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A Survey on Smart Healthcare System Using Blockchainand Machine Learning

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Abstract:- In the dynamic landscape of healthcare, the fusion of blockchain and machine learning has emerged as a potent force for revolutionizing data security, interoperability, and decision-making processes within Smart Healthcare Systems. This survey paper conducts a systematic review of existing literature, spanning academia and industry, to comprehensively explore the current state of this integration. It elucidates the essential components of smart healthcare systems, emphasizing the central roles of data management, security, and interoperability, while unveiling the intricate challenges and future prospects. The survey underscores the pressing need to address data security and interoperability issues and highlights the potential of blockchain and machine learning to enhance decision-making in the healthcare ecosystem, making a significant contribution to this evolving field and guiding future research and innovation.

Keywords:- *Blockchain, Machine Learning, Healthcare, Security, Ethereum, Smart Contract, Electronic Health Records, e-Health, Permissioned Blockchain, Decentralized Database.*

I. INTRODUCTION

With the revolution of the medical infrastructure in the recent years, the smart healthcare system has been paid more considerable attention. Smart healthcare is a novel concept that refers to a set of rules that integrate prevention, diagnosis, treatment, and management. Different from traditional medical systems, smart medical systems can connect and exchange information at any time and place. Compared with traditional medical treatment, smart healthcare has the characteristics of preventability, immediacy, and interconnection of information. Through wireless network, using portable mobile devices, medical staff can constantly perceive, process, and analyse major medical events (preventability).

Doctors can grasp the case information of each patient at any time and quickly develop a diagnosis and treatment plan (immediacy).

Medical personnel can log in the medical system anywhere to inquire about medical images and medical advice and patient's referral information can be accessed at any hospital through the medical network (interconnection of information). These functions are supported by new digital technologies. Blockchain follows absolute privacy rules to identify users related to transactions.

It is mainly used for the management of information systems to help achieve secure storage, transactions, process automation, and other applications. ML is the leading technology for performing complex analysis, intelligent judgment, and creative problem solving in healthcare. Today we have enormous amount of data available in every sector, with the advent of technology available, it is possible to provide solutions to many problems. It provides solutions to the problems related to healthcare data management using Machine Learning and Blockchain. Extracting only the relevant information from the data is possible with the use of Machine Learning. This is done using trained algorithms. Once this data is stored, the next problem is Data sharing and its reliability. This is where Blockchain comes into picture. The consensus in Blockchain technology makes sure that data is legitimate and transactions are secure. Blockchain technology can potentially change health care management for the better by placing patient at the epicentre of the healthcare system and increasing the privacy and interoperability of health data. Generally, previous studies related to application of digital technologies in smart healthcare domain were limited to

study in one field or one country. No studies have mapped the current status of these two technologies in the medical field. Also, there is no relative study that specifically addresses the relationship between authors, affiliations, keywords, and the hotpots of the research.

In the past five years, the study of smart healthcare has attracted extensive attention from scholars of a series of disciplines, which requires us to integrate the viewpoints of scholars of different disciplines and study the status to seek deeper discoveries.

Therefore, this research proposed portraying the status of application of two types of digital technologies, Machine Learning and Blockchain, in smart healthcare studies by bibliometric visualization. In this survey, we have found a comprehensive review on the application of ML and Blockchain techniques in the healthcare sector. We analyze the research status in terms of countries, institutions, publication volume, authors, journals, sponsors, and subject areas. In addition, this paper subdivides the main application scenarios of the prior art in the medical field. Our research will provide healthcare practitioners with an insight to keep Machine Learning and Blockchain technologies fully utilized. Finally, we analyse the latest research trends based on Machine Learning and Blockchain technology in order to provide a research direction for future research.

II. HEALTHCARE

In the realm of healthcare, the landscape of data management and accessibility is undergoing a transformation, yet several challenges persist. A significant disadvantage lies in the fragmented nature of healthcaredata, often stored in various databases on the cloud. These databases contain critical medical information such as lab tests, imaging results, and a patient's medication history, but the lack of a unified system for accessing these data securely and conveniently remains a pressing issue [14]. While many healthcare departments have transitioned from manual record-keeping to computer-based systems, which undoubtedly reduces the labor and time associated with data retrieval [16], a critical gap remains. Patients still face the inconvenience of physically visiting healthcare facilities to access their own data, a process that can be time-consuming and inefficient. The need for a more accessible, patient-centric approach to healthcare data management is becoming increasingly evident as we seek to enhance the overall healthcare experience.

III. MACHINE LEARNING IN HEALTHCARE

In recent years, the integration of machine learning techniques in healthcare has opened up a wealth of possibilities to enhance patient care and disease management. Machine learning's potential in this domain is vast, including its ability to identify treatment options, offer personalized recommendations, and predict disease outbreaks. One of the promising applications of machine learning is in providing disease summaries based on the symptoms entered by patients. These summaries are generated through processes such as tokenization, stop word removal, and stemming, contributing to more efficient healthcare delivery [10].

Several machine learning techniques, such as Support Vector Machine (SVM) classifiers, Naive Bayes, and Decision Trees, have been employed to achieve this, with remarkable results - some achieving an accuracy percentage of up to 98.51%. Moreover, machine learning algorithms have the capacity to provide lifestyle suggestions to patients, taking into account their current medical situation and historical health data. They can also be harnessed for predicting future health outcomes [11]. For example, the combination of neural networks with SVM has been utilized to forecast outbreaks of diseases, like malaria in Maharashtra State, leveraging factors such as rainfall, temperature, historical cases, and other medical details to make predictions. However, despite these remarkable advances, a major challenge faced by researchers in this field is data acquisition.

The process of obtaining appropriate and comprehensive healthcare data is often an arduous endeavor, and the lack of such data can limit the efficiency and accuracy of machine learning models [6].

As the field of healthcare continues to embrace machine learning, addressing these challenges and pushing the boundaries of what is possible will be pivotal to realizing the full potential of this technology in revolutionizing patient care and public health.

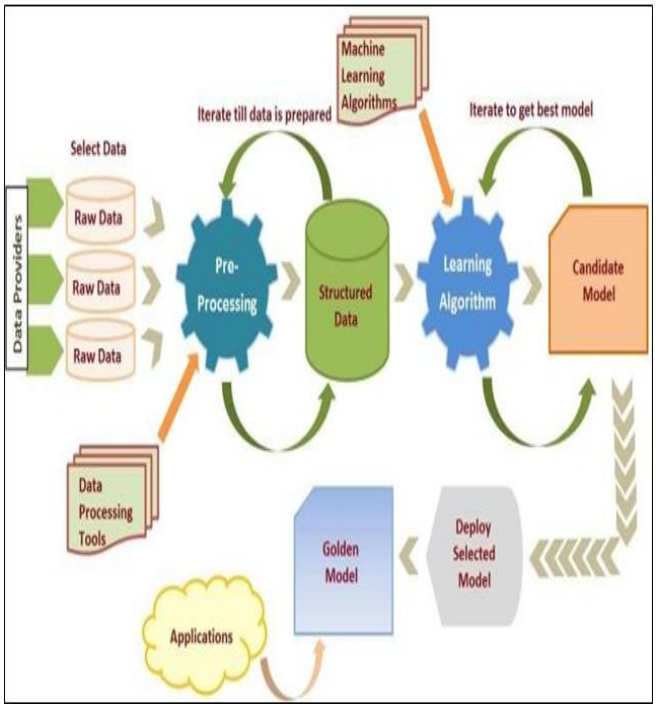

Fig 1 Machine Learning Process

IV. ARTIFICIAL INTELLIGENCE

Artificial intelligence and machine learning are witnessing a remarkable proliferation in the field of medicine, particularly in areas that heavily rely on various forms of biomedical imaging. This holds especially true for medical disciplines where diagnostic procedures involve the collection and analysis of vast datasets comprised of digital images. The integration of machine learning techniques into the processing of medical images has shown great promise, yielding consistent and highly accurate reporting.

This research paper delves into the application of machine learning algorithms specifically aimed at processing chest X-ray images, with a primary objective of aiding healthcare professionals in the diagnostic decision-making process. The focus of this investigation is on leveraging deep learning algorithms, notably convolutional neural networks (CNN), to construct a robust processing model. This model assumes a pivotal role in addressing a critical classification problem: the accurate identification of chest X-ray images exhibiting patterns indicative of pneumonia, as well as classifying these images into two distinct groups based on the outcomes of this detection process. The adoption of deep learning and CNN-based models in this context represents a significant advancement in the realm of medical image analysis. These models excel in their ability to recognize subtle and complex patterns within chest X-ray images, which are often challenging for human observers to discern. By facilitating the differentiation of X-ray images into pneumonia-consistent and non-consistent categories, this research aims to augment the diagnostic capabilities of healthcare providers, enhancing both the speed and precision of pneumonia detection. This application of AI and machine learning showcases their potential to revolutionize diagnostic procedures, providing an invaluable tool for healthcare practitioners while paving the way for further advancements in the field of medical imaging and healthcare. The results of this research have the potential to significantly impact patient care and contribute to the ongoing evolution of medical technology.[17]

V. LITERATURE SURVEY

[3] The synergy of Machine Learning and Blockchain technology in healthcare. It emphasizes the significance of data quality and reliability for Machine Learning's accuracy and decision-making capabilities. The decentralization and security features of Blockchain are highlighted as essential components in ensuring data reliability. The survey reviews previous research in this domain, covering applications of Blockchain in healthcare, including protecting patient privacy, preventing fraud, and enabling secure data sharing. It discusses the shift from public to private Blockchain networks and their role in facilitating information exchange among healthcare entities. The survey also touches upon the challenges of data acquisition in Machine Learning and suggests how Blockchain can solve these issues by providing high-quality, reliable data to train models. Lastly, the potential of combining Machine Learning and Blockchain for healthcare applications is explored, including lifestyle recommendations, disease prediction, and equipment maintenance. The survey highlights the promise of this integration for enhancing healthcare services and patient care.

[16] The convergence of Machine Learning and Blockchain technology in the healthcare sector, focusing on the need for secure data management, challenges in healthcare data handling, and the potential advantages of this integration. It touches on supervised and unsupervised learning techniquesin medical data analysis and emphasizes the significance of data security in improving patient care. The survey highlights the potential for more accurate predictions and secure data access, offering substantial benefits to healthcare providers and patients. [1] In this paper they explores the convergence of Internet of Things (IoT), Blockchain, and Machine Learning in the context of Smart Healthcare. It emphasizes the significance of remote monitoring and data sensing using wearable devices and bio-sensors to provide efficient and timely healthcare services. The survey highlights how Blockchain technology is utilized for secure data storage and access control, ensuring data authenticity and privacy. The use of Machine Learning is discussed for anomaly detection in patient data. The framework addresses the challenges of trust, security, and data authenticity in healthcare data. Overall, it outlinesa comprehensive solution to enhance the efficiency and reliability of healthcare services.

[20] It discusses the implementation of a Blockchain-based Electronic Health Record (EHR) framework to address common issues in medical services, such as data privacy, accessibility, and interoperability. It highlights the key features of EHR, reasons for adopting Blockchain in healthcare, and introduces the Hyperledger Fabric as a suitable platform. The proposed system aims to provide secure access to patient data, allowing stakeholders like patients, doctors, hospitals, and insurers to interact through a distributed ledger. The features of the proposed system include time-limited access, privacy through zero-knowledge proof, compatibility with various health applications, and improved quality outcomes.

[17] The application of machine learning, specifically Convolutional Neural Networks (CNNs), in processing chest X-ray images to support the diagnosis of pneumonia. Pneumonia is a respiratory infection, and X-rays play a crucial role in its detection. This study utilizes a dataset of chest X-ray images, employs data preprocessing techniques, and builds a CNN-based deep learning model to classify images as either showing changes consistent with pneumonia or not. However, the paper acknowledges the need for more extensive datasets, further research, and the involvement of medical specialists for robust disease diagnosis. The utilization of deep learning in medical image analysis is a rapidly evolving field and holds significant potential for improving diagnostic accuracy.

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[21] The development of a Clinical Decision Support System (CDSS) for Chronic Obstructive Pulmonary Disease (COPD) using various Machine Learning techniques. The motivation for such a system arises from the challenges in diagnosing COPD, which is often underdiagnosed due to factors such as late visits to doctors and complex diagnostic procedures. The CDSS aims to provide quicker and more accurate diagnosis and treatment strategies for COPD patients. It utilizes Support Vector Machines, Neural Networks, and Decision Trees as part of its Machine Learning framework. [] Machine learning can be used to classify lung sounds, which could be used as a tool to help diagnose lung diseases. Support vector machines and decision trees are the most accurate machine learning methods for this task. Seven diagnostically valuable parameters of lung sounds can be used to train machine learning models.

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Table 1 Survey Table of Research Reviewed

Year	Author	Techniques Used	Features	Application	Challenges Addressed	Outcomes
2021	N .V. Pardakhe,V .M.Deshmu kh[16]	Machine Learning(Su pervised and Unsupervise d) Blockchain	Focus on need of machine learning and blockchain techniques , Using Supervised and Unsupervise d Methods	Enhance the interoperability by handling and maintaining distributed data on cloud	To Enhance the security of the data stored on cloud.	Machine learning and blockchain technology makes it possible to make accurate estimations or predictions about future results .
2021	Vardhini B, Shreyas N Dass, Sahana R, Dr.R. Chinnaiyan[20]	Blockchain(Smart Contracts)	Focuses on The likelihood of representingmedical records to make sure data privacy, data accessibility and interoperabil ity.	It maintains a sharable digital format across multiple organizations	As it is possible to distinguish the people engaged in the transactions it endangers their confidentiality and secrecy.	Adopting Electronic HealthRecord solves thesignificant issuesof authority and accessibility
2021	Luka Racic, Tomo Popovic, Stevan Cakic, Steven Sandi[17]	Deep Learning, ConvolutionNeural Network	Convolution Neural Network is used for Disease Detection.	The prediction model can be potentially used asa decision supporttool by the medical specialists for diagnosing the patient.	Data cleaning and accurate image collection.	The model accuracy is found to be 90%, and it can be used as a decision support tool by the medical specialist.
2019	Pronaya Bhattacharya, Sudeep Tanwar, Umesh Bodkhe, Sudhanshu Tyagi, Neeraj Kumar[19]	Blockchainbased DeepLearning asa Servie	It operates in two phases, first is signature and authentication and second is deep learning as aservice	It provides a trust and interoperability among all the stakeholders	It does not provide riskanalysis of the application.	Integrating DL and blockchain to securely store the patient EHR data and provides future predictions based on past repositories
2019	Sonali Vyas , Mahima Gupta , Rakesh Yadav [3]	Permissioned Blockchain and Decentralized Databases.	Use of Permissioned Blockchain and its various components and use of SVM, Decision Tree classifier.	The trained modelcan predict the outbreak and it can also predict the need to	In permisssioned blockchain there may be uncertainties in providing permission access and for predicting lifespan of a	Machine Learning models can directly fed with data for better accuracy and blockchain increases efficiency and

				change/remove the machine or a part of machine.	machine we will need real time access and data feeding.	security.
2017	Anna Poreva, Yevgeniy Karplyuk, Valentyn Vaityshyn[18]	MachineLearning	Machine Learning is used for classifying lung sounds.	Lung Disease classification based on lungs sound	The use of bayes classifier does not give better results.	The greatest accuracy of the right decisions was obtained from SVM and Decision Tree classifiers.
2017	Sudhir Ankal, Sandhya P[21]	Machine Learning (Classifier Assemble Methods,SV M,Neural Network , Decision Trees)	Clinical Decision Support System for Chronic Obstructive Pulmonary Disease.	Clinical Decision Support System which helps the physician to provide better andeffective diagnosis and treatment.	The Patients do not visitthe doctors for treatment which directly affected data accumulation .	Clinical Decision Support System helps the medical specialist for diagnose of the disease and the system classifies the different stagesof Chronic Obstructive Pulmonary Disease. And alsohas a quit smokingtest.

VI. BLOCKCHAIN IN HEALTHCARE

In the realm of healthcare, blockchain technology has emerged as a revolutionary system that has garnered the attention of both users and technical experts in recent years. This technology, known for its transparency and distributed nature, is primarily employed to fortify the security of highly sensitive data [16]. In a blockchain network, every user is granted an authorized certificate from a Certificate Authority, which serves as a digital identity [3]. This digital certificate plays a vital role in ensuring the legitimacy of transactions within the blockchain.

It enables users to sign and submit their transactions securely, offering multiple benefits. Firstly, it authenticates that the user initiating or requesting a transaction is indeed a legitimate participant in the network. Furthermore, it ensures that the user possesses the necessary rights to access the ledger for the specific transaction they are conducting. For instance, in the case of a patient, they would obtain a certificate from the relevant authority, allowing them to access their own healthcare details while maintaining strict limitations on their access to other patients' information. This robust system of identity verification and access control not only bolsters the security of sensitive medical data but also preserves the privacy and confidentiality of individual patient records [3].

VII. CONCLUSIONS AND FUTURE WORKS

In conclusion, this survey has unveiled emerging trends and opportunities that point toward a promising future for healthcare. The convergence of blockchain and machinelearning with cutting-edge technologies such as the Internet of Things, edge computing, and 5G networks is poised to ignite a new era of healthcare innovation. These developments are set to create more interconnected, data-driven, and secure smart healthcare systems, poised to transform healthcare delivery and enhance patient outcomes. Furthermore, as these technologies evolve, they will empower healthcare professionals with enhanced diagnostic and predictive capabilities. Machine learning algorithms can analyze vast datasets to detect patterns and anomalies, aiding in early disease detection and personalized treatment plans. Blockchain's security features will ensure the integrity and privacy of patient data, instilling trust in patients and healthcare providers.In the near future, we can anticipate greater patient involvement in their own healthcare management. Patients will have secure, real-time access to their medical records and treatment recommendations, promoting transparency and patient-centered care. Telemedicine and remote monitoring will become more efficient, allowing patients to receive high-quality care without the need for frequent in-person visits, particularly important in times of public health crises.As we move forward, addressing challenges such as data standardization, interoperability, and ethical considerations will be paramount. Collaboration among stakeholders, including researchers, healthcare providers, policymakers, and technology innovators, will be crucial in realizing the full potential of smart healthcare systems.In summary, the integration of machine learning and blockchain in smart healthcare systems has the potential to be a game-changer for the healthcare industry, equipping healthcare providers with the tools needed to deliver more efficient, secure, and patient-centered care. By actively addressing challenges and fostering ongoing collaboration and innovation, we inch closer to realizing the vision of smart healthcare systems. This progress has the power to enhance the well-being and healthcare experiences of individuals on a global scale.

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