EXPLORATION OF ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN TECHNOLOGY IN SMART AND SECURE HEALTHCARE

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PREFACE

From the last decade onward, a considerable amount of research and developments in technology have taken place especially in the healthcare industry, with the involvement of technologies like Artificial Intelligence (AI), Machine Learning (ML), Deep Learning, Blockchain, Communication Systems, Internet of Things, Multisensory Systems, *etc*. The purpose is only to make smart and secure healthcare possible. Machine Learning techniques and algorithms are required to give a boost to the aim of smart healthcare. Hence, to fulfill the vision of smart healthcare, the tools and applications based on Artificial Intelligence and Machine Learning are becoming extremely popular for producing more accuracy (in terms of values) in predicting results (without being explicitly programmed) in the healthcare industry. However, Artificial Intelligence-based algorithms are quite helpful for the transformation of physiological data into clinical information of real values, but for processing such big data from a set of medical images and identifying or extracting characteristic patterns of health function, then translating these patterns into clinical information definitely requires an adequate knowledge base of physiology, advanced digital signal processing capabilities, and machine learning. The domain of Artificial Intelligence can be taken into three main groups *viz*. Artificial Slight Intellect, Artificial Overall Intelligence, and Artificial Super Intelligence, and undoubtedly all these groups work in an absolute manner in the presence of fundamental or advanced Machine Learning techniques. There are a number of categories existing concerning the AI/ML algorithms used for fulfilling the objective of smart healthcare such as supervised (regression, decision-tree, classification) and unsupervised (clustering, association analysis, hidden Markov model, *etc*.). Although the preparation of intelligent algorithms or systems based on AI/ML combined with novel wearable portable devices (especially sensors *etc*.) offers unprecedented possibilities and opportunities for remote patient monitoring, traditional sharing schemes cannot guarantee the security and immutability of data. Machine Learning along with Artificial Intelligence is quite helpful towards the research and development in health care, but still lacking somewhat especially in security and privacy related to healthcare information of all categories *i.e*. the dream of smart healthcare is far behind. So to make the dream of smart healthcare come true, the emerging Blockchain technology is spreading its feet in the healthcare industry having revolutionized results. The Blockchain is helping in numerous perspectives in health care such that for managing the security, the integrity of data *i.e*. electronic health records (EHRs), electronic medical records (EMRs); preserving immutability of data, tracking the origin, spreading of data, the authenticity of data, data sharing, protection against data spoofing, *etc*., as compared to traditional security mechanism *i.e*. a single technology having a number of features. In simple words, smart healthcare will only be possible if both the accuracy in results, security and privacy of such results will be equally maintained. In a nutshell, the primary goal of this book is to offer a variety of techniques for a broad readership, ranging from computing and methodologies to business analytics in the health sciences.

In the chapter titled, "Blockchain Associated Machine Learning Approach for Earlier Prognosis and Preclusion of Osteoporosis in Elderly", the authors discuss a fully automated mechanism for suspecting osteoporosis patients, which uses machine learning techniques to improve prognosis and preciseness through various processes. Here, we created an automated method that combines principal component analysis (PCA) and the weighted k-nearest neighbors algorithm (wkNN) to effectively detect, predict, and categorize BMD scores as normal, osteopenia, and osteoporosis.

In the chapter titled, "Online Detection of Malnutrition-Induced Anemia from Nail Color using Machine Learning Algorithms", the author proposed a noninvasive online-based malnutrition-induced anaemia detection using a smartphone App for remotely measuring and monitoring anaemia and malnutrition in humans. This painless method enables user-friendly measurements of human bloodstream parameters such as haemoglobin (Hb), iron, folic acid, and vitamin B12 by embedding intelligent image processing algorithms that will process photos of fingernails captured by the camera in the smartphone, thereby providing a contact-free measurement system during this Covid 19 pandemic.

In the chapter titled, "Artificial Intelligence and Bioinformatics Promise Smart and Secure Healthcare: A Covid-19 Perspectives", the authors elaborate on the principle, procedure and applications of AI equipped with bioinformatics knowledge to create opportunities, and prospects and answer the challenges met by academicians, researchers, students and industry professionals from the background of computer science, bioinformatics, and healthcare.

In the chapter titled, "Detection of Breast Cancer using Context-Aware Capsule Neural Network", the authors' primary focus in this work is on the extraction of the features of the images and to accomplish this work, 3D mammogram images are pre-processed. Noise is removed and these preprocessed images are further passed through different convolution layers. After convolution process is done, images are fed to the capsule layers for final classification.

In the chapter titled, "Enhancement of Breast Cancer Screening through Texture and Deep Feature Fusion Model using MLO and CC View Mammograms", the authors' proposed model is more concentrated on the extraction and fusion of deep features from the two views to improve screening efficacy. The efficacy of the model is evaluated on mammogram images taken from MLO view and CC views of the DDSM data set. Medical imaging-based ML techniques are commonly used for breast cancer detection and diagnosis, but they are time-consuming.

In the chapter titled, "Artificial Intelligence Assisted Colonoscopy in Diagnosis of Colorectal Cancer", the authors discuss how AI has gained attention for its potential to improve standard clinical practice. One such use is in diagnostic colonoscopy, where it can help identify precancerous lesions early and permit appropriate care.

In the chapter titled, "Developing a Smart Device for the Manufacturing of Health Products for Patients Using the Internet of Things", healthcare analytics in a connected world were briefly discussed. In this study, the causes of the creation of contemporary healthcare are methodically examined, along with its causes, methods, and effects.

The authors of the chapter titled, "Blockchain Security in Healthcare" discuss the security and privacy needs, threats, and solution strategies in healthcare Blockchain for the exchange of electronic medical data, which further aids healthcare professionals, healthcare service developers, and healthcare consumers in gaining a thorough understanding of the security and privacy requirements and technologies for enabling a secure and decentralized EMR data sharing.

In this chapter titled, "Enhancing the Communication of Speech Impaired People using Embedded Vision Based Gesture Recognition through Deep Learning", the author proposes to employ an image-based recognition system for American Sign Language (ASL) namely, (i). classification of handcrafted features using Machine Learning methods, (ii) classification utilising a pre-trained model *via* transfer learning, and (iii) classification of deep features derived from a specific layer by machine learning classifiers.

The chapter titled, “Advancing Data Science: A New Ray of Hope to Mental Health Care” examines the contributions of AI/ML and Blockchain to several mental healthcare system domains and discusses its potential in many additional unexplored frontiers in this discipline.

The chapter titled, “Machine Learning Based Techniques for Pneumonia Disease Identification in the Health Industry”, discusses the applications of one of the AI sub-disciplines, ML, and the difficulties and obstacles that researchers encounter when identifying early-stage pneumonia disease. In conclusion, Blockchain technology combined with ML and DL may be useful to create safe diagnostic systems as cloud systems have grown to be a possible hazard due to the accumulation of data stored there.

In the chapter titled, “Framework towards Smart Healthcare Tourism based on the Internet of Medical Things (IoMT)”, the authors provide the outlines of the Internet of Things-based health monitoring system that may be helpful for foreign visitors and hotel management throughout maintaining the health of both its guests and staff. The system will identify and examine the body’s many vital signs before telling the operator of the condition of each person’s health.

This chapter titled, “Unmasking the Sentiments of People Towards Pandemic: Twitter Sentiment Analysis in Real Time”, aims at examining and assessing people’s feelings and sentiments throughout the coronavirus outbreak. The study analysed people’s sentiments on the COVID-19 pandemic among Indians using sentimental analysis from tweets collected on Twitter.

In the chapter titled “Application of Industry 4.0: AI and IoT to Improve Supply Chain Performance”, the author briefs about how Artificial Intelligence and the Internet of Things play a vital role in enhancing supply chain management specifically in the healthcare industry. The businesses may streamline operations, cut expenses, and enhance decision-making by utilizing such emerging technologies.

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CHAPTER 1

Blockchain Associated Machine Learning Approach for Earlier Prognosis and Preclusion of Osteoporosis in Elderly

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Abstract: Osteoporosis (OP), or porous bone, is a severe illness wherein an individual's bones weaken, increasing the likelihood of fractures. OP is caused by micro-architectural degradation of bone tissues, which raises the probability of bone fragility and can result in bone fractures even when no force is placed on it. Estimating bone mineral density (BMD) is a prevalent method for detecting OP. For women who have reached menopause, prompt and precise forecasts and preventative measures of OP are essential. BMD can be measured using imaging methods like Computed Tomography (CT) and Dual Energy X-ray Absorptiometry (DEXA/DXA). Blockchain (BC) is a revolutionary technique utilized in the health sector to store and share patient information between clinics, testing centres, dispensaries, and practitioners. The application of Blockchain could detect drastic and even serious errors. As an outcome, it may improve the confidentiality and accessibility of medical information interchange in the medical field. This system helps health organizations raise awareness and enhance the evaluation of health records. By integrating blockchain technology with machine learning algorithms, various bone ailments, including osteoporosis and osteoarthritis, can be identified earlier, which delivers a report regarding the prediction of fracture risk. The developed system can assist physicians and radiologists in making more rapid and better diagnoses of the affected ones. In this work, we developed a completely automated mechanism for suspicious osteoporosis patients that uses machine learning techniques to improve prognosis and precision *via* different processes. Here, we developed a computerized system that effectively integrates princi-

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pal component analysis (PCA) with the weighted k-nearest neighbours algorithm (wkNN) to identify, predict, and classify the BMD scores as usual, osteopenia, and osteoporosis. The ranked results are validated with the DEXA scan results and by the clinicians to demonstrate the efficacy of the machine learning techniques. The laboratories use BC to safely and anonymously share the findings with the patients and doctors.

Keywords: Blockchain (BC) technology, Bone mineral density (BMD), Dual energy X-ray absorptiometry (DEXA/DXA), Osteoporosis (OP), Principal component analysis (PCA), Weighted k-nearest neighbours algorithm (wkNN).

INTRODUCTION

Healthcare records encompass the physical information concerning our bodies and are essential for diagnosing and treating diseases. Medical data includes several patient-related archives necessary for proper care and areas for further study. Moreover, it must be kept securely and distributed to safeguard the data's confidentiality [1]. With the fast progress of artificial intelligence (AI), healthcare information has emerged as a valuable asset that can support the creation of AI diagnostic modelling techniques that could help therapists diagnose. Even though medical data documentation has progressed from paper files to electronic health records, which are more useful for accessing data and retrieval, more consideration should be given to data security. Numerous hospitals and organizations have already whittled down the transfer and sharing of data to mitigate personal data breaches, resulting in the development of a repository as health records are dispersed within and between diverse healthcare centres [2]. The data-sharing operation among external organizations benefits patients by allowing them to analyze their data using the latest methodologies and tools to detect a disorder.

Moreover, patients are concerned about the lack of openness in the information exchange procedure because their records could be revealed to a third person. This demonstrates the necessity for a technological system that helps eliminate intermediary entities, reduces expenses, and boosts patient honesty and trust. Blockchain is a technological advancement that may effectively and reliably share data using its decentralized paradigm to address this issue [3]. A problematic situation arises when accessing and evaluating the patient's vital information, which is housed across many healthcare systems. Blockchain implementation can address this issue with health information exchange platforms by backing reliable and decentralized databases. Fig. (**1**) depicts the various types of Blockchains.

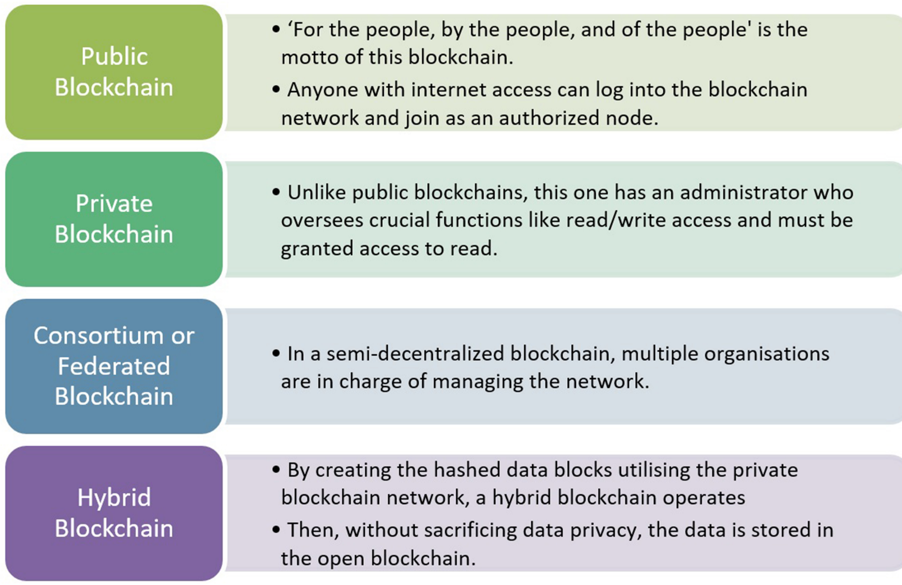

Fig. (1). Types of blockchain.

BLOCKCHAIN IN HEALTHCARE	Securing patients data
	Streamline care and prevent costly mistakes
	Breakthrough in Genomics
	Point of care Genomics management
	Managing Electronic Medical/Health Record (EMR/EHR)
	Interoperable Electronics Health Records
	Medical supply chain management
	Ease in drug traceability
	Remote patient monitoring
	Personal health record data management
	Diseases and outbreaks being tracked
	Claims for health insurance
	Mobile health Apps
	Easy access and storage of patient information
	Data collection and analysis
	Cybersecurity
	Clinical trials
	Personalized healthcare
	Accelerating Research & Development
	Giving patients control of their data
	Neuroscience studies
	Telemedicine and E-Healthcare

Fig. (2). Applications of blockchain in healthcare.

Because of its decentralized and tamper-proof characteristics, blockchain (BC) technology is extensively utilized in the healthcare industry to manage records. In the medical system, the BC network stores and shares patient forms among

CHAPTER 2

Online Detection of Malnutrition Induced Anemia from Nail Color using Machine Learning Algorithms

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Abstract: This chapter enlightens the identification of anaemia due to malnutrition from the colour of the nail images using a smartphone application. This method enables remote measurements and monitoring using a noninvasive procedure. Since this method does not involve invasive techniques, there is no blood loss, and it is painless. In addition, the smartphone application facilitates easy measurements of various physiological parameters related to the blood. They include Hemoglobin (Hb), iron, folic acid, and Vitamin B12. This technique can be accomplished using a feed-forward neural network trained with a Radial Basis Function Network (R.B.F.N.). The image of the fingernails is photographed using a camera built into the smartphone. Online anaemia detection smartphone application will classify the anaemic and Vitamin B12 deficiencies as onset, medieval, and chronic stages by feature extraction from the nail images. The specific measurements made instantly can extract features like the colour and shape of the fingernails. These features train the R.B.F.N. to identify Anemia due to malnutrition. This method will enable the depreciation and disposal problems associated with bio-medical waste. Also, this method will offer a contactless online measurement scheme. The application could help in the early detection of Anemia due

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to malnutrition, allowing users to seek medical advice and intervention promptly. In terms of accessibility, by utilizing a smartphone application, this technology could reach a broad audience, including those in remote or underserved areas.

Regarding the privacy of medical images, Blockchain's encryption and decentralization would enhance data privacy and control for users. The data extracted from the nail images for research is obtained with the user's consent. Anonymized data could be used for research purposes, contributing to a better understanding of anaemia and malnutrition trends.

Keywords: Anemia, Image processing algorithms, Nail colour, Radial basis function network.

INTRODUCTION

The critical importance of this method is that it relies on a non-intrusive scheme to identify various physiological parameters like Hemoglobin (Hb), iron, folic acid, and Vitamin B12. Presently, syringes with needles are used to gather blood samples from patients to identify the values of Hb, iron, folic acid and Vitamin B12 levels in laboratories. All intrusive methods induce pain. Removing the wastes involved in blood sample extraction is a challenging task that is also laborious and prone to infection. Telemetry in healthcare assistance is of great importance in the present scenario. A smartphone application ensures unintermittent and online identification by extracting the nail colour and shape.

RELATED STUDIES

The proposed Noninvasive method using a smartphone application will be superior as compared with the “Noninvasive haemoglobin measurement using embedded platform” technology in such a way that the patients will be able to receive instantaneous measurements about Hb, iron content, folic acid and Vitamin B12 levels once the images of the Fingernails are capture during the camera in mobile phones [1, 2]. People worldwide have developed a noninvasive technique that uses a smartphone App to identify only Anemia from the fingernails anywhere and at any time [3, 4]. This method is a noninvasive real-time haemoglobin monitoring system. In this system, a multiple-wavelength photometric method using spectral analysis of the blood sample is used . LED-based OxyTrueHb® sensor system is developed, a noninvasive way to monitor the Hb level in the human bloodstream [5, 6]. In Switzerland, the measurement of Haemoglobin using a noninvasive method without the extraction of blood and without using a needle and syringe has become state-of-the-art in screening anaemia. Researchers have proposed the use of occlusion spectroscopy, which uses optical measurement with a ring-shaped pneumatic probe [7, 8]. Researchers have proposed a noninvasive visual sensor system for continuous, real-time monitoring and assessment of hemodynamics in Germany. This system enables a painless monitoring system [9 - 15].

OBJECTIVES AND NOVELTY OF THE PROPOSED WORK

This method aims to identify the Hb, iron, folic acid, and B12 levels from nail colour using a smartphone application using image processing algorithms and R.B.F.N. Adding to the objective of this scheme, the proposed method will offer an online, dynamic, and instantaneous measurement without the problem of handling the biomedical wastes involved in laboratory analysis.

Scientific Significance

The scientific significance of the system for detecting Anemia and malnutrition includes safe and secure online, instantaneous measurement of Hb, iron, folic acid, and B12 without direct human interference. This scheme also eliminates the time delay involved in analyzing the blood samples in the laboratory so that the measurements for Hb, iron, folic acid and B12 can instantly be obtained for patients undergoing major surgery without any further delay. This indigenous system also finds a significant need in mobile health monitoring vehicles. Presently, the world is facing the pandemic situation of COVID-19, where even hospitals and diagnostic centres are facing a considerable challenge to cater to the needs of the patients without creating clusters. This proposed smartphone App, once developed, may solve this crisis by offering clinical analysis with social distancing. Precision and accurate measurements can be obtained as comparable with the laboratory testing standards.

The estimated patient population per year is nearly 190.7 million people affected by anaemia and vitamin deficiency, as per the report from the Food and Agriculture Organization, in association with the State of Food Security and Nutrition. This figure accounts for 14.5% of India's total population. Malnutrition is found to deteriorate health conditions, costing around 0.8 to 2.5%4. The death occurrence due to malnutrition and Anemia is 0.5% in India. Approximately 50 to 60% of school-going children and women are affected by anaemia and vitamin deficiencies. Fig. (**1**) illustrates the trend chart.

CHAPTER 3

Artificial Intelligence and Bioinformatics Promise Smart and Secure Healthcare: A COVID-19 Perspective

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Abstract: Recent developments in the fields of Artificial Intelligence (AI) and bioinformatics have played a vital role in securing smart healthcare. Notable contributions have been made in the field of viral immunology after the COVID-19 outbreak with the help of AI and bioinformatics. Various diseases and disorders such as viral diseases, metabolic disorders, and genetic disorders require the application of AI and bioinformatics to provide safe and error-free treatment. The tools of bioinformatics and modern-day biology used for smart and secure health care include single-cell genomics, proteomics, and next-generation sequencing technologies. During the COVID-19 outbreak, AI and bioinformatics helped to create methods and services to combat the pandemic. In this chapter, we elaborately highlight the principle, procedure, and applications of AI equipped with bioinformatics knowledge to create opportunities, and prospects and answer the challenges met by academicians, researchers, students, and industry professionals from the background of computer science, bioinformatics, and healthcare.

Keywords: Artificial intelligence, Bioinformatics, Covid, Healthcare.

INTRODUCTION

Recent advances in the bioinformatics and AI domains have been crucial in ensuring the safety of smart health care. After the COVID-19 outbreak, notable advancements in the field of viral immunology were accomplished with the use of AI and bioinformatics. To provide safe and error-free treatment for a variety of illnesses and disorders, including viral infections, metabolic disorders, and genetic disorders, bioinformatics and AI must be applied.

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Modern biology and bioinformatics tools like single-cell genomics, proteomics, and next-generation sequencing technologies are applied to provide smart and secure healthcare. AI and bioinformatics were crucial in developing healthcare tools and services. As of April 17, 2020, SARS-CoV2 is the pathogen causing the COVID-19 pandemic. The disease, which has touched practically every nation on earth, exhibits symptoms that are more typical of flu illnesses. However, this virus evolves quickly, with $8 * 10^{-4}$ changes per site and roughly one mutation every two weeks. Due to the ability of the viral species in bat cells, the refractory resistance of the bat, and the innate and adaptive immunity in bats, bats are good repositories for viral species. Although there are several barriers to viral spill-overs, they occasionally happen because of ecological opportunities for contact, cellular and molecular compatibility between the virus and host, and evaded immune responses. This has led to a significant number of bat-borne zoonotic viral spillovers. After rodents, which make up 20% of the diversity of mammals, bats are the mammal species with the greatest diversity. A diversified viral niche could be produced by the variety of bat species. Bats living in every region of the world contain viruses with all forms of genetic material according to the Baltimore classification. Therefore, a comparative examination of the SARS-CoV2 genome and proteome with those of other possible bat viral candidates that can infect humans may aid in the discovery of new therapeutic targets as well as vaccine epitopes. This chapter examines the sequence alignment of SARS-CoV2 and other viral species from the bat virome using EMBOSS online tools and phylogenetic analysis using MegaX software. We specifically highlight the principle, process, and applications in this chapter.

ARTIFICIAL INTELLIGENCE AND BIOINFORMATICS

It was formally established in 1956 that AI is the study of building intellectual machines. Whereas, bioinformatics solution typically entails the following essential steps:

1. Compiling statistical data on numerous biological topics.
2. Creating an algorithm or computational tool based on the data.
3. Run an algorithm simulation program on the statistical data.

AI can be used in the aforementioned phases to produce improved performance and obtain the optimized result [1]. The scientific community now has access to a greater variety of datasets thanks to the use of large databases and the expanding body of current knowledge on biological processes. This has made it possible to model and optimize jobs in various processes or to conduct an analysis to make it simpler to acquire relevant information [2]. The goal of bioinformatics is to create new techniques for logically analyzing enormous amounts of data. Algorithms based on AI applications make it possible to do molecular dynamic simulations, develop vaccinations for diseases, analyze molecular docking data, locate novel chemicals, detect ADMET features, and forecast in silico structure. These algorithms are employed to produce knowledge quickly [3]. AI strategy for protein structure prediction will have a substantial impact on bioinformatics research and development and offer a new framework for managing innovation in the biotechnology sector. The top methods now available for predicting the tertiary structures of proteins are examined in a large-scale study known as CAPSP [4].

Role of Bioinformatics in Healthcare

Data about healthcare comprises expense details, spending vouchers, reviews on patient care, medical data from various parts of the body, and cost information. Before bioinformatics, the telemedicine concept that uses electronic-based technologies to deliver medical care to those who live far away had usage in the field of medicine, including consultations, diagnostics, nursing, medications and treatments, psychiatry and psychology, rehabilitation, and some specialized services. Rural inhabitants who live distant from healthcare professionals can be connected through the use of telemedication [5]. With the use of computer techniques and technology, biological details are analyzed with the help of bioinformatics. Ailments like metabolic illnesses, kidney ailments, genetic disorders, and diseases can be discovered early on using bioinformatics techniques [6]. Bioinformatics has grown from providing essential services like sequence alignment, structural predictions, and phylogenetic analysis into a stand-alone, data-driven field. Future biological research will heavily rely on big data sets, of which we are only witnessing the tip of the iceberg. New potential calls for creative solutions that demand the capacity to deal with noisy, unstructured data to give relevant biological insights [7]. Bioinformatics uses computational software and methods to investigate massive biological data. The primary focus is on processing biological data for use in basic biological domains. Data analytics are being used in the healthcare sector to mine understanding and make informed decisions as a result of the data explosion [8]. Translational bioinformatics (TBI) grew in popularity in the early 2000s due to the Human Genome Project. TBI's primary goal is to provide personalized care with the capacity to combine biological data. It effectively speeds up drug development and re-purposing while causing the patient little long-term harm [9]. Genomic information reveals the inherited disease-causing components, which aids in the identification and treatment of diseases and disorders. The socioeconomic, medicolegal, and technical aspects of incorporating genetic data into healthcare raise several questions. Bioinformatics, a crucial integration component, presents a sizable number of unanswered problems [10]. Clinical bioinformatics delivers biological

CHAPTER 4

Detection of Breast Cancer Using Context-Aware Capsule Neural Network

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Abstract: Cancer is the second deadliest disease in the world. Breast cancer tops the list among the diseases affecting women. Specific strategies should be devised which will mitigate the effects of breast cancer. The risks can be mitigated if the detection takes place at an early stage. Early detection leads to improved outcomes, and survival remains a cornerstone of cancer control. Currently, mammograms are used to capture and observe the 2D nature of the tissues. 2D mammogram reports are used to train convolutional neural networks. 2D mammograms capture anterior and posterior images of the breast. These images, alone, are not sufficient to adjudicate whether the lump is benign or malign. Convolutional Neural Networks have attained great success in image classification, but they fail in some areas since they learn about the image statically. They do not take into consideration spatial information about the image and its sub-parts. There is no significant change reflected in the output if there is some alteration in the input. CNNs tend to lose lots of valuable information in the process of pooling. To overcome all these shortcomings, 3D data will be used to train the network, which captures all the orientations of the tissues. 3D mammograms, also known as tomosynthesis, are also very helpful for women who have concentrated dense tissues. Dense tissues make it difficult to locate the abnormalities. In addition to 3D data, clinical history, genomic information, and pathology reports have been taken into consideration. The amalgamation of the heterogenic data helps in the accuracy of the prediction because it will analyze all the contexts before arriving at a decision. Capsule neural networks have been used to overcome the drawbacks of convolutional neural networks. Convolutional neural networks require a lot of training data, which is not readily available. It takes a lot of time to train the model since the volume of data is huge. It is not capable of recognizing deformed objects in various orientations. Capsule Neural Network addresses all these issues and improves the performance reasonably.

Keywords: Capsule neural networks, Convolutional neural networks, Ductal carcinoma, Tomosynthesis.

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INTRODUCTION

Cancer is the umbrella term for the disease which includes abnormal and fast multiplication of cells in any organ and can spread to other body parts. Fast and prompt growth of abnormal cells may lead to a condition that does not allow the human body to function properly and may lead to tumors. Cancers can originate from cells of any body part and circulate to other body parts and cells. If cancer originates from the breast and spreads to the lungs, it is still called breast cancer. According to the World Health Organization report (WHO), cancer is one of the prominent causes of death worldwide [1]. As per the World Cancer Report given by the International Agency for Research on Cancer in 2020, the highest number of cancer incidences were related to breast cancer, contributing 11.7% of the total cancer-related incidences [2] as shown in Fig. (**1**).

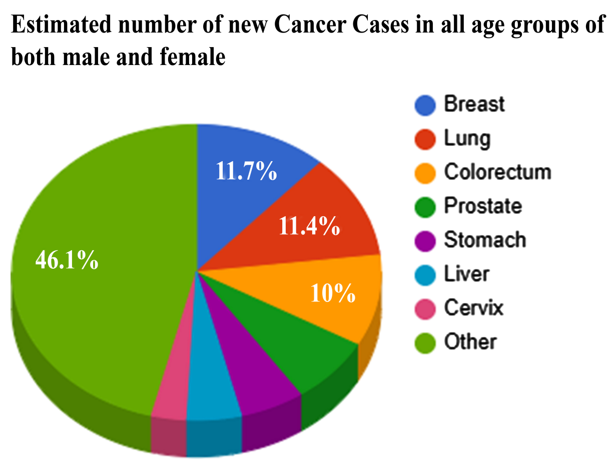

Fig. (1). Cancer incidence statistics for the year 2020.

When cancer cases are taken into consideration among both genders, statistics reveal that lung cancer takes the first rank followed by breast cancer in contribution to deaths as shown in Fig. (**2**). The most threatening cancer among women is breast cancer. It holds the top place in terms of incidences that occurred due to cancer as shown in Fig. (**3**). Women over the age of 50 are likely to have mutations in the breast cells. In conjunction with age, the communication between internal factors (genes) and external factors (carcinogens) is responsible for this abnormality. There are different types of breast cancers given below.

- Invasive Ductal Carcinoma
- Ductal Carcinoma *in Situ*
- Invasive Lobular Carcinoma

- Triple-negative Breast Cancer (TNBC)
- Inflammatory Breast Cancer
- Paget's disease of the breast

Among all types of breast cancers, Invasive Ductal Carcinoma contributes 80% of the total cases.

APPROACHES FOR BREAST CANCER DETECTION

Screening the woman's breast for the spotting of any abnormality before the symptoms are visible or once the symptoms persist. These imaging techniques help in the early and timely detection of the disease which improves the chances of survival. According to a meta-analysis of population screening trials reporting on randomized controlled trials, giving mammograms to women between the ages of 50 and 70 lowers breast cancer mortality by 20% [3]. 8 disease-specific deaths are prevented for every 1000 screened women, but 11 still pass away from breast cancer [4]. There is a need for timely detection of abnormalities which require proper screening techniques. The procedure starts with the physical examination of the patient followed by some routine tests, imaging tests, or biopsies depending upon the severity. Usually, the procedure involves:

- Blood tests
- Imaging modalities
- Biopsies

Blood tests for breast cancer detection include complete blood count (CBC), tumor markers, and protein tests. In this procedure, fluid from the suspected region is taken and examined microscopically. There exist a lot of procedures for biopsy ranging from needle biopsy, skin biopsy, incisional biopsy, or laparoscopic biopsy. Imaging modalities include:

- 2D Mammograms
- 3D Mammograms or Computed Tomography (CT) scan
- Ultrasounds
- Magnetic resonance imaging (MRI)
- Positron Imaging test (PET) Scan
- Thermography

Each of these techniques works well in specific conditions. They have their significance. Some techniques when used in conjunction with each other show promising results by early detection.

CHAPTER 5

Enhancement of Breast Cancer Screening through Texture and Deep Feature Fusion Model using MLO and CC View Mammograms

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Abstract: A common cancer subtype found in women with high mortality and occurrence rates is Breast Cancer (BC). BC ranks second among the causes of high mortality rates in women. The annual death rate due to breast cancer surpasses that of any other cancer type. The global survival rate for patients with breast cancer remains suboptimal. To enhance this survival rate, it is essential to implement intervention techniques for early detection and treatment. Screening using the Medio-Latera--Oblique (MLO) view and the Cranio-Caudal (CC) view improved the detection of cancer signs in small lesions. This motivated the radiologist to use both mammographic views for screening and subsequently to acquire additional information. To automate this sequential screening process, Image Processing, and Artificial Intelligence (AI) techniques are incorporated into these views individually and their results were fused. Further, feature fusion from both views is analyzed by researchers to enhance the overall performance of the system. The proposed model is more concentrated on the extraction and fusion of deep features from the two views to improve screening efficacy. The effectiveness of the proposed workflow is assessed on mammogram images taken from the MLO view and CC views of the DDSM dataset. Medical imaging data in conjunction with Machine Learning (ML) methods are employed for breast cancer (BC) detection and classification, but they tend to be time-intensive. Leveraging Deep Learning (DL) algorithms has the potential to further enhance the detection accuracy.

This work focuses on improving the detection performance by using a fusion of texture and Resnet 50 deep feature of MLO and CC view mammograms followed by Support Vector Machine (SVM) classification. An improved accuracy of 98.1% is achieved when compared to existing works. Henceforth, this work can be employed for the early BC diagnosis.

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Keywords: Breast cancer, Deep learning, Feature fusion, Detection, Classification, Accuracy, Mammogram, Texture, Deep features, Resnet 50.

INTRODUCTION

Breast cancer (BC) is a leading cancer subtype found in women worldwide with high incidence, survival risk, and mortality. BC is identified as the leading contributor to cancer-related fatalities in women, particularly in developing and underdeveloped nations, where the survival rate remains comparatively low. Hence, suitable intervention techniques in a primitive stage of the disease are essential to increase the survival rate. Imaging of the breast is usually called a mammogram. X-ray mammogram was used as a golden standard for screening. Though it is taken in different views, the Medio-Lateral-Oblique (MLO) view was used for screening in the early days. Later some time, it was evidenced that the inclusion of Cranio- the Caudal (CC) view in screening improved the detection of cancer signs in very small lesions. This subsequently motivated the radiologist to use both mammographic views for screening with additional information. To overcome the subjective results obtained from different radiologists, computer-assisted screening methods were introduced. Rapid advancements in ML and DL techniques have automated Computer Aided Detection (CAD) with reduced manual intervention. Incorporating double mammographic views in CAD methods would further improve the performance of the screening. Feature fusion is the most appropriate technique to combine the information present in both mammographic views. Feature reduction or selection is an important step to be performed before fusion to remove redundant and irrelevant features. Redundant features increase the computational complexity involved in the automated detection/diagnostic techniques. The irrelevant features lead to slow convergence in the classification procedure. Many texture features have been introduced to represent the presence of a tumor and are used to distinguish the malignancy from normal surrounding soft tissues. Deep features deeply representing the image characteristics could be extracted using neural networks with more layers. They provide a better representation of the information available in an image. Literature shows that the combined use of deep features and hand-crafted features would enhance the CAD system performance instead of using them separately for disease diagnosis. Hence, a fusion of texture and deep features extracted from multiple mammographic images would improve the screening performance further. Multilayer Convolutional Neural Networks (CNN) are the frequently employed architectures to extract deep features. Several Deep CNN (DCNN) architectures were proposed in the literature for deep feature extraction from images. Resnet is a popular architecture that gives better results for various real-time applications. This research study aims to increase the performance of the BC screening system using the fusion of mammographic features extracted from

MLO and CC view. Fusion of various textures and deep features extracted from both views followed by evaluation of metrics is experimented with in this work.

RELATED STUDY

Features extracted from the images usually represent the information available in those images. The fusion of two or more features was suggested in many literatures for the improved performance of a diagnostic system. Breast cancer screening by single-view CAD can be broadly classified into the following categories.

- Hand-crafted texture features are extracted and classified by ML algorithms.
- Deep features are extracted and classified through a pre-trained CNN model through Transfer Learning (TL).
- Deep features extracted from the pre-trained CNN model through TL and classified by ML algorithms.

To improve breast cancer screening, fusion methods at the feature level or decision level were proposed with single view/modality mammographic images and implemented in the literature as follows.

- Hand-crafted radiomic features derived from single-view images are fused and classified.
- Deep features obtained from one-view images through various pre-trained CNN models by the TL method are fused and classified.
- Deep features obtained from one-view images through various layers of a pre-trained CNN model by the TL method are fused and classified.
- Single-view hand-crafted radiomic features and deep features extracted from single-view images through a pre-trained CNN model are fused and classified.

For further enhancement of screening performance, features extracted from more than one view are combined and then classified. Many literatures addressed the fusion of hand-crafted radiomic features extracted from two or more view/modality images and showed improved performances. In addition to this, the fusion of deep features extracted from multiple views is also possible. Further, the fusion of both radiomic and deep features of multiple views/modalities is also possible for further improvement. Depending on the availability of datasets, the other features namely histopathological image features, gene expression features, and features extracted from clinically used data may also be combined with the above-mentioned features for further performance improvement. A feature fusion model to classify breast cancer subtypes was proposed in which the best features from clinical, gene expression, Copy Number Variations (CNV), and deep features extracted from histopathological images are fused. Different

CHAPTER 6

Artificial Intelligence Assisted Colonoscopy in Diagnosis of Colorectal Cancer

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Abstract: As medicine continuously evolves, recent advances such as Artificial Intelligence gain prominence for their potential role in enhancing routine clinical practice. One such application is its role in diagnostic colonoscopy to aid in the early detection of precancerous lesions and enable prompt management.

Keywords: Artificial intelligence, Colorectal cancer, Diagnosis, Oncology.

INTRODUCTION

Colorectal cancer (CRC) is a leading cause of cancer and cancer-related death affecting around 2.17 million people in 2019, 2.5 times higher than the number of cases in 1990 [1, 2]. Epidemiological trends demonstrate an alarming rise in CRC cases among younger adults of 50 years, which is frequently attributed to factors such as diet and lifestyle [2]. Over the past few decades, colonoscopy has gained wide acceptance as a modality for CRC screening. In addition to detection, colonoscopy can be utilized to resect adenomas, highlighting its partial therapeutic role as well [3, 4]. Traditional colonoscopies, on the other hand, are operator-dependent and have a highly variable adenoma detection rate (ADR) that ranges between 7% and 52%. Furthermore, previous research has revealed a 26% missing rate for neoplastic diminutive polyps and 3.5% for CRC [5 - 8]. As a result, it is critical to improve the efficacy and standardize the quality of colonoscopy to improve ADR for early CRC detection. In recent years, computer-aided detection (CADe) software, a component of Artificial Intelligence (AI), has

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been studied as an adjunct diagnostic and treatment enhancement to conventional colonoscopy for intestinal diseases [9 - 12, 14]. AI can help identify polyps that would otherwise be difficult to detect [13], segment, and classify pathologically [5, 15, 16, 17]. Furthermore, AI can speed up the process of optical biopsy characterization of detected polyps, lowering the rate of misdiagnosis.

In this context, AI can encourage the development of advanced diagnostic modalities with im- improved precision and accuracy that mimic human-level intelligence. Two core physical and virtual components of AI include machine learning (ML) and deep learning (DL) [21]. Convolutional Neural Network (CNN) is an immensely popular DL scheme that consists of a multilayer artificial neural network capable of improving image classification. This has resulted in the development of AI models that have improved surveillance, real-time screening, classification, image-based detection, and characterization of adenomatous and hyperplastic polyps, especially diminutive and flat polyp lesions which are often missed by conventional colonoscopy [21]. When compared to conventional colonoscopy, AI-assisted colonoscopy (AIC) has shown significant improvement in ADR, potentially resulting in early detection and timely management of precancerous lesions [18, 19, 20]. However, cost-effectiveness, a lack of health infrastructure, and training to support widespread implementation remain major concerns in cancer care. AIC has the potential to transform colorectal cancer care and prognostic outcomes with more research and better clinical guidelines. This chapter delves into the AI principle in diagnostic medicine, the role of AI in oncology, and the applications, limitations, and recommendations for AI integration in colonoscopy to aid in the early detection and management of CRC.

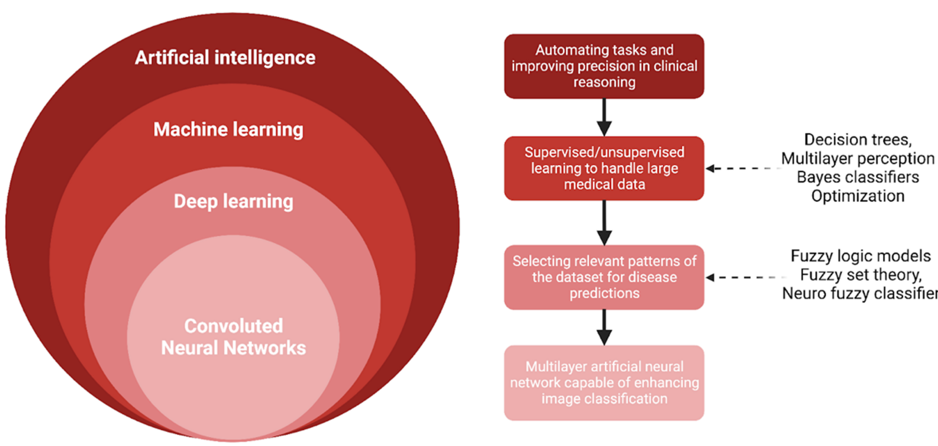

Fig. (1). Hierarchy of AI models and functions in clinical medicine.

OVERVIEW OF AI IN DIAGNOSTIC MEDICINE

Diagnostics is a complex process because diseases evolve, and physicians are constantly confronted with new challenges as a result of the healthcare system's dynamic and changing environment. An accurate and dependable diagnostic process is critical for time management. In this regard, AI can potentially enhance healthcare provision by improving clinical decision-making [22, 23]. Diagnosis is a patient-centered complex process that involves the collection of information and clinical evaluation to diagnose a patient's health problem through teamwork. Integrating AI in diagnostic processes can significantly improve care delivery and overall patient well-being by improving the process of identifying relevant medical data from multiple sources personalized to each patient and their management plans [22]. Hence, AI algorithms are gaining popularity among researchers for the early detection of various cancers [24].

ML is based on the principles of supervised (under the supervision of a human expert) and unsupervised (with little or no human intervention) learning, in which machines are directed to adopt a concept or theory through the formation of examples and pattern models that differentiate between two or more subjects. In medicine, ML aids in disease diagnosis by assisting in the handling of large and complex medical data. Several ML algorithms are used in the diagnostic process, including decision trees, support vector machines, and multilayer perceptrons, to name a few [25]. Various studies have investigated the application of machine learning models to detect heart diseases, coronaviruses, and diabetes (Fig. **6.1**). In their study, Bahaj *et al*. investigated various optimizations such as particle swarm optimization (PSO) and ant colony optimization (ACO), while another study conducted in China used a dataset from the city of Luzhou to predict and diagnose diabetes [26]. DL models mimic the operation of the human brain, generate patterns for decision-making, and solve problems from start to finish. They are known to produce higher quality and more precise results than ML models in medical science. DL, on the other hand, can enable the selection of the most relevant elements of the dataset, resulting in more accurate disease prediction [25]. A study investigating dermatological conditions implemented a back propagation neural network. Another study on the diagnosis of hepatic diseases caused by hepatitis utilizing recurrent neural networks (RNN) showed 97.59% accuracy. Similarly, other studies also used residual neural networks to diagnose other gastrointestinal pathologies [24]. Confusion is caused by the ambiguity and imprecision of the symptoms of various diseases, which poses a challenge to physicians, particularly those with limited experience; thus, fuzzy logic methods have been used to reduce ambiguity. These can provide prompt medical examination, which is especially useful in data analysis of infectious diseases

CHAPTER 7

Developing a Smart Device for the Manufacture of Healthcare Products for Patients Using the Internet of Things

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Abstract: The area for communication and networking, as well as the area for the body, and the Service Delivery Area, are the three key components that make up Smart Healthcare. In addition to enhancing the quality of medical care delivered by remote monitoring, this technology has the potential to cut the cost of a variety of medical equipment while simultaneously boosting their operational efficacy. Connecting the Internet of Things with Big Data and cloud computing has the potential to deliver answers to a variety of urgent problems that occur in real time when these technologies are used in conjunction with intelligent apps for healthcare. Cloud computing offers a collaborative environment for working with the Internet of Things (IoT) and big data as a result of its many applications. Big data is in charge of the data analytics technology, while the Internet of Things is in charge of the data source. Both of these facets are managed by the Internet of Things. An overview of healthcare analytics in an environment made possible by the Internet of Things is presented in this chapter. Topics covered include the advantages, applications, and issues associated with this field. The applicability of the framework is evaluated by real-time analysis of data provided by patients for automated management of the patient's blood sugar levels, body temperature, and blood pressure. Improvements have been made to the patient's health monitoring conditions as a direct consequence of the integration of the system. The technology notifies doctors and other medical professionals in real time about any changes that may have occurred in their health status to provide recommendations on preventative care. The efficiency of these kinds of systems is determined by the use of a wide range of technological approaches. In this study, we take a methodical look at the factors that led to the development of modern healthcare, including its origins, its methods, and its effects. An explanation of the chronological order of the procedures is provided. In the article, each stage of development is broken down and analyzed in terms of its social relevance, scientific and technical significance, communications significance, and application of information technology significance. A particular emphasis was placed on the technical component of the system, in particular, the application of network technologies and services, as well as the introduction of emerg-

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ing technology that consists of numerous factors, and assists us in the process of monitoring a person's status by providing us with useful information. Because of the widespread spread of COVID-19, health problems have emerged as a primary source of worry. A healthy population is required for the existence of a harmonious society. The foundation for a healthy society will be laid by forward-thinking healthcare in forward-thinking cities. Technology improvements in sensors and communication devices have resulted in the development of effective solutions in a variety of networking industries, public and private corporations, and government agencies throughout the world. In addition, the worldwide reach and efficiency of smart devices and mobile technologies have expanded thanks to the expansion of their use in the healthcare sector. Patient monitoring systems located at the bedside as well as patient monitoring systems located remotely are the two primary subtypes of patient monitoring systems that may be distinguished from one another. It is becoming more common for healthcare professionals to make use of such technology in clinical as well as non-clinical contexts. As a consequence, major advancements have been made in the field of healthcare. In a similar vein, untold numbers of normal operators benefit from M-Health (Mobile Health) and E-Health, both of which use information and communication technology to sustain and improve. Through the use of an ontology-based survey, the researchers expect to be able to follow the participants' health over time and make suggestions for routine workouts. This project's primary emphasis is placed on the creation of the findings of the MAX30100 sensor, the MLX sensor, and the digital BP sensor after they have been combined into a single kit, as well as on the integration of these three sensors into the kit. The results of the temperature, blood pressure, SpO_2, and heart rate monitoring are concurrently shown on the LCD and in the mobile app as normal or abnormal readings. The device is also capable of displaying a person's overall health status. The comparison of all four threshold values brings in this result, which may either be normal or abnormal depending on the circumstances.

Keywords: IoT healthcare, M-health, Mobile technology, Smart healthcare system, Smart device.

INTRODUCTION

The Internet of Things (IoT) has taken over the business world, and its applications are quite diverse. They include everything from transportation and agriculture to healthcare services. The environment of a hospital may be rather stressful, especially for senior patients and children who are still young. Because of an increase in the total number of people in the world, the typical patient-doctor visit is no longer practical. Because of this, having educated healthcare becomes necessary. At each stage of a patient's life, from the monitoring of an infant's temperature through the monitoring of an elderly patient's vital signs, intelligent healthcare may be implemented. Users of smart healthcare are empowered to handle some emergency circumstances on their own. It places a focus on enhancing the user's quality and experience. Utilizing the resources that are available to the fullest extent is made possible by smart healthcare. It helps with patient monitoring from a distance and lowers the user's treatment costs. Additionally, it makes it possible for medical practitioners to spread their services to patients located in other countries. In light of the rising trend toward smart cities [1], an effective and innovative healthcare system is essential to ensuring that its citizens continue to lead healthy lives.

The corporate world has been dominated by the Internet of Things (IoT), and its applications are quite diverse [2]. They include everything from transportation and agriculture to healthcare services. The environment of a hospital may be rather stressful, particularly for elderly patients and young patients who are still young. due to a rise in the population as a whole in the world, the typical patient-doctor visit is no longer practical. Because of this, being educated about healthcare becomes necessary. At each stage of a patient's life, from the monitoring of an infant's temperature to the monitoring of an elderly patient's vital signs, intelligent healthcare may be implemented. Users of smart healthcare are empowered to handle some emergency circumstances on their own. It places a focus on enhancing the user's quality and experience. Utilizing the resources that are available to the fullest extent is made possible by smart healthcare. It helps with patient monitoring from a distance and lowers the user's treatment costs. Additionally, it makes it possible for medical practitioners to spread their services to patients located in other countries. In light of the rising trend toward smart cities [1], an effective and innovative healthcare system is essential to ensuring that its citizens continue to lead healthy lives. The term Internet of Things (IoT) refers to a system in which common objects are capable of identification, measurement, networking, and processing. Not to mention, devices made possible by the Internet of Things will be all-pervasive, conscious of their surroundings, and able to understand ambient intelligence. Before the Internet of Things can be widely utilized, several tough problems must be answered, as well as social and technological nodes that must connect. The medical and healthcare industries are among the most promising for Internet of Things application development [6]. The Internet of Things has the potential to give birth to a broad range of medical applications. In addition, The Internet of Things can identify the optimal times to replenish the supply of different sorts of devices. The fact that they can run their business without interruptions or problems is the evidence of their achievement. The Internet of Things also makes it possible to schedule limited resources in an effective manner, which ensures that those resources are put to their greatest use and can attend to a greater number of patients. The figure presents some recent developments in the healthcare industry. It is a crucial trend to enable patients, clinics, and healthcare organizations to communicate with one another in a way that is both cost-effective and easy while maintaining a secure connection. Wireless technology will make it possible for contemporary healthcare networks to assist in the early diagnosis of chronic conditions, ongoing observation of

CHAPTER 8

Blockchain Security in Healthcare

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Abstract: The most liked blockchain healthcare application at present is safeguarding our critical medical data. There are many security issues that the healthcare sector must deal with. Between July 2021 and June 2022, 692 significant healthcare data breaches were revealed. The thieves grabbed information from banks, credit cards, health data, and genomic tests. Data on the blockchain is incorruptible, decentralized, and transparent, which makes it perfect for security applications. Furthermore, blockchain protects the confidentiality of medical data by being transparent and private, hiding anyone's identity with intricate and secure algorithms. Patients, medical professionals, and healthcare providers may simply and securely exchange the same information thanks to the technology's decentralized nature. Blockchain applications enable the accurate identification of medical errors, including risky ones. Blockchain technology significantly contributes to the handling of fraud in clinical trials. In this case, the technology may increase data efficiency in the healthcare sector. By supporting a distinct data storage pattern, the system can aid in preventing data manipulation in the healthcare industry. It guarantees adaptability, connectivity, accountability, and data access authentication. The confidentiality and safety of health records are essential for different purposes. Healthcare data can be digitized and protected in a decentralized manner with blockchain technology.

Keywords: Blockchain, Decentralization, Healthcare, Interconnection, Security.

INTRODUCTION

Blockchain technology is presently being explored in a range of different industries, but it has already made significant headway in the healthcare sector. The fact that data is kept utilizing a cryptographic hash is what contributes to blockchain's rising popularity. Blockchains are immutable, dependable, and decentralized. Several important paradigm shifts have been brought about by the adoption of blockchain technology in the healthcare industry's commercial and

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governance sectors. A recent study by Markets and Markets predicts that by 2022, the global market for blockchain technology in the healthcare sector will be worth more than USD 9.5 billion [1]. This growth may be attributed to the rising demand for secure and open data exchange in the healthcare sector. By using blockchain technology, the healthcare sector can reduce fraud prevent data breaches, and improve interactions between insurance providers and physicians on the cryptocurrency market. The growing demand for secure and transparent data exchange in the healthcare sector is the primary driver of the adoption of blockchain technology in this sector. For the transfer of medical records, the use of blockchain technology provides a platform that is secure and decentralized. It will help to reduce the likelihood of fraudulent activity, lessen the risk of data breaches, and improve the standard of care given to patients [2]. The application of blockchain technology in the healthcare business will help the sector as a whole save money and become more efficient. One day, the adoption of blockchain technology might make medical processes more efficient and do away with the need for middlemen. It will enhance patient care while also assisting in bringing down the overall cost of healthcare. The increased interest large healthcare organizations are demonstrating in utilizing the technology is another significant element influencing the growth of blockchain technology in the healthcare market. Major players in the healthcare sector, including IBM, Microsoft, and Oracle, are investing in blockchain technology to create healthcare systems that are effective and safe. It will aid in the expansion of blockchain technology used in the healthcare industry. Another key barrier to the use of blockchain technology in the healthcare sector is data privacy. Health-related data must be protected because it is sensitive and personal [3]. Even while blockchain technology provides a platform that is secure and decentralized for the exchange of healthcare data, there are concerns about how data will be stored and made available on the network. This critical concern, which is shared by many healthcare companies, must be addressed before blockchain technology can be widely used in the healthcare industry. Lack of knowledge about blockchain technology in the healthcare sector is a significant barrier to the development of blockchain technology [4]. Since the blockchain is a young technology still in its infancy, many professionals working in the healthcare industry are ignorant of its potential applications in the industry. By providing a platform that is secure and efficient for the exchange of patient data, blockchain technology is triggering a revolution in the healthcare industry. This will help to reduce costs and raise the standard of care given to patients [5]. It is projected that the increased use of blockchain technology by significant healthcare organizations will fuel the rise of technology in the healthcare sector.

PRIVATE BLOCKCHAIN NETWORK

The patient's medical record history may be located using this contract, which contains a list of references to PPRs. In the system that is being suggested, a patient-oriented medical record categorization structure is being built. Every record may be thought of as a PPR-based smart contract. Fig. (**1**) depicts the organizational plan for the medical records to be kept. Fig. (**2**) presents an example of the deployment of a private blockchain network, which is used for the level of care. The principal private blockchain network may be deduced from the shown solid lines [6]. The important network devices are usually maintained by medical centers or hospitals, and the dispersed databases must be synced among all of them. The only thing the clinics need to do to keep their databases up to date and accurate is to synchronize with the blockchain network nodes that are located nearby. Patients who have inquired about their medical records and sent their data requests to the blockchain network are shown by the lines with dots. In this scenario, it is the responsibility of the key blockchain network nodes (for example, the medical center or hospital) to deal with the requests since the network equipment at these locations is equipped to handle the significant network traffic that is caused by a large number of requests. As the most important node in the blocks [7].

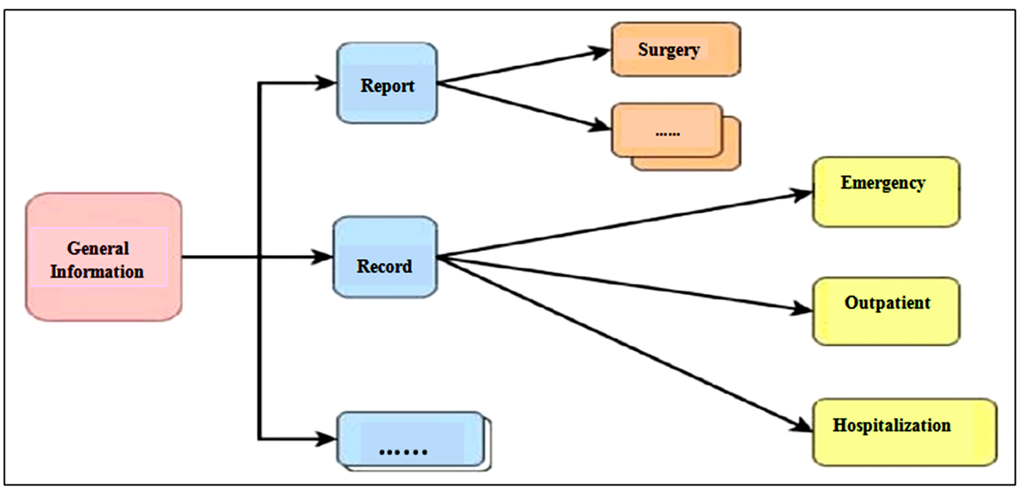

Fig. (1). An example of the personal medical record that is being proposed.

A revolutionary, decentralized technology called blockchain shields data against illegal access.

The management will be pleased with the patients after smart contracts are

CHAPTER 9

Enhancing the Communication of Speech-Impaired People Using Embedded Vision-based Gesture Recognition through Deep Learning

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Abstract: Communication between people is the key to delivering a message. It is easier for normal people to have a communication medium (language) known between them. A person with speech impairment or hearing difficulty cannot communicate with others like a normal human. Sign language helps people with disabilities to communicate with each other. In sign language systems, there is no de facto standard followed by all the countries in the world. It is not easy to get recognized using sign language alone. Hence, recognition systems are required to improve their communication capabilities. The rapid growth in the field of Artificial Intelligence motivated us to build a gesture recognition system based on machine learning and/or deep learning techniques for improved performance. In this chapter, an image-based recognition system for American Sign Language (ASL) is designed using 1. Hand-crafted features classified by Machine Learning algorithms, 2. classification using a pre-trained model through transfer learning and 3. classification of deep features extracted from a particular layer by machine learning classifiers. Among these three approaches, deep features extracted from DenseNet and classification using K-Nearest Neighbor (K-NN) yield the highest accuracy of about 99.2%. To make this system handy, low cost, and available to needy people, the Resnet 50 model is deployed in a Raspberry Pi 3b + microcontroller.

Keywords: Speech impaired, Artificial intelligence, Communication, Deep features, Gesture recognition, Machine learning, Transfer learning, Deep learning.

INTRODUCTION

Speech is an invaluable gift to human beings. Speech in one's mother tongue is essential for communicating with others and understanding the needs of elders, children, and the disabled. Speech impairment and inability to make sounds may

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cause loneliness, fear, inferiority complex, anticipatory anxiety, unemployment, and difficulty in leading a regular life. Approximately 18.5 million people are affected with any disorder. 10% to 15% of children with age between 3 – 5 and 6% of school-going students have communication disorders. In India, nearly 5 million people have communication disabilities. As a result, an alternate mode of communication must be provided for those suffering from speech impairment to overcome difficulties and improve their quality of life. The advancement of technology and the development of artificial intelligence may provide a solution for developing Assistive Technology (AT) for the speech impaired. Sign language is a visual replacement for speech communication in which information is conveyed through body movements, hand gestures, and facial expressions. There is no universal sign language worldwide. Hence, a common, unique way of interpretation is necessary for learning and understanding sign language. There comes gesture recognition, a computer-based perception system. Sign Language Recognition (SLR) systems are divided into two types: vision-based and non-vision-based approaches. Non-vision-based techniques are generally cost-effective and are designed using sensors. The sensors include flex sensors, accelerometer sensors, electromyography sensors, and so on. The sensors are made to be embedded in a hand glove and the sensor values collectively represent a sign. The disadvantage of using this technique is that the sensors cannot be synchronized together to represent a sign. This reduces the recognition accuracy in detecting a gesture. On the other hand, vision-based techniques overcome this synchronization problem. Vision-based systems generally use high-quality cameras and help in effectively identifying the sign. Vision-based techniques are driven by image data which contains many images for each sign. Owing to the performance improvement in Machine Learning (ML), Deep Learning (DL), and Transfer Learning (TL) the proposed work focuses on the same for enhancing the recognition accuracy in gesture-based recognition systems. The key contributions of the proposed chapter are:

- Performance comparison of sign language recognition using 3 different approaches.
- Three different approaches using Machine Learning, Deep Transfer Learning, and Deep feature extraction techniques are explored to improve the performance of the gesture recognition system.
- Local Image and texture features are classified using SVM and KNN classifiers. Feature reduction using PCA is also analyzed to enhance accuracy.
- Four Transfer Learning (TL) models such as Resnet50, Densenet, Efficientnet, and Mobilenet are experimented on an augmented dataset to obtain improved performance.
- Deep features extracted from the global pooling layer of the above TL models are classified using SVM and KNN classifiers.

- A comparison of the above models is also presented based on the performance metrics such as accuracy, Precision, Recall, and F1-score.
- Deployment of the Resnet 50 deep transfer learning model in a Raspberry Pi 3b+ microcontroller for sign language recognition. Building a low-cost hardware device helps in the recognition of sign language in real-time.

RELATED STUDIES

Literature review studies focusing on the machine and deep learning methodologies for gesture recognition systems are presented. Further, the microcontroller implementation of the machine learning models and assistive technology used in gesture recognition is also detailed. Deep learning systems based on CNN and Transfer learning for the recognition of sign language are experimented with to improve the recognition accuracy [1, 2]. To evaluate the performance of this system, the training and testing is done using VGG11 and VGG16. The scale transformation of the model was found to be invariant [1, 2]. A hand-gesture-based recognition system on the ASL dataset is experimented with in real-time through images captured by a webcam. A Visual transformer Model was used for the recognition of 29 static gestures from the ASL data set [3]. An assistive system was proposed to help the deaf and dumb people [4]. Gesture image recognition combining the concept of embedded system and image processing is proposed. This system converts an image of a gesture into speech. The Raspberry Pi is used to perform the conversion. The long-term Recurrent Convolutional Network LRCN technique is used to process gesture picture recognition [5]. A gesture recognition technique developed is based on CNN with a double channel. In the region considered for the recognition, first pre-processing is done, followed by denoising, and edge detection on the source gesture images. The input to CNN is edge-detected gesture images. The number of convolutional layers and parameters in each channel is identical but each has its weight. Finally, at the full connection layer, feature fusion is conducted, and the classification of the output is done using the softmax classifier. This algorithm has a recognition rate of 98.02 percent, which is greater than other CNN models [6]. To address the issues of dynamic ASL identification, the work proposed in [7] uses 3-D CNNs, a successor to CNN that can recognize patterns in volumetric data such as videos. The proposed work's computing time is 0.19 seconds per frame.

A wearable surface electromyography biosensing device is used [8]. This system uses a hyper-dimensional neuro-inspired computing approach for classification in real-time, as well as training the model and updating it under multiple postures of the arm and sensor replacements. The system is developed for 13 gestures in which an accuracy of over 97% was achieved. When the number of gestures is increased to 21, the accuracy is about 92.87%. A real-time ASL-based sign

CHAPTER 10

Advancing Data Science: A New Ray of Hope to Mental Health Care

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Abstract: Mental health care has unique challenges and needs, unlike other medical fields. Complex biopsychosocial causation of psychiatric disorders demands advanced computational models for scientific probing. Artificial intelligence and machine learning (AI/ML) are showing promising leads in improvising psychiatry nosology, which in the current state lacks biological validity. Increasing mental health care needs can be addressed only with the appropriate use of advancing technologies. Increased accessibility to personal digital devices demonstrates the scope for sensitive behavioral evaluation amidst gathering large amounts of data. Patterns in, thus acquired, digital phenotypes can be effectively evaluated only through big data analysis techniques. This has the potential to open newer avenues of preventive as well as therapeutic psychiatry. Unique legal and ethical conundrums in clinical and research domains of psychiatry arise while managing one of the most vulnerable populations with health care needs, who may often approach facilities in a state of illness, unawareness, and diminished decision-making capacity. Secure blockchain technology amalgamating with AI/ML can enhance the applicability in such conditions in improving compliance, individualizing treatment, and enhancing research without compromising ethical standards. AI/ML is hoped to guide Interventional psychiatry, an evolving promising field that relies on neuroscientific approaches using multimodal data and neuromodulation techniques. The current chapter reviews the contributions of AI/ML and blockchain in various mental healthcare system domains; and proposes its potential in many other uncharted territories in this field.

Keywords: Artificial intelligence, Biology, Block chain, Environment, Machine learning, Privacy, Psychiatry, Personalisation.

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INTRODUCTION: AI AND MENTAL HEALTHCARE

Data is the new oil. Like oil, data is valuable, but if unrefined, it cannot be used. It has to be changed into gas, plastic, chemicals, *etc*. to create a valuable entity that drives profitable activity. So, data must be broken down, and analyzed for it to have value was famously quoted by an American data scientist Clive Humby. The quote beautifully captures several critical dimensions of the use of data; first the “data valuable only if refined” emphasizes the importance of “clean” data; the need for smart intelligent systems (Artificial intelligence) to analyze and make sense of this data; and the most important aspect the “profitable aspect”, that is given the potential value it brings an entire ecosystem needs to be present for ethical distribution across socioeconomic strata and systems (blockchain technology) need to be present to look at safety needs. In this chapter, we discuss and attempt to shed some light on each of these important dimensions of the use of data in the field of mental healthcare and what the future might hold for it.

Table 1. Donabedian framework for quality of healthcare exemplified for mental healthcare.

Sl. no	Framework	Description	Examples
1	Structure	Looks at the adequacy and quality of available resources for the delivery of mental health care.	Availability and accessibility of mental healthcare facilities, training facilities for mental healthcare personnel, infrastructure availability, and mental healthcare policies.
2	Process	Are evidence-based processes of care being delivered?	The process of care delivery can include documentation, unmet needs in mental health care, regularity of follow-ups, *etc*.
3	Outcome	What are the clinical outcomes given the healthcare delivery, and how are these outcomes assessed?	Suicidal rate, hospitalization rate, functional recovery, employment status, *etc*.

The World Health Organisation in its latest report on mental health care mentions that one in every eight individuals worldwide lives with a mental health disorder and globally, there are significant gaps and imbalances in information and research, governance, resource, and service allocations. Further, it mentions utilizing digital solutions involving new technologies, like AI as one of the potential foundations to drive the change in improving mental health care (WHO, 2022). To appreciate the value that the new age data systems can bring to improve mental health care, we first need to discuss the current scenario of mental healthcare delivery and how good it is in terms of quality of care. Although there has been a lot of effort to develop and implement good health care service delivery indicators, a recent study reported that even high-income developed countries find it hard to implement systems that measure and inform on the quality of mental health care delivered (Lima *et al*., 2021). Donabedian gave a framework (Donabedian, 1988) for quality of care describing the healthcare delivery systems. It includes three parts: structure or organization of care, the

process of care delivery, and the outcome that is being achieved with the above structure and process of care in place (Table **1**).

Related Studies - The Structure of Care

Globally half of the world's population resides in places where there is just one psychiatrist available for every 2 million people. On average, countries invest less than 2% of their healthcare budgets on mental health with gross variability of how the mental health budgets are utilized resulting in striking differences in the care that is received. In middle-income countries, more than 70% of the mental health expenditure is spent on psychiatric hospitals rather than community-based care, and in low-income countries, there is a scarcity of availability of basic psychotropic medications [1]. Similarly, in Europe and other developed countries community-based model of mental health care has proven to be beneficial. This makes it evident that one model of care does not work for every place, it is important to study and understand what model of care works in what conditions (also known as built environment) and how a system needs to be built to optimize the availability of the best care based on the local socio-demographic scenario.

So, one of the core aspects of mental health research and treatment involves understanding the disease processes in the context of its environment, studying a built environment (that encompasses the physical and socio-economic aspects) can give vital information to design innovative systems that can optimize healthcare delivery, the major challenge in doing so is the multivariable aspect of the built environment. Several studies have attempted to explain the link between mental health outcomes and the built environment, for example physically deteriorated neighborhood and their impact on the prevalence of depression has been reported [2, 3]; similarly specific characteristics of the built environment such as staying in deck access homes (homes without recreational spaces) [4] and restricted access to green spaces [5] have also been linked to the prevalence of depression. Most of these studies are limited by their methodological approach in parsing the complex multi-variable interactions, failing to capture the nonlinearity in the data and the inter-relationships of multiple dimensions in health outcomes. It is here that recent advances in big data analytics using AI can be leveraged to better understand the complex interplay linking built environments. A multi-level scenario-based predictive analytics framework (MSPAF) is one such AI-driven solution proposed to analyze and study these complex links, in its preliminary findings it suggested that declining socio-economic conditions of the built

CHAPTER 11

Machine Learning-Based Methods for Pneumonia Disease Detection in Health Industry

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Abstract: Due to partial medical facilities accessible in some developing nations such as India, early disease prediction is challenging. Pneumonia is a deadly and widespread respiratory infection affecting the distal airways and alveoli. Pneumonia is responsible for high mortality rates and short- and long-term mortality in persons of all age groups. The spread of Pneumonia mainly depends on the immune response system of human beings. The symptoms of Pneumonia vary from person to person and also on the severity of this disease. In the 21st century, Artificial Intelligence (AI) is recommended as one of the early-stage disease diagnosis methods. This chapter discusses the uses of one of the AI subdomains, which Machine learning challenges and issues that researchers face while diagnosing early-stage pneumonia disease.

Keywords: Artificial intelligence, Diagnosis, Deep learning, Machine learning.

INTRODUCTION

Machine learning is considered a trending field in the field of information technology. We already use Artificial Intelligence in various scientific areas, such as weather forecasting, information analysis, *etc*. Similarly, these techniques can be used for disease prediction such as type 1 and type 2 diabetes, Pneumonia, heart-related diseases, and many more. There are many examples in which disease forecasting can be done, but still, there is room for improvement in accuracy [1]. Machine Learning contribution is an improvement in the area of artificial intelligence. As this uses previous data, it can match human intelligence [2]. Its contribution mainly enhances the recognition and classification system used in di-

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sease prediction. Under its self-adaptive proficiency, many applications exist for learning terminology in healthcare, data analytics, gameplay, information data retrieval, stock market exploration, data and text pattern recognition, and pattern matching [3]. The proposed research work in this chapter emphasizes Pneumonia prediction using a Machine learning approach. Other challenges and issues that other researchers face while diagnosing Pneumonia using machine learning are discussed. This chapter also contributes to the introduction of lung and lung diseases. Along with this, a detailed contribution of artificial intelligence to machine learning is also provided.

Problem Outline

Today, Pneumonia can be considered a life-threatening disease. The risk of Pneumonia is massive, especially in South Asian countries. Poverty and pollution are two major concerns for its widespread use. According to a World Health Organization report, more than 4 million premature children die yearly due to Pneumonia. On an annual basis, many children under the age of 5 get infected [4]. The problem can worsen in the sub-continent due to shortage and lack of doctors and supporting staff. So, the diagnosis of Pneumonia should be as early as possible, or else it can create serious problems [5]. A respiratory infection causes Pneumonia. It affects people mainly living in undeveloped countries. Pneumonia can cause pleural effusion in which the lungs could be filled by liquefied material. So, early and accurate diagnosis is required for better results. As the highly contagious nature of this disease, proper isolation is necessary to control this disease. Its symptoms can affect the multiple organs of a human rapidly. So, deep learning-based models can be used to detect the disease for betterment of results [6]. In terms of percentage allotment, the Indian cases are almost forty percent as compared to globally. Pneumonia could be termed a silent killer due to its high mortality rate. The reason for its spread globally is poor education and inappropriate childcare. In today's world, AI-based subdomain fields are essential for detecting Pneumonia from medical images [7].

Anatomy of Human Lung

The primary responsibility of the lungs is to deliver oxygen to the blood. Alveoli carry out this task. It is a single-cell membrane that permits the exchange of gas. Two types of organs also assist with inhalation and exhalation, respectively [8].

The anatomy of the lungs consists of three different parts having different surfaces and borders. Apex is placed over the first rib. The additional three border surfaces are inferior, anterior, and posterior. The lung's anterior part is squeaky and can split the lung base from the surface area. The rear area is dense and can be protracted, as shown in Fig. (**1**). Lung surface consists of different surface types that include the costal part, medial and diaphragmatic. The cover of the coastal region is enclosed with costal pleura and is beside the ribs and sternum. This joins the anterior and diaphragmatic area at the inferior edge. To separate anteriorly and posteriorly, medial surface area is used. To the sternum, the anterior part is connected, and the vertebra part is connected to the posteriorly. The base of the diaphragmatic surface is concave and lies on the diaphragm vault. Due to the presence of the liver, the position of the right dome is higher than that of the left crown.

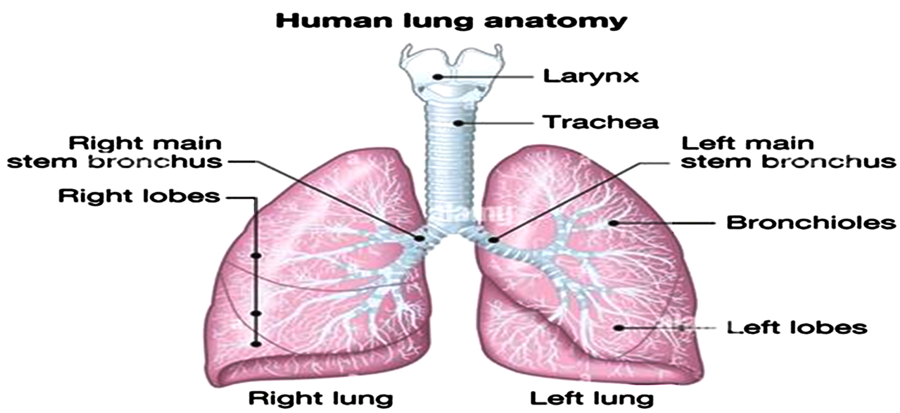

Fig. (1). Anatomy of the human lung [8].

Lung Disease Types

Lung disease is a disease of the lungs in which the lungs cannot function correctly. There exist mainly three main types of lung diseases.

1. Airway Diseases: Airways are the tubes that transmit oxygen and fumes that the lungs can pump. These diseases could block our airway path. Asthma, COPD, and bronchiectasis are all airway diseases. The most common symptom people feel is difficulty breathing, such as taking air through a straw.
2. Lung Tissue Diseases: These diseases affect the lung tissue structure. Tissues get inflamed, due to which the lungs are not able to expand fully. Because of this, the lungs cannot inhale oxygen and exhale carbon dioxide appropriately. Its symptoms include being unable to breathe correctly. Examples of lung tissue diseases are pulmonary fibrosis and sarcoidosis [9].
3. Lung Circulation Disease: Blood vessels in the lungs are affected by Lung Circulation disease. The main reasons for this disease are clotting, inflammation, or scarring of blood vessels. Again, the lungs become ineffective in inhaling and exhaling correctly, and this disease affects the working of the

CHAPTER 12

Framework towards Smart Healthcare Tourism Based on the Internet of Medical Things (IoMT)

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Abstract: COVID-19, or Corona Virus Disease, has developed as a global epidemic, affecting nearly every country. Infected humans are multiplying at an exponential rate throughout the planet. With such many patients, healthcare facilities are in high demand. Although every government is putting up considerable effort to combat the epidemic, a lack of medical facilities, particularly in highly populated countries such as India, poses a significant issue. The fear of a pandemic has trapped everyone in residences, wreaking havoc on various industries. Pandemics are wreaking havoc on the hotel and tourist industries. Smart healthcare tourism is the newest IoT-based healthcare tourism application to gain traction. This paper outlines an Internet of Things-based health monitoring system that may be helpful for foreign visitors and hotel management throughout maintaining the health of both its guests and staff. The system will identify and examine the body's many vital signs before telling the operator the condition of each person's health. The study focuses on the application of IoT technology, which includes wearable sensors, to monitor health eminence, identify sickness, and provide online well-being facilities for the health tourism industry.

Keywords: COVID-19, Internet of things (IoT), Innovative healthcare, Medical tourism, Pandemic.

INTRODUCTION

The world is dealing with a significant epidemic caused by a coronavirus known as Covid-19. The virus infects many people, and because it is a contagious disease, it spreads quickly. According to an early study, a single individual may infect about 2-2.5 individuals [1]. According to a recent study, one person can in-

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fect between 4.2 and 6.49 additional persons [2]. There are, therefore, contaminated individuals everywhere, which strains the medical system. According to the WHO, there are 6,663,304 infected people worldwide, with 392,802 deaths [3]. Due to the extraordinary demand, any country's healthcare system will struggle to cope with many patients demanding medical assistance. Many affluent nations, including the United States, China, Russia, and England, are experiencing a scarcity of medical facilities, such as ventilators, intensive care units, and personal protective equipment (PPE) necessaries that could be given to Coronavirus-infected patients. Given these circumstances, it is clear that an emerging nation like India, which has an enormous population but few health clinics, would need more healthcare services. In addition to endangering global health, Covid-19 has a massive effect on the worldwide economy. So, each industry, including the auto industry, aircraft manufacturers, tourist industry, oil industry, food sector, health sector, and others, experiences losses.

IoMT could be very important in this critical setting. Wearable health sensors and remote monitoring technologies can transfer some of the burden from physicians to homes or quarantine facilities. IoT-based healthcare providers (referred to as IoMT) give patients direct access by reviewing the information generated by WBAN sensors online. The patient may indeed be prescribed medication despite constantly contacting the premises if there is a mechanism to detect disease in its earliest stages related to health issues and send the data to doctors or hospitals. 60% per cent of countries employ telehealth to replace direct patient visits to hospitals, as per WHO research [4]. This article suggests a healthcare strategy for Indian medical tourism based on the Internet of Things as a consequence. The approach would help healthcare practitioners manage the enormous number of patients visiting hospitals for coronavirus screening.

The portions of the paper are as follows: The COVID-19 illness, its clinical symptoms, and preventative strategies are introduced in Section 12.2. Section 12.3 discusses Indian health tourism; Section 12.4 discusses the Internet of Things; Section 12.5 presents the healthcare structure in IoT and its significance to the COVID environment; Section 12.6 shows the suggested framework; Section 12.7 presents the framework debate, including Section 12.8 on the study's findings.

COVID-19 DISEASE SYMPTOMS AND PREVENTIVE MEASURES

Coronavirus, caused by SARS-COV-2, infects the nose, upper throat, and sinuses. Pericardial effusion shock, the common cold, influenza, acute respiratory syndrome (SARS), spread Of bacteria, and other ailments are all brought on by the bacterial illness. Other symptoms in some patients include pharyngitis (sore throat), myalgia (muscle pain), headache, and shortness of breath (Fig. **1**). Few people have symptoms such as nasal and conjunctival congestion, nausea, and diarrhea [5]. According to the WHO, secretions produced by coughing spread coronavirus across human to human [6]. These drops have a maximum range of 1.8 metres (or 6 feet). According to the WHO, the bulk of infected people suffer from mild to severe breathing difficulties and improve even without any exceptional treatment. Youngsters, pregnant women, and aged people who suffer from conditions like diabetes, cardiovascular diseases, and lung issues are particularly prone to COVID-19 [7]. Asymptomatic, minimal, moderate, severe, then critical are the five categories into which COVID-19 sufferers are categorized. Most countries only admit patients with severe disease-related sicknesses to address healthcare facility concerns. Patients with minimal symptoms can get care in the home, and moderate cases might not always require treatment unless they rapidly deteriorate [8, 9, 10]. According to WHO figures gathered from China, only 15% of diseases require oxygen, and only 5% require a respirator. The other 80% of instances are trivial or symptomless [11]. In Italy and Spain, roughly 40-50 percent of corona victims were brought to hospitals, with 7-12 percent of cases requiring admission to intensive care units (ICUs) [12]. The emergence of a novel strain (n COV-2) speedily increases the process of healthcare frameworks, impeding their ability to provide aid to individuals with COVID-19 infection and those with other medical conditions.

Symptoms: The primary signs and symptoms of a viral assault include heat, sore throat, chest discomfort, shortness of breath, exhaustion, nausea, anxiety, and chills, occasionally accompanied by trembling, body pains, loss of sensibility of smelling and tasting, and diarrhea.

Preventive Measures: The proper working of a person's immune system is crucial. The immune system is the sole mechanism in the human body that protects it against sickness. We will only become sick with a robust immune and functional digestive system. As a result, this is one method through which we avoid becoming infected with Coronavirus. Ayurveda can boost the body's defence and keep it healthy. As a preventative treatment for front-line personnel and affected patients, ashwagandha and perhaps other Ayurvedic drugs, including Guduchi, Yasthimadhu, or Peepli, are already being studied by the Ministry of AYUSH and indeed the CSIR in India [12]. The disciplined approach of the AYUSH system concentrates on boosting immunity *via* healthy living, diet, and preventative care (Fig. **2**) [13]. With an emphasis on lung diseases, the Ministry of AYUSH offers various recommendations that may help with adaptive immunity, including preventive health practices [14, 15, 16].

CHAPTER 13

Unmasking the Sentiments of People Towards Pandemic: Twitter Sentiment Analysis in Real-Time

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Abstract: Social media provides a wealth of user-generated data, including ratings and comments on various causes, products, diseases, and public policies. A new field of text mining called sentiment analysis uses a variety of techniques to filter out people's moods and emotions. The World Health Organization (WHO) has declared COVID-19 a pandemic, and people worldwide are fighting for their lives. As a result, people experience various physical and mental problems such as fear, anxiety, irritability, and unhappiness. This study uses sentiment analysis to examine how individuals feel about the COVID-19 epidemic affecting Indians. Tweets were collected from January 2020 to March 2020. Data have been extracted from Twitter using TweepyAPI, and Numpy, Pandas, and Matplotlib perform analysis based on subjectivity and polarity. Through an automated system, we analyzed the tweets and categorized them into three categories: positive, negative, and neutral. From our analysis, we discovered that initially, people started putting negative tweets, but over time, people's sentiments changed to positive and neutral comments. The results from the study concluded that initially, the situation was terrible and tragic, but with time, people were able to handle the situation. They got accustomed to a new lifestyle following measures to prevent infection from the COVID-19 virus.

Keywords: COVID-19, Polarity, Subjectivity, Sentimental analysis, Social media.

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INTRODUCTION

Facebook, Twitter, and YouTube are just a few examples of social media sites that significantly impact people's daily lives. Social data, as it is commonly called, is a vast collection of information. Social media provides a massive opportunity for people to freely discuss their views and opinions on the events and happenings of everyday life within our societies and communities. Accordingly, it has immense potential value for researchers and entities willing to keep an eye consciously on the heart of both public well-being and social issues. The coronavirus pandemic, known as COVID-19, began to erupt in Wuhan, China, at the end of 2019. It still exists worldwide, including in India and is one of the most conversed and increasingly contagious and infectious diseases worldwide. There are a vast amount of unknowns and unexpected facts as a result of the COVID-19 epidemic. In a short period, many unseen and unanticipated events occurred, and the government was required to take quick action to halt the widening of the coronavirus. According to the World Health Organisation (WHO) statistics, while we are analyzing and studying, more than 20000000 people have been infected with the disease, and over 157000 people have lost their lives worldwide (WHO – World Health Organization, 2020/4/20).

From the above statistics, it has been observed that this is one of the country's most contagious and affected virus outbreaks so far. Analyzing real-time social media data from social media platforms can help authorities and medical staff make the best choices at the right time and understand the sentiments and feelings of the public. Owing to the extreme unfamiliarity of the coronavirus pandemic, the precise outcomes and consequences have yet to be researched effectively. This is true regarding its medical effects and effect on people's attitudes and opinions. Initial studies on the impact of the coronavirus pandemic on people's lives have been published [1], but such studies are based on surveys and polls which are generally limited to a relatively small number of respondents. However, social data through social media platforms provide extensive user-generated messages and discussions reflective of users' attitudes, moods, and perceptions. The novelty of this study is an innovative approach integrating a laterally concurrent Twitter to keep an eye on classification to identify and track people's behaviour towards COVID-19 by categorizing their sentiments, analyzing them, and visualizing them to get an idea of people's reactions towards the current pandemic situation. It would assist medical practitioners and government officials to make the best decision to accommodate the feelings and reactions of the public.

RELATED STUDIES

Various academicians and scholars use attitude analysis on community media platforms like Twitter in literature; some crucial studies have provided support for analyzing user behaviours and circumstances in the different events happening worldwide. Herewith, a few essential research papers are embraced in this section. The majority of operations and enterprises have been impacted by the coronavirus epidemic, not just in India but in all of the afflicted nations worldwide. Sentiment analysis was an excellent method for analyzing and figuring out the scenario. The news in the print media and television may need to be on time in giving the sentiments and opinions of the citizens. Still, social media provides instant insights into people's sentiments and views at the moment [17]. Such statements and user posts on various social media platforms are considered sentiments for the analysis. Monitoring issues related to public health concerns expressed on digital platforms and social media through the internet have explicitly been very significant in examining the public perception regarding several diseases, like H1N1 influenza [5], Zika virus [9, 20, 26] and Ebola virus [12 - 27]. Numerous studies have trusted and counted on data derived from the Twitter platforms and examined it from the initial stages of the COVID-19 pandemic. A study that emphasized the existence of stress in students because of the COVID-19 pandemic and the shutting down of educational institutions revealed that students were very concerned about their studies throughout the pandemic and the incarceration at home. Such a situation resulted in emotional and psychological stress, including anxiety, phobia, depression, social disconnection and so forth [4]. Effective communication during health crises can mitigate public concern and promote the acceptance and implementation of significant risk-alleviating behaviours. Getting the most out of their interactions requires public health organizations and decision-makers to consider what talking points best address the needs of their Twitter followers, according to research focusing on the essence and engagement of COVID-19 tweets [25]. The coronavirus pandemic has impacted business operations and procedures in all affected nations, and many are experiencing financial difficulties [14]. As a result of the novelty of the scenario, several scientists working in related disciplines are trying to find a strategy to treat and stop the pandemic [12, 23].

The coronavirus epidemic is causing the airline sector to experience a comparable recession and financial crisis, and many of them have laid off staff to address the problem [8, 15, 21, 24]. According to the analysis of people's sentiments and opinions regarding coronavirus disease, interesting results appear in positive, unbiased, and negative emotions over distinct visualizations [6]. To achieve the objective, Twitter API was used for social data collection regarding the coronavirus pandemic, and then analysis was done with the help of machine

CHAPTER 14

Application of Industry 4.0: AI and IoT to Improve Supply Chain Performance

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Abstract: Today's companies acknowledge the importance of Artificial Intelligence and IoT (- Internet of Things) to achieve quality and operational efficiency in supply chain performance. Numerous elements, such as shifting demands, routes, severe disruptions, and compliance problems, continuously impair supply chain systems. As a result, supply chains need to be monitored and continually optimized. And that's why we needed advanced technologies like Artificial Intelligence and IoT in the supply chain process. The vision of Industry 4.0 emphasizes global machine networks in an innovative factory environment capable of exchanging information and self-monitoring. Supply chain resilience can be increased by utilizing AI and IoT technologies, often known as AIoT, which have recently been essential in enhancing supply chain performance. This study investigates the potential effects of Industry 4.0 and related technology advancements, such as Artificial Intelligence and IoT, on Supply Chain (SC) performance. Through an exploratory study, our research will assess the impact of AI and IoT on the efficiency of the industrial supply chain. This study aims to shed new light on the subject and offer suggestions for further research.

Keywords: Artificial intelligence, Healthcare, Internet of things (IoT), Industry 4.0, Supply chain management.

INTRODUCTION

Artificial Intelligence (AI) has become a mainstream technology in the business world, with 86% of CEOs reporting its adoption in their office in 2021. Leading businesses have also shown a substantial investment in AI, with 91.5% continuing to invest in it continuously. The use of AI in organizations is expected to increase customer satisfaction by 25% by 2023, according to Gartner. According to McKinsey, businesses face several risks that must be addressed as they continue to adopt AI [1]. The first risk is Cybersecurity, as the deployment of AI may introduce new vulnerabilities in the organization's systems. To address this risk,

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companies must ensure proper cybersecurity measures [2, 3] are in place to protect against potential threats. The second risk is compliance, as the use of AI may lead to legal and regulatory issues. Companies must ensure that their use of AI complies with existing laws and regulations, particularly in areas such as data privacy, bias, and discrimination. The third risk is explainability, which refers to the ability of companies to understand and explain how their AI systems make decisions. This is particularly important for businesses operating in highly regulated industries, as they may be required to justify the decisions made by their AI systems. Companies must ensure their AI systems are transparent, auditable, and explainable. Finally, personal privacy is another critical risk associated with the use of AI. Companies must ensure their AI systems do not infringe on individuals' privacy rights, particularly in data collection, retention, and sharing. To address these risks, McKinsey urges companies to prioritize Cybersecurity, compliance, explainability, and personal privacy when deploying AI. By prioritizing these areas, businesses can mitigate the risks associated with AI and unlock its full potential to drive growth and innovation. Major corporations like IBM and Google are leading the way in advancing AI's future development. IBM has significantly improved its Watson AI platform by enhancing natural language processing. IBM is also looking into the possibilities of fluid intelligence, a more sophisticated use of AI that mixes diverse knowledge to address challenging issues. The authors discuss the limitations of conventional supply chain management and emphasize the transformative potential of data analytics. In addition, they evaluate the role of Artificial Intelligence and its capacity to process large amounts of data while acknowledging obstacles such as data quality and security concerns [4]. The article emphasizes the significance of adopting these technologies to maintain competitiveness and achieve business success during the fourth industrial revolution [5]. A study conducted a systematic review of 107 studies on AI and ML applications in supply chain management [6-8, 36]. The studies were categorized into five themes, and the authors analyzed the AI and ML techniques employed and their benefits and drawbacks. In addition, the article identifies future research directions, such as investigating the integration of AI and ML with other technologies and investigating the ethical implications of AI and ML in supply chain management [9 - 17]. The article provides valuable insights into AI and ML's potential to enhance supply chain efficiency and sustainability [18, 19]. Consequently, this study offers insights into AI by comprehensively analyzing the relevant literature on artificial intelligence, SCM, and IOT published in scholarly journals like Scopus. The methodology is founded on reviews that have received considerable attention in the field of Artificial Intelligence for supply chains [20-28]. The purpose of this research review is to (a) Identify notable previous contributions to the fields of AI and SCM from journals included in Scopus' index, (b) Categorize articles based on various characteristics, and (c) Identify voids in the existing literature. It is necessary to systematize the existing literature to address identified research gaps, which will increase and support the long-term effectiveness of AI and IoT in SCM. To answer the general research questions, a review research is necessary regarding the development and design processes. In addition, the initiative intends to provide significant research insights into how Artificial Intelligence and the Internet of Things may enhance supply chain management efficiency. This chapter attempts to emphasize the development and progress of research on numerous aspects of a theme, subject, or topic, as well as the evolution of the subject and any research gaps. Based on the above issue, the Research Questions (RQ) for the study are as follows:

- RQ1: What is the significance of AI and IOT in the SCM?
- RQ2: What challenges and issues does an organization face when implementing AI and IOT in Supply Chain Management?
- RQ3: How has the central theme of AISCM evolved?

The whole research is based on secondary data and divided into four sections. In section 14.2, we discussed the topic and its evolution from literature reviews; section 14.3 describes the data collection method and research design or layout; section 14.4 elaborates on results; and section 14.5 concludes the chapter.

Related Studies

The entire research relies on secondary data. A review of the literature reveals themes and topics associated with Artificial Intelligence, the Internet of Things, and Supply Chain Management (Table **1**). The data was extracted from Scopus between the years 2006 and 2022.

To track the evolution of the research domain, the quantity of research publications published over time is displayed initially. Its purpose is to monitor the development of supply chain research utilizing applications of Artificial Intelligence (AI) and the Internet of Things. The expansion of supply chains using Artificial Intelligence and Internet of Things methodologies has recently been observed to involve both academics and practitioners. Fig. (**1**) presented below shows publications pertaining to Artificial Intelligence, the Internet of Things, and Supply Chain Management as a function of time. This graph illustrates the evolution of Artificial Intelligence, the Internet of Things (IoT), and Supply Chain Management research from 2016 to 2022.

SUBJECT INDEX

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