International Journal of Interdisciplinary Innovative Research & Development (IJIIRD)

ISSN: 2456-236X

Vol. 10 Issue 01 | 2025

Integrating Internet of Things Blockchain and Deep Learning for Secure and Efficient Healthcare

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DOI: 10.5281/zenodo.15751564

ABSTRACT

The integration of advanced technologies such as Internet of Things, blockchain and deep learning holds significant promise for revolutionizing supply chain management within the healthcare sector. This paper proposes a novel framework that combines these technologies to enhance the efficiency and security of healthcare supply chains. By leveraging the decentralized and immutable nature of blockchain, the framework ensures data integrity and traceability. Simultaneously, deep learning algorithms provide robust predictive analytics for early disease detection. Nowadays, machine learning (ML) has attained a high level of achievement in many contexts. Considering the significance of ML in medical and bioinformatics owing to its accuracy, many investigators discussed multiple solutions for developing the function of medical and bioinformatics challenges using deep learning (DL) techniques. The importance of DL in Internet of Things (IoT)-based bio- and medical informatics lies in its ability to analyze and interpret large amounts of complex and diverse data in real time, providing insights that can improve healthcare outcomes and increase efficiency in the healthcare industry. Several applications of DL in IoT-based bio- and medical informatics include diagnosis, treatment recommendation, clinical decision support, image analysis, wearable monitoring, and drug discovery. The review aims to comprehensively evaluate and synthesize the existing body of the literature on applying deep learning in the intersection of the IoT with bio- and medical informatics. In this paper, we categorized the most cutting-edge DL solutions for medical and bioinformatics issues into five categories based on the DL technique utilized: convolutional neural network, recurrent neural network, generative adversarial network, multilayer perception, and hybrid methods.

Keyword Blockchain Deep Learning, Internet of Thing, Healthcare etc.

INTRODUCTION

The healthcare business is changing a lot because new technologies like Blockchain, Artificial Intelligence (AI), and Machine Learning (ML) are being used. These improvements are changing how medical data is kept, accessed, and used. This is leading to better outcomes for patients, more accurate diagnoses, and more efficient medical research. But traditional healthcare systems still have a lot of problems, such as weak data security, healthcare providers that can't talk to each other, and people getting into private patient information without permission. In traditional systems, centralized databases are often open to cyber threats, data breaches, and delays, all of which can put patient privacy and trust at risk. Also, different healthcare institutions store data in different ways, which makes it harder for information to flow smoothly and speeds up the evaluation and treatment processes. Blockchain technology has become a hopeful way to deal with these important problems. Blockchain protects medical data from beginning to end because it is decentralized, can't be changed, and is cryptographically safe. It allows for permanent record-keeping, which stops any illegal or fraudulent changes to patient information. Additionally, blockchain's ability to allow hospitals, study groups, and patients to share data in a safe and open way promotes greater interoperability and improves teamwork in healthcare. This Article looks at how blockchain could be used to find diseases and keep an eye on people's health in real time, especially when combined with AI-powered testing systems. Medical workers can find diseases earlier, make better decisions, and keep data safe by using blockchain's security features along

with AI and ML's predictive abilities. When AI, machine learning, and blockchain work together, they create a big change in healthcare. In the future, patient records will be safe, diagnoses will be faster and more accurate, and medical data will be available while still being safe.

Blockchain technology is transforming the healthcare sector by offering safe, decentralized, and transparent data management solutions. The growing dependence on digital medical records, AI-based diagnostics, and interoperability among healthcare providers has heightened the necessity for stringent data security and privacy safeguards. [1] Blockchain guarantees immutable storage of medical data, mitigating the danger of data breaches, unauthorized alterations, and fraudulent actions. This article explores the disruptive impact of blockchain on disease detection, highlighting its integration with artificial intelligence (AI) and machine learning (ML) for early and precise diagnosis. Blockchain improves data integrity by utilizing decentralized ledgers, guarantees real-time access to verified medical records, and enables secure exchange across hospitals, research institutes, and patients. We investigate the uses of blockchain in early disease detection, namely in diagnosing severe health diseases such as cardiovascular disease, diabetes, renal disorders, and hepatic malignancies. AI-driven medical imaging and predictive models, integrated with blockchain technology, facilitate a more dependable, efficient, and privacy-conscious healthcare system. Additionally, we examine the potential obstacles, emerging trends, and future research avenues regarding the implementation of blockchain in the healthcare sector, facilitating a more secure, transparent, and AI enhanced medical environment.

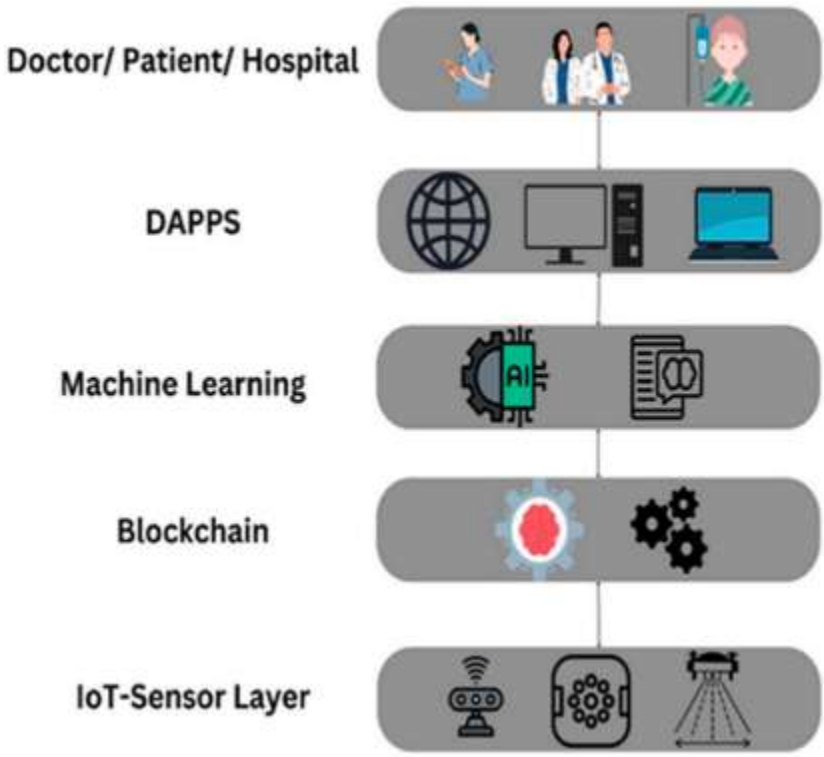

Fig 1 Blockchain based E-healthcare System

ı **Tamper-Resistant Records** A key property of blockchain is its immutability. once data is inscribed in the blockchain, it cannot be modified or erased without the network's consensus. This functionality is especially advantageous in electronic health records (EHRs), medical imaging, and clinical trial data, where preserving the integrity and precision of patient information is essential. Prevents Data Manipulation: Modifications to medical records create a traceable audit trail, thereby diminishing fraud and illegal alterations. Augments Data Integrity: Guarantees that patient histories, laboratory reports, and diagnostic outcomes remain precise, unaltered, and verifiable. Safeguards Against Malicious Attacks: The decentralized nature of blockchain eradicates a singular point of failure, hence diminishing the likelihood of data breaches and cyberattacks.

II Privacy Protection Healthcare data is extremely sensitive, and its illegal disclosure can result in identity theft, insurance fraud, and breaches of privacy. Blockchain guarantees data secrecy via sophisticated cryptography methods and access control systems. Encryption and Anonymization: Patient data is maintained in an encrypted format, rendering it available just to authorized parties.

III Blockchain-Enabled Disease Detection By providing a safe and dependable framework for data storage, blockchain technology significantly contributes to the improvement of AI-based disease diagnosis, which in turn enhances prediction accuracy and healthcare decision-making. AI and blockchain integration guarantee that machine learning models are trained on authentic, high-quality medical information, resulting in more accurate and reliable predictive modeling. This is especially crucial for illness detection, since precise diagnosis and patient outcomes depend on data integrity. Further more, by allowing real-time access to patient health data while upholding strict security standards, blockchain promotes effective disease monitoring. Healthcare practitioners may easily access and review patient records without worrying about data breaches or illegal changes because to decentralized and secured storage. By enabling physicians and researchers to monitor the course of diseases, compare prior data, and make more informed clinical decisions, this real-time accessibility improves medical responsiveness.

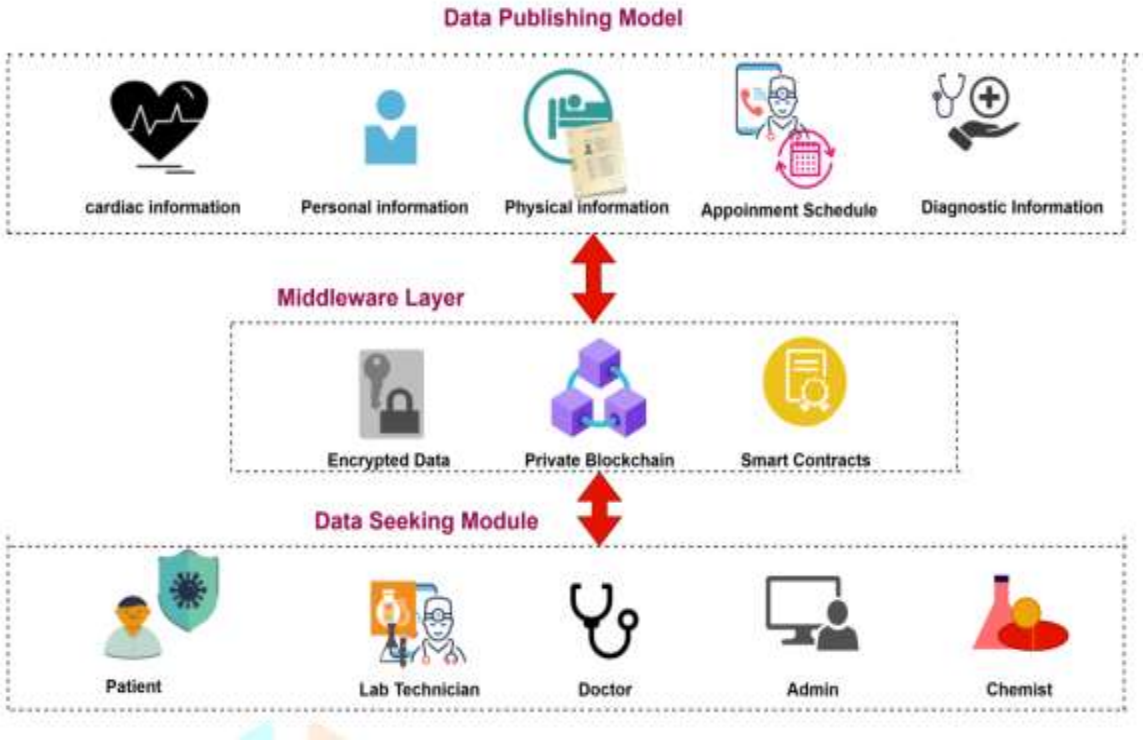

Fig 2 Blockchain based Framework

LITERATURE SURVEY

Internet of Things

The Internet of Things (IoT) has become an integral component of modern digital ecosystems, enabling seamless connectivity among devices across various domains, including healthcare, industrial automation, smart cities, and home automation. As IoT networks continue to expand, the security and privacy of data exchanged between interconnected devices have emerged as critical concerns. The distributed nature of IoT, coupled with resource constrained devices, makes traditional security mechanisms inadequate in mitigating cyber threats such as unauthorized access, data breaches, and network intrusions. These challenges necessitate innovative solutions that can provide robust, scalable, and efficient security mechanisms tailored for IoT environments. One of the primary

security concerns in IoT is ensuring data integrity and confidentiality, given that these devices often operate in open and untrusted environments. Traditional cryptographic techniques, while effective in conventional computing, are not always suitable for IoT due to their computational overhead. Moreover, centralized security architectures introduce single points of failure, making the entire network vulnerable to attacks. Blockchain technology has emerged as a promising solution to address these concerns by offering a decentralized and immutable ledger that enhances data security and trust. By leveraging cryptographic techniques such as hashing and digital signatures, blockchain ensures that data stored within the network remains tamperproof and verifiable. Additionally, smart contracts—self-executing contracts with predefined rules—can be utilized to enforce secure access control policies, preventing unauthorized interactions between devices. While blockchain provides a strong foundation for secure IoT transactions, it alone cannot fully address dynamic security threats, such as zero-day attacks and sophisticated intrusion attempts. Deep learning, a subset of artificial intelligence (AI), has demonstrated exceptional capabilities in anomaly detection and threat prediction by analyzing vast datasets in real time. Machine learning models, particularly deep neural networks (DNNs), can identify malicious patterns in network traffic, classify threats, and even predict potential security breaches based on historical data. The combination of blockchain and deep learning creates a hybrid cryptographic approach that not only secures data transactions but also proactively detects and mitigates cyber threats in IoT environments. The proposed study explores the integration of blockchain and deep learning to develop a secure and intelligent IoT framework. By leveraging blockchain for decentralized data storage and smart contract-based access control, the system ensures transparency, integrity, and trustworthiness. Concurrently, deep learning techniques enhance security by continuously monitoring network behavior, detecting anomalies, and preventing cyberattacks in real time. This hybrid approach addresses critical challenges such as scalability, computational efficiency, and energy consumption—factors that are crucial for resource limited IoT devices. Furthermore, this study evaluates the effectiveness of the proposed hybrid model by analyzing its impact on IoT security across multiple application domains, including healthcare, smart grids, and industrial automation. Key performance indicators, such as attack detection rates, computational overhead, and energy efficiency, are assessed to determine the feasibility and practicality of the approach. The findings demonstrate that integrating blockchain with deep learning significantly enhances IoT security, reduces vulnerability to cyber threats, and provides a resilient framework for future IoT deployments

Deep learning

Three classifications of DL methods are supervised, semi supervised, and unsupervised learning. An input vector as a value for the supervisory signal is a desired value. Present labels aid the method of predicting the desired output labels [4]. Classification approaches employ supervised learning to detect faces and traffic signals, translate voice to text, identify spam in a file, and perform a variety of other tasks. Semi-supervised learning is a strategy that crosses the gap between unsupervised and supervised ML approaches [3]. This approach, which falls between supervised and unsupervised learning, uses unlabeled and labeled values as training data. When combined with a modest quantity of labeled data, the learning accuracy of unlabeled data improves significantly. In theory, the data adjacent to it have the same name. Likewise, the cluster assumption, which states that every data in a cluster is the same, has a similar name [5]. Also, rather than using the whole input space, the data are limited to a single dimension. Unsupervised learning describes the interrelationships between the components and then categorizes them. These algorithms are used in neural networks, clustering, and anomaly detection. Detecting anomalies typically takes the benefit of unsupervised learning, specifically in security areas. By the same token, feature processing and extraction are possible by using DL techniques and artificial neural networks [6].

OBJECTIVES

I. The study explores and understands the characteristics of blockchain technology for its implementation in the healthcare industry to strengthen data privacy.

II. The study discusses the importance of standardization and compliance in the development and integration of blockchain technology into IoT-based systems to ensure data security and management.

III. The study also explores the challenges and opportunities of blockchain integration in IoT and ways for addressing these challenges. The study addresses the benefits of handling security issues in the healthcare industry and proposes the benefits of blockchain technology integration into IoT systems.

ISSN: 2456-236X
Vol. 10 Issue 01 | 2025

NEED AND MOTIVATION

Patient monitoring system and its need Patient monitoring refers to the continuous or intermittent observation of a patient's vital signs, physiological parameters, and other relevant health information to assess their medical condition and ensure timely intervention if necessary. This monitoring can take place in various healthcare settings, including hospitals, clinics, ambulances, and even in the patient's home. The primary goal of patient monitoring is to detect any changes in a patient's health status promptly so that healthcare providers can make informed decisions about their treatment and care. Many patients want this kind of monitoring system like the patient whose physiological regulatory system is unstable and the patient who is suffering from life-threatening diseases. The patient monitoring system comprises microcontrollers, minicomputers, and sensors utilized to track and detect health data. After collecting all the patient's health data, it is transmitted to the caretakers or medical staff [10].

Patient monitoring is essential in healthcare for several reasons.

• **Early Detection and Timely Action:** Patient monitoring aids healthcare providers in detecting changes early by tracking vital signs and health conditions. This allows them to intervene quickly, preventing small issues from turning into big problems and lowering the chances of complications.

• **Tailored Treatment Plans**: Continuous monitoring provides a full picture of a patient's health. This helps doctors create treatment plans that match each patient's needs, making treatments more effective and personal.

• **Managing Chronic Conditions**: People with chronic illnesses like diabetes, heart disease, and high blood pressure need regular monitoring. It helps keep track of how their conditions are changing and how well treatments are working.

• **Avoiding Complications**: Monitoring detects even small changes that could indicate the onset of a problem. Taking early action can prevent problems from escalating and may reduce the likelihood of patients needing to return to the hospital.

• **Personalized Care**: Every person's health is different. Patient monitoring helps doctors create care plans that fit a person's unique situation, like how they respond to treatments and other factors.

• **Remote Care:** Monitoring lets patients get healthcare from home through things like telemedicine. This is useful, especially for people who live far from hospitals or need help in emergencies.

• **Using Data for Decisions**: Monitoring collects lots of data that doctors can utilize to make smart decisions. This information is crucial for adjusting treatments and therapies.

• **Efficiency in Healthcare**: Continuous monitoring makes healthcare more efficient. It reduces the need for numerous visits to the doctor's office, conserves resources, and improves efficiency.

• **Better Quality of Life:** With monitoring, people can manage chronic illnesses and treatments more effectively. This helps them feel better and live healthier lives.

SYSTEM DESIGN

EXISTING SYSTEM

The system used before in health observance is that the fastened observance system, which might be detected only the patient is within the hospital or bed. It takes abundant time for doctors additionally as patients. within the existing system, the patient has to get hospitalized for normal observance or routine medical. The systems are mensuration the health parameter of the patient and send by it through totally different platform like Bluetooth protocol many more. These are used for under short-range communication to transfer the information. The doctor cannot fetch all the small print in the slightest degree times.

PROBLEM STATEMENT

- In rural hospitals, the facilities for health caring are limited. The poor quality of health management enables issues in health care system.
- In developing countries there is lack of resources and management to reach out the problems of individuals.
- A common man cannot afford the expensive and daily checkup for his health.

PROPOSED SYSTEM

- In our proposed system, we are using the Arduino Uno, Temperature Sensor, Pulse Sensor, Thing Speak IoT platform, Wi-Fi Module, Power supply.
- A Smart patient health Monitoring System will not only help in maintaining health but also reducing the work of doctors and saving the time of patients.
- The proposed method of patient monitoring system monitors patient's health parameters using Arduino Uno. After connecting internet to the Arduino uno, it is connected to cloud database system which acts as a server. Then the server automatically sends data to the receiver system. Hence, it enables continuous monitoring of the patient's health parameters by the doctor. Any abrupt increase or decrease in these parameter values can be detected at the earliest and hence necessary medications can be implemented by the doctor immediately.

PROJECT IMPLEMENTATION

The system is implemented using the combination of hardware components. The smart patient health monitoring system will have sensors to detect body temperature, pulse rate and ECG data. The health monitoring sensors are used to collect health related data i.e., for data acquisition. Communication can be done by controller for sending data on internet wirelessly. Data processing has been done at server. All data collected and aggregated at server point. To get health related information in understandable format it can be shown on web page using Thing Speak IOT. All these data will be accessible in real time scenario for continuous monitoring. Health monitoring is the major problem in today's world. Due to lack of proper health monitoring, patient suffer from serious health issues. There are lots of IoT devices now days to monitor the health of patient over internet. Health experts are also taking advantage of these smart devices to keep an eye on their patients. With tons of new healthcare technology start-ups, IoT is rapidly revolutionizing the healthcare industry. Here in this project, we will make an IoT based Health Monitoring System which records the patient heart beat rate and body temperature and also send an email/SMS alert whenever those readings go beyond critical values. Pulse rate and body temperature readings are recorded over thing Speak and Google sheets so that patient health can be monitored from anywhere in the world over internet. A panic will also be attached so that patient can press it on emergency to send email/SMSs to their relatives.

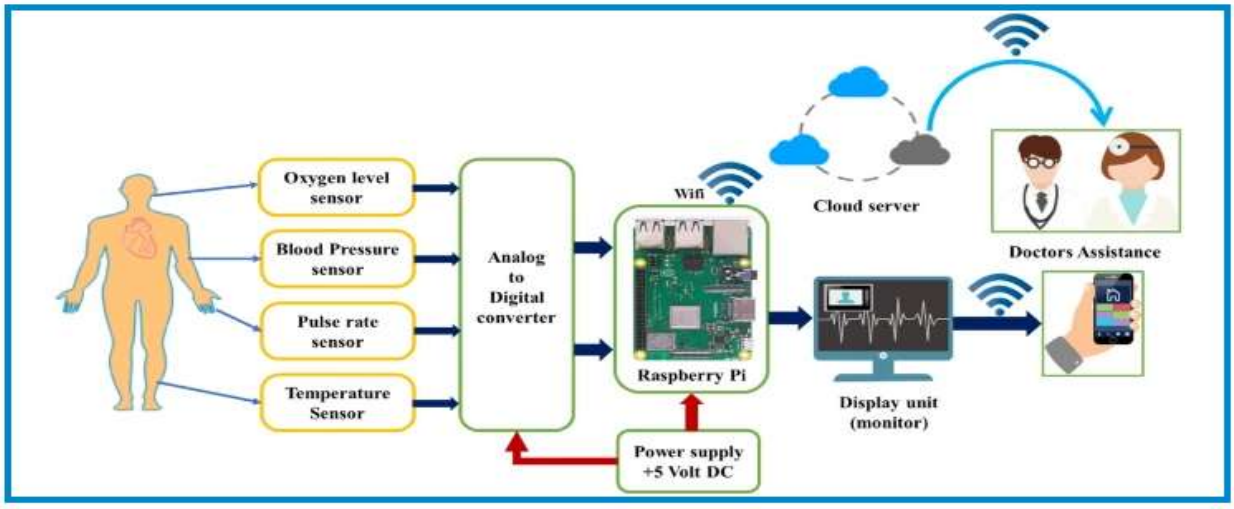

Fig 3 Project Workflow

ISSN: 2456-236X

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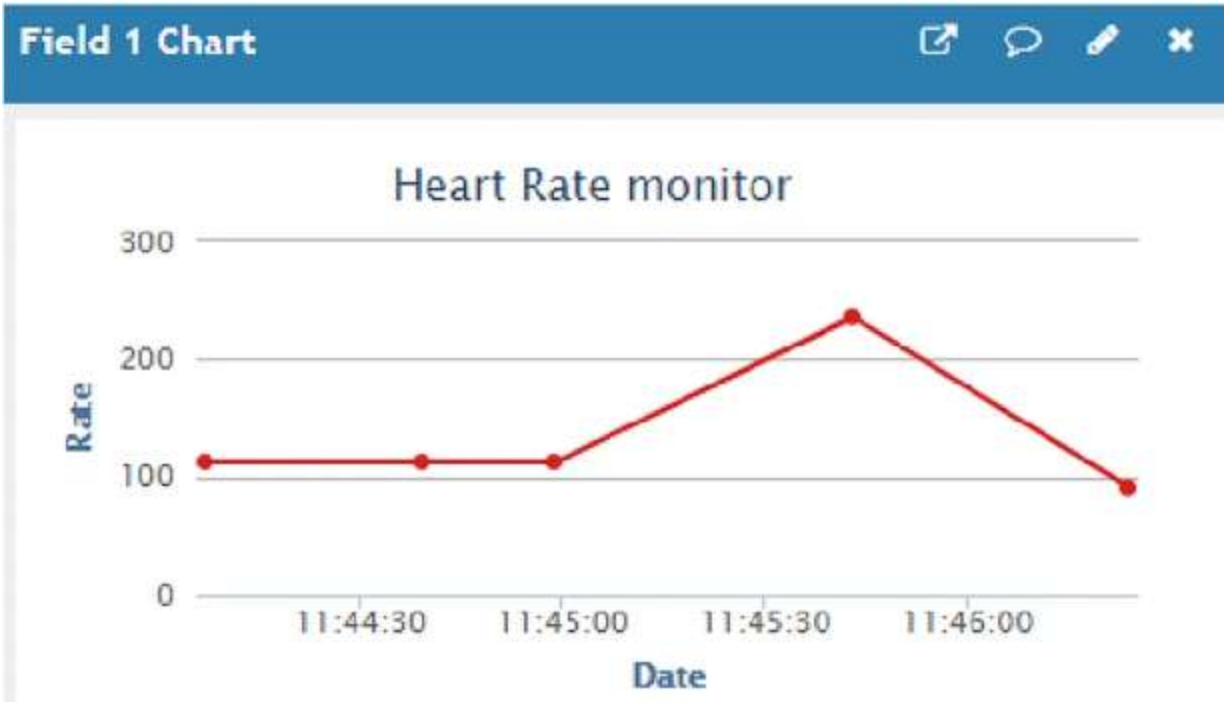
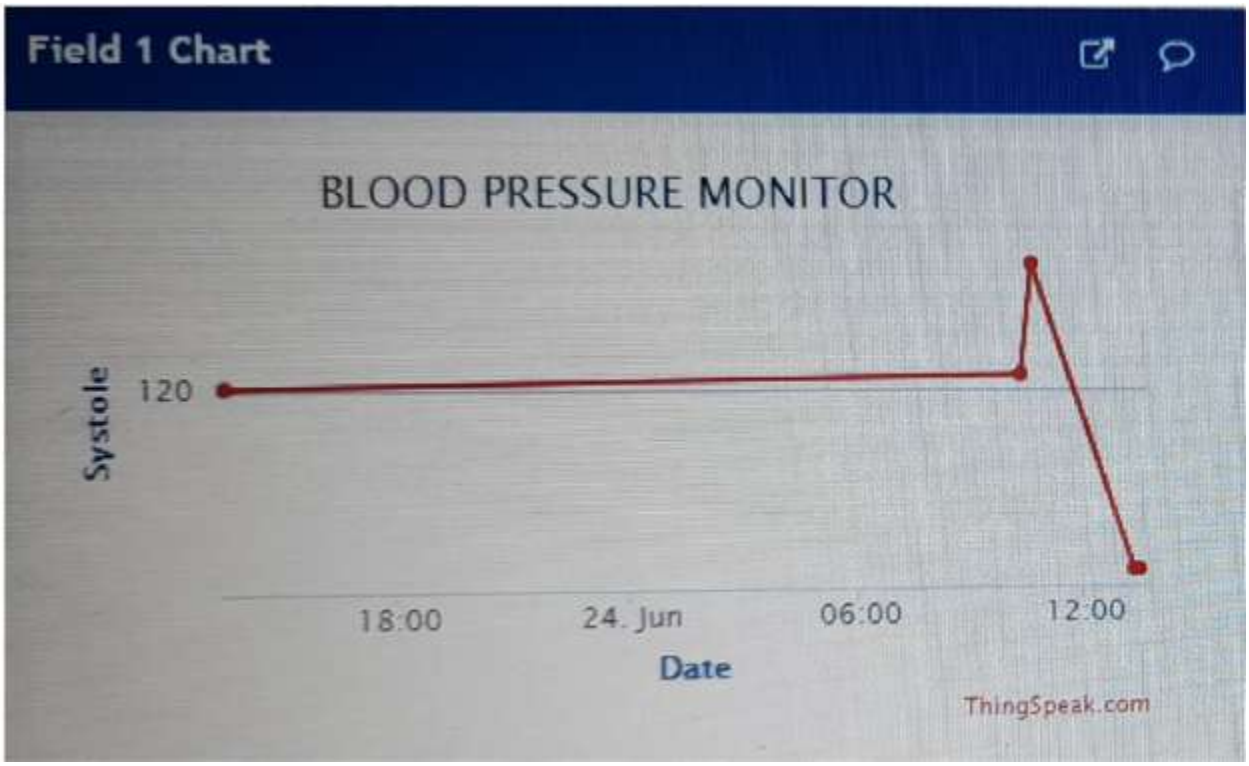
RESULT ANALYSIS





4. CONCLUSIONS

Blockchain technology is a revolutionary way to keep medical data safe while also making it easier to find diseases and make accurate diagnoses. The designed prototype is tested on different patients or subjects to obtain the performance of health monitoring system. For performance analysis, four patient parameters i.e. heart rate, body temperature, blood pressure and SPO2 were measured. The efficacy of the system can be evaluated by comparing the measurement data with commercial sensors available. Adding blockchain to healthcare solves some of the biggest problems that have been stopping medical systems from being efficient and open for a long time. These problems include data privacy, security holes, and problems with how different systems can talk to each other. Blockchain has the potential to change the global healthcare ecosystem by making sure that patient records stay private, can't be changed, and are easy for approved stakeholders to access. This is because it is decentralized and can't be changed. The safety of private patient data is one of the most important issues in healthcare right now. Cyberattacks, unauthorized access, and data breaches are very likely to happen with traditional centralized systems. This can put patients' privacy and trust at risk. There are some risks with blockchain, but they are lessened by using cryptography and private storage. Every medical record on the blockchain is encrypted and tied to a chain of transactions that can't be changed. This concludes that blockchain technology could completely change how medical data is managed and diseases are found by creating a safe, open, and compatible system. By solving problems with data privacy, security, and access, blockchain can make it possible for AI to make more accurate diagnoses and improve health results. In the future, researchers should work on improving blockchain platforms, making it easier to integrate AI, and making sure that this technology can be used easily to change healthcare systems around the world.

5 FUTURE ENHANCEMENT

The healthcare industry will change a lot because blockchain technology will solve important problems with data security, collaboration, and patient privacy. As the use of blockchain grows, a number of important new technologies are appearing that could improve healthcare processes, make patient care easier, and make AI driven diagnostics more accurate. One of the most important new ideas is the use of smart contracts, which are very important for automating healthcare tasks, especially managing patient permission. Smart contracts are agreements that are saved on the blockchain and take action when certain conditions are met. In healthcare, they can make sure that patients give their permission and that this permission is kept permanently, which makes sharing medical data safer.

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