the evolution of photography through the application of photographic principles in the detection of the disease incurred in an individual. Photographic techniques include radiography, computed tomography, positron emission spectroscopy, magnetic resonance imaging and thermal imaging. Unlike other procedures, imaging is non-invasive and cost-effective. Conventional diagnostic approaches are being replaced by smart techniques because of tremendous research advances in the field of sensors [6]. It is not surprising that even smartphone-based devices for proper health monitoring and diagnosis of several diseases are being developed [7].

This chapter dwells on human health and a selection of prognostic and diagnostic procedures for the identification of diseases. The concepts of molecular, biopotential measurement and imaging techniques used in the diagnosis of various diseases and malfunctions are discussed herein.

2 Defence Systems of the Human Body

The human body automatically activates mechanisms by which it can withstand diseases. These mechanisms could be specific or non-specific, based on the impeding agent responsible for the disease in question (Fig. 1).

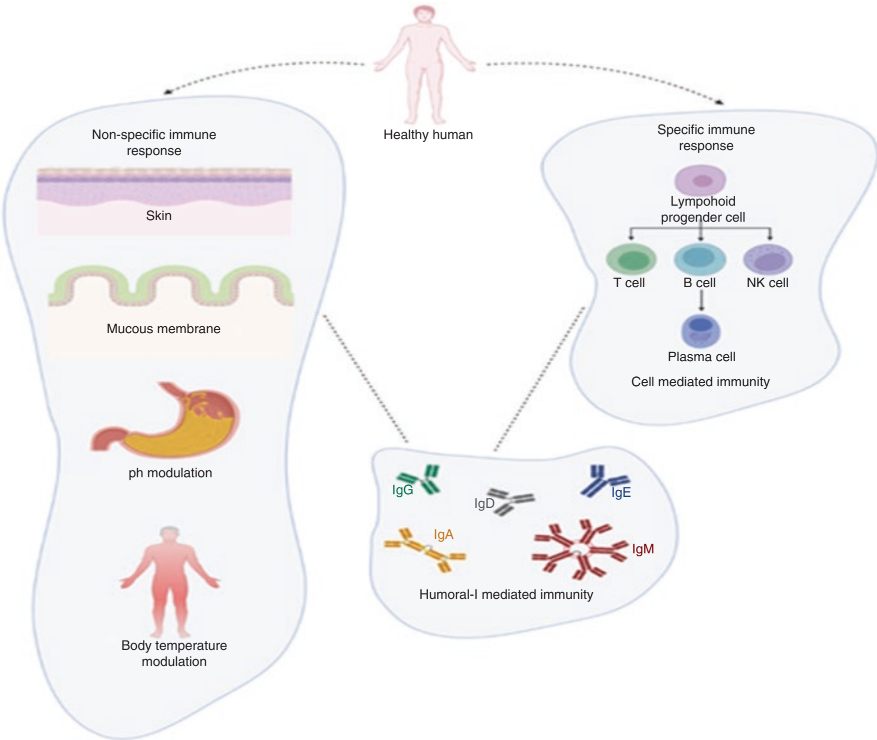

Fig. 1 Types of immune response

2.1 *Non-specific Immune Response*

This is also known as the first line of defence of the body against any extraneous agent, such as a pathogen. It comprises natural barriers like the skin, which prevents intrusion by any organism, and the mucous membrane, which traps the organism; mechanisms like physiological regulation of body temperature and extracellular pH; and processes, such as the triggering of antibody production and activation of the complement cascade. The reaction time for non-specific immune response is much shorter than that for specific immune response.

2.2 *Specific Immune Response*

This consists of adaptive immune responses wherein the body specifically targets the invading organism. It occurs mostly by cell-mediated responses involving T cells and B cells which attack the foreign organism, or by humoral-mediated responses involving biological molecules capable of inducing responses. Specific immune response has exclusive characteristics like the ability to discriminate between self- and non-self-components, induction of diverse immune responses and memory of an initial infection for a quicker response against a repeat infection [8–10].

3 Vital Signs of the Body

Vital signs are important indices for assessing the normal functioning of the organs. Measurable vital signs include respiratory rate, oxygen saturation, blood pressure, pulse and temperature. These provide crucial information in determining the probabilities of adverse events in the body. They are measured and recorded in the emergency units of hospitals to determine the clinical deterioration of the patient [11]. Several instruments like the thermometer, sphygmomanometer, pulse oximeter, spirometer and stethoscope are used for measuring the vital signs, as shown in Fig. 2. Many smart wearables are designed nowadays for rapid and accurate readings of these signs [7, 12].

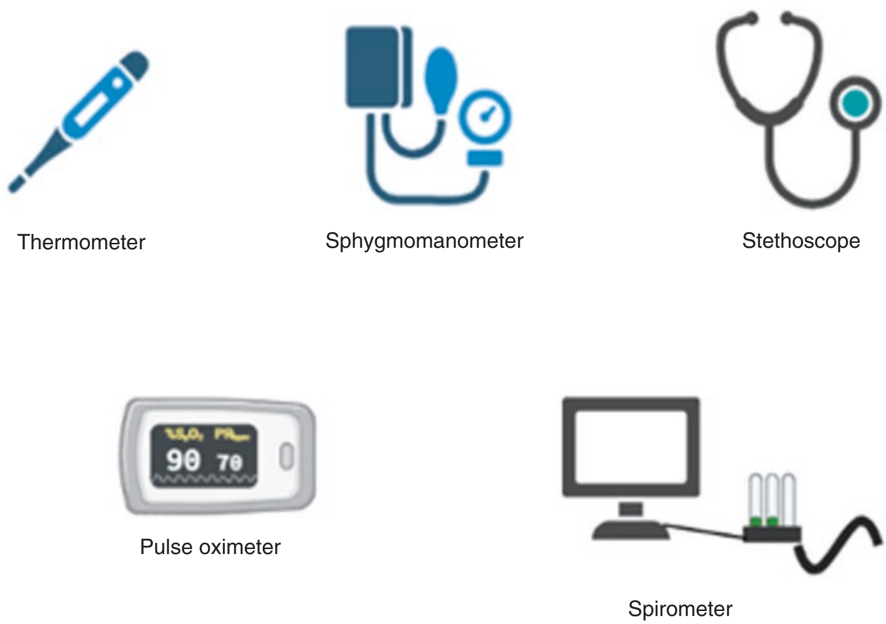

Fig. 2 Instruments for measuring vital signs

4 Molecular Techniques for Disease Detection

Molecular techniques involve the tracing of biomolecules for the detection of diseases. The commonly used molecular techniques in the lab (represented by their associated instruments) are shown in Fig. 3.

4.1 Polymerase Chain Reaction

Polymerase Chain Reaction (PCR) is an enzyme-based technique used for the diagnosis of many microbial diseases. The principle underlying PCR is the selective amplification of DNA in the clinical sample through multiple cycles of denaturation, primer annealing and extension. The US-FDA has approved the deployment of many techniques involving the principle of PCR. Many modifications were done for the accurate detection of diseases by incorporating fluorophore quenchers, as in real-time PCR. In some cases, even the evolution of antibiotic sensitivity could be profiled using PCR techniques. Despite limitations like high cost and a high dependence on optimal conditions for the reactions to occur, this technique could become handy if the pathogen is non-cultivable and the sample volume is too low. PCR is now widely used in clinical labs for the diagnosis of viral infections like hepatitis

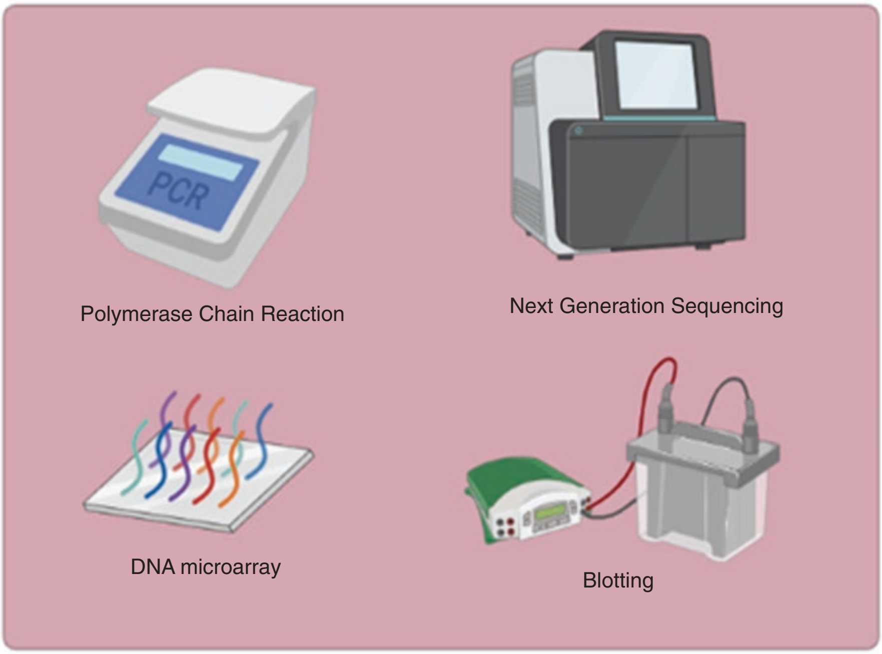

Fig. 3 Molecular techniques for disease detection

and influenza, and bacterial infections like tuberculosis, COVID 19 and many other diseases [13, 14].

4.2 Next-Generation Sequencing

Next-generation sequencing (NGS) has evolved to be a relatively accurate technique for the identification of several genetic abnormalities, especially disorders that require improved molecular techniques for diagnostics due to their uncertain phenotypic symptoms. The initial development of Sanger sequencing involving chain termination led to the exploration of numerous genetic components and the disorders associated with them. Later, improvisations in the sequencing techniques of the exome and whole genome allowed the screening of clinically important genes and brought to light the relationship between genes and the phenotype of individuals. Although NGS provides data of the entire genome, only 1–2% of this corresponds to protein-coding genes and accounts for approximately 85% of mutagenic diseases. NGS, coupled with exome sequencing, was first employed in clinical diagnosis in 2012. The diagnostic yield was highest for dermatological and ophthalmological diseases like skin cancer and retinopathy, respectively. It also diagnosed neural conditions like epilepsy with high specificity even in the early stages of onset of the disease [4, 15, 16].

4.3 Blotting

Blotting is a very sensitive technique used for the identification of dysfunctional proteins or genes. It involves fixing either the nucleic acid or protein on a membrane followed by its specific hybridization with selective probes, thus enabling disease diagnosis. Generally, hybridization involves interactions between single-stranded nucleic acids and the primer, as also those involving antigen and antibody [17]. In Southern blotting, DNA samples are blotted to map abnormalities, whereas Western blotting is concerned with the analysis of protein samples. In clinical laboratories, Southern blotting is used in the diagnosis of infectious diseases [18], and Western blotting is used as a confirmatory test for many infections like AIDS [19].

4.4 DNA Microarrays

DNA microarrays are being widely used mostly for the clinical diagnosis of genetic, mutational and chromosomal abnormalities because of the rapidity and accuracy of the diagnostic process. A DNA microarray is actually a modified form of Southern blotting. DNA microarrays are majorly used for the detection of tumours and microbial infections. Mutations and certain hereditary disorders could also be accurately mapped using the microarray technique. The protocols prescribed for RNA isolation, reaction conditions, data extraction and data analysis require validated equipment and instrumentation [14, 20].

The DNA microarray technique for the detection of diseases involves the following steps [21], as illustrated in Fig. 4.

- Isolation of the biological sample from the patient.
- Preparation of the sample by removal of proteins using Proteinase K.
- Extraction of the genetic material from the sample.
- DNA amplification by PCR.
- Monochrome or two-coloured labelling of the probe.
- Hybridization of the probe in a predesigned DNA array.
- Quantification of hybridization using fluorescence measurements.

5 Biopotential Measurement Techniques

Biopotential is electric potential in the miniscule range generated by the tissues of living organism like muscle and nerve [5]. The instrumentation used to measure biopotential is shown in Fig. 5. Conventionally, the measurement of biopotential is obtained using wet electrodes placed over the skin along with a conductive gel.

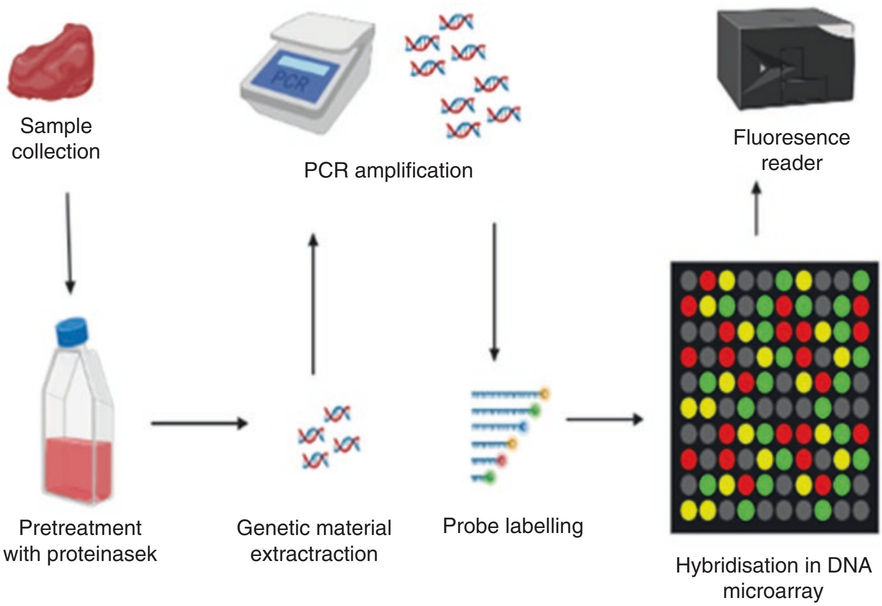

Fig. 4 Steps in disease diagnosis using a DNA microarray

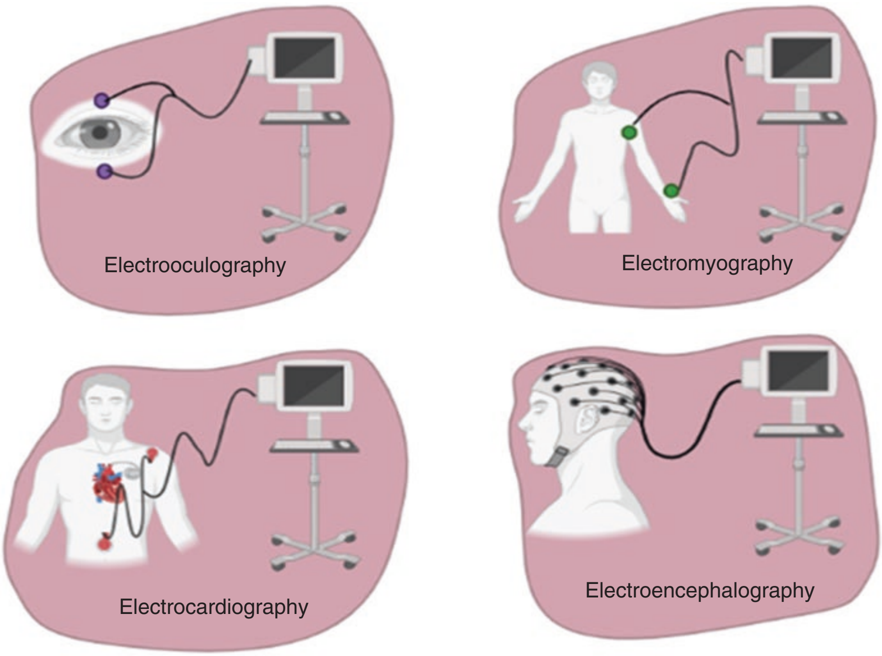

Fig. 5 Biopotential measurement techniques

5.1 Electromyography

This technique measures the electrical activity of muscle during its cycles of contraction and relaxation, particularly with respect to the neuromuscular junction. EMG is used for the study of skeletal muscle functioning. The electrically neutral cell of the human body generates electric currents at a very low range due to the movements of ions in the cell as a result of neural movements. The technique specifically measures the functioning of neurons of motor units as these provide the motor unit action potential (MUAP) that could be used for the diagnosis of neuromuscular disorders by analysis of the shape and firing rate [22].

5.2 Electrocardiography

Electrocardiography measures the rhythm of the heart. It measures cardiac output by recording electrophysiological events. Conductive cells of neural origin in the heart generate impulses for the regulation of cardiac rhythm. The neural cells in the sinoatrial node, atrioventricular node and Purkinje fibre possess the property of automaticity, which is the ability to initiate an electrical impulse. Therefore, disorders like arrhythmias or other cardiac abnormalities could be detected by mapping these electrical signals [23].

5.3 Electroencephalography

Electroencephalography measures the electrical signals occurring within the neurons of the brain. The brain being a complex organ has many cerebral maps representing regions with specific functions. The technique also traces all the twelve cranial nerves which can be correlated with their biological roles. Therefore, by measuring the signals between these regions, several neural disorders like Alzheimer's disease, Parkinson's disease and Autism could be confirmed [24].

5.4 Electrooculography

Electrooculography measures the integrity of the connection between the photoreceptor and the epithelial cells of the eyes. It is measured by placing electrodes over the top and bottom of the eye during voluntary eye movement. The amplitude of this potential directly represents the corneoretinal potential of the eye. This technique is utilized for the diagnosis of glaucoma and certain cases of trauma [25].

6 Imaging Techniques

These techniques involve creation of images of individual parts or the whole of the human body for diagnostic purposes and analysis of organ anatomy. The evolution of photography and microscopy has rendered the techniques of medical imaging important as diagnostic tools [6].

6.1 Radiography

This is one of the oldest imaging techniques that use X-rays to produce maps of the diseased parts of the body. X-rays are non-ionizing radiations generated by X-ray machines, which may be fixed or portable. The technique is used for the detection of fractures in bones, tumours in breasts and tuberculosis. It also has health implications such as hair loss, skin burn (radiation dermatitis) and cancer due to excessive exposure to X-rays [6].

6.2 Computed Tomography

This technique is an advanced form of radiography that uses high-intensity of X-rays for generating 3D images of organs. The diagnostic instrument has a doughnut-shaped sliding table with an imparting scanner, X-ray source, detector and computer. The types of computed tomography include spiral computed tomography and multi-slice computed tomography in which single and multiple detectors, respectively, are used for scanning the body. The technique is used for the diagnosis of several traumas in the head and many other injuries [26].

6.3 Magnetic Resonance Imaging

The principle of magnetic resonance imaging is based on the magnitude of the nuclear spin in an atom depending on the number of protons in it rotating with a velocity in proportion to the applied magnetic field. In diagnostic MRI, cryogenic superconducting magnets are used as the source of the magnetic field. The susceptibility of tissues in response to the magnetization reveals their morphological and physiological conditions. The technique is used for the detection of diseases of the brain, liver, pancreas and other visceral organs. MRI is a functional imaging technique that is used as a prognostic tool when a second opinion is necessary. It uses a strong magnetic field and pulsating radio waves to produce a high-quality image at various cross sections. The patient is made to intake a contrast agent that adds up to a better production of the required target image (Saslow D et al. 2007). This modality is expensive and requires a long time for patient preparation and imaging. Hence, MRI is generally recommended for high-risk patients who have already developed a serious illness and require an accurate prognosis [6, 27].

6.4 Positron Emission Tomography

It is a combinative technique with features of both computed tomography and magnetic resonance imaging. It uses radioisotopes as tracers for detecting disease in a particular organ. The detection of both benign and malignant infections in internal organs like lungs, mediastinum and appendix is done using this technique. Even distinctions between infective and inflammatory symptoms can be made in order to trace the causes of unknown clinical conditions [6].

6.5 Thermal Imaging

Thermal imaging is also known as thermography or infrared imaging. Heat is known to be a very good indicator of health. For its normal functioning, the human body needs to maintain its internal temperature within the range 33–42 °C. Even a subtle change in the body's internal temperature is considered to be a clear indication of illness. The physiological process by which the body controls its temperature is called thermoregulation. In 1868, Carl Wunderlich scientifically declared that temperature indicates a person's health condition based on serial studies conducted on ill patients suffering from fever. Since the emissivity of human skin is extremely high (i.e., within 1% of that of a black body), the IR emitted by the skin can be converted directly into accurate temperature values [28–31].

6.5.1 IR Equipment

Infrared detection systems utilize high-end infrared cameras and sophisticated computers to detect, analyse and produce high-resolution images. The human eye cannot detect IR radiation; hence, a Digital Infrared Thermal Imaging (DITI) camera is used to obtain images called thermograms (Qi, H et al. 2012). Although the potential of thermal imaging was recognized many decades ago, the IR equipment then available was inadequate. Many technical problems were encountered while using the first-generation infrared camera systems, which included improper detector sensitivity, thermal drift, calibration instability, analogue interface issues and poor resolution at slow scanning times (Diakides NA 1998). In the early 1990s, the major concern was improving the sensitivity of detection.

An infrared imaging instrument consists of a detector and electronic circuitry that amplifies the signals and converts them into electrical pulses. In general, there exist three types of detectors: photon detectors, which produce electrical energy during the incidence of infrared radiation; thermovoltaic detectors, which generate voltage signals when IR is incident on them; and photon detectors that maximize sensitivity using choppers. The last converts the IR emitted from the skin surface into electrical impulses that are visualized in colour on a monitor. The body temperature is graphically mapped to produce what is termed a thermogram. The spectrum of colours is calibrated by the amount of IR being emitted from the body surface. Since a healthy body shows thermal symmetry, subtle abnormal temperature asymmetries can be easily identified.

An IR camera needs to be selected while considering parameters such as temperature measurement range, thermal sensitivity, and detector type and measurement accuracy (Jones and B.F et al. 1998). Any IR detector must be calibrated against a perfect radiator, such as a black body. The latest equipment come with self-calibrating scanning detectors that calibrate with the black body emissivity. Table 1 lists the different types of IR cameras used for thermogram acquisition in

Table 1 Different types of IR cameras reported in the literature

Equipment type	Temperature measurement range	Measurement accuracy	Thermal sensitivity	Field of view	Detector type	Spectral range	Weight
Amber PM	−20 to 500 °C	±2 °C	<0.1 °C	10.2° × 7.7°	FPA 320 × 240	7.5–13 μm	2.3 Kg
FLIR PM 575	−20 to 500 °C	±2 °C	<0.1 °C	10.2° × 7.7°	FPA 320 × 240	7.5–13 μm	2.3 Kg
IR 4040	−10 to +250 °C	±2 °C	<0.1 °C	10.2° × 7.7°	160 × 120 Uncooled micro bolometer	8–14 μm	0.8 Kg
FLIR Thermo cam 345	−10 to +250 °C	±2 °C	<0.1 °C	10.2° × 7.7°	FPA 320 × 240	7.5–13 μm	3.4 Kg
Thermo tracer TH7102 WL	−40 to +500 °C	±2 °C	<0.1 °C	29° × 22°	FPA uncooled	8–14 μm	1.6 Kg
FLIR T400	−20 to 120 °C	±2 °C	0.05 °C at 30 °C 50 mk	25° × 19 °0.4 m (40 cm)	320 × 240 uncooled microbolometer	7–14 μm	0.8 Kg
Meditherm IRIS 2000	18 to 40 °C	±1 °C	<100mK (0.1 °C)	50° × 35° 60 cm to ∞	320 × 240 amorphous silicon microbolometer	7–14 μm	2.1 Kg

breast thermography research. The basic components of a piece of IR equipment and two models of IR camera are shown in Figs. 6 and 7, respectively.

6.5.2 Other Applications of Thermography

Thermography being a functional imaging modality, it is used to detect various other pathological conditions in the field of medicine (Lahiri, B.B et al. 2012). A few major applications wherein thermography is extensively utilized as a non-invasive tool to understand the physiological processes of the particular organ are described below.

In **dentistry** (Sikdar, S.D. et al. 2010), thermography is utilized to diagnose a condition called inferior alveolar nerve deficit that occurs due to blockage of the vascular neuronal vasoconstrictive messages. Under thermal imaging, asymmetrical thermal patterns can be observed in the lower chin region of subjects with this type of deficit when compared with normal subjects. These asymmetrical variations help in understanding pathological conditions so that timely treatment can be catered to the affected area. Another orofacial area wherein thermal imaging is used effectively is the Temporomandibular Joint (TMJ). The dysfunction occurring in this joint causes great discomfort in eating habits and excruciating pain while chewing. The treatment can be analysed and specifically applied by monitoring through

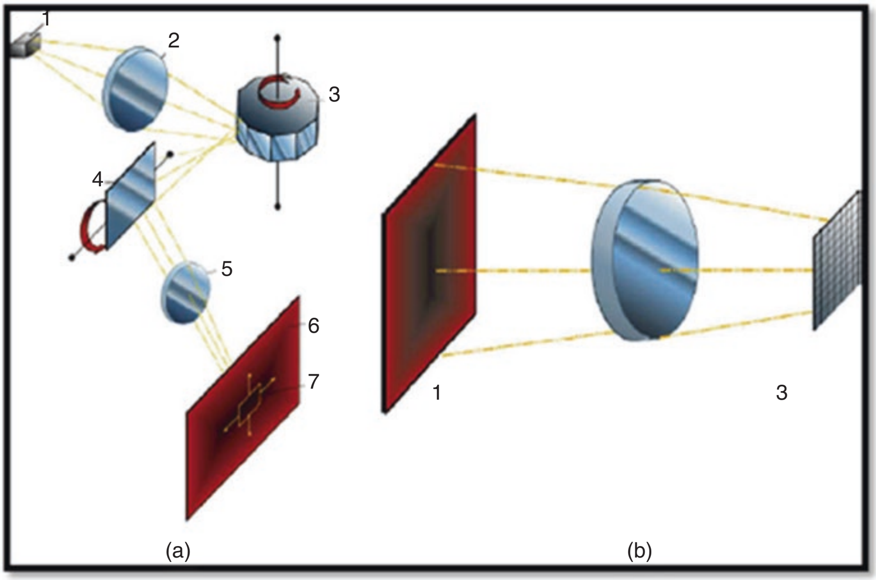

Fig. 6 Parts of an IR imaging instrument. (**a**) Scanning array 1. Detector 2. Lens 3. Horizontal deflection mirror 4. Vertical deflection mirror 5. Lens 6. Object 7. Measuring spot. (**b**) Focal plane array: 1. Object with measuring spots. 2. Lens. 3. Detectors

Fig. 7 Two types of IR cameras: (**a**) FLIR T400 and (**b**) Meditherm IRIS 2000

thermography. Studies show that subjects with such dysfunctions exhibit asymmetrical variations in temperature distribution when compared with those having no TMJ disorders. Another application wherein thermal imaging is used to monitor the treatment is the detection of Herpes Labialis during the prodromal phase. This phase is the stage of the disease that shows initial signs of symptoms. Herpes Labialis is a type of cold sore that occurs primarily around the lip. Hence, when the dentist recommends patients to apply an acyclovir cream to cure these sores, thermography is used to monitor the stages of the curing process.

In **ophthalmology** (Tan, J.H et al. 2009), dynamic thermography plays an important role in detecting the ocular surface temperature (OCT) to study the inflammation of the human lacrimal drainage system, dry eye syndrome, carotid artery stenosis, glaucoma, ophthalmic post-herpetic neuralgia and vascular neuritis of the optic nerves. Generally, the OCT of an eye needs to be maintained (Purslow, C. and Wolffsohn, J.S 2005). Thermography is used in studying the physiological processes inside the cornea and the posterior ends of the eyes that are responsible for clear vision. Invasive methods like needle probing create discrepancies in measuring accurate OCT. But thermal imaging has made it feasible to measure the OCT with progressive monitoring of ocular physiology, particularly in subjects with dry eyes and those whose eyes are affected by wearing contact lenses.

In the **diagnosis of diabetic neuropathy and vascular disorder** (Bharara, M et al. 2012), thermal imaging is used to measure the mean foot temperature in diabetic subjects. The study says that about 50% of diabetes mellitus patients suffer from foot complications. Vascular disorder and neuropathy cause changes in skin surface temperature, and thermography is a suitable diagnostic tool to detect sympathetic damage in diabetic feet even in the early stages. These sympathetic conditions are mainly caused by a thermoregulatory sweating disorder in the foot. Another vascular disorder type is arteriosclerosis obliterans (ASO), which causes complications in the peripheral circulation (Hosaki, Y., et al. 2002). Using thermography, a quantitative comparison between normal and unhealthy contralateral sites can be made in order to understand the physiological processes of diabetes mellitus subjects.

In the **mass screening of fever**, thermography has played a very important role during public health crises such as severe acute respiratory syndrome (SARS) and influenza. International airports have adopted thermal imaging to screen passengers suspected of running a fever for high-temperature distribution in their bodies during an epidemic outbreak (Nguyen, A.V et al. 2010). As elevated body temperature is one of the most common syndromes of many infectious diseases, thermography turns out to be a powerful tool for mass screening in public places.

In **dermatological applications**, thermography finds extensive use in detecting abnormalities under the skin. The surface temperature changes due to internal inflammation, leprotic conditions and burn injuries. Thermal imaging is considered to be a suitable non-invasive technique to diagnose skin disorders effectively. In leprosy, cooler areas such as the nasal and otic regions are affected. Using thermal imaging, the initial stages of leprosy can be detected, and this has also been validated by clinical findings. In addition to this, infrared thermography is used in hair depilation and vascular lesion treatment wherein laser–tissue interactions are carefully conducted. With the intervention of thermal imaging, a safe surgery or treatment is achieved that avoids unnecessary side effects like burning or missed treatment areas (Thomas, R.A., et al. 2002).

In the **diagnosis of rheumatic diseases** (Schiavenato, M. and Thiele, R.G., 2012), thermal imaging is used in pain assessment, especially after the treatment of arthritis. Studies report that thermography is an excellent technique for measuring skin temperature over different joints. The abnormal distribution of temperature in the joints is a clear indication of pain due to arthritis. Clinical findings correlate well with the decreased movements and hypothermic temperature patterns as detected in thermal imaging [32–40].

6.5.3 Other Imaging Modalities

Advanced imaging technology has enabled the early detection of cancer. Detecting an abnormality at the earliest improves the chances of survivability and reduces the cost of treatment. Currently, the most widely used imaging diagnostic tools are mammography, ultrasonography and magnetic resonance imaging (MRI) (Lee CH et al. 2010). A mammogram is an X-ray of the breast tissue that is produced at a low dosage of radiation. The procedure followed in imaging for mammography requires the gentle placement of the breast between the heavy plates of the X-ray machine. Mammograms are generally recommended for women over the age of 35. The high tissue density of younger breasts poses problems for the detection of abnormalities by mammography, thereby increasing the chances of false-positive and false-negative results.

Ultrasound makes use of sound waves for imaging. This type of imaging tool is well suited for tumours that have attained a certain size, making it possible to determine whether the detected tumour is a cyst made of fluid or cells. The procedure requires some initial preparation, such as applying a gel around the affected area, after which the radiologist would run a microphone-like device (transducer) over the area (Brem R. F et al. 2015). The advantage of this technique over other ionizing modalities is its non-invasive and non-intrusive methodology. Apart from X-ray mammography, digital mammography, also known as breast tomosynthesis, provides 3D images, produced by X-rays that act as transmitters and digital detectors as receivers. Although this imaging modality has increased the sensitivity and specificity rates, it is generally employed along with an X-ray mammography (Friedewald S.M et al. 2014). This causes serious discomfort to the patients as they are exposed to twice the amount of radiation.

7 Therapeutic Products in Healthcare

Biologics are pharmaceutical products employed in the treatment of various ailments and improving the health status of individuals. Many biologics have been used since ancient times, from natural phytocompounds to the 3D organs of present times. A few classes of these therapeutic products are presented in Fig. 8.

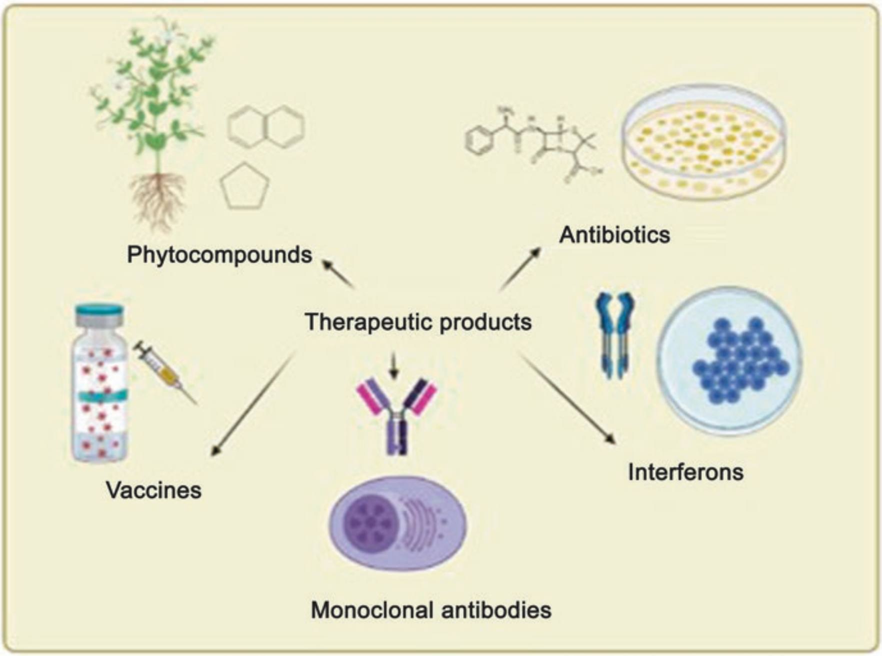

Fig. 8 Examples of therapeutic products

7.1 Phytocompounds

Traditionally, phytocompounds or compounds from plants were used as therapeutic agents for various diseases. Evidence as old as 5000 years describes the utilization of plant parts as therapeutic agents. Traditional Chinese medicine and the Indian Vedas depicted the use of alkaloids and flavonoids from plant parts, which would serve as an irrational treatment strategy. Several other civilizations like the Assyrian, Egyptian and Greek also emphasized the study of phytocompounds [41]. Nowadays, most pharmacopoeias around the globe are endeavouring to expand the chemical space of phytocompounds to utilize them efficiently. The exploration of phytocompounds became more popular with the drug designing pipeline becoming vital for rational treatments. Several phytocompounds like choline, niacin, isoquercetin are used for the treatment of many diseases [42].

7.2 Antibiotics

Antibiotics are another class of vital therapeutic products used to prevent infections against certain pathogens. The antibiotic Salvarsan, discovered in 1910, led to a drastic change in the treatment strategies of microbial diseases, which was further amplified by the large-scale use of penicillin during World War 2 to treat casualties of the war. Moreover, antibiotics have diverse mechanisms of action against a narrow or broad spectrum of pathogens.

However, the unrestrained use of antibiotics may lead to the problem of antimicrobial resistance in which the pathogen so evolves as to be able to withstand the effect of the antibiotic. Antibiotics are primarily produced from microbial sources but are chemically synthesized as well. Examples of antibiotics are aminoglycosides, tetracycline, amphotericin B, macrolides, bacitracin and cyclosporine [43].

7.3 Monoclonal Antibodies

Monoclonal antibodies (Mabs) are soluble molecules used for the treatment of various diseases. They are produced by B cells and are capable of targeting a specific antigen. They were first produced in 1975 by Kohler and Miller using the hybridoma technique. The United States Food and Drug Administration (US-FDA) approved the use of these antibodies for therapeutic purposes in 1986. Since then, a boom in the commercial production of monoclonal antibodies has been witnessed. They are used as humanized antibodies to prevent the rejection of transplants, as probes in various techniques due to their high selectivity, in the treatment of autoimmune diseases and cancer, and in product purification techniques like chromatography [3].

7.4 Interferons

Interferons play a vital role in the non-specific immune response against viral infections and are commercially produced for the treatment of these infections. Initially, interferons isolated from humans and primates were found to be functional, narrowing the sources for their production. With the advent of animal cell culture and recombinant DNA technology, their production was normalized. They are currently used for the treatment of hepatitis B, multiple sclerosis and certain tumours [44].

7.5 Vaccines

Vaccines are therapeutic products capable of evoking pathogen-specific primary immune responses that become part of the host's immunological memory. Antibodies produced during the primary immune response constitute the humoral component of immunological memory, while the memory B and T cells comprise the cellular component. When the host is subsequently infected by the pathogen, the memory B and T cells respond immediately to the infection and, together with the antibodies already produced, eliminate the pathogen. According to an estimate by the World Health Organization (WHO), 2–3 million deaths from diseases like diphtheria, tetanus, pertussis, influenza and measles are prevented every year by adherence to vaccination schedules. Vaccines are categorized as live and inactivated types, referring to the attenuated and killed forms, respectively, of the pathogen. In addition to these two vaccine types, toxoids, subunit vaccines and virus-like particles are also used to prevent various infections like diphtheria, anthrax and hepatitis B [45].

8 Conclusion

Health is a vital factor for the survival of human beings. Monitoring health is important for preventing the progression of diseases in the human body. This chapter explains the principles and concepts behind various prognostic and diagnostic techniques with tremendous potential for detection of diseases that have evolved over time. These procedures owe a lot to the extensive increase in our knowledge of human physiology. Techniques used for the identification of diseases at the molecular level by detecting the genetic material and proteins, biopotential techniques used for figuring out abnormalities in signal transduction within the nervous system and imaging techniques used in the prediction of a disease with images generated from affected organs are some of the breakthroughs achieved in disease detection.

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Part V
Evolution of Healthcare Techniques (Therapy)

Evaluating the Impacts of Healthcare Interventions

K. Umamaheshwari, R. Sundar, Swati Sikdar, B. Vijayalakshmi, John Amose, and N. Rajasingam

1 Introduction

Healthcare organizations are concentrating more on increasing the safety of the patients by putting them in the center. They strongly focus on care and predict the risks which promote the safety of patients. Medical persons make more efforts to retain the physical and mental health of patients and also make sure that their emotions are in control. The people who provide these services are called as healthcare providers. They help in preventing diseases and make proper strategies to make the patients aware of treatments and procedures. Any changes in the system should be ensured strictly because if any problems happen or any updates are not been added, it may provide false results and make people in a confused state. US healthcare was started between 1750 and 2000 with a simple home remedy system and doctors with little training called the medical industrial complex.

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2 Bioethics

In bioethics, ethical concerns resulting from scientific and pharmaceutical developments are examined. It suggests having a public conversation on moral knowledge, which is generally anticipated to be connected to clinical planning and practise as well as to more pressing concerns like the environment and flourishing. Bioethics is stressed over the ethical requests that arise in the associations among life sciences, biotechnology, prescription, administrative issues, regulation, reasoning, and hypothesis [4, 19].

It consolidates the examination of characteristics associated with fundamental thought, various pieces of prescription ("the ethics of the ordinary"), moral preparation in science, animal, and natural ethics. Ethics also interfaces with various sciences outside the area of natural sciences, and bioethics is in like manner ensured as one more ethic to address complex requests of contemporary society [3].

Certain demonstrations are managed by networks to think about their authenticity. Such guideline is called morals. Figure 1 shows the bioethics incorporate principles followed by us to direct the exercises connected with natural exercises.

2.1 Reason and Extension

The field of bioethics has watched out for a wide wrap of human solicitation; going from talks over the constraints of life (for instance, hatchling evacuation and killing), surrogacy, and the piece of insufficient clinical benefits resources (for instance,

Fig. 1 Ethical standards

organ gift and clinical consideration proportioning), aside to dismiss clinical thought for severe or social reasons. Bioethicists much of the time contrast among themselves over the specific uttermost spans of their discipline, examining whether the field ought to worry about the ethical appraisal of all questions including science and prescription, or simply a subset of these requests. Some bioethicists would restrict moral appraisal just to the significant nature of clinical treatments or mechanical turns of events, and the situation of clinical treatment of individuals. Others would enlarge the degree of moral evaluation to consolidate the significant nature of everything exercises that might be useful or naughtiness living creatures prepared for feeling fear [4, 12].

The degree of bioethics can develop with biotechnology, including cloning, quality treatment, life extension, human innate planning, astroethics and life in space, and control of central science through changed DNA, XNA, and proteins. These headways will impact future turn of events and may require new guidelines that address life at its middle, as biotic ethics characterizes life itself at its fundamental natural cycles and developments and searches for their multiplication. Panbiotic hopes to get and develop life in the framework [1].

History expert Yuval Noah Harari sees an existential risk in a weapons challenge in man-made mental ability and bioengineering and he imparted the necessity for close co-movement between nations to handle the risks by creative interference. Harari said AI and biotechnology could demolish being human [6].

2.2 Standards

Human experimentation is one of the key areas that modern bio-ethicists closely monitor. The National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research was first got comfortable in 1974 to perceive the fundamental moral guidelines that should underlie the direction of biomedical and social assessment including human subjects. In any case, the essential principles proclaimed in the Belmont Report (1979), to be explicit, respect for individuals, accommodation, and value, have influenced the considering bioethicists across a wide extent of issues [6]. Figure 2 shows the major issues in the treatment of bioethics.

Others have added non-fierceness, human pride, and the holiness of life to this overview of cardinal characteristics. For the most part, the Belmont Report has coordinated assessment in a way focused on guaranteeing powerless subjects similarly as pushing for straightforwardness between the trained professional and the subject. Research has flourished over the past 40 years, and in light of the advancement in development, it is envisioned that human subjects have outgrown the Belmont Report, and the necessity for adjustment is needed [7].

What is happening of crucial importance on debate and display is another important bioethical principle. Different discussion-based bioethics bundles exist in schools across the United States to advocate exactly such targets. Models integrate

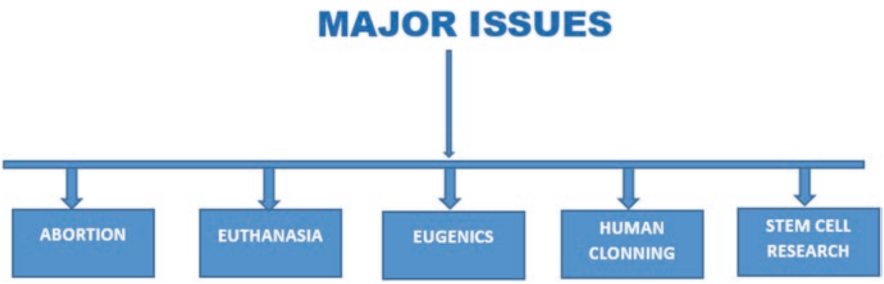

Fig. 2 Major issues in treatment

the Ohio State Bioethics Society and the Bioethics Society of Cornell. Similar level types of these associations exist [8].

Various bioethicists, especially clinical specialists, accord the most raised need for autonomy. They acknowledge that each understanding should sort out which approach they contemplate most as per their convictions. Thusly, the patient should reliably have the chance to pick their own treatment [4].

3 Genetic Counseling and Research

The National Society of Genetic Counselors (NSGC) describes inherited coordinating as the most widely recognized approach to assisting people with cognizance and acclimating to the clinical, mental, and familial consequences of innate responsibilities to disease (National Society of Genetic Counselors, 2012). This cycle integrates the interpretation of family and clinical records to assess the shot at disease occasion or rehash. Innate prompting regularly incorporates giving guidance about inheritance, testing decisions, ailment of the board, and expectation. Innate encouraging moreover propels informed choices and change to the risk or condition (National Society of Genetic Counselors, 2012) [2, 9].

Innate prompting frequently has a specific helpful focus, such as pre-birth, paediatric, mental, or dangerous development. The place of innate coordinating is to assist with peopling in their ability to make a good choice concerning genetic testing and the implications of such testing. Individuals search for innate education for a collection with respect to reasons. The typical customers of genetic counselling are those who have queries on the onset of illness or traits in their family or racial group. The people who could find genetic coordinating steady integrate individuals who have, or are concerned they might have, an obtained issue or birth flaw. Specialists also imply pregnant women whose very amazing appraisals or blood testing exhibit that their pregnancy may be at extended risk for snares or powerlessness, similarly women above 35 who are pregnant. Couples who currently have a child with a genetic defect or who give birth to a new baby who is partially predicted by routine new natal screening to have an inherited condition may similarly look for inherent guidance. Innate aides are prosperity specialists with express tutoring, planning and involvement with clinical inherited characteristics, and prompting (National Society of Genetic Counselors, 2006) [10].

Hereditary educators typically work as a part of a clinical consideration bunch, giving information and support to families who have people with birth deserts or innate issues and to families who may be in peril for a combination of obtained conditions (National Society of Genetic Counselors' Definition Task Force, 2006). Innate educators communicate with clients and other clinical consideration specialists in an assortment of clinical and non-clinical settings, for instance, school-based clinical centers, confidential clinical facilities, confidential practice, and industry settings (American Board of Genetic Counseling, 2012). To a consistently expanding degree, fundamental thought experts are giving elements of inherited coordinating and innate organizations, achieving a need to plan orderlies, social workers, and specialists. Genetic counselors provide a fundamental occupation in educating providers and making standards of preparation. Innate teachers in like manner bear the expense of prosperity specialists and patients the important opportunity to talk with others, similar to policymakers and the media, about new genetic organizations and advancements (National Human Genome Research Institute, 2012) [9].

3.1 Variety in Hereditary Examination is Critical

All ethnic gatherings must be addressed in hereditary exploration. This is on the grounds that individuals of a similar ethnic gathering share a significant number of the very changes and varieties in their DNA with one another that they may not impart to individuals of an alternate ethnic gathering. If by some stroke of good luck, one ethnic gathering is engaged with hereditary exploration, we learn just with regard to the varieties in DNA that are related to sickness in that specific ethnic gathering [7].

At the point when hereditary examination looking for qualities engaged with the bosom disease was simply starting, most ladies who partook in hereditary exploration studies were Caucasian. That examination leads to the disclosure of two vital qualities (BRCA1 and BRCA2) that are currently known to place ladies who have changes in these qualities at high danger for bosom and ovarian malignant growth. It was discovered that numerous transformations in the BRCA qualities can prompt a high danger for malignant growth. In any case, just those transformations that were normal in the Caucasian populace were found through the underlying exploration projects. This implied that when a non-Caucasian lady was tried for transformations in the BRCA qualities by her primary care physician, there was a high possibility that the outcomes would not be decisive. After numerous long periods of extra exploration, hereditary testing for the bosom disease has incredibly improved for non-Caucasian ladies and testing of these qualities is presently more advantageous for them. By remembering all ethnic gatherings for hereditary exploration, everything ethnic gathering can profit from the discoveries of hereditary examination [8, 15].

4 Involvement of Patient or Public in Healthcare System

For formulating health policies, the patient has to be involved. Policies, plans, and decisions regarding the patient's health and treatment must be considered by the patients as the policies and plans deal with the life of patients,see Fig. 3. In developed countries, acceptance of policies with patient participation promotes fairness and liability. A healthcare service to be approved by the public should be patient-oriented; these services should consider the necessity, inference, need of patients, opinion of the caretakers, and the society. Enforcement of patient-oriented healthcare services is a challenge. These services provide adequate treatment at a low cost, comfort to the patients, and good medicinal outcome [5].

4.1 Benefits and Consequences of Patient Participation in Healthcare

Planning with the patient in mind provides several benefits, including power and assurance in the therapy. Improved patient lifestyle, decreased fear, recognition of private needs, direct interaction with medical personnel results in enhanced health, and queries from different sectors on a common topic may provide the best solution related to all sides, diagnosis, and detection sectors that are magnified, good understanding about the treatment given with clear picture of the procedure. Feedback

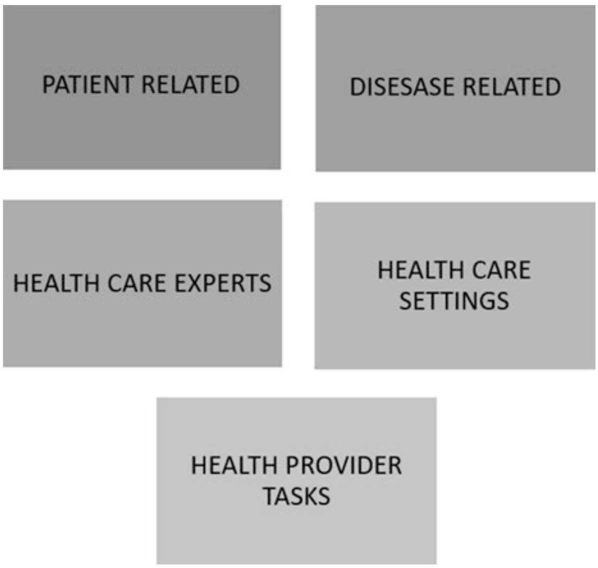

Fig. 3 Factors influencing patient participation in healthcare decision-making

and reaction from the patients may lead to the promotion of the medical staff. Disappointment from the patient side may lead to the improvement of quality treatment.

4.2 Public Involvement Policies

- Democratic deficiency in the National Health Sector (NHS) can be rectified by public involvement policies with the best effect.
- Forerunner of the current policies dates back to the establishment of the internal market, choice, and competition in NHS in 1990.
- Local voice initiatives are enforced in 1992.
- A survey of policies from 1948 to 1997 infers the least involvement of the public.
- New survey period from 1990 shows the growth of democracy in NHS.
- With the labor government's power in 1997, a bunch of new policies with patient and public involvement.

4.3 Current Policies to Encourage Public Involvement

- NHS Organizations, for example, NHS trusts, essential consideration trusts, and key well-being specialists are given with new legal obligations by the Health and Social Care Act 2001 to guarantee that patients and the public are requested at the beginning phase for the preparation and associations from administrations.
- NHS trusts should have Parent Advisory and Liaison Service to provide data to help patients.
- Autonomous Complaints Advocacy administration gave locally observes the National Guidelines.
- Patients gatherings are to be set up in each NHS trust to "bring the patient's point of view" to the executive's choices. Gatherings choose a part to sit on the trust board as a non-chief.
- To assist communities' Local resource group consists of professional members reformed to set up "Voice."
- The Commission for Patient and Public inclusion in Health is to set principles, give preparation, and screen new plans.

Local authority outlines and examination boards of trustees, comprised of chosen councilors, presently have abilities to investigate the NHS.11 The advisory groups can survey any part of NHS care locally and censure NHS chiefs for their activities. They have the ability to allude to any expected change to the Secretary of State for Health for an ultimate choice.

5 Epidemiological Evolution

The public will actually want to become associated with the running of NHS establishment trusts by becoming members. Three members will be the legitimate proprietors of the trust and will actually want to choose agents from techniques and approaches for further developing quality in medical care that have advanced quickly throughout the course of recent years. This has happened because of a few factors: a huge number of field encounters that have occurred and a wide range of regions and claims to fame; the expanding intricacy of medical care conveyance and arising new requirements for productive and financially savvy care; expanded assumptions for clients; and finally, it advances our insight on progress, the board, and clinical practice.

Today, the Internet is changing the medical care industry by giving an abundance of assets and data on well-being, well-being administrations, and well-being items. There is a major potential for well-being records to further develop care for purchasers and back decision production by medical services suppliers. There is a perceived need in non-industrial nations for an incorporated well-being framework for the development of proficiency in medical care administration conveyance at all levels. Assortment and capacity of value information will consider epidemiological examination in this manner giving the logical premise whereupon medical care conveyance is improved and public approach choices are made [16].

In Kenya, helpless assortment, stockpiling, and investigation of epidemiological information have been accounted for at all levels. A framework that would gather, store, dissect, and report epidemiological information would go far in further developing the manner in which choices are made inside the well-being area. By utilizing an announcing device, for example, GIS frameworks would help in recognizing neglected well-being needs, describing regions and high-need populace gatherings, distinguishing well-being hazard determinants, and assessing the effect of well-being mediations [14].

5.1 Types of Epidemiology

Observational epidemiology alludes to the surmising about the etiological elements that impact the infection event in view of the assortment and examination of information from human populace gatherings. Quite a bit of the study of disease transmission falls into this classification. The plans utilized in these examinations can be grouped into two classifications, review (cross-sectional or case–control) and forthcoming (longitudinal or cohort) plans. These plans are portrayed later. There are a few halves and half forms of these plans, which are additionally momentarily portrayed later. A greater part of this paper is restricted to observational studies [10].

Trial epidemiology comprehensively alludes to an arranged trial where the agent has command over the populace bunches by concluding which gatherings are presented to a component under a magnifying glass. For instance, a significant part of the OK assessment investigations of preventive estimates falls into this class. The plan and examination techniques utilized in these examinations are like those utilized in randomized clinical preliminaries. A peruser keen on observing more insights regarding the plan and scientific issues can think that they are in various books and a well-known one is recorded in the references. There are a few provisos that are remarkable to trial the study of disease transmission. For example, an assessment of preventive measures might include randomization of gatherings, rather than individuals [9].

Normal experiments allude to a random circumstance where a normal flow of public occasions intently estimated an arranged control analysis. Nonetheless, these are essentially observational examinations. For example, the government assistance change in the United States has instigated significant contrasts in social conditions. In this manner, the impact of changes in the social conditions on the infection event can be considered through the examples of illness events in the two-time frames, when the government assistance changes were carried out. Such normal analyses happen through significant public strategy changes at both the state and public levels [11]. A regular examination may likewise happen in a setting of an associate report. For instance, the Monitoring the Future review is an ongoing enormous school-based longitudinal overview to inspire data about medication and liquor use and to concentrate on its effect on prosperity (Fig. 4). Over the span of this review, numerous new laws overseeing drug use were established, along these lines giving a characteristic test setting to perform "before-later" correlations. The normal techniques talked about in Sect. 3 can be utilized to investigate the information from such examinations [13].

Hypothetical Epidemiology alludes to the improvement of numerical and factual models to clarify the examples of the event of infections. A few models to clarify the episode and spread of irresistible sicknesses have been created. Modern registering

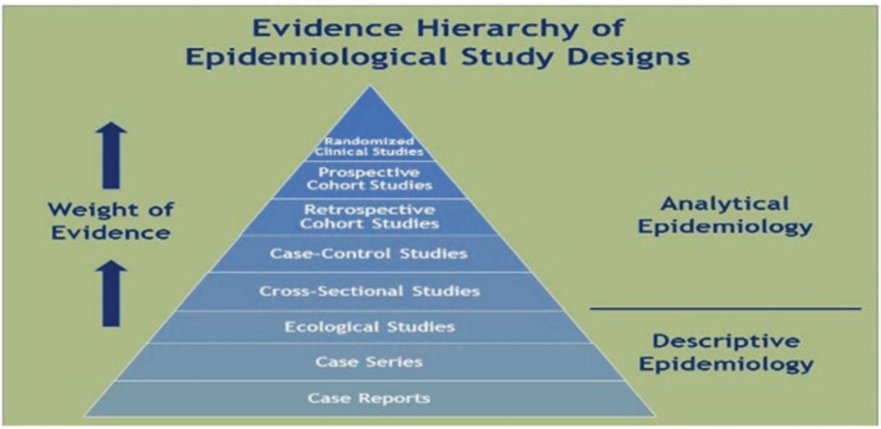

Fig. 4 Hierarchy of epidemiological review plan

power empowers mathematical reproduction to check and refine these models. It is additionally conceivable to utilize the outcomes from the observational and arranged or normal analyses to foster numerical models.

6 Assessment of Matrix

The assessment plan lattice is a basic instrument for orchestrating and figuring out an assessment. It is fundamentally a table with one line for each assessment question and areas that address assessment arrangement issues, for instance, data grouping methodologies, data sources, assessment strategies, rules for relationships, etc. The Evaluation Matrix (now and then called an Evaluation Framework) shapes the vitally logical system for an assessment. It sets out how every assessment question and assessment model will be tended to. Also, sway assessments utilize a pre-investigation plan. Its breakdowns the primary inquiries into sub-questions, planning against them information assortment and examination techniques, pointers or/and lines of request, information assortment instruments, and wellsprings of data. This gives an unmistakable view from the assessment questions as characterized toward the beginning of the assessment to the discoveries as laid out in the last assessment report [17].

The Evaluation Matrix fills in as a getting sorted-out device to assist with arranging the direction of the assessment, showing where auxiliary information will be utilized and where essential information should be gathered. It guides investigation, guarantees that all information gathered is dissected and located, and upholds the ID of proof holes. The Assessment Matrix ensures that the assessment setup is robust and tenable, taking everything into account [18]. In this manner, an assessment framework is utilized.

The Evaluation Matrix is one of the vital results of the beginning stage. It is created by the Evaluation Team once assessment questions are surveyed and affirmed and accessible auxiliary sources are thought about/gathered and quality checked, in accordance with the focal point of the assessment questions and the evaluability constraints. It likewise permits the explanation of the assumptions between the EM and the assessment group, working on the straightforwardness of the assessment cycle. The Evaluation Manager (EM) ought to guarantee the assessment group utilizes and follows the concurred assessment lattice all through the information assortment and revealing stages to direct information assortment, examination, and report composing.

When fostering the assessment lattice, it is critical to see how various techniques and sorts of information will be consolidated to address various inquiries, how various information sources will be utilized to respond to a similar assessment question, and how any triangulation will be embraced. The Evaluation Matrix is additionally valuable to audit the plan considering sexual orientation and more extensive value aspects to guarantee that the viewpoints or worries of various populace bunches including margined gatherings will be thought of.

6.1 Utilization of an Evaluation Matrix During Every Assessment Stage

6.1.1 Stage 1: Planning

N/A

6.1.2 Stage 2: Preparation

The EM is answerable for detailing clear and applicable assessment questions, connected to the suitable assessment rules, in accordance with the reason, targets, and planned utilization of the assessment, just as with the mediation Theory of Change (ToC) if it exists [11].

6.1.3 Stage 3: Inception

- The assessment group is answerable for fostering the Evaluation Matrix at the commencement stage dependent on the assessment questions and the proposed strategic methodology in the TOR and the ToC. In the event that no ToC was explained during the plan of the intercession, the assessment group is relied upon to remake the ToC and approve it through partners' conferences during the commencement stage.
- The assessment group refines and concludes the assessment questions and grows them with sub-questions on a case-by-case basis. It then, at that point, fosters a proper assessment and scientific methodology for the assessment. This suggests choosing fitting quantitative pointers or/and subjective examination aspects, information assortment instruments, and insightful techniques for every assessment question. This ought to be archived deliberately in the Evaluation Matrix [11].
- The Evaluation Matrix ought to be remembered as an addition to the origin report. It is supplemented by different apparatuses, for example, information assortment polls and conventions, field mission plans, and so forth.
- The EM actually looks at the nature of the Evaluation Matrix while investigating the draft Inception Report and guarantees that it gives the following:
  - A breakdown of the principle inquiries into a satisfactory number of sub-inquiries so that it empowers a deliberate appraisal against the assessment questions, keeping the assessment centered to accomplish profundity of investigation in accordance with the assessment reason/destinations.
  - An outline of how every one of the assessment questions and assessment models will be tended to, including GEWE aspects.
  - A bunch of markers expressly alluding to the ToC utilized.
  - Explicit information assortment strategies.

– All applicable wellsprings of data, indicating whether optional information will be utilized and where essential information is required.
– An outline of how triangulation will happen.
– Reference to the Accessibility and Dependability of the Information

6.1.4 Stage 4: Data Collection

– The assessment group gathers essential and optional information to quantify the quantitative markers or potentially surveys the subjective investigation aspects that have been distinguished, utilizing the strategies and apparatuses concurred in the assessment network. The assessment group consequently examinations the gathered information and data to address the assessment questions, utilizing the logical techniques archived in the assessment framework.
– As the group gathers and examinations information, it surveys the quality and accessibility from various sources and updates the data on accessibility and dependability of the proof gathered in the assessment network. Any progressions from the Evaluation Matrix when gathering information ought to concur with the Evaluation Manager and archived explicitly [13].

6.1.5 Stage 5: Data Analysis and Reporting

• The Evaluation Matrix is utilized by the assessment group to illuminate examination, including any triangulation. Any progressions from the assessment framework while examining the information ought to be reported. Discoveries and ends ought to be set out against the assessment questions and follow methodically from the information gathered and examination. The assessment grid ought to be incorporated as an Annex to the last assessment report [11].
• The Evaluation Manager audits and remarks on the draft report involving the assessment framework as a source of perspective points. More specifically, s/he ensures that all assessment questions have been addressed and that the evidence has been obtained, organised, and located as suggested in the evaluation matrix.

7 Conclusion

The developers in the information industry that is related to healthcare that is based on home services are having inadequate or very less guidance related to the contents of the product. The structural design, access to the system, and usability in informing the innovations are related to the system and the evolution of personal health records. Access to the care recipient and information in the electronic healthcare record is also a challenge to the developers in IT. The ONC, when the health information technology certification was initially announced, states that the requirements for its process will be based on personal health records which are most important for the patients. It is also based on the care to the access of the information, that is, health records in the system. More importantly, there is no guidance on the contents that must be provided to patients or any minimum standards that are needed for accessibility and functionalities. In the same way, some of the portals are developed based on continuous updates on the case records. Recent researches show that the records and portals which are based on this model are not understandable and not interpretable even with college education. The lack of guidance in this area makes the developers of the portal more challenging to design systems depending on the needs of consumers.

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Hemodynamic Analysis of Bifurcated Artery Using Computational Fluid Dynamics

Hemapriya Dhamodaran, B. Shreeram, and C. Li

1 Introduction

1.1 Blood as the Fluid

In this work, blood is assumed to be an ideal fluid in nature. The ideal Newtonian fluid is where high shear rate occurs in large arteries. The simulations were carried out by considering the following material parameters such as density 1000×10^{-6} kg/mm^3 and dynamic viscosity of 1000 centipoise for all the cases reported here. The theory of Navier-Stokes equations was used for simulations of the blood flow.

1.2 Geometry Preparation

The various geometry cases for the bifurcated artery configurations created on this platform are listed in Table 1.

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Table 1 Geometry and configuration details of bifurcated artery

Geometry	Configuration	θ_1	θ_2
Case 1	No plaque with bifurcation angles	30°	30°
Case 2	Two plaque configuration 1 without blood clot	30°	30°
Case 3	Two plaque configuration 1 with blood clot	30°	30°
Case 4	Two plaque configuration 2 without blood clot	30°	30°
Case 5	Two plaque configuration 2 with blood clot	30°	30°
Case 6	No plaque with bifurcation angles	30°	45°
Case 7	Two plaque configuration 1 without blood clot	30°	45°
Case 8	Two plaque configuration 1 with blood clot	30°	45°
Case 9	Two plaque configuration 2 without blood clot	30°	45°
Case 10	Two plaque configuration 2 with blood clot	30°	45°

1.3 Meshing

Meshing is the process of breaking down the object into smaller items to define the shape of the object. It is one of the critical steps of the modeling process. With the larger number of elements, an increased accuracy in solution is produced but it takes longer time to process the data. Here, the surface of the shape is to be smoothened to remove the remains of the restoration algorithm. In this simulation, the meshing of the physical object is created by using computer-generated program; the various sizing options including relevance center, smoothing, span angle center, and curvature angles are chosen where plagues are present. Also, fine refinements are carried out in case they are need. Selections are made for the various surfaces and they are named and used for defining the boundary conditions.

1.4 Physics Setup

The physics setup was established considering the steady-state 2D planar flow of an incompressible fluid. The double precision was used, the fluid material was blood with a density of 1000 kg/m^3, a viscosity of 0.001, and the velocity was adjusted to get a Reynolds number as 400. The cell zone conditions, for the interior surface, were chosen with the blood as the fluid. Then the boundary conditions for the walls, inner surface, inlet, and outlet were set up with wall, inner surface, velocity inlet, and pressure outlet, respectively, as the type was chosen. This was followed by adding the reference values like density, viscosity, and temperature as 300 K. The solution was initialized by standard initialization and the reference frame was relative to the cell zone that was opted. The initial velocity was set at 1 m/s. The next step is the computation modeling in which the desired solution is generated after several iterative steps. The results show the various display modes for CFD which include the 3D visualization of velocity streamlines, wall shear stress in various boundaries, and pressure contours.

1.5 Fluid Mechanics of Blood Flow

The major characteristics of hemodynamic of any fluid can be realized by analyzing the various related fluid behavioral phenomena. For instance, a study of fluid flow inside conduits provides imminent factors that determine resistance to flow inside blood conduit. Equally, fluid mechanical aspects determine the circulation of fluid stress due to shear acting on the inner side of blood vessels, which has a vital biological consequence.

The most important parameter is the wall shear stress (WSS) [1–9]. WSS is considered carefully as the spatial gradient changes when the dynamic viscosity of the blood acting perpendicular to the blood vessel changes. If the dynamic viscosity of blood is identified, WSS can also be determined.

The stream velocity flow patterns or vector flow patterns are associated with the development of plague formation and progression of the plague before and after vascular interventions. The pressure contours determine an increase in pressure gradient as the bifurcation decreases the flow velocity at that point. By analyzing the above data, the hemodynamic nature of the artery can be studied effectively [10].

2 Contour Analysis

2.1 Velocity Streamline and Pressure Contour

The various factors like shear stress of the walls, streamline, its pressure contours, and velocity are analyzed for the bifurcated artery in all the regions of walls for obtaining the hemodynamic changes and stenosis pathophysiology (Fig. 1).

Case 1: No plaque with bifurcation angles (θ_1 = 30°and θ_2 = 30°)
The streamline velocity was found to be maximum to about 1.394 ms-1. Due to the bifurcation at the inner wall, the pressure concentration was confined at that point as shown in Fig. 11. The WSS was 14 Pa at the left wall and 10 Pa at the right wall as in Fig. 12. WSS for the left wall was higher than that of the right wall because the diameter of the wall reduces after bifurcation. The pressure contour depicts that there is an increased pressure at the bifurcation point compared to the high-velocity area (Fig. 2).

Case 2: Two plaque configuration 1 without blood clot (θ_1 = 30°, θ_2 = 30°)
A plague was introduced in this case on both the left and the right wall of the artery and this increased the velocity to 1.879 ms^{-1}. Also a recirculation of the blood flow was found near the left walls near the plague due to the thinning of the wall at the bifurcation. The maximum WSS was observed at 26 Pa that was seen on both the right and the left wall initially, but as the distance of the wall on right and left increased towards the outlet, there was a slight dip in the WSS as shown in Figs. 13 and 14. This is because the blood flow had a path to travel after the bifurcation point. The pressure was high near the bifurcation and the dipped lower along the streamline (Fig. 3).

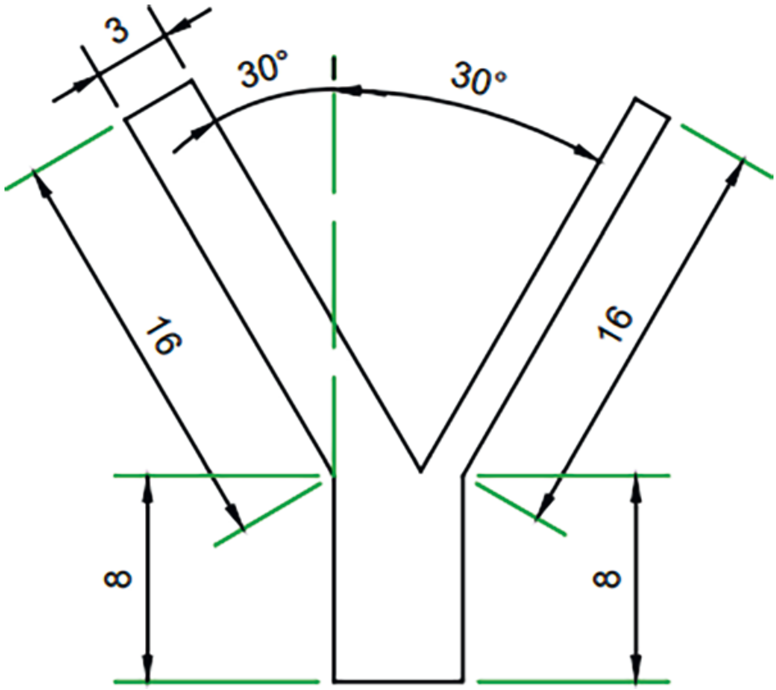

Fig. 1 No Plague (θ_1 = 30°and θ_2 = 30°)

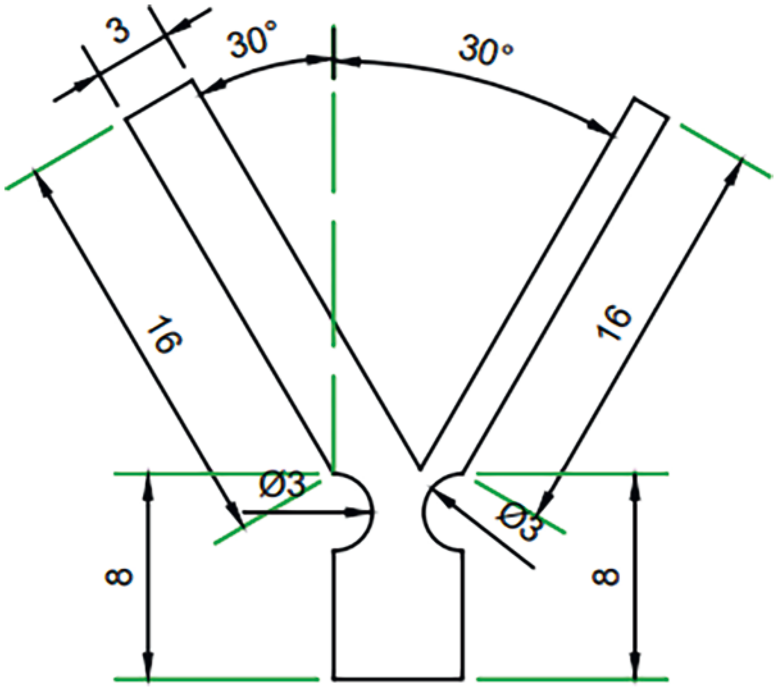

Fig. 2 Two plaque configuration 1 without blood clot (θ_1 = 30°and θ_2 = 30°)

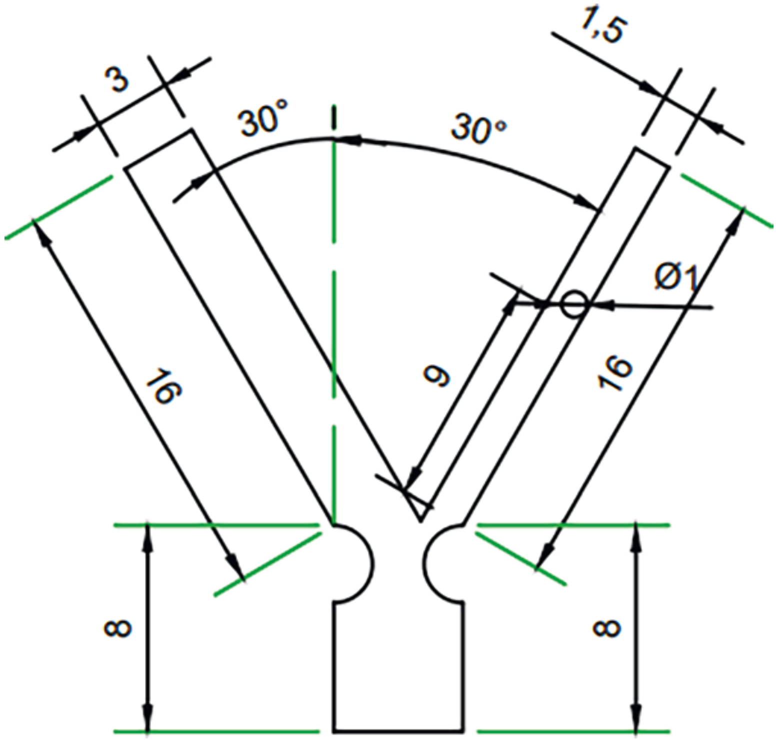

Fig. 3 Two plaque configuration 1 with blood clot (θ_1 = 30°and θ_2 = 30°)

Case 3: Two plaque configuration 1 with blood clot (θ_1 = 30°, θ_2 = 30°)
In this configuration, a clot is introduced in the left wall. The maximum streamline velocity was found to increase with the clot to 2.594 ms^{-1}. The streamline velocity increases at the plague and then due to the recirculation of the blood flow, it increases at the right inner wall. When the blood flows with a high velocity near the right wall, it directly bangs the inner right wall; hence, the velocity is found to increase again near the inner right wall. The pressure gradient was found to decrease compared to Case 2. The WSS at the right wall was initially found to be 39 Pa at the first plague, which then increased to 41 Pa at the left wall as in Figs. 15 and 16. But as we go towards the outlet, the right wall had an increased pressure at about 0.015 m in the artery (Fig. 4).

Case 4: Two plaque configuration 2 with blood clot (θ_1 = 30°, θ_2 = 30°)
In this case, three plagues were introduced in which two are in right inner, right outer wall, and one in the left outer wall. Compared to Case 2, the velocity was found to be doubled of 4.537 ms-1. In the left side, the high velocity was found at the region of plague because the artery was thinning out at that point. Also, two recirculation blood flow points were noticed due to the plague geometry; on the

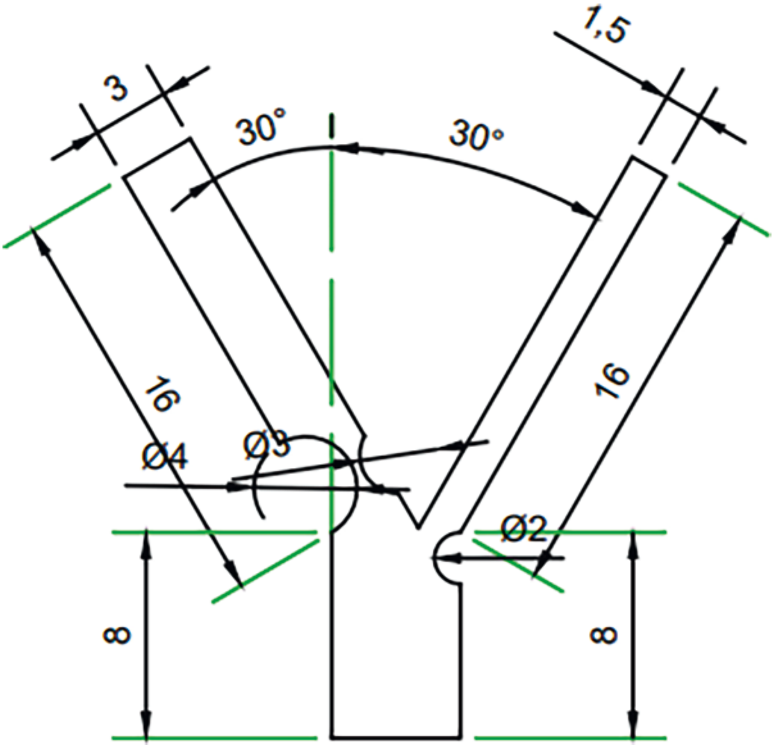

Fig. 4 Two plaque configuration 2 without blood clot (θ_1 = 30°and θ_2 = 30°)

other hand, the right side bifurcation did not have major change. It had higher velocity at the plague and then the streamline became normal. The pressure was found to decrease compared to Case 2 as shown in Figs. 17 and 18. The WSS was found to increase at the inner wall and it gradually decreased. But the right wall had a high WSS at the beginning and then faded gradually as flow proceeded near the outlet [11] (Figs. 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 and 18).

Case 5: Two plaque configuration 2 with blood clot (θ_1 = 30°, θ_2 = 30°):
In this geometry, a clot was introduced in the left wall same as Case 3 along with a geometry of Case 4. The streamline velocity was found to increase to a maximum of 6.267 ms-1. Due to the clot geometry, there was an increase in the velocity near the clot and near the bifurcation and plaque. The main reason behind this is due to the decline in the diameter of the vein after the plague and clot. WSS overstated to a peak value of 250 Pa at 0.015 m due to the diameter size of the artery that blocks the flow of vessel. The pressure gradient was found to be more at the recirculation part in the left side as there was an increase in the diameter after the plague. This is clearly shown in Figs. 19 and 20.

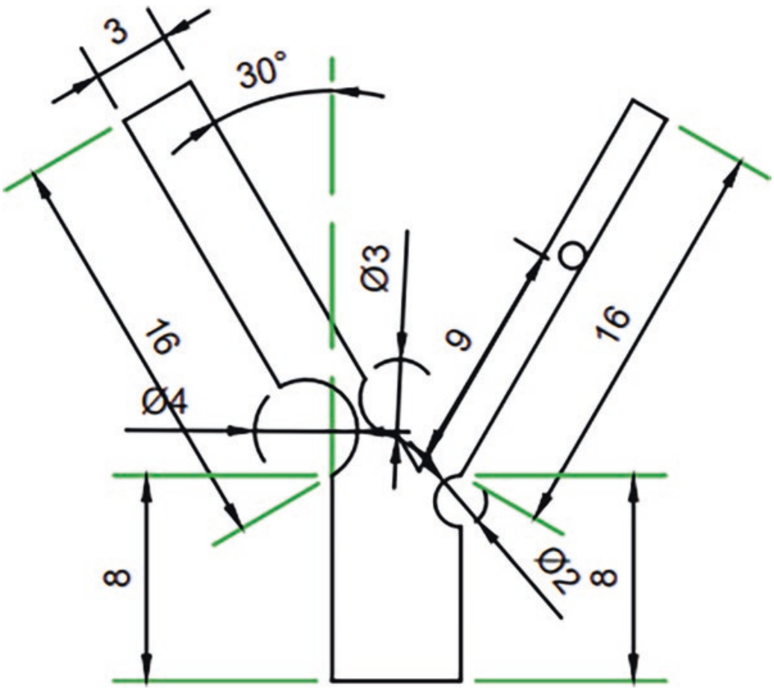

Fig. 5 Two plaque configuration 2 with blood clot ($\theta_1 = 30°$and $\theta_2 = 30°$)

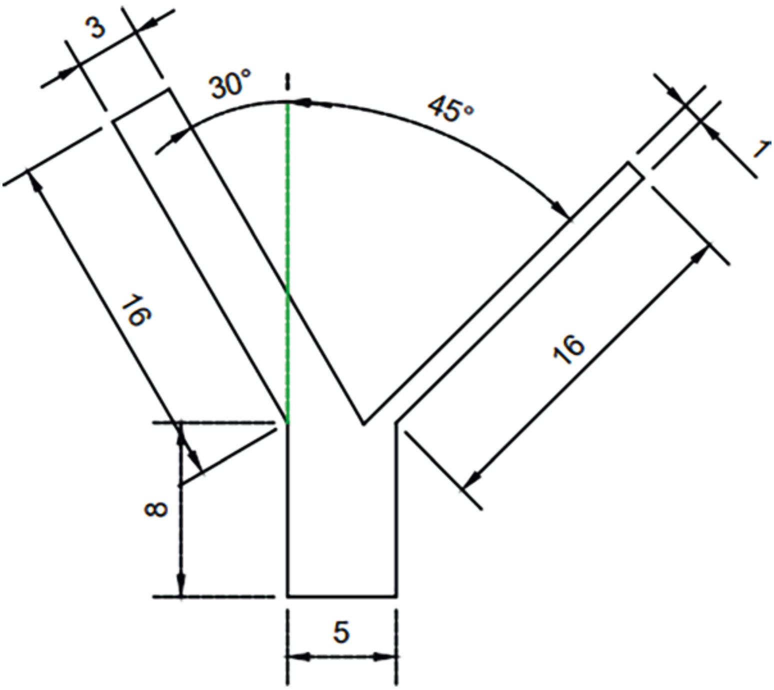

Fig. 6 No plague ($\theta_1 = 30°$and $\theta_2 = 45°$)

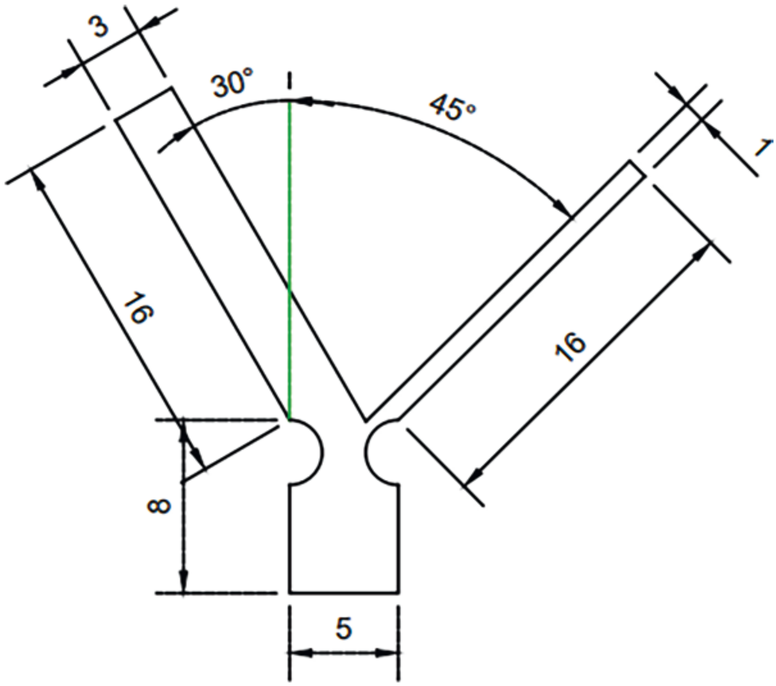

Fig. 7 Two plaque configuration 1 without blood clot (θ_1 = 30°and θ_2 = 45°)

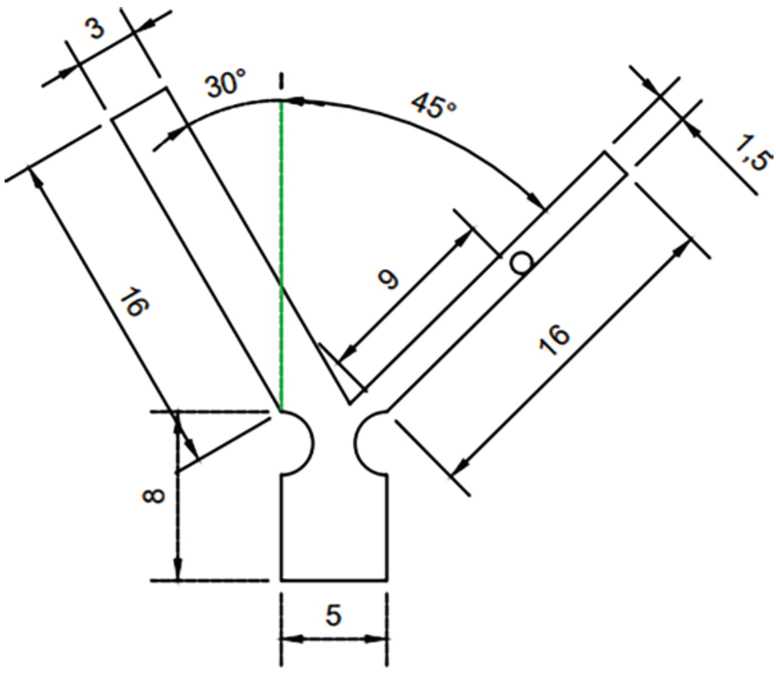

Fig. 8 Two plaque configuration 1 with blood clot (θ_1 =30°and θ_2 = 45°)

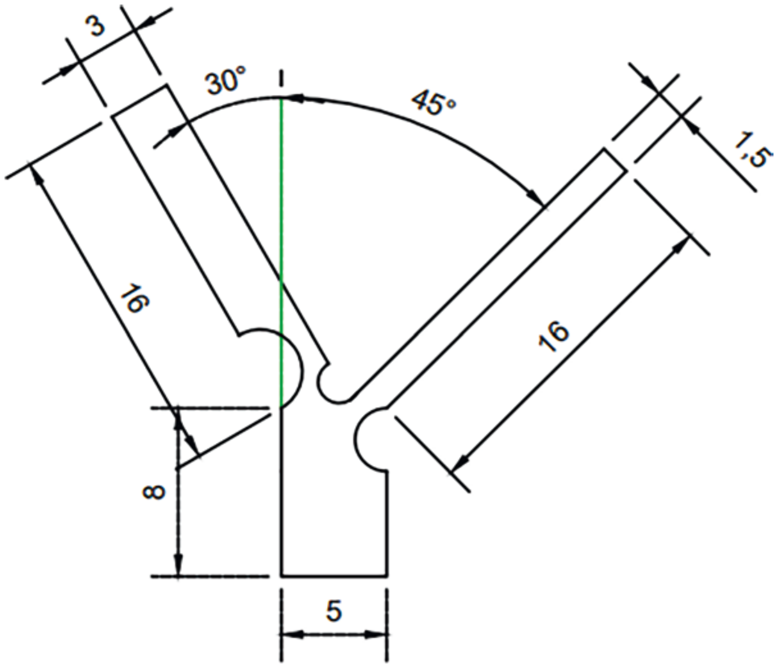

Fig. 9 Two plaque configuration 2 without blood clot (θ_1 =30°and θ_2 = 45°)

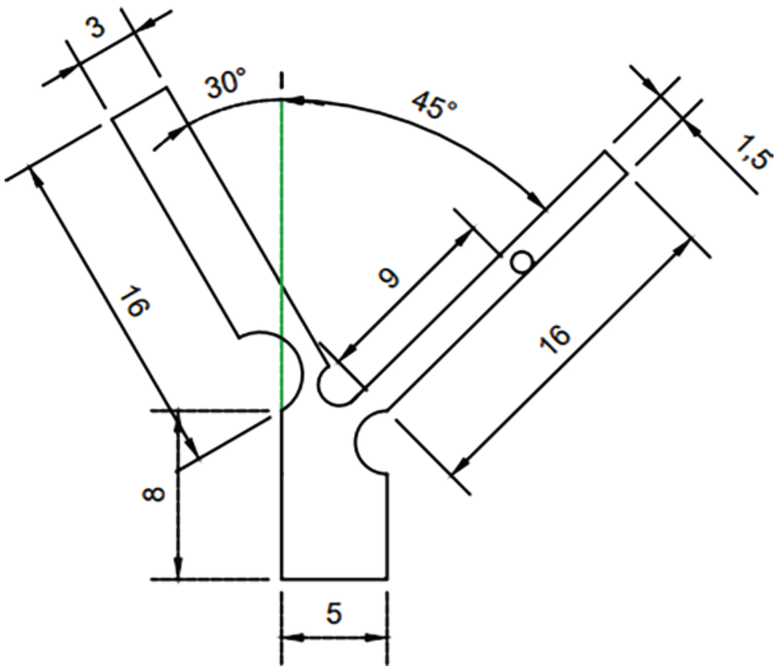

Fig. 10 Two plaque configuration 2 with blood clot (θ_1 = 30°and θ_2 = 45°)

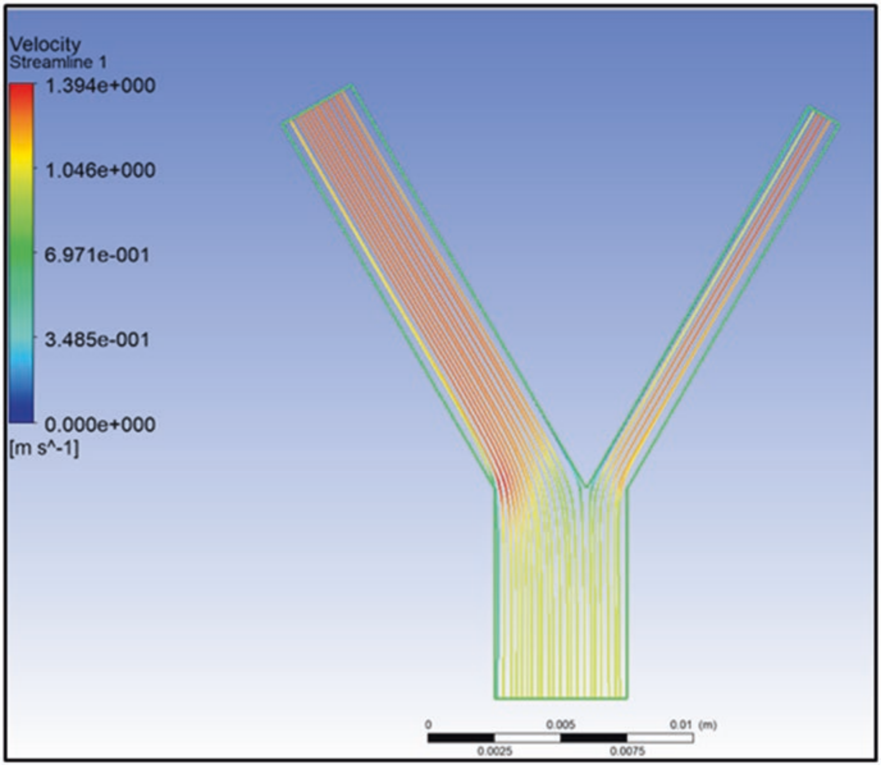

Fig. 11 The velocity streamline curve for Case 1

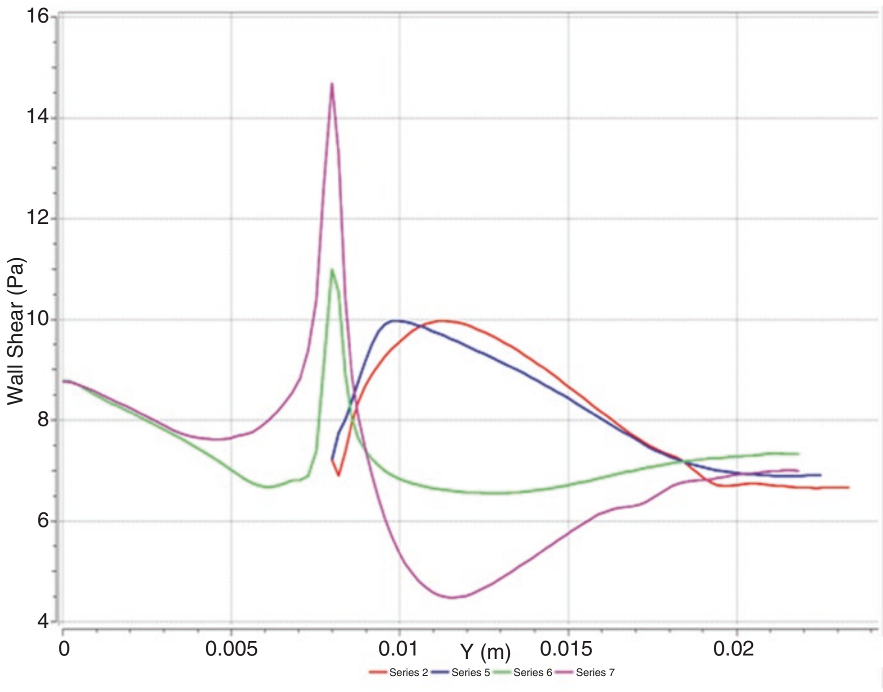

Fig. 12 WSS – various walls for Case 1

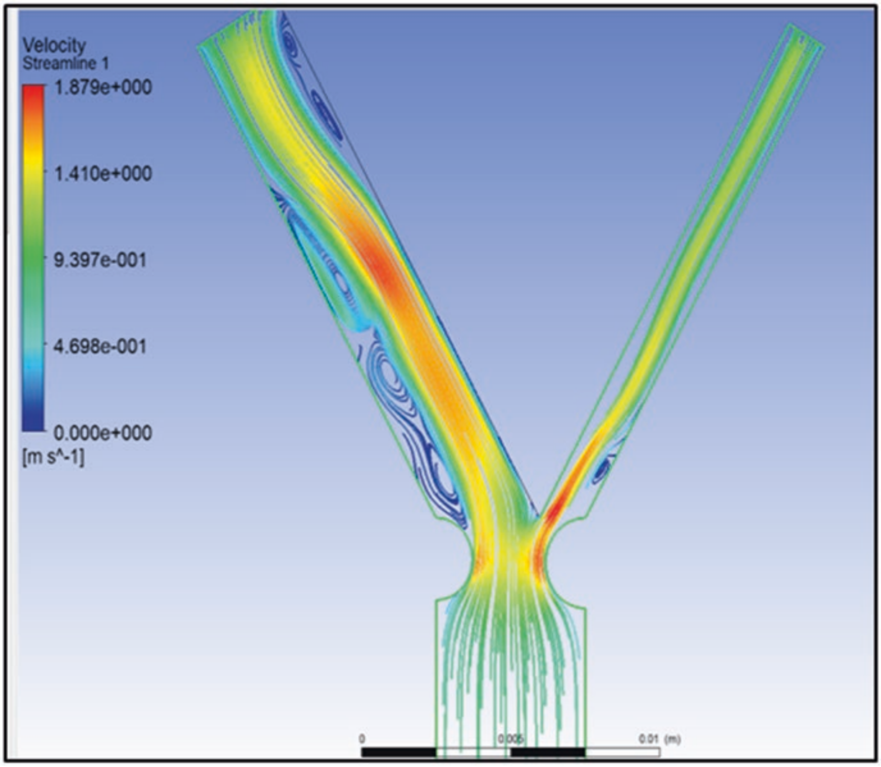

Fig. 13 The velocity streamline curve for Case 2

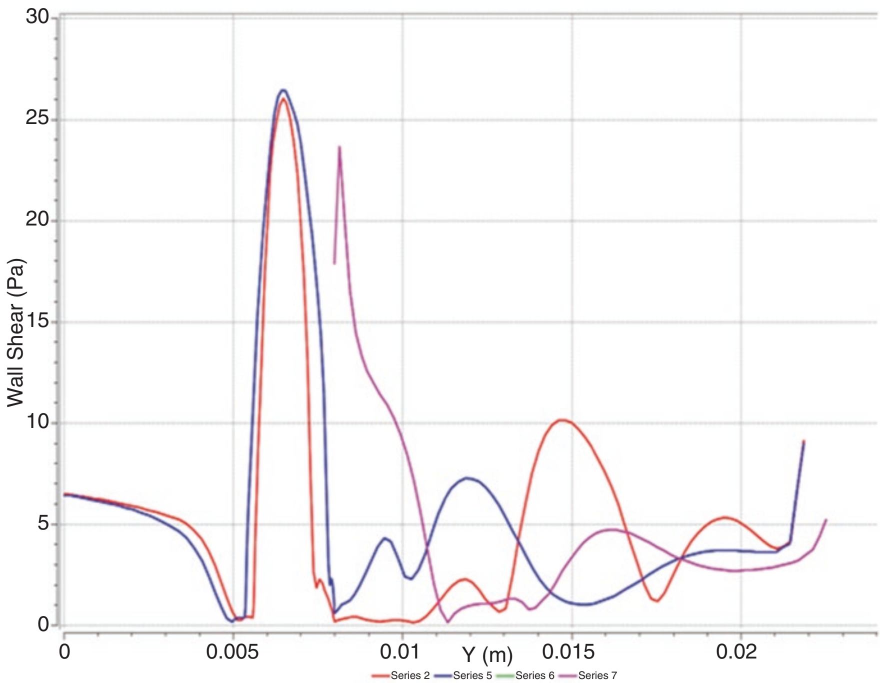

Fig. 14 WSS – various walls for Case 2

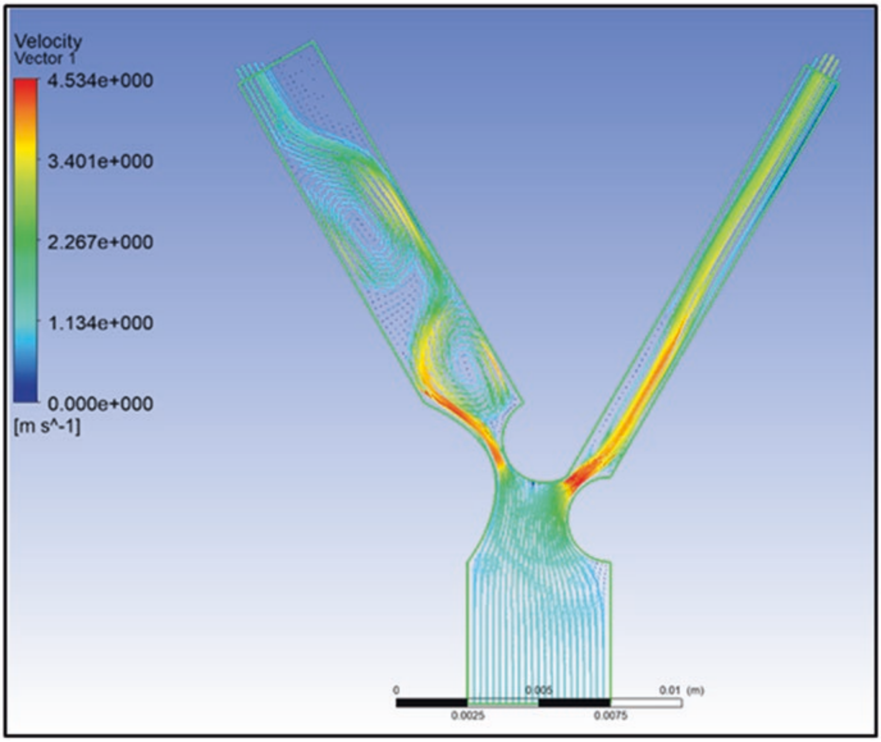

Fig. 15 The velocity streamline curve for Case 3

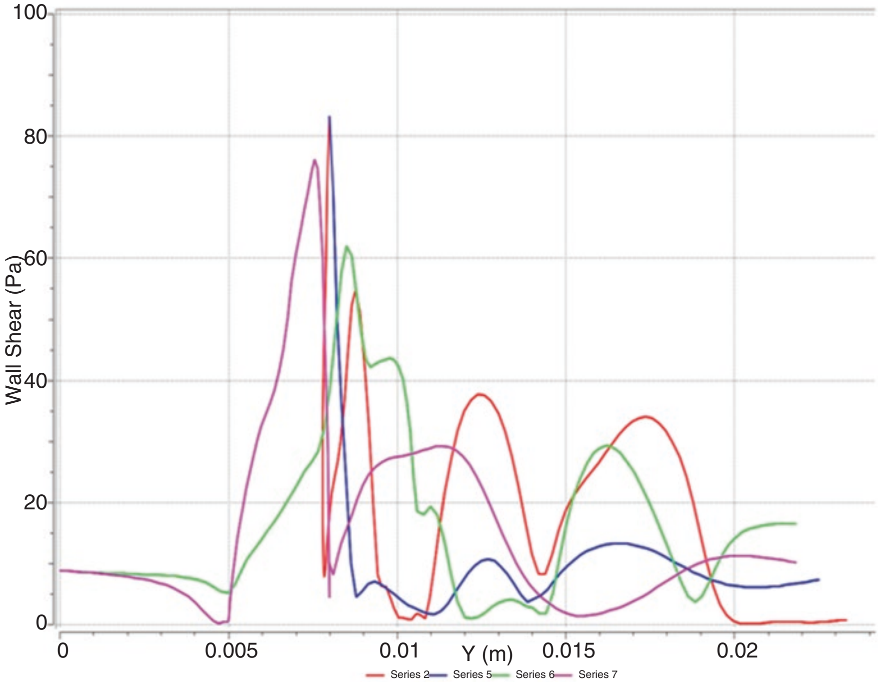

Fig. 16 WSS – various walls for Case 3

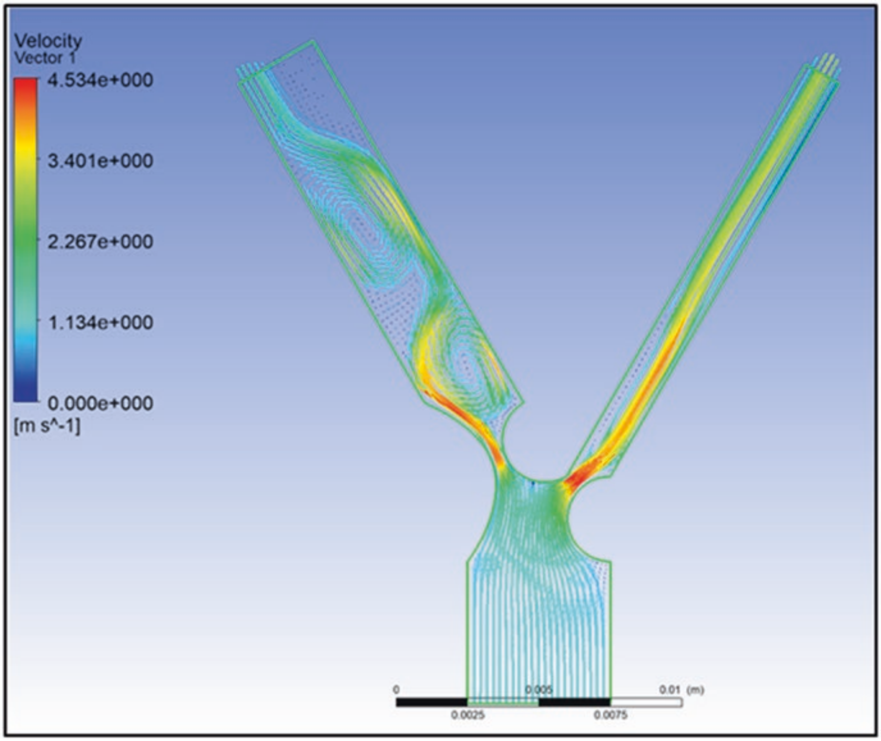

Fig. 17 The velocity streamline curve for Case 4

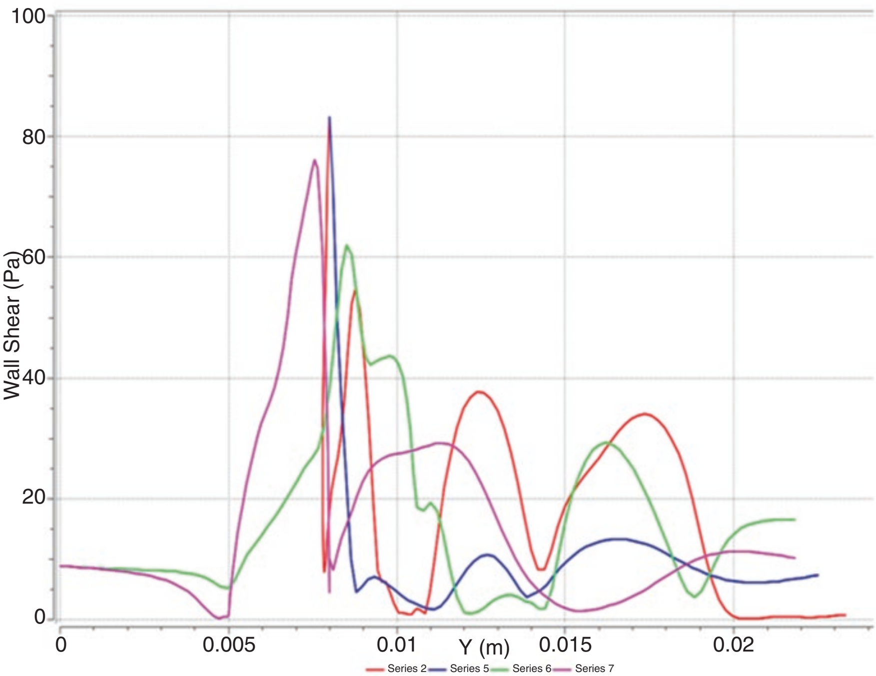

Fig. 18 WSS – various walls for Case 4

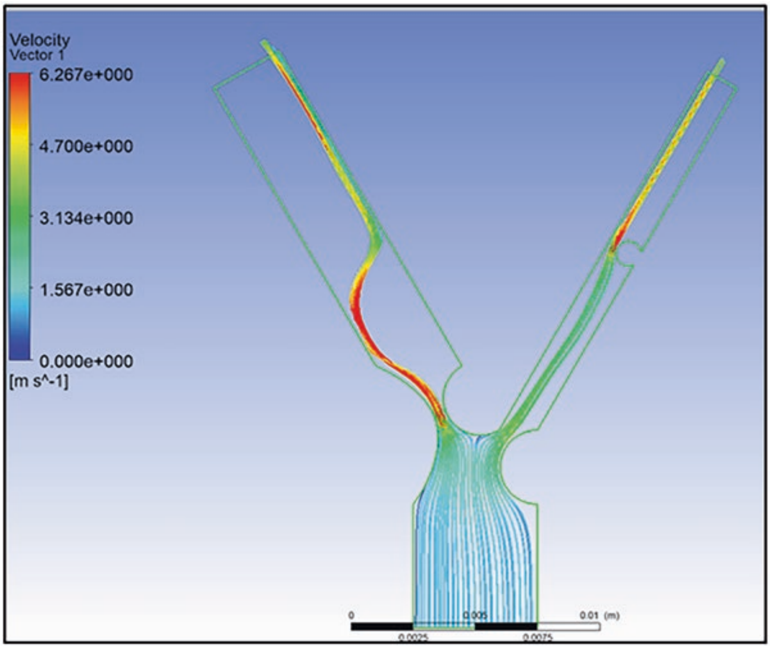

Fig. 19 The velocity streamline and pressure curve for Case 5

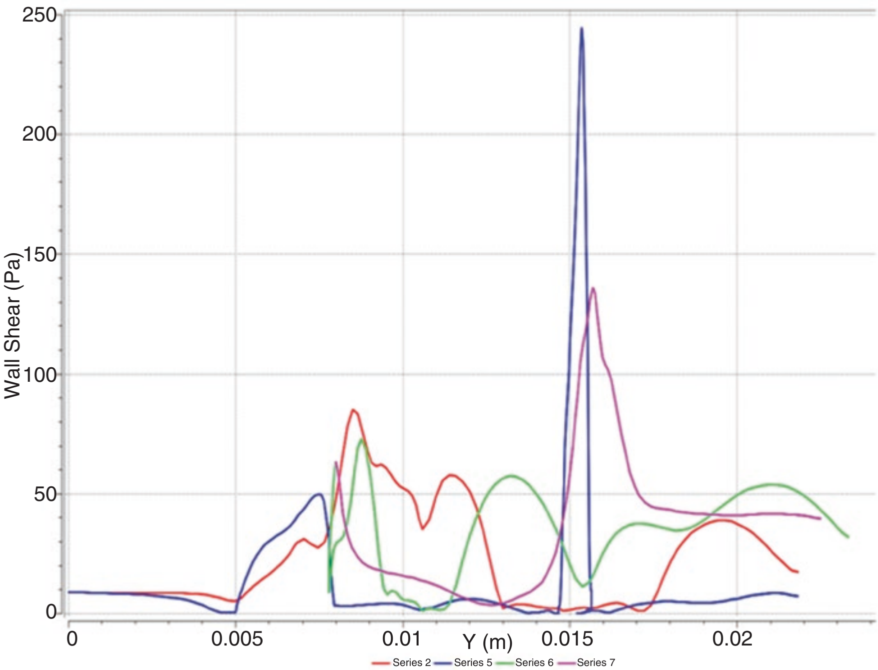

Fig. 20 WSS – various walls for Case 5

Case 6: Two plaque configuration ($\theta_1 = 30°$, $\theta_2 = 45°$):
In this case, one of the angles was increased to 45°. This increases the streamline velocity to 1.765 ms^{-1} due to the change in the bifurcation angle. The WSS in the left has 2 peak values of 13 Pa and 10 Pa at 0.0025 m and 0.007 m, respectively; this is due the increase in the curvature in the bifurcation. Also, the right wall has 10 Pa WSS at 0.0025 m. The pressure gradient was seen to be more initially and then it decreased gradually nearing the outlet of both the walls. This is clearly shown in Figs. 21 and 22.

Case 7: Two plaque configuration 1 without blood clot ($\theta_1 = 30°$, $\theta_2 = 45°$):
This is the same as Case 2 but one of the angle was $\theta_2 = 45°$. The velocity was increased just near the plague but as not in Case 2. This is because the blood flow has a curvature which increased the maximum velocity at that point to 1.979 ms^{-1}. The WSS was found to increase the curvature of both left and right walls initially but the velocity towards the outlet in left wall increased after recirculation of the blood flow towards the inner left wall as seen in Figs. 23 and 24. The contour pressure was found to increase in the beginning for the right wall but as we proceed towards the outlet, the pressure dropped.

Case 8: Two plaque configuration 1 with blood clot ($\theta_1 = 30°$, $\theta_2 = 45°$):
This case is the same as Case 3 configuration with a variation in the second angle by 45°. Due to the increase in the bifurcating angle, it was found that the velocity was 2.624 ms^{-1} near the closer end of outlet. The WSS in the left had two peak values of

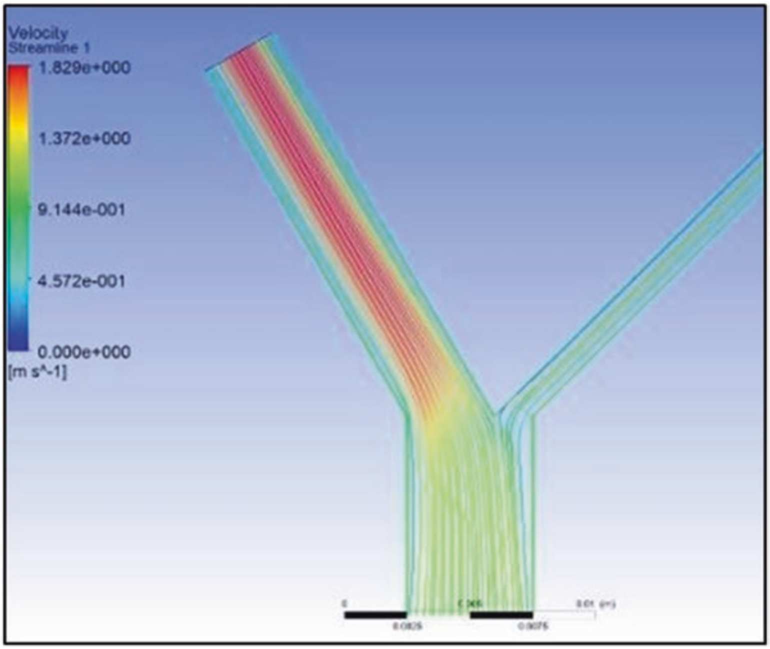

Fig. 21 The velocity streamline and pressure curve for Case 6

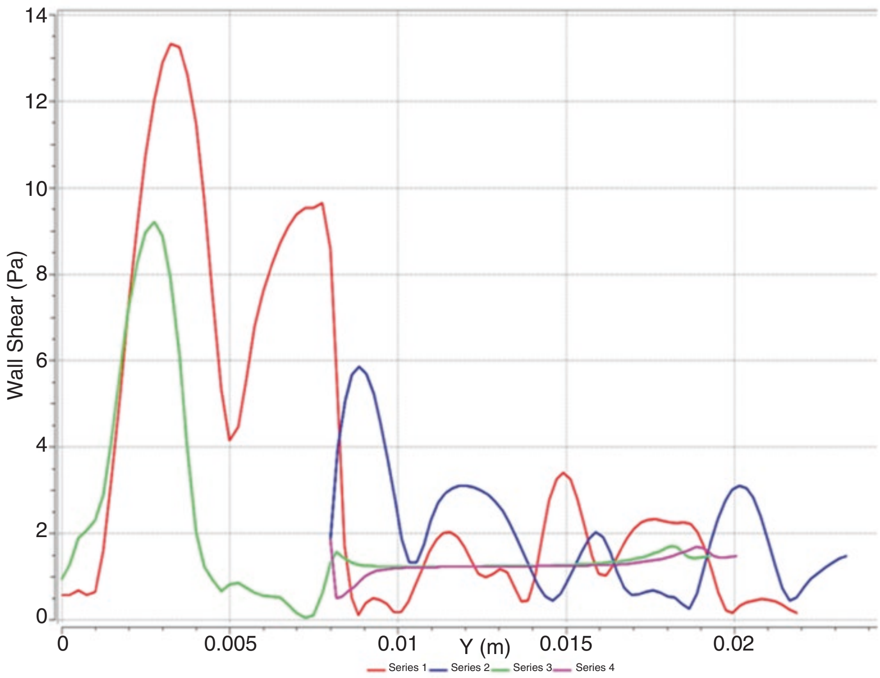

Fig. 22 WSS – various walls for Case 6

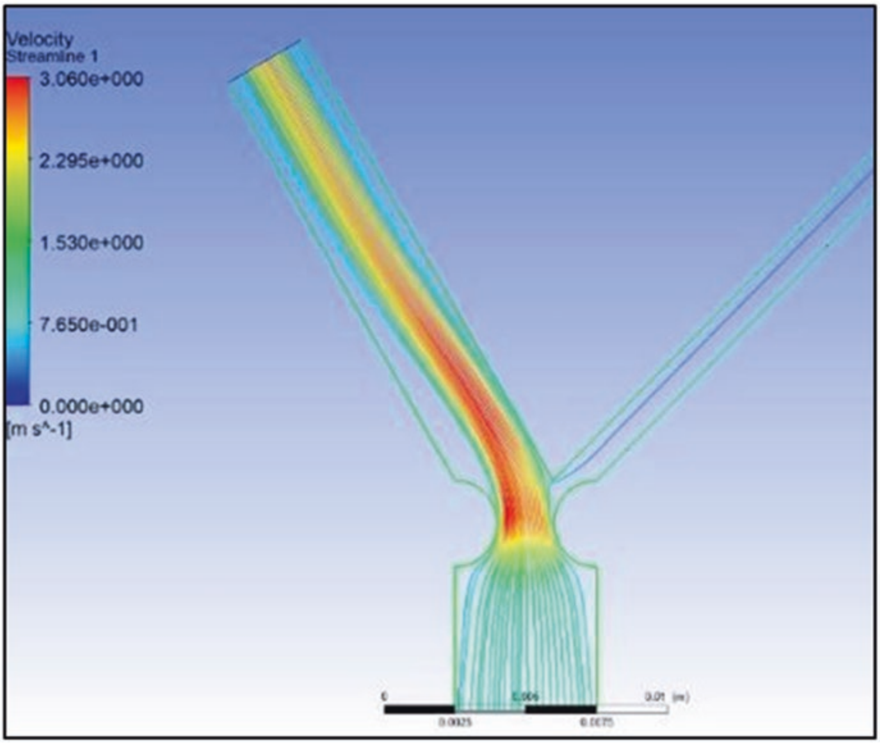

Fig. 23 The velocity streamline and pressure curve for Case 7

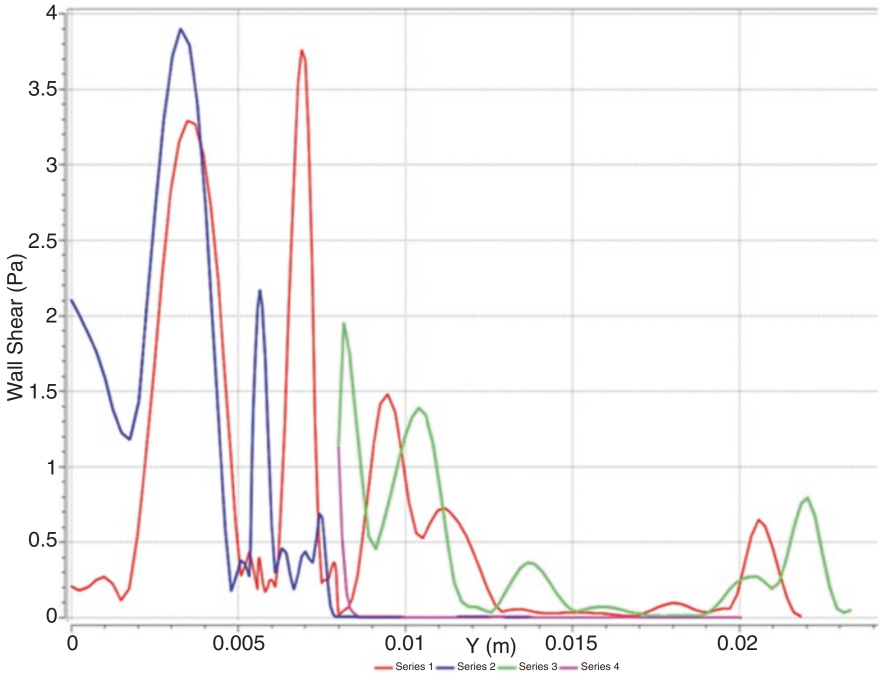

Fig. 24 WSS – various walls for Case 7

40 Pa and 13 Pa at 0.005 m and 0.0175 m, respectively, whereas the WSS was 30 Pa and 60 Pa at 0.005 m and 0.015 m, respectively. This is the area where a blood clot was introduced as shown in Figs. 25 and 26. The pressure was found to increase at the inlet and decrease towards the outlet.

Case 9: Two plaque configuration 2 with blood clot ($\theta_1 = 30°$, $\theta_2 = 45°$): This is a similar geometry to Case 4 but with a change in the second angle. The streamline velocity was maximum at 4.507 ms^{-1}. In the left side, there were two changes in the flow directions due the increased velocity and recirculation of blood flow. The velocity in the right stream was high for a while and then it took time for normalizing [12]. The WSS for the left had two peaks at 30 Pa in 0.0125 m and 20 Pa at 0.02 m, whereas for the left, all artery had a peak pressure of 75 Pa at 0.0075 m and it gradually reduced to 60 Pa at 0.01 m and subsequently it decreased to 9 Pa at the outlet, as shown in Figs. 27 and 28. The pressure gradient was high for the inner wall than for the outer wall.

Case 10: Two plaque configuration 2 with blood clot ($\theta_1 = 30°$, $\theta_2 = 45°$): In this configuration, Case 10 is like Case 5 but with a different angle geometry. Here the velocity was found to be the highest as 7.816 ms-1. There was a huge vortex circulation happening in the left wall away from the bifurcation and plague. Due to the presence of the clot, the velocity was found to increase near the clot in the

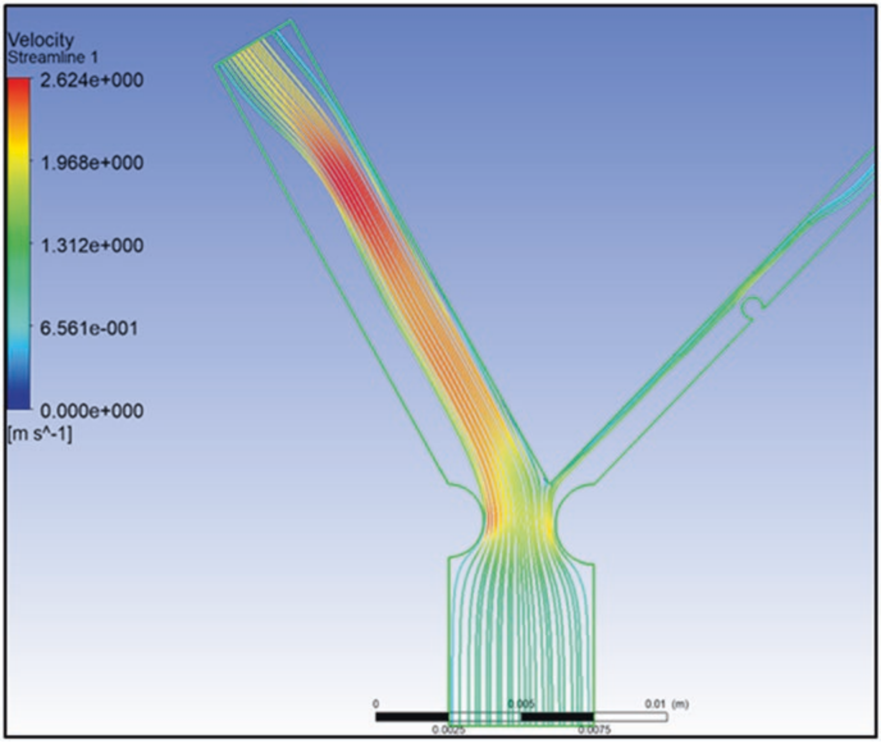

Fig. 25 The velocity streamline and pressure curve for Case 8

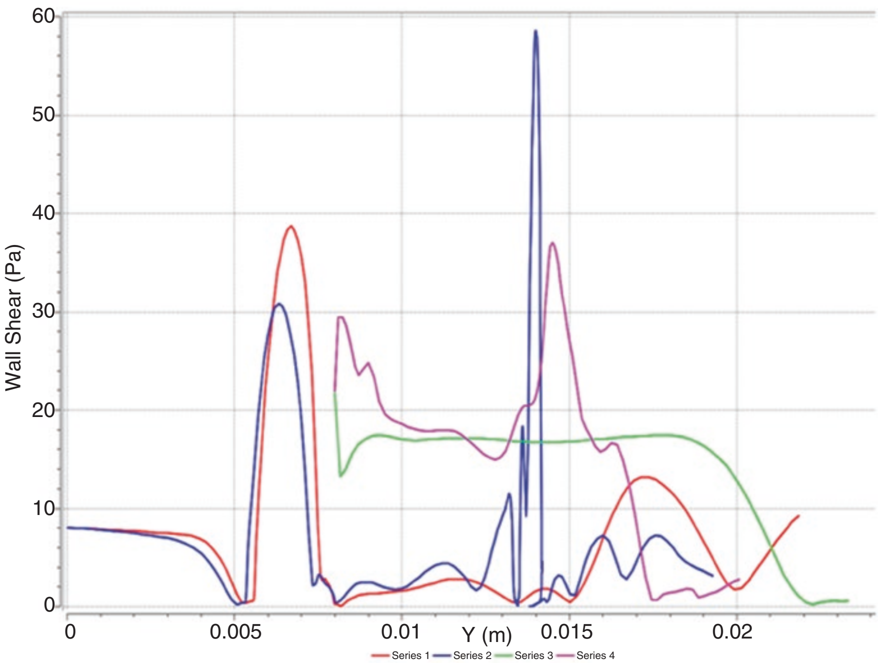

Fig. 26 WSS – various walls for Case 8

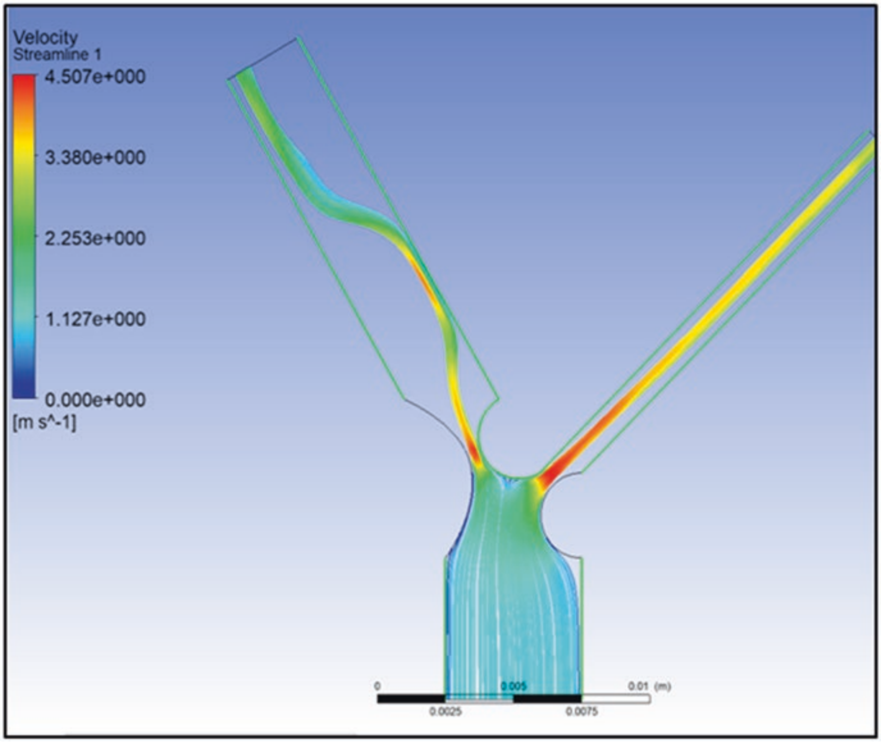

Fig. 27 The velocity streamline and pressure curve for Case 9

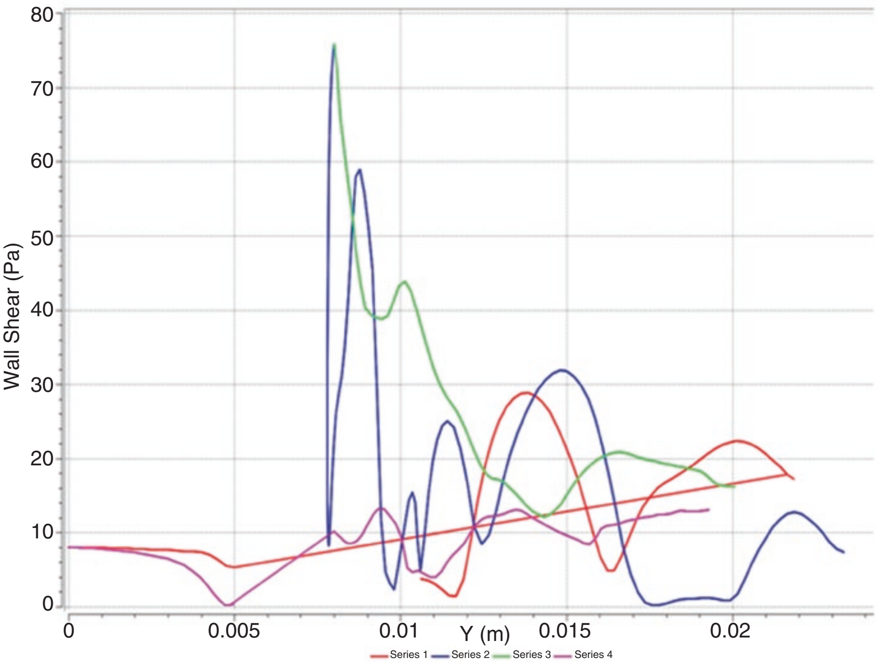

Fig. 28 WSS – various walls for Case 9

right side of the artery. The WSS was increased to 270 Pa at 0.015 m in both the right and left inner wall side as shown in Figs. 29 and 30. The pressure contour was the highest at the left arm of the artery until the clot and then it reduced.

2.2 *Hemodynamic Characteristics*

This experiment describes the various parameters associated with the hemodynamic characteristics of bifurcated artery with various geometries, plague configuration, and blood clot [10–13].

2.2.1 Blood Flow Velocities Analysis

The streamline velocity measurement performed in computational software for geometric model with rigid walls is shown in Table 2.

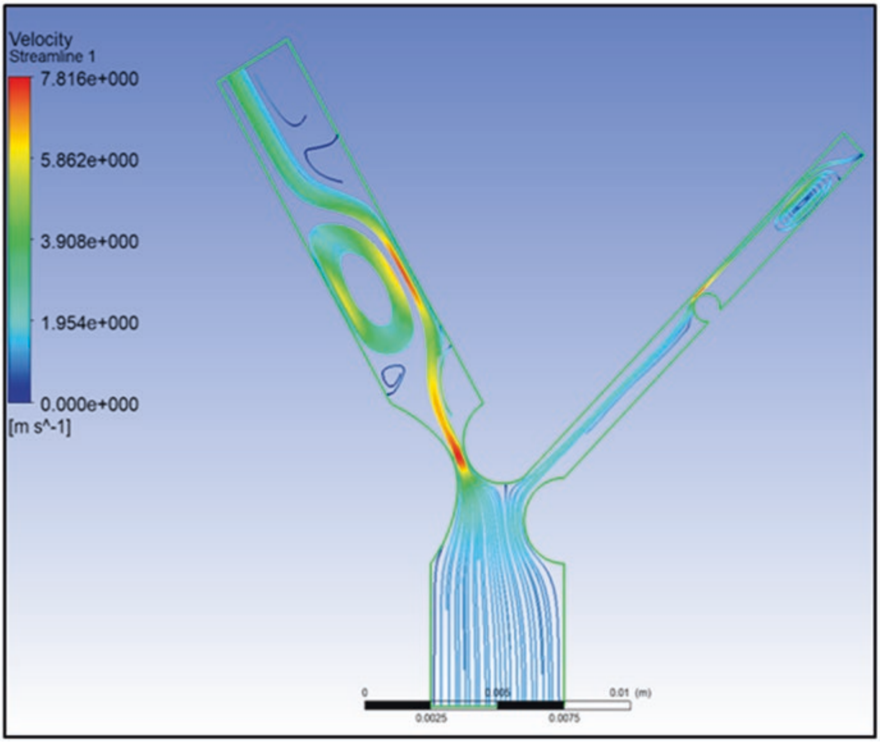

Fig. 29 The velocity streamline and pressure curve for Case 10

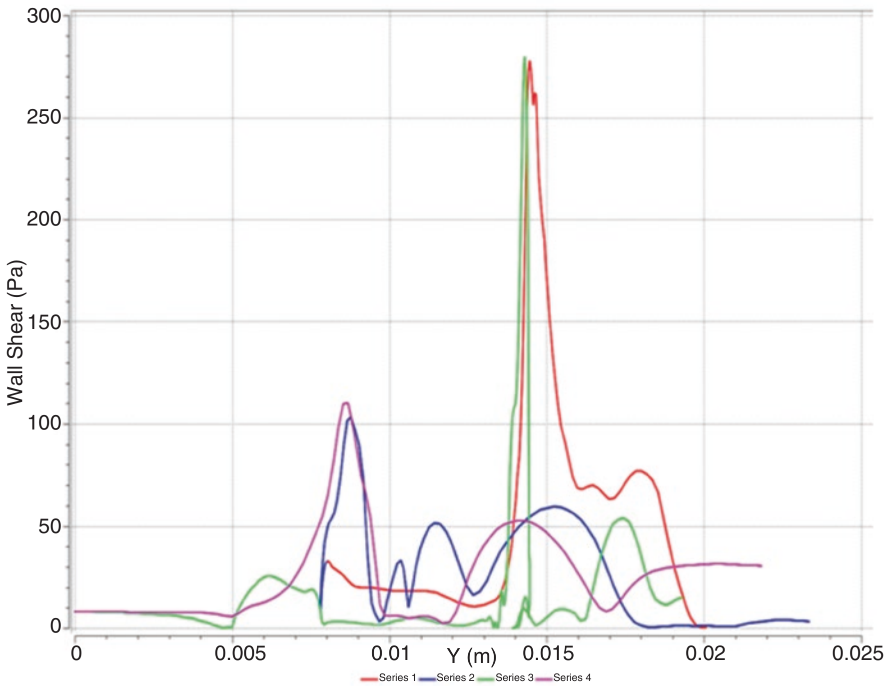

Fig. 30 WSS – various walls for Case 10

Table 2 Velocity streamline for various cases in detail

Geometry	Observation
No plague	High velocity in both walls but in the middle of the streamline not near walls
Plague with configuration 1	Right wall – Recirculation and high velocity towards inner wall rather than middle stream and near the plague Left wall – High velocity near plague
Plague with configuration 1 and blood clot	Right wall – Recirculation and high velocity towards inner wall rather than middle stream but for long distance and near the plague Left wall – Recirculation and high velocity near plague
Plague with configuration 1	Right wall – 2 recirculation near inner and outer wall high velocity near the plague Left wall – High velocity at plague and continued for longer distance.
Plague with configuration 1 and blood clot	Right wall – 2 recirculation near inner and outer wall high velocity near the plague and sides inner wall Left wall – High velocity near the plague

From the graph, it is visible that the velocity increased for each of the cases of 30–30°. But the graph also showed a variation in the velocity for different angles in each case. The 45–45° had a huge velocity variation and increased the value than the 30–30 case. This is because the bifurcation angle changed which in turn changed the secondary flow of various vessel geometries.

The vector analysis was also done, and it was found that at the center of the vessel, the flow is diverted from the left to the right and, at the side walls, it is opposite in direction. Centerline flow is found to be more prominent in the simulations. There is also a significant role of Reynolds number. In this experiment, the Reynolds number was maintained at 400. If the flow velocity at the inlet is changed, then the Reynolds number also changes. For higher Reynolds number, more recirculation at the hooks and the crannies would have an irregular plague wall. At downstream side area, the flow is reversed and the recirculation zone was at its peak. It is twice the diameter in length. In Table 2, the velocity streamline for various cases observed is presented.

As the angle increased, the velocity had a higher value but the same pattern was seen. In both the localities, a distorted low velocity patterns was seen at the external vessel wall, medium velocity values at the sides next to the external wall surface [13].

2.2.2 Wall Shear Stress Analysis

In the central region, the WSS values drop rapidly nearly to zero as the flow of blood suddenly increases in areas. At the zones near recirculation, very low WSS values occur near the sides of the walls. The WSS value is low due to complex flow separation.

The stress value reaching peak at 450 is noted in a 45-degree veins. An increase in blood pressure values is noticed near blocked bifurcated area. A stress value of 70 Pa is observed without clot for $\theta_1 = 30°$, $\theta_2 = 45$ configuration where as a 270 Pa stress value is observed with clot for $\theta_1 = 30°$, $\theta_2 = 45$ configuration as shown in Figs. 31 and 32. The shear stress values purely depend on the shape. Stress values have been reported to be minimum at relation between radius of the vessel and the bifurcation angle. Flow separation is observed at the outer wall near to the bifurcation area and later the flow redevelops and an increase in WSS value is observed.

Although atherosclerotic plaques are preferentially located at bifurcations and inner curves of the vasculature, they co-localize with the regions of low WSS. While high WSS induces an atheroprotective environment, low WSS results in an atheroprone endothelial phenotype; hence, early arterial wall thickening initiates at the regions of low WSS (Table 3).

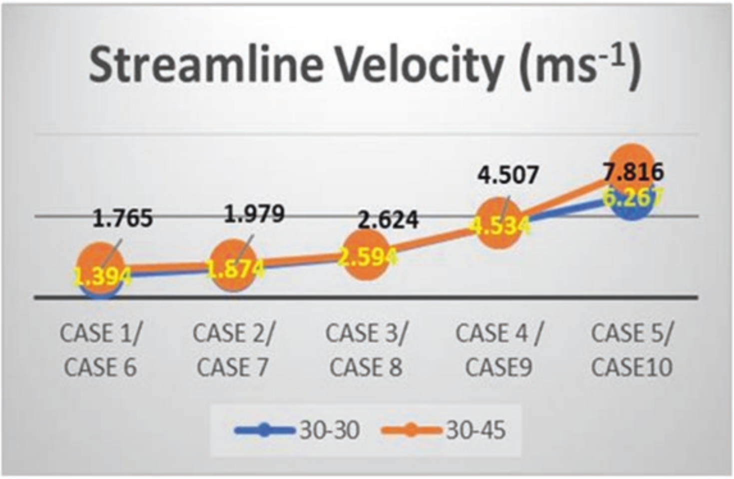

Fig. 31 WSS vs. 30–30 geometry

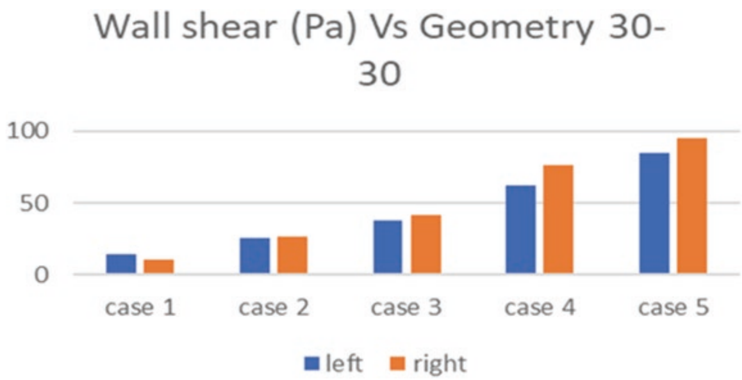

Fig. 32 WSS vs. 30–30 geometry

Table 3 Diameter vs high WSS for each case

Geometry	Distance (mm)	WSS (Pa)	Geometry	Distance (mm)	WSS (Pa)
Case 1	8	10.99	Case 6	3.25	13.32
Case 2	6.43	26.42	Case 7	3.28	3.89
Case 3	15.19	41.46	Case 8	14.01	58.58
Case 4	8	83.22	Case 9	8	75.89
Case 5	15.36	244.75	Case 10	14.31	279.68

2.2.3 Arterial Damage

It is reported that stroke and heart attack are often due to the burst of weak atherma-nous plaque in the bifurcated arteries. The hemodynamic and the burst of the stenotic arteries are still not very clearly understood. The drop in pressure in comparison with shear stress is higher near the stenosis. Hence, pressure can be a critical triggering factor for the burst of the plague. For the above tables and the figures, it is evident that high stress in the wall leads to the rupture in Cases 5 and 10. Cases 3 and 7 are also prone to breakage, but the intensity of breakage is more for Cases 5 and 10.

3 Conclusion

Critical factors like velocity curve, WSS, and pressure are studied near the bifurcated veins. In the left wall, the flow is highly determined by vortex followed by strong helical flow. The curvature and asymmetry of the bifurcated profile induces these types of flow. Very low WSS zones occur at either of the walls. It is observed that the existence of atherosclerotic plaques is highly related to the vessel profile. Other important factors for assessing the hemodynamic study of the vessel are WSS, regions of flow separation, and spilt of unidirectional flow.

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Therapeutic Equipment and Its Enhancement via Computational Techniques

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1 Introduction

Therapy, generally characterized, is a treatment for a lack of problem or which intends to carry an unfortunate individual to well-being. An upgrade is an improvement or augmentation of some trademark, limit, or movement. The two definitions accept at a minimum some broad feeling of a human standard, which people should either be assisted in coming to or be supported to outperform (and the issues of this "standard" are mentioned later).

The distinction between therapy and upgrade is difficult to express for three main reasons:

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- They are not fundamentally unrelated.
- The movement included does regularly something similar.
- The norm of well-being and "improvement," against which the contrast between therapy and improvement, may be estimated can be exceptionally difficult to characterize [1].

The appearance of the data age, likewise normally known as the computerized age, significantly affects well-being sciences. Huge measures of data sets now move through the various phases of medical services associations, and there is a significant prerequisite to extricate information and utilize it to work on these focuses in all regards. Smart PC frameworks offer help to well-being experts in both clinical and administrative settings. Among these frameworks, computational insight approaches have acquired expanding prominence provided their capacity to adapt to a lot of clinical information and uncertain data.

The objective of this extraordinary issue is to offer an expansive perspective on this interesting field, the consistently developing significance of which is driven by the expanding accessibility of information and computational power. The field of computational healthcare empowers customized medication and exists at the point of interaction of biomedical sign processing, computational display, AI, and well-being informatics—all taking advantage of electronic well-being record (EHR) information, physiological time-series information, genomics, and so forth.

Biomedical image processing is comparable in concept to biomedical sign processing in numerous aspects. It incorporates the investigation, improvement, and showing of images caught by means of X-ray, ultrasound, MRI, atomic medication, and visual imaging advances. AI is presently rapidly stretching out in all sciences and designing examination fields, including biomedical sciences. In this specific circumstance, computational knowledge ideal models containing various branches, for example, neural organizations, swarm insight, master frameworks, transformative processing, fluffy frameworks, and counterfeit safe frameworks, can play a fundamental part in handling the various parts of example acknowledgment and information examination [2].

2 Therapeutics

The treatment of a disease or injury for an extensive period of time is planned to mitigate or recuperate from a disorder. The therapeutic value is associated with the treatment of illness or problems by healing specialists or methods. Therapeutics, treatment, and care of a patient are performed with the end goal of both forestalling and fighting infection and lightening torment or injury. The term therapeutics is a Greek word that signifies "inclined to serve."

From a wide perspective, therapeutics implies serving and focusing on the patient in an extensive way, forestalling infection as well as overseeing explicit issues. More explicit trials are used to treat explicit manifestations that include the use of medications to calm torment or treat contamination, medical procedures to eliminate infected tissue or supplant inadequately working or nonfunctioning organs with fully functioning ones, and advice or psychotherapy to alleviate enthusiastic pain. Trust in the doctor and in the strategy chosen upgrades adequacy.

3 Therapeutics Devices

Therapeutic devices are commonly classified into two types: those that help a patient in their day-by-day exercises and those that help medical individual in conveying therapeutic administrations. Patient-assistive devices include amplifiers, visual guides, sticks, walkers, or whatever other gadgets that permit patients to perform errands; they in any case would not have the option to perform because of an actual constraint or handicap. Examples of therapeutic devices used by medical faculties include oxygen conveyance frameworks, catheters, intravenous lines, and exercise-based recuperation hardware.

For those with minor visual or hearing hindrances, therapeutic devices, such as amplifiers or glasses, can assist them in accomplishing fundamentally further developed vision and hearing. Indeed, even in serious cases, these devices can enormously upgrade the clients' capacity to perform customary day-by-day assignments, like perusing, staring at the TV, or carrying on a discussion. There are also additional accessible assistive devices for those with complete loss of hearing or vision. These might incorporate text-to-discourse projects and Braille books for the visually impaired and shut inscription innovation for the hard of hearing. Although these

Fig. 1 Therapeutic Devices

devices do not re-establish any lost senses, they permit clients to take an interest in exercises that may some way or another keep them away from these devices (Fig. 1).

For those with actual debilitations that restrain their capacity to walk, various kinds of therapeutic devices are used. Props and sticks can assist those with transitory or minor debilitations, while walkers and wheelchairs are accessible for those with more extreme constraints. A fake joint can supplant a patient's existing damaged one to give better general portability. The most well-known methodology incorporates knee or hip substitutions. Active recuperation gear, including knead tables, weight machines, and, surprisingly, hot tubs, can be utilized to assist patients with recovering portability after a medical procedure or mishap.

Specialists and attendants utilize therapeutic devices consistently in medical offices. Oxygen conveyance frameworks, including covers, tanks, and different devices utilized in respiratory therapy, are among the most commonly used devices in an emergency clinic setting. Catheters can be used to both convey fundamental medications into the body and eliminate explicit liquids, like pee, from the body. Techniques for wound consideration, for example, suctioning devices and wraps, are therapeutic since they help injuries to recuperate and keep contamination from happening. Therapeutic devices may also include home alterations that provide patients with a more extensive scope of portability or keep them more secure. For instance, people who use a wheelchair or experience difficulty in climbing steps may have a slope introduced externally to their home. For indoor flights of stairs, extraordinary lift devices can be introduced to convey patients securely to the upper levels. Rails and seating can be introduced in showers or baths. These devices make it more straightforward and more secure for patients with actual impediments to stay in their own homes [3].

4 Types of Therapeutic Tools

Disease, wounds, and certain medical issues can disturb the body's homeostasis, or balance, and can impede the body's capacity to move or function appropriately. Therapeutic devices are instruments or gadgets used to support recuperating useful portability. The use of therapeutic instruments may likewise be important to support a modified measure of portability and independence with ongoing medical problems.

Therapeutic medicines use gadgets called modalities, which are types of therapeutic devices, to assist in reducing agony side effects, discharge muscle snugness of fits, and increment the scope of movement or development. These instruments, like ultrasound and electrical excitement gadgets, are usually used during a therapy meeting. In cases of supported or constant torment issues, an electrical feeling gadget called a transcutaneous electrical nerve stimulator (TENS) may be used at home under the oversight of a specific medical care provider, such as an actual advisor. Other therapeutic instruments are used to help with safe practical portability and might be required briefly until the body recovers from ordinary work. Long-lasting handicap or brokenness, as seen with specific persistent medical problems, for example, strokes, extreme head wounds, or life-changing mishaps, may require the use of such apparatuses or gadgets on a super durable premise if the reduced portability issues are steady and unflinching. These kinds of therapeutic instruments are frequently alluded to as versatile hardware.

Versatile gear therapeutic devices can go from assistive gadgets to support ambulation needs to instruments to aid different types of portability. For instance, sticks, props, and walkers help a person with strolling. These can be used when a physical issue, such as a wrecked bone, restrains the utilization of an appendage because of torment or weight-bearing constraints during the mending system. These ambulation devices may likewise be utilized when there is extremely durable harm diminishing the capacity to stroll, as should be seen with specific ailments like a few types of multiple sclerosis or persistent shortcoming in the appendages.

Other beneficial therapeutic instruments can include such things as move sheets, raised latrine seats, get bars, and wheelchairs. Move sheets help a nonmobile person move starting with one spot and then onto the next, for example, from the bed to a seat. Raised latrine seats, snatch bars, and preachers or grabbers help the versatility debilitated with ordinary everyday exercises. Wheelchairs help in versatility and can be used as dynamic situating gadgets to restrain unfortunate body situating from exasperating pre-existing postural issues. Normally, they come in standard manual sorts where the individual should utilize the upper arms to move or in particular electric styles taking care of the singular's necessities and existing portability.

5 Therapeutic Treatments

Therapeutic treatment is a type of treatment regulated to treat or fix an infection, actual turmoil, or injury. All things considered, a therapy or treatment that mitigates the manifestations of a condition—rather than restoring the condition—could likewise be viewed as a therapeutic treatment. There are many sorts of therapeutic medicines that can be conveyed by a scope of experts, and they can incorporate intercessions, for example, active recuperation, antibodies, drug medicines, and talking treatments that can assist with empowering a patient to make a way of life or social changes. Generally speaking, restoration to full well-being after ailment or injury may be the great focal point of a therapeutic treatment program. Accordingly, an advisor can utilize methods meant to work with a patient's prosperity and re-establish well-being. One trait of therapeutic treatment is that it tends to be continuous for a period of weeks, months, or even years. It is not unprecedented for a patient to take part in a scope of therapeutic intercessions to effectively treat or fix a condition. A person with a back physical issue, for instance, may be alluded to a physiotherapist, who can prompt that person on actual activities that could assist with mitigating the symptoms. Furthermore, physiotherapy may be combined with another therapeutic treatment, like a back rub.

A few immunizations could likewise be viewed as therapeutic medicines. At the point when a few types of diseases have been analyzed or a patient has been distinguished as being at a high gamble of developing malignant growth, a therapeutic program could incorporate the use of inoculations. On these occasions, therapeutic therapies emphasize immunization to shield the patient from the advancement of the infection or treat a current condition using an antibody to assist with fortifying a patient's regular insusceptibility against disease.

Paradoxically, some therapeutic medicines do not involve the use of medications or active recuperation. Mental and behavioral treatments, for instance, outline how therapeutic treatment assists in re-establishing or working on a patient's psychological well-being. At the point when an advisor plans to treat a few types of misery, the focal point of therapeutic treatment could zero in on assisting the patient to settle on a better way of life decisions. Some portion of this treatment could incorporate fostering another group of friends or observing new leisure activities and interests, which in themselves could be considered therapeutic. Moreover, an advocate could likewise embrace work with a patient that includes adjusting thought processes, such as supplanting negative considerations with positive contemplations, in order to build confidence and a positive mental self-view [4].

6 Preventive Medicine

The idea of preventive medicine is to perceive danger factors in each individual and reduce or take out those who face a challenge in an attempt to hinder disease. Fundamental balance is the preparatory lead that attempts to dismiss affliction before it decides, for example, inoculating young people against diseases. Discretionary contravention is the area of sickness or its precursors before aftereffects appear and completely plan to thwart or ease it. Models consolidate common cervical Papanicolaou test (Pap smear) screening and mammography. Tertiary aversion is an undertaking to stop or confine the spread of a disease that is currently present. Clearly, the fundamental expectation is the most common-sense method for infection control.

The main reasons behind death, by and large, are cardiovascular ailment, threatening development, cerebrovascular affliction, unexpected injuries, and chronic lung contamination. A huge preventable justification for death is cigarette smoking, which is associated with an extended bet of cardiovascular disease (e.g., respiratory disappointment), threatening development, stroke, and chronic lung diseases like emphysema and progressing bronchitis. Different affiliations overall have spread out ideas and rules for contamination balance.

The super preventive direct in diverting illness is the repugnance of tobacco smoke. Smoking accounts for 30% of all threatening development passes, and there is growing affirmation of the gamble of normal or given over tobacco smoke to the nonsmoker. Fundamental evasion of skin harmful development consolidates restricting receptiveness to bright light by using sunscreens or cautious clothing. For various cancers, assistant preventive estimates integrate mammography, clinical chest evaluations, and chest self-appraisals for chest sickness; pelvic evaluations and Pap tests for cervical dangerous development and ovarian infection; and sigmoidoscopy, electronic rectal appraisals, and stool tests for strange blood for colorectal harmful development [5].

7 Treatment of Symptoms

7.1 Pain

Torment is the most broadly perceived of all side effects and oftentimes requires treatment before its specific cause is known. Torment is both an exciting and genuine experience that tries to balance from one person to another. One patient may have a high aggravation cutoff and issue exclusively after the affliction cycle has progressed past its starting stage, while one with a low aggravation edge may whimper about torment that is ignored or persevered by a considerable number of individuals. Torment from any explanation can be extended by anxiety, fear, misery, sorrow, dissatisfaction, or shock.

Extraordinary agony serves as an accommodating limit as a protective part that prompts the removal of the wellspring of aggravation, whether it is restricted injury or defilement. Continuous torment serves a less significant limit and is often more difficult to treat. But serious agony requires fast thought, its goal is typically conveniently found, while continuous torment grumblings may be more questionable and harder to disengage from.

The best procedure for treating torment is to discard the explanation, for instance, to painstakingly wipe out a stirred plan, to apply hot packs to a muscle fit, or to set a broken bone in a cast. Decisions to sedate treatment, similar to work-out-based recovery, are relied upon at whatever point what is going on permits. Torment-easing drugs (pain killers) most often used to ease delicate and direct agony are the nonsteroidal antiinflammatory drugs (NSAIDs) like calming medication, ibuprofen, acetaminophen, or indomethacin [6].

7.2 Nausea and vomiting

Nausea and vomiting are normal symptoms that might emerge from infections of the gastrointestinal tract (including gastroenteritis or gut obstacle), from prescriptions like analgesics or digoxin, or due to aggravations of the sensory system like headaches or movement disorders. Retching is constrained by a heaving community situated in the medulla oblongata of the brainstem.

Recognizing and treating the reason is significant, particularly assuming the condition reacts well to treatment, and is not kidding if it is not tended to. An entrail deterrent can happen because of bonds from a past stomach medical procedure.

Clogging and waste impaction can also cause impediment or decreased entrail motility. Such significant and treatable causes should be precluded before falling back on antiemetic (serving to forestall or fix regurgitating) drugs. The most commonly used antiemetic drugs are phenothiazines, the most well-known of which is prochlorperazine (Compazine). Allergy medicines might be helpful in treating the disorder. More recent and more effective medications are expected to control the retching related to malignant growth chemotherapy. Ondansetron is given to patients going through malignant growth chemotherapy, a medical procedure, or radiation therapy with specialists that cause extreme nausea and regurgitation. This medication is exceptionally successful for these patients.

7.3 Diarrhea

Extreme cases of the runs can result from food defilement, diuretics, alcohol, and a couple of stomach-settling specialists. For the most part, it is achieved by a serious tainting with microorganisms, for instance, *Escherichia coli*, *Salmonella*, and *Staphylococcus aureus*. These experts can enter the body through food, water, or when degraded articles (e.g., a restorative ring) are set into the mouth. In children, extraordinary looseness of the bowels is by and large self-limiting, and treatment involves essentially hindering parchedness [7].

7.4 Cough

Hacking is a normal reflex that helps clear the respiratory tract of emanations and new material. It can result from irritation of the flying course or the fervor of receptors in the lung, stomach, ear (tympanic layer), and stomach. The most notable justification for an extraordinary hack is an ordinary infection. A couple of safer nonnarcotic antitussive (hack-preventing) experts are available, for instance, dextromethorphan, which has for all intents and purposes identical reasonability yet fewer accidental impacts. Most hack game plans containing dextromethorphan also contain a decongestant and an expectorant. Since hacking is a huge insurance instrument in clearing releases off of hindered flying highways, a helpful hack (one that produces discharges) should not be smothered [8].

7.5 Insomnia

Insomnia is the trouble of nodding off or staying unconscious, or the inclination that rest is not reviving. Transient insomnia can happen following upsetting life occasions or timetable changes, as shift laborers or people who traverse various time regions experience. Upset sleep can also be linked to the use of invigorating medications or the presence of nervousness, wretchedness, or medical circumstances related to pain. The older invest less energy in resting, and their rest is lighter and set apart by more regular renewals. The present circumstance might be exacerbated by early evening time resting. The treatment of insomnia includes laying out great rest cleanliness: keeping a reliable timetable of when to retire and stir, setting an agreeable room temperature, and limiting problematic stimuli like commotion and light. Day-by-day practice is useful, however, you ought to have stayed away from the preceding sleep time. Energizers ought to be kept away, including nicotine and caffeine. Liquor disturbs the typical rest design and ought to likewise be avoided. They might have long-, halfway, or ultrashort-acting impacts. None ought to be utilized routinely for significant stretches. Different nonbenzodiazepine hypnotics and tranquilizers are likewise accessible, and their value fluctuates as indicated by individual inclination.

8 Various Therapeutic Devices

8.1 Pacemaker

A pacemaker is a little gadget that is inserted in the chest to help control the heartbeat. It is also used to relax and keep the heart back from pounding. Implanting a pacemaker in the chest requires a medical procedure. A pacemaker is furthermore called a cardiovascular pacing gadget, contingent upon your condition, and you could have one of the various types of pacemakers.

- *Single-fold chamber pacemaker*—This type normally sends electrical impulses onto the right ventricle of your heart.
- *Two-fold chamber pacemaker*—This type sends electrical impulses onto the right ventricle and the right chamber of your heart to help control the situation of tightening influences between the two chambers.

Biventricular pacing, moreover, called cardiovascular resynchronization treatment, is for people who have cardiovascular breakdown and heartbeat issues. This kind of pacemaker fortifies both of the lower heart chambers (the right and left ventricles) to make the heart beat even more faster. A pacemaker is embedded to assist with controlling your pulse. Your PCP might suggest a transitory pacemaker when you have a sluggish heartbeat (bradycardia) after a respiratory failure, medical procedure, or prescription excess; however, your pulse is generally expected to recuperate. A pacemaker may be embedded permanently to address a constant sluggish or sporadic heartbeat or to assist in the treatment of cardiovascular breakdown. Figure 2 shows the basic block diagram of the pacemaker.

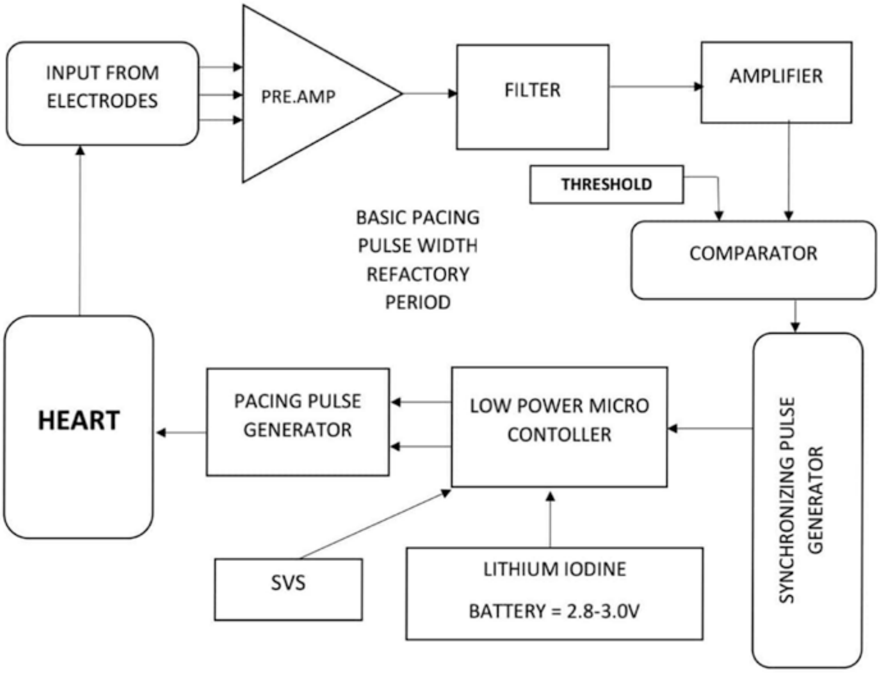

Fig. 2 Block Diagram of Pacemaker

8.1.1 What a Pacemaker Ensures?

Pacemakers work when required. Assuming that your heartbeat is unnecessarily lazy (bradycardia), the pacemaker passes electrical messages onto your heart to address the bang. A few newer pacemakers have sensors that recognize body development or breathing rate and signal the gadgets to fabricate a beat during exercise, contingent upon the circumstance.

A pacemaker has two sections:

- *Beat Generator*—This little metal holder comprises a battery and the electrical hardware that controls the pace of electrical heartbeats sent from the heart.
- *Leads (Cathodes)*—One to three adaptable, protected wires are each positioned in at least one chamber of the heart and convey the electrical heartbeats to change the pulse. In any case, some newer pacemakers do not need leads. These devices, called leadless pacemakers, are embedded directly into the heart muscle.

8.1.2 How Does a Pacemaker Function?

Your heart's sinus center point is your ordinary pacemaker (found in the upper right office of the heart, known as the chamber). It sends an electrical impulse to make your heart beat. A pacemaker's control is to take deceptive command over the gig of your sinus center point if it is not filling properly. Electrical impulses are sent by the pacemaker gadget to encourage your heart to understand and produce a heartbeat. Most pacemakers work precisely when they are required—on demand. A couple of pacemakers convey impulses continually. A couple of pacemakers convey the main impetuses continuously, which is called a fixed rate.

Most pacemakers are little machines with two areas:

- A little, metal battery-operated PC that is typically inserted into fragile tissue under the skin in the chest,
- Wires (drives/cathodes) that are implanted in your heart and related with the PC. The pacemaker reliably screens your heartbeat and conveys electrical energy (as adjusted by your PCP) to pace your heart if it is throbbing excessively. Your pacemaker also stores information about your heart.

This permits your PCP to more likely assess the therapy and, if necessary, change your pacemaker settings. Precisely embedded under the skin close to the right or left collarbone, pacemakers consist of a generator, a battery, and somewhere in the range of one to three little wires. Anodes toward the end of the wires join the explicit region of the heart and send information to the generator's little PC. It then, at that point, sends modified signals that, in addition to other things, tell the lower chambers of the heart when to thump. Batteries last somewhere in the range of 5–12 years and require a minor medical procedure to replace them. Doctors can decipher information sent by the device from a distance and roll out required improvements involving a software engineer in their office. Request pacemakers are utilized for slow or missed pulses, while rate-responsive ones change the pulse in view of an individual's action [9, 10].

8.2 Defibrillator

A defibrillator is a device that gives a high-energy electric shock to the core of somebody who is in cardiac arrest. This high-energy shock is called defibrillation, and it is a fundamental part of attempting to save the existence of somebody who is in cardiac arrest. A defibrillator is also known as a defib, an automated external defibrillator (AED), or a public access defibrillator (PAD).

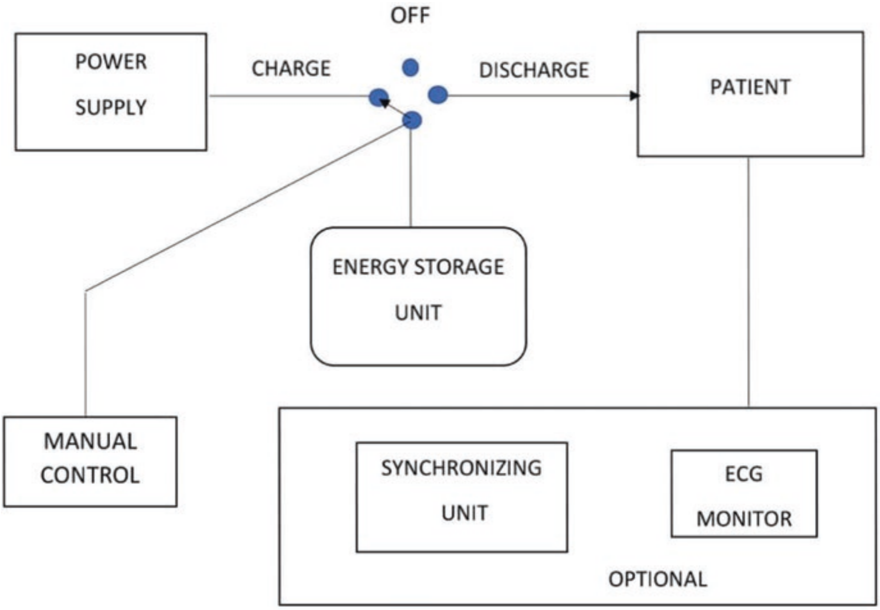

Fig. 3 Block diagram of defibrillator

8.2.1 Defibrillation

Defibrillation is a treatment for unsafe cardiovascular dysrhythmias, unequivocally ventricular fibrillation (VF), and nonperfusion ventricular tachycardia (VT). A heart that is in asystole (flatline) cannot be restarted by a defibrillator but would be dealt with by means of cardiopulmonary restoration (CPR), as shown in Fig. 3.

Instead of defibrillation, synchronized electrical cardioversion is an electrical shock passed in synchrony onto the cardiovascular cycle. Although the individual may be debilitated on a very basic level, cardioversion is typically expected to end insufficiently perfusing heart dysrhythmias, for instance, supraventricular tachycardia. Defibrillators can be external, transvenous, or installed (implantable cardioverter defibrillators), depending upon the sort of gadget used or required.

8.2.2 Defibrillator Applications

Signs Defibrillation is regularly a significant stage in cardiopulmonary revival (CPR). CPR is a calculation-based intervention planned to re-establish cardiac and aspiratory function. Defibrillation is only seen in particular types of cardiac dysrhythmias: explicitly ventricular fibrillation (VF) and pulseless ventricular tachycardia. Assuming that the heart has totally halted, as in asystole or pulseless electrical action (PEA), defibrillation is not demonstrated [11].

Application Technique The defibrillation device that is generally accessible outside of medical communities is the computerized outer defibrillator (AED), which is a versatile machine used even by clients with no prior preparation. That is conceivable because the machine produces prerecorded voice directions in the manual for the client and naturally looks at the casualty's condition and applies the right electric shocks. In any case, there are written guidelines for defibrillators that explain the system step by step.

Results Endurance rates for out-of-medical clinic cardiac captures are poor, frequently under 10%. The result for in-clinic cardiac captures is higher at 20%. While gathering and giving cardiac arrest, the particular cardiac cadence can fundamentally affect endurance rates. Contrasted with individuals who give nonshockable mood, individuals with a shockable musicality (like VF or pulseless ventricular tachycardia) have further developed endurance rates, going somewhere in the range of 21 and a half.

8.3 Ventilators

Ventilators are here and there called "respirators," a term ordinarily utilized for them during the 1950s (especially the "Bird respirator"). Notwithstanding, contemporary emergency clinic and medical phrasing utilizes "respirator" to allude rather to a facial covering that safeguards the wearer against dangerous airborne substances [12].

8.3.1 Function of Ventilators

Ventilators may be equipped with checking and alert structures for patient-related limits (e.g., strain, volume, and stream) and ventilator work (e.g., air spillage, power disillusionment, and mechanical dissatisfaction), support batteries, oxygen tanks, and regulators, as shown in Fig. 4. The pneumatic system is nowadays often superseded by a PC-controlled turbopump. Present-day ventilators are electronically compelled by a little embedded structure to allow a precise change of strain and stream ascribed to a solitary patient's prerequisites. Similarly, adjusted ventilator settings make ventilation more acceptable and pleasant for the patient. In Canada and the United States, respiratory guides are responsible for tuning these settings, while biomedical technologists are obligated to maintain them. In the United Kingdom and Europe, the organization of the patient's participation with the ventilator is done by fundamental thought orderlies [13].

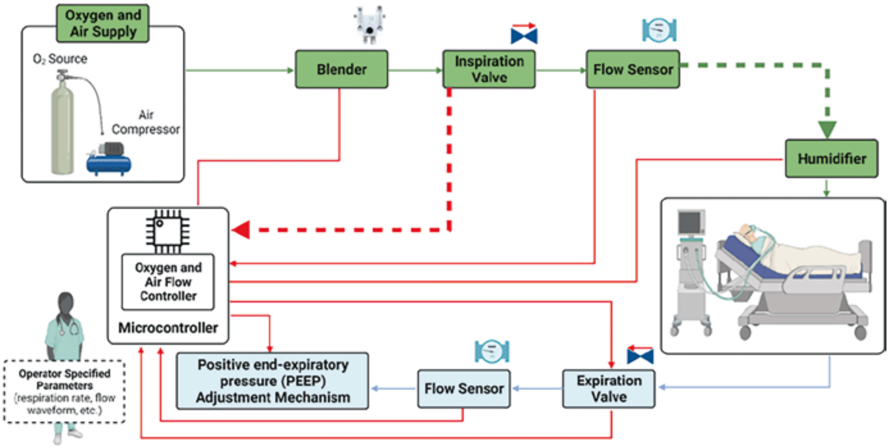

Fig. 4 Block diagram of ventilators

8.3.2 Ventilators and COVID-19

- *For What Reason Do We Need a Ventilator?*

Whenever your lungs breathe in and breathe out air, they take in the oxygen your cells need to function and remove carbon dioxide. Coronavirus can aggravate your airways and basically suffocate your lungs in liquid. A ventilator precisely helps siphon oxygen into your body. The wind streams through a cylinder that goes in your mouth and down your windpipe. The ventilator additionally may inhale out for you, or you might do it all alone. The ventilator can be set to take a specific number of breaths for you at each moment. Your primary care physician likewise may choose to program the ventilator to activate when you truly want assistance. For this situation, the machine will blow air into your lungs naturally if you have not calmly inhaled in a brief time span. The breathing cylinder might be awkward. While it is attached, you cannot eat or talk. Certain individuals on ventilators will be unable to eat and drink regularly. Provided that this is true, you'll have to get your supplements through an IV, which is embedded with a needle in one of your veins.

- *How Long Do You Need a Ventilator?*

A ventilator does not fix COVID-19 or other diseases that cause breathing problems. It assists you with getting by until you improve and your lungs can chip away on their own. Whenever your PCP thinks you are alright, they will test your relaxation. The ventilator remains connected, however, with the goal of allowing you to inhale on your own. At the point when you inhale, typically, the cylinders will be taken out and the ventilator will be switched off [13].

8.3.3 Ventilators During Surgery

During any surgery that requires general sedation, a ventilator is fundamental. There are likewise times when a ventilator is expected after surgery, as the individual will be unable to inhale on their own following the strategy.

During Surgery General sedation includes incapacitating the muscles of the body for a brief time. This includes the muscles that allow us to breathe in and breathe out. Without a ventilator, breathing during general sedation would not be imaginable. The vast majority are on the ventilator while the surgery is occurring, and then, at that point, a medication is given after the activity is finished to stop the impacts of the sedation. When the sedation stops, the individual can inhale all by himself and is removed from the ventilator.

After Surgery A ventilator is fundamental when an individual who has gone through surgery cannot inhale properly to give oxygen to the cerebrum and body. Certain individuals, because of injury or sickness, cannot inhale well enough after surgery to be taken off the ventilator. This might be because of unfortunate lung function before surgery, which can happen when patients have harm to their lungs brought about by things like constant obstructive aspiratory disease (COPD). This can likewise occur because of injury, contamination, or another genuine medical issue. An individual who is on the ventilator before surgery will probably stay on the ventilator after surgery until they recuperate to the point of breathing well all alone. A few medical procedures require an individual to be on a ventilator for a brief period of time after surgery. For instance, individuals having open heart surgery are commonly kept on a ventilator until they awaken to the point of taking their head off their pad and following basic orders. They are not given a medication to stop the sedation; rather, the sedation is permitted to wear off all by itself.

8.4 Diathermy

Diathermy is a treatment choice that utilizes energy sources to profoundly heat a region of your body. Rather than a heat source, diathermy utilizes sources like sound and power, which are converted into heat by your body. Diathermy, additionally called "profound warming," warms far beneath the outer layer of your skin. It targets muscles and joints to give therapeutic advantages [13].

8.4.1 Types of Diathermy

The three types of diathermy used by actual specialists are ultrasound, short wave, and microwave. The use of moderate heat by diathermy increases blood flow and speeds up digestion and particle dissemination across cell films. When exposed to warm conditions, the sinewy tissues in ligaments, joint containers, and scars are all more easily extended; thus working with joints firmness and advancing unwinding of the muscles and decline of muscle fits. Figure 5 shows the block diagram of electrosurgical diathermy.

Microwave diathermy-induced hyperthermia raises the temperature of profound tissues from 41 °C to 45 °C by utilizing electromagnetic power. The organic component that directs the connection between the warm portion and the mending system of delicate tissues with low or high water content or with low or high blood perfusion is as yet under study. Microwave diathermy treatment at 434 and 915 MHz can be viable in the momentary administration of musculoskeletal wounds. Hyperthermia is avoided if the temperature is held below 45 °C or 113 °F. The outright temperature is, notwithstanding, not adequate to foresee the harm that it might create. Microwave diathermy-induced hyperthermia provided transient relief from discomfort in layed-out supraspinatus tendinopathy [14].

The actual attributes of the majority of the gadgets used clinically to warm tissues have turned out to be wasteful in achieving the fundamental therapeutic warming examples in the scope of the profundity of the damaged tissue. The primer examinations performed with new microwave gadgets working at 434 MHz have exhibited empowering results. All things considered, enough planned and forthcoming controlled clinical examinations should be completed to affirm the therapeutic adequacy of hyperthermia with an enormous number of patients, long-term follow-up, and blended populaces.

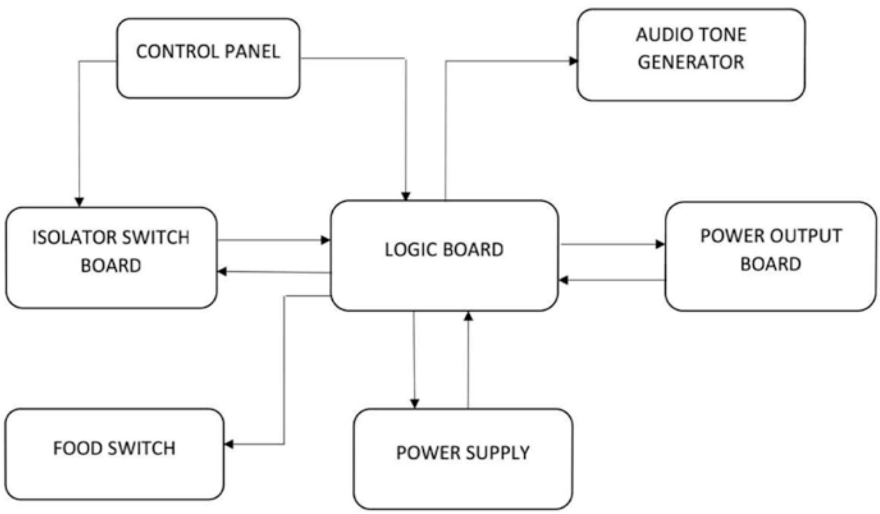

Fig. 5 Block diagram of electrosurgical diathermy

8.4.2 How Does Diathermy Work?

The two kinds of diathermy produce profound heat in your body's tissues. In any case, they do it in one-of-a-kind ways with marginally various outcomes, as shown in Fig. 6.

Any diathermy gadget ought to have the option of keeping a temperature of 104 degrees Fahrenheit to 114 degrees Fahrenheit two creeps beneath the skin. The ideal temperature ought to be reached in a few hours or less.

- *How Radio Wave Diathermy Works*—There are two essential techniques for radio wave diathermy. Dielectric-coupled diathermy joins radio waves and an electric voltage. The radio wave diathermy gadget makes an electric field between anodes situated on one or the other side of the body part. The electric charge goes through your tissue and upsets the atoms. As the atoms endeavor to realign themselves, they knock against one another and cause grating. Their erosion prompts profound hotness. Inductive-coupled diathermy uses frequencies to create an attractive field. The gadget is situated close to the body part, and the electromagnetic fields produce profound hotness in your body's tissues [14].
- *How Microwave Diathermy Works*—This kind of diathermy uses microwave frequencies to heat a body part. Microwave radiation is sent to the tissue from a utensil. The size, shape, and distance of the implement from the skin can be in every way adapted to a specific treatment.
- *How Ultrasonic Diathermy Works*—This technique utilizes a device with a round head and a unique gel. The gel is applied to the skin, and the device (or "wand") is scoured across the region in a delicate circle. The wand sends ultrasonic energy

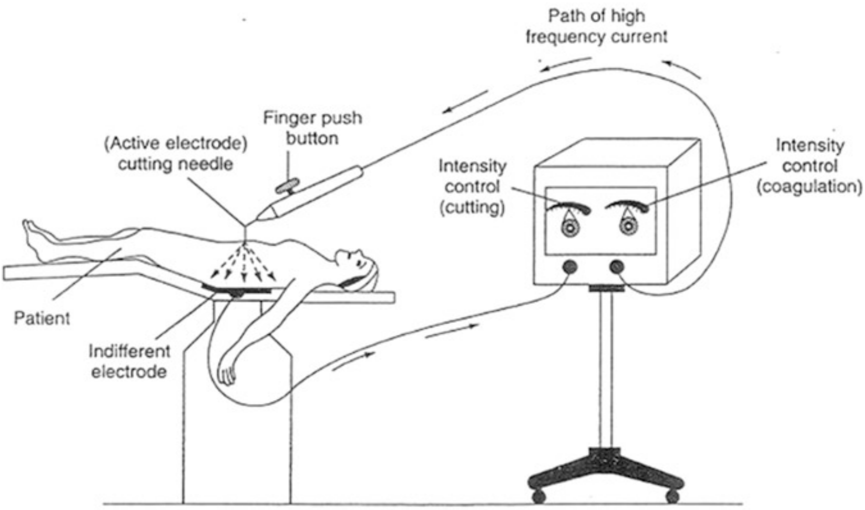

Fig. 6 Block Diagram of Diathermy

through your tissue, creating profound heat beneath the surface. The gel assists the energy travel more straightforwardly and provides therapeutic warmth.

8.4.3 Advantages of Diathermy

Most diathermy medicines assuage agony, pressure, and irritation in the muscles and joints. Each type of diathermy can be used to treat various circumstances.

Radio Wave Diathermy Medicines Radio wave diathermy really treats enormous regions. It could very well be used to treat:

- A limited area of outer muscle torment
- Aggravation of your joints and tissues
- Fits
- Sprains

It can also be a successful treatment for different circumstances, like tendonitis, tenosynovitis, bursitis, joint inflammation, periostitis, and capsulitis.

Microwave Diathermy Medicines This technique for diathermy is more specific. It targets explicit muscles and applies profound heat to them. It can

- Make your collagen tissue more adaptable
- Improve contracture muscles
- Decrease muscle fits
- Treat joints in the hands, feet, and wrists

Ultrasound Diathermy This strategy is great for dealing with bigger joints like the shoulder and hip. You can consolidate ultrasound therapy with exercise-based recuperation to work on your range of movement with your bigger joints. Ultrasound diathermy can be utilized to treat an assortment of conditions, including

- Calcific bursitis
- Reflex vasodilation
- Neuromas
- Joint contractures and bonds
- Myofascial torment
- Apparition appendage torment

8.5 Dialyzer

A dialyzer is regularly referred to as an "artificial kidney." Its capacity is to eliminate the abundance of squanders and liquid from the blood when the patient's kidneys can never again play out that assignment. Dialyzers are made of a slightly stringy material. The filaments structure a semipermeable layer, which permits more modest particles and fluids to go through.

The dialyzer has four ports: one channel and one outlet port each for blood and dialysate. The semipermeable dialysis film isolates the blood compartment and the dialysate compartment. The vehicle processes across the film are dissemination (dialysis) and convection (ultrafiltration). The evacuation of little solutes happens fundamentally by dissemination; bigger parts, for example, β2-microglobulin, are all the more successfully taken out by convection.

There are significantly two kinds of dialyzers: High flux and low flux dialyzers. The term “transition” alludes to the porousness of the layer in the dialyzer (artificial kidney) across which aggregated poisons and abundances of liquid pass during hemodialysis. High transition layers, as opposed to low motion layers, have bigger pores and permit dispersion of more noteworthy measures of uremic poisons and center atoms, for example, β2 macroglobulin, and along these lines, they might diminish the gamble of dialysis-related amyloidosis. In any case, low-motion dialyzers are a possibility for intense and ongoing dialysis where a slower pace of liquid evacuation (e.g., ultrafiltration coefficient) is wanted. In any case, there is one more medium removal (MCO) dialyzer, which assists with eliminating bigger center atoms related to indications connected with the aggregation of uremic maintenance solutes. The medium removal (MCO) dialyzer has shown great leeway of enormous center atoms; however, its drawn-out impacts are hazy. A bigger dialyzer with a bigger film region (A) will ordinarily eliminate a greater number of solutes than a more modest dialyzer, particularly at high blood flow rates.

Empty fiber dialyzers are the most widely recognized dialyzers being used today. They are not difficult to utilize and give low bloodstream opposition, great mass exchange, low consistency, and controllable ultrafiltration.

The dialyzer may either be disposed of after every treatment or reused. The essential technique for a dialyzer going back over includes four stages: washing, cleaning, execution testing, and sanitization and disinfection.

Dialysis

Dialysis is a treatment for individuals whose kidneys are coming up short. Whenever you have kidney disappointment, your kidneys do not channel blood in the manner in which they ought to. Accordingly, squanders and poisons develop in your circulation system. Dialysis accomplishes crafted by your kidneys, eliminating by-products and excess liquid from the blood [15].

Need for Dialysis

Individuals who have kidney disappointment, or end-stage renal disease (ESRD), may require dialysis. Wounds and conditions like hypertension, diabetes, and lupus can harm the kidneys, prompting kidney infection. Certain individuals foster kidney issues, which is not a great explanation. Kidney disappointment can be a drawn-out condition, or it can come on abruptly (intensely) after an extreme disease or injury. This kind of kidney disappointment might disappear as you recuperate. There are five phases of kidney infection. In stage 5 kidney infection, medical services providers believe you have ESRD or kidney disappointment. Now, kidneys are doing around 10–15% of their typical capacity. You might require dialysis or a kidney transplant to remain alive. Certain individuals go through dialysis while sitting tight for a transfer.

What Do the Kidneys Do?
Your kidneys are important for your urinary framework. These two bean-molded organs sit beneath your ribcage on each side of your spine. They clean poisons from your blood, returning separated, supplement-rich blood to the circulation system. The waste and additional water make pee, which moves from the kidneys into the bladder. Your kidneys additionally assist with managing your circulatory strain. There are two ways to get dialysis:

- Hemodialysis
- Peritoneal dialysis (PD)

8.5.1 Hemodialysis

Hemodialysis is a treatment to channel squanders and water from your blood, in the same way that your kidneys did when they were healthy. Figure 7 describes the hemodialysis assists to control blood pressure and achieve equilibrium in your blood with significant minerals, like potassium, sodium, and calcium. Hemodialysis can help you feel much better and live longer; however, it is anything but a remedy for kidney disappointment.

A desensitizing cream or splash can be utilized if setting the needles annoys you. Each needle is joined to a delicate cylinder associated with the dialysis machine. The hemodialysis bloodstream from your arm into the cylinder, past a strain screen, a blood siphon, and a heparin siphon, which forestalls coagulating. Bloodstreams past another strain screen before entering the dialyzer or channel. Separated blood goes on beyond a venous tension screen, an air trap and air locator, and an air finder cinch, and gets back to your arm [16].

8.5.2 Peritoneal Dialysis

PD is a kind of dialysis, which involves the peritoneum in an individual's midsection as the layer through which liquid and disintegrated substances are traded with the blood and is shown in Fig. 8. It is used to eliminate excess liquid, correct electrolyte issues, and remove poisons in those with kidney failure. PD has preferred results over hemodialysis during the main two or three years. Other advantages that are more prominent are adaptability and better decency for those with huge heart disease.

Intricacies might include contaminations inside the midsection, hernias, high glucose, draining in the mid-region, and blockage of the catheter. Use is absurd in those with a previous critical stomach medical procedure or incendiary gut disease. It requires a few levels of specialized expertise to be done properly [17].

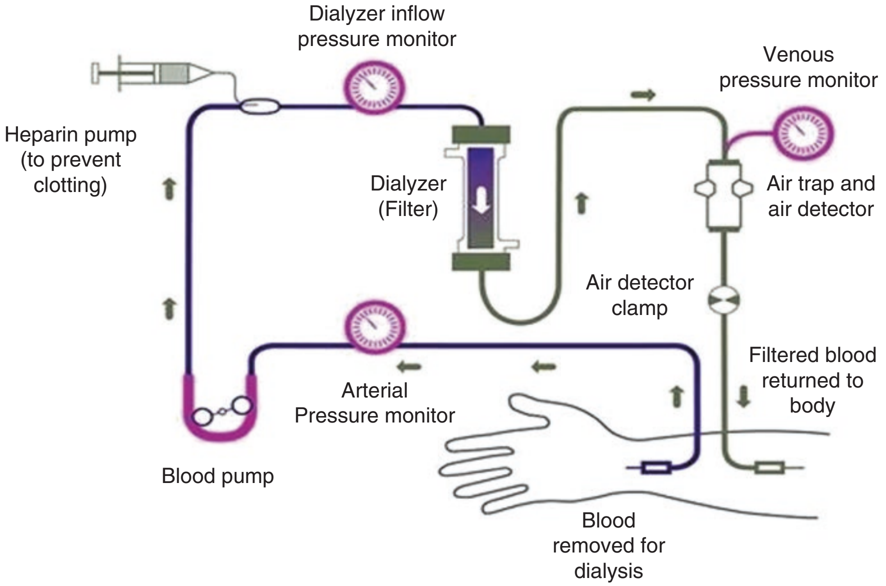

Fig. 7 Hemodialysis

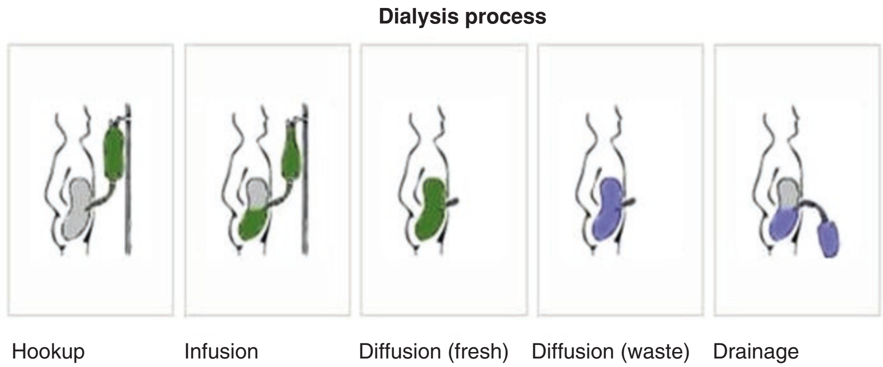

Fig. 8 Peritoneal Dialysis

9 Challenges in Therapeutic Devices and Procedures

Three challenges exist in driving and translating any calculated overview; those are particularly material for deliberate reviews of supportive devices or medical procedures:

- Thought or dismissal of dull composition
- The occupation of nonrandomized studies

- Issues in applying the results to clinical thought that is excellent to the cautious and healing contraption composing

We highlight three troubles that could arise in coordinating and translating any purposeful review that evaluates the practicality or ampleness of accommodating devices or operations. We moreover review the specific verification relevant to these methodologic issues generally and present the evidence express to contraptions or frameworks where it is available. We do not focus on the meaning of assessing the focus on quality in light of the fact that another article in this supplement settles this issue. In this article, we use the U.S. Food and Drug Administration (FDA) definition of a supportive device as "an instrument, contraption, execute, machine, development, implant, in vitro reagent, or other equivalent or related article, including a section, or frivolity as most would consider to be normal to impact the plan of any limit of the body and which does not achieve any of its fundamental arranged purposes through substance movement inside or on the body and which is not likely to being used for the achievement of any of its fundamental anticipated purposes." Accommodating devices and medical procedures obviously contrast colossally in unpredictability and costs; anyway, the issues we analyze here are comprehensive no matter what the sort of contraption or method.

10 Computer-Assisted Therapy

Computer-assisted treatments, that is, use of computers to convey a few parts of psychotherapy or social treatment directly to patients through association with a computer program, or by means of the internet offer invigorating possibilities to address at minimum a portion of the various difficulties confronting psychiatry. Through their wide and prepared accessibility, possible expense investment funds, and capacity to stretch out to underserved or challenging to arrive at populaces, computer-assisted treatments may enormously grow the reach and collection of psychiatry and stretch out intriguing new open doors to clinicians and clinical scientists. Until this point, in excess of 100 distinct computer-assisted treatment programs have been produced for a scope of mental issues and conduct medical issues.

Computer-assisted treatments can be conveyed by means of a program that runs on the actual gadget (for example, PCs and workstations, individual advanced aides, intelligent phone informing, and message informing), or through the Internet, which regularly allows a higher level of intuitiveness between the client and the program. The intricacy of the content can range from exceptionally negligible, text-based organizations (similar to perusing a leaflet) to profoundly refined, intuitive, augmented simulation designs, which are all the more promptly accessible due to the speed of internet associations. Inconstancy of the level of contribution with a clinician or companions is one more significant aspect of these projects; existing projects range from no clinician association to those that deal with peer support through directed talk rooms to those with a very undeniable degree of clinician inclusion, wherein the client and clinician connect widely through email correspondence. The last option approach is typically alluded to e-treatment since e-treatments have been explored as of late somewhere else; they are not discussed further in this article. A few computer-assisted treatments "remain solitary"—that is, they are planned for clients to get to them without essentially captivating in different types of mediation or specialist contact, while others are expected to act uniquely as assistants to formal treatment. Force can go from those offering truth-be-told, exceptionally concise, single-meeting appraisal and input, which require just minutes to finish, to programs with numerous mind-boggling modules that can require a little while or months to manage.

The objectives and expected results of computer-assisted treatments vary broadly, frequently relying on whether they are aimed at overall communities (which as a rule infers the intercession is focused on people with lower levels of the issue or issue) to clinical populaces with complex mental issues and comorbid issues (ordinarily conveyed in the center as an expansion to treatment). Some computer-assisted treatments are imagined basically as "online bibliotherapy," in which the client is given access to data about the confusion or treatment, or furnished with a scope of assets and connections to additional help (e.g., http://www.quitnet.com). Other computer-assisted treatments offer openness to more thorough, observationally approved treatments, like mental social treatment (CBT), with broad use of sight and sound highlights, for example, recorded guides to exhibit abilities with intelligent activities that permit clients to evaluate their learning and practice new procedures [16, 18].

11 Conclusion

The target of individual treatment is to persuade change and work on individual fulfillment through care and self-examination. The fundamental objective in the examination of clinical advancement is the prevalent sufficiency of people. The fundamental costs of the shortfall of a good structure for advancement evaluation are to human flourishing patients do not get ideal thought. Anyway, there are also monetary costs when the most functional developments are not applied or when inadequate advances are.

The value of drug development evaluation extends beyond patient assurance and its economic utility. The outcomes of evaluation are also expected by crisis facilities and various workplaces that buy and apply headways; by organizations that cultivate developments; by the master social orders that spread information to clinical benefits subject matter experts; and by the protection office, government associations, and corporate prosperity designs that remunerate the use of advancements. A method for looking over clinical development, consequently, ought to think about the systems for evaluation as well as the necessities, solicitations, and assurances of the individuals and beneficiaries meanwhile.

Clinical development evaluation has been filled piecemeal, considering express demands instead of a structure planned to give the information expected to improve and shield the prosperity of general society and enlighten public course of action decisions. What is required now is the arrangement of an overall structure for the coordinated directness of clinical development assessment. Remedial intercessions will be assessed for effects, practicality (or ampleness), and capability. Influences are essentially unmistakable results of the mediation. Regardless, restorative ampleness can be assessed solely by relating the effects of a remedial intercession to a helpful point. Its explanation with and by the patient is one objective of the informed consent process as most would consider being normal by respect for freedom and balance of the patient. Examination of the loads that are connected with the utilization of remedial ampleness before long serves the assessment of restorative capability.

Broad implementation of computer-assisted medicines depends on the not-yet-spread-out doubt that the sufficiency of these systems is proportionate to that of more traditional clinician-conveyed, observationally supported medicine. More examinations are expected that recommend direct connections of computer-assisted medicines to the principal guide conveyed structures on which they are based, with appropriate control conditions. The epic capacity of computer-assited medicines may be diminished if one expects their benefits to be overstated or the medicines are completely conveyed or dissipated before being carefully evaluated using comparative deliberate advances and methodologic rules that are necessities for surveying clinician-conveyed medicines. In any case, those not completely settled forever to be safeguarded, whether or not they are unassumingly convincing, can have a colossal impact at whatever point passed on to the tremendous number of individuals who could benefit from them.

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Part VI
Novelty in Emerging Soft Computation

Emerging Techniques and Algorithms Used in Soft Computation

A. S. Subaira, T. Primya, C. Vinothini, K. Karpagavadivu, S. Saranya, and C. Ram Kumar

1 Introduction

Soft computing in computer science helps to solve complex problems by providing insights into the machine using its computational techniques. Artificial intelligence is the ability of a machine to make its own decisions to get the answer. As we progress up the ladder, the clear thinking, nebulous handling, complexity, artificial intelligence, and working dimensions improve. The ultimate goal is to create a computer or machine that can perform tasks similar to those performed by humans, i.e., human wisdom can be artificially recreated in computers. Meditation is always used to promote intuitive consciousness/wisdom, which is an important topic in soft computing. This is, without a doubt, an exceptional task and, in many ways, brand-new phenomena.

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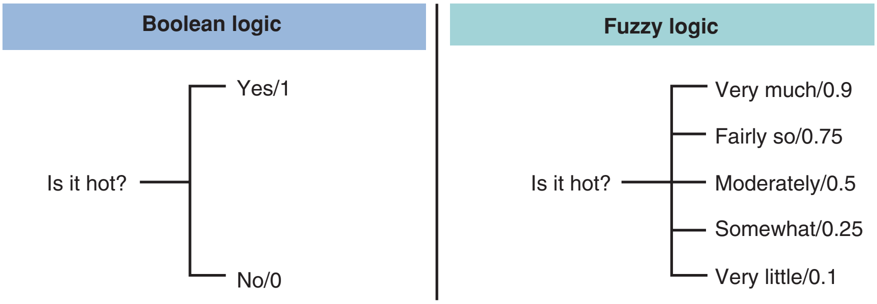

Fig. 1 Boolean logic vs fuzzy logic

2 Emerging Techniques in Soft Computing

2.1 Fuzzy Computing

Fuzzy means "not clear" or "vague." It computes based on the approach called "degrees of truth." In the real-world modern computing, the given problems or statements are based on Boolean logic, i.e., true or false (1 or 0). Figure 1 shows the comparative analysis of Boolean logic and fuzzy logic. It is well-matched for the following [1]:

- In engineering, it is utilized to pursue choices without clear assurances and vulnerabilities, or with erroneous information, for example, normal language handling advancements.
- It controls and manages machine yields in view of different information sources/ input factors for temperature control frameworks.

2.2 Neural Network

Neural networks are the core of profound learning calculations and profound learning are a subset of machine learning [14]. It is otherwise called artificial neural networks (ANNs) and simulated neural networks (SNNs). It perceives fundamental connections in a bunch of information through an interaction that mirrors the manner in which the human mind works and it contains a progression of calculations. Counterfeit neural networks are containing an info layer, at least one secret layer, and a result layer. All hubs are interconnected to one another in different layers of the organization and have a related weight and edge. When a particular node exceeds the predetermined threshold value, it becomes activated and transmits data to the next layer of the network [2].

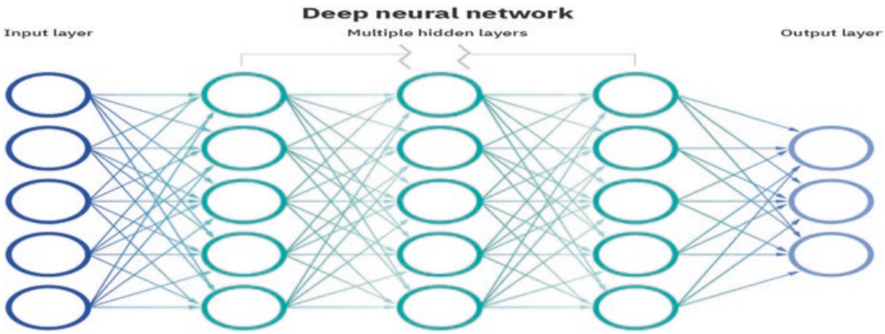

Fig. 2 Perceptron

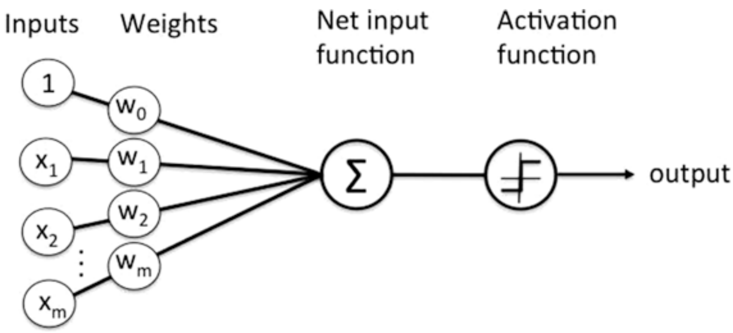

Fig. 3 Single-layer perceptron

2.2.1 Perceptron

A perceptron is a calculation for directed learning of paired classifiers [3]. This calculation assists with empowering the neurons to learn and handle the components in the preparation set each in turn (Fig. 2). There are two sorts of perceptrons:

- *Single-Layer Perceptron* – It can assist with learning just straight divisible examples.
- *Multi-facet Perceptron* – It contains at least two layers to create extraordinary handling power. It is otherwise called feed forward neural networks.

Single-Layer Perceptron
In single-layer perceptron (Fig. 3), to draw a direct choice limit, the calculation learns the loads for the information signals [4]. This empowers line to separate between the two directly detachable classes +1 and −1.

Multi-facet Perceptron
A completely associated multi-layer neural network is called a multilayer perceptron (MLP), as shown in Fig. 4.

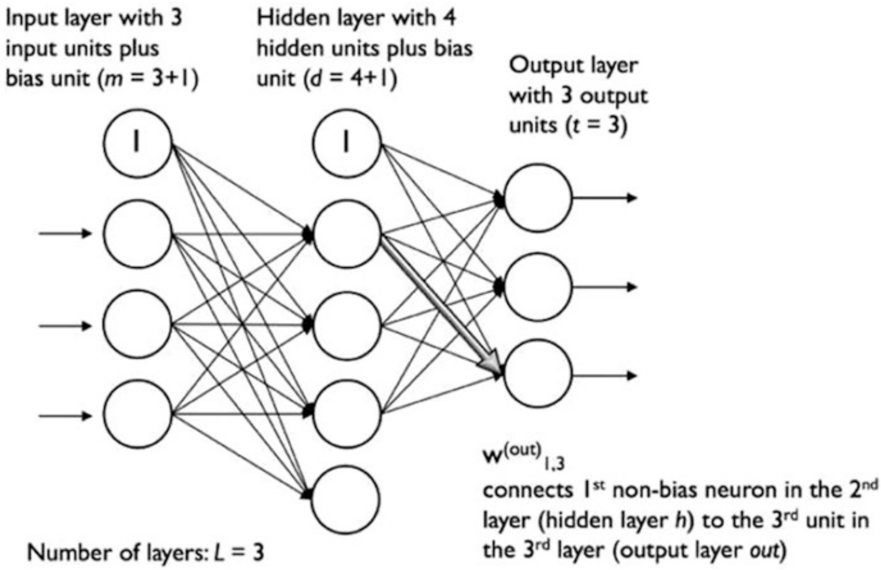

Fig. 4 Multi-facet perceptron

2.2.2 Probabilistic Neural Network

To deal with order and example acknowledgment issues, a kind of feed forward neural network is planned that is known as probabilistic neural organization (PNN), as illustrated in Fig. 5. The probability distribution function (PDF) of each class is assessed utilizing a Parzen window (a non-parametric capacity). The likelihood dispersion capacity of each class is then used to appraise the class likelihood of the new information and the Bayes' standard is utilized to allot the class with the most noteworthy back likelihood to the new info information. The chance of misclassification is brought down with this technique. This sort of artificial neural network was made utilizing a Bayesian organization and a factual methodology known as Kernel Fisher discriminant examination.

2.3 Genetic Algorithm

The hunt put together enhancement method based with respect to the philosophy of genetics and natural selection is known as Genetic Algorithm (GA). It is regularly used to find ideal or close ideal answers for the intricate issues, which, in any case, would take a lifetime to address [5]. It is routinely used to tackle improvement issues in AI and exploration. Figure 6 shows the example for genetic algorithm.

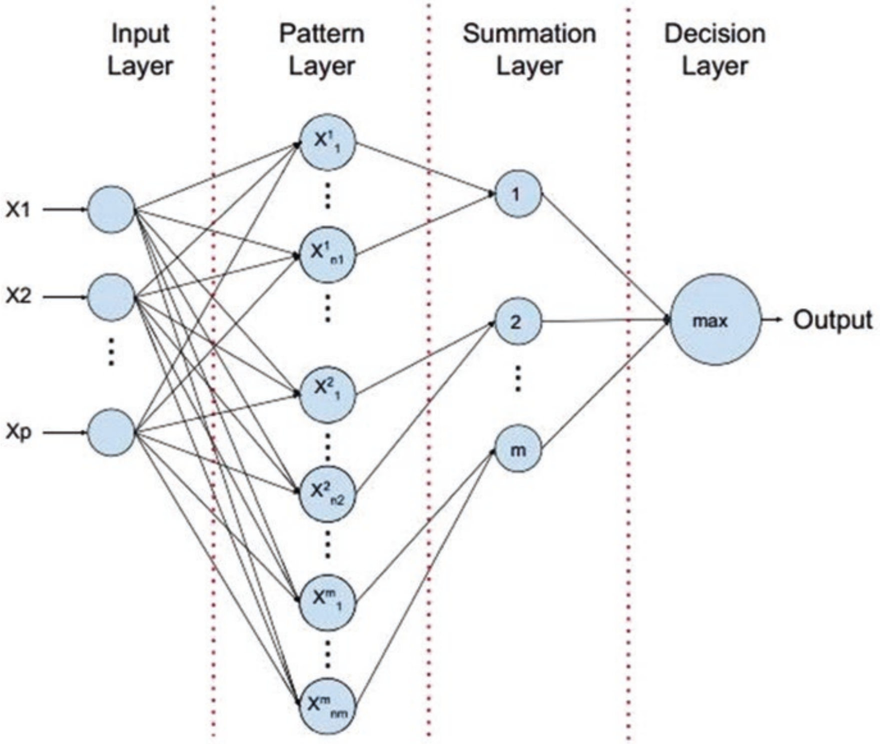

Fig. 5 Probabilistic neural network

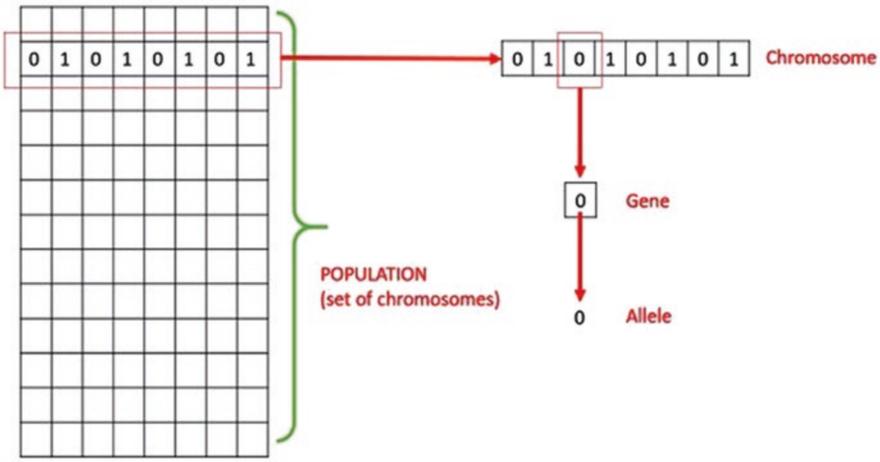

Fig. 6 Genetic Algorithm example

Basic Terminology – It is important to know all the basic genetic algorithm terminologies.

Population – It produces all the possible solutions to the specified problem. The population for a genetic algorithm is similar to the population for human beings.

Chromosomes – Chromosomes make suggestions for solutions to a given problem. It contains a set of parameters.

Gene – Gene is the essential element position of the chromosome.

Allele – A gene that can take the value for a particular chromosome is known as allele.

Genotype – It is referred to the population of the computational space. The proposed solutions are entitled easily. In the computational space, to understand and manipulate the data using a computing system is shown in Fig. 7.

Phenotype – The arrangements are addressed in a manner they are addressed in certifiable circumstances. Aggregate is the populace in the genuine true arrangement space.

Decoding and Encoding – For straightforward issues, aggregate and genotype spaces resemble much. Anyway, in most cases, aggregate and genotype spaces are distinctive. Interpretation changes the response from genotype to aggregate space, and coding changes the response from aggregate to genotype space. The unravelling should be quick, as it will be performed multiple times in the GA during the wellnesss esteem computation.

Fitness Function – A wellness work characterized as a capacity that accepts the arrangement as information and produces the appropriateness of the arrangement as the result. In different cases, the wellness work and the goal capacity might be something similar, while in others, it may very well be different in light of the issue.

Genetic Operators – These administrators modify the hereditary piece of the posterity. These incorporate hybrids, change, and determination.

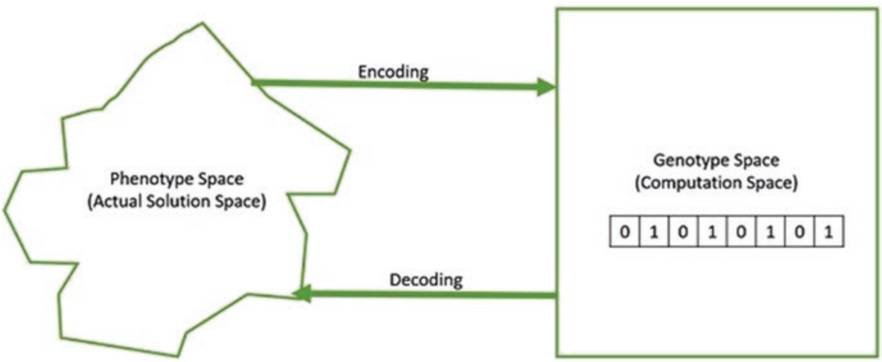

Fig. 7 Geno type

2.4 Associative Memory

Associative memory is an exceptional kind of memory. It is optimized to carry out scratches throughout the data. Based on the address, it provides a simple direct access to the data. Associative memory is also known as content addressable memory or associative array. Associative memory of conventional semiconductor memory (generally RAM) added examination hardware that empowers a pursuit activity to finish in a solitary clock cycle. It is an equipment web crawler, a unique kind of PC memory utilized in specific exceptionally high looking through applications [6].

2.4.1 Auto-associative Memory

An auto-acquainted memory recuperates a formerly put away example that most intently connects with the ongoing example, as shown in Fig. 8. It is otherwise called an auto-cooperative correlator.

x [1], x [2], …..x[m] is taken as the quantity of put away example vectors and x[m], a component quantity that shows the quantities gotten from the examples. The auto-acquainted memory will bring about an example vector x[m] while putting an uproarious or inadequate rendition of x[m].

2.4.2 Hetero-associative Memory

The recuperated design is for the most part unique from the information design in type and arrangement as well as in happy. It is otherwise called a hetero-acquainted correlator, and it distinguishes the unequalled examples well overall.

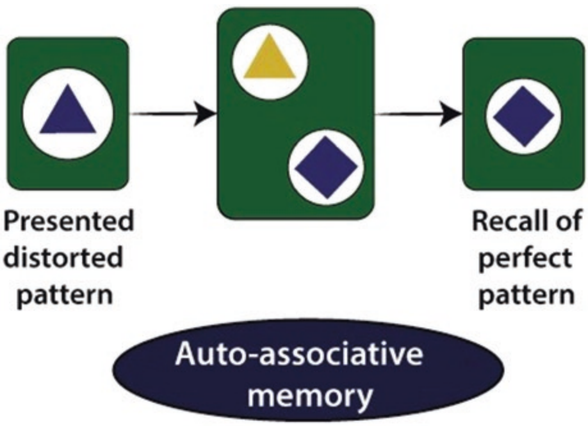

Fig. 8 Auto-associative memory

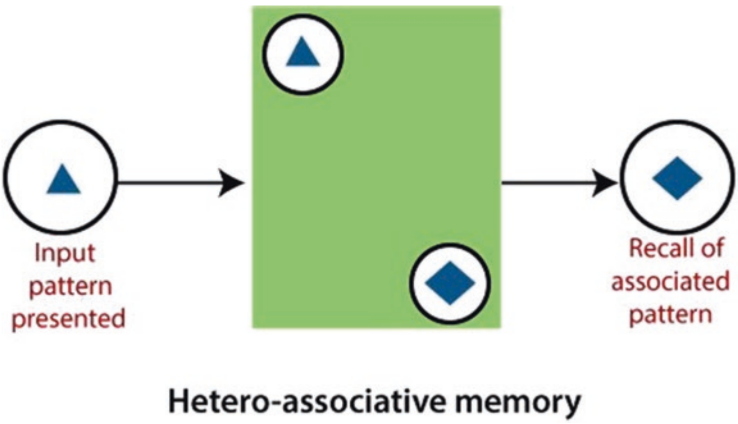

Fig. 9 Hetero-associative memory

Consider various key reaction matches {a(1), x(1)}, {a(2),x(2)}, {a(3),x(3)},……. {a(m),x(m)} shows the key reaction matches. Example vector x(m) is given by the hetero-acquainted memory when the boisterous or fragmented adaptation of the a(m) is provided in Fig. 9. Neural associative memory refers to memory models that are implemented using neural networks. The most basic form of this type of memory is called direct mapping neural associative memory. These models use a specific neural network architecture to store and retrieve information.

2.4.3 Working of Associative Memory

Cooperative memory is a collection of various architectures that are related to each other. When the input pattern matches the pattern stored in the output repository of a particular architecture, it triggers the activation of that architecture. The stored pattern can be a precise or one-sided representation of a previously stored example, as shown in Fig. 10.

On the off chance that the memory is delivered with an information design, may say α, the related example ω is recuperated naturally [7].

Encoding or Retention Encoding or memorization refers to the process of creating a familiar memory. This involves constructing a weight matrix X, which associates an input pattern (represented by Eq. 1) with a stored pattern, allowing for the retrieval of the stored pattern when the input pattern is presented.

$$\left(x_{ij}\right)_k = \left(p_i\right)_k \left(q_i\right)_k \tag{1}$$

where

$(p_i)_k$ represents the *i*th component of pattern p_k, and

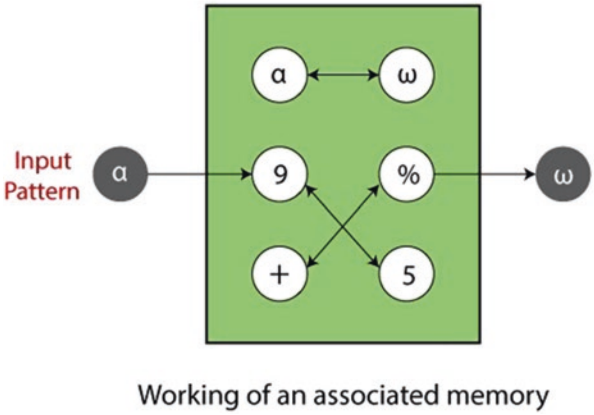

Fig. 10 Working of associative memory

$(q_j)_k$ represents the *j*th component of pattern q_k.

Where

strong > $i = 1,2, \ldots, m$ and $j = 1,2,\ldots,n$.

Constructing the association weight matrix w is accomplished by adding the individual correlation matrices w_k in Eq. 2, i.e.,

$$W = \propto \sum_{p}^{k=1} Wk \tag{2}$$

where α = constructing constant.

Applications of Associative Memory

- In memory designation design just, the acquainted memory is utilized.
- Cooperative memory is widely utilized in the information base administration frameworks.

Advantages of Associative Memory

- It is utilized where search time should be a more modest sum or short.
- It is well reasonable for equal pursuits.
- Partner memory frequently used to speed up information bases.
- It is utilized by the virtual memory and furthermore utilized in neural networks. Associate memory often used to accelerate databases.
- It is used by the virtual memory and also used in neural networks.

Disadvantages of Associative Memory

- It is more extravagant than random access memory.
- Every cell has its own stockpiling ability and sensible circuits for coordinating its substance with outer contention.

2.5 Adaptive Resonance Theory

In 1987, the Adaptive Resonance Theory (ART) was introduced as a neural network model. The basic ART utilizes unsupervised learning, with "adaptive" referring to its ability to learn continuously, and "resonance" indicating that it retains previous information while providing new information. ART networks are designed to solve the stability-plasticity dilemma, where stability refers to the network's tendency to remember past learning, and plasticity refers to its ability to acquire new information [8]. As a result, ART networks are capable of learning new patterns of data without forgetting previous ones. The ART network uses a clustering algorithm, where input is presented to the network and the algorithm determines if it fits into one of the pre-existing clusters. If it does, the input is added to the corresponding cluster. If not, a new cluster is formed.

Types of Adaptive Resonance Theory (ART)
After 20 years of research, Carpenter and Grossberg developed different ART architectures. It can be classified as follows

- *ART1* – The main ART engineering is straightforward and the fundamental. It is fit for bunching paired input values.
- *ART2* – It is the expansion of ART1 that is equipped for bunching consistent esteemed input information.
- *Fluffy ART* – It is the expansion of fluffy rationale and ART.
- *ARTMAP* – It is a directed type of ART realizing where one ART learns in light of the past ART module. It is otherwise called prescient ART.
- *FARTMAP* – This is a directed ART design with Fuzzy rationale included.

2.5.1 Basics of ART Architecture

Adaptive Resonance Theory (ART) is a type of neural network that is characterized by its self-organizing and competitive nature. It is designed to be flexible and adaptable, hence the name "adaptive resonance theory". ART networks are based on the principle of resonance, where input signals resonate with stored patterns, and the network adjusts its weights to match the input. This allows the network to classify input patterns into pre-existing categories or form new categories if necessary. It very well may be of the two kinds, the unaided ones are ART1, ART2, ART3 and the directed one is ARTMAP. As a general rule, the administered calculations are named with the addition "Guide." The fundamental ART model (Fig. 11) is solo in nature and comprises the accompanying places:

- F1 layer or the correlation field (where the information sources are handled).
- F2 layer or the acknowledgment field (which comprises the grouping units).

The reset module (that goes about as a control component).

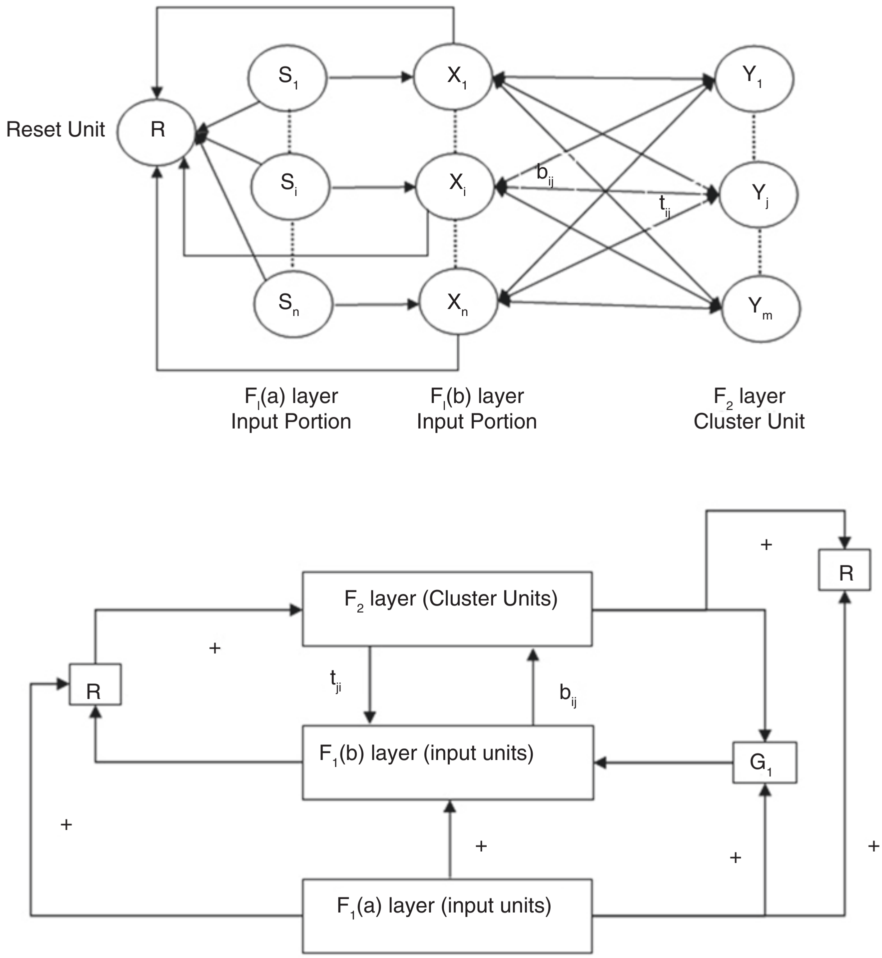

Fig. 11 Adaptive resonance theory

The best coordinates with the characterization factor happen when F1 layer acknowledges the information sources and plays out a handling and moves it to the F2 layer. There exist two arrangements of weighted interconnections for controlling the level of comparability between the units in the F1 and the F2 layer.

The F2 layer is a cutthroat layer. The group unit with the enormous net info turns into the possibility to become familiar with the information design first, and the remaining F2 units are overlooked. The reset unit pursues the choice whether the bunch unit is permitted to gain proficiency with the information design contingent upon how comparable its hierarchical weight vector is to the info vector and to the choice. This is known as the cautiousness test.

Hence, the watchfulness boundary assists with coordinating new recollections or new data. Higher cautiousness creates more definite recollections; lower carefulness delivers more broad recollections [9].

By and large, two sorts of learning exist: slow learning and quick learning. In quick learning, weight update during reverberation happens quickly. It is utilized in ART1. In slow learning, the weight change happens gradually comparative with the length of the learning preliminary. It is utilized in ART2.

ART1 Adaptive resonance hypothesis is intended to group twofold vectors. This can be seen better with its engineering.

Design of ART1 It contains the accompanying two significant units.

Computational unit – This is the principal unit comprising the accompanying,

- *F_1 layer (input unit)* – It is grouped into two portions: the F1aa input layer and the F1bb interface layer.
  - The F1aa input portion layer: No process takes place in this portion in the adaptive resonance hypothesis. This portion holds only the input vectors. This is connected with the interface portion, i.e., F1bb layer.
  - The F1bb interface portion layer: This portion is responsible for combining the signal from the F1aa input layer and the F2 layer. This is connected to the F2 layer through the bottom-up weights b_{ij}. The F2 layer has a connection to F1bb interface layer through the top-down weights $t_{ji.}$
- *F_2 layer (cluster unit)* – This is a good to go layer. The unit having the biggest net info is chosen to become familiar with the information design. The enactment of any remaining bunch unit is set to 0.
- *Reset mechanism* – Crafted by this technique depends on the closeness between the hierarchical weight and the information vector. Presently, on the off chance that the level of this likeness is not exactly the watchfulness boundary, the group isn't permitted to get familiar with the example and a rest would occur [10].

Advantages of Adaptive Resonance Theory
- ART displays dependability and it acknowledges by a wide assortment of information sources given to its organization.
- To give all the greater outcomes, it tends to be incorporated and utilized with different methods.
- Craftsmanship utilized for different fields, for example, portable robot control, face acknowledgment, land cover order, target acknowledgment, clinical conclusion, signature check, and bunching web clients, and so forth.
- It has got benefits over serious learning like BPNN. The serious learning comes up short on capacity to add new bunches when considered significant.
- It doesn't ensure strength in framing bunches.

Disadvantages of Adaptive Resonance Theory

- Some ART networks are conflicting like the fuzzy ART and ART1 as they rely on the request in which preparing information, or upon the learning rate.

2.6 Classification

With the assistance of pre-sorted preparing datasets, grouping in AI programs impact a wide scope of calculations to characterize future datasets into separate and pertinent classifications [11]. Order is named as the course of distinguishing proof, understanding, and gathering of items and realities into present classes called "sub-populaces."

One of the most boundless utilizations of grouping is for sifting messages into "spam" or "non-spam," as utilized by the present top email specialist organizations. To put it plainly, grouping is a type of "design acknowledgment." In this, arrangement calculations applied to the preparation information track down a similar example (comparative number successions, words or feelings, and such) in later informational indexes.

2.7 Clustering

The unlabeled dataset is assembled by the idea called Clustering or bunch examination. It is a significant AI strategy. It tends to be characterized as "An approach to gathering the pieces of information into various groups, comprising of comparative data of interest. The items with the potential likenesses stay in a gathering that has less or no similitudes with another gathering." It does it by discovering a few comparable examples in the unlabeled dataset like shape, size, variety, conduct, and partitions them according to the presence and nonappearance of those comparable examples.

No management is given to the calculation since it is an unaided learning strategy and it manages the unlabeled dataset. Subsequent to applying this bunching strategy, each group or gathering is furnished with a bunch ID. ML framework can utilize this ID to work on the handling of huge and complex datasets. The bunching strategy is usually utilized for factual information investigation [12].

2.8 Probabilistic Reasoning

The idea of pr is applied in probabilistic thinking to demonstrate the vulnerability in information portrayal. Here the likelihood hypothesis is joined with rationale to deal with the vulnerability. It involves likelihood in probabilistic thinking since it gives a method for dealing with the vulnerability that is the aftereffect of somebody's apathy and obliviousness. There are loads of situations in the genuine world, where the conviction of something isn't affirmed [13].

Need of Probabilistic Reasoning in AI

- It is used in the situation for unpredictable outcomes.
- Probabilistic reasoning is necessary when the probability of the predicates is too bulky to control.
- Probabilistic reasoning is useful when an unidentified error occurs during the trial.

In the case of uncertain knowledge, problems can be solved in probabilistic reasoning using two approaches: Bayes' rule and Bayesian statistics.

The following are the issues used in probabilistic reasoning and its probability-related terms.

Probability Likelihood can be characterized as a likelihood that a dubious occasion will happen. Likelihood is the mathematical proportion of the probability that an occasion will happen. The worth of likelihood generally builds up somewhere in the range of 0 and 1 that addresses ideal vulnerabilities.

- $0 \leq P(A) \leq 1$, where P(A) is the probability of an event A.
- P(A) = 0, indicates total uncertainty in an event A.
- P(A) =1, indicates total certainty in an event A.

The following formula Eq. 3 is used to find the probability of an uncertain event.

$$\text{Probability of Occurence} = \frac{\text{Number of desired outcomes}}{\text{Total number of Outcomes}} \tag{3}$$

Event The outcome of every variable that is possible.

Sample Space The cluster collection of all events that are possible.

Random Variables The real-world objects and events are represented using random variables.

Prior Probability This is an amalgamation of prior probability. After considering all the evidence and information, the new information in posterior probability is calculated.

Posterior Probability It is to calculated after all evidence or information has been considered.

Conditional Probability When an event has already happened and the probability for the occurrence of another event is known as conditional probability.

2.9 Bayesian Network

Bayes' Theorem Bayes' theorem provides a formula to calculate probability of an event and given probabilities of other events [3].

Applying Bayes' Rule Bayes' rule is constructive when the terms: P(X|Y), P(Y) and P(X) have good probability and is helpful when needed to determine the fourth one. In case an unknown cause's effect needs to be perceived and that cause wants to be computed, the Bayes' rule (Eq. 4) will be

$$P(\text{cause} \mid \text{effect}) = \frac{P(\text{effect} \mid \text{cause})\, P(\text{Cause})}{P(\text{effect})} \tag{4}$$

Bayesian Network "It addresses a bunch of factors and their contingent conditions utilizing a coordinated non-cyclic chart."

This is likewise called as Bayes organization, Bayesian model, choice organization, or conviction organization. It involves likelihood hypothesis for expectation and peculiarity identification. Bayesian networks are probabilistic on the grounds that these networks are worked from a likelihood circulation in Fig. 12.

Joint Probability Distribution Consider the variables a_1, a_2, a_3,…,a_n then the probabilities of a different combination of a_1, a_2, a_3,…, a_n, are known as joint probability distribution.

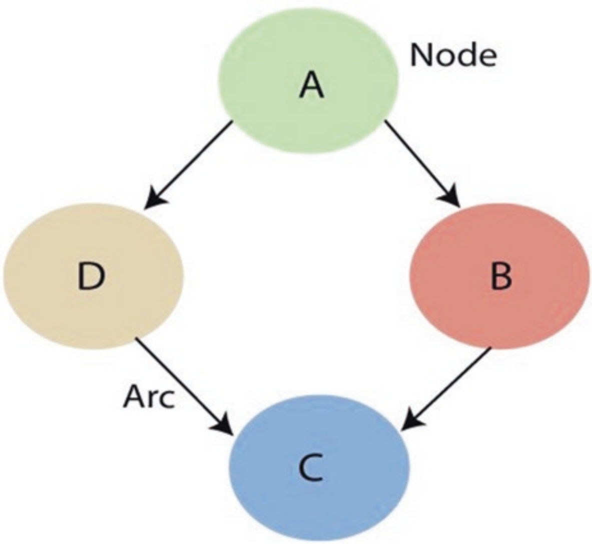

Fig. 12 Bayesian theory

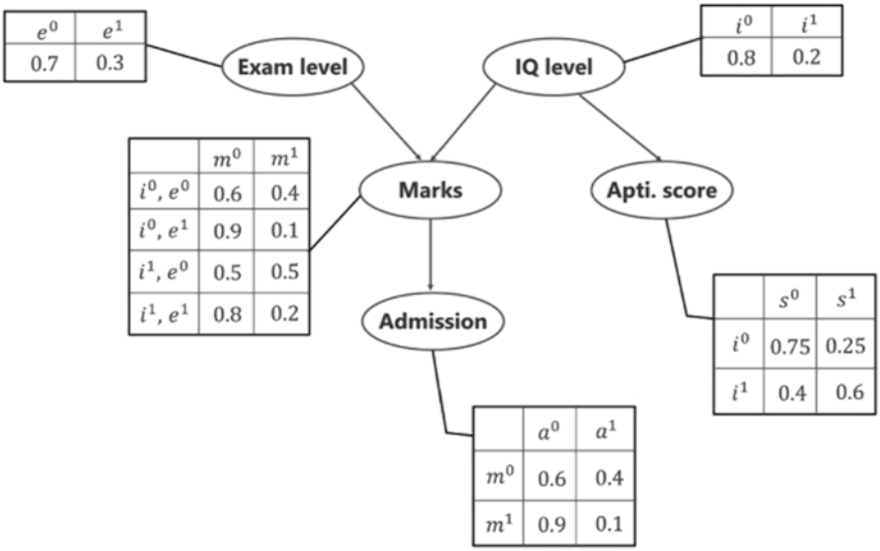

Fig. 13 Example of Bayesian Network

Example of Bayesian Networks The technique for Bayesian Networks and their benefits has been perceived with the assistance of a basic model. In the accompanying model, let us imagine that the given assignment is displaying of an understudy's imprints (M) for a test he has quite recently finished. From the given Bayesian Network Graph beneath, that the imprints rely on two different factors. The likelihood dissemination for getting conceded (A) to a college is likewise given beneath. In Fig. 13, the few tables showing the likelihood dissemination upsides of the given five factors.

3 Application Areas of Soft Computing

3.1 Agricultural Machinery

A color co-occurrence approach, in which co-occurring colors are mapped in a pixel matrix, is used to examine the texture of leaves to detect illnesses. To discriminate between weeds and crops, an image processing system and a fuzzy logic decision-making system are utilized. Water stress, nitrogen content, and nitrate leaching can be utilized to describe soil based on hazy and inaccurate information on soil type (nitrogen loss) using artificial neural networks and fuzzy inference systems to categorize crops based on color and referring them with digital picture panels; artificial neural networks and fuzzy inference systems might be used to classify crops based on color.

3.2 Biomedical Engineering

Pupil diameter (PD), electrocardiogram (ECG), and photoplethysmogram may be utilized to detect stress and other mental states using genetic algorithms and fuzzy support vector machines (PPG). Artificial neural networks (ANNs) may be used to study gene expression and recognize DNA patterns. Amino acid sequences may be classified and protein structure can be identified using fuzzy logic.

3.3 Consumer Electronics

Adaptive neuro fuzzy inference systems (ANFIS) may be easily integrated into consumer electronics such as cell phones, digital cameras, microwaves, and other devices to analyze fuzzy data and execute numerous dynamic tasks utilizing sensors.

3.4 Decision Support

Neural networks may be utilized in market analysis to provide a market prediction ahead of time, and a genetic algorithm can make the decision of which outcomes are the most effective and best. In the agricultural and housing markets, the quality of ground water may be estimated by building a fuzzy water quality index (FWQI) model utilizing data on water hardness (i.e., salts present in it).

3.5 Intelligent Agents

In the e-commerce industry, fuzzy set-based intelligent agents can instantly select which type of advertisement to display on a website depending on the particular user's characteristics. All of the user's web behaviors are utilized as an initial set of fuzzy data, which is analyzed in order to perform a specific action for the targeted user. A decision support system (DSS) may be built utilizing a number of concurrent intelligent agents based on fuzzy data sets, with each agent's result decided by genetic algorithms.

3.6 Nano and Micro Systems

Inter-atomic interactions and quantum mechanics are used to operate nano electronic devices. The use of linguistic data may be used to structure and program these systems. Because nano electronic systems are based on probability theories, the uncertainties of fuzzy logic work to their advantage.

Glass, silicon, and nitride thin films are employed in microelectromechanical systems (MEMS). The mechanical functionality of these systems may be affected when their dimensions shrink. When force is applied linearly, Young's modulus offers a measurement of a material's tensile strength. This is a common MEMS component. Young's modulus may be calculated using neural networks by providing the physical dimensions of the materials used as inputs and adjusting the weights of the nodes so that the output tracks the inputs.

3.7 Robotics

Intelligent autonomous vehicles (IAVs) are self-driving automobiles that resemble human decision-making. While driving, fuzzy sets are used to hold unsharp data, and genetic algorithms make judgments based on the selections from the fuzzy criteria. Accurate information is difficult to obtain in navigating robots. As a result, fuzzy logic emerges as the recommended approach.

4 Conclusion

For situations that are difficult to characterize using analytical or mathematical models, soft computing approaches are superior to traditional problem-solving methods. Fuzzy rule-based systems knowledge representation, paired with artificial neural network learning capabilities and evolutionary approaches like the genetic algorithm, presents a new potential path toward more intelligent and resilient robotic systems. Soft computing approaches help to achieve one of robots' long-term goals: solving issues that are unexpected and imprecise, such as those found in unstructured real-world contexts.

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Emerging Soft Computation Tools for Skin Cancer Diagnostics

J. Bethanney Janney, Sindu Divakaran, T. Sudhakar, P. Grace Kanmani, R. J. Hemalatha, and Manas Nag

1 Introduction

Machine learning (ML) and artificial intelligence (AI) are quickly developing fields, particularly adversely influencing numerous conventional organizations and enterprises, and offer to rebuild numerous parts of day-to-day existence. Such rebuilding will be especially helpful in medicine, where life or death choices could be altogether further developed utilizing information and calculations. High-level clinical image examination is progressively fundamental in the visualization, treatment, and analytical assessment of illness. A perspective of machine-learning and deep-learning algorithms is extended to investigate and prefer a non-invasive technique for skin cancer diagnosis that accurately classifies the lesions as malignant or benign melanoma.

Earlier recognition of skin malignancy is critical. Skin cancer is now considered to be a major hazardous form of cancer observed in humans. One of the biggest causes of skin cancer is the sun's ultraviolet (UV) emission. Continuous exposure to sun can affect ageing and pave the way for cancer development. The sun's UV light may damage the elastin fibers present in the skin, and when these fibers break down they continue to sag and stretch and finally lose the ability to get back to the original

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place [1]. Skin malignancy develops when the melanocytes mutate and become cancerous. Skin malignancy is commonly categorized as malignant or benign melanoma. When a group of melanocytes gather together and form a lesion, owing to elevated concentration of melanin, a brown pigmented patch appears on the skin. These melanocytic lesions may consist of cells that are benign or malignant. It is possible to divide non-melanocytic lesions into benign and malignant neoplasms. Seborrheic keratoses, vascular lesions, and dermatofibroma are examples of the former. The malignant neoplasm is termed basal cell carcinoma (BCC). It is the prevalent type of fatal skin disease, but owing to its slow growth, it is regarded as less hazardous than melanoma [2].

Melanoma is an assortment of melanocytic injuries that is dangerous. This injury progresses more quickly than BCC, profoundly fit for attacking tissues and metastasizing to different organs. The deadliest type of skin malignant growth is one of these melanomas [3]. Recuperating can be effective when melanoma malignant growth is recognized at the beginning phase. One of the strategies utilized by dermatologists to analyze melanomas is an imaging strategy called dermoscopy, where an amplification apparatus and a light source are utilized to review the skin injury. This enables the dermatologist to detect subcutaneous patterns that would require extensive preparation to be undetectable [4]. Furthermore, the determination is abstract and often difficult to imitate. Hence, programmed strategies should be created to help dermatologists give a more exact conclusion. Clinical image determination can be successfully performed utilizing Personal Computer vision. A computer-based demonstrative framework for the skin image has significant screening and disease-finding potential. Improvement in the determination of the progress of melanoma is accomplished utilizing computer-based object recognition system. As a visual framework frequently causes fault, the requirement for better accuracy and second opinions is featured. On the other hand, it decreases a doctor's assignments and obligations. Many investigations in the programmed recognition of melanoma have been created. The imminent advantages of such examinations are significant and immense. In addition, the interdependence of difficulties is high, and the new contributions in the area are highly valued. Then again, it is generally perceived that better precision is expected by the more certain and proficient identification frameworks [5].

2 Analogous Performance

To improve the computational capability of standard ABCD assessment, a computer-assisted diagnostic system is adopted. Melanin production and surface (photodynamic therapy [PDT]) qualities are characterized by features gained from local investigation of lesion intensity. The findings demonstrate that PDT structures are hopeful qualities that, when combined with standard ABCD features, can increase the detection efficiency of pigmented skin lesions [6].

A Boltzman Entropy novel technique is employed for categorizing carcinogenic and noncarcinogenic skin lesions. DullRazor performs hair removal, whereas lesion texture and color information are used to enhance lesion contrast. A hybrid method is introduced in lesion segmentation and outcomes are combined using the addition law of probability. Subsequently, the serial-based technique is implemented to extract and fuse attributes such as color, texture, and histogram of oriented gradients (shape). The merged attributes are then chosen using a novel Boltzmann entropy technique. Last, support vector machine (SVM) classifies the chosen features. Compared with current techniques, the suggested method detects and classifies melanoma relatively well [7].

A multi parameter artificial neural networks on basis of manageable personal health info with elevated sensitivity and specificity for early identification of non-melanoma skin cancer, even in the lack of known exposure to UV rays was generated [7].

A further approach had two phases: an initial step used a kernel- and region-based convolutional strategy to consistently crop the particular object on dermatological imaging, and the next segment used the ResNet152 framework to discriminate potentially cancerous abnormalities. The efficacy of the categorization methodology has been enhanced [8].

A deep convolutional neural network (CNN) based on a deep-learning strategy is also employed for appropriate identification of normal and infected dermatitis. The deep CNN paradigm is tested with transfer learning approaches such as AlexNet, DenseNet, MobileNet, ResNet, and VGG-16 to determine overall effectiveness. The eventual findings of the current deep CNN model are described as being much more effective than authorization learning techniques [9].

Furthermore, a CNN with a dynamic GoogLeNet topology is constructed. The eight performance indicators assessed were polygon region, kappa, categorization efficiency, sensitivity, F-score measurement, specificity, area under the curve, and time complexity. According to the observations, the generated CNN had the best calculation efficiency with the least amount of time to accomplish the assignment [10].

3 Evaluation of Skin Malignancy Using Machine-Learning Methodologies

In the development of computer-based detection methods for melanoma diagnosis, different classification algorithms were used. Whether one technique outperforms the other, however, is not evident. As there are robust and fragile points in each category process, selecting only one method to carry out all comparisons of features and descriptors is not simple. Therefore, five distinct algorithms were implemented in this work. An appropriate classification scheme for melanoma images is developed using methods of machine learning to characterize skin lesions as harmless or cancerous. Figure 1 uses machine-learning methods to demonstrate the flow chart of the classification of skin lesions.

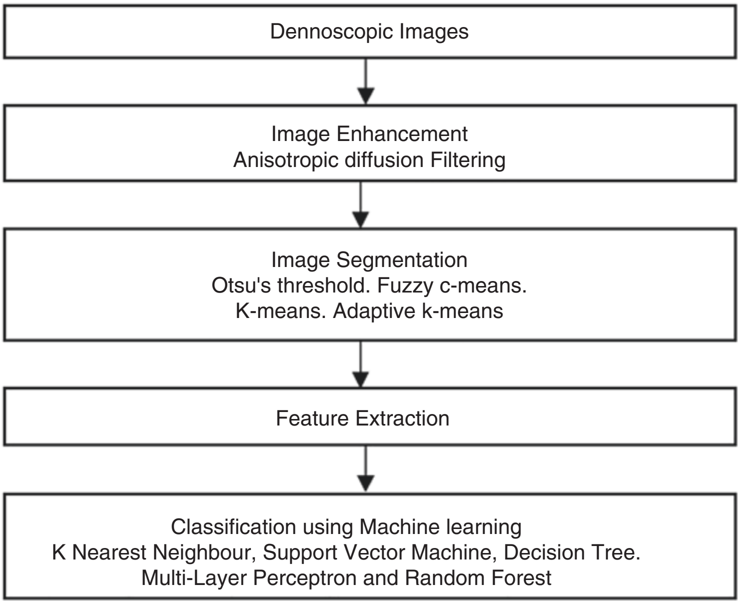

Fig. 1 Flow chart of skin lesion classification using machine-learning techniques

3.1 Anisotropic Diffusion Filtering

Dermoscopic images usually contain some artifacts. Powerful approaches to eliminate artifacts and enhance the appearance of the initial images are therefore required. The basic motive behind this pre-processing is to improve melanoma image quality by evacuating irrelevant portions and noise for further processing in the background of an image. Using 2D anisotropic diffusion filter, noise and artifacts were removed at the original point [11]. ADF method was applied to minimize image noises, assuring essential elements of image detail, generally borders as well as outlines / equivalent points are not disturbed from image view. On three channels (red green blue [RGB]) the anisotropic filters were implemented individually. Unsharp masking was implemented on an entire image only after denoising. The image was sharpened using gray world normalization. After that, color constancy was implemented on the three channels together. Hairs behave as an ambiguity on dermoscopic images. Gray world normalization is used to identify the hair. An inpainting technique was used to separate the identified hairs. Figure 2 shows the results of the steps used for pre-processing.

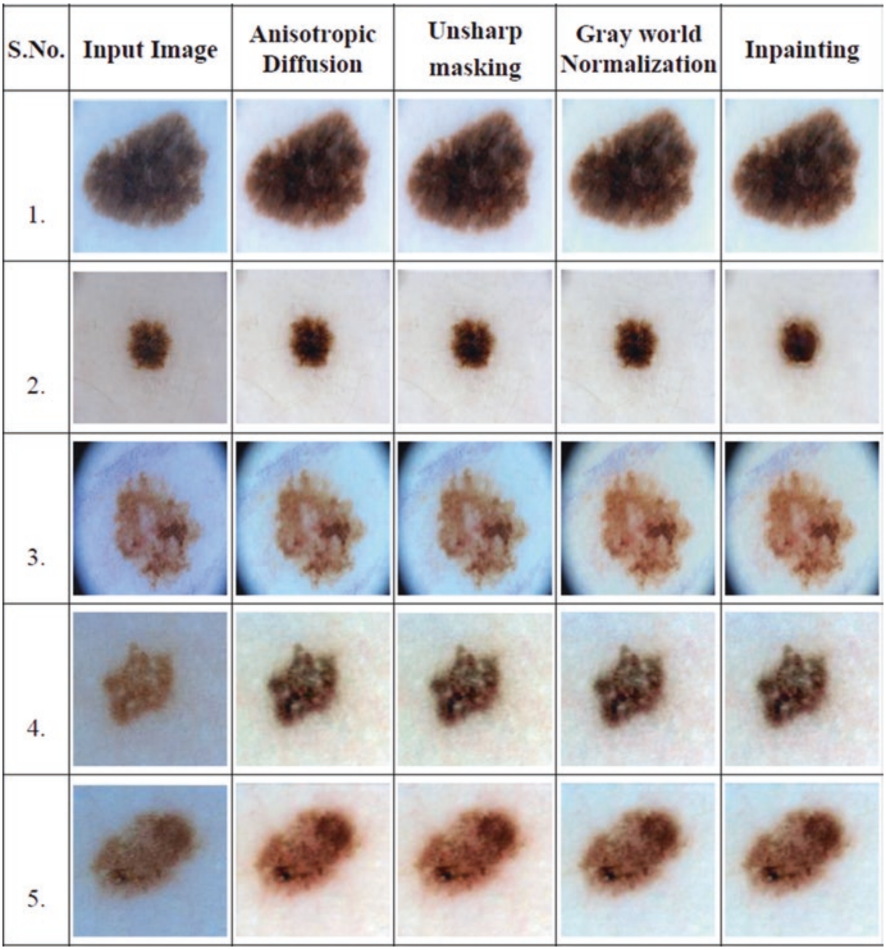

Fig. 2 Results of the pre-processing steps

3.2 Melanoma Segmentation Analysis

Numerous segmentation forms of algorithms such as Otsu's threshold, *k*, fuzzy *c*, and adaptive *k*-means were used for the segmentation of melanoma. Maximizing interclass variability and minimizing intraclass variability is performed using Otsu's thresholding method. A threshold limit is fixed and the value above the limit is regarded in the forefront and the value under the limit is taken in the background [12].

The variance of the inside class is described in Eq. 1 as:

$$\sigma_w^2 = \mathrm{weight}_{\mathrm{background}} * \sigma_{\mathrm{background}}^2 + \mathrm{weight}_{\mathrm{foreground}} * \sigma_{\mathrm{foreground}}^2. \tag{1}$$

Only the centroid defines all cluster. The closest centroid classifies each pixel. In *k*-means clustering [13], there were two clusters (Eq. 2):

$$\arg_{\min}\left(c_i, x\right)^2, c_i \in c. \tag{2}$$

The centroid needs an update under each iteration's end, wherein the succeeding equation is used to update the centroid. If the value does not change further, the iteration stops (Eq. 3):

$$c_i = \frac{1}{\left|s_i\right|}\sum x_i \in s_i, x_i\,. \tag{3}$$

Fuzzy *c* means algorithm functions through assigning each pixel to the segment. The comparison depends on the distance of particular pixel from multiple clusters. The Euclidean division between two points states that the correlated condition that can characterize *i* and *j* in Eq. 4 is

$$\mu\{i,j\} = \frac{1}{\sum_{k=1}^{2} d\{ij\} / d^{\frac{2}{m}-1}\{ik\}}. \tag{4}$$

There are two clusters: one cluster denotes the foreground whereas the background is denoted by the other one, m indicates the fuzziness factor, $\mu(i, j)$ represent the membership variable, $d(i, j)$ is Euclidean distance within *i*th data and the center of *j*th form of the data set. The outcome produced showcases the ground truth provided. The Dice similarity index (DSI) facilitates determination of image segmentation accuracy (Eq. 5):

$$DSI = \frac{2\left|\text{Grnd.Truth} \cap \text{Seg.Image}\right|}{\left|\text{Grnd.Truth}\right| + \left|\text{Seg.Image}\right|}. \tag{5}$$

To quantitatively assess performance of the segmentation method, the work also utilizes the Dice similarity coefficient. All targeted areas are effectively segmented using the above-mentioned segmentation techniques. The focus of this procedure is to evaluate the execution of segmentation with radiotherapy conveyance control of the distinct techniques for treating the targeted region. Abdel and Allan [14] provided analysis parameters on the basis of a unique class pertaining to region from the calculated DSI shown (Table 1).

In segmenting lesions, the *k*-means and Otsu's Dice coefficients appeared lower than FCM and adaptive *k*-means coefficients. Findings (Table 1) indicated that the Dice coefficient of adaptive *k*-means appeared significantly high and much more appropriate for region separation of images. Figure 3 represents the outcomes of the different segmentation processes.

Table 1 Computed Dice similarity index (DSI) with various clustering algorithms

S. No	Clustering algorithm	Computed DSI
1.	Adaptive *k*-means	0.809 ± 0.1693
2.	Fuzzy *c*-means	0.807 ± 0.2320
3.	*k*-means	0.748 ± 0.1794
4.	Otsu's threshold	0.712 ± 0.3070

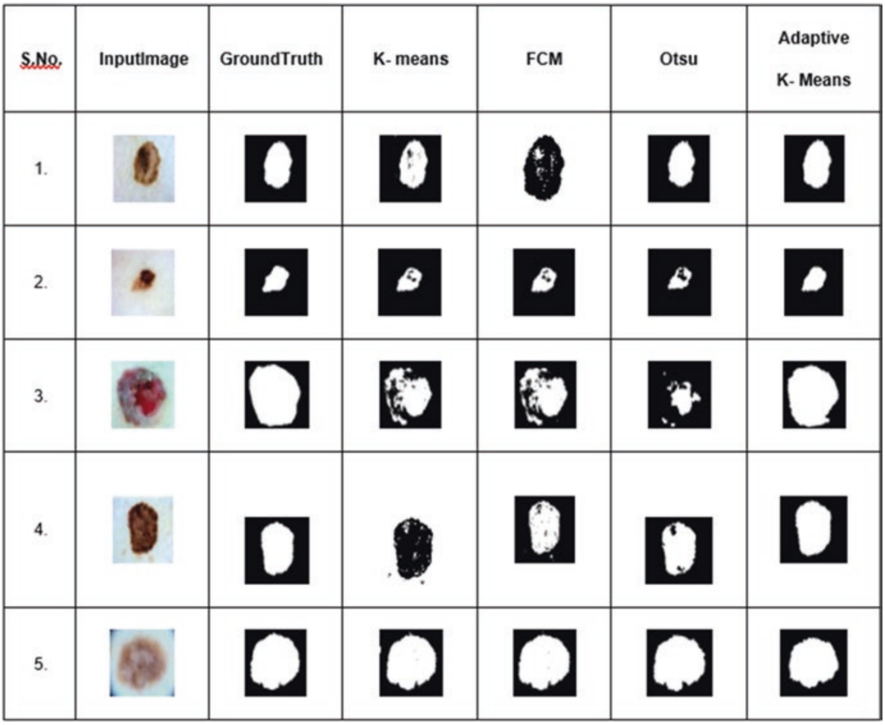

Fig. 3 Output images from various algorithms of segmentation

3.3 *Feature Extraction*

To categorize the images, feature extraction techniques are used to obtain features. Three elements of structure are obtained from binary differentiated images: irregularity, shape, and circularity signal.

Equation 6 shows how to calculate the irregularity:

$$\text{Irregularity} = \frac{\text{Standard Deviation}(\text{BI})}{\text{Mean}(\text{BI})}, \tag{6}$$

where BI is the binary image. The fast Fourier transformed the shape signal and split it into ten rays. Each ray was considered an element. There were 13 shape elements in all. Binary object circularity is calculated in Eq. 7:

$$\text{Circularity} = \frac{4 * \text{pi} * \text{area}}{\text{Perimeter}^2} \tag{7}$$

Texture-derived attributes were obtained through three distinct channels (R, G, and B) from segmented images. Using mean and standard deviation the first-order statistics of an image may be acquired. These are associated with separate pixel characteristics. Second-order image statistics obtained via the gray-level co-occurrence matrix (GLCM) accounting for spatial interdependence of two pixels at particular relative places. Contrast, correlation, power, homogeneity and entropy were five Haralick attributes acquired from the GLCM. The following formula is used to measure average (Eq. 8) and standard deviation (SD) (Eq. 9):

$$\text{Mean} = \sum_{k=0}^{L-1} r_k P\left(r_k\right); \tag{8}$$

$$SD = \sum_{k=0}^{L-1} \left(r_k - \text{mean}\right) P\left(r_k\right). \tag{9}$$

Ten local binary pattern features were also calculated [15].

3.4 Benign and Malignant Classification

Classifiers have been trained via obtained attributes. Five distinctive classifiers have been learned and their precision has been compared: k-nearest neighbor (k-NN), support vector machine (SVM), decision tree (DT), multi-layer perceptron (MLP), and random forest (RF) [16]. The condition of all classifiers has been enhanced by ten-fold cross-validation. Of the total images, 60% were used as training samples and the testing set utilized the remaining 40%.

3.5 K-Nearest Neighbor

This computation depends on a pseudo-parametric identification methodology. The output is determined as the category with the maximum malignancy from the k-most comparative events at the stage where k-NN is used for interpretation. The value of k has been maintained as five. The melanoma that is categorized as harmless or cancerous will be identified as the primary vote it gets from its nearest neighbor.

3.6 Support Vector Machine

It is selective. With labeled learning information being supplied, a hyperplane is drawn that chooses the boundaries of selection. To categorize images using SVM, the hyperplane separates item sets with completely unpredicted forms of memebership. The analysis of the hyperplane classifies the images as cancerous and non-cancerous.

3.7 Decision Tree

This classifier supports the algorithmic principle of supervised learning. The goal of using DT is to produce a training model that is used by learning data to predict category or estimate target variables by learning choice rules. By using tree delineation, the DT resolves the problem. The internal node of each tree is comparable with a quality. Each leaf node is associated with a category tag. In decision tree, it is typical to start at the base of the tree, predict a class label, and examine the root features with actual data. During examination, the algorithm compares the branch to successive nodes and moves forward. Once it reaches the leaf node of the expected class, the algorithm classifies as harmless (benign)/cancerous (malignant).

3.8 Multilayer Perceptron

This classifier relies on a neural mechanism (feed forward) made up of three layers. Each layer is entirely connected to the layers above in the system. The primary is the layer of input, the hidden level represents the second, and the tertiary is the yield layer. The input data are represented by nodes within the primary layer. All distinct node points of input layer are processed by using linear input mixture with node w weights linked to bias b and using activation function. It could be formed with $K + 1$ layers (Eq. 10) in a network frame for the MLP classifier as needed. The sigmoid operator is used by nodes in hidden layers (Eq. 11).

$$x = \left(\ldots f_2\left(w^T f_1\left(w^T x + \mathrm{b}_1\right) + \mathrm{b}_2\right)\ldots + b_k\right) \tag{10}$$

$$\left(z_i\right) = \frac{1}{1 + e^{-z_i}}. \tag{11}$$

Nodes in the yield layer use the softmax function (Eq. 12):

$$\left(z_i\right) = \frac{e^{z_i}}{\sum_N k = 1e^k}. \tag{12}$$

To train MLP, the back propagation method is utilized. The number of neural network nodes equivalent to number of categories in the yield layer.

3.9 Random Forest

This creates a DT group from an arbitrarily selected sub-set of the training set. It then summarizes the votes from various trees of selection to settle on the test object's ultimate category. It is made up of the number of DTs. There were 100 trees in this analysis. The principal distinction between DT and RF is that the single tree is represented by DT, whereas RF consists of multiple trees [17].

Receiver-operating characteristics (ROC) curve indicates sensitivity/specificity for testing to evaluate the consistency of five classifiers. The ROC curve is nothing but the true-positive (TP) rate and the false-positive (FP) rate relation. TP, FP, false negative (FN), and true negative (TN) are the four parameters that are utilized to figure out the accuracy, sensitivity, and specificity of the classifiers. The positive qualities effectively estimated by the model define the true-positive rate, and the false-positive rate is positively misidentified by negative attributes. The corresponding condition measured the accuracy of the different computational models (Eq. 13), their sensitivity (Eq. 14), and their specificity (Eq. 15):

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} * 100; \tag{13}$$

$$\text{Sensitivity} = \frac{TP}{TP + FN} * 100; \tag{14}$$

$$\text{Specificity} = \frac{TN}{TN + FP} * 100 \tag{15}$$

Figure 4 revealed the effects of classification using the ROC curve of five distinct classifiers.

The accuracy of different classifiers is mentioned in Table 2. The general accuracy of RF can be obviously noted to be the highest. The confusion matrix of five classifiers is depicted in Table 3, for DT, out of 900 (458 benign and 269 malignant) 727 are properly classified and 173 misclassified (benign), 99 are categorized as malignant and 74 as benign. For k-NN, out of 900, 727 are properly categorized (420 benign and 307 malignant) and 173 are found to be misclassified, 71 as malignant and 102 as benign. For MLP, 727 out of 900 are correctly classified (393 benign and 334 malignant) and 173 are misidentified, 54 as malignant and 118 as benign. For SVM, 727 out of 900 are properly classified (411 benign and 316 malignant) and 173 misclassified, 47 as malignant and 126 as benign. For RF, 727 are properly categorized (613 benign and 114 malignant) and 173 misclassified, 121 as malignant and 52 as benign.

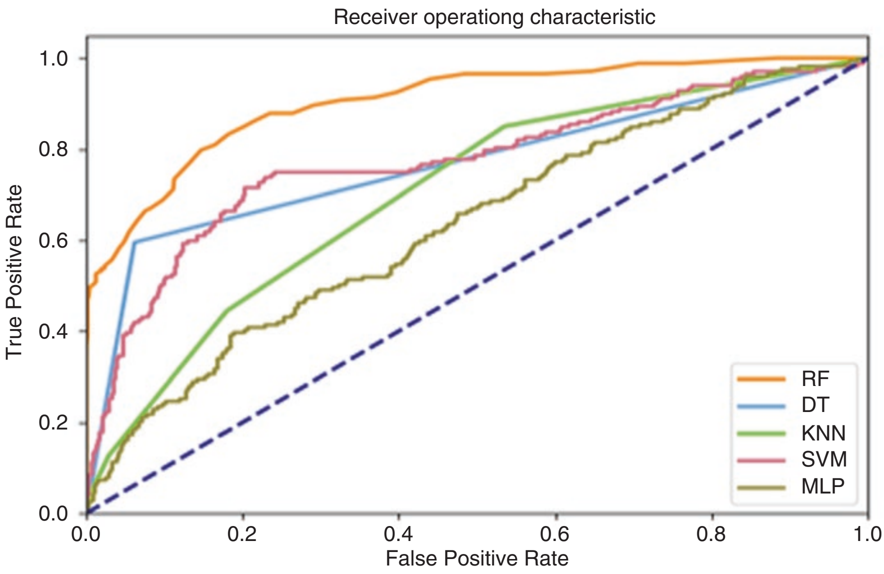

Fig. 4 Receiver-operating characteristic curve of the classifiers

Table 2 Classification accuracy by different computational models

Computational models	Training accuracy	Testing accuracy	Total accuracy
K-nearest neighbor	0.8405	0.57	0.7141
Support vector machine	0.7766	0.5865	0.6816
Decision tree	1	0.7287	0.8683
Multi-layer perceptron	0.9218	0.5587	0.7402
Random forest	1	0.8593	0.9337

The average calculation time for pre-processing to classification was found to be 2.043 ± 0.122 min. Overall computation interval in 20 images is graphically denoted in Fig. 5.

Table 4 demonstrates that the highest level of learning and test efficiency is generated by RF. A cross-validity score of 93.47% was estimated for RF.

3.10 Summary of Melanoma Classification Using Machine Learning

An effective melanoma image classification scheme has been developed to classify a noncancerous (benign) form and a similarly cancerous (malignant) type of lesion. Different segmentation algorithms employed over 900 dataset images. The DSI was used to validate the segmentation technique, and adaptive *k*-means clustering

Table 3 Error (confusion) matrix for classified images

	Decision tree		K-nearest neighbor		Multi-layer perceptron		Support vector machine		Random forest	
Parameters	Benign	Malignant	Benign	Malignant	Benign	Malignant	Benign	Malignant	Benign	Malignant
Correctly classified	458	269	420	307	393	334	411	316	613	114
Misclassified	99	74	71	102	54	118	47	126	121	52

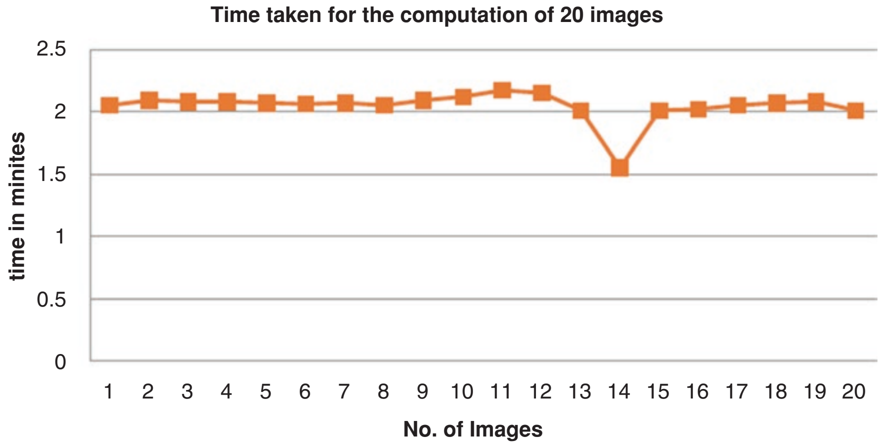

Fig. 5 Time taken for the computation of 20 images

Table 4 Comparative representation of present work with that of random forest classification

Parameters	Specificity %	Sensitivity %	Accuracy %
Ebtihal Almansour	85.84	93.97	90.32
Mohd Anas	–	–	83.33
Esteva et al. [20]	–	96	72.10
Gautam [27]	79.81	86.21	77.26
Li and Shen [23]	–	–	91.20
Random forest	–	–	93.47

outperformed the other clustering algorithms in terms of precision. The estimation of the efficiency of the five classifiers is determined. The best of five classifiers is assessed on the basis of precision, specificity, and sensitivity. The ROC plot is used for further analysis. From the observational outcome, the precision of the classifier is 93%, 86.9%, 75%, 71.5%, and 69% respectively for RF, DT, MLP, k-NN, and SVM. From this it could be surmised that the classifier with the greatest accuracy is RF. Thus, it served as an effective classifier for the detection of benign/malignant forms of skin lesions.

4 Deep-Learning Approaches to Skin Cancer Diagnosis

Deep-learning strategies are now employed to categorize harmless and cancerous lesions [18]. Using a similar sample, transfer learning techniques such as AlexNet are being used to assess effectiveness. The layout of the intended work is presented in Fig. 6 as a schematic drawing.

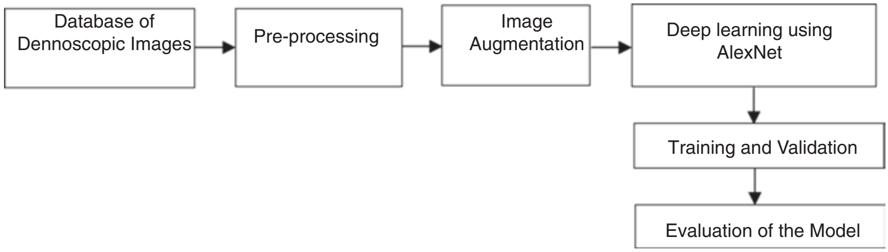

Fig. 6 Schematic layout: diagnosis of skin cancer

4.1 Image Enhancement

Many strategies exist for downsizing, hiding, filtering, hair elimination, and converting RGB shading to gray resolution images. They are implemented to greatly reduce noise and reflective aberrations. The median window is used to de-clutter the image, disguise the undesirable traits, and eradicate them. It is frequently employed to remove the error without diminishing the image quality, thereby improving the image clarity [19].

4.2 Augmentation of Images

Augmentation is a technique for increasing the volume of data without generating new data by introducing slightly altered imagery into old training samples. The training sample number could be considerably increased, or the system could be protected against overfitting, through oversampling. To minimize overfitting, augmentation parameters such as rotation, shear, zoom, channel shift, height shift, and width shift are applied [20].

4.3 AlexNet Topology

Krizhevsky designed AlexNet, which uses the ReLu function. AlexNet provides multi-general processing unit (GPU) learning, in which half of a net neuron is handled on one GPU whereas the remaining neurons are processed on the other. AlexNet is composed of eight layers: five convolutional layers with a combination of max-pooling layers, and three fully linked layers [21]. This primarily enables larger-scale training, thereby also reducing the training process [22].

4.4 Experimental Findings

The effectiveness of skin cancer screening is improved by employing deep neural networks. Melanoma malignancy is diagnosed through images from the International Skin Imaging Collaboration (ISIC) repository dataset. Initially, the image is loaded and normalized. It is processed via image augmentation, and the architecture and layers of the network are constructed. The CNN uses AlexNet [23, 24]. The system is then trained using supervised learning after the loss function of the dataset is created. During testing and training, the data are equally divided. Finally, the validation is performed by computing accuracy (Eq. 16), F-measure (Eq. 17) and recall (Eq. 18):

$$\text{Accuracy} = \frac{TN + TP}{TN + TP + FN + FP}; \tag{16}$$

$$F - \text{Measure} = \frac{2TP}{2TP + FN + FP}; \tag{17}$$

$$\text{Recall} = \frac{TP}{FN + TP}. \tag{18}$$

The deep neural module in MATLAB R2020b is employed to construct and validate the network. The dataset aggregation is categorized into two major groups: 80% data trained and 20% data utilized for testing. The learning rate is set at 0.0001 and the number of epochs is limited to six. In elements of accuracy, F-measure, precision, and recall, the relevant formulas are utilized to analyze and evaluate the results of the network procedure.

The ISIC dataset (http://www.isic-archive.com) has been used to collect 900 pictures (600 benign and 300 malignant) for this proposed assessment [25]. Eighty percent of the lesions in each category were selected at random and utilized as training examples, whereas the leftover data have been used as a testing set. Both malignant and benign presentations are displayed in Fig. 7. The use of AlexNet to characterize benign and diseased lesions is a high priority of our conceptual framework.

The confusion matrix of AlexNet is given in Table 5. Table 6 depicts its performance when examining quantitative metrics such as accuracy, F-measure, precision, and recall evaluation outcomes. The efficiency of the AlexNet framework training and testing processes is depicted in Fig. 8.

To validate the efficacy of the AlexNet architecture, F-measure, precision, accuracy, and recall parameters are estimated. Specific factors such as TN, FP, TP, and FN were employed to compute the performance of the AlexNet system [26]. The TP factor refers to the percentage of positive traits correctly identified by the system, whereas the FP score refers to the percentage of negative traits misappropriated as positive.

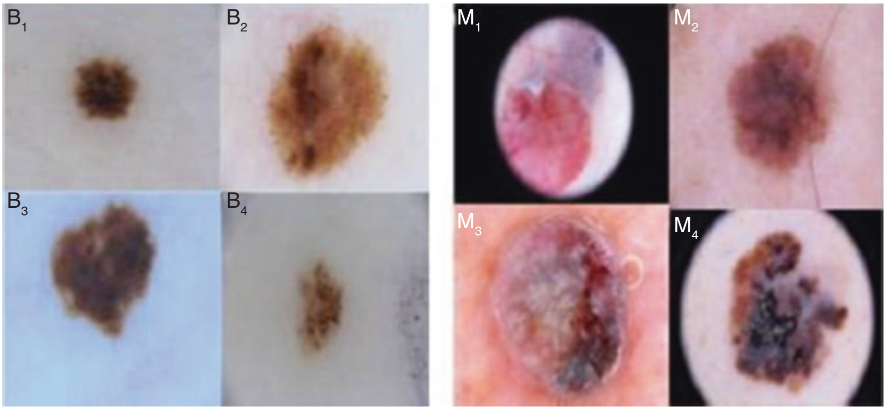

Fig. 7 Sample images of cancerous (M) and noncancerous (B) lesions

Table 5 AlexNet's confusion matrix

True \ Predicted	Benign	Malignant
Benign	560	29
Malignant	16	295

Table 6 Correlation of quantitative performance measures

Performance measures	AlexNet
F-measure	0.929
Precision	0.910
Recall	0.948
Accuracy	0.95

Table 5 indicates that AlexNet correctly categorized 855 images out of 900 datasets, whereas 45 were inaccurately categorized (295 malignant and 560 benign). Table 5 shows the quantifiable parameters used by AlexNet. AlexNet is shown to have a 95% accuracy level. As an outcome, AlexNet may be used by specialists to categorize dermoscopy images and generate appropriate predictions.

As a result, larger sample sources are set to increase the significance of the findings. The approach can be implemented in a clinician's computer-assisted sensing devices to aid in the identification of skin malignancy. It can also be applied to images of lesions taken from patients and delivered on handheld devices. It therefore allows a quick cancer diagnosis, which dramatically streamlines therapy and improves chances of recovery.

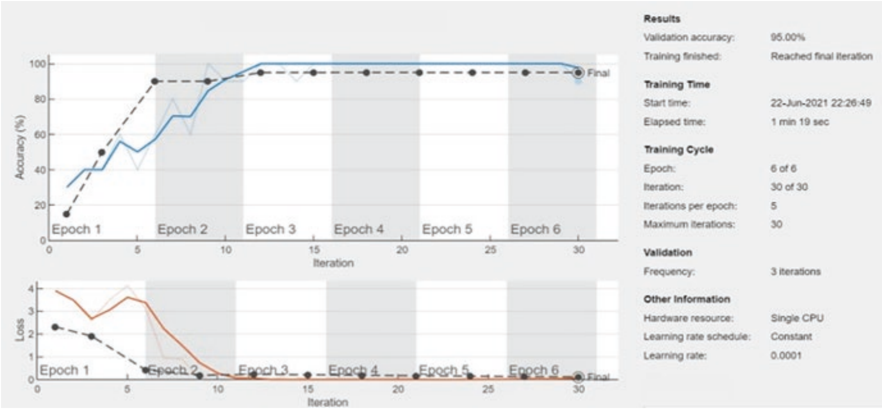

Fig 8 Progress of the training of AlexNet

5 Conclusion

The significant impacts of work in this field are summed up concerning portions of the framework, potential strategies, intercessions, and insightful results. A viewpoint on machine learning and deep learning is described in the above review to propel a skin injury acknowledgment technique for characterization on dermatoscopic images of threatening and harmless lesions. A thorough examination data set is produced by gathering dermoscopic images from different chroniclers such as the International Society for Digital Imaging of the Skin and ISIC. To empower similar examinations on dermoscopic image division and characterization calculation for research and benchmarking purposes, the PH2 dataset has been made. The main attribute of the examination work is that around 900 dermoscopic image tests are chosen for the exploratory work. Thus, the handling speed is essentially expanded. A systematic evaluation was successfully carried out between different machine-learning techniques, such as DT, MLP, SVM, k-NN, RF, and deep-learning techniques such as AlexNet. The experimental results illustrate the importance and main achievements of this work, which has an estimated classification accuracy of 93% for the RF model and 95% for the AlexNet model. Therefore, the deep-learning system shows an automated diagnostic technique for constant and accurate determination of skin malignancy with an extraordinary ability to carry out treatment strategies using non-invasive methods.

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Part VII
Precise Healthcare Technologies Serving in Cancer Research

Advanced Sustainable Technological Developments for Better Cancer Treatments

Heena Patel, Himanshu K. Patel, and Igor Dinner

1 Introduction

Cancer is among the most leading diseases due to which death occurs in the world. In 2020, there were millions of new diagnoses, and deaths were recorded. The most common types of cancer were breast cancer, lung cancer, colon cancer, rectum cancer, prostate cancer, skin cancer, blood cancer, stomach cancer, etc. From all of the above types, the most common causes of deaths due to cancer in 2021 were due to lung cancer, liver cancer, and stomach cancer [5].

For better understanding of all type of cancer causes and treatments, there are many areas gaining attention of many researchers. In cancer, some body cells multiply and spread to other adjacent body parts. We can say it's a very complex disease which is very hard to cure. There are many types of cancer-like diseases which are diagnosed and located at different locations of organs of the body and sub-tissues. There are also other types of cancer classifications based on their molecular arrangements.

In addition to this, they look different based on the location and stage of the cancer. In place of complexity and appearance of cancer, they are treated with the common generic therapies [2]. There might be chances to reduce the cancer if identified

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and treated early. There are two elements of cancer diagnosed at early stage: early diagnosis and screening.

2 Early Diagnosis

If cancer is detected at an early stage, cancer is treated well with greater possibilities of survival and less chances of deaths. There would be remarkable chances of improvements in cancer patients if cancer is detected at an early stage and timely treatment given to the patients.

There are three points to be considered for early diagnosis:

- To become familiar with the signs of different types of cancer and to consult the doctor for advice.
- Need to have acquittance of assessment and diagnostic techniques available.
- Finish the treatments on time.

Early diagnosis and detection of characteristics of cancers is relevant in all types of cancers. There are many cancer programmes that are created to decrease delays in diagnosis, treatments, and care for proper cancer treatment and care.

2.1 Screening

The main objective of screening for cancer is for the identification of a specific type of cancer and also to diagnose the individual with research suggestive of a precancer stage before the development of more symptoms. During screening, when abnormalities and diseases are identified.

These screenings for cancer are very impactful for only a few types of cancer and not effective for all types. The selection of patient for different cancer screening is based on the age of the patient and different risk factors to omit the wrong studies of diagnosis. A few examples of screening methods are colonoscopy, sigmoidoscopy, mammography, HPV (human papillomavirus testing), etc.

2.2 Cancer Effective Treatment

A proper diagnosis is important for the proper treatment of cancer and to reduce the death ratio. The first step for the treatment is to determine the goal to cure cancer. The secondary goal is to improve the patient's quality of life, which is the most important goal. This goal is achieved by supporting cancer physically, psychologically, and spiritually and providing palliative care in the terminal stages of cancer.

2.2.1 Palliative Care

Palliative care is a major and important treatment, especially to cure cancer patients and to make them live their life with their families. Palliative care will be helpful to people to live their life more comfortably. Palliative care is needed in cities and places where the number of cancer patients is higher and needed to cure when there is less chance for recovery. A special team of doctors, nurses, and all other specialists works to give special and important treatment to the cancer patient. So finally, we can conclude that palliative care is provided based on the requirement of the patient not on the forecast of the patient's condition. It is appropriate for any type of patient of any age or any stage, even for a seriously ill patient who needs curative treatment.

More than 90% of cancer patients having advanced stage of cancer get relief from physical pain, psychological treatment, and meditation through palliative care.

To treat cancer and to relieve patients' pain, palliative care is essential for improved and good health strategies and good care from home. Oral morphine is good for the treatment of moderate to severe cancer pain.

2.3 Types of Treatments of Cancer

The stage of the cancer decides which type of treatment is needed for a cancer patient.

2.3.1 Biomarker Testing System for Cancer Treatment

Biomarker testing is a type of cancer treatment in which to find the genes, proteins, and other substances that provide the facts about the cancer, as shown in Fig. 1. Biomarker testing system can be helpful to the patient and doctor to select the type of cancer treatment [4]. The pattern of biomarker may vary from person to person. Some biomarkers check the effect of oncology on how the cancer treatments work, and it helps the doctor to diagnose and treat patient in a better way.

Biomarkers testing for cancer treatments can be used for more purposes:

- Approach to patients' risk of cancer development.
- Regulate the patients' risk of cancer recurrence.
- Predict the probability that a given therapy will work for a particular cancer patient.
- To observe cancer development to decide if therapy is working or not.

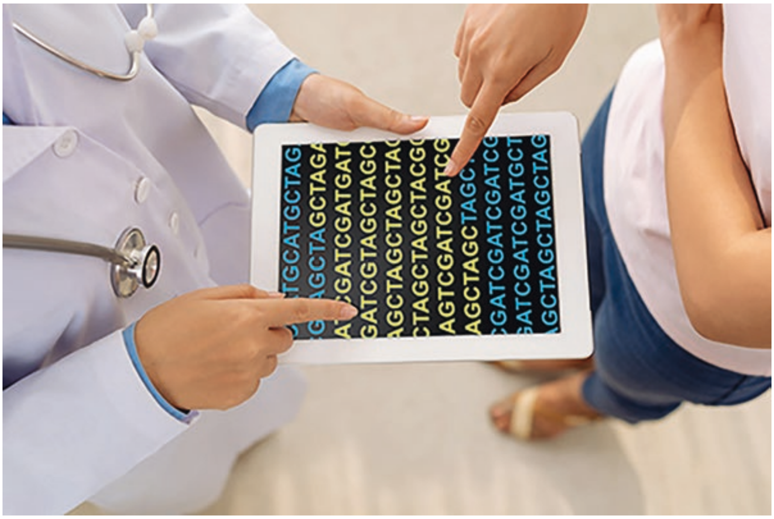

Fig 1 Biomarker testing system [National Cancer Institute: United states Government official Site data]

2.3.2 Biomarkers' Uses for Targeted Therapies

The first step is to select the biomarker and then the next step is to determine whether there is any genetic change driving the growth of tumour or that can be targeted with available drug. There are also researches going on for developing new therapies like targeted therapy drugs that decrease the growth of cancer cells.

Another name of biomarker test is a companion diagnostic test when it is paired with a specific type of cancer treatment. Biomarker testing and genetic testing are different that if someone has inherited mutations that are responsible for cancer. Inherited mutations originate since the birth. They are passed on to you by your parents [9].

Chemotherapy To treat cancer patients, chemotherapy uses many drugs to kill cancer cells growing (Fig. 2). It only works to stop cancer cells' growth, divide them and stop generation of new cells. As the drugs used are very powerful, they also affect and damage healthy cells. In standard chemotherapy, these powerful drugs can be used [11, 12]. In this type of therapy, doctors use different ways, as listed below:

- During surgery or radiation therapy, neoadjuvant chemotherapy is used to shrink tumours.
- In adjuvant chemotherapy, when surgery for cancer is finished or radiation is used to diminish cancerous cells.

Fig. 2 Chemotherapy [National Cancer Institute: United states Government official Site data]

- To treat leukaemia and lymphoma, the chemotherapy uses blood or the lymphatic system.

Hormone Therapy In hormone therapy, hormones are used to treat cancer cells as it slows or stops the growth (Fig. 3). There are two types of hormone therapy: in the first type, hormone therapy is used to block the body's ability to reproduce new hormones, and another type of hormone therapy is in which they restrict the hormone's behaviour in the body against cancer cells.

Hyperthermia Hyperthermia is a type of non-invasive method to treat cancer patients by increasing tumour tissue temperature to as high as 113 °F to simulate blood flow to supply oxygen to the tissues and tumour cells (Fig. 4), which are more sensitive to radiation. Through this hyperthermia radiation therapy, the doctor boosts the control of the tumour cells by minimizing damage to normal tissues [10, 14].

Fig. 3 Hormone therapy [National Cancer Institute: United states Government official Site data]

Fig. 4 Hyperthermia Therapy [National Cancer Institute: United states Government official Site data]

Photodynamic Therapy Photodynamic therapy is a therapeutic procedure used to treat malignant cells to exert cytotoxic activity. In photodynamic therapy (Fig. 5), photosensitizing agents are administered, followed by irradiation at different wavelengths corresponding to an absorbance band of sensitizer. There would be many

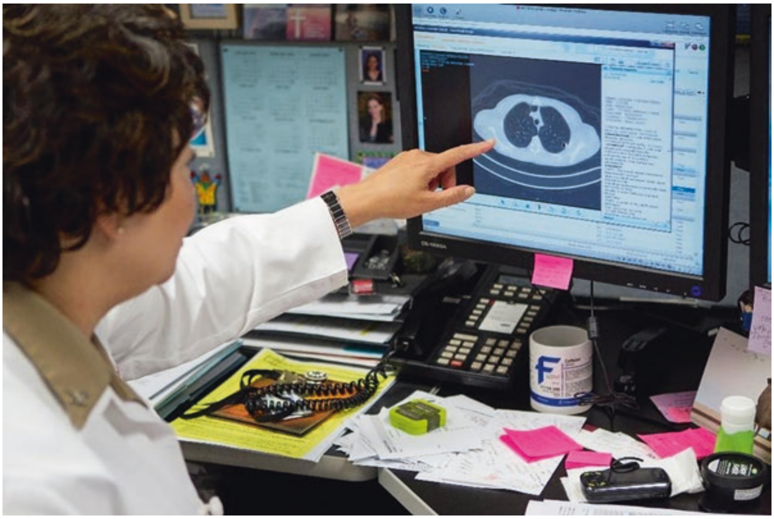

Fig. 5 Photodynamic therapy [National Cancer Institute: United states Government official Site data]

events that lead to death of tumour cells. It also damages the microvascular and creates inflammatory reaction. It can cure the patient having inoperable cancers and significantly improve the cancer patient's life. In PDT, there is a laser light or LEDs are used to treat cancer patients. This type of phototherapy is most commonly used as a local treatment to treat a particular part of the body [3].

Radiation Therapy There is one more therapy to treat cancer patients: radiation therapy (Fig. 6). In this, different beams of intense energy radiation are used to kill cancer cells. In radiation therapy, X-rays are often used, but protons or other types of energy also can be used.

Stem Cell Transplant Specialized blood cells means stem cells are used in stem cell transplant that restore stem cells, and they help to grow into blood cells in patients whose cells have been destroyed because of high doses of chemotherapy or radiation therapy to treat cancer (Fig. 7). These stem cells are very important cells that grow into various types of blood cells like white blood cells, red blood cells, and platelets. People having disorders related to the bone marrow have problems with their blood cells.

Surgery Surgery is a type of procedure used to provide the care to the cancer patients in which doctor removes the cancer from the body (Fig. 8).

Targeted Therapy In targeted therapy, the treatment uses drugs to target a specific part as target that changes into cancerous cells that help treat them to grow, divide, and spread [6] (Fig. 9).

Fig. 6 Radiation therapy [National Cancer Institute: United states Government official Site data]

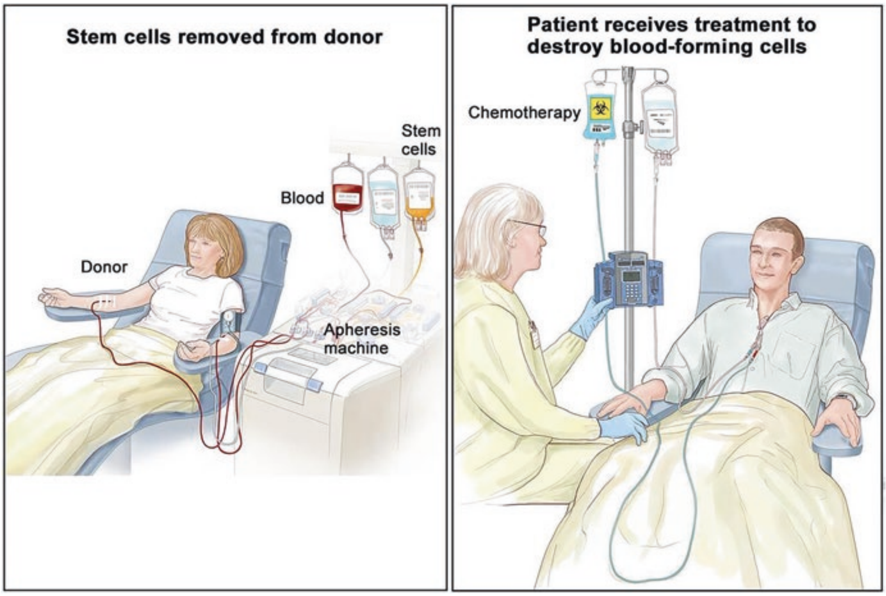

Fig. 7 Stem cell transplant therapy [National Cancer Institute: United states Government official Site data]

Immunotherapy Immunotherapy is a useful treatment to treat cancer patients through boosting the immune system to fight against cancer (Fig. 10). Through this treatment, the body's immune system becomes more active and boosts the immune system to fight against diseases and infections [13].

Fig. 8 Surgical therapy [National Cancer Institute: United states Government official Site data]

Fig. 9 Targeted therapy [National Cancer Institute: United states Government official Site data]

There are many immune checkpoint inhibitors that are used as drugs that directly block and stop the target places of the immune system. These target places are part of the immune system of the body to make the system too strong to fight against diseases. By blocking cancer cells from growing by these types of drugs makes immune cells to respond more strongly to cancer.

T-cell transfer therapy is a type of therapy that increases the capability of immune cells of the immune system and is also used to enhance the natural ability of T cells to fight against cancer. In T-cell transfer therapy, immune cells are taken from the

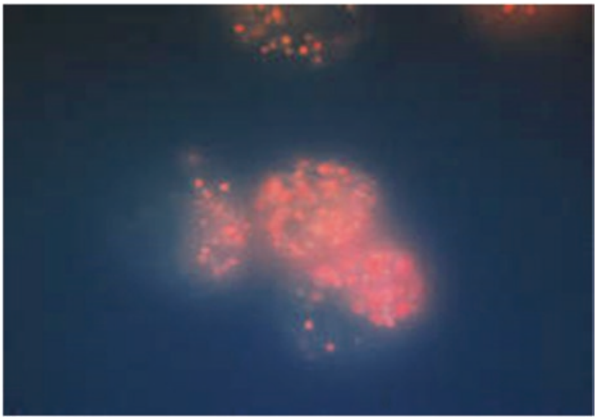

Fig. 10 Immunotherapy [National Cancer Institute: United states Government official Site data]

tumour which are most active against cancer. They are selected such that they become active and be able to attack cancer cells in a better way. They are grown in many batches, and then they are placed back into the body through a needle directly into the vein to attack and to fight against more cancer cells [7].

Monoclonal antibodies are immune system proteins used to treat cancer. They are created in the laboratory to bind to specific target places on cancer cells. There are few monoclonal antibodies cancer cells are marked so that they will be seen properly and can be destroyed easily by the immune system. These monoclonal antibodies are a type of immunotherapy which are also called therapeutic antibodies. Treatment vaccines work to boost the patients' immune system against cancer by boosting immune response to cancer cells.

Immune system modulators help to increase the body's immune system response against cancer cells. Several agents affect specific places of the immune system, whereas other agents affect the immune system in another way [10]. The agents for modulating the immune system are used for immunotherapy to boost the body's immune response against cancer.

The list of various types of immune-modulating agents includes Cytokines - a type of proteins which are madeby leukocytes (white bolld cells). They play an important role in the body's immune response and immune system to fight against cancer cells.

3 Transcriptomic, Proteomic, and Metabolomic Techniques

The data regarding genes is also used for understanding effects of drugs and treatment in body's physiological systems. It is also used to correlate the genotypic effect to phenotypic effect like transcriptome, proteome, and metabolome.

3.1 Transcriptomics

Main macromolecules of genes and production are ribonucleic acids (RNA). RNAs depend on the genomic template of the cellular process through transcription. During transcription, a segment of the DNA is copied into the RNA. The segments of DNA transcribe into the RNA molecules that encode proteins to produce m-RNA (messenger RNA). The assembly of protein uses the cellular process.

Transcriptomics are used to characterize different states of cells, tissues, or cell cycle phases by different patterns of expression and also used to explore the molecular mechanisms. They are used to differentiate the biomarker's expression between the diseased state and healthy state.

3.2 Comparative Transcriptomics Analysis

Comparative Transcriptomics Analysis (CTA) is an approach to find the gene expression profiles. Different models are presented as per the development of technology to treat patients [8].

Immunotherapy is the cancer treatment used to cure cancer, and it is the treatment in which the concept of precision and personalized medicine (PPM) is used. PPM therapy is selected and tailored as per the requirements of each individual. In precision cancer, treatment includes precision medicines, which involves testing DNA from patients' tumours [3].

3.3 Proteomics

Proteomics is used to identify and classify the types of proteins and the relationship between all the types of proteins in a cellular system. If we use PPM, data used in transcriptional changes or abundance of proteins would be important for diagnoses, development, and treatment of diseases.

It is clear that all the patients' cancer types are different, so cancer treatments are also different. They all have different responses to generic treatments like chemotherapy, radiation, hormone therapy.

3.4 Precision Medicine

Precision medicine is the combination of predictive, preventive, personalized, and participatory healthcare service. There are many researches going in the field of molecular biology and information technology to make precision medicine a reality and to make use of it. Cancer is one of the most important and leading threats in developed countries. In precision cancer medicine, research is one of the most hopeful. There are many challenges of PCM in the fields, such as technical, organizational, ethical, legal, social [1].

4 Conclusion

I have attempted to highlight the common types of cancer, effective cancer treatments, importance of early diagnosis of cancer, and its possible treatments. I have also tried to identify the probable areas of effective cancer treatment approaches as per the patients' need. I have tried to cover the positive impact of PCM to improve cancer care with less harm to healthy tissue.

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Healthcare Technologies Serving Cancer Diagnosis and Treatment

R. Ramya, A. Siva Sakthi, R. Rajalakshmi, and M. Preethi

1 Introduction

One of the most common and deadly diseases in the world is cancer. Early prediction of cancer can extend the survival rate of the patient. Early diagnosis and cancer prediction can be achieved by incorporating artificial intelligence in picture. The application of artificial intelligence in cancer research and oncology is vast. These include early prediction, detection, and diagnosis of cancer and its sub-types, treatment optimization, and identification of new therapeutic targets in drug discovery. Data from various imaging modalities are used for training the model. Cancer research involves prevention, causes, and development of cancer and genes involved in it. Cancer is described based on the cell that formed them, which is epithelial or squamous cell. Cancer is divided into many types based on its origin such as carcinoma, sarcoma, leukemia, lymphoma, myeloma, melanoma, brain, and spinal cord tumors. Carcinomas are the most common types of cancer among various cancer types, and they are formed by the epithelial cells which cover the inside and outside surfaces of the body. Carcinoma that forms in different epithelial cells have specific

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names. One such type is adenocarcinoma; this is a cancer in epithelial cells that produce mucus or fluids. Breast cancer is a type of adenocarcinoma. Cancer that forms in squamous cells is known as squamous cell carcinoma; this is a type of epithelial cell which lies just beneath the outer surface of the skin. Lung cancer belongs to this type of carcinoma. In this chapter, cancer research in breast cancer and lung cancer is addressed.

1.1 Breast Cancer

The most common type of cancer among the female population is breast cancer. It can be either benign or malignant. It is a malignant type that starts in the epithelial cell lines of the female breast. Several factors can increase the risk of getting breast cancer, which include lifestyle changes and damage to the genetic material; genetic mutations that led to breast cancer have been experimentally linked to estrogen exposure. Defects in genes like BRCA1, BRCA2, and P53 can also cause breast cancer. Based on the type of spreading nature of cancer, it is classified as in situ and invasive breast cancer.

Cancer which starts growing at milk duct and not grown in the entire organ is termed in situ breast cancer, whereas invasive breast cancer is a type where the cancer cells spread into the entire breast. Preliminary diagnosis of breast cancer includes physical examination of the organ, and radiation methods like mammogram and breast ultrasound. Advanced diagnosis includes tissue biopsy and breast MRI. The treatment includes chemotherapy, radiation therapy, and surgical removal of breast. Chemotherapy uses drugs to destroy cancer-causing cells. Chemotherapy can be given to the breast both before and after the surgery, depending on the individual's symptoms or needs. Radiation therapy uses high-powered beams of X-ray and protons to kill cancer cells. It can be done by passing the radiation from the machine that aims at the cancer cells, i.e., external beam radiation. Radiation therapy can also be done by placing a radioactive element inside the body, i.e., brachytherapy [1]. The various types of breast cancer are shown in Fig. 1.

The malignant growth that begins in the covering of the milk channel and is painless goes under the type ductal carcinoma in situ. It is an early type of bosom disease and it is reparable whenever treated early. On the off chance that it is left untreated, it spreads to the encompassing tissue and is called intrusive ductal carcinoma. This kind of malignant growth is the most well-known sort of bosom disease and records for around 70–80% of the bosom disease analyzed and has a place with this sort of disease. It is normally found in men too [2].

The disease cells which present in the lobules of the bosom go under the kind of lobular carcinoma, which don't spread beyond the lobules that is all there is to it is painless. Lobular carcinoma is exceptionally treatable and when this moves to next stage it becomes intrusive lobular carcinoma. It spreads to the encompassing bosom tissue as well as goes into the circulation system and lymphatic framework and

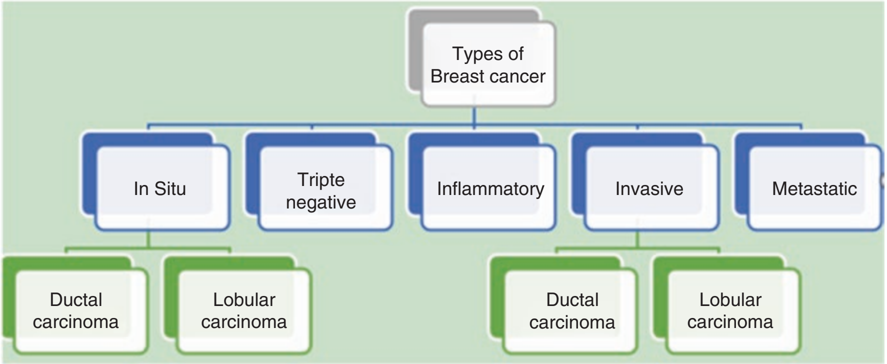

Fig. 1 Breast cancer types

spreads to different organs in the body. Among different sorts of bosom disease, it is the second most considered normal kind of bosom malignant growth on the planet.

The disease cells which tried negative for chemical epidermal development factor receptor 2 (HER 2), estrogen receptors, and progesterone receptor go under triple negative bosom malignant growth. This sort of disease is challenging to treat with hormonal treatment since it misses the mark on normal receptors. Being the most forceful type of bosom cancer, chemotherapy might be a reasonable choice.

One of the forceful and quickly developing malignant growth cells are inflammatory bosom disease. In this malignant growth, the disease cells invade the skin and lymph vessels of the bosom. Whenever the malignant growth cells block the lymph vessels, the bosom becomes red, enlarged, reversal, straightening, and dimpling of areolas might happen.

Metastatic malignant growth is the last phase of disease where the malignant growth cells spread to different parts of the body, particularly to lungs, liver, bones, and cerebrum [2].

1.2 Lung Cancer

The most well-known reason for disease passing in all kinds of people overall is because of cellular breakdown in the lungs. This kind of cancer begins in the parenchyma of the lungs or bronchi. Chain smoking is additionally one of the significant reasons for cellular breakdown in the lungs. Presenting to cancer-causing specialists like asbestos and metals, for example, nickel, arsenic, and chromium has the most noteworthy gamble of getting cellular breakdown in the lungs at a later phase of life. It is the most commonly analyzed disease around the world. Persistent openness of cancer-causing agents and tobacco smoke prompts strange development of lung epithelium. Hereditary changes happen assuming that the openness of such specialists proceeded and lead to harm in protein union. This influences the periods of the cell cycle and advances carcinogenesis.

The most well-known quality changes liable for cellular breakdown in the lungs incorporates MYC, BCL2, p53, EGFR, KRAS, and p16. In view of the presence of the cellular breakdown in the lungs' cells under magnifying instrument, it is extensively grouped into Small Cell Lung Cancer (SCLC) and Non-Small Cell Lung Cancer (NSCLC). SCLC is more normal among smokers and it is described by little cells with no particular core. It has a higher development rate and metastasize to different organs like central nervous system (CNS), liver, and bones. The SCLC and NSCLC can be separated by particular sorts of biomarkers.

Ordinarily seen biomarkers in SCLC are thyroid record factor 1, CD 56, synaptophysin, and chromogranin. NSCLC is a typical term which incorporates numerous different kinds of cellular breakdown in the lungs [3]. The sorts of cellular breakdown in the lungs are displayed in Fig. 2.

Squamous cell carcinoma is primarily connected with smoking. It tends to be available in lungs as pancoast growth and hypercalcemia. The cancer in the prevalent sulcus of lungs is named as pancoast growth. Post-medical procedure repeat spot of pancoast cancer is cerebrum. It is dominatingly found in men to ladies.

Adenocarcinoma is most usually found in ladies and non-smokers. This is because of the openness of cancer-causing specialists. The biomarkers answerable for adenocarcinoma incorporate Napsin A, Cytokeratin-7, and thyroid record factor 1 [3]. Adenosquamous carcinoma has over 10% of blended glandular and squamous parts, while enormous cell carcinoma misses the mark on separation of a little cell and glandular or squamous cells. Carcinoid cancer is additionally partitioned into average and abnormal. Commonplace carcinoid conveys better visualization and is sporadically connected with carcinoid conditions. Cellular breakdown in the lungs can be analyzed by CT filter, PET sweep, bronchoscopy, mediastinoscopy,

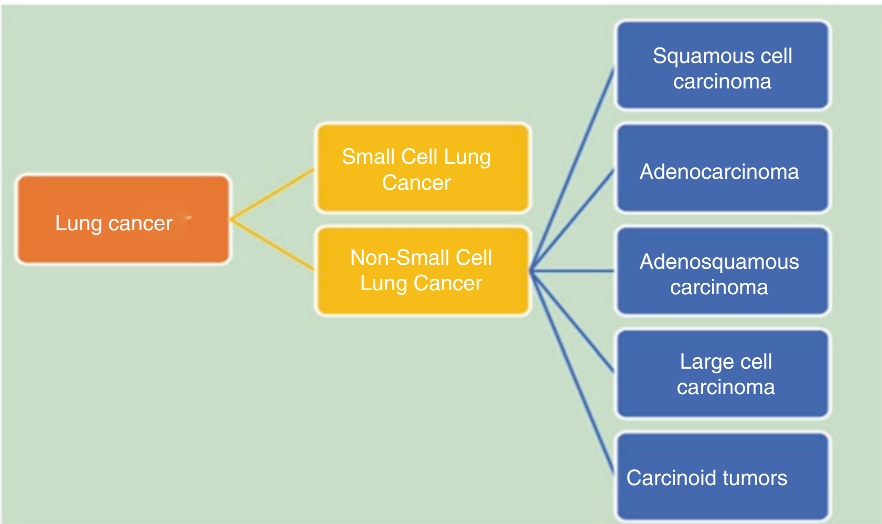

Fig. 2 Types of lung cancer

thoracoscopy, and biopsy. Therapy for cellular breakdown in the lungs incorporates radiation treatment, chemotherapy, immunotherapy, designated drug treatment, and medical procedure. The medical procedure methodology for cellular breakdown in the lungs includes wedge resection, segmental resection, lobectomy, and pneumonectomy [4].

2 Imaging Modalities for Cancer Screening and Detection

2.1 Imaging Modalities

Imaging modalities help in screening and diagnosis of cancer images. The preceding section gives an overview of different imaging based on various regions in electromagnetic spectrum and some impedance, thermal, and elasticity properties of human tissues that are in clinical usage and under research.

X-ray imaging: The human body is allowed to flow the X-ray beam into the body and the non-absorbed beams are recorded by the film or computer screen. The techniques which use X-ray imaging are computed tomography (CT), fluoroscopy, mammograms, digital breast tomosynthesis, and radiography. These non-invasive techniques use ionizing radiation to generate images of the body [5].

Ultrasound imaging: Breast images are obtained by passing high frequency ultrasound waves. Breast ultrasound is required to identify and differentiate solid masses and cysts. But this method may not predict all the early signs of cancer possibilities like micro-calcification, which is a micro calcium deposit. It is suitable for pregnant women and age less than 40 years [5].

Radio wave imaging: The low-frequency range of the EM spectrum are the radio waves. The radiowave imaging gives 3D image of the tissue in which it travels. Acquisition of radio waves are done using multi-static array processing which uses radio waves that is suitable for breast cancer screening and diagnosis [5].

Magnetic resonance imaging (MRI): MRI employs muscular magnetic field and radio waves for the diagnosis of breast cancer. This helps to spot the footage and location of tumor and also to know the status of tumor growth for treatment. A contrast agent named Gadolinium is inoculated into the human body before the test. The agent is washed out through the kidneys [5].

Gamma imaging: Using mammogram, it is difficult to identify lumps in the breast where gamma imaging helps to diagnose it. The radioisotope Technetium (99mTc) is injected into the body which emits gamma rays, and it is captured by the gamma detectors. Positron emission tomography and breast-specific gamma imaging use this imaging technique [13].

Functional magnetic resonance imaging (fMRI): fMRI uses the combined concepts of MRI and blood oxygen. It helps to identify the molecular behavior of breast. Diffusion weighted imaging and dynamic contrast-enhanced MRI belong to the fMRI technique [5].

Breast thermal imaging: The infrared (IR) light emitted by our body surface is the source of thermal imaging. The emitted IR light is captured by an IR camera and records the thermal pattern. The cancer region reflects more IR light than other regions. This technique is radiation-free, contactless, and painless [5].

Nuclear medicine imaging: Radio tracers are infused into bloodstreams where they emit radiations and are captured by a radio detector. Scintimammography, sentinel lymph node scintigraphy, and positron emission tomography work on this imaging principle [14].

Electric impedance imaging: Cancer cell has low electrical impedance. Electrodes are attached to the body, and electrical impedance of the body cells is recorded in electrical impedance tomography [15] and electrical impedance mapping. These recordings from the electrodes are reconstructed as images which are used for further study.

Elasticity imaging: This is a hybrid imaging technique that encloses ultrasound imaging and elasticity imaging software. Cysts and solid lesions in breast can be differentiated in elasticity imaging. Digital image elasto yomography uses elasticity property of tissues and measures the variation in healthy and cancer tissues [12, 16].

Photoacoustic imaging: This is a hybrid technique which works on photo-acoustic effect. Laser pulse of 532 nm from an optical microscope focuses on the sample, and ultrasound is used to record the image [17].

Microwave imaging: Microwave region of electromagnetic spectrum is used for image capturing. Water content of tissues possess dielectric properties like permittivity and conductivity. The dielectric properties vary for malignant and normal tissues, and this variation is recorded and constructed as 2D and 3D images [6]. Figure 3 shows the image modalities under research which are not familiar in clinical usage.

2.2 Cancer Screening and Diagnosis Techniques

Cancer screening refers to abnormalities in human cells. Thermography, electrical impedance tomography, ultrasound, and magnetic resonance Imaging techniques help for cancer screening. Diagnosis refers to locate the cancer cells; how much it has spread and also identify its stage. Mammography, positron emission tomography, tomosynthesis, and electronic palpation imaging techniques support both screening and diagnosis. The preceding section provides the mechanism of operation, sensitivity, specificity, and method of examination of different imaging techniques. Sensitivity in medical diagnosis refers to positive result of a test and specificity tells the negative result of a test.

Mammography: In mammography, low energy X-rays are used to examine human breast, which help in preliminary spotting of breast cancer. This shows a sensitivity of 90%, also in contrast, specificity greater than 94%. It may cause pain in

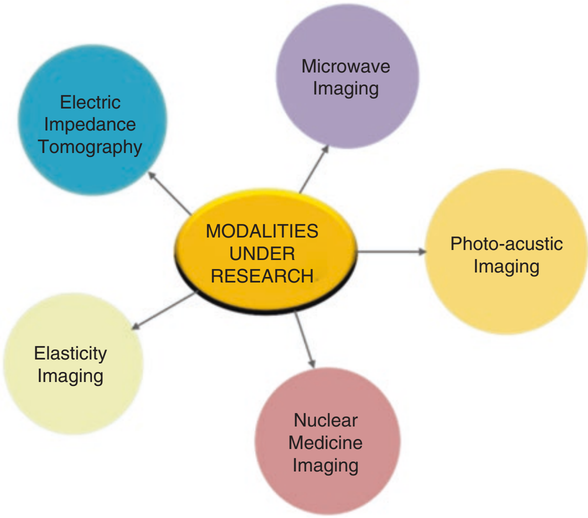

Fig. 3 Breast imaging modalities under research

breast, reaction to contrast reaction and claustrophobia. It is not suitable for women of all age group and pregnant women. Tomosynthesis, the 3D mammography uses low energy X-rays and gives 3D image of the breast with sensitivity of 84% and specificity of 92% [5–7]. Contrast-enhanced mammography (CEM) has sensitivity similar to MRI and shorter than MRI in predicting lesions. Non-ionic low osmolar iodinated dissimilitude material is rendered to the person under examination intravenously before examination. The dosage amount of 1.5 ml/kg is passed at a rate of 3 ml/s. After 120 s of dosage, low-energy and high-energy images are obtained by bilateral craniocaudal and mediolateral oblique imaging [18].

Magnetic resonance imaging: Radio waves, along with muscular magnetic field, is utilized in MRI. Based on the emission of radio waves by the body tissues, the image of organ is obtained. It gives a high resolution image and suitable for breast implants. On the other hand, it suffers from contrast dye reaction and risk of excessive sedation. Its sensitivity is 90%, and its specificity is 50% [5, 6].

Ultrasound scan (US): Ultrasound is a screening technique that has a transducer to produce ultrasound frequency acoustic waves and it is passed into the body and reconstructed as image. This can guide doctors to do biopsies. US supports to scan certain organs, whereas it is not suitable to scan brain, lungs, and pelvis. Its sensitivity is about 82%, and its specificity is about 84% [5, 6].

Positron emission tomography (PET): Radioactive tracers are injected into the body that emit gamma rays from the tracer substances. PET helps to find out the spread of cancer to other regions. It has improved localization and better image contrast. This technique is not suitable for kidney patients and may give allergic reactions and also it's more expensive than other imaging techniques. Its sensitivity is about 90% and specificity is about 86% [5, 6].

Thermography: Thermography is a screening technique, where temperature sensors are placed on the skin surface and surface temperature is measured. It is free from radiation and can be used as wearable. Its sensitivity and specificity are greater than 90% [5].

2.3 Lung Cancer Detection Using CT Scan Images

Lung cancer is a killer disease seen in a large proportion of the population. Cells in lungs grow abnormally, which is difficult to predict in early stages. Smoking and exposure to toxins are the major causes of lung cancer. This section gives an insight on tumor detection, features, and classification of tumor from CT images [8].

Tumors are classified as benign and malignant based on their size, shape, and appearance. Sizes less than 10 mm are benign and greater than 10 mm are considered as malignant. With respect to shape, malignant is classified as lobulated, speculated, ragged, and halo. Benign has an even appearance whereas malignant has uneven appearance [12].

CT image obtained is subjected to pre-processing to diminish the unnecessary regions. Pre-processing includes smoothing, noise removal, applying filter, histogram equalization, median filter, etc. [11, 12]. Features of tumor can be based on shape intensity and texture. The shape of mass includes area, perimeter, compactness, and circularity. Texture decides the visual smoothness of image in spatial domain. It includes mean, variance, median, standard deviation, and smoothness. Intensity features are based on the statistics of individual pixels. Features include uniformity, contrast, entropy, energy, and homogeneity [9–12].

3 Cancer Prediction and Detection with Data Analysis

Disease is the best reason for death and enduring universally, according to the World Health Organization. Precise and early disease diagnosis will decrease the malignant growth-related wretchedness and mortality. Computer supported disease assessment helps in identifying the high risk nature of malignant cancer. Early discovery limits the gamble of malignant growth spreading to different areas of the body and guarantees legitimate treatment when the illness initially shows up.

In the field of medication, the volume of information created has extended essentially since the computerization era [19]. Simultaneously, there has been an increase in interest in utilizing AI and neural organization advancements to break down clinical information and to create expectations [20]. The preparation strategies for ML and Neural organization insightful instruments for clinical applications by and large need huge volumes of named information, which is a specific test.

Conventional manual naming is a period monotonous procedure that, much of the time, forestalls the age of huge satisfactory examples. Gathering huge homogeneous datasets in the clinical calling is extreme, notwithstanding the naming trouble. The inborn fluctuation of authentic information assembled in regular clinical practice, specifically, presents a compromise between informational index quality and informational collection amount. This strategy utilized AI classifiers, for example, support vector machine (SVM), logistic regression, decision tree (C4.5), random forests, and K-nearest neighbors (KNN) on the breast cancer. Figure 4 shows the Wisconsin Diagnostic informational collection used to foster the best powerful and prescient calculation for bosom malignant growth screening.

It begins with information assortment and afterward continues on to pre-handling, which incorporates four stages: information purging, quality determination, target role setting, and element extraction. The data is then used to foster AI calculations that can foresee bosom malignant growth in view of a particular arrangement of execution pointers. To furnish the new information and allotted marks to assess the calculations and it is executed [21]. This is often achieved by utilizing the train test split capacity to divide the marked information that obtained into two sections. The preparation information or the preparation set accommodates 75% of the information used to foster our AI model. Test information, or test set, is 25% of the information that will be utilized to perceive how well the model performs. In the wake of applying five essential calculations, support vector machine has accomplished great outcomes in breast cancer forecast and analysis, and it provides the best exhibition concerning exactness and accuracy.

3.1 Cancer Analysis Using Neural Networks

Breast cancer is the most common cancer among women, according to statistics. A basic neural network can be used to detect and forecast the possibility of cancer in breast lumps. A Particle Swarm Optimized Wavelet Neural Network (PSOWNN) that uses mammograms as its input set to detect worrisome spots in breast masses is used to detect breast abnormalities in digital mammograms. The goal of WNN optimization is to enhance classification accuracy in breast cancer diagnosis while lowering the rate of mis-classification. The PSOWNN classifier, which was created by applying the PSO algorithm to WNN, is being tested for diagnosing breast cancer in mammograms.

The application of neural networks in breast cancer detection provides a significant advantage over traditional methods in terms of time taken for examination. ANN investigates a massive amount of data after a short training period, whereas traditional approaches need a long time to evaluate one data at a time.

ANNs are simple to implement and estimate outputs with high precision. Predicting outcomes in medicine has traditionally taken years of experience and knowledge in the field. Furthermore, other forms of ANNs can be developed to identify breast cancer, broadening the frontiers for earlier and easier diagnosis of breast cancer.

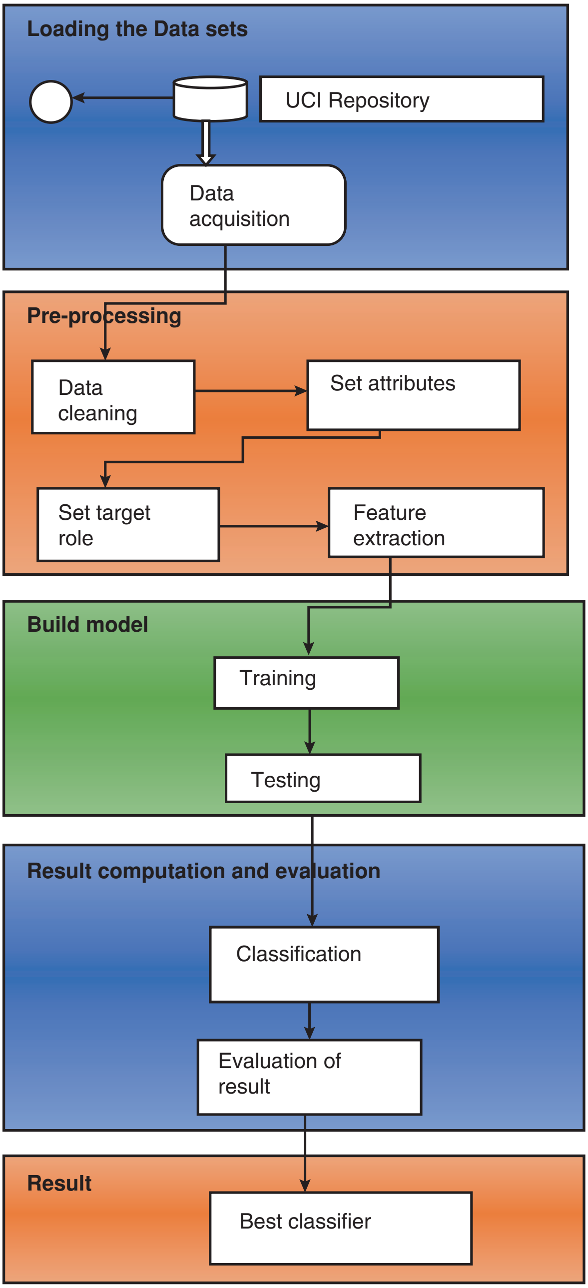

Fig. 4 Process of breast cancer prediction using machine learning algorithm

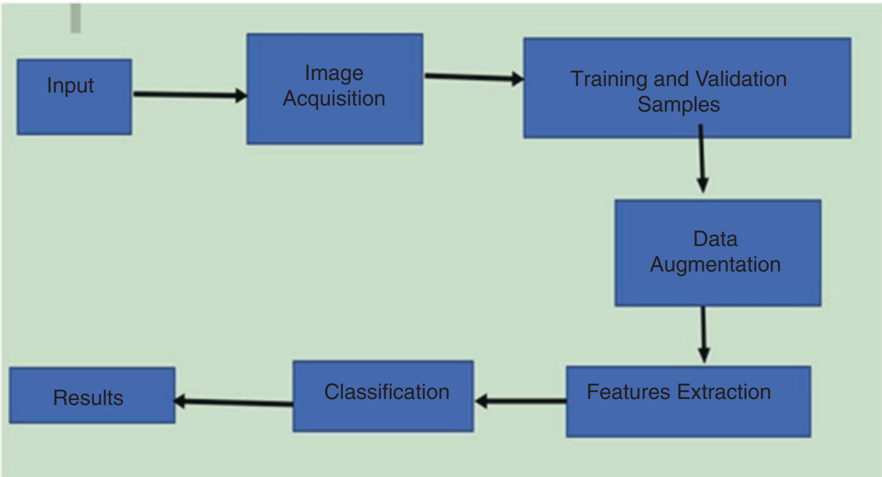

Fig. 5 Block diagram for detecting cancer using neural networks

BreakHis data set of breast tumor data set was used to collect the data [22]. After that, the data was separated into various training and test set ratios. Ten percent of the training set is used as a validation set for cross-validating the model in all trials. Image scaling and data augmentation are examples of image pre-processing, as shown in Fig. 5. To get better results, we used image re-sizing and data augmentation methods like rotation, zooming, random flip, horizontal flip, and vertical flip to pre-process the photographs. Before the training, we scaled the images to 230*230 and 460*460 pixels. The use of these strategies increases the performance of the network by allowing it to generalize more effectively and avoid over-fitting [23].

4 Conclusion

The chapter provides a summary of cancer diagnosis, treatment, biopsy method examination, different imaging techniques used in screening and diagnosis, and finally data analysis in cancer detection. When concerned about imaging techniques, thermography and ultrasound scans are radiation-free, less expensive, and suitable for screening. Mammography and tomosynthesis are based on protocols and give good sensitivity in diagnosis. MRI and PET scans are expensive; on the other hand, they give high resolution images with improved localization. After preliminary diagnosis by the above techniques, to confirm the presence of cancer, biopsy procedure guides us. Through endoscopy, the cancer cells are located and tissues are collected and examined further in biopsy. Being an invasive procedure, this may cause the cancer cells to burst and spread to surrounding cells. Data analysis in cancer detection became a new horizon with machine learning and artificial neural networks. ANN with swarm optimization techniques gives improved results in processing massive data.

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Therapy and Diagnosis of Cancer Techniques: A Review

P. Poovizhi, J. Shanthini, R. M. Bhavadharini, S. Karthik, and Anand Paul

1 Introduction

1.1 Outline of Artificial Intelligence

The term artificial intelligence (AI) gives rise to mixed feelings. Artificial means "man-made", and intelligence means "thinking power", which characterizes AI. Supplanting people with a savvy machine is the genuine importance of AI. The questions emerge: "what is intelligence?", "how to gauge the knowledge?" Or "how does the cerebrum work?" These are significant inquiries when humans attempt to figure out the man-made consciousness. The objective of AI is to create or make machines that act smart. Here, the production of a machine with modified calculations that can work with its own insight is the adage of AI.

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1.2 Introduction to Cancer

Definition: Some of the cells in the human body growing uncontrollably and spreading to parts of the body define the disease named cancer.

Cancer cells can be found anywhere in the human body. Cell division is the technique where the human cells grow and multiply to emerge as new cells. The older cells and damaged cells will die, and the new cells take their place [1]. Sometimes the damaged cell may multiply, which should not take place. These cells may form tumors. These can be cancerous or not. Tumors that are not cancerous are called benign.

Cancerous tumors spread or get into nearby tissues and will penetrate to all places in the body to form new tumors. This process is named metastasis. Benign tumors do not usually spread into nearby tissues. Once removed, the tumors do not grow.

1.3 Differences Between Cancer Cells and Normal Cells

The difference between cancer and normal cells can be in the way of growth, cell death, stickiness, and spread. Figure 1 shows the difference between normal and cancer cells.

Table 1 describes the difference between cancer cells and normal cells [2, 3].

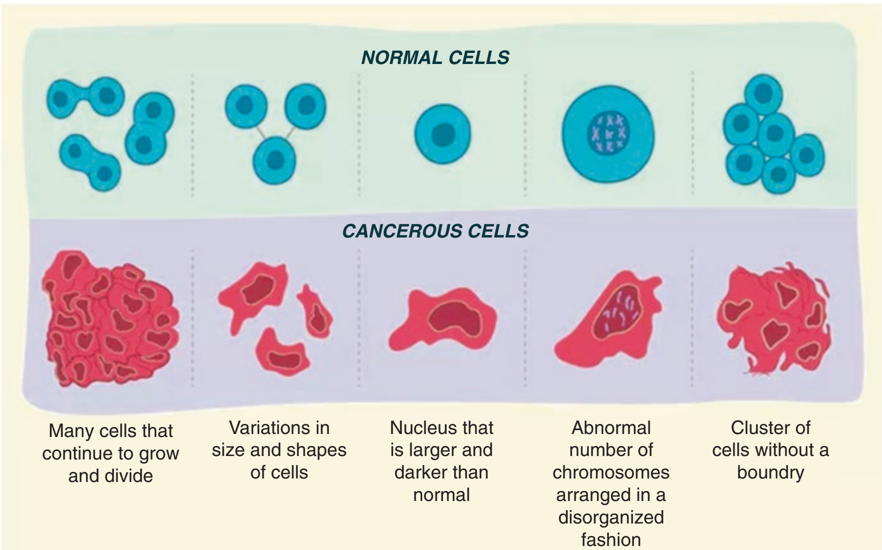

Fig. 1 Cancer cells versus normal cells

Table 1 Difference between cancer cells and normal cells

S.No	Cancer cells	Normal cells
1	Grow in the absence of signals	Only grow when they receive signals
2	Ignore the signal to die or divide	Do not move around the body
3	Immune system functions in the manner of removing the dead cells. These cells hide from the immune system	Not affected by the functioning of the immune system
4	Change the nature of the chromosome	Do not change the nature of the chromosome

2 Goals of AI

The aims of AI are listed below:

- Replicates human intelligence
- Builds a machine to perform human intelligence tasks
- Creates a system that exhibits behavior, learns new things by itself
- An intelligent connection of perception and action

3 Interconnection of AI with Other Disciplines

Intelligence is composed of:

- Reasoning
- Learning
- Problem solving [4]

Figure 2 shows the interconnection of AI with other disciplines.

4 Techniques Used in Cancer Diagnosis and Therapy

Cancer continues to threaten patients and induces researchers to carry out the research work. Many research projects are in progress to detect cancer in the early stages for the improvement of the patients. Some types of cancer can be cured at some stage. The determination at an early stage can save the lives of many humans. Technological advances in medical imaging helps early detection, treatment, and monitoring of the cancer.

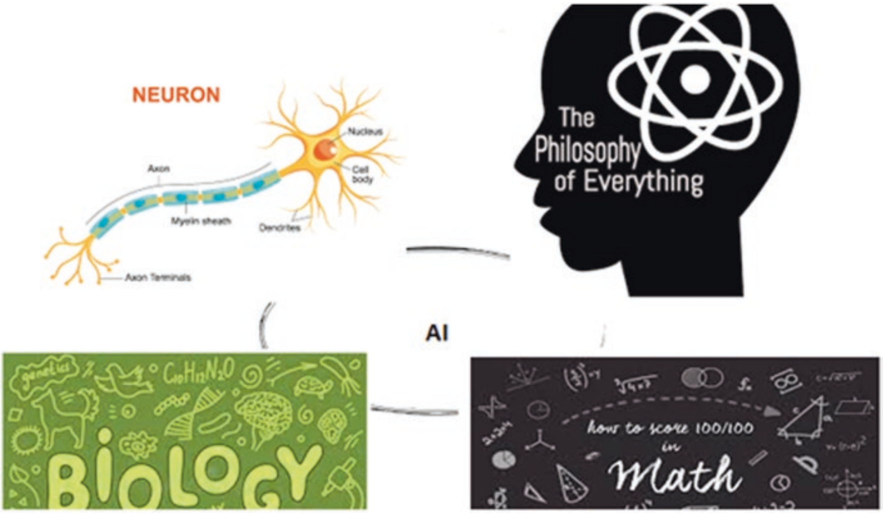

Fig. 2 Interconnection of artificial intelligence with other disciplines

Fig. 3 Test, analyze, and decide the data using artificial intelligence techniques

4.1 Nanomedicine

Nanomedicine is the form of nanotechnology where the nanoparticles, which are less than 100 nm, are passed through the human body for the treatment of cancer. The primary purpose of these nanoparticles is to deliver the drugs to the affected cells. The nanoparticles fight with the cancer cells in order to convert them into normal cells [5].

Figure 3 shows the steps for AI techniques. Nanoparticles have advantages over other traditional cancer therapies in targeting the drugs with a high level of attainment. The therapy and the diagnosis are usually combined to obtain a reasonable result. To attain such a result, multi-modal or multi-functional nanoparticles are used. This type of combining both therapy and diagnosis introduced the concept of theragnostic into the field of nanomedicine. This technique overcomes the drawbacks of traditional therapies i.e., with high selectivity of the cancer cells, and early diagnosis on molecular imaging [6].

Gold nanoparticles are used for the treatment of cancer as well as for the diagnosis of cancer. The properties of gold nanoparticles such as surface plasmon resonance, which allows GN to be used in near infrared-resonant biomedical imaging such as MRI and X-ray scatter imaging. This GN generates heat, which makes it suitable for cancer treatment. The ability to travel into tumor cells gives better advantages in cancer treatment [7].

4.2 Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) implies superparamagnetic inorganic nanoparticles for cancer therapy. Because it is toxic, it is limited to clinical application. i.e., reactive oxygen species are produced by superparamagnetic iron oxide nanoparticles (SPIONs), which damage the DNA. Hence, SPIONs are not used in MRI in the clinic. In the case of ultrasmall GNs, there is no such toxicity [5].

4.3 Photoacoustic Imaging

IPhotoacoustic imaging is a biomedical imaging method. Here, the tissues are illuminated with non-ionizing laser pulses that absorb light.

4.4 Positron Emission Tomography Imaging

Positron electron tomography imaging is a method for early detection of the disease, and is significantly used in tumor diagnosis. This technique also has its own drawbacks [8].

4.5 Chemotherapy

Chemical drugs are used to treat cancer. The main risk in using chemotherapy is that it increases the growth of therapeutic drugs in tumor cells.

4.6 Phases of Cancer Diagnosis and Therapy

Figure 4 shows the phases of cancer diagnosis and therapy.

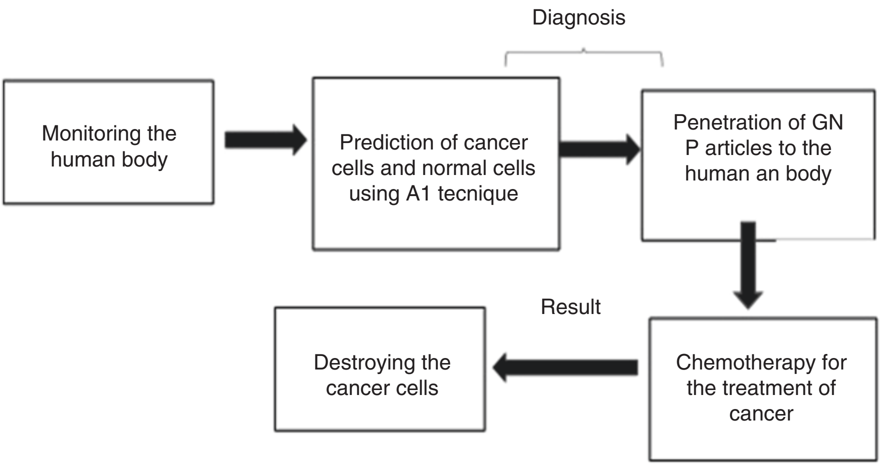

Fig. 4 Phases in cancer diagnosis and therapy

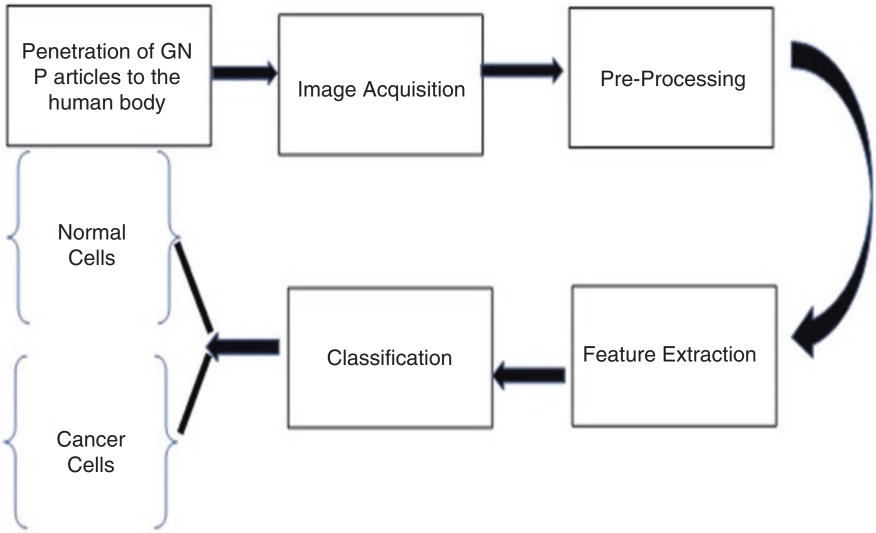

Fig. 5 Prediction of cancer cells using artificial intelligence techniques

4.7 Prediction of Cancer Cells Using AI Techniques

Figure 5 shows the steps to predicting cancer cells using AI techniques. The human body is exposed to AI techniques. The phases in predicting cancer consist of image acquisition, pre-processing, feature extraction, and classification as normal and abnormal cells, then these steps are given as input into cancer therapy.

4.7.1 Image Acquisition

The images are collected from the sources. The source images are gathered from the dataset sources.

4.7.2 Pre-processing

The collected images contain noise. Hence, these images are pre-processed using filtering techniques. The collected datasets may be missing some values or contain redundant data. Hence, the pre-processing is the main step before the feature extraction step.

4.7.3 Feature Extraction

The same dataset can yield different results where the feature extraction makes the difference. The training depends on the feature extraction and selection, which yields the improvement in the performance of the algorithm [9]. Data transformation is another name for feature extraction. The extracted features can be in the form of:

- Continuous values
- Discrete values
- Interval values

These are quantitative features. Some are qualitative features:

- Nominal
- Ordinal

4.7.4 Classification

Neural Network The ANN consists of many layers (Fig. 6) such as input, hidden, and output layers. There are no limitations on the number of hidden layers.

Decision Tree The decision root node has been placed from which the decision label is segregated and the leaf node is placed at each branch as shown in Fig. 7.

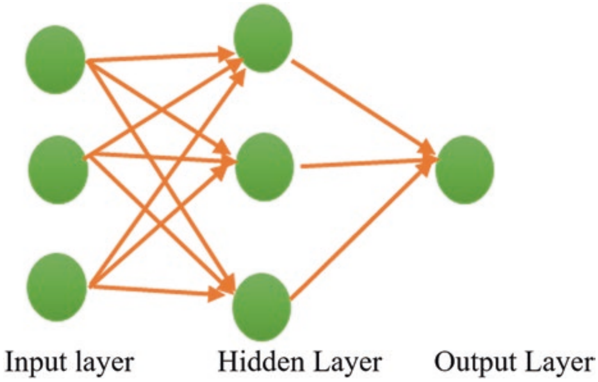

Fig. 6 Structure of neural network

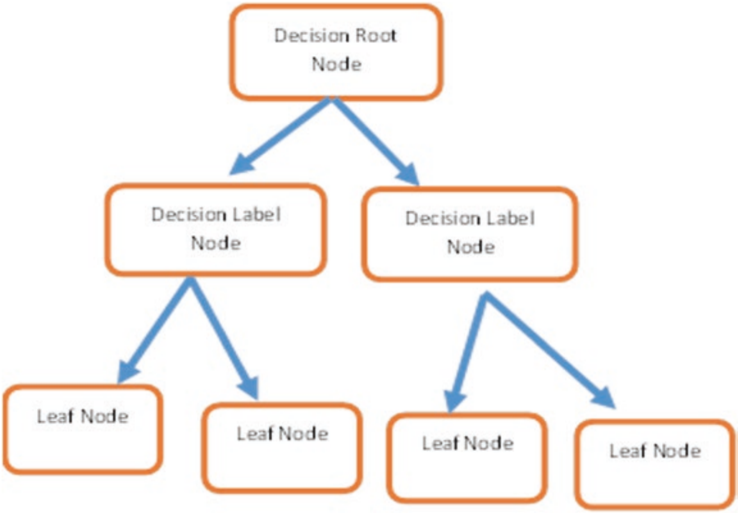

Fig. 7 Decision tree structure

5 Other AI Techniques for Cancer Diagnosis and Therapy

5.1 k-*Means Algorithm*

k-means is the nonfuzzy clustering algorithm. Let $G = \{g_1, g_2, g_3 \ldots g_x\}$ represent the set of data, where x is the sum of data points, $H = \{h_1, h_2, h_3 \ldots h_y\}$ is the set of centers, where y is the cluster size [10]. In the case of the squared error function, the main objective of *k*-means is to reduce the target function $J(H)$ in Eq. 1:

$$J(H) = \sum_{i=1}^{y} \sum_{j=1}^{y^i} \left| g_{ij} - h_j^{\,2} \right|. \tag{1}$$

Here, $\|g_{ij} - h_j\|^2$ represents the Euclidean distance between g_{ij} and h_j.
The procedure of this algorithm is as follows:

1. Select y clusters at random.
2. Manipulate the distance between all the data points and every center.
3. Based on the minimum distance, data will be assigned to a cluster.
4. Again, step (2) will be repeated. i.e., recalculate the center positions.
5. Compute the distance between each data point and each center again.
6. Stop the process if there are no data to be reassigned. If there are, repeat step (3).

The above steps can be used to cluster the affected tumors. i.e., the normal cells will be differentiated from the cancer cells [11].

5.2 *Fuzzy* c-*Means Algorithm*

One of the important and commonly used pattern recognition technique is the fuzzy c-means algorithm. $J(U,V)$ is a squared error clustering criterion and is shown in Eq. 2:

$$J\left(U,V\right)=\sum_{i=1}^{n}\sum_{j=1}^{c}\left(\mu_{ij}\right)^{m} x_i - v_j{}^2. \tag{2}$$

Here, (μ_{ij}) $n{*}c$ = fuzzy partition matrix.

$\|x_i - v_j\|^2$= Euclidean distance.
m = fuzziness index.

The following steps can be followed:

1. Initialize the cluster centers.
2. Calculate the fuzzy membership.
3. Compute the fuzzy centers.
4. Repetition of steps (2) to (3) until the lowest k-value is attained [11].

5.3 *Wavelet Analysis*

In earlier days, Fourier transform was used to detect disease. But the wavelet transforms overcome the drawbacks of Fourier transform. Here, the signal is broken and a scaled version of the unique wavelet.

- *Orthogonal wavelets*: the inner product is zero, which implies that the two functions f and g are said to be orthogonal to each other.
- r: there will be two parts in output; first, the low-pass filter produces output; next, the high-pass filter produces filter. The output of the high-pass filter and the low-

pass filter are reduced by the factor of 2; this means that the power sum of low and high pass is equal to 1 Orthogonal Wavelets must obey quadrature mirror filter.

The feature extraction by wavelet analysis classifies the tumors as normal or abnormal. The normal cells are named mass. The abnormal cells are named microcalcification. The mass cells can be malignant or benign. The microcalcification can also be either malignant or benign. This type of classification gives a better result for the detection of cancer cells in the breast [12, 13].

6 Implementation and Results

The dataset related to breast cancer are cancers are collected from Kaggle. In this study, the input nodes given to the classifier are thickness of the cell and cell size. The neural network produces the output as normal or benign cells.

6.1 Decision Tree

The Weka tool is used to implement the decision tree. The Weka tool consists of multiple decision tree algorithms. Here, J48 is considered. The total leaves assumed is 14 and the tree size is 27. The time taken to build the model is 0.01 s. This algorithm classifies the normal and abnormal cells with an accuracy of 95%.

6.2 ANN Classifier

The ANN can be applied with different parameters, i.e., the number of hidden layers can be changed and tested. Here, three hidden layers are used to obtain the improved result. Two input parameters are given and the output resulted in two layers, as shown in Table 2 using a confusion matrix. Finally, the ANN classifies the result with an accuracy of 97%. The remaining 3% deals with the wrongly classified instances.

Table 2 Confusion matrix

Parameters	Instance is negative	Instance is positive
No. of exact predictions	430	230
No. of improper predictions	7	16

7 Discussion

This research paper mainly contributes as an eyeopener for the research work that can be carried out in the field of cancer diagnosis and therapy. Many machine-learning techniques can be applied to the cancer dataset, where the therapy of using GN can be passed over the human body. The images are captured and collected as a dataset. The collected images are pre-processed with the algorithms, then given as input to the feature extraction step. Features such as the thickness of the cells can be compared to know the difference between normal and cancer cells. Many classification algorithms can be applied to the extracted features. After the study of the research work, the decision tree and the neural network classifiers can be used to achieve improved accuracy regarding the detection of cancer cells. This paves the way for research using machine-learning techniques.

8 Conclusion

Health care technologies are migrating toward the usage of advanced techniques using mutations and AI. This paper shows the techniques that can be used in the therapy and diagnosis of cancer. The phases of the AI are elaborated. Glimpses of AI techniques that can be applied over the data sets to detect abnormal cells are given. Abnormal and normal cells can be classified with the use of neural networks or decision trees. The selection of classification algorithms is based on the type of cancer disease.

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Robust Intelligent Multimodal Biometric Authentication Systems for a Secured EHR

M. Swathy, S. Logesh Kumar, and R. Priyatharshini

1 Introduction

In healthcare monitoring applications, a new frontier for IoT monitoring integrating biomedical sensors has evolved. The information gathered by the sensor nodes is vital for further diagnostics. To be analyzed, the data must be transferred to the access point for subsequent handling and preparation. One of the most significant restrictions in any remote monitoring program is energy. The sensing detector nodes that collect data are generally devices with rechargeable batteries, which make battery replacements expensive, challenging, and complex. The nodes' power consumption should be decreased in these types of applications. The data collected from the sensors in remote healthcare monitoring apps powered by the Internet of Things should be accessible at all times and from any location, which necessitates ongoing network connectivity [1].

A remote healthcare monitoring application that allows transmission on a continual basis will generate vast volumes of data. This, too, contributes to the hyperconnected predicament. In hyper interconnectivity, all devices with ability to reach a global audience will be linked to the internet. If we employ the usual technique of delivering data continually in healthcare monitoring applications, we will not be able to make effective use of the available bandwidth. Due to delays and buffer crowding, it could also result in data loss, which is inappropriate in healthcare applications. The latency and information leakage that occurs in Wireless Sensor Networks (WSNs) premised on wireless internet technology for transmission owing

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to passage interference is researched as the number of nodes transmitting data expands [2].

If the user's temperature or pulse rate exceeds the set threshold, the gadget will send an alert to the user with the location of nearest hospitals. The user's relatives will be advised of the user's deteriorating condition as well as his or her current location after the critical level has been achieved. For both the user and the doctor, the system generates daily and monthly reports. In terms of analysis, these reports can assist both the user and the doctor. The user's current location, as well as the date and time, is recorded. The device will alert the user and provide contact information for nearby hospitals if the user's temperature or pulse rate reaches a particular level [3].

Medical services are quite possibly the most major problem defying each nation today. Regardless of the way that the medical care business contributes widely on innovation, the expected enhancements in persistent well-being and efficiency still can't seem to appear. Indeed, even today, associations depend on paper clinical records and handwritten notes to impact their choices. Data is shared carefully across divisions and applications. Patient information sharing across experts, divisions, and even patients is exceptional and troublesome. Embracing cloud and IoT innovation in medical care could be the response to permitting medical care associations to zero in their assets on clinically important administrations and patient results, considering all the more speedy and helpful diagnostics therapy at a lower cost [4].

The Internet of Things (IoT) can assist healthcare in heterogeneous ways, including through the utilization of biometrics, physiological sensors, intelligent equipment, and so on. It also allows for online patient identification utilizing Multimodal Biometrics. The exchange of data and collaboration among services will have a disruptive impact on personal healthcare as technologies such as IoT and Cloud evolve. A comprehensive Cloud–IOT healthcare system based on the same notion to empower depressed patients over their treatment process. We construct a network of all health actors in our proposed framework for data and service sharing and collaboration on a single platform [5].

Medical evidence gathered by biomedical sensors should be sent to the adjacent gateway for interpretation in mobile healthcare monitoring applications. The flow of information causes a significant increase in network traffic as well as an increase in transmission electricity usage. In this study, we propose a healthcare datalogging and intelligent transmission line architectural style low- and medium-rule engine [6], with transmission of data to the gateway utilizing IEEE 802.15.4 standard. By implementing occurrence transmission instead of continuous data transmission, the device's power utilization and network traffic can be minimized. This research is aimed at the mechanism of ECG data collection and transmission. The quantity of electricity saved and the reduction in network traffic are the parameters utilized in performance analysis. The new proposal engine is shown to substantially reduce energy consumption and network traffic development.

People nowadays are less concerned about their health as a result of their contemporary lifestyle, which leads to an increase in health difficulties. Between the pressures of work, home, and family life, people rarely find time to focus on their health. The level of one's health varies from day to day. Every activity we take up has an effect on our bodies in some way. Regular health monitoring is critical in light of the present environmental changes. We must monitor our health on a frequent basis to ensure that we are healthy. We have a fair chance of preventing those dreadful events if we can recognize these problems before they become catastrophic. This effort will be aided by the health monitoring system. As a result, even catastrophic diseases can be averted if signs are identified early on. We want to offer a structure typically consisting of a wearable gadget that can be used to monitor one's health on a continuous basis. The device will continually monitor the user's temperature and pulse rate, as well as the user's geolocation and the time and date.

2 EHR Biometric Modules

An advanced rendition of a patient's well-being matter in an itemized and organized design with an adequate number of specialized terms is known as an Electronic Health Record (EHR). EHRs exhibit restriction-focus, which allows authorized individuals to access information honestly and securely. While an EHR framework incorporates a patient's clinical and treatment history, it is planned to go past the standard clinical data gathered in a supplier's office and give a more nitty-gritty comprehension of a patient's consideration. Various modules are connected to the microcontroller in this project, which regulates all of the processes that take place during the on phase. Temperature, pressure, and ECG sensors are among the sensors used to assess the patient's biological signals, as well as a finger print sensor and a speech recognition sensor for patient authentication. So that physicians can simply and securely access the health records of their patients, ensuring that their personal and health records are not exploited.

Each patient will be given a unique patient ID that will contain all of the patient's information and may be accessed at any time by both the patient and the physician at any healthcare facility. When a physician needs to access a patient's medical records, the patient is asked to give biometric information of his or her choice. When the patient delivers biometric data, the stored raw data (for example, the fingerprint or voice signal) in the IC's registers is compared to the live data provided by the patient. The patient's information and health records are shown on the webpage supplied for each patient once the device has authenticated the patient. Once the webpage has been opened, the doctor will have access to the patient's medical information.

The blood pressure, body temperature, and ECG of a patient are all monitored using sensors that are attached to the patient and shown on a web page. All sensor information and raw data are sent to the correct IP address via wireless networking and saved for future use. Each sensor input is carefully monitored and followed in accordance with the instructions presented on the LED display of each module. Patients' health records are updated through hosting once all diagnoses and treatments have been delivered to them.

Hosting is the process of storing and updating various data or information on a webpage. Once the gadget is turned on, the bio sensors will broadcast the output values to the webpage on the actual time. When the sensors are attached to the patient, the relevant values are displayed on the webpage; however, when the sensors are removed from the patient, all sensor data are negated, and the output is nil or “0”.

The PIC1650 is the core of the PIC microcontroller series, which was made by General Instrument’s Microelectronics Division. The acronym PIC stands for Peripheral Interface Controller. By 2013, the organization had transported more than 12 billion individual parts to an assortment of implanted frameworks. For program capacity, early PIC models utilized read only memory (ROM) or field-programmable EPROM, with specific variants, including the capacity to wipe memory. For program capacity, all cutting-edge models utilize streak memory, and later ages permit the PIC to reconstruct itself. The expressions “information memory” and “program memory” are compatible. Information memory is 8-cycle, 16-digit, and 32-bit wide in the most current variants. Contingent upon the PIC family, program edict can constantly be 12, 14, 16, or 24 pieces in length. The arrangement of directions fluctuates by model, with computerized signal handling guidelines being tracked down on further developed CPUs. PIC chips arrive in an assortment of sizes, going from 6-pin SMD to 144-pin SMD, and highlight free I/O pins, ADC and DAC modules, and interchanges associations like UART, I2C, CAN, and even USB. Numerous classes have low-power and fast adaptations.

3 PIC Microcontroller Module

Microchip Technology in Chandler, Arizona, generates a set of customized microcontroller chips marketed as PIC microcontrollers. Regardless of the fact that the terminology “peripheral interface controller” is infrequently in use, the acronym PIC stands for “peripheral interface controller.” A microcontroller is a small computer that regulates intelligent systems in cars, robotics, office equipment, medical devices, mobile phones, vending machines, and other devices. A CPU, memory, and peripherals are all included in a conventional microcontroller. PIC microcontrollers are widely popular between electronics and robotics enthusiasts and experimentalists (see Fig. 1). Wide availability, relatively low cost, ease of reconditioning with constructed EEPROM (Electrically Erasable Programmable Read Only Memory), a large number of available application notes, a large number of software applications, and a depth of information available on the Web are only a few of the perks. PIC microcontrollers are generally sold under the PIC trademark. Every PIC microcontroller does indeed have a collection of registers that perform as RAM (random access memory). Purpose-built control registers for the on-chip hardware resources are also available in the subspace. As illustrated in Fig. 1, each PIC does indeed have a stacking where returned values are kept. The stacking really wasn’t application accessible on previous versions of the PIC; however, this barrier was eliminated in succeeding devices.

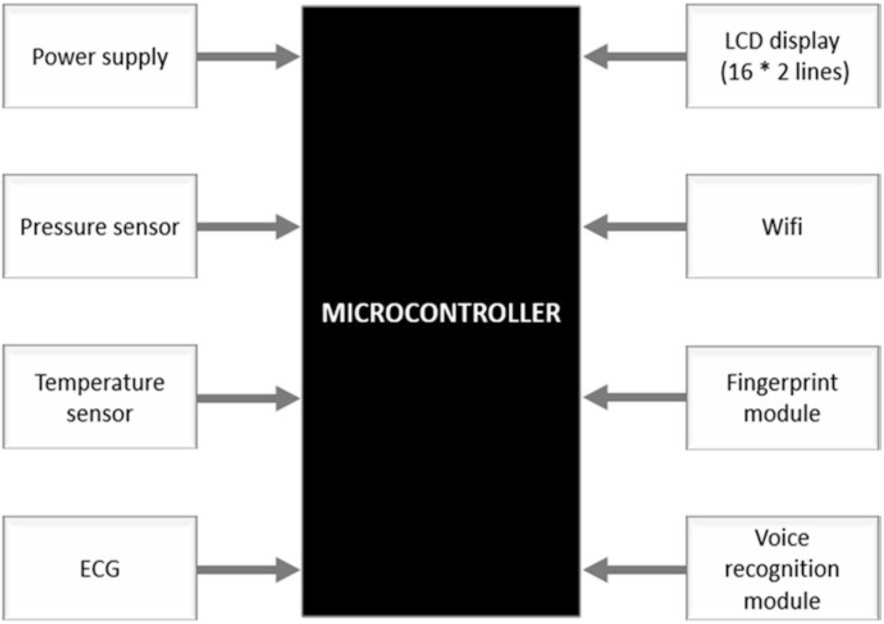

Fig. 1 Smart healthcare system

3.1 PIC18F4520 Flash 40-Pin 32kB 40 MHz Microcontroller (Microchip) Specification

- 32 KB of flash program memory on a 40-pin low-power microcontroller
- Data Memory in EEPROM: 256 bytes
- SRAM 1536 bytes of data memory
- I/O 36 pins
- Timers: Three 16-bit/one 8-bit
- 10-bit A/D converter. Thirteen channels are available
- 10-bit PWM. There are two modules
- Enhanced Support for RS-485, RS-232, and LIN on the USART
- MSSP: Support for SPI
- Oscillator (external): approximately 40 MHz
- 8 MHz internal oscillator

3.2 Features of Power Management

The states of the CPU and other peripherals have to be maintained at respective levels as mentioned in Table 1.

Table 1 On and off states of CPU and peripherals

State	CPU	Peripherals
Idle	Off	On
Sleep	Off	Off
Run	On	On

- Input leakage of 50 nA or less
- Mode of operation currents are down to 11 amps. Idle mode in its most basic form. Currents as low as 2.5 A. Sleeping mode is standard
- Up to 40 MHz in four crystal modes

3.3 Internal Oscillator Block

- Typical 1 microsecond wakeup speed from Sleep and Idle
- 8 frequencies to choose among, with its broad range of 31 kHz to 8 MHz
- It offers an entire bundle of clock rates starting at 31 kHz and extends till 32 MHz when coupled with a PLL
- The Secondary Oscillator, which uses Timer1 at 32 kHz, can be adjusted to account for frequency drift, and the Bit Error Timer Monitor allows for safe termination if the peripheral clock fails

4 Finger Print Module

4.1 Finger Print Sensor

The TTL UART interface allows people to communicate with the microcontroller's UART directly or via a MAX232/USB-Serial converter connected to a PC (see Fig. 2). In 1:1 or 1:N mode, the client can save the fingerprint information in the subsystem and employ it to identify the person. The FP module can be directly connected to a 3v or 5v microcontroller. A level converter is recommended when interacting with a PC serial port (such as MAX232). Access management, attendance management, safety locker authority, and car locking and security are just a few of the applications for this multipurpose adaptive optical biometric fingerprint reader.

The all-in-one fingerprint reader can undergo subsequent improvement and be used in a variety of final products due to its integrated picture gathering and processing chip. With sophisticated optical technology and high-accuracy module manufacturing procedures, this gadget has low power dissipation, relatively low cost, a compact size, and decent performance. Images using image processing and analysis skills can be obtained at a resolution of 500 dpi [7].

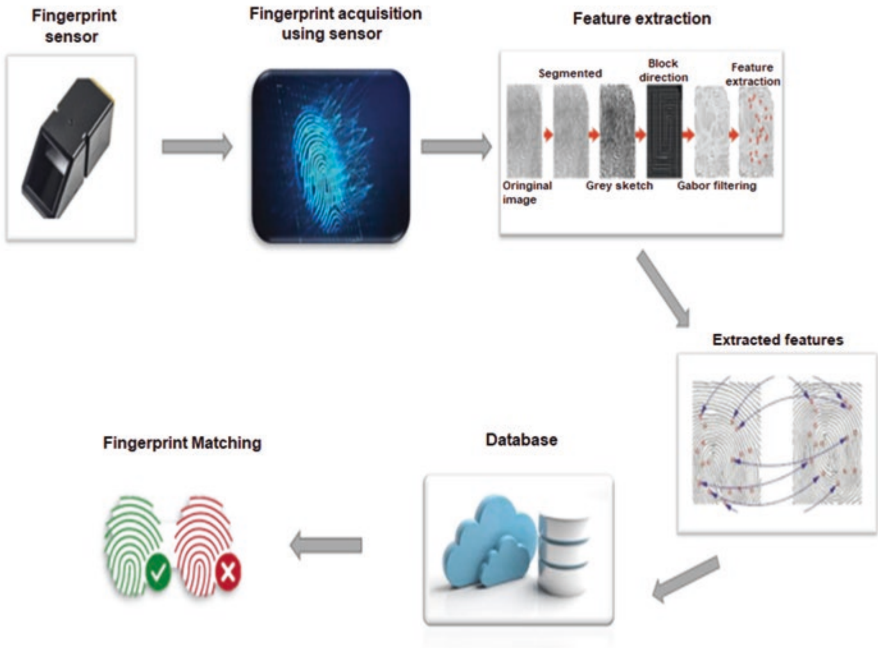

Fig. 2 Fingerprint sensing process

4.2 Fingerprint Sensor Type and Its Specifications

- An optical sensor has a life expectancy of 100 million times
- A static indication of 15KV
- USB1.1/UART interface with a dark green lighting
- RS232 communication baud rate adjustable: 4800BPS115200BPS
- Image Capture Surface 1.5–8(mm); Image Capture Surface 1.5–8(mm)
- Dimensions: 55*32*21.5 mm
- Character file size: 256 bytes
- Dimensions: 55*32*21.5 mm
- FAR (false acceptance rate): 0.0001% 0.10%
- Reliability and dependability levels
- 500 DPI resolution false rejection rate (FRR)
- Operation current: Typical 90 mA, Peak 150 mA
- Operating Environment temperature fluctuates between −20 and 45 °C

4.3 Inputs and Outputs of Fingerprint Sensor

4.3.1 Input: Two Ways to Trigger the Function of Fingerprint Sensor

- Add, Empty, or Search on the onboard switch
- Set the remote microcontroller's pin to low for 5 ms, depending on the function to be performed

4.3.2 Outputs (Response)

After a function has been executed, there are two ways to monitor output reaction.

- ERROR or OK onboard LEDs
- After the function has been executed, read the byte

4.4 Types of Function

You may use the fingerprint sensor for three varying features. We'll take a quick look at each of them.

4.4.1 Add (Enroll) Function

Returns a byte with the newly added ID after adding a fingerprint to the database. The values returned range from 0 × 00 to 0 × FE. If there is an issue, such as no finger being inserted, the return code is 0 × FF. The value 0 × FF denotes an error in the function's execution.

4.4.2 Search Function

When a finger is pressed and the search function is invoked, the device returns a matching ID if one is located in its memory. The values returned range from 0 × 00 to 0 × FE. If there is an issue, such as no finger being inserted, the return code is 0 × FF. The value 0 × FF denotes an error while executing the function.

4.4.3 Empty Function

This feature can be used to clear all fingerprint data recorded on the sensor. You'll get 0 × CC as OK or 0 × FF as an error after running this method. Special features of fingerprint module

- Simple to operate
- Status LEDs
- Function Switches
- Single byte response
- 5 V operation
- UART 9600 bps response

5 Voice Recognition Module

5.1 Voice Recognition

This Voice Recognition Module is a simple speech recognition. This item is a voice recognition module that requires a speaker to function. It has a total capacity of 80 voice commands. At most, seven voice commands can be activated at the same time. Any sound can be programmed to serve as a command. Before the module can recognize any voice command, users must first train it. The General Input Pins or the Serial Port (full function) are the two ways to control this board (part of function). The board's General Output Pins could emit a variety of waves when a voice command was recognized.

5.2 Parameters

Intensity, pitch, voice quality, duration, voice activity, signal to noise ratio, and activity detection of voice matter are all the basic factors in speech processing. The Lombard effect's strength is taken into account in some algorithmic applications. Taking this into consideration and including the effects to bad circumstances numerous people's performance different algorithms are created. Algorithms for extracting certain parameters have been published. Automatically, the speech signal is not a framework. It is proposed that evaluation must be trained using machine languages to encourage algorithmic development and to conduct study and create advancement equivalent.

6 Physiological Sensors Module

6.1 Role of Sensor Module

A sensor is an electronic device that identifies any changes in its surroundings and reacts by producing a signal. Sensors are used in a multitude of daily necessities, such as touch-sensitive operating buttons (tactile sensor) and lamps that alter their light intensity when the base is contacted, among many other possibilities that most people are unaware of. Thanks to breakthroughs in micromachinery and comfortable micro controller frameworks, sensor applications have broadened beyond the most conventional fields of temperature, pressure, and flow monitoring, such as MARG sensors. Analog sensors such as potentiometers and force-sensing resistors are still generally utilized. Manufacturing and machinery, machineries, aviation and aircrafts, cars, medical, and robots are just a few examples [9].

6.2 Temperature Sensor

The LM35 series of temperature estimation detecting parts are exceptionally proficient and dependable incorporated circuit installed parts that produce a straight related voltage result to the temperature in degrees Centigrade. Regardless of straight temperature estimation adjusted in Kelvin, the LM35 model doesn't need the developer to eliminate a high consistent voltage from the result to give advantageous Celsius change. The LM35 device gives normal exact upsides of 14 °C at encompassing temperature and 34 °C across a temperature scope of 55–150 °C with no extra adjustment or cutting. Wafer-level decrease and tuning ensure less expensive expenses [10].

Because of the very low output impedance, linear output, and accurate intrinsic calibration, the LM35 microcontroller gadget is uncomplicated to integrate to reading or command circuitry. A solitary power system or a plus and minus supply can be used to energize the device. Because it only requires 60 A from the source, the LM35 device has a very low self-heating of less than 0.1 °C in still air, as shown in Fig. 3. Although LM35 device has a temperature sensitization range of 55–150 °C, accurate sensing lies from a temperature range of 40 to 110 °C (with greater accuracy of 10°). The LM35-series devices are available in hermetic TO cases, whereas the LM35C, LM35CA, and LM35D are available in TO-92 plastic cases [8].

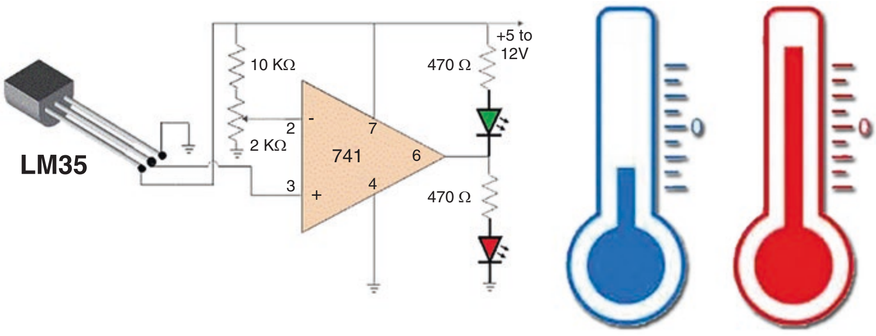

Fig. 3 LM35 temperature sensor

6.3 ECG Sensor

The bioelectrical activities of a live heart can be displayed using an ECG (Electrocardiogram), which can then be investigated using an analog readout. Because of the fact that most ECGs can have a lot of noise and artifacts, for this purpose, the AD8232, which acts as a heart rate monitor with single lead design can be employed. The AD8232 operator acts by permitting only the required signal of the PR and QT Intervals to be retrieved.

The AD8232 is a unified signal conditioning block for ECG and other bioelectrical signal monitoring and obtaining applications. It's developed to obtain, intensify, and regulate simple and minute biopotential signals in noisy circumstances such as those generated by mobility or distant location electrode insertion. The Heart Rate sensor with AD8232 signal conditioner has nine terminals that can be connected to the IC through pins, wires, or supplementary connectors (see Fig. 4).

For usage with an Arduino or comparable development board, the pins SDN, LO+, LO−, OUTPUT, 3.3 V, and GND are essential. The RA (Right Arm), LA (Left Arm), and RL (Right Leg) interfaces on this circuit will be used to interface and to use your any other customized sensors depending on the necessity. A heartbeat-synchronized LED display light is also integrated with the setup. Biomedical detector pads and a sensor wiring are also permitted for the heart monitor [11].

6.4 Pressure Sensor

A strain sensor, as displayed in Fig. 5, is a gadget containing a tension touchy component that actions the strain of a gas or fluid against a tempered steel, silicon, or other material stomach and converts the deliberate worth into an electrical sign.

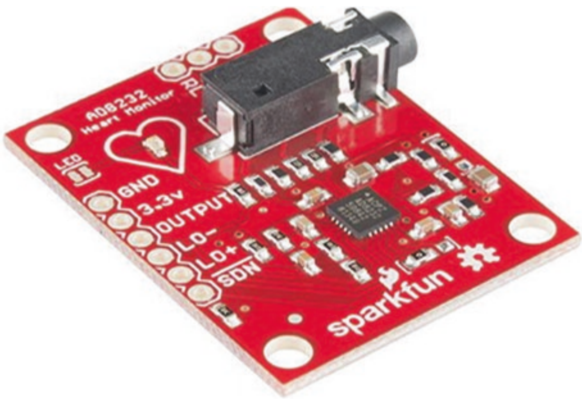

Fig. 4 Heart rate ECG sensor

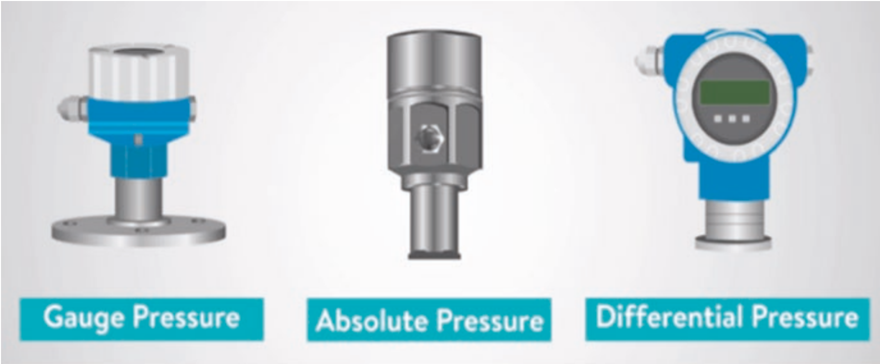

Fig. 5 Pressure sensor

6.4.1 Various Modes of Pressure Measurements

The pressure ranges that a sensor measure, the operating range of temperature and the nature of pressure they monitor are all used to classify pressure sensors. Pressure sensors are known by a variety of names depending on their use, but they all employ the same technology [12].

- *Absolute pressure sensor*: The pressure is measured with respect to absolute zero with this sensor.
- *Gauge-type pressure sensor*: The pressure gauge sensor measures the pressure in relation to the surrounding atmosphere. The pressure being monitored by a tire pressure gauge is equal to the ambient pressure when it reads 0.
- *Vacuum pressure sensor*: Vacuum or subatmospheric pressures are measured with vacuum sensors. The term "vacuum" refers to pressures below atmospheric pressure. Due to the fact that pure vacuum is never achieved, the measurement is made in terms of a near-absence of gas pressure.
- *Differential pressure sensor*: This approach detects the difference between two pressures that are applied on opposite sides of the sensor to be developed. Differential pressure sensors are used to estimate pressure drops over oil filtration systems or air purifiers, hydraulic levels (by contrasting pressure above and below the fluid), and flow rates (by comparing pressure above and below the fluid). A pressure transducer sensor, for example, is nothing more than a difference pressure transducer with one side accessible toward the outside world.
- *Sealed pressure sensor*: This sensor works indistinguishably from a check pressure sensor, despite the fact that it estimates pressure comparative with the reference point as opposed to gaseous tension (which differs as per the area and the climate).

7 Compiler Module

7.1 CCS Compiler for PIC Microcontroller Software

More than 20 years ago, CCS created the first C compiler for Microchip microcontrollers, and the company continues to deliver software to embedded application developers who use PIC MCU and PIC24/dsPIC DSC devices. CCS compilers are simple to understand and utilize [13].

7.2 Key Features of Compiler Module

- C++ language style data formatting for input/output operations
- Minimal time for developing integration with peripheral controllers and standard C components
- Use peripheral drivers and standard C components to reduce development time
- Facility to include CCS libraries and easy object codes to design, set up, and handle interrupts
- Use convenient methods like #bit and #byte to insert C variables in absolute positions

7.3 Pro Level Optimization

Standard C structures, many pre-processing bundle of functions and a large repository of Built-In functions are all a part of the PIC compilers' Pro-Level Optimization option. At the embedded C language level, this gives developers exclusive authority to design and develop special features for hardware. The identical C syntax and customized functions are used by all chip families, making switching to a new chip a breeze. Developers can use Ready-to-Run program and utilize the device libraries to develop programs that use cutting-edge technologies such as capacitive contacting, wired and wireless communications, motor regulation, and energy regulation.

Equipment-specific designs include files that contain all the data required by the compiler to improve the programming environment for the PIC MCU in question [14].

- Data storage limit
- Pin operation, memory
- Secondary supply source
- Size of the hardware package

7.4 Optimization of Strings

- Use 7-bit ASCII text compression to improve string compression
- Switch Statements—Compare strings quickly, resulting in simpler, easier-to-maintain compiled code, and a ROM architecture that is less
- Constant Length Variation Strings
- Print f—Using this function, you can reduce the number of times you have to print several strings

7.5 Efficient Data Structures Mapped into Program Memory

Because of the compiler's extensive variable data structure handling, it can handle linear interpolation of any size. This would be beneficial for developers that stacking layers of linear interpolation for trigonometric functions or maintain FPGA configurable memory photos in on-chip MCU storage. In program memory, constants (including strings and arrays) are preserved. Manually allocating variables to data areas for greater accessibility via pre-processor instructions can improve DSP speed.

7.6 Additional Features

- Optimized functional administration—Broadens function trees further than the hardware stack
- Selective compression—Preconfigured for space rather than speed, saving up to 60% on application memory
- For in-assembly to refer C variables and insert assembly code anywhere in the source code
- Function overloading—This feature allows to invoke numerous functions with the same identity, but different parameters and types at the same instant
- Parameter number variable—Create functions with any number of parameters
- Default parameters—These values are used when no arguments are provided
- Intelligent Interrupt Handling and Autonomous Fuse Configuration

7.7 PIC KIT3 for Programmer

By incorporating in-circuit troubleshooting circuitry inside each chip with Flash memory, Microchip's PIC kit 3 In-Circuit Logic delivers a reduced and affordable cost hardware breakpoint and operator. Some of the benefits of in-circuit debugging are as follows:

- No need for expensive connectors or adapters
- Low cost
- Only a small amount of additional equipment is required for troubleshooting

The PIC Kit 3 In-Circuit Modules is not a commercial compiler. It should only be used for innovative developments and research innovations. Using the MPLAB X Integrated Development Environment's comprehensive graphical user interface, the MPLAB PICkit 3 debugs and programs PIC and dsPIC Flash embedded systems at a cheap cost (IDE). A full-speed USB interface connects the design engineer's PC to the MPLAB PICkit 3, and a Semiconductor debug (RJ-11) connector connects the target to the design engineer's PC (compatible with MPLAB ICD 2, MPLAB ICD 3, and MPLAB REAL ICE). The connector employs two instrument I/O pins and the resetting line to support in-circuit testing and In-Circuit Serial Coding [15].

Relatively smaller header boards with a dedicated MCU are used to debug various 8-, 14-, and 18-pin devices. This MCU has additional pins for PICkit 3 communication, allowing the software to use all of the component's pins. For programming, the header board is not used or required. The header, on the other hand, must be utilized for debugging particular devices.

7.8 Features

- MPLAB IDE compatibility
- Real-time execution and fully enclosed
- USB (interface to host PC at full speed of 12 Mbits/s) (free copy included)
- Low voltage Support up to 2.0 volts
- Firmware expandable via PC/web
- Read/write microcontroller program and data memory
- Erase program memory space with verification
- Breakpoint freeze-peripherals
- Program up to 512 K bytes of flash memory using the Programmer-to-Go* Header

8 Conclusion

Whether or not the specialist is there, a viable PHMS is laid out to monitor the patient's ongoing status. The innovation catches information from the patient, for example, temperature, circulatory strain, and heartbeat rate, and sends it to the specialist. The framework was tried in an exploratory setting, and test information from patients was gathered to approve their condition. The specialist can intermittently analyze the situation with the patients' well-being and give them well-being guidance. The framework can be improved by adding more capacities to the versatile application, for example, associating rescue vehicle benefits, a rundown of top specialists and their specializations, medical clinics and their particular offices, etc. Specialists can utilize the versatile application to bring issues to light about sicknesses and related side effects. The system is beneficial for patients and doctors to improve their patients' medical evaluations based on the evaluation and analysis results. In the future, web page updates can be done through a process called hosting, and messages can be transmitted to relatives and caretakers via IOT-based mobile monitoring when the patient visits the hospital, or anytime he/she keeps his biometrics for authentication.

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Prognosis and Diagnosis of Cancer Using Robotic Process Automation

M. Sreekrishna and T. Prem Jacob

1 Introduction

Advancements in machine learning, artificial intelligence, data analytics, computer networks, and various other technologies have paved way for robotic process automation (RPA). RPA is a software bot that converts repetitive administrative tasks into an automatic process. There are several real-time applications where data needed to be managed accurately without human entry errors. One of the fields where utmost care has to be taken is the medical field. In order to track the patient's data, the details of the treatment and updating based on the visit need to be recorded periodically. In certain cases, such as cancer, the patient record has to maintained with utmost care [1, 2]. Around 224,390 new cancer cancers were suspected in 2016 [3–5]. It was also found that the comparative study of patients with the same clinical properties and pathological features provided distinct outcomes for providing treatment to the current one in an efficient way. As a result, more close observation and recording of data are needed to address the treatment [6, 7]. It is said that automation will replace half of the global workforce in precision medicine. With the rapid development of artificial intelligence and machine learning the capabilities of understanding human interaction with computer systems has improved phenomenally, leading to no or a smaller human workforce to perform the processes.

The scope for automation in the medical field is great, mostly in the fields of sensitive data entry and data sharing. As the emerging treatment for cancer to different patients concentrates on bringing out new generation technologies and innovations to facilitate the work of humans, data manipulation and pre-processing jobs make the workers sit for hours and finish them without errors. These manual,

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repetitive tasks are now automated with bots and it can work 24/7 monitoring and processing workflows without any input from humans, improving scalability and efficiency. The influence of robotic process automation (RPA) will not only rely on handling internal processes of an organization. Not only this, now the companies can move toward automation These things show that RPA can improve the medical field in the forthcoming years compared with the previous year, resulting in the successive levels of patient care. Cancer data collection involves identifying patients diagnosed with cancer, obtaining data from cancer-related centers, radiological departments, laboratories, or other related areas. Analytics of cancer data begins by data collection. Various administrative tasks such as the hospital management system, in the database of research and cancers registry report database has to be automated. The collected data sets are utilized for analysis and prediction for many research works. When the collected data are described accurately, then the accuracy outcome for analytics can be improved with error detection. In recent years, analysis and mining of medical images has dramatically improved for the diagnosis of cancer. One of the best approaches to processing the features of the image to identify the diagnosis is radiomics. Quantitative analysis of medical images plays a vital role in investigating and analyzing the structure of healthy tissue compared with diseased tissue [8]. Radiomics is the process of extracting a quantitative analysis of data from medical images. Intratumoral heterogeneity quantification and risk evaluation of cancer can be processed. Various quantitative features can be extracted from the digitized image. The data that are generated can be placed in the database for the generation of hypotheses and testing. Radiomics acts as a tool to support decision making by comparing the data generated from radiomics with accompanying patient identity. The data that are extracted from various images are correlated with information that improves decision making.

2 Related Work

Hospitals are the places where patients recover from illness. The data generated from this medical field are highly sensitive (Table 1). Maintaining administrators to manage the data is costly [9].

Recording patient history was done manually in the old days. Technology improvements in maintaining health records of patients electronically support by collecting the data systematically [10]. Various software companies are approaching hospitals to introduce tools for hospital management. Clinical or hospital management systems integrate information from the administration, clinical aspects, and financial aspects of a hospital [11]. Electronic means of data processing are enhanced in achieving best patient data storage. Further improvement was achieved in maintaining radiology information and laboratory-oriented information. Electronic medical records include patient details, medical data history, treatment undertaken, laboratory test results, medical information, appointments, reminders, diagnosis, billing, and other relevant information [12]. The main characteristics of the

Table 1 Registry system in general

Information system	Responsible authority	Data collection mechanism	Usability	Periodicity
Simple registration system	Office of the Registrar General	Population-based survey of the usual inhabitants	Vital events and morality data	Annual
Civil registration system	Office of the Registrar General	Compulsory administrative data and permanent reporting	Legal requirements under United Nations, enacted through a central birth and death registration. Provides medical certification for cause of death	Continuous
Integrated child development scheme	Directorate General of Health Services	Decentralized state-based surveillance program	Picks early warning signs for an impending outbreak of specific diseases in specific states	Continuous
Rural health statistics	Directorate General of Health Services	District household survey, generates evidence by undertaking requisite blood test	Reports on decentralized planning and coverage of Reproductive Child Health (RCH) services	Not defined
Annual health survey	Just Independent survey	Independent population survey in Empowered Action Group states	Report on outcome of schemes under the National Health Mission	Annual

Table 2 Registry history

Year	Registry description
1839	Cancer death registration
1901	Leprosy population registry
1935	United States population-based cancer registry
1956	Approved cancer registry in American College of Surgeons
1971	Cancer institute of research, detection, and treatment
1973	Surveillance, Epidemiology, and End Results Registry
1992	National Program of Cancer Registries funding for state cancer registries
1993	Hospital-based cancer management system

electronic information system are to update the details periodically, avoid duplication of data, and long-term usage and storage of records are possible [13]. The National Cancer Registry Association introduced a cancer registry, which is a valuable tool for storing diagnosis information and treatment undertaken for cancer (Table 2) [14].

The data stored helps in evaluating the outcome of the patient, calculating the rate of survival, referral patterns, and support in the educational system. The first cancer information was London's "General Census of Cancer" in 1728 [15]. Ernest

Table 3 Registry tools

Tools	Description
C3D	Cancer Central Clinical Database is based on the collection of medical elements of data that provide reusability, interoperability, and sharing for multiple studies and sites
CDS	Computer-based Clinical Decision Support is a password-protected, web-based data submission system that collects details of gene-based tests used in breast cancer
C3PR	C3PR is a web-based application that helps to organize and manage participant registration data collected in multi-center clinical trials
caAERS	Tool to collect patient's data in multi-center clinical trials
caTIES	This system automates the extraction of coded information from surgical pathology reports and presents it in a standardized format; users can query, browse, and acquire annotated tissue data and physical material
caTRIP	Connects existing the data system, including basic science data, to enhance patient care. The system leverages clinical pathology, tissue, and basic science data, including data from existing patients, to inform the treatment of a new patient

Amory Codman introduced a registry that stored patient end result cards. The outcome of the patients is tracked to improve patient care.

The introduced Hospital-Based Cancer Registry has the exact status of the cancer registry details, which has demographic data, tumor data, treatment data, analysis of data flow from one sector to the other sector in an medical organisation. The data collected in this way support by reviewing patient details. The exact status of cancer before treatment and after treatment can be monitored. The medical history of various patients can be taken for comparison for the patient who has the same cancer feature characteristics. The analytics of the cancer database play a major role in prediction. There is a need for systematic and continuous collection of data. The National Cancer Registry Program was introduced in 1982 by the Indian Council of Medical Research to maintain the details of cancer patients accurately (Table 3). These registries provide information about cancer, its types, location-based cancer details, and its control measures.

There are hospital-based registries that have details about cancer extent, stages and treatment progress, and survival rate. Semi-automated cancer tools were developed in a clinical environment for various cardiology specialties, for Parkinson disease, etc.

3 Need for Robotic Process Automation in Health Care

For the prediction of cancer, the patient record is maintained at various stages. This involves patients meeting the doctor, taking laboratory reports, analyzing the patient data, maintaining personal identification, financial reports, diagnosis, and medication, as shown in Fig. 1.

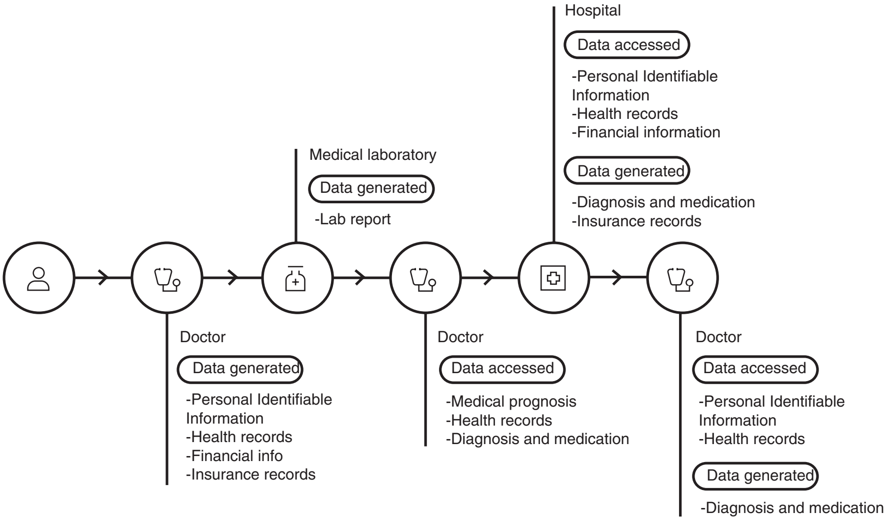

Fig. 1 Basic medical data history of cancer patients

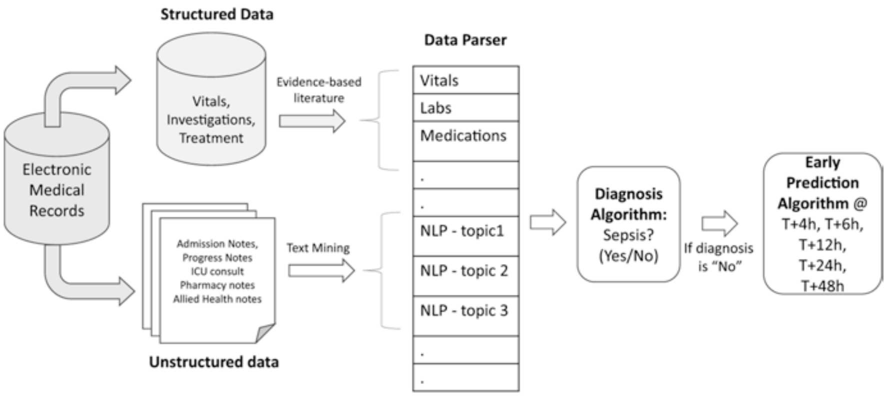

Fig. 2 Early risk assessment

Before RPA there were various methods for the prognosis and diagnosis of cancer. The research involves utilizing unstructured, semi-structured, or structured data for analysis. Various algorithms are used to process the diagnosis of the cancer patients for prediction as shown in Fig. 2. Efficiency in detecting the history of cancer patients can be increased if we have a proper automated system that maintains the record without error and also supports in mapping the cancer treatment history with other patients.

The need for medical robots for health care can processed by certain automation, which can increase the efficiency in the medical services. The treatment of patients, their health history, security, and safety can be monitored periodically with the emerging RPA technology.

The generation of data in health care is periodically increasing as the number of cancer patients increases, for various reasons. The extraction of data to improve patient health can be retrieved faster with the support of RPA. Medical data ordering is another important challenge that is found to take more time to process. However, the RPA can improvise the ordering process effectively. Time is very important in predicting the early stage of cancer. Detecting the cancer with delayed time can cause a developing risk of succumbing to the disease. Further, the maintenance of the data with greater accuracy is a very tedious task for medical workers. To overcome this, the automatic disease identification can give an immediate and exact result. The automation helps the patient in the early detection of cancer. With this automation, determining the cancer disease before the symptoms can be predicted using the medical records by manipulation using neural networks. This term of detection is found to be faster than a trained radiologist. RPA automation can also detect the deviation of patient from the prescribed health plan.

4 RPA Workflow

The RPA tools and platforms are perform best when integrated with other tools and technologies. As RPA is more versatile and commanding, and can perform several functions alone, but the final consequences would be gained by utilizing it with other tools. Demands in usage of diverse applications such as Cancer Registry Management (CRM) software, Intrusion detection system/Intrusion prevention system (IDS/IPS) systems, Big Data centers, Cloud storage, and different types of automation are required to satisfy the organization's process flow. The whole competitive advantage of the medical field lies in creating a total workforce consisting of people as well as machines that are intelligent to work various applications.

The scope of RPA is huge and infinite. It is considered to be the future. The career prospects for RPA practitioners and developers have increased by 52%. Tools such as Blue Prism, Pega, Automation Anywhere, and Uipath have been adopted by businesses leading to over 65% of their processes being automated. Still, the appetite for RPA among companies is high. More innovations and inventions will make the business process smarter than today, creating a better digital world. The main responsibility in the pandemic situation is to treat the cancer patient's life with care. In general, the doctors take more than 40 h in a week maintaining the paperwork. It is though that in 2026, Indian Council of Medical Research (ICMR) reports of cancer will be found to be leading the health care sector for business workflow. The health care sectors that use machine learning, natural language processing are widening and extending with RPA.

Managing medical data history related to patients is a main challenge in today's world. Several cancer patients were provided with various treatments that depend on image data, extracting features in terms of quality and quantity, stage of cancer analysis, prediction, and treatment. But the patient cancer treatment based on new

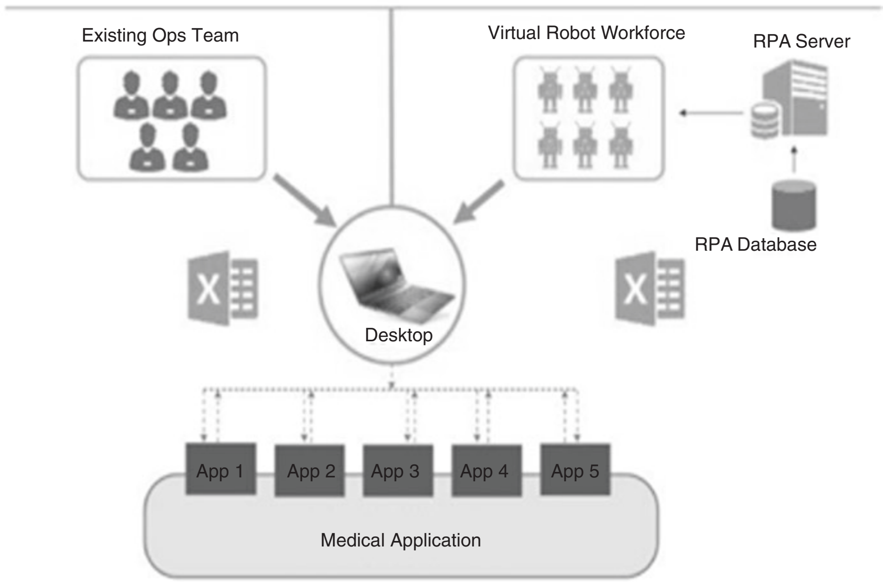

Fig. 3 General workflow

methodology has to be recorded to be successful. A certain large volume of sensitive data in terms of cancer patients is a great challenge. To support and integrate this, the RPA workflow involves integrating various quantitative details of patients using software robots. To support and integrate this, the RPA workflow involves integrating various quantitative details of patients using software robots that provides the solution to the process.

In Fig. 3, the workflow of the RPA performs coordination with various client processes. Initially, creation of an RPA automation plan and developing automation solutions can be done. The time-consuming, labor-intensive, and repetitive tasks can be automated with the RPA design maintenance of radiomic feature data extraction by updating treatment steps. Progressive data analysis for prediction will improve the development of medical care systems in the future.

5 Methodologies

5.1 Prepare RPA

The initial step in designing an RPA for the radiomic feature analysis. The pipeline for building automation is the process of initiating RPA. The return of investment in implementing the tool in cancer feature analysis should increase the value. It should be ensured that the RPA design pipeline is strong by satisfying the predefined rules.

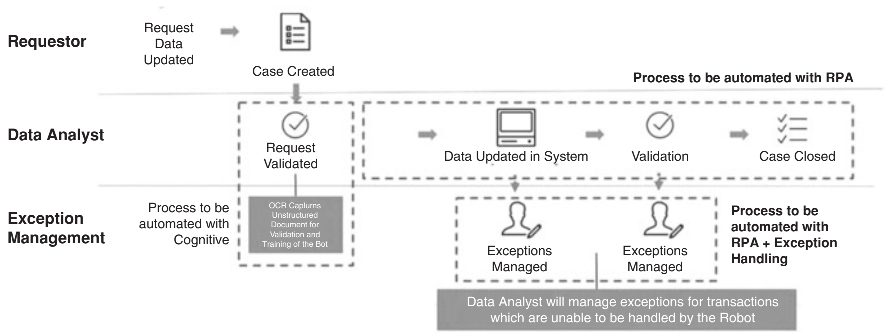

Fig. 4 Processing of data using robotic process automation

RPA can be designed for the rules that are repetitive, that occupies maximum volume of transaction, and the processes that are well defined and constant in an cancer medical application can be considered to design an RPA. The RPA assessment design tool can be successful if the above criterion is satisfied.

5.2 RPA Solution Design

After the requirement gathering from the RPA plan, it is necessary to proceed with automation design steps that involve the procedure of creating, testing, and deploying the entire scheme of function automatically. Automating radiomic feature automation enables human errors to be eliminated upon entering the data into the various systems. Further, the investigation and competitive research studies can be improved. The originality of the data can be retained as the radiomic feature values are quantitative with accurate measurements, as shown in Fig. 4.

5.3 RPA Build and Test

The registration of a cancer dataset and its relevant radiomic quantitative features can be made automatic, which can avoid the redundancy of work using RPA. With the registry cancer data and based on the relevant feedback, further registry data can be improved. The RPA builds, prepares, and tests the data. The data change is validated and the report evaluated. The errors can be reported and corrected. The final test results can be recorded for implementation in real time in Fig. 5.

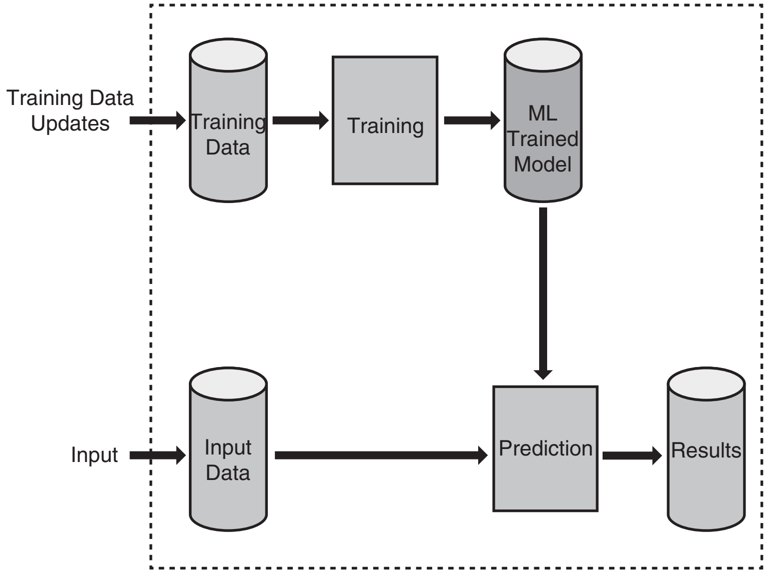

Fig. 5 Robotic process automation build and test process

5.4 Stabilize RPA and Constant Improvement

Once the build and test are done, live preparation of the data in medical analysis can be processed to stabilize the RPA. The expected results can be compared with the actual results and performance assessment can be performed. The final outcome can be used for the real RPA cancer medical implementation.

6 Conclusion

The medical data in cancer are being increased, the software bots when created can make data maintenance accurate by reducing errors. The processing time and cost of patient data can be reduced with increase in efficiency of precision medicine. The illustrative research implies that an increase in the complexity of quantitative data in cancer patients can be managed in such a way that large-scale automation can be achieve in less time. Use of such smart machines can increase the liability, transparency, authorization, and confidentiality. Extraction of needed radiomics measurement from historical data can be compared for the future treatment process. Thus the obtained methodology provides efficient radiotherapy planning, information tracking and best results can be utilized for better treatment processing.

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Part VIII
Telecommunication with Improved Intelligence in Medicine

Remote Delivery of Healthcare Services

Bindu Babu, S. Sudha, and S. Caroline Jebakumari

1 Introduction

The present healthcare system is a pioneer in providing only the basic needs for human beings in requirement. The foremost drawbacks of the currently available healthcare system are time and space. These drawbacks will be overshadowed in the upcoming years. The present facility provided by an ambulance is something which can be provided by a car too. Services offered to elderly people are not up to the mark to be very honest [1]. Due to the lack of medical treatment at the correct time in the ambulance, most of the patients die before reaching the hospital. The current healthcare systems are also poor or at times not able to detect real-time accidents. Due to the absence of accurate and precise framework and active offices, it's completely challenging to control the loss and pandemic issues. It is highly important and necessary foremost to develop a healthcare system like telemedicine which is intelligent. "The delivery of healthcare requirements, by all healthcare experts using data and transmission systems for the transfer of valuable data for education, treatment, and to avoid the spread of illness and damages, evaluate, research, and continuous knowledge of healthcare suppliers, with sole idea of improving the health of possibly and possibly every living being on Earth," according to the World Health Organization [2]. Telemedicine compiles real-time video conferencing, image transmission, e-health, which includes patient vitals, remote vital sign monitoring, continuous medical education, and medical call centre(s).

Telemedicine is a typical transmission of medical data that uses wired as well as wireless technology to send signals (biomedical), images, and data to a remote place for diagnosis [3]. This reduces the heat on medical professionals drastically, while it also compensates for the physical distance between patients and clinic/

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health centres fact. The first official instance of using telemedicine happened in the early twentieth century when the cardiograph data was transmitted through telephone lines.

Video communication in telemedicine is classified as video conferencing, which is a live, real-time, and interactive session between patients from various locations [4]. Using video conferencing, doctors will be connected with the patients who are technically far distant from them. Some examples of video conferencing include team meetings, tele-consultation, and education. In tele-presence, images of the field to be operated can be projected to the destination screen, which is at remote distance. By using telerobot, surgeons can perform operation without physically being with patients. Tele-robotics was first created with the intention of monitoring the wounds of soldiers on the battleground. Tele-presence surgery overcomes limitations of the operational manpower shortages in remote locations. Operational telemonitoring is an additional attribute for tele-presence telemedicine in which it provides access to display, provide instructions, command, and connect with another medical expert (e.g., a specialist) in an alternate location at a high time during an operation or clinical emergency.

2 Block Diagram of Telemedicine

Specific physiological signs should be recorded from people in their living surroundings during everyday activities and can then be used to identify any indications of medical distress or crisis circumstances [3]. Various research has been completed on considering various factors like types of sensors, type of information gathered, identifying gadget, and handling/clinical measurements and calculations. Biosignal sensors, which are mid-range units, raw information transfer networks, and importantly, a typical medical service centre are certain basic and ideal essentials for setting up an ideal telemedicine framework.

The biosignal sensors have the responsibility of gathering and moving raw information (the patient's important bodily functions) to the processing unit (signal) [5]. Each remote monitoring system's sensor layer is individually assigned with a handling gadget for signal compilation, maintenance, investigation, and formatting at an advanced speed. Following this, information is passed to the next layer, which is called correspondence layer. An ideal telemedicine framework's handling unit is simply a PC, or a cell phone, or even an implanted gadget (rare cases). In recent telemedicine consultations and results, many clinical measurements and calculations have been gathered and calculated to support patient health condition and early recognition of cardiovascular issues as shown in Fig. 1. Considering the fact that the pulse addresses an individual's condition of well-being, beat assessment has for some time been still the examination and exploration focal point of interest in the physiology field.

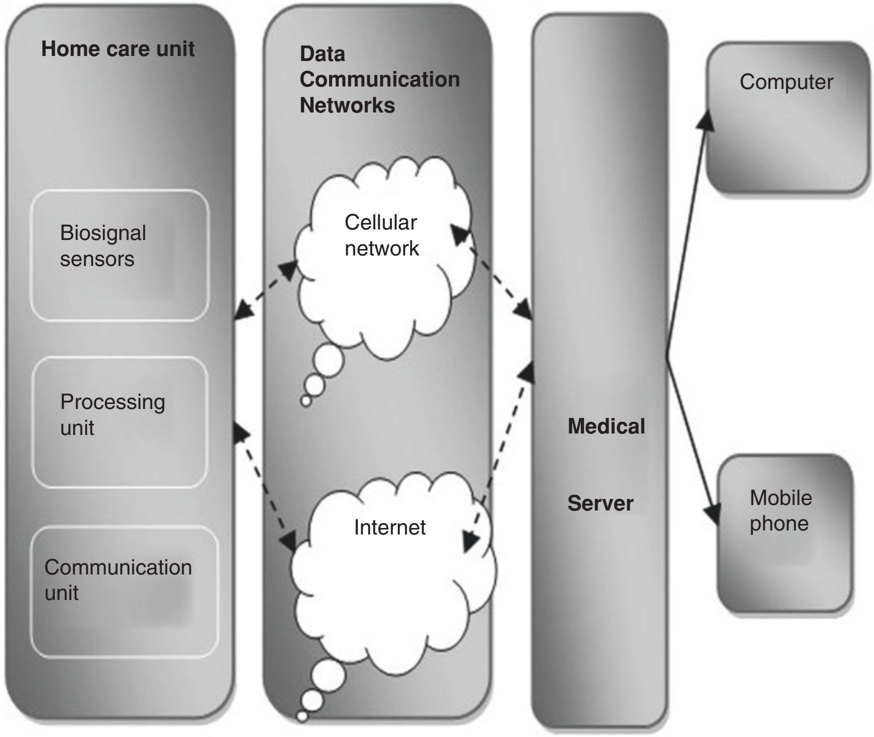

Fig. 1 Block diagram of telemedicine

3 Delivery Modes of Telemedicine

Telemedicine is mainly divided as (based on modes of delivery)

- *Store and forward mode (the asynchronous method)*: In asynchronous (store and forward method), patient's data, pictures, etc. are sent to another destination. This type of method is predominantly used for situations where a second opinion is required, and this includes methods like tele-radiology, tele-dermatology, and tele-consultation.
- *Real-time mode (the synchronous method)*: In this mode, patient's data is accessible at the server end itself, acquisition of data is done completely. It is mandatory that both patient and doctor are there at the same time and a communication portal that allows both of them to interact. It's an online module that allows a two-party interaction between the patient, treatment provider, and specialist doctor. The essential signs are communicated by mode of PC modules, cell modules, public phone modules, or satellite TV modules to the main server. The wired network, however, limits the level of opportunity for the same which is to be noted.

- *Hybrid Systems*: The combination of real time and store and forward together give hybrid systems. Which combines stored images or video with real time video conferencing [5].

4 Technology Used in Telemedicine

The information which is needed to be compiled and shared in telemedicine includes: (1) Personal information, data of physiological factors, disease and health history, payment for the corresponding, etc.; (2) Audio check-ups and compilation of data like typical heart sounds and sounds from/due to respiration, etc.; (3) X-ray, CT, MRI images, skin images, images of tissue and cellular specimens are considered as part of radiography.

4.1 HL7 (Health Level 7)

HL7 is a healthcare-compiled data shared between multiple computer systems/modules. HL7 is an abbreviation which is: health level 7. Level 7 is responsible for the application level of OSI model for medical condition. HL7 is a predominant protocol for electronic information sharing and performs transmission transactions for patient registration, patient insurance, patient billings, and patient orders.

4.2 Transmission of Images

The analogue images which contain large amounts of data should be digitized, as a result of which size of image is reduced to a smaller size so that sending and storing and managing will be economical, and this includes sharing of diagnostic images like X-rays, CT, MRI, histopathology slides, etc. Data stored in X-ray film is converted to a digital form ideally by a conventional scanner. Coupled devices which are charged and laser scanners are used in digitizing the film-captured images. Images from ultrasound, CT, and MRI devices are readily available as video, computer, or computer file format.

4.2.1 Standards for Still Images

Three still-image coding standards commonly used in telemedicine are as follows:

JPEG: Joint Photographic Experts Group (JPEG) is one of the most common compression standards for the sharing of images. JPEG uses DCT technique, in which, sampled data is in 8 × 8 pixel blocks which is then converted into component-based cosine functions using DCT (discrete Cosine Transform) technique as mentioned above. Non-detectable frequency to the human eyes is identified by the means of comparing the coefficients to that of a set coefficient. These frequencies are then re-assigned with zero value(s) as they will have no impact on the image quality even if they are lost. This results in a good and quality compression. The wavelet compression method works globally on the image and replaces the sequence of pixels with repeatedly assembled parts of much smaller wavelets. The performance of JPEG compression methods was examined based on an examination of tuberculosis X-ray data [6]. The method is found to perform good in low compression ratios. Both methods, fortunately, are useful in storing, maintaining, and sharing scanned images of the chest area (X ray). All shortened images are then shown to doctors and will be tested subjectively. The processed images were good and best in comparison to the unprocessed ones as a result of the testing process.

Digital Imaging and Communications in Medicine: Digital Imaging and Communications in Medicine is simply a simple facilitating processing and sharing of images and corresponding in the digital form. DICOM is the third version of a developed standard in 1983 transferring radiological images and other medical data from one computer to another. It allows diagnostics as well as usage of therapeutic equipment and systems from various manufacturers to communicate digitally and efficiently. In medical care, such availability is basic in terms of cost-effectiveness. Clients can capitalize on minimizing their expenses by making sure that the new equipment and frameworks are reliable. Additionally, clinical pictures are caught and shared all the more rapidly, permitting doctors to provide quick treatments and take decisions [7]. The objective of developing DICOM is to set a general standard that can be used and applied to all the images in the medical area and also to harness the development and expansion of PACS that interferes with other systems of hospital data. DICOM compiles the input of machinery such as workstations, central hubs into picture storage and communication units.

Picture Archiving and Communication System: The Picture Archiving and Communication System includes PCs. It is subjected for ability, recovery, conservability and show of medical images. PACS maintains pictures from different imaging ranges like radiography, ultrasonography, computed tomography, MRI, PET, and mammography. PACS is an electronic method for regular radiological filming: pictures are obtained, saved, shared, and displayed, as shown in Fig. 2. At the point when such a model is introduced all through the clinic, a filmless clinical condition results.

The first step in PACS is obtaining images like X-ray film or any other corresponding digital image. Images like X-ray film need to be digitized using a digitizer. The data connection between the various components of the PACS acts like a pathway for the complete system. The main functional unit (Brain) of the PACS is the sole database server, which keeps track of the data, images, image attributes/

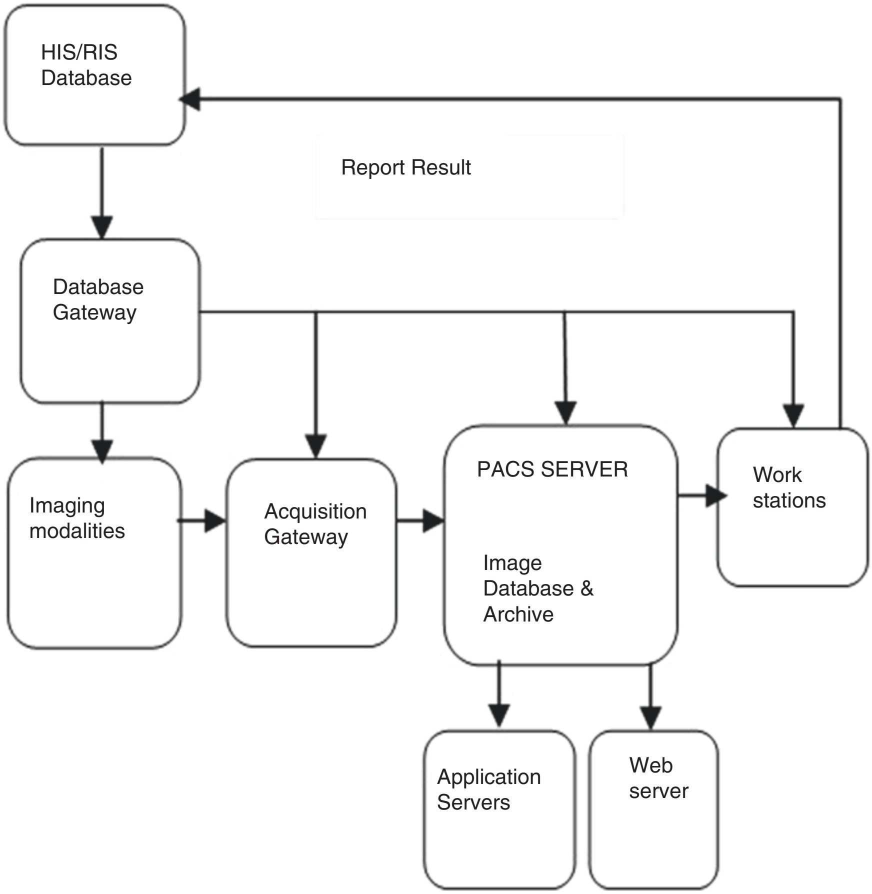

Fig. 2 Picture archiving and communication systems

conclusions, and image locations. The next important component is the Archival system, which electronically archives image information. The Radiological Information System maintains patient demographics, schedules, and interprets results based on corresponding examination. The display workstation provides a clear view of the image data to the clinician. PACS provides high efficiency due to electronic handling of data [8].

– When an image is acquired, it will never get lost or misplaced. It will be available all the time and can be accessed anytime.
– The images can be at different locations at the same time, which is not possible for a basic radiological film.
– Images stored in the PACS database can be easily retrieved as they are stored in sequential order, correctly arranged and labelled.
– After processing of images, computer tools can be used, which will enhance the view.

4.3 Transmission of Video

For proper diagnosis of the patient, it is mandatory to have the video data of the patient. In video, the bandwidth requirements must be multiplied with the video frame rate which will take up a lot of memory and hence video compression needs to be done before sharing the video.

In video compression, unwanted or repeating pixels are removed from each frame. A high rate of compression can be obtained if we are transmitting the difference between the frames. Video compression is performed using special ICs (Integrated Circuits) called codecs, which stand for compression and decompression. Video codecs mainly perform two functions:

- They convert the analogue video into digital form.
- Reduction in the bandwidth is obtained by compressing the digital data signal.

4.4 Transmission of Audio

Telemedicine has audio channels that are available in electronic stethoscope or Doppler ultrasound. The frequency response in an electronic stethoscope ranges from 20 Hz to 2 kHz, while it is from 100 Hz to 10 kHz for Doppler ultrasound. Audio signals are first digitized and then compression is done using ideal compression algorithm.

Audio compression methods for normal equipment and work have data rates ranging from 16 to 64 Kbps. In healthcare applications, where a high data rate of 120 Kbps is required to produce full audio frequency range from 20 Hz to 20 kHz over a range of 90 dB. Initially, Pulse Code Modulation (PCM) was used for the audio compression. Then, Adaptive Differentiable Pulse Code Modulation (ADPCM) was used for compressing the audio signal. In ADPCM, the difference between the two samples is sent which will reduce the data required for storing each sample.

5 Wireless Technology for Telemedicine

Wireless telemedicine is an emerging technology which connects the wireless technology with the medical and health systems for the ultimate well-being of the humans and other living beings on Earth. Wireless telemedicine has the ability to facilitate accurate diagnosis and examination, as well as the transfer of medical information, treatment history, medication details, test results, laboratory results, and insurance data. The availability of user-friendly, cost-efficient, and low-power consuming and portable wireless devices, patient treatment and care will be ultimately improved through better recording and observation of patient on the move.

And also, it supports patient health and treatment with full-time observation, timely health check-up, data, and follow-ups [4].

Multiple challenges are still there which are to be mentioned while using the wireless technology with healthcare instruments. Factors like reliability, low-power requirement, nodal failure, transmission reliability, power consumption, and for comfort of the patient, the wireless gadget must be small and lightweight, are the main difficulties to be considered while moving to smart wireless technology for telemedicine. While telemedicine is still in its early stages, there are a number of obstacles in the path, which includes license, reimbursement (if any damage), liability, and quality.

Technologies, such as mobile 4G, and the famous Wi-Fi, enable representatives to access important data from any place and any time in the formed networks topology. Radio-frequency identification, wireless sensor networks, ZigBee, and Bluetooth have been introduced only recently, but supporting the access of wireless communications as well as incorporation into delivery systems (health-oriented), we can make wonders.

5.1 Wi-Fi

Wi-Fi is routinely used in the home, office, and some commercial facilities to provide wireless connection; they also are widely used in telemedicine systems.

5.2 WiMax

IEEE 802.16 or simply the WiMax is good in wireless access solution that comprises basic attributes of spectrum flexibility that may be used elsewhere on the planet. The benefits of telemedicine are:

- Wireless access by broadband is available in fixed settings and in mobile setting.
- Bandwidth is significantly high, which minimizes the time it generally takes for high-quality photos to be sent.
- Telemedicine services, enabled by WiMax's network capacity, include various types of diagnostics, physical observation, medicine dosage management services, high-quality conversation and corresponding talk of a doctor and a patient, and talk with medical specialists.
- WiMax security features are found at the medium access control (MAC) layer which provides control for wireless telemedicine facilities.
- The 802.16e framework enables the smooth and effective transmission of medical data [9].

Table 1 shows the comparison of WiMax over WLAN set systems.

Table 1 Comparison of WiMax and WLAN technologies

Standard	Network	Band	Bit rate	Channel bandwidth	Bandwidth efficiency	Radio technique
802.11	LAN < 100 m	2.4 GHz	1 or 2 Mb/s	20 MHz	2.7 Mb/s/Hz	FHSS
802.11a	LAN < 100 m	5 GHz	6–54 Mb/s	20 MHz	2.7 Mb/s/Hz	OFDM
802.11b	High-rate LAN < 100 m	2.4 GHz	11 Mb/s	25 MHz	0.44 Mb/s/Hz	DSSS, CCK
802.11 g	LAN	2.4 GHz	22 Mb/s	20 MHz	2.7 Mb/s/Hz	OFDM
802.16	MAN, 1–3mi	10–66 GHz	32–134 Mb/s	20, 25, 28 MHz	5 Mb/s/Hz	QPSK, 16 QAM
802.16a	MAN, 3–5 mi	2–11 GHz	<70 Mb/s	20 MHz	5 Mb/s/Hz	64 QAM
802.16e	MAN, 1–3mi	<6 GHz	15 Mb/s	5 MHz	5 Mb/s/Hz	256 QAM

Table 2 Bluetooth power classes

Power class	Maximum output power	Typical range
1	100 mW (20 dBm)	100 m
2	25 mW (4 dBm)	20 m
3	1 mW (0 dBm)	10 m

5.3 Bluetooth

Bluetooth is seen to be the most promising technology for wireless communication with a short range of around 7–10 m. Bluetooth meets the following requirements, which include providing direct access to data, providing mobile information acquisition, providing the access to the usage of peripherals, and access to novel device architectures.

Bluetooth's most notable features include the ability to connect a maximum of up to eight devices and data transfer, which is normally available between 10 m and up to a maximum of 100 m. Bluetooth has low power and has also a short-range transmission system that operates in the scientific and medical frequencies range zones. It also supports data and voice communications and transmissions, as well as data for other short-range wireless gadgets, with a maximum and best data rate and potential range zones [10]. Table 2 illustrates the Bluetooth power classes with respect to maximum output power and range.

Bluetooth assures secure and reliable transmissions, reliable by using frequency-hopping spread spectrum algorithms and corresponding packet encryption methods and techniques.

Bluetooth Low Energy is a version of Bluetooth that uses less power consumption and is illustrated in Fig. 3. This minimizes the cost and size of battery, power consumption, and the chip design allows the technology to be included in small instruments without the requirement to significantly enclose the extensions. There are generally two types of Bluetooth low energy implementations: Small Bluetooth

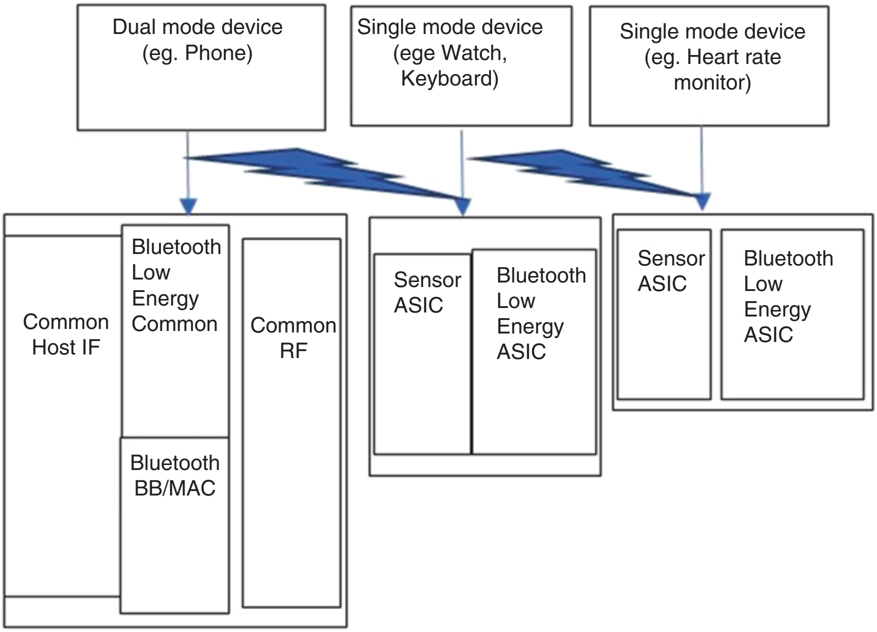

Fig. 3 Bluetooth low-energy devices

communication units that are generally incorporated into medical monitoring (wireless) with dimensions which are of just a few millimetres range comes under the category of single mode devices. Dual-mode devices are Bluetooth communication units that can be used both on mobile phones and personal computers [11].

5.4 Zigbee

Zigbee, which is a standard-based protocol, was established by using The Alliance, which was a non-profitable organization of enterprises, government regulatory bodies, and universities, which was specially assigned to facilitate multiple application environment. The IEEE 802.15.4 standard, which is predominantly embraced by the wireless sensor and networks community, decides the bottom layer of the ZigBee protocol.

5.5 Ultra-Wideband Technology

The Ultra-Wideband (UWB) is used in small-range communication, which has grown in popularity in recent past years. The UWB is the reason for reliable datarate (low data rate) sharing personal networks (WPANs), which is also accurate in range capabilities. Intrinsic noise characteristic is found in UWB signals. This makes it harder to check and prevents jamming, and hence possibly removing or eradicating the need for complicated encryption methods in devices. UWB acts as a communication interface in medical network topologies as a result of the mentioned qualities (WBAN).

Capsule endoscopy is a predominant application of UWB in terms of a wireless communication network. It is simply a camera which is in the form of a small pill that can be consumed to view the intestinal tract. They were ideally designed to send images of the intestinal tract to examine and identify problems.

UWB technology may be employed in healthcare systems in a variety of ways, including as a wireless communication network. The IR-UWB radar, for example, can detect microscopic motions inside the human body without causing any harm. As a consequence, monitoring cardiovascular physiological parameters is entirely feasible. Because of the architecture of the UWB radar, the same electronics may be used for radar detection and IR-UWB communications. Another possible application of UWB technology is used on the surface of and in-depth-situated tissues, such as for cancer treatment. This technology has the potential to replace X-ray mammography. The absence of negative effects from long exposure to ionizing radiation is a significant advantage of UWB.

6 Evolution of Wireless Communication

6.1 Zeroth Generation (0G)

The 0G was the first wireless phone, found during the World War days (predominantly World War II). In those pre-cell days, when there were only a few channels accessible, the calls were set up by the mobile provider. These phones do not support the handover function, which allows you to change the frequency of the channel. This generation of network refers to mobile communications technology from the 1970s, such as radio phones, which some individuals used in their automobiles before cell phones became ubiquitous. A mobile radio telephonic system underpins modern cellular mobile-telephony technology. These frameworks are known as 0G (Zero Generation) Systems, thinking of them as the precursors of cell phones.

6.2 1G (First Generation)

First-generation mobile systems were launched in the early 1980s. 1G was an outmoded analogue technology that could only handle the initial generation of analogue mobile phones at 2.4 Kbps. These analogue mobile phones were rather large and couldn’t be carried in a pocket. The voice information was conveyed on a frequency-modulated carrier in these devices. Every one of the frameworks upheld changeover and meandering; however, the phone networks couldn't interface across borders (i.e. users could only make voice calls inside a single nation). The drawbacks of 1G mobile networks include restricted frequency, unsteady handoff, poor voice communication, and inadequate security; calls become vulnerable to spam calls.

6.3 2G (Second Generation)

Second-generation telephones were launched in the early 1990s and are based on digital technology to fulfil expanding capacity demands in a cost-effective way. On 2G, text communications, picture messaging, and MMS were all possible. In the 2G system, digital mobile access technologies are utilized to provide simpler signalling, reduced interference, and the integration of transmission and switching operations.

CDMA provides a unique code for communication, while TDMA separates the signal into time intervals. Furthermore, the 2G networks permitted global roaming, which allows connectivity all over the world. TDMA technology is used in GSM, PDC, iDEN, and iS-136.

GSM covers a vast region. GSM (Global System for Mobile Communication) is a technology that was developed in Europe in 1982. Today, GSM is the most commonly utilized cellular technology in the world, with extensive worldwide coverage. It employs digital radio transmission to deliver a wide range of cellular communication services such as voice, data, and multimedia communication. GSM cellular technology employs RF channels with frequencies of 200 kHz. The fundamental use of a GSM system is obviously to be used for voice or speech communication.

This is accomplished by digitally encoding the speech and afterwards decoding it with a coder. GSM, in addition to phone services, enables a wide range of additional data services. The data services are normally offered with user data rates of up to 9.6 Kbps per channel slot. SMS, Short Message Service, is one such data service. GSM has good subjective speech quality, is inexpensive, terminals are portable devices, the system permits worldwide roaming, and has high spectrum efficiency.

GPRS is a technique that enables existing 2G networks to provide packet-based services while also improving available data speeds. It offers mobile phone and computer customers' data speeds ranging from 56 to 114 Kbps as well as continuous Internet connection. It supports a wide range of multimedia services, but at a somewhat modest pace. Email may be sent using a GPRS-enabled phone [12].

Migration road to 3G Wireless System: In the near future, there will be a greater desire to blur the distinctions between fixed and mobile networks. The challenge for the 3G system, with assistance of new communication technologies, is the globalization and convergence of office and home applications and services. However, the issue is not clear. As previously noted, the enormous range of communication technologies accessible today spans numerous geographical locations, each with its own set of economic, political, legal, and social challenges, making it difficult to rise in bringing together to a single meeting point.

Significant investments have already been made, and creating standards from the ground up is extremely difficult, if not impossible. With this in mind, it has been recognized that a standard that permits current networks to remain backward-compatible, while simultaneously defining a common framework within which these networks may expand should be devised.

6.4 3G (Third Generation)

Third-generation mobile networks provide fast speeds in terms of data transmission, bandwidth is wider, and hence there is an increased wireless communication capacity. All of these variables contribute to the availability of new mobile phone services. Internet connectivity, multimedia apps, worldwide roaming, and so forth are examples of these services. Data transfer speeds range from 384 Kbps to 2 Mbps, with a maximum speed of 14.4 Mbps. As a result, this network provides mobile phones with services such as voice, video, and file transfer, Internet surfing, viewing TH and high quality videos, playing online games, watching live sports, and much more. In comparison to 2.5G and previous networks, 3G provides the following advantages:

- Streaming audio and video have been improved.
- Several times faster data transmission.
- Support for video conferencing.
- Higher speed web and WAP browsing.
- Support for IPTV (Internet television).

Figure 4 depicts a situation in which direct transmission of ECG signals is used for telemedicine through a wireless network. This system comprises a real-time acquisition of cardiac data using an ECG equipment, a 3G mobile phone functioning as a persona, a server, and a medical server with Internet connectivity. The detected signal is sent to the mobile phone using Zigbee or Bluetooth wireless technology, which then transmits it to the base station or over the Internet to the care provider or automatic monitoring and recording system. Future advances, such as 3G technologies, will allow more data to be sent while on the move, influencing the trajectory of the wired and wireless computing areas.

6.5 4G (Fourth Generation)

It's simple to see a future in which mobile phones, PCs, licences, charge cards, controllers, security gadgets, smart money, and so on—all consolidated into a single device. However, if a person is accessing the Internet via his mobile phone using

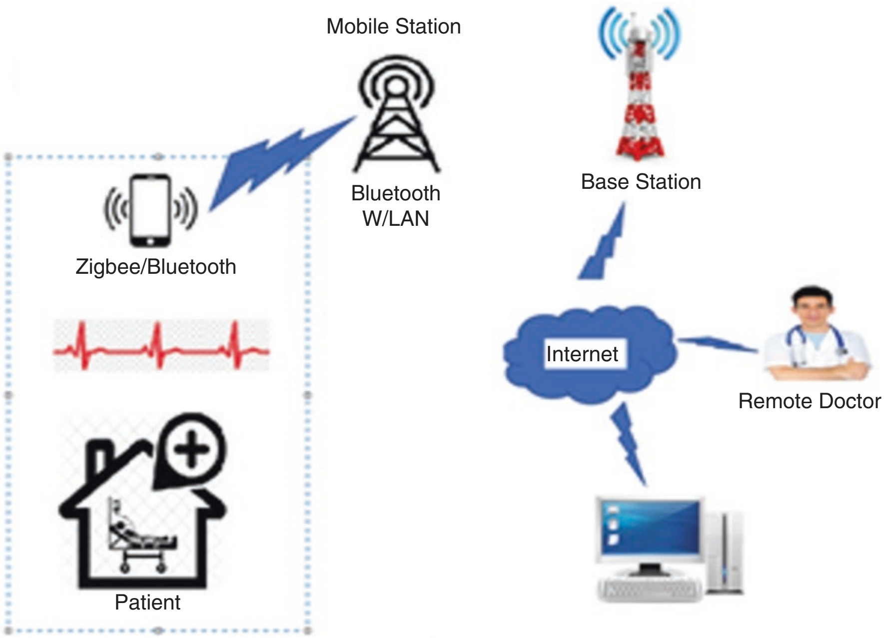

Fig. 4 Scenario of telemedicine system for cardiac applications based on 3G wireless network

any of the technologies such as Wi-Fi, WiMax, GPRS, EDGE, and is travelling to a region where network interoperability is not accessible, that user would be stranded. If the user has 4G, he can access the Internet while travelling from one area to another using any of the aforementioned technologies.

The following are some of the concerns that are expected to be handled in this 4G mobile technology:

- Larger data rate transmission and reception.
- 4G mobile technology has the capacity of downloading ten times faster than 3G.
- Call interference.
- LTE is designed to be integrated into 4G mobile LTE (Long-Term Evaluation) to provide high-level security as well as high-speed data transmission, avoiding delay.

6.6 5G (Fifth Generation)

Transmission speed is a milestone in 5G technology, with data transmission speeds of up to 10 Gbps. Aside from improved speed, 5G has low latency. Additional (far broader) frequency bands, as well as enhanced spectral bandwidth per frequency channel, are proposed for 5G technology. As of now, the predecessors (generations) of mobile technology have demonstrated a tremendous increase in peak bitrate. 5G has also progressed in terms of significantly improved peak data rate.

- Greater data volume.
- High capacity.
- Lower battery usage.
- Better connectivity, regardless of distance.
- A larger number of connectable devices.
- Infrastructure level development at very low cost.
- Communication quality is highly improved.

It's worth thinking about what 5G means for healthcare. Aside from speed Internet, telemedicine will benefit predominantly from trustworthy Internet access, which is needed for huge items and instruments, whose capacity is generally high. The most probable areas where 5G has a direct influence are virtual reality as well as augmented reality, with possible contributions for intelligent medicine as the technology advances [13].

Virtual reality and augmented reality are crucial for concise extremities rehabilitation and healthcare. Another sector that would gain from 5G would be telemedicine, as the reach of telemedicine would be expanded, and this could happen quickly. Precision medicine, on the other hand, is a conundrum that cannot be solved without the assistance of 5G technology. Bandwidth and data transfer speed have long been recognized as the most important limiting factors. The most crucial factors to consider are bandwidth and latency. This implies that a large number of devices have the ability to connect and communicate, clogging the topology. VR, no-delay response, and augmented reality result in a more engaging experience. The evolution from first generation to fifth generation in wireless technologies is showcased in Table 3.

Table 3 Evolution of wireless technologies from 1G to 5G

Generation	Speed	Technology	Key features
1G	14.4 Kbps	AMPS	Voice only services
2G		TDMA, CDMA	Voice and data
2.5G–2.75G	171.2	GPRS	Voice, data, mobile internet, low speed streaming services
3G	3.1 Mbps	EDGE	Voice, data, multimedia, support for smartphone applications
3.5G	14.4 Mbps	HSPA	All the services from 3G network
4G	300 Mbps	Wimax, LTE, Wi-fi	High speed, high-quality voice over IP, 3D gaming, HD video conferencing and worldwide roaming
5G	1–10 Gbps	NOMA	Superfast mobile internet, internet of things, security and surveillance, autonomous driving, smart health applications

6.7 6G (Sixth Generation)

Prospective technology will dominate the whole health industry by 2030 as a result of implementation of 6G. 6G governs the health business and a number of other industries as well. 6G is projected to transform several industries. In future, Healthcare will be run by artificial intelligence and 6G connection technology, affecting our notions of our life style [2].

Holographic communication and augmented/virtual reality will also aid intelligent healthcare systems. The terahertz (THz) wave will be utilized to transfer data in 6G. The THz signal boosts data rate and bandwidth. Furthermore, the bandwidth will be three times that of a 5G transmission, i.e. mm Wave. The THz signal boosts data rate and bandwidth. In addition, it will have three times the bandwidth of a 5G transmission. The 6G data rate will be one terabit per second (TBPS).

The 5G and B5G correspondence structures are 2D, but the 6G correspondence structures will be three-dimensional, taking into account time, space, and frequency. Because of AI, blockchain, this generation of mobile communication system (6G) will actually desire to provide 3D forms of aid. The 6G organization will be enormously broad and well-connected. 6G will provide more and more widespread inclusion and satellite networks. 6G comprises combining handling, routing, and detection into a single correspondence structure. In terms of security, this generation will encompass the safety, mysticism of big data created by many of dazzling devices and sensors. Regardless of which, there is a separation from intelligent gadgets, as shown in Fig. 5.

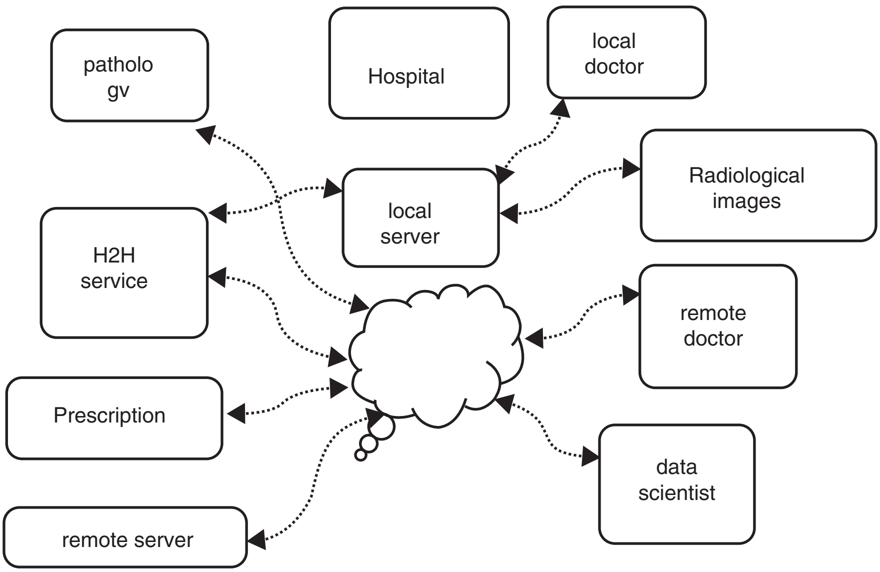

Fig. 5 Intelligent healthcare system

7 Mobile Telemedicine Systems

Service, including patient check-ups, and medicinal service providing can all be done from mobile telemedicine systems.

- *Emergency telemedicine*: Patients who are in need of emergency treatment, for example, in an unfortunate disaster, can make use of a mobile telemedicine system. It has the ability and capacity to significantly increase emergency survival rates of patients. The system shares signals (including BP, heart beat rate) and other information (such as pictures of injuries) to the hospital/clinic, allowing doctors to provide correct and timely suggestions and treatment.
- *Patient monitoring (mobile) and healthcare provision*: Patient monitoring with mobile patient monitoring is possible, which uses advanced and intelligent sensors to check on vital signs of patients so that doctors may treat remotely.
- *Treatment data (mobile)*: access (wireless) to all patient data and information is available. Patient's data with comparable symptoms can be searched in order to get data from previous experiences and better treatment can be given. Considering the patient's privacy, only medical data is available and accessible, which does not reveal the patient's identity. This medical information of patients can be accessed wirelessly by patients as medical experts.
- *Robotic systems (mobile)*: Medical experts can now use mobile systems to control highly sensitive and accurate medical instruments such as ultrasonic gadgets at the patient's side from remote location which is a revolution in the medical field. Medical surgeon can control equipment wirelessly, allowing them to precisely measure and provide accurate medical data while removing the need for patients to operate medical gadgets. This type of service is provided by tele-echography (mobile) using a very ultralight weight robot (OTERO). Raw communication and sufficient bandwidth for sharing high-resolution digital films and photos are required for robotic systems, and WiMax technology meets these criteria ideally.
- *Pre-hospital care*: In an ambulance, WiMax technology potentially improves treatment before getting into hospital. Ambulance members can use WiMax network to access the particular hospital's medical information and get the required medical information for patients at risk [R3]. The doctor in a hospital will be able to undertake and do the corresponding examination as well as diagnose, until the time that the ambulance reaches the hospital, using video conferencing and robotics technology.

8 Conclusion

This chapter has highlighted the improved telecommunication in medicine using telemedicine. Various technologies, especially PACS and the delivery modes used in the telemedicine, have also been explained. AI-driven medical services and innovations of medicine in 6G technology are also explained.

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Part IX
Future of Medicine and Computational Techniques in Healthcare

Future of Medicine in Cognitive Technologies and Automatic Detection via Computational Techniques

S. Shanmuga Raju, B. Paulchamy, K. Rajarajeswari, and S. Nithyadevi

1 Introduction

Recent healthcare system is a reactive method for treating illnesses, infections, and accidents after they have happened or after individuals have observed apparent signs. The victims' effort in approaching a healthcare centre determines how quickly they will be diagnosed and treated. In the therapy of the condition, such a lag in time is crucial. In many circumstances, simply waiting too long to get a prognosis will result in chronic illnesses, progressing cancer phases, and also death. Early identification and intervention can improve the chances of therapy and recover from any disease, including tumor. As a result, proactive instead of reactive healthcare is required, with the ability to identify sickness, infections, and injuries not just as they occur, but also, ideally, before they occur. In order to deliver patient-focusing prognosis and therapeutic services in a smooth and dynamic manner, futuristic healthcare is heading toward that predictive, proactive, preventative, and customized paradigm [1]. In addition, with the rise of clinical big data and the advancement of computational tools in healthcare, researchers and practitioners have been able to draw out and display clinical huge information on a whole advanced level. A huge volume of information available in today's technology age is increasing at an exponential rate. Wearable gadgets generate a massive quantity of data. For appropriate administration, display, and extraction of information inside large data, modification in the form of analytic-based techniques is necessary [2].

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Wearable gadgets, electronic clinical report (ECR) producers, and smartphone clinical care systems are examples of smart IoT-based applications that have changed the traditional healthcare system into a digital healthcare system. On a daily basis, these gadgets create a large amount of data. The exponential growth of clinical big data has piqued the scientific group's interest for the extraction and visualization of fresh insights out of the data. Registration information, bioscrypt information, ECR, radiology reports and images, patient records, web information, biomarker information, medical information, and administrative information are just a few of the big data sources accessible in the clinical care business [3].

Communication between patients and physicians, review consultation, and the presence status of consultants are all becoming worryingly obvious. Our modern-day healthcare system's problems may be resolved by innovation and technical solutions. Recently, machine learning (ML) has discovered as containing significant technical implications in the field of healthcare. While these methodologies certainly will not replace doctors entirely, they have potential to alter the healthcare industry, benefiting patients and providers alike. PCs might distinguish doctors experiences from information by figuring out how to utilize specific ML algorithms. ML's iterative nature permits it to change its methods and results as it is uncovered to newer conditions and data [4].

Machine learning might be considered in mechanizing the revelation of portrayals expected for forecast from raw information [5]. Profound learning methods are portrayal learning calculations with many layers of portrayal made by building straightforward yet nonlinear modules that progressively change the portrayal at one level (starting with the crude contribution to) a higher, to some degree more dynamic level [6]. Profound learning models performed well and have a ton of potential in errands like PC vision, discourse acknowledgment, and normal language handling [7]. Profound learning ideal models give charming new potential to biomedical informatics, given their laid out adequacy in a few regions and the speedy development of strategic advances. Profound learning approaches are either being utilized or are being considered for use in medical services. Other computational strategies, for example, clinical imaging, genomics are predominant candidates of medical care. In this section, a brief summary on AI and profound learning on medical service applications were depicted, followed by other computational strategies such as clinical imaging, E-well-being record, and genomics.

2 Machine Learning in Healthcare

Artificial intelligence is a natural extension of ML. When dealing with difficult statistical analyses, researchers and medical practitioners frequently turn to ML. Healthcare informatics is the field that combines both clinical care information and ML for detecting models of relevance. As a result, the purpose of clinical care information science is to find model from information and then get trained from them [8].

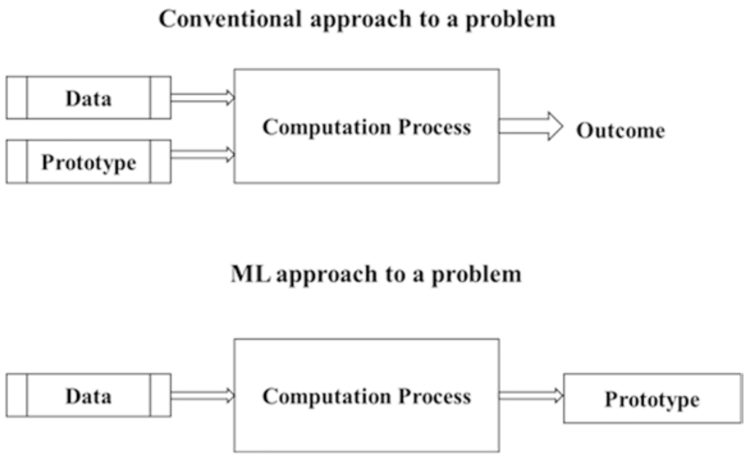

Fig. 1 Approaches in problem modeling

ML incorporates ideas from a variety of disciplines, including computer science, statistics, and optimization. Every ML issue may be framed as an enhancement issue with regard to a set of data at their core. Figure 1 depicts a typical ML model that explains the fundamental difference between the conventional approach and ML approach to model a problem.

In a typical method to data analysis, the model is used as the machine's input. Starting with the data, an ML (or data-driven) technique produces a prototype that subsequently implemented with fresh information. This job may be accomplished using a variety of learning techniques such as logistic activism, decision trees, ensemble approaches, and deep neural networks. The underlying objective function and limitations of these strategies differ. ML-based studies generally seek nonlinear correlations among hundreds or thousands of factors, despite their tight ties to classical statistics.

Martis et al. introduced an ML approach in view of wavelet for the examination of ECG signals. The minuscule varieties in the sufficiency and length of the ECG are not enough reflected in the time and recurrence areas since it is a nonlinear sign. R-point recognition utilizing the Pan-Tompkins strategy, discrete wavelet change (DWT) decay, sub-band head part investigation (PCA), factual approval of highlights, and example order were all important for their approach. To take out inclination in choosing preparing and testing sets for grouping, they took on k-overlay cross approval. They likewise used the normal order precision as an examination point. A few classifiers were utilized, including the Gaussian blend model (GMM), the mistake back engendering neural organization (EBPNN), and the help vector machine (SVM). They expressed that the made AI strategy might be utilized in an online telemedicine framework that can be utilized in various medical care informatics frameworks for distant patient observing [9].

Zhu et al. introduced a clever glucose level guideline of diabetic patient. They continued by introducing a numerical model that portrayed the connection between human glucose levels and different variables. Then, to oversee glucose levels in diabetic patients, a nonexclusive fluffy rationale regulator with a bunch of fluffy rationale rules is proposed. The re-enactment discoveries propose that the fluffy rationale control is effective in controlling glucose levels utilizing a criticism technique [10].

Cheng et al. developed an ML-based rehabilitation model for home care clients. The RAI-Home Care (RAI-HC) evaluation tool was used to collect data for this study, which was based on standardized client assessments. Machine-learning algorithms, according to our research, can make better judgments than traditional healthcare protocols. More crucially, we've demonstrated that machine-learning algorithms are more capable of making "black-box" projections; also, they are able to produce significant advanced medical and scientific knowledge. Using those findings, finer judgments can be made regarding patient diagnostic plans and healthcare supply management, evolving in improved patient results and improved reliability and efficiency in clinical care system [11].

The advancement of technologies such as cellular communication, utility computing, and data mining methods is also boosting the ability of ML algorithms for healthcare systems [12].

These methodologies could play a basic undertaking in restoring the medical care business, notwithstanding added advantages, for example, giving tele-medical services administrations to far off regions. Figure 2 portrays the different phases of laying out a medical services framework in view of AI calculations. Different types of ML specifically unsupervised learning, supervised learning, semi-supervised learning, and reinforcement learning are utilized in different applications, including medical care. Unaided learning strategies are AI moves toward that utilization input information. Solo learning can be utilized to find abnormalities, like grouping. In medical services, these methodologies are being utilized for the early recognition of heart sicknesses through bunching [13] and early discovery of hepatitis infection [14] through standard boundary assessment.

Supervised learning methods are those that use labelled training data to create or match the inputs' connection with outputs. The job is referred to as classification if the output is binary and regression if the output is continual. The categorization of different forms of lung ailments and the detection of distinct bodily parts from medical photographs are two typical applications in healthcare. When both labelled and unlabelled data, like labelled data in little volume and unlabelled data in huge volume are there for training, semi-supervised learning approaches are beneficial. In the literature, many aspects of semi-supervised training employing various training algorithms have been suggested. Reinforcement learning procedures are those that train a goal function from a series of tasks, and rewards in accordance for measurement taken over a period of time. It has the ability to alter several medical implementations, and recently employed in illness diagnosis via context-aware illness sign evaluation. Healthcare providers produce a vast quantity of heterogeneous data

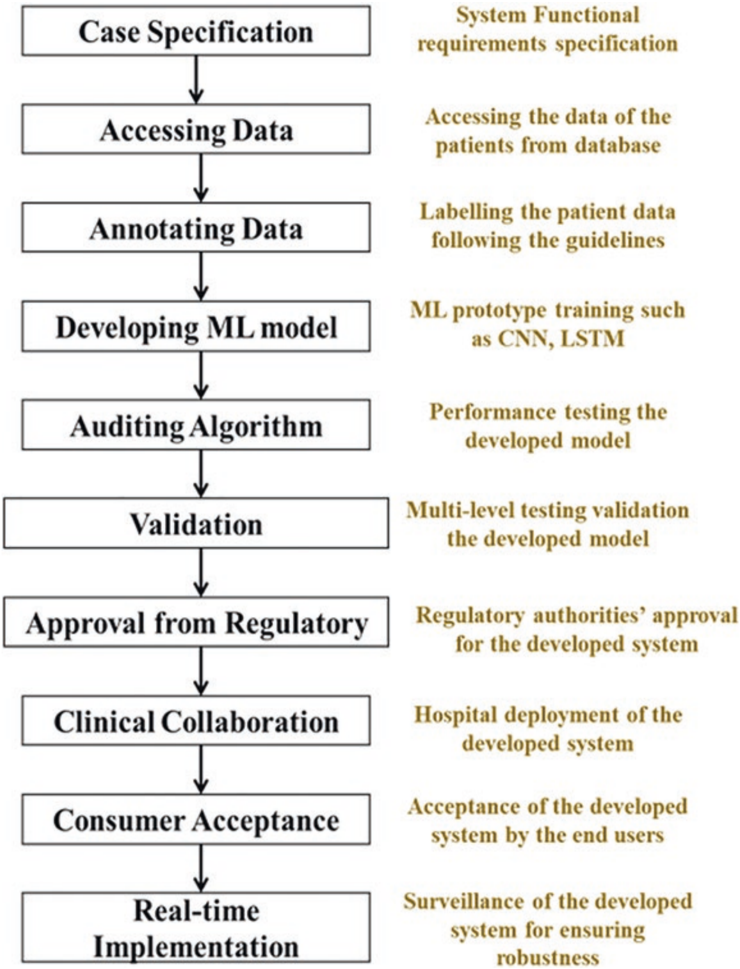

Fig. 2 Crucial development stages of ML-based healthcare systems

and information on a regular basis, making it challenging to assess and handle using "conventional methods."

The use of machine learning technologies aids in the effective analysis of this data in order to provide actionable insights. There are also a variety of data sources that may be used to supplement healthcare information, like genetic information, medical information, social media information, and environmental information, among others. Prediction, detection, therapy, and clinical exercise are the four key healthcare uses that can take advantage through ML approaches [15].

There are various benefits of using machine learning-based solutions in healthcare. They may be instructed through vast amounts of information, referred to as instruction dataset, and later use inductive deduction to help medical practice in threat assessment and therapy formulation. These models can eliminate human fault through removing manual factors present in the model, also they perhaps perform repeated tasks, increasing the effectiveness over human labor. Artificial intelligence (AI) can aid physicians in consulting and providing proper patient care, which is tiresome for humans, by learning facts relating to clinical research from literature, and hospital practices. However, contemporary ML algorithms lack the conclusions that a human mind can draw. With the mixture of ML and IoT instruments, observing, administering, and evaluating clinical records becomes simpler. Furthermore, machine learning algorithms can analyze enormous amounts of healthcare information and identify particular models and variations that are linked to a variety of illnesses, thus speeding up the development of new therapies. To a certain extent, AI can deliver health monitoring and consulting services online, dubbed "health bots" in the process [16].

3 Deep Learning in Healthcare

Deep learning (DL) is one of the machine learning approaches in which a network learns and creates intrinsic properties from buried layers of neurons. The word "deep" comes from the Artificial Neural Network (ANN) model containing many hidden layers. The ANN program simulates a brain's behavior. The prototype is realized using an input layer, output and hidden layer structure. A connection link connects each neuron or node in the next layer to the neuron in the previous layer. The axon termed as output, dendrites referred to input, node called as soma, nucleus which is the activation function, and synapses make up a nerve cell called weights. The artificial neuron's activation function represents the nucleus of a real neuron, while the incoming signals and their values represent the synapses and dendrites, respectively [17].

Many health problems manifest themselves in a variety of ways, making it difficult to make a precise diagnosis through the period. Many complicated diseases necessitate clinicians being up-to-date on the newest treatment choices and data. A DL healthcare platform enables all doctors to practise around the same skill level as a group of the best. Because DL models may be shared across clinics without exposing patient information to ethical hazards, the potential for developing a new personalized medicine paradigm based on the decisions and results of varied clinicians treating various patients is essentially endless, as illustrated in Fig. 3 [18].

Since the dawn of the AI revolution, traditional ML techniques have been used in clinical information systems and medical discoveries. However, ML approaches have only recently gained acceptance in primary care, because of the development of powerful computing tools, low-cost electronic storage, and widespread adoption of e-health records. DL approaches, which build on traditional machine learning, offer a new layer of capacity to automate complex cognitive activities, this moment employing big data. The necessity of often sophisticated processing to extract the required exclusionary characteristics is one of the key drawbacks of traditional ML

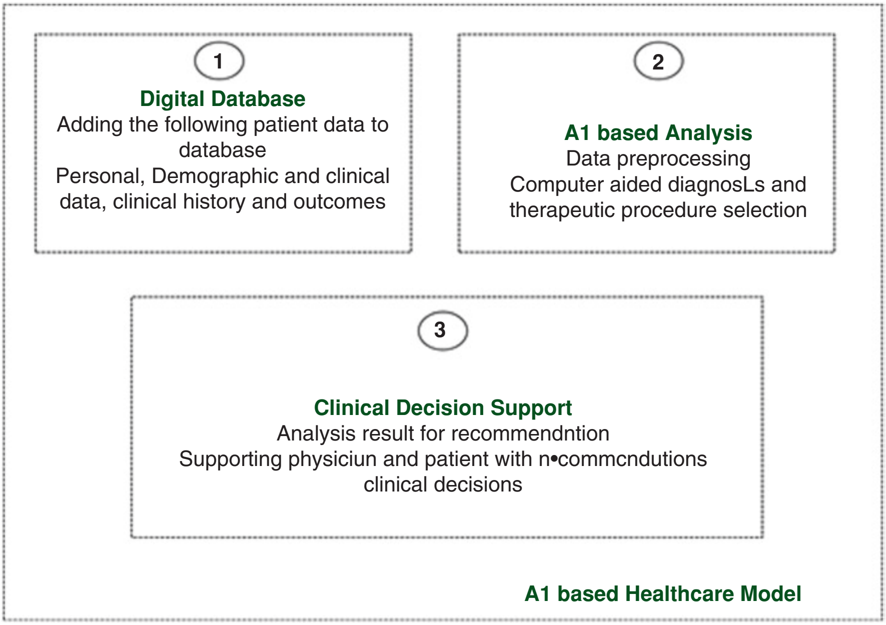

Fig. 3 A deep-learning model for healthcare

algorithms. Non-DL models required extensive subject knowledge and data processing ability to train. DL, on the other hand, excels in extracting abstract characteristics from original data. Various layers of the system learn abstract characteristics that are representational of the data on their own. Without the requirement for extensive domain expertise, a simple, well-designed, and trained network may produce quality outcomes across a wide range of applications. DL is currently automating many cognitive functions that were previously assumed to be restricted to human operation owing to the complexity of the data [19].

DL's current prevalence can be attributed to various factors such as computing power increase, data size increase, and research in advanced DL. It may be a strong and effective option for system healthcare monitoring because of its capacity to handle huge data and gain multi-level representation. Handcrafted component development, extraction of features, and model construction are the main components of traditional data-driven system healthcare monitoring. Support Vector Machine, Naive Bayes, and logistic relapse are used to create the proper collection of features, which are then fed into basic ML algorithms. System healthcare monitoring based on DL aims to derive multi-level features from data by using different layers of non-linear manipulations in deep neural networks. One layer function may be thought of as a modification between input and output values. As a result, one layer's implementation may learn new features of the input data, and several layers' overlaying structure can allow a system to learn complicated ideas from basic concepts that can be formed from source input. Furthermore, these systems provide the ability to learn complex functions from direct input and forecast targets without manual interventions. They do not require as much human work and expertise for hand-crafted functionality creation as traditional data-driven healthcare monitoring models. All design parameters, along with feature categorization modules, may be trained at the same time. As a result, DL-based models may be used to deal with system healthcare monitoring in a broad sense. For instance, the model supervised for defect detection might be employed for forecast by substituting the top layer with a linear regression layer, which would need some re-supervision [20].

4 Computational Intelligence Used in Healthcare

The future of healthcare system relies upon the emerging field of AI called Computational Intelligence (CI) that includes computing hypotheses based on neuro-cognitive and biophysical capabilities. CI focuses on lower grade cognitive capabilities such as detection and command. CI includes major forms such as Neural Networks, Fuzzy Logic, and Evolutionary Computation. The Neural Networks (NN) are computing frameworks algorithms that, contrary to classical computing, contain model and function similar to that of a human brain. As they are made up of a succession of inter-networked processing units that function in concurrence, NN are also known as fully convolution systems, or adaptive systems. Because all of the inter-networked processing units alter concurrently with the information flow and responsive rules, NN lack centralized control in the traditional sense. Fuzzy Logic is a refinement of Classical Propositional Concept. Raw data in propositional reasoning are binary. For example, given this assumption, we can predict whether a value is related to a set or not based on its features. Fuzzy logic comprises various membership functions such as triangular, trapezoidal, and S-function set. Evolutionary Computation is a term that refers to a collection of machines-based problem-solving techniques that depend on biological evolution principles. Genetic Algorithms, Evolutionary Programming are just a few of the methodologies available. Their main variations are in the alternates of individual structure representation and operators of variation, despite the fact that they are comparable at the highest level. Developments in information technology, as well as the volume of data generated by these emerging technologies, have presented the CI society with new challenges. This is especially true in medicine, in which computers are used to capture, store, and interpret patient information in a variety of forms at all times. This opens up a lot of possibilities for establishing strong computational solutions to enhance the healthcare quality [21].

NN has been used to diagnose and estimate the fate of prostate tumor in the early stages. When linked into intelligent systems, they're also useful for detecting prostate tumor early. The input from rectal ultrasonography and MRI were given to NN system for the identification of prostate tumor. The predictive efficacy of an NN model was measured in the existence and lack of scan data from 684 patients who have undergone biopsy. The analysis found the mean AUC of 85% when TRUS data were incorporated, indicating that performance had increased [22].

Delivering successful digital healthcare services is critical for policymakers and the general population in the framework of a smart city. Patients and physicians can gain benefit from customized healthcare services that provide optimal advice and guidance based on personal and community profiling and powerful algorithms of Big Data analytics. For instance, in a latest study, investigators examined the variables that influence older persons' use of hearing devices in the setting of a smart city. They urged this demographic to visit smart clinics to speak with audiologists about the loss of hearing ability and retraining hearing devices, so as to improve their livelihood. In order to give customized medication and therapeutic management choices, it is critical to have a deeper understanding of a person or a team's healthcare requirements. Furthermore, this includes way of life, and welfare monitoring based on customized choices and objectives that may be utilized to support good health, assist nutrition, fitness, and stress – management of behavior modification. Observing and offering these services using individual, cloud-based, and m-Health apps would enable people to better maintain their condition and lifestyles, resulting in lower healthcare expenditures. Health informatics may be used to construct easily understandable decision-making support systems for supporting better healthcare policy and visioning for crisis situation using huge inhabitant's data [23].

The basic CI system architecture is shown in Fig. 4. Pre-processing is the first step in the architecture, that involves preparing and transforming the raw information. To create conceptual classification, medical raw information is turned into a comprehensible manner. As a result, during this stage, the classified data comprises testing and transfer learning. The second step in the architecture is learning, that seeks to merge a variety of learning techniques into a more precise aggregate classifier rule. The major criterion of this step is to organize the input pattern in order to generate basic classifiers using a supervised learning as a base classifier. The third part of the learning process is performance analysis, which picks the best classifier for medical information. Specificity, sensitivity, and robustness are the most often employed performance analysis metrics in contemporary research. The last step is a judgment process that fine-tunes the training rules to increase detection capability [24].

A number of CI techniques to nuclei separation in microscopic images were proposed in literature. Clustering is one of the most critical processes in an automated clinical diagnosis based on the analysis of microscopic image, and it is essential for making a good screening choice. Conventional segmentation algorithms are ineffective with biological pictures due to their complexity. The new modified techniques, namely, watershed algorithm, active curves, cellular automata, the Grow Cut methodology, and innovative methods such as fuzzy sets, and the echolocation method were proposed for effective image clustering [25].

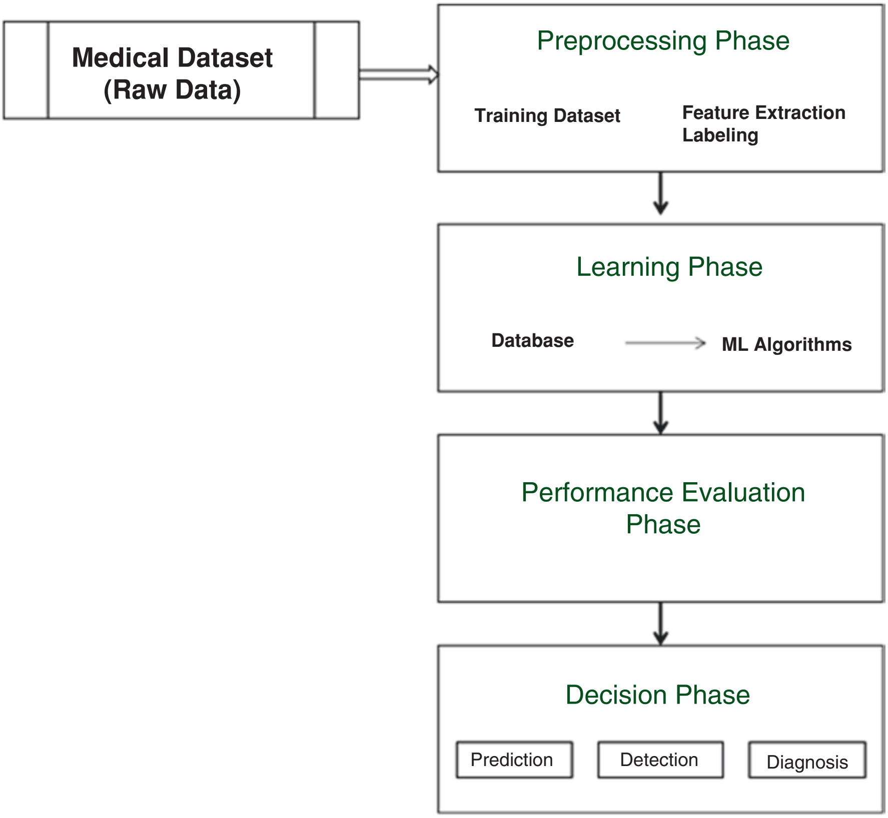

Fig. 4 CI system architecture

4.1 Clinical Imaging

Hardware for radiology scanners has progressed dramatically in the recent years, while software algorithms have generally taken longer to develop. This gap might be overcome for a variety of applications, involving protocoling, image collection, and noise removal, if algorithms are acquiring patient information and earlier radiological investigations. Thus, depending on the medical information and justification provided in the request, scan procedures for radiography, CT, and MRI may well be dynamically recommended in the computerized scheduling system. With the use of deep learning NN to choose between regular and tumor MRI treatments automatically, clinical imaging has been travelling in yet another dimension. Image restoration of 3D MRI images or CT scans procedures are automated to reduce the time it takes to complete the report and the amount of time clients have to wait in the emergency unit or doctor's office [26]. AI has the ability to speed up restoration and be employed in an autonomous restoration technique, applied with CT as well as high-precision 3D MRI, allowing techs for spending moments on clinical outcomes instead of doing repetitive, time-consuming, and hard labor. In addition, AI has the ability to boost image resolution.

In respect of ease, non-intervention, and concurrent features, ultrasound (US) imaging outperforms other medical imaging modalities. CT exposes the patient to radiation, whereas MRI is non-interventionist but expensive and tedious. As a result, across a variety of medical professions, US scanning is routinely utilized for both screening and conclusive diagnosis. AI has advanced quickly in the last decade, and it is now being used more often in healthcare research and applications. Because of ultrasonic diffraction, US imaging usually has limited spatial resolution and many artifacts. These traits have an impact on not just US examinations and diagnoses but also AI-based picture processing and identification. As a result, numerous approaches for picture pre-processing in the United States have been presented to remove noises that obstruct accurate image analysis [27]. Due to their hyper-perfusion and imprecise borders, pixel-level labeling of acoustical shadowing is extremely expensive and complex. Meng et al. used annotations for each picture with acoustic shadows to estimate accuracy maps in a semi-supervised manner [28]. Using the quasi of realistic artificial shadows placed onto US images, Omoumi et al. suggested a semi-supervised strategy to incorporate area expertise from digital information architecture, as shown in Fig. 5 [29].

Imaging, in nuclear cardiology, is done on a frequent basis in the hospital to help the doctor make decisions, such as whether or not a myocardial stenosis has to be treated. Single-Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET) are two of the modalities employed, and they are frequently used in conjunction with a CT or PET or MRI scan. ML and DL-dependent imaging approaches are involved in recent times because of the significant number of assessments performed, particularly in cardiac treatments, as well as those investigations are greatly standardized and implemented quantitative measurements. As a result, AI has progressed in the domains of imaging information segmentation, coronary artery disease treatment, and major undesirable heart event prediction. AI techniques are increasingly being used in fundamental and practical field of nuclear imaging, along with the implementation of image evaluation. Prior to picture restoration, PET data requires extensive processing and data rectification. Attenuation

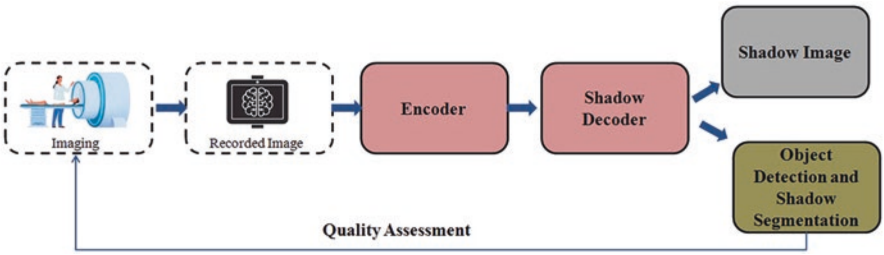

Fig. 5 Detection of acoustic shadow

rectification, for example, is an important step in quantitative image restoration that is carried out in today's PET/CT systems utilizing attenuation maps produced from CT information. Several methods have been studied that seek to enhance attenuation rectification in PET/MRI images utilizing ML- and AI-oriented methodologies [30].

Under the area of microscopy, increased picture quality provides for a more detailed view of digitized slides or the scanning of whole-slide photos with fewer photographs, saving scan time. While common interpolated techniques boost the amount of image pixels, they don't always enhance image quality. Since interpolation is basically a forecasting issue, DL methods and generative approaches have been extended to provide a range of ultra-resolution algorithms for enhancing picture resolution. These new techniques are widely used in the microscopy field recently, allowing for better scans and faster scanner throughput. Within the last decade, ultra-resolution methods have heavily reduced the required line width. Typical entire-slide imaging technologies capture images on a grid pattern and put together the output image when reading a part of a slide. The picture grid may be up to two-fold scarcer using ultra-resolution methods, lowering the set of images required and enhancing slide scanning efficiency. As the cognitive problems of using AI in medical services are intriguing from an academic standpoint, it is also critical to know how caretakers will respond to the introduction of strong emerging innovations in technology that will fundamentally transform their profession. AI-R approaches can offer findings and outcome measures without the help of professional radiologists, and they've been shown to be useful not only at medical centers but also in remote areas where radiologists are few. More crucially, AI-A enables the intervening doctor to analyze the data without the need for a qualified radiologist's assistance; suitable examples include ophthalmology and oncology [31].

4.2 E-Health Records

Over the last two decades, public health technology has advanced significantly. Health records, that are an important part of any hospital information system, have evolved from a paper-oriented structure to an electronic version known as Electronic Health Records (EHRs) (EHR). An electronic reservoir of a patient's health information that is securely kept and shared has been designated as an ERR. Shifting medical providers to digital settings utilizing EHRs enhanced the integrity and precision of data gathered, reduced the time and effort required to locate, update, and share records, minimized document devastation, and reduced diagnostic mistakes owing to misreading of handwritings. The Client-Server architecture or the Internet concept can be used to build ERR devices. The Client-Server paradigm describes a program to keep its hospital records on machines within the company. As a result, technical expertise of equipment, application, and IT is required to access and manage the infrastructure. The healthcare facilities that own the platform will certainly have documentation stored on it. Internet-based ERR, on the other hand, keeps data on remote servers that may be associated with the Web. As a result, using the information management system does not necessitate a lot of hardware, programming, or extensive IT experience [32].

Given that one of the key objective of Electronic Health Records [EHRs] is to improve healthcare efficiency and help all participants in the development, it is critical that EHRs conform to strict quality control and administration procedures. Such solutions must be integrated across the whole EHR life span, from development to maintenance. Apart from the technical, functional, and organizational components, the gathering and formulation of EHR-specific criteria provide the foundation for systems that encourage the quality of EHRs. These needs come in a variety of forms and origins, including responsive, legislative, organizational, and so on. Because of this variety, selecting and coordinating such standards across organizations or even countries is challenging. Irrespective of the precise needs chosen in a given situation, it is vital to be aware of experimentally proved and applicable criteria for EHRs as a prime step [33].

The demands of today's dispersed networks and the continually changing healthcare facility are not met by existing EHRs. It has become critical to effectively convey, analyze, and react on complicated healthcare data. Scalable element designs that can function smoothly inside a healthcare process are the way of the future. Many EHRs are continuing in an atmosphere influenced by paper chart mentality, which is limiting progress. More study is needed to better know the integration elements of human–technology interface that may be prompting doctors to rely on paper-based substitutes to the EHR. More study is required to figure out how to better effectively incorporate the EHR into clinical visits and provide doctors with more authority over the EHR [34].

While the aim of building interconnected EHRs is within our grasp, its realization will be contingent on the formulation and, more importantly, the acceptance of norms by all stakeholders concerned. HIE that enables data linkage, vital link, and CDS across various EHRs has long been a sought, but mostly unachieved, goal of healthcare analytics, particularly in business EHR systems. Merchant-supported, Internet CDS design platforms, as well as merchant-supported application programming interfaces (APIs), will be required to enable the usage of novel, modular, replaceable, and API-based CDS systems. Web apps based on Substitutable Medical Apps and Reusable Technologies are becoming increasingly popular.

4.3 Genomics

Genomics is a multidisciplinary science area concerned with the structure, operation, sequencing, and alteration of genomes. A genome is a complete set of an organism's DNA, which includes all of its genes. We may divide genomics into three categories: control, structure, and function. AI and ML have had an impact on nearly all areas. Healthcare is not an exception. The industry has largely supported innovation, and now a growing number of academics are focusing on AI developments. ML is becoming vital in this field's progress. By combining DL and computer vision methods, researchers can analyze the growing volume of genetic picture data. ML models can tackle challenges in computer vision like semantic segmentation, picture identification, and image withdrawal. AI techniques can be used in genomics for genomic sequencing, gene editing, pharmacogenomics, and newborn screening procedures. In clinical genomics, AI methods can be used for calling variant, explanation of genome, classification of coding and non-coding variants, mapping and prediction of phenotype and diagnosis of image to genetic [35]. The DL architectural workflow [36] for genomic applications in depicted in Fig. 6.

In genomic sequencing, researchers turning to functional genomic methods for the investigation of health issues are increasing. Open access to a growing number of combined genomics resources tracking biological DNA sequence, alterations, common variances, proteins, and also genome analysis across organisms, are among these tools. Furthermore, unrestricted access to genotyping and phenotyping data from concluded wide genetic epidemiology research is expanding secondary data collection potential. Whether using a genome-wide, hypothesis-independent method to genetic research or a specific genes strategy to genetic research, methods for high throughput collection of expression of genes and genotyping data are becoming more available at affordable costs. Sequencing of DNA, single nucleotide polymorphism (SNP) chips, and comparative genomic homogenization for copy number variations are all examples of high capacity genotyping technologies. The genotype data generated allows for the investigation of possible links between genotype, other personal characteristics, and exposure to environment [37].

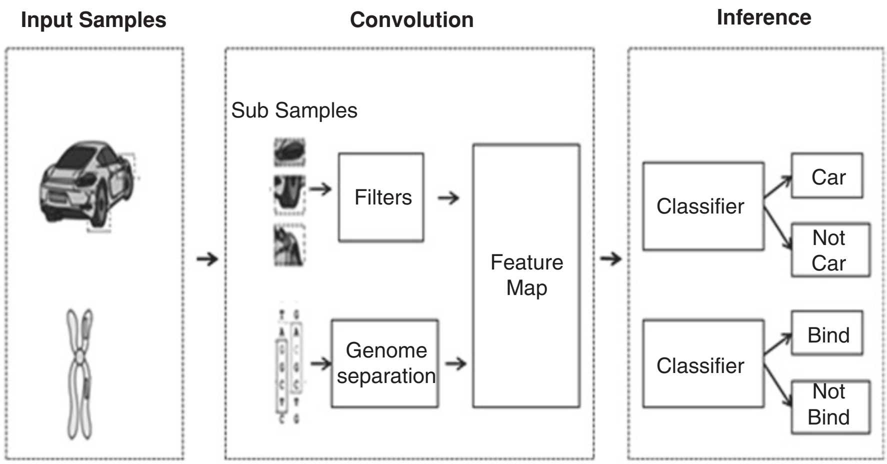

Fig. 6 Workflow of neural network architecture in genomics

4.4 Categorizing Brain Tumor Data Using Data Analytic Method Ensemble with Attribute Selection: Case Study

Because EHRs are widely often used in healthcare institutions, healthcare information can be gathered for evaluation for improving patient care quality more effectively. Investigation of such data, on the other hand, is difficult due to its intrinsic diversity, imperfection, unbalanced character, and high dimensionality. Medical information is frequently diverse, with patients' records containing a range of choices, comprising real and integer value systems with varying ranges, as well as picture and text kinds. Huda et al. proposed a novel data mining approach for classification of healthcare data in brain tumor diagnosis which is one of the examples of advanced computational technique used in health care [38].

Figure 7 depicts the proposed feature selection approach for healthcare data, particularly in brain tumor diagnosis. To construct the diagnostic classification algorithm, the method builds a globally optimal NN approximation of input gain-based blended attribute extraction that is paired with a quartet categorization strategy. The suggested method locates important aspects that aid in the generation of a simpler

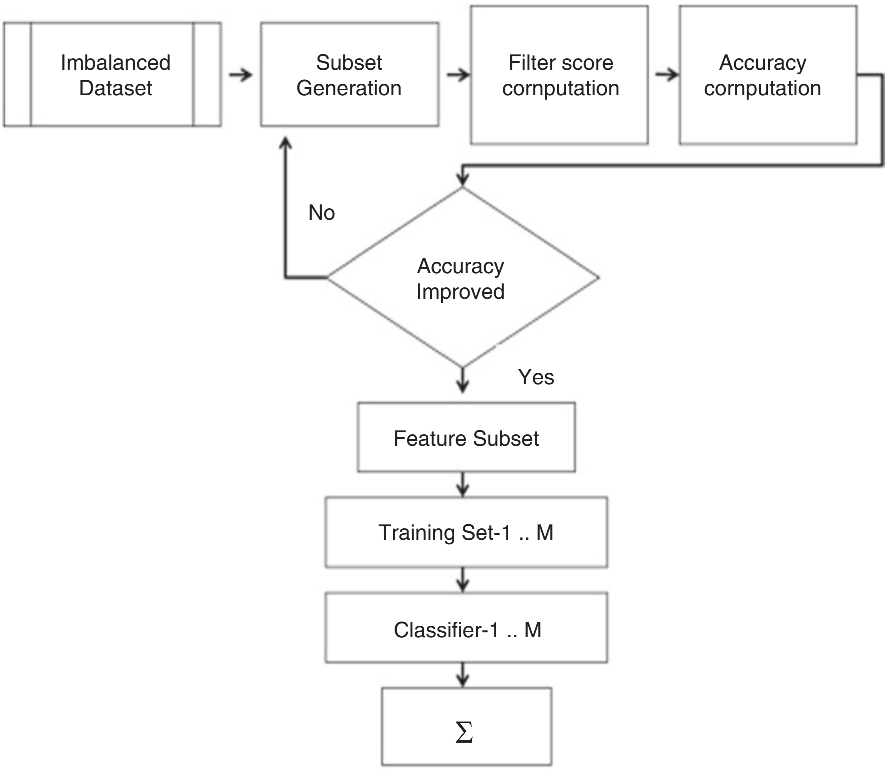

Fig. 7 Data mining architecture with ensemble technique

rule. The categorization accuracy is improved by using an ensemble classifier. The inherent correlations between the diagnostic characteristic and tumor class may be discovered using the filter technique. The filter technique, on the other hand, did not apply any accuracies-based quality grading rubric. Although the filter is efficient and robust, there is no guarantee provided for final tumor attribute set chosen that is important. Wrapper method, on the other hand, evaluates effectiveness over correctness. Because the wrapper strategy applies a categorization correctness-based quality analysis criterion while instructing, it might guarantee that the selected subset will achieve superior performance; nevertheless, it will incur a higher computational cost. This method incorporates information about the intrinsic link between a given characteristic and the related class as determined by the wrapper search's filter.

The wrapper retraining of NN is used to construct the NN approximation of measure Input Gain. The NN's conventional back feedforward training approach produces locally optimum values, which may be detrimental in the case of an unbalanced dataset. As a result, the usual feedforward training has been combined with a global optimization strategy. The relevance and redundancy score are calculated using the maximum similarity scores of candidate tumor information containing with single subgroup and the lay-off value between both the applicant attribute and the balance dataset. Next to feature selection, the collected samples are classified utilizing decision tree and ML methods called as bagging, which is a straightforward technique that employs sampling of bootstrap. Then, by combining the individual classifiers, a compound classifier (H) is generated. Following that, a new sample t_i is categorized into class c_j based on the number of votes received from certain classifiers Hm. Next implemented technique is a decision tree, common data mining strategy that focuses on constructing a model for generating decision rules. Through a divide and conquer approach, a decision tree may estimate the amount of a feature space by creating a tree from the supplied input features. A goodness score of the characteristic is used to choose the candidate characteristic from a group of ranking features. The tree's branches are labelled with either a class score or a class probability distribution.

This method is evaluated on a 63-sample brain tumor dataset without and with co-deletion. The proposed methodology combines the complimentary qualities of a filter into a brain tumor ensemble classification. The experiment result describes that using an ensemble technique resulted in a simpler choice making rule with improved correctness that could perhaps be implemented for neuropathology diagnosis. In healthcare data, an unbalanced dataset is a natural restriction that may be solved by using globally optimal feature extraction, bootstrapping, and cross-authentication. To enhance classification accuracy, more work has to be done on picture separation and morphological extraction of features. The findings show that the proposed selection of features and classification based on ensemble using decision tree and bagging outperform all the other known algorithms and may give a reduced diagnostic set of rules that can be employed for a dataset with unbalanced brain tumours.

4.5 Automatic Detection of Stress Through AI-Based Wearable Device: Case Study

For quite a long time, individuals have known about the malicious outcomes of mental weight on their well-being. To keep away from these unfavourable outcomes, an undeniable level pressure should be analyzed right off the bat. Following the presentation of wearable innovations that can possibly turn into a piece of our regular routines, specialists have started to recognize exorbitant pressure in individuals who use them all through their normal schedules. Can et al. fostered an independent framework that distinguishes the physiological signs estimated from wearable gadgets for estimating the anxiety [39]. For true circumstances, this framework offers methodology explicit curio decrease and separating highlights calculations.

The proposed stress level detection system architecture by them is depicted in Fig. 8. Their system consists of photoplethysmography (PPG) sensors for measuring the cardiac activity by blood flow measurement while cardiac pumping. Body sweating and skin sensitivity rise in response to stressful arousal. Along with the cardiac signal, the system measures the electrodermal activity (EDA), which is one of the greatest and most extensively utilized discriminative signals for detecting stress.

They created a multi-stage stress tracking system that used information from the PPG sensor, the EDA sensor's electrodermal information, and temperature records. To remove the artefacts in this data, their EDA pre-treatment program leverages accelerometer and thermal inputs. They went on to extract characteristics from the accelerometer, but they didn't use temperature data to do so. For each mode, pretreatment and feature extraction algorithms were created. Mode-specific techniques were used to remove artifacts, clean data, and extract characteristics for each sensor. Following feature extraction, the most effective ML techniques in the literature were used to classify the physiological parameters. Despite having distinct

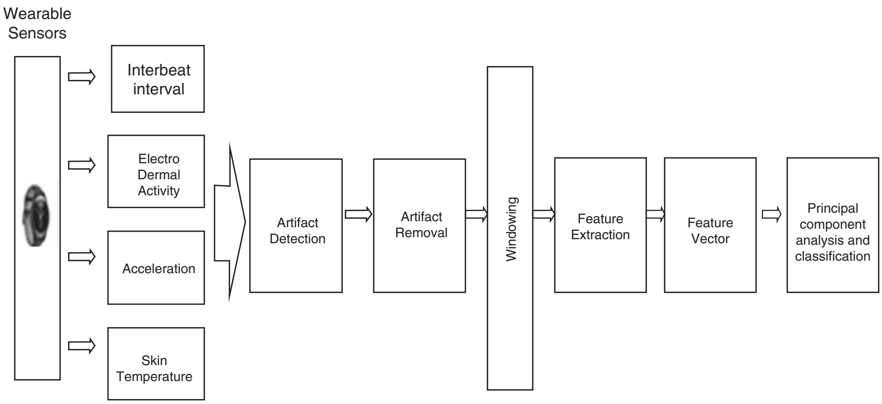

Fig. 8 System architecture of detection of stress level

platforms and sensors, their solution is interoperable with a range of smart forearm devices. Experts manually categorize the defects in the EDA signal in order to build an ML model. This program detects defects in EDA signals with 95% accuracy using the Support Vector Machine separator with gravitometer and thermal data. Features were recovered after the signals were cleaned of defects. They deconstructed the EDA signal by running it through the EDA tool, which uses a convex strategy to decompose the signal. Conductivity of the skin, the level element contains more protracted, moderate changes, whereas the phasic component contains more rapid changes. Researchers employ the tonic component for analyzing the mean, standard deviation, and percentile characteristics because they don't want to overstate these long-term changes by comparing them to occurrence-based quick modifications. The characteristics computed after removing the phase component. For the extraction of attributes, MATLAB tools, HRV toolbox, and designed preprocessing tool have been utilized. The cardiac rate activity data is also affected by the individuals' mobility and loosened wrist devices. To address these issues and to remove defects from the signal, the study team created a MATLAB preparation program. They used a defect detection 20% limit between both the data and the regional average using this technique. They used the Weka toolbox to categorize the information. They used a quantitative to actual transformation on the category column to pre-treat the features. Because their dataset was uneven based on class instance participation, they inserted samples from of the marginalized group and deleted instances from the class label to correct the imbalance. There are three stages to the algorithmic programming. This algorithmic programming competition drew 84 students of various degrees of skill. A 9-day algorithmic programming competition camp was organized. At the ground levels, data on physiological signals and questionnaires were gathered from 21 individuals. The guests were 18 males and 3 women, with an average age of 20.

Through experiments, they achieved 90.40% success rate for 3-class stress level identification using Empatica E4 devices with good data quality, compared to 84.67% with Samsung S devices. They can extrapolate from the findings that device data quality improves stress level accuracy of classification. Even with the findings achieved with the 3-class categorization, their approach shows superior levels of accuracy when compared to previous real-life investigations. They may conclude that the impacts of various pre-processing techniques and parameters are dependent on the selected ML algorithm after studying the impact of varying pre-treating methods and parameters. Researchers should choose these strategies based on how well they function with certain machine learning algorithms. Moreover, individual models consistently outperform general models in terms of classification accuracy. With these models, they were able to detect three levels of stress with a high precision of 97.92%.

5 Conclusion

This chapter discusses the primary technologies in the healthcare sector, as well as prominent methodologies, tools, and databases, so that interested scholars may have a better understanding of the current status of the field. Various technologies were used to complete the task. Because of flaws in these technologies, to overcome the resistance to cloud adoption, new ideas will be required. ML- and ANN-based Big Data analysis are two relatively emerging disciplines in this field. Response of blood sugar to the changes in daily nutrition, exercise, and other activities can be utilized to forecast future outcomes. Nutrition tailored to the individual. As a result, we can anticipate results in the forthcoming years.

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Evolution of Computational Intelligence in Modern Medicine for Health Care Informatics

R. Manju, P. Harinee, Sapna S. Gangolli, and N. Bhuvana

1 Introduction

The healthcare system has seen divergent and distinct in the last 50 years. It has incorporated something as simple as how health-care providers dress to how medical records have been maintained. There were days where people feared a spike in body temperature. Gone are those days and it is safe to say that practically a whole lot of the medicine and technology used in the health care sector has been replaced, with better and time-efficient results. The world has been endowed with abundant information available on the internet. Modern medicine surfaced after the industrial revolution in the eighteenth century. Over the last few decades, crucial milestones have been set in innovation and technology of health care. Current trends, especially the post-pandemic scenario, have seen a drastic digital transformation involving countless open and secure platforms. The approach of the digitally transformed future is going to be focused on bolstering wellbeing rather than responding to illness. Diabetes along with cancer could accompany polio as defeated disorders in the next two decades [1].

Biological and health care data have grown immensely on a much greater scale. This exponential growth is seen because of an increase in daily research activity. Conventional methods of processing data such as manual collection of data, questionnaires, and document examination are incapable of processing and controlling complex and multidimensional data [2].

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Computational health care informatics has emerged to provide accessible and improved health care. For instance, artificial intelligence (AI) has dominated the health care space for years. In 2020, it cemented its position. AI has given accessibility to policymakers as well as frontline workers to contain the spread of COVID-19. It has fast-tracked the process of evolving vaccines [3].

2 Precision Medicine

Precision medicine is also designated by other scientific names such as 'stratified medicine,' 'targeted therapy,' or 'deep phenotyping.' All these designated names focus on classifying patients like any normal novel taxonomy. This is done by clinical, lifestyle, genetic, or any biomarker data. The leading use of personalized medicine determined the epidermal growth factor in humans with a receptor (HER)-2 status in breast cancer patients. CRISPR (Clustered Regularly Interspaced Short Palindrome Repeats) genomics under precision medicine has been used in order to study drug resistance and synthetic lethality [4].

In the face of visualizing the successes of precision medicine, the meaning and its designated names remain unclear. Some definitions may include treatment personalized to the individual based on various markers discussed above to distinguish one patient from another. The pivotal aspect of this structure is that data are being collected from the patient, creating clinically advanced models. Further patients can be assessed, thus highlighting the procedure of precision medicine [5]. Figure 1 represents the schematic flowchart of the various steps involved in precision medicine.

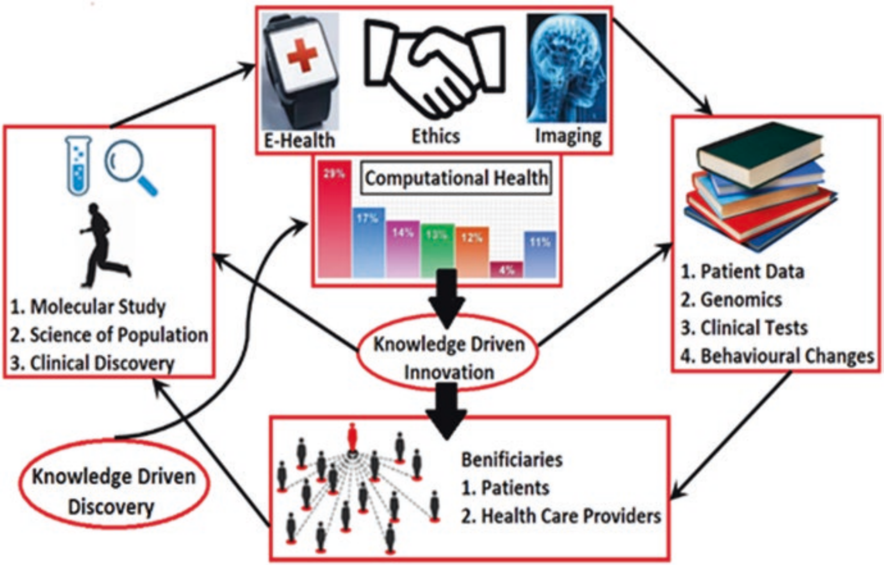

Fig. 1 Simple flowchart of the steps involved in precision medicine

2.1 Detection Methods in Precision Medicine

The detection methods applied in precision medicine are panomics/multi-omics analysis and system biology to determine the causative agents and factors that make the environment feasible for disease interaction with the body at a molecular level. Treatments are then given to target the progress of an individual's disease [5].

2.2 Multi-omics/Panomics Analysis

Inclusion of the word omics in a microscopic phrase hints at an exhaustive and global evaluation of a group of molecules. The "omics" field has been solely focusing on technological progress that is cost efficient and outrunning various analysis of biological molecules. For example: – cDNA arrays were hybridized to cDNA and then made into "expression arrays". In early 2000s, innovations in array technology made it achievable to survey the loci that direct gene expression. This was termed expression of quantitative trait loci. It has been conclusive in genome-wide association studies. Other technologies developed make transcription of proteins and metabolites possible too [6].

2.3 Omics Data Types

- *Genomics*: studying data related to the structure and function of DNA. The sequencing methods of various genomes are analyzed and researched under this broad field.
- *Epigenomics*: researchers map the location and analyze the functions of the tags marked under a genome.
- *Transcriptomics*: a complete set of RNA transcripts produced by a genome under certain circumstances are studied under certain methods such as microarray analysis.
- *Metabolomics*: micro molecules (metabolites) belonging to organisms along with body fluid, tissues, and their interactions within a system (metabolomes) are classified in this field.
- *Microbiomics*: microbial cells (fungi, protozoa, bacteria, etc.) and the diseases they cause are studied. Humans and microbiomes have had a symbiotic relationship since the evolution of mankind. This makes this a significant field of analysis [6].

3 Transforming Health Care with Computational Techniques

Clinicians spend a large portion of their time going through and sorting out large amounts of raw data. Computational techniques come into play here as they promote development of medical and health care industries. Computational techniques are rapid, uncomplicated, definitive, and systematic ways or methods of solving mathematical, scientific, engineering aspects, and statistical problems by the use of computers. This computational technique plays a major role in health care. There are ultrafine but significant differences between key terms such as AI, outcome-predicting software – machine learning (ML), deep learning, and semantic computing (Fig. 2). It is important to understand how the data are consumed, analyzed, and composed at the user end [7].

Despite a dedicated response and aid being provided for quality health care, problems continue to arise owing to a lack of cognitive support, hence adding to medical errors and inefficient diagnosis. Because of this computational technique health care is advancing every second. By using this aspect, doctors or physicians can more easily diagnose certain diseases when compared with the old days [7].

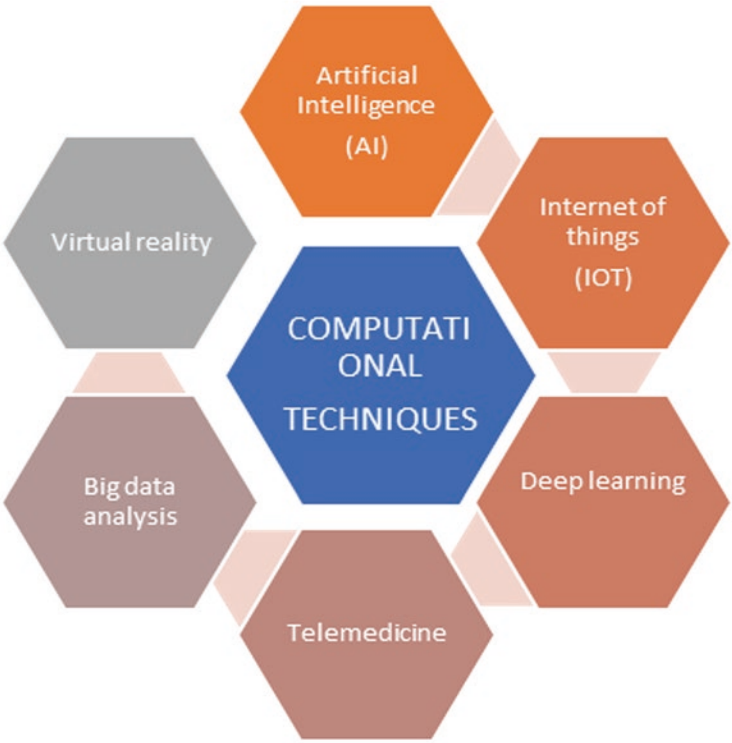

Fig. 2 Various computational techniques used in health care

3.1 Artificial Intelligence

Artificial intelligence is defined as a cybernetic hardware or software system that is able to perform physical tasks along with cognitive functions. The past few decades have seen the misdiagnosis of diseases and illnesses. Medical errors have occurred many times while diagnosing these diseases. In the light of all these calculative errors and misjudgements, AI has promised us a better future by providing proper, time-efficient, inexpensive molecular diagnosing procedures. In a study that was conducted, an AI model developed by a convolutional neural network (CNN) outperformed 11 pathologists by diagnosing breast cancer at a faster rate.

When we consider the destiny of AI, we ought to photograph the state-of-the-art robots that may imitate people so efficaciously that they are indistinguishable from people. Truly, the ability of AI to rapidly learn, undertake tasks, and compare facts in order to make selections is a good-sized attribute. However, most of the coding community thinks that AI is surely a subdivision referred to as machine learning. Artificial intelligence has turned out to be a blanket encompassing a whole range of algorithmic regions in arithmetic and PC science.

There are some essential differences among them that need to be understood so as to optimize their vast potential. The funding in AI will rise, due to which the use of AI as a service platform will allow professionals to make a device. These algorithms are available on hand to customers without state-of-the-art technical knowledge. As a result, it is essential to study those technology features and the way in which they might be applied to enhance the destiny of information sciences [8].

3.1.1 More Efficient Diagnosis of Cancer with AI

Massachusetts-based company PathAI has developed a technology to arrive at conclusive results. The motto of the company is to decrease the amount of error and provide groundbreaking methods of providing individualized treatment [9].

3.1.2 EIT Health with McKinsey & Company Workforce

McKinsey & Company EIT Health focused on creating a discussion surrounding AI in health care, explicitly focusing on practitioners and their working organizations. Development of this particular AI algorithm casts light on the arrangements made and trade-offs for contrasting elements of the public health system in Europe and afar [10].

3.1.3 Future of AI in Health Care

Treatments in healthcare, doctors can tailor treatment plans to individual patients based on their genetic makeup, lifestyle, and medical history. This approach can improve treatment outcomes and reduce the risk of adverse reactions using AI and ML. AI algorithms can analyze medical images such as CT scans, MRIs, and X-rays to assist radiologists in identifying abnormalities and making accurate diagnoses. A AI powered virtual assistants can assist patients in managing their health by providing personalized health advice, reminders to take medication, and monitoring their symptoms.

Data-driven tools were able to gain the insights needed to effectively collaborate with patients and make informed decisions, resulting in benefits such as fewer hospital visits and successful remote health check-ups., etc. Clinicians have a chance to thank AI. Take a look at some of the common cases in the use of AI. With the growth of AI in health care treatments. With the ability to diagnose and treat diseases using medical diagnostic images such as MRI, CT scans, X-rays, and ultrasound, the diagnosis is given [11].

With AI design, prescribed medication and scanned data are essential factors in management. It is transforming patient health care by generating fresh information and data in large quantities, allowing analytical organizations to make more effective decisions, and by allowing personnel to time check patients who perform repetitive tasks such as scans. The research in these domains is taken up as a challenging prospect in the future.

The continuous movements in man-made awareness in clinical benefits have made us question accepting that AI instruments would eventually supersede human specialists. All things considered, AI cannot supersede human specialists, yet they will really need to help them to achieve more conspicuous results and accuracy in the clinical area. The availability of healthcare data is a crucial support for this advancement, which is rapidly growing within the healthcare industry [11].

AI involves creating models using patient data such that, when new data is presented, it can be effectively analyzed and interpreted. Precision drugs are the most generally perceived utilization of AI in clinical benefits. Precision medicine involves using past patient data to predict which treatment strategies would be the most effective for a given patient, reducing the likelihood of harsh treatment methods.

This kind of affirmation from prior learning will require getting ready models with datasets, which is insinuated as controlled learning. Drug correspondence is a gamble for patients who are taking various prescriptions at the same time, and the risk increases as the number of cures taken increases. It is trying to address all medical coordinated efforts and eventual outcomes, but computations using AI had the choice of eliminating information on drug participation and reasonable antagonistic results from clinical composition, seeing the test input and considering the prelearning [11].

3.2 Machine Learning

Today, machine learning has endless applications and is proving to be a rationalized and time-saving process in the role of administration in hospitals, mapping and treating infections. The current focus on machine learning in health care is automated medical billing, clinical decision support, and guidelines of clinical care. Some of the coexistent machine-learning medical applications are the respective functions. This technology totally changed people lifestyles in the following ways:

- Image recognition
- Speech recognition
- Traffic prediction
- Medical diagnosis

3.2.1 Usage of Machine Learning's Natural Learning Program

The use of natural learning program technology to ascertain the noteworthiness of the consumer, such as an individual's social media, can be utilized to discover a patient's chart for details such as medication, treatment plans of existing medical conditions, scheduled appointments, and much more. Forsee Medical is a software company based on machine learning that increases the profits of Medicare contracts. Machine-learning data consist of several algorithms that are involved in training machines to recognize speech patterns and provide context to important medical terms.

They have a powerful engine that can determine key terms and negation (contradictions to a set of statements) [12].

The four types of negations that are used as indicators to determine the context of the consumer data are as follows:

- Hypothetical (chance to occur – maybe)
- Negative (retract)
- History (the past – ancestry)
- Family history

Clinical data, notes written by a doctor on the patients they review, and miscellaneous raw data used by other health care providing services are reviewed by their proprietary algorithms. They have a medical disease detector called Foresee detector and a medical disease dictionary made unique to use for searching for medical terms [13].

3.2.2 Future of Machine Learning

The exponential increase in the quantity of organic information raises the following concerns: on the one hand, the efficiency of storing and managing information and on the other, the retrieval of relevant information from these data. Another concern is one of the principal demanding situations in computational biology, which calls for the improvement of equipment, tools, and strategies in order to rework this kind of heterogeneous information into biological understanding of this underlying mechanism.

These tools and strategies must permit us to head past a trifling description of the information (data) and offer understanding within the reach of testable models. By this implicatory extraction that is present at the core of this model, we are able to achieve results for the provided data. There are numerous organic domain names in which device-gaining knowledge of strategies are implemented for understanding extraction from information. These concerns are divided into six special domain names: genomics, proteomics, microarrays, structural biology, evolution, and textual content mining [14].

The motive of ML is to provide advantageous effects with increasingly unique predictions. These machine-retrieving techniques are closely predicated with computing power. With the revolution of the clinical infrastructure over the years, the smart health care system has been paid considerably more attention. Smart health care is a singular concept that refers to hard and fast policies that integrate prevention, prognosis, treatment, and management. Specific traditional scientific structures or smart clinical structures can connect and trade facts at any time and in any region. ML is the main era for providing complicated analysis, intelligent judgment, and creative problem solving in health care [15].

3.2.3 Biomedical Screening

In several research projects conducted on ML, scholars revealed several hormone fluctuation signs of chronic illnesses (diabetes, Alzheimer's, cognitive impairment, and many others) via special algorithms and tried to enhance the accuracy of monitoring and diagnosis via various structured programs used in ML. Studies focus on biological tracking. Tchito Tchapga et al. have begun to speak about the impact of the size of the market on ML by mastering their algorithms and features proposed to perform the classification of biomedical images collected through various modalities [16, 17]. Patel et al. designed a shrewd disease-perceiving algorithm based totally on deep-learning information consisting of a set of rules that have appropriate worldwide adaptability and science for monitoring the adaptive behavior of youngsters with ADHD [18]. Albhari AS et al. are seen as capable of examining videos through in-depth deep learning combined with the subcategories of ML [19].

3.3 Internet of Things – Health Care Monitoring System

The Internet of Things (IoT) plays an important role in health care monitoring systems in hospitals. It is an improved technology that makes complex functions simpler tasks. It has a huge response in portable devices such as sensors in health care (pCO_2, pO_2). The growth of the IoT led to an advancement in internal medicine. It is also termed a "smart health care system." In this context, the IoT in patient monitoring systems is analyzed. IoT technology uses inbuilt sensors in patient monitoring systems [17]. The sensors utilize remote environmental conditions. Generally, patient monitoring is an effortless method of analyzing the patient's body temperature, room temperature, and range of heartbeat. To analyze these basic functions, sensors are used to measure the patient's body conditions such as room temperature, carbon monoxide, and carbon dioxide. Recorded data are collected and stored in hospitals [17, 18].

3.3.1 Major Components of Patient Monitoring System

Heartbeat sensor: heartbeat or simply heart rate is the number of times our heart beats per minute (bpm). The normal range is 60–100 bpm. This factor is essential in detecting the proper functioning of the heart. The heartbeat sensor finds the deviation or changes in the flow of blood in various parts of the body. Here, light is absorbed by blood and it is reflected to the light-to-light detector of the sensor.

Body temperature sensor: it is used to measure the range of temperature by the transmittance of electrical signals. The electric signals use the property of change in voltage or resistance that hence cause a change in temperature. Room temperature sensor: it is essential to measure the room temperature. It plays an important role in patients' body condition. A microcontroller is used to collect the data from the sensors and process the respective analog data into digital.

Carbon monoxide (CO) sensor: it is used to detect toxic gas that causes fluctuations in our body. It uses a potentiometer that detects the resistance change with respect to the gas.

Carbon dioxide (CO_2) sensor: it is termed the amount of carbon dioxide present; by sending infrared light to blood, this gas is measured [17, 18]. Figure 3 shows the components mentioned in an IoT health care monitoring system and its salient features.

3.3.2 Internet of Things for Patients

Wearable technology makes use of wearable devices such as smart watches and some wirelessly connected devices such as heart rate monitoring cuffs, calculation of fat burn, and blood pressure. These devices are used to customize personalized information of patients (Fig. 4). In this technology the sensor plays a major role. The above-mentioned devices are integrated with sensors that measure [17, 18].

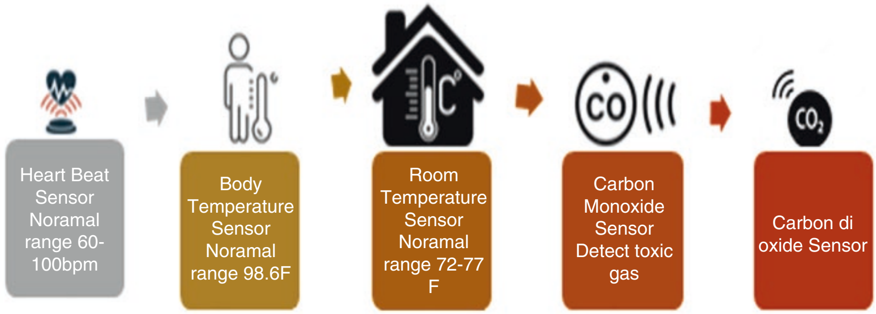

Fig. 3 Components of an Internet of Things health care monitoring system

Fig. 4 Constituents of the Internet of Things (IoT)

3.3.3 Internet of Things for Physicians

This is an embedded technology that allows the live condition of patients to be tracked. Telecommunication and the IoT play a major role in health care. An alarm is given to the patients and physicians as they are continuously tracked. It provides dynamic support to the patient as well as the physician. IoT devices are enabled in some medical equipment, which is helpful in collecting and storing data. Data that are collected from IoT devices can be used for future reference, which paves the way for better treatment. There are many other fields in hospitals where IoT devices are installed and integrated that have many benefits [19].

3.4 Telemedicine

This is one of the most eminent virtual health care technologies that exists; we can consult a doctor using telecommunication. It allows the patient to make use of this technology quickly and connect with doctors from any part of the world. It was especially helpful during the COVID-19 pandemic and is still continuing to be effective for health care in general. During the peak of the COVID-19 wave, people were unable to consult physicians; thus, telehealth and telemedicine paved the way for improved technology. In telecommunication people connect with the physician virtually so that the physician can diagnose the patient's symptoms and prescribe the right medication. Telemedicine brings high-quality healthcare to remote locations, especially rural areas. As of now, work forces are becoming more decentralized. Digital health care allows the employees to select the benefits they need. It leads to a healthier and more productive work environment. Therefore, the future of health will be tech-powered with telemedicine [20].

3.5 Future of Telemedicine in Health Care Management Systems

With the accessibility of web association and improvement of innovation moving toward better conditions, the broad utilization of telemedicine will prompt more examination later on. It will be utilized in persistent crisis medicine and value-based medical care with incorporated advances such as 3D printing, virtual reality, etc. Finally, it is critical to note that telemedicine with different innovations will be a part of future medical care encounters for everybody [20].

Like any problematic clinical advancement, it requires investment, approval, and the right impetus to be completely embraced by the clinical local area. In illumination of the COVID-19 pandemic, one development is at the cutting edge of changing the clinical climate, i.e., telemedicine [21]. Since February 2020, telemedicine has expanded from 1% of essential consideration visits to 43.5% in April 2020. With the major turn of events and fast acknowledgment of telemedicine today, it is essential to change the working of the clinical framework and reclassify care and cost control for clinical involvement with the healthcare community [22, 23].

4 Implication of Big Data in Medical Science

Big data science includes cognitive computing and numerous prominent technologies as a backbone of health care clinical management. In the field of health care informatics, big data analysis generates a significant portion of potential interpretation of analytical data description. Implementation of AI algorithms and novel fusion algorithms such as ML and IoT can be quite hazy, as it aids critical social infrastructure components and services that will be efficient and interactive. With the advent of the potential computational technologies all medical records in the field of medicine have been designed with a standard and broadly adopted in practice. The electronic health records (EHR) are computerized medical records that resides in an electronic system that can be used to capture, transmit, store, receive, retrieve, and manipulate multimedia data for the primary purpose of providing improved access to data in health care sectors. The information collected includes the entire medical history of a patient, which might include medical diagnosis, perception, demographics, clinical narratives, and various medical tests. EHR can eliminate or solve the problem or delay in the building management area, which acts as a beneficiary to the public health sector. The practice of EHR by the health care professionals can improve the health care practices enormously and also prompts awareness regarding medical emergency, cancer screening, and medical camps in rural areas via a technological management system. Similar to the EHR, the electrical medical record (EMR), the personal health record (PHR), and medical practice management software (MPNT) store the data analytics in multiple nodes. Today, there are at least two trends that encourage the health care industry to adopt big data. The first is from a service payment model that rewards caregivers by performing steps toward a value-based care model that rewards caregivers based on the health of the patient population, as described above. It is a transition. Health care data analytics enables the measurement and tracking of the health of the population and enables this transition. The second trend is toward using big data analytics to provide evidence-based information. This will increase efficiency over time and provide a better understanding of illness, injury, or illness-related best practices. Maintaining patient health and avoiding illness is at the top of everyone's list of priorities. Consumer products such as the Fitbit Activity Tracker and Apple Watch can also monitor an individual's physical activity and report on specific health trends. The resulting data have already been sent to a Cloud server to provide information for physicians to use as part of their overall health and wellness program. Fitbit has already partnered with United Healthcare to reward policyholders with up to $1500 a year for regular exercise. The Informed Data System's OneDrop app for Android and Apple makes a dramatic difference in A1C for diabetics. Meanwhile, Apple's HealthKit, CareKit, and ResearchKit leverage technology built into Apple's mobile devices to manage patient conditions and enable researchers to collect data from hundreds of millions of users around the world. Image analytics data include CT, X-ray, positron emission tomography, molecular imaging modalities, picture archiving and communication system (PACS), and digital imaging communication in medicine (DICOM), the most widely used imaging technologies to analyze such complex technologies as "big data research and development initiative," which have been launched to enhance the quality of big data. Sparkseq, SAMQA, ARI, DistMAP, Seqware, CloudBurst, Hydra, BlueSNP, Myrna are efficient cloud-ready platform frameworks for identifying, sequencing, and computing genomic data. In the past few years, a massive commercial data analysis platform has been launched to enhance the computational techniques (Fig. 5). Finally, big data analysis in medicine has shown high accuracy and efficiency for the prognosis and diagnosis of certain chronic illness [24].

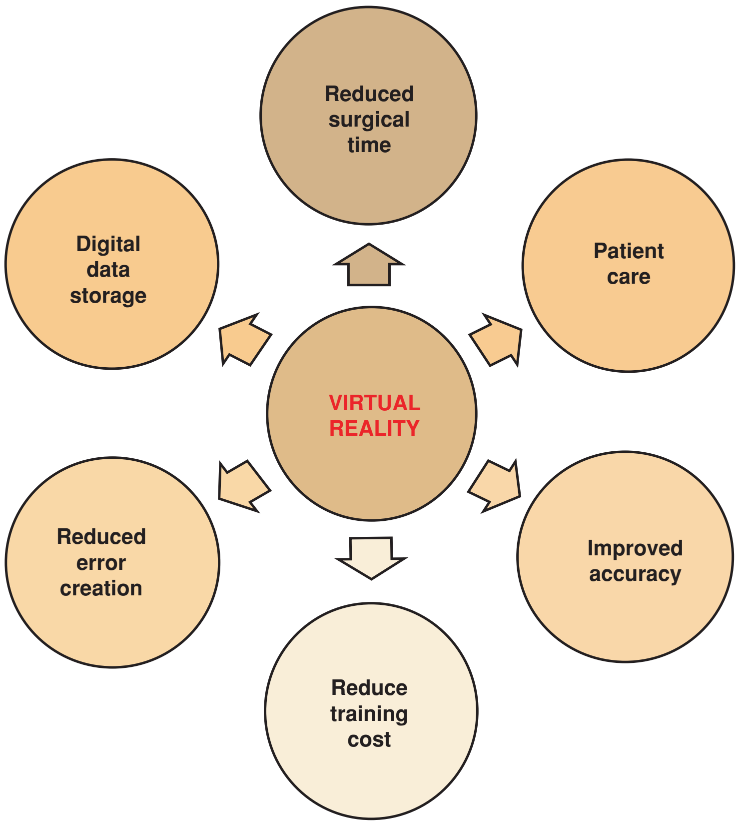

Fig. 5 Systemic approach to data sciences

5 The Future of Healthcare – Trends Making an Impact in the Economy

Health care is entering a period of rapid change, like many other booming sectors. The endurance and advancements of new technologies are a combination of the existing technologies with new add-ons. Experts from the field of health care have predicted that innovations will be divided into two terms – the near term (the next 5 years) and the long term (the next 20 years). Tomorrow's hospitals will rely deliberately more on robots and the associated digital technologies.

5.1 Virtual Reality in Health Care

Virtual reality (VR) has enabled patients and doctors to interact within simulated environments specifically combined for medical education, pain management, and reliability. The estimated global health care VR market in 2020 was $336.9 million.

5.1.1 The Essential Drivers in VR Acquisition

- Stipulation for sound health care services
- Cost-driven health care market has to be significantly reduced
- Health care-related connected devices play an increased role

Roles brought in by VR (Fig. 6) to assist the health care industry are creating awareness of diseases, treating patients, marketing medical services, and training for medical practitioners [25].

5.1.2 3D Printing

Added manufacturing (AM) procedures produce actual articles from 3D computerized information through the "method involved with associating materials to display objects from 3D information, for the most part layering upon a substrate layer, rather than crude subtractive assembling". AM processes generally alluded to as 3D printing, utilize computer-aided manufacturing programming to manufacture actual 3D articles layer by layer from a computer-aided design model. The additive manufacturing materials utilized for healthcare applications can be powders, plastics, earthenware production, metals, fluids, or living cells, making the interaction immensely flexible [26].

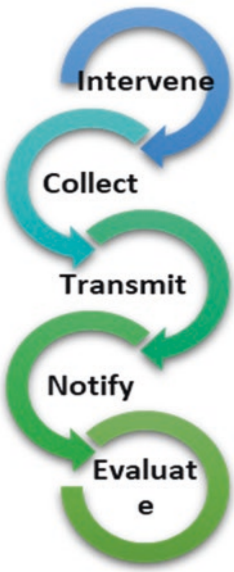

Fig. 6 Provisions for acquiring virtual reality

5.1.3 Surgical Planning

One of the most incredible potential uses of 3D printing is careful preparation. This includes concentrating on the life structures and physiology of organs such as the cerebrum or the heart, or physical examples, for example, the pelvis or the spinal cord, 3D models that will assist specialists with organizing their tasks. The work room ought to be ready to deal with the diseased organs, and thus this is the best utilization of 3D printing [26].

5.1.4 Drug Delivery

It is certain that drug delivery will significantly transform the role of specialists in 3D printing, as the technology now allows for the printing of tablets with intricate structures. With the ability to control release rates, 3D printing can now produce tablets that accurately deliver the recommended dosage, making it an invaluable tool in medication administration. 3D printing can cautiously control the spatial game plan of cells, extracellular framework, and natural materials to build organs or tissue on-a-chip for drug testing. The printing of medications is not limited to specific doses. The use of 3D printing also reduces production time and can potentially lower the cost of drug manufacturing. While this technology is still in its early stages, it holds great promise in the development of personalized medicine and the improvement of patient outcomes. The prompt delivery layers can change the measurements profile. 3D printed drug delivery gadgets that fit the life structure of a patient precisely are additionally being worked on [27].

6 Conclusion

The future of health care is taking place before our eyes with the above- debated health care technologies. The world must familiarize itself with the latest technology. In light of this, as a part of large community, we must take the reins of technology and not allow technology to take over the human race. The future can be visualized only when health care workers and technology work hand in hand with each other. The relevance pertaining to a particular software/technology must be embraced with a fresh mind open to combining new and old practices to make better solutions every day. There is synergy between our existing health care system and the computational techniques. For example: During the study of the impact of social media on health, various networks were discovered underlying the diverse platforms of social media. Interpersonal behavioral traits are widely influenced by a person's network (family, friends, etc.). Apart from this, numerous issues have to be addressed such as Tweets on Twitter and directed links on Facebook. An algorithm has to be designed and implemented to collect these unsorted and unambiguous data.

A similar synergy exists with health and its corresponding constituents, leading to the design of custom models and agent-based system level issues. Applications where interconnections play a role, such as binge drinking and the spread of diseases make these models. A recent study has offered a concise summary of agents utilized in modeling, providing several instances of their application in the management of chronic diseases, and revealing potential areas for future research. These computational techniques are generating results step by step and usage of them is turning out to be established and widely appreciated. Their implementation in society will conquer problems together by expanding their usage with leading organizations and aiding data scientists further in their research.

However, organizational improvements can also face obstacles: employment and cost. In the future, to enhance human health, we must now no longer only expand these algorithms but also consider the coexistence of human beings with AI. Hence, computational techniques play a huge role in the field of medicine by creating time-effective algorithms to organize these data in a structured manner.

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Covid-19 Diagnosis, Prognosis, and Rehabilitation: Latest Perceptions, Challenges, and Future Directions

V. Priya, L. R. Sujithra, and Praitayini Kanakaraj

1 Introduction

Human coronavirus (HCoV) was the first coronavirus to be discovered in humans in 1960 [1]. It produced minor illnesses of the lower and upper respiratory tracts, which, in some cases, resulted in acute respiratory failure [2]. A severe acute respiratory syndrome (SARS-CoV) was revealed in 2003 in China, and the situation grew much more critical [3]. SARS-COV infected over one million people at the time, with a 9.5% fatality rate. The spread of the virus was halted by isolating sick individuals and identifying the source of infection. SARS-COV has been discovered in cats and bats in subsequent wild animal research [4]. As a result, the virus was thought to have moved from animals to humans, then from person to person [5]. From 2004 until the introduction of another severe virus in 2102, the situation with the Middle East respiratory syndrome coronavirus (MERS-CoV) remained unchanged. MERS-CoV was initially identified in Saudi Arabian patients with acute pneumonia [6, 7]. Despite the fact that MERS-CoV has a minor rate of dissemination than SARS, MERS-CoV patients died at a higher rate [8].

By the end of 2018, documented cases of MERS-CoV had been around 2500, with a death rate of up to 30%. In 2019, the globe was confronted with another coronavirus, SARS-COV-2, which created Covid-19, originated from an outspread in China [9]. Covid-19 is a fast transmissible virus that spreads through direct contact with an infected individual. Infections are mostly caused by respiratory droplets

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(direct contact) and aerosolized droplets (secondary contact) [10, 11]. In the absence of a Covid-19 vaccine, non-medicated treatments such as individual hygiene and communal isolation are the most effective means of preventing a Covid-19 epidemic [12]. It's important to remember that, at its highest, the disease overwhelms current medicinal facilities. As a result, intensive care and emergency units have outgrown their ability to handle the growing number of afflicted people. Covid-19 typically begins with modest indicators like temperature and cough and progresses to failure of a particular body part and demise [13]. As a result, in such pandemics, medical experts and even the patients' families must make quick and informed judgments to prevent rapid worsening of the body.

Identification and classification are the key issues of Covid-19. Nowadays post-Covid infections have drastically improved in many cases. By its association with other lung infections, this is the case. The reverse transcriptase quantitative polymerase chain reaction (RT-qPCR) is now used to identify Covid-19 [14]. Minor amounts of virus-related RNA are extracted from the nasopharyngeal culture and intensified, allowing virus identification techniques to be used. Unfortunately, the standard RT-qPCR method is laborious and needs medicinal competence, which makes it not always available. Instead, some research studies have found that RT-qPCR testing has a significant probability of false positives [15–17]. As a result, experts in the fields of virology, medicine, and artificial intelligence (AI) ought to rise to the challenge of limiting the catastrophe through novel ways.

In this context, the AI community has contributed valuable methods that could aid in the detection, forecast, and treatment of Covid-19 [18]. For a Covid-19 diagnostic, documented and emission data are deliberated as basic data kinds. Patient histories, PCR analysis, movement data, and other textual data are examples of textual data. Chest CT, X-ray, and other radiation data are examples. AI has been widely utilized to handle a variety of problems using a variety of data kinds (i.e., text, video, indicators, pictures, etc.). Machine learning (ML) algorithms train and update prototypes to resolve precise tasks based on the data supplied. This chapter's main contribution is to study diagnosis, prognosis, and rehabilitation methods for Covid-19 viral infections.

- The symptoms, behaviors, and patterns of Covid-19 are discussed in detail.
- In Covid-19 diagnosis, a different category of methods, including analytical methods, has been studied.
- Prognosis and treatment category of all methods have been studied.
- We look at the current literature on Covid-19 domain and provide deductions about how to address these problems in the future.

The following is how the entire article is structured. The diagnosis procedures used to diagnose Covid-19 are described in Sect. 2. Section 3 presents a review of the literature for the prognosis of Covid context. Section 4 discusses the rehabilitation strategies for people with post-COIVD symptoms. Section 5 covers the limitations of present solutions as well as future directions, and Sect. 5 wraps up the article.

2 Diagnosis Methods for Covid-19

Identification/analysis of Covid-19 is a critical task faced by machine learning researchers. There are many clinical methods available for Covid-19. Different category of diagnosis methods based on clinical methods is shown in Fig. 1.

2.1 Virology-Based Methods

These methods depend on the viral load in the infected patients. Throat and nasopharyngeal swabs are collected and tested based on clinical methods. These methods study the protein samples and nucleic acid samples from the swab to detect the antigens of the SARS Covid-19 from the swabs. The realization of infection isolation and detection depends on the load of the virus: samples that contained <106 copies for each ml (or copies for each sample) never produced a segregate. Viral genomic sequences are primarily used for these methods. Very common and gold standard methods based on nucleic acid and genomic sequences which are currently used are:

- *RT-PCR*: These findings serve as a guide for selecting SARS-CoV-2 trial collection spots.
- *Digital PCR*: RT-PCR is now universally accepted as the gold standard for Covid-19 diagnosis. The enormous number of inaccurate records, on the other hand, is a severe drawback. False-negative results can also be caused by little amounts of virus in infected patients. To overcome the limitations of RT-PCR, a more profound RNA discovery approach is required for more reliable Covid-19

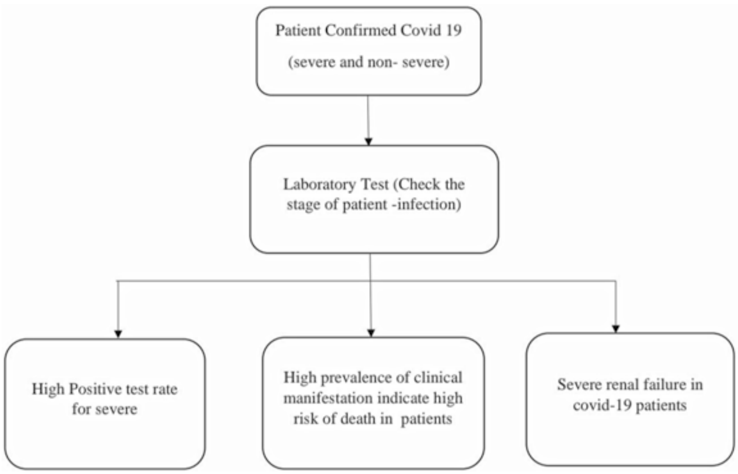

Fig. 1 Categorization of diagnostic techniques

diagnosis. To obtain absolute quantification of nucleic acids, digital PCR uses trial dilution, extreme PCR, and Poisson distribution. Researchers have compared the susceptivity and precision of droplet digital PCR (ddPCR) with RT-PCR to see if it could detect SARS-CoV-2 from medical oropharynx swab sections.

- *RT-LAMP*: Isothermal amplification mediated by a reverse transcription loop. Another possible alternative approach for the quick discovery of CoV-2 is reverse transcription loop-mediated isothermal amplification (RT-LAMP). To synthesize strand displacement DNA, the RT-LAMP uses four to six specifically designed primers, combined with chain displacement activity for DNA polymerase at a persistent temperature (60–65 °C). The improved product is continually prolonged, circularized, and re-extended, resulting in DNA with various hairpin-based topologies. Turbidity or fluorescence is used to monitor the amplification response. RT-LAMP provides a number of advantages over RT-PCR, including ease of use, quick response time, distinct apparatus is for measurement, and high sensitivity, making it ideal for on-site detection. Yang et al. [19] developed a method for the optimization of the RT-LAMP test for revealing of CoV-2 in medical sections or tissues, a set of five primers targeting the genes from orf and spike. The RT-LAMP assay detected CoV-2 in 130 clinical samples with 100% susceptivity and specificity, and the recognition time was 25.18 5.38 min, suggesting that the RT-LAMP assay is a potent device for SARS-CoV-2 identification.

2.2 *Serology-Based Methods*

Contrasting to the molecular approaches, blood serum-based testing procedures (known as antibody testing) can be used to detect past and present SARS-CoV-2 infection as well as track disease progression and immune response. They can identify antibodies in the blood serum and plasma of Covid-19 patients. Other genetic fluids, such as saliva and sputum, but not restricted to them, could also be used. Antibodies are created by the immune system as a resistance mechanism against Covid. Upon few days after the infection is found, IgM is created and lasts for about 14 days, shadowed by IgG creation, which lasts for some days.

2.2.1 Lateral Flow Assay

It is one of the most widely used serum-based methods in hospitals to identify antigens, neutralizers, and augmented nucleic acids in a variety of organic samples such as blood. LFA is a two-lined film strip that looks like paper. Anti-human IgG/IgM antibodies are found on the first line and anti-rabbit IgG serums are found on the second line, the control line.

Antibodies are pushed by duct action near the lines that overpass the conjugated pad where a precise compound antitoxin and rabbit-gold compounded neutralizers are blocked after a patient specimen (e.g., blood) is added to the sample collection. These neutralizers bind with gold Covid antigen compound to form a complex. Anti-human antibodies fix to the complex and immobilize at the trial line, whereas rabbit-gold compound antibodies mix with anti-rabbit neutralizer and immobilize at the regulator line. Due to the concentration of gold particles, the effect will be seen as a red line. When both the trial and regulator lines are red, the result is positive. If the regulator line alone is red, the result is negative. The result is invalid if two lines vanish or only the trial line appears.

2.2.2 Enzyme-Linked Immunosorbent Assay

Enzyme immunoassay is a different type of serological test (ELISA). In clinics and research laboratories, ELISA is a plate-based approach for identifying and measuring solvable molecules such as polypeptides and serums. It consists of both direct and indirect formats. An antigen (N protein) of interest is used in the indirect method adopting ELISA, which is more prevalent and profound than the direct method using ELISA.

In the process of discovering Covid-19 virus, both molecular and serological approaches are not flawless, and both methods have their own sets of limitations. Atomic approaches are more consistent than serological ones, but both can produce misleading results for a variety of reasons. For example, erroneous positive and negative results could be caused by faulty sampling, insufficient viral particles in the collection, inappropriate RNA removal, contradiction with other viral classes, contagion, and technological difficulties. Secondary diagnostic tools, such as a CT scan in the chest and images from X-ray, can be used to overcome these difficulties and boost the certainty of supplied results.

2.3 Imaging-Based Methods

Imaging-based methods depend on scan images from the patients. They are subjected to CT scan of chest or lungs to diagnose the viral infection. These methods rely on radiology-based scans. Currently, chest CT (computed tomography) scan and lungs CT scan are very useful in diagnosing early detection of Covid-19 infection.

Beyond these, many methods have been proposed by researchers using machine learning, artificial intelligence-based analytical methods. Another recommendation for Covid identification is to employ artificial intelligence approaches for clinical image processing, which has recently appeared in a number of coronavirus research papers. These methods mostly rely on clinical and survey data collected from the infected people or people who are undergoing treatment currently. Some of them also rely on the medical images obtained through radiology-based X-rays and scans. These studies provide a clear picture about the fact; X-ray pictures and advanced scans are frequently employed as inputs to DL models in order to discover diseased Covid cases automatically. The scientists developed a deep convolutional neural network (CNN) algorithm for the discovery of Covid cases after discovering that infected Covid patients generally show anomalies in radiography pictures captured in the chest region. Some algorithm-based significant methods proposed by researchers are detailed in the next section.

2.4 ML Algorithms-Based Methods

In the paper proposed by Sujatha [20], a real time collection and processing of medicinal data and a modified random forest model improved using Ada boost algorithm. A boosted random forest is a two-part approach that includes the AdaBoost boosting algorithm and the random forest classifier algorithm, which is made up of many decision trees. A decision tree creates models that resemble real trees. Our data is divided into smaller subsets by the algorithm, which also adds branches to the tree. The end result is a tree with leaf nodes and decision nodes. The value of each feature (such as age, symptoms, etc.) assessed is represented by two or more branches in a decision node, and the result value on the patient's eventual condition is held by the leaf node (target value). As indicated by the information investigated in the review, passing rates were higher among Wuhan occupants, in contrast with non-locals for Covid patient condition prediction. Moreover, male patients' mortality was at a higher rate than female ones. Most of those impacted are between the ages of 20 and 70. The dataset is to forecast the intensity of the corona virus and the likely consequence of recovery or demise. This paper collects the dataset, data analysis, and data pre-processing.

Another study [21] predicted that the number of Covid tests taken by the patient and made the recommendation and the recovery of the Covid-19 exercises a gradient-boosted tree algorithm. The full WVU dataset on internal cohort was subjected to a Shapiro–Wilk test to ensure that the data was normal. It was discovered that all of the variables were found to be normally distributed; therefore, to conduct further statistical analysis, parametric approaches were employed [21]. Continuous data was given as mean and standard deviation, while categorical data was offered as counts or percentages. The Kruskal–Wallis test, with Dunn–Bonferroni adjustment test, was performed to examine the significance of continuous variables in all three groups (Covid positive, negative, and influenza). An independent sample t-test was used to establish significance between two of these three groups (Covid $+^{ve}$ vs. Covid $-^{ve}$, Covid $+^{ve}$ vs. influenza, influenza vs. Covid $-^{ve}$).

Another research by Laure [22] studied the multiple diagnostic and prognosis models for Covid-19, all of which show moderate to good discrimination. Model overfitting, incorrect model assessment (e.g., calibration neglected), use of unsuitable data sources, and imprecise reporting all put these models at high or uncertain risk of bias. As a result, their performance approximations are likely exaggerated and unrepresentative of the target demographic. The Covid PRECISE group does not suggest any of the present prediction models for clinical usage, but both diagnostic and prognostic models each from one category from higher-quality research should be (independently) verified in additional datasets. At high risk, the reported prediction is probably optimistic and detection of Covid patients and identify the health issues of post Covid patients. Covid-related prediction models which use sharing data and proficiency for the validation and updation of the model is immediately needed. Some of the significant challenges potentially would be addressed for diagnoses are presented in the following section.

2.5 Challenges in Diagnosis Techniques

Every day, a new clinical challenge is presented by the novel coronavirus. As nations throughout the world discussion restricting the utilization of measure in friendly removing, boundless testing, and early location of the problem is exceptionally basic one. Despite multiple efforts by government agencies and international organizations, Covid-19 diagnosis remains difficult. The following is a summary of the present challenges for the identification of Covid as studied, using the above-mentioned methods:

- Though RT-PCR is the standard for Cov-2 virus detection, it is not without its drawbacks. This testing might be costly due to the equipment and lab facilities required. A certain amount of biosafety is required in the testing setting, examples are cabinets with BSL-2 for trial development or, preferably, an undesirable compression room. These facilities are not available in most regular testing locations around the world. Furthermore, these services require experts with the competence and involvement to conduct the tests in a seamless and error-free manner. As a result, most countries around the world confront primary diagnostic issues due to a lack of testing centers and trained technicians. Another important diagnostic issue with this testing is the possibility of getting false negative and positive results.
- For both clinicians and executives, asymptomatic patients have turned into a genuine concern. They are harder to identify and separate, and they imply a more serious danger of uncontrolled transmission of the infection. A most recent review found that asymptomatic patients have a comparative viral burden to suggestive patients, demonstrating that they have a similar bandwidth. Another main pressing issue about this is greater part of the patients with asymptomatic signs might decline to go to centers or offices.
- Although Covid-19 patients had apparent chest scan using CT for manifestations, despite being RT-PCR-verified Covid patients, other researchers have described normal reports for CT scan. Another issue is that it necessitates numer-

ous scans (at least two, six days apart) for maximum diagnostic accuracy, putting additional strain on already-scarce CT scan machines.

- Specific antibodies tested against Covid-19 infections are detected using serological detection methods. These tests have the benefits of being inexpensive, quick discovery, and easy accessibility, but they have low susceptibility, as demonstrated with other classes of coronavirus and other virus such as influenza antibody tests. Antibody responses, on the other hand, vary between each individual and take days to grow once infected. This might not be helpful to accurately diagnose viral infection, except for confirming delayed infection of Covid-19 cases in patients and recovered people's immunity. Despite this, they consistently expressed skepticism about the tests' ability to detect the virus early in infection. Next section elaborates on the prognosis approaches used for Covid −19 infections.

3 Prognosis Approaches for Covid-19

The prognosis is a prediction of a disease's likely conclusion or course, as well as the patient's chances of recovery. In order to reduce the burden on the healthcare system while also delivering the best care for patients, data on the prognosis is more vital for the condition than diagnosis information. Age, comorbidity, vital signs, imaging characteristics, sex, leukocyte count, and Cb1 and Cb2 proteins were the most commonly used prognostic variables for Covid-19. Prognosis techniques look at the outcome of a situation using a prediction model. Especially during pandemic times, the machine learning based on clinical, radiological, and etiological data will be able to recognize image processing and clinical affect thinking to illness severity, as well as possibly estimate prognosis (hospitalization needs, ICU admission, orotracheal intubation). The importance of prognostic approaches is depicted in Fig. 2. Here are a few essential strategies that are discussed.

In federated learning approach [23] to predict the future oxygen requirements of symptomatic patients from multiple data sources. This system predicts the X-rays of heart and lungs and is monitored. This model monitors the age and the immunity power; based on the results, the doctor prescribes the medicines and the exercises to be followed regularly. Patients undergo ventilation; it is necessary to check the pulse rate and the oxygen in the patient's body. The model called EXAM (electronic medical record [EMR] chest X-ray [CXR] AI model) uses CXR and EMR features. In total, 20 features were used and the outcome labels for oxygen requirement were set in the mentioned categories: room air (RA), low-flow oxygen (LFO), high-flow oxygen (HFO)/non-invasive ventilation (NIV), and mechanical ventilation were the oxygen therapy categories (MV). The outcome label was set to 1 if the patient died within the prediction time frame.

The approach studied by Felipe Campos Kitamura et al. (2021) studied [24] the chest CT of patients with symptoms of respiratory syndromes. Machine learning models were deployed based on clinical, radiological, and epidemiological data to

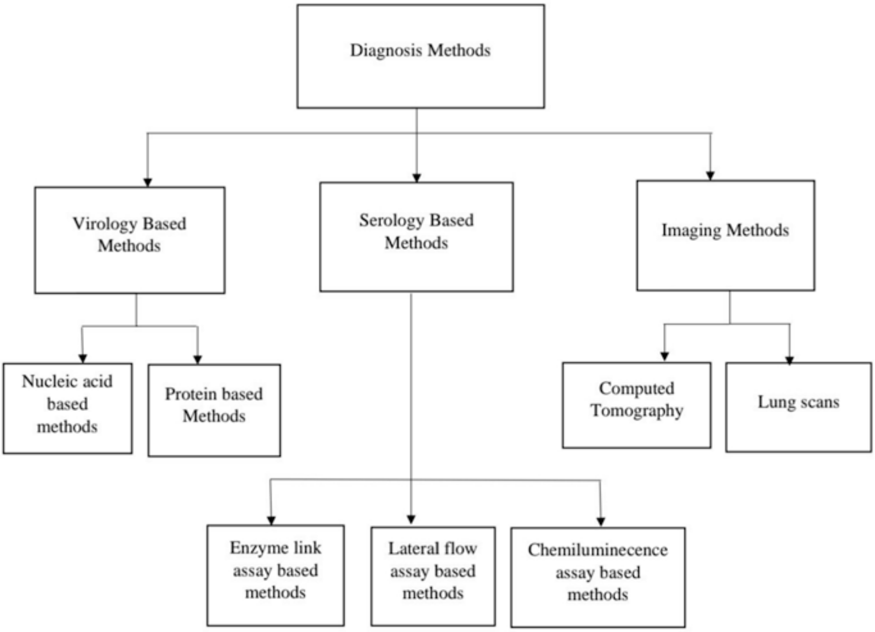

Fig. 2 Significance of prognosis

predict the severity prognosis of patients. Patient's respiratory syndrome and chest part is tested. If both are good, medicines with less dosage is prescribed and the exercise will be less. If pulse rate and respiratory strength is weak, the exercise and the medicines prescribed will be of heavy dosage.

Validation of AI algorithms enables the identification of solutions that, if allowed by regulatory agencies, have the potential to be used in a variety of situations in the future. This study is particularly relevant and promising at this time of pandemic, when the identification of prognostic markers can be critical in determining the optimal course of action and therapeutic strategy not just for patients but also for the entire health system.

4 Rehabilitation Approaches for Covid-19

Infection with the corona virus illness 2019 (Covid-19) necessitates rehabilitation. There are many techniques available for rehabilitation. Some significant methods adopted by researchers are discussed here. Because there are no English-language standards for the treatment of these people, a review of most recent reports was done. If the Covid tests are measured and identified, it shows the physical function review, measures of Heart and lungs rate, kidney if it is checked, recommendation of recovery will be based on the suggested issues and checks for the improvement.

Based on the current state of scientific knowledge and data, physiatrists and therapists [23] are expected to become more engaged in the treatment of these patients in order to enhance functional status, physical and psychological effectiveness, and restore a good quality of life for patients. Preparation ahead of time and careful planning can assist to mitigate the effects of this unexpected event.

According to the most recent estimates, 10–20% of SARS-CoV-2 patients who go through an initial symptomatic phase continue to have symptoms after 12 weeks following diagnosis. Despite the fact that researchers are beginning to look into this new ailment, there are still severe questions about diagnosis, which limits the optimal therapeutic strategy. Activity levels and exercise regimens are well-known modulation schemes of clinical symptoms and outcome in many chronic conditions. This paper predicts and suggests exercise for the patients who have recovered from Covid-19. Clinical issues must be treated, but cognitive and psychological components must be included in the evaluation, as well as the impact on society that this disorder entails, which necessitates an interdisciplinary and integrative approach that includes exercise sciences [25]. These exercises are to be maintained such as muscle strength, cardiorespiratory and other possible post-infection syndromes. There is need to have good health and a good immune system after recovery.

Coronavirus is a contamination that is brought about by a Covid that was as of late found. At the point when an infected person hacks or sniffles, the Covid-19 infection spreads dominatingly through spit beads or nasal release. The infection can enter the body through the nose, mouth, or eyes. As indicated by a few ongoing examinations, the infection can be communicated, however, through the droplets that stay suspended in air in shut and cooled conditions, for example, workplaces, AC taxis, shopping centers, and theaters because of an absence of consolidation; in any event, when you are not in touch with a contaminated individual [26].

In this study, they recommend that heart, diabetic, and hypertension patients should not meet in public places. Patients should not medicate on their own. The patients have to take their regular medicines as prescribed by the doctor every day without leaving one day. This paper suggests the patients to take heart rate and oxygen pulse, and these should be less than 80%. PROLUN, a multicenter prospective cohort research conducted at clinical sites [26]. Participants came from five of the clinics in the sub-study. Participants must be 18 years old and have been admitted for more than 8 h with a discharged indication of Covid-19 before June 1, 2020. Prior diagnosis of COPD, myocardial infarction, heart failure, or peripheral artery disease, living beyond the hospitals' catchment areas, incapacity provide the informed consent, or participation in the WHO Solidarity trial were all exclusion factors. More information about the study's design and participants has been released. This paper says that the fatigue and muscle weakness will be 63% for any post-Covid patient. Oxygen uptake, minute ventilate, heart rate, blood pressure, respiratory rate have to be checked every end of the week.

The impact of this pestilence is huge, and the best way to slow the sickness' spread is to rehearse social removing. The commanded lockdown has affected numerous components of individuals' lives, including regular work-out projects of wellness monstrosities, bringing about serious mental problems and extreme wellness and health concerns. The writers of this article needed to get familiar with the assorted encounters of well-being cognizant individuals during the Covid-19 lockdown. The objective of the review was to perceive the way that they managed mental worries and actual medical problems at home by doing various activities and wellness exercises. Twenty-two adults who were often practicing out in the exercise room before the Covid-19 episode yet chose to remain at home during the far-reaching lockdown was consulted over the versatile in semi-organized interviews. In this paper, the creator recommends exercise to individuals who are at home during pandemic, yet we propose exercise to the post-Covid clients [27]. They recommend a minimum of 30 min of exercise during pandemic, yet here we propose more: 30–45 min. In this paper, the outcome produced will be less precise for the individual who was impacted by Covid and has presently recovered.

Covid-19 affects the immune system, physical health, and mental health, with the lung being the primary target organ of SARS-CoV-2 in the respiratory system. The rate of spread of corona disease virus infection is increasing every day and there is currently no vaccine available, making it imperative to dismiss patients with minor symptoms as quickly as possible. For the reasons stated above, it is critical to develop rehabilitation programs for such mildly affected people in order to recover physical health, pulmonary function, and reduce anxiety, all of which contribute to a better quality of life. Post-discharge patients with coronavirus illness benefit greatly from rehabilitation programs. Yoga has a significant role to play in the post-Covid-19 era, as it reduces psychological stress and strengthens the immune system, limiting infection transmission and averting consequences. Yoga is also beneficial for strengthening immunity and sustaining respiratory health. Practicing yogic breathing practices (pranayama) on a regular basis improves lung airflow, capacity, stamina, and efficiency [28]. Yoga, in combination with breathing exercises, may help individuals with chronic obstructive lung disease increase their respiratory capacity, resulting in an overall benefit of yoga training on enhanced pulmonary function. Yoga-based aasana (postures) and doing this (respiratory patterns) have been identified as beneficial workouts for Covid therapy. In this light, an example exercise regimen has also been offered.

One of these issues is post-Covid-19 syndrome, which is becoming more prevalent as the pandemic progresses. According to the most recent estimates, 10–20% of SARS-CoV-2 patients who go through an early diagnostic phase continue to have symptoms 12 weeks after being diagnosed. Although study into this new ailment has begun, there are still substantial problems about diagnosis, which limits the appropriate therapy strategy. In many chronic conditions, exercise regimens and levels of physical activity are well-known modulation schemes of clinical symptoms and prognosis [29]. This narrative review highlights the most recent research on corona disease to help people understand it better. It also describes how regular activities can improve with many of these signs and lessen the long-term impact of the disease. The paper suggests a few exercises, these exercises reduce the long-term effect of Covid-19. Exercise and physical activity level should be monitored periodically. Intake of food and immunity boosters should be monitored regularly. Rehabilitation during pandemic was suggested in the work [30]. In their paper, patients can do their daily physical activity at their respective places with the help of social media and through online. After every session, blood rate and lungs rate is to be noted regularly. The author suggests that the improvement in body health and mood profile in elder people has to be monitored based on certain criteria.

The older people were chosen using the following criteria:

- Patients must be aged above 60 years.
- They must have engaged in physical activity for at least 2 months previous to the start of the Covid-19 epidemic.
- They should not possess any limitation for practicing physical activity.
- They should have clogged to their routine exercises and also should be under isolation for at least 3 months.

This study had two video-based phone calls. The first one had an elaborate discussion about the protocol and how to approach for answering the questions [31]. The second detailed about the remote exercise session and immediately after that they answered Brunel Mood Scale questionnaire. The exercises suggested were squat, push-up, stiff, push-up on the wall, upright row, etc.

This study suggested that remote exercises enabled them to improve total mood disorders like tension, anger, depression, and mental confusion, etc. It studied [32] a systematic review of Covid 19 patient articles from database sources like pubmed, Cochrane library, web of science, etc. They conducted randomized control studies of exercise therapy for Covid 19 disease patients. Aerobic exercise, daily exercise, endurance training, and so on are some of them.

Weight mean difference or standards mean difference were the metrics employed. This is used in studies on the therapeutic benefit of exercise to measure the efficacy of 95% CI. This informs other researchers on the prevention and treatment of Covid 19 activities, and it could be extended across language barriers.

To develop a machine learning model [19] to predict the future risk among patients diagnosed with Covid 19. Based on previous vitals, laboratory, and demographic data, a machine learning algorithm was built to predict the presence of intubation in the future. Using a sliding-window method, this model defined a supervised binary prediction classification. This is used to forecast intubation 72 h after the 24-h sampling window ends. From the time of admittance, a prediction job must be completed every 12 h.

There are various drawbacks to the proposed model. To generate a prediction, it currently requires a 24-h sampling window. As a result, fast risk evaluations for patients with less than 24 h' worth of data are impossible. It may be possible to lower this sample window in future experiments. Because different laboratory and vital sign results are updated at different times and at variable rates, we employed an indefinite feed-forward and up-sampling interpolation method to standardize feature sample frequency. Missing data was discovered following feature alignment to time because the laboratory and vital signs were updated at different times. Table 1 shows a summary of the methods discussed.

Table 1 Rehabilitation methods and activities

S.No	Method	Activities
1.	Physical activity or exercises	Squat, push-ups, etc.
2.	Yoga and breathing exercises	Pranayama, aasana (postures)
3.	Remote exercises	Improve mood disorders using Brunel Mood Scale questionnaire, aerobic exercises, endurance testing
4.	ML methods	Forecasting intubation using ML algorithms

4.1 Challenges in the Recent Studies in Rehabilitation

Some of the general challenges for patients include tiredness, sleep disorder, etc.

- Patients suffering from Covid-19 often feel tired and exhausted both physically and psychologically, as a result of modest activity; however, this will improve over time. Patients are likely to have lost immunity strength throughout their illness, and their joints may be tight. During sickness, it is projected that they have lost 2% of their muscle mass per day.
- Because everyone recovers at a different rate, it's tough to put a time frame on recovery, but patients shouldn't be concerned if it takes weeks or even months to get back to normal. Walking and exercising "little and often" is the only method to recuperate and strengthen.
- After deciding the activities that could be accomplished that day or even that week, establish a strategy to spread them out so you get enough rest. Begin with minor goals and progressively expand your workout time. Nowadays, most of the people work with their trainees or patients with physiotherapists and reading booklets with extra exercises for patients to practice at home on their own.
- After completing the Covid-19 physiotherapy exercise program, you should notice that your sleep pattern returns to normal as your activity levels increase. The most essential thing to remember is not to become concerned about lack of sleep because this will just exacerbate the situation. Before going to bed, try some relaxation techniques such as mindfulness, meditation, or even relaxing hobbies such as listening to soothing music or reading a book.
- The studies presented in this paper have a drastic lag in recommending personalized exercises for patients with post Covid syndromes. This could be an extensive area of study for researchers interested in this domain.

4.2 Limitations of Current Solutions to Covid-19

The research provided has a wide range of methods. State decision makers can assess the Covid-19 pandemic crisis in a way that prevents future crises involving other infectious illnesses. The findings of our study, which demonstrate the most disruptive impacts of the pandemic on people, can be used to establish strategies for dealing with the crisis' repercussions so that public mental health does not deteriorate in the future. Our findings can also be utilized to influence future limits communication in order to guarantee that they are fully respected (for example, by giving rational explanations of the reasons for introducing particular restrictions). Furthermore, our findings can be utilized to provide guidance on how to deal with the limits that may arise in the event of a repeat Covid-19 pandemic, as well as other possible scenarios.

The findings revealed that the Covid-19 epidemic, particularly the lockdown periods, is posing a severe challenge for many people owing to the loss of social contact. Social contacts, on the other hand, can help people shift through crises more smoothly. This understanding should drive policymakers to design strategies to assure pandemic safety while keeping social contact to a minimum, as well as solutions that give people a sense of control (instead of depriving them). Providing such alternatives can help people manage better with a pandemic by reducing the psychological issues that come with it.

5 Conclusion

This chapter seeks to identify recent challenges in prognosis, diagnosis, and rehabilitation of corona virus-affected patients. Many methods are based on the clinical study of data and also on ML-based techniques need improvement in early diagnosis of Covid-19 infections among people. Prognosis techniques are discussed based on the stages of viral cycle. This also finds a systematic review of all the existing methods for analyzing the techniques adopted for rehabilitation of patients with post-Covid syndrome. In rehabilitation approaches, personalized recommendation of exercises could be helpful. These could be automated based on diagnosis and combined with ML-based algorithms for providing recommendations. There are many solutions still under research for Covid diagnosis, prognosis, and rehabilitation. Some general limitations to these solutions have also been addressed. This would throw light on researchers to develop solutions using clinical and machine learning-based solutions not only for detection and prognosis but to recover in an effective manner.

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Part X
Conclusion

A Summary of Translating Health Care Through Intelligent Computational Methods

J. Jeslin Libisha, B. Govarthan, K. Divya Bharathi, C. Ram Kumar, and G. Naveenbalaji

1 Introduction

Conventional drugs are mainly used in elderly people and they use herbal medicine as a substitute for improvement in the treatment of chronic disorders. Yet, it is critical to survey whether this home-grown medication makes a huge impact on a regular medication or the other way around as this can prompt different unfavourable impacts. To get to an evidence-based, esteem-driven wellbeing framework we need to adjust every one of our expert instructive projects to show new frameworks and abilities. Artificial intelligence (AI) is emerging in the health care field focusing on the prognosis and diagnostic methods. Another AI technology with relevance to supporting health care is machine learning (ML); a further idea is to incorporate AI into physical robots. Normal surgeries utilizing automated medical procedures include gynecological, prostate, and head and neck. The AI method has been broadly utilized in smart medical care frameworks, particularly for malignant growth in breast cancer (BC) findings and anticipation. By applying arrangement strategies AI

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is assuming a huge part in the determination and prediction of carcinomas additionally utilized to distinguish harmless from threatening cancers and to anticipate guess. To be successful, frameworks should incorporate the legitimate prizes, impetuses, and financing for suppliers and the resources to pay for required cycles and IT frameworks and developments. The complexity of clinical proof is overwhelming in any event, for experienced, prepared experts who analyze and treat disease; however, it is undeniably more testing to the non-expert. Reducing this intricacy is vital to enabling patients – not just as better educated shoppers regarding medical services but also as dynamic accomplices in further improving health outcomes.

Contact following is an irresistible counteraction measure used by government experts to confine the spread of a disease. Contact following works by coming to an affected individual that has been introduced to an individual who has contracted the disease and instructing them to segregate to prevent further contamination. There is a lot of trust that will form the existence of AI in clinical field in an range of ways, not just for patient examination, patient perception, drug divulgence, but also to fill in as a partner for specialists and provide prevalent and more altered knowledge for patients. Such existence of AI has been controlled by producing successful results. Next, there are irrational suppositions for what AI can do and what the state of the clinical consideration industry will look like later on. The usage of AI in any field of study contains an enormous number and composing computer programs is only one of them. For the continuation of advancement, improvement, and achievement of AI applications under clinical consideration, specialists and data scientists need to continue with participation to develop huge AI structures. Specialists need to understand what AI can achieved and survey how their occupation can be improved with AI. Specialists need to give this information to data scientists who might then have the option to create an AI structure. The joint effort does not end here. Together, specialists and data scientists ought to figure out what kind of data they require for model planning and, further, when the model is collected, its presentation ought to be examined and unraveled, both of which require a concerted effort between specialists and data analysts. The utilization of wrong frameworks in any field of medical care has its share of constraints and difficulties. The opportunity has presented itself to shift our perspective from being responsive to being proactive with regard to loss of new development.

There is developing acknowledgment that the arrangement of the atomic structure blocks from which natural frameworks are created is not adequate for understanding the utilitarian properties of the frameworks in wellbeing and sickness. For sure, work does not only start at the level of the quality, advancing in a feed-forward style through more significant levels of natural association. Moreover, computational visualization can be used to understand how biological systems behave when they are infected, and knowledge acquired from demonstrating can thus be utilized to foster the further development of techniques for determining illness and therapy. We allude to this arising approach as “computational medicine.”

2 Unease of Conventional Medicine

Ordinary prescription is a structure wherein clinical trained professionals and other clinical consideration specialists (such as orderlies, drug subject matter experts, and counsels) treat signs and symptoms using medications, radiation, or surgery, moreover, called allopathic medicine, biomedicine, standard drug, standard prescription and Western medicine. Ordinary (universal) medication is protected and powerful, with painstakingly planned preliminaries and examination. The essential utilization of ordinary medications results in less serious side effects in patients [1].

Conventional drugs can be derived by chemical synthesis, and are also called nature drugs; naturally occurring pharmacologically active substances are used to detect several infections and are divided amongst the plants, fungus, bacteria, or the animal world. But there are many disadvantages of conventional medicine, owing to a lack of solid research. Dangers and possible benefits still remain unproven. Yet, it is critical to survey whether this home grown medication makes the huge impact of a regular medication or the other way around, as this can prompt different unfavourable impacts. Sometimes conventional drugs may also lead to misdiagnosis and inappropriate treatment methods.

The healing period will also be long with this type of conventional drug methods. Thus, conventional evidence-based medicine hierarchies occupy an uneasy position. Informed consent is poorly understood, as this causes confusion among physicians and patients [2]. Problem selection and data collection are the challenging task. This platform produces difficulties in the prognosis and diagnosis of several diseases. There should be an alternative method of rectifying and easing the work. The future of cancer care is depicted in Fig. 1.

Fig. 1 Future of cancer care

3 Mutating Medicine Using Intelligence

Artificial intelligence is an upcoming field in the clinical sciences and continuously changing clinical practice. Coordination of man-made reasoning approaches, for example, AI, deep learning, and natural language processing to handle the difficulties of adaptability and the high dimensionality of information, and to change big data into clinically significant information, is growing and transforming into the establishment of precision medicine [3].

Precision medicine is "an arising approach for infection therapy and anticipation that is basically utilized in the adjustment of qualities, climate, and furthermore the way of life for every individual." This is currently generally utilized in the reversal of pathological conditions and shown in the treatment of malignant growths. Ordinary applications consolidate the diagnosis of patients, beginning to end drug exposure, and improvement, further creating correspondence between specialist and patient, deciphering clinical reports and prescriptions, and remotely treating patients. Computerized reasoning is utilized in the changing medications of the medical services industry. In the field of malignant growth genomics, Artificial intelligence (AI) has recognized the vital role of inherited information and other useful information in determining the most effective treatment. Artificial intelligence showed the actual morphological changes that myelodysplastic conditions imprint on invariant components [4].

An assorted prescient model from AI or information mining has been utilized to perform predictions of the impact of transformations on the p53–ERα association. Different investigations showed that ML models have been fruitful in breast cancer studies. Many algorithms have been implemented to develop the AI process in health care. They have also been used to identify the mutation patterns and are helpful in building up the mutation medicine to block the disorders. For example, p53 mutations can be identified by ML technologies using different algorithms for the detection of carcinomas and other disorders. The WEKA AI programming support vector machine calculation was utilized for 1–4D part classifiers. AI plays a priority role in the preparation of mutation medicine in the health care industry [5].

4 Evolution of Health Care Techniques (Prognosis and Diagnosis)

Artificial intelligence is emerging in the health care field focusing on the prognosis and diagnostic methods. Another AI technology with relevance to supporting health care is ML; a further idea is to incorporate AI into physical robots. However, the final decision is made by human surgeons. Clinicians typically stick to their own insights and clinical experience when analyzing patient's signs and side effects. These clinical data and information can be utilized to analyze illness, yet the precision of the finding cannot be ensured, and it is difficult to avoid confusing analyses.

AI utilizing integrative handling and extraction brings about extremely precise conclusions because of the excellent viability and adequacy accomplished during preparing and learning from a large number of samples [6].

Artificial intelligence techniques have been comprehensively used in intelligent clinical examination methods, especially for harmful developments in breast cancer findings and expectations. Artificial Intelligence (AI) is expected to play a significant role in the quantification of carcinomas by using planning techniques. It will also be utilised to distinguish benign from malignant tumours and to make predictions. Reliably, ML estimations have been by and large used in breast cancer findings and predict distinct outcomes from data analyses. Man-made intelligence is a sort of AI uses a variety of quantifiable, probabilistic, and smoothing tools to gain and further foster execution, therefore, designs from new data and past experiences, without explicitly adjusted headings. Man-made thinking, especially AI and significant learning, has emerged at new heights and considerable learning, which has seen continuous work in applications of clinical disease research. Until this point, precise treatment data modified for a patient is genuinely difficult to achieve [7].

In any case, AI can be utilized to process and investigate multifaceted information from numerous patient assessment data to predict disease anticipation, such as the endurance time, and uncover more exact outcomes. Various kinds of algorithms and classifiers with conventional logistic regression statistical approaches had exhibited that AI might play a part in giving prognostic and prescient information to patients with malignant ovarian growths [8].

Artificial neural networks have been utilized in the clinical determination, image examination in radiology and histopathology, data interpretation in the intensive care setting, and waveform analysis.

5 Evolution of Health Care Techniques (Therapy)

On-going advances are utilizing man-made consciousness, AI (ML), augmented reality (AR), virtual reality (VR), and other progressing techniques to address those issues with quicker and more straightforward diagnostics, and at-home restorative methodologies intended for all ages. Man-made reasoning (AI) really attempts to mirror human intellectual capacities. The roles and responsibilities of all medical service partners are going through transformative change and – regardless of whether we approach change as suppliers, payers, analysts, wellbeing item designers, or purchasers – there is a lot to gain from all who are engaged with these cooperative conversations concerning how to battle with the quick changes in the medical services framework. Medical services suppliers, regardless of whether engaged with conveying or repaying care, face an interesting array of difficulties, as care is progressively educated by and coordinated around quickly advancing proof. Increasing better ways of dealing with repayment and different components that help the conveyance of value care are at the front line for all suppliers, and many pilot projects are as of now under way. A key thought, as represented throughout this report, is the solid impact of neighborhood societies on training designs. To observe less difficult answers to complex medical services issues, AI is turning out to be an increasingly acknowledged and simpler strategy. Applying the bio-electronic treatment to patients experiencing Parkinson's disease by means of the resting tremor signals is extremely compelling. An AI advisor (AI-T) had executed the verbal prompts of expert specialists who had a broad involvement in preparing the robot-assisted step involving the SUBAR for stroke patients. The AI-T was created utilizing a neuro-fuzzy framework, an AI strategy utilizing the advantages of fuzzy rationale and artificial neural networks [9].

The AI-T was prepared with the expert specialist's verbal prompt information, just as clinical and automated information was gathered from the robot-assisted step prepared with genuine stroke patients. Aphasia is a correspondence problem that frustrates the capacity to communicate and speak. The job of AI is to order aphasia seriousness utilizing various calculations, which gives the best outcomes. Deep-learning models order enormous datasets dependent on neural organization. They have the capacity to automatically extract the features. Later models such as convolutional neural networks, recurrent neural networks, bidirectional long short-term memory, and hybrid models give preferable outcomes over customary calculations. The above are a few examples of AI in different treatment fields. Along these lines, AI ends up being a powerful advancement in the universe of treatment in the medical services industry [10].

6 Novelty in Emerging Soft Computing

A growing management and reasoning technique is delicate registering, which enables the brain's unexpectedly greatest reaches to defend against and learn in the event of vulnerability. Delicate processing relies upon some regular methods such as genetic characteristics, advanced technologies, the general information hubs, and the human system.

By and by, delicate registering is the fundamental course of action when we do not have any mathematical showing of decisive reasoning (i.e., computation), there is always a need to address a periodic problem, adapt to the new circumstance, and carry it out with the same care. Its colossal applications in various areas such as diagnostics, computer vision, machine information, prediction, organizing progression, life-saving intervention (LSI) setup, plan affirmation, composed by human computer interaction advancements, etc. The progression of chronic disease is perhaps the greatest illness confronted by societies all over the world. Hence, the research is aimed at avoiding and limiting the spread of the predicted disease and the on-going diseases by utilizing the new framework [11].

The framework of soft computing is shown in Fig. 2 and is to plan a development model to deal with and predict nontransmissible diseases to help official wellbeing

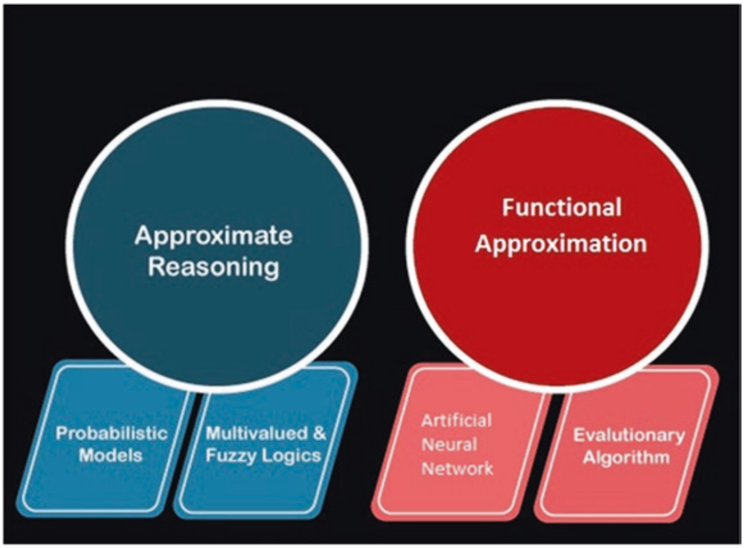

Fig. 2 Soft computing

and control the spreading infections. The nondirect delicate registering was applied to predict persistent illnesses. The standard information is assembled from the Centers for Disease Control and Prevention. The web search design is acquired from Google. From the trial examination, it is explored that we can plan a framework that predicts ongoing illnesses to be specific by utilizing search terms.

It is inferred that there are relations between the clinical information that is enlisted in general wellbeing and search questions that are presented by the populace. Simulated intelligence models have displayed their centrality in different divisions such as aid organizations, transportation, and on-line commerce, etc. It is routinely used for figures, and furthermore, for distinguishing proof of contaminations such as diabetes thus improvising therapeutic administrations. As the growing requirements, the extended information, and data are taken care of in combined servers. The combined server similarly faces the error issues; furthermore, along these lines the unflinching nature of the information perseveres. Blockchain goes with a decentralized information base without picking information with consistent speed. The information is available to customers via the decentralized information base [12].

Blockchain advancement could be a passed on framework of interconnected centers. Each of the focuses has the duplicate date of the distributed record, which has the fundamental concerns on each single exchange inside the blockchain affiliation. Information is routinely brought carefully into AI models. Each block has shown its versatility and limit based on previous financial experience.

7 Precise Health Care Technologies Serving in Cancer Research

Precision medicine can be characterized as a prescient, preventive, customized, and participatory medical services administration conveyance model. With malignant growth being perhaps the greatest public health threat in the developed country, both the examination of the local area and states have been contributing a huge amount of time, money, and effort in precision cancer medicine. The advancement of a coherent malignant growth developmental system that is agreeable to hypothetical and computational modeling is fundamentally essential to acknowledge more precise predictions. Both oncological treatment and examination are generally still thought to constitute an data-poor environment, as most information is not deliberately (and electronically) accumulated, organized, or incorporated into IT frameworks. The practical evaluation of precision health care is shown in Fig. 3, which depends mainly on a person's daily lifestyle.

There are small areas that include enormous informational indexes (e.g., omics information or radiology information), yet information on cycles, results, or external information actually requires a great deal of manual work or is not recorded in any way. The requirement of the model is to consolidate the spatial imperatives in tumor growths and ideal sampling approaches and parameter sets that should be estimated in a cancer to illuminate such prescient models should be characterized. In future, there may be an increase in precision oncology or cancer practices by combining the advancements in diagnostic technology and accessibility with the growing amount of targeted therapy. The degree of proof needed to exhibit clinical advantage should be adjusted to this new reality without altogether leaving the standards of the organized and checked perception of patients' experiences [11].

Fig. 3 Practical precision medicine

Genomics is thankfully teaching some interesting things about unusual growths, by elucidating tumorigenesis mechanisms, describing tumor tissue heterogeneity, and locating clonal evolution in therapy, even if their usage in patients is not required. The goal of this work is not to project the importance of genomics in precision medicine but to find new drugs and to prescribe the existing drugs to the patients suffering from cancer through additional approaches. Like the genomic methodology, the functional methods lag behind the existing genomic methods; as a result they lack clinical validation in a prospective way. The major challenge in perspective analysis is acquiring tissue. For clinical pathological methods the specimens to be examined need not be handled using any standardized protocols, whereas the functional methods suggest that the tissues under study might need to be fresh or frozen. The tissue biopsies are taken for direct therapy and all the tissue biopsy should be viable. There is developing acknowledgment that the arrangement of the atomic structure blocks from which natural frameworks are created is not adequate for understanding the frameworks' utilitarian properties in wellbeing and illness. For sure, work does not start only at the level of the quality, advancing in a feedforward style through more significant levels of natural association. The process of precision public health is shown in Fig. 4.

Assuming that practical accuracy medication approaches can show predominant adequacy in confirmation of the rules of clinical investigations, these outcomes will give a force to carry out the strategies expected to guarantee that suitable tissues are acquired for this reason. Second, I accept that there is an obsolete discernment that practical methodologies are to some degree unrefined and unsophisticated. We

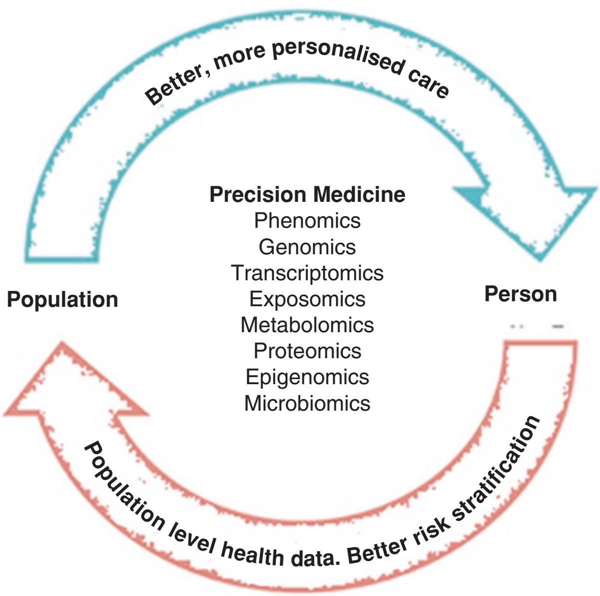

Fig. 4 Precision public health

should accumulate proof and, at present, should fight the temptation to institute an intercession for each revealed 'significant' change, taking care not to hurt patients at a truly weak point in their lives by trying to get a questionable and some of the time even unwarranted clinical advantage [12]. Nonetheless, development remains centrally influenced by stochastic impacts and accurate estimations of the whole clonal creation of a malignant growth will not be imaginable in precision cancer medicine.

8 Telecommunication with Improved Intelligence in Medicine

With the progression of deep learning and different advancements, AI is presently in the phase of being utilized in explicit enterprises to build effectiveness and diminish costs. AI has been effectively applied to programmed pilots, clinical medicines and wellbeing, finance, retail, diversion, AR, VR, and numerous different fields with remarkable significance. A few specialists say that AI may turn into the new productivity and surprisingly one of the vital drivers of the fourth modern transformation. The general flow of telecommunication is illustrated in Fig. 5. For telecom

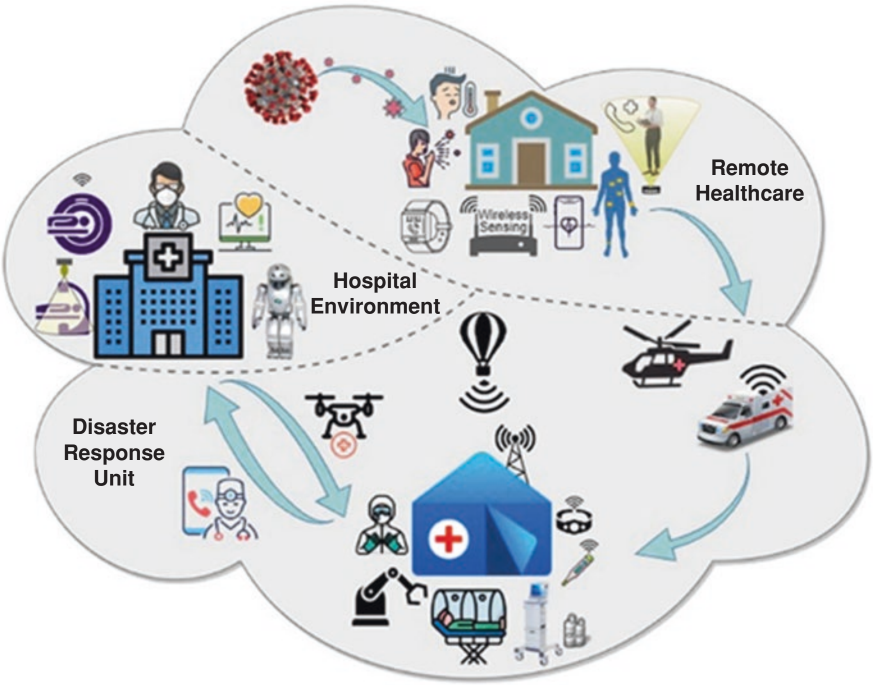

Fig. 5 Telecommunication

administrators, the chances and difficulties coincide behind AI improvement. From one viewpoint, the biggest information framework and the enormous information assets extraordinarily work with the AI improvement of the telecom administrator. Rich information assets can extraordinarily assist with concentrating on AI calculations and training models. Then again, there are numerous deterrents to survival, for example, the gap between administrators and internet ventures on the part of algorithm framing and market advancement [13].

Over the years, scientists have begun to investigate the mixture of different innovations such as sensing, signal processing, communication, processing, and systems administration with medical services to work on the trustworthiness and quality of service conveyed to patients. This has prompted more astute medical service conveyance to patients including younger people, the elderly, and others who are persistently sick. E-healthcare is an intriguing and consistently developing area. It is obvious from the examination audited to date that there are regions requiring improvement to effectively coordinate and use the innovation to its maximum capacity, both in metropolitan and rural regions. Clearly, the utilization of telemedicine advances, including tele-consultations, permits lessening of the quantity of potential complexities of the therapy and diagnostic cycle, just as to expand the degree of identified illnesses during the early stages; building attention to the proactive discovery of obsessive conditions, consequently expanding the preventive direction in the therapy and indicative course of numerous nosologically types of illnesses; increasing the social and monetary proficiency both in the exercising of the clinical association and according to the viewpoint of a singular patient; building the accessibility and nature of clinical consideration, particularly for patients living in remote regions, along these lines working fair and square and with personal satisfaction of the populace; making measurable customer data sets that help to screen and track changes in the wellbeing status of the populace, including when utilizing electronic versatile applications; profoundly qualified experts of unfamiliar and home-grown centers trading insights, data, and scientific material on different issues, which can to some extent take care of the issue of staff deficiencies of clinical associations in remote and inadequately populated regions; leading consistent preparation for clinical faculty, yet also for patients and the populace, which is vital in the present unusual states of society improvement; aggregating, storing, and interacting with data and logical material on the elements of the wellbeing status of the populace. Today, not all clinical experts are prepared to execute telecommunication technology in the act of a clinical association, because of the absence of information, abilities, and experience working with data innovations, particularly in gatherings of experts of more seasoned age. In this way, as we would like to think, it is important to direct extra instructive work in the field of utilizing present-day data and media communication innovations, just as portable utilizations of electronic wellbeing. What is more, it is important to expand the degree of information and skills in the field of data innovation for clinical subject matter experts, yet also to increase and work on the nature of preparation of numerical and design experts working in the field of medication and medical care [14].

9 Future of Medicine and Computational Techniques in Health Care

A system framework of sensors to collect the vital parameters of patient data and sharing the data over a particular network in a secure manner is called H-IoT (health care internet of things). The data collected from the patient are processed and analyzed to find inconsistencies in vital parameters; if such deviations are found then an alert is sent. This forms the new fully automated system, namely Medicine 4.0, to fulfill patient monitoring and IoT-powered diagnosis. Various architectures including ML, edge computing, software-defined network blockchains, etc., are some computational paradigms for H-IoT implementation. The ML methodologies are used in the multiuse purpose of H-IoT to maintain networks and to help in achieving service performance and the optimal network. One of the architectures is edge computing, widely employed to reduce the latency of the system, thereby improving the system's reliability. When the data are sent over an unsecure network, it eliminates the data traffic. In the case of processing larger data sets, the advantage of employing big data analytics is used in H-IoT. The introduction of 5G along with some efficient wearable devices could accelerate the novel technologies of H-IoT. Numerous genuine difficulties have been recognized, which are hindering the broad reception of the H-IoT frameworks; however, there are a few novel answers to relieve these difficulties. H-Big data analytics give a structure to continuous disclosure of abnormal activity, as well as making future predictions about the patient's condition. The blockchain is improving the information stockpiling abilities by presenting a straightforward and secure technique for data and conveyance [15].

Software-defined networks take into consideration greater adaptability in keeping up with the network and improving the abilities by presenting the detachment in the information and network management planes. The internet of nano-things is driving the organization turmoil on the nano-scale with applications in precision medicine and recognition. These difficulties have been recognized in this work, and based on, the future exploration is recognized [16].

The tactile internet is a main change in perspective in H-IoT correspondence, and it is opening up new paths in medical care. By close investigation of the writing and the market patterns, obviously the enormous scope of H-IoT is unavoidable.

Computational display can likewise be applied to comprehend the unique design and capability of living cells in infection, and knowledge acquired from demonstrating can thus be utilized to foster further developed techniques for illness determination and therapy. This arising approach is called "computational medicine." It includes not just models of sub-atomic organizations and physiological cycles but also demonstrating anatomical shapes layered with physiological capacity. Despite the fact that displaying approaches utilized in every one of these spaces of computational medicine vary, the ongoing theme is the utilization of quantitative models to comprehend adjusted construction and capacity in illness. Figure 2 gives instances of the various sorts of models utilized and kinds of information expected to depict natural cycles and illness across various organic scales. It is critical that predictions with regard to irregular structure and stage of illness be tried utilizing information excluded from the model structure. Model expectations could conceivably be upheld by results from the investigations they propel. Subsequent to testing these expectations, models ought to be reconsidered depending on the situation in order to all the more precisely diagnose the cause of illness.

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