

Secure Electronic Health Record System Using Blockchain Technology

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Abstract— *Securing electronic health records (EHRs) is critical in modern healthcare to uphold patient privacy, data integrity, and public trust in health information systems. Existing EHR systems, while efficient, are susceptible to vulnerabilities such as data breaches, unauthorized access, and data tampering. This research proposes an enhancing EHR security by integrating blockchain technology. Blockchain, a decentralized and immutable ledger, offers a robust solution to address these challenges. By leveraging blockchain's key features – transparency, security, and data immutability – this study aims to develop a secure and tamper-proof EHR system that significantly minimizes the risk of data breaches and unauthorized modifications. Furthermore, Data Security are employed to automate and enforce access controls and consent management, further enhancing the security. This research comprehensively analyses the limitations of current EHR systems, emphasizing the critical need for improved security measures. It then investigates the feasibility of implementing a blockchain-based solution, considering both technical and operational aspects, including hardware and software requirements. The findings suggest that a blockchain-based EHR system can offer superior security and transparency compared to traditional approaches. By leveraging advanced decentralized storage, this system has the potential to significantly enhance patient data protection, streamline healthcare operations, and foster greater trust in electronic health records.*

Index terms — Blockchain, Data integrity, Data Privacy, Decentralized and Immutable, Sensitivity Analysis, Verification, Doctor and Patient data Protection.

I. INTRODUCTION

The rapid advancements in technology are transforming every facet of human life, including healthcare. While

Electronic Health Records (EHRs) and Electronic Medical Records (EMRs) have brought significant improvements in security, user experience, and various aspects of healthcare, challenges remain. These include concerns regarding data security, patient data ownership, and data integrity. Blockchain technology emerges as a potential solution, offering a secure and tamper-proof platform for storing and managing healthcare information. Prior to the digital era, healthcare relied on paper-based systems for storing medical records, leading to inefficiencies, security vulnerabilities, and organizational challenges. These systems were prone to errors, data duplication, and redundancy as each healthcare institution maintained separate copies of patient records. The advent of EHRs aimed to address these limitations by integrating paper-based and electronic records. EHRs were designed to store and manage clinical notes, laboratory results, and other crucial patient information, with the goal of improving patient safety by reducing errors and enhancing access to information. While EHR systems have been widely adopted in hospitals globally due to their improved security and cost-effectiveness, they still face certain challenges. A

study conducted in Finland revealed that nursing staff experienced issues with EHR reliability and user-friendliness. This diagram outlines the workflow of a blockchain-powered Electronic Health Record (EHR) system. Users initiate medical transactions (e.g., patient record updates, diagnoses) which are then sent to a Blockchain. blockchain-powered Electronic Health Record (EHR) system, designed to enhance security, transparency, and patient privacy within the healthcare domain. The system begins with user interaction, where healthcare professionals such as doctors, nurses, administrators, and pathologists initiate medical transactions. These transactions, which could include updates to patient records, diagnoses, or other relevant medical information, are then transmitted to a crucial component known as the Blockchain Handshake. This intermediary acts as a bridge between the traditional EHR system and the decentralized blockchain network. The Blockchain Handshake plays a pivotal role by securely transmitting the medical transaction data to the public blockchain network for verification. Upon receiving the transaction, the blockchain network employs a critical mechanism: smart contracts. This layer of smart contract-based security significantly enhances the system's robustness against unauthorized access and data breaches. Finally, the updated patient records are securely stored within a robust cloud database. This centralized repository provides a centralized location for accessing and managing patient information while leveraging the enhanced security and transparency afforded by the blockchain integration. By integrating blockchain technology, this EHR system aims to address the inherent vulnerabilities of traditional systems, such as data breaches and unauthorized access. The decentralized nature of the blockchain, combined with the robust security measures provided by smart contracts, creates a more secure and trustworthy environment for managing sensitive patient data. This system represents a significant step towards improving patient privacy, enhancing data integrity, and streamlining healthcare operations. EHRs were designed to store and manage clinical notes, laboratory results, and other crucial patient information, with the goal of improving patient safety by reducing errors and enhancing access to information. While EHR systems have been widely adopted in hospitals globally due to their improved security and cost-effectiveness, they still face certain challenges. A study conducted in with EHR reliability and user-friendliness.

II. LITERATURE SURVEY

S. Ballal et.al.,[1] Blockchain technology offers a transformative solution to the challenges faced by Electronic Health Records (EHR) systems, particularly in security, privacy, and data integrity. By leveraging its decentralized and immutable nature, blockchain enhances the reliability and protection of patient information. Smart contracts automate access control, ensuring that only authorized parties can view or modify records, thereby streamlining collaboration and safeguarding privacy Performance tests indicate that blockchain-based EHR systems match or surpass traditional systems in data storage speed, exchange

rate, and scalability, efficiently handling larger volumes of data without compromising operations.

A. Shibu et.al., [2] The rise of globalization has driven significant advancements in healthcare technology, particularly in electronic medical records (EMRs). However, many existing EMR systems are still vulnerable to security breaches, lacking robust data protection. Blockchain's strong encryption safeguards sensitive information, ensuring that only authorized personnel can access or modify records. By integrating blockchain with existing EMR systems, healthcare providers can enhance data security, transparency, and traceability. M. Wattimena et.al., [3] Since Bitcoin's inception in 2009, blockchain technology has emerged as a transformative tool, particularly in addressing vulnerabilities in electronic health records (EHRs) such as data breaches, operational inefficiencies, and fragmentation of patient history. This article examines how blockchain-enabled EHR management can create a distributed, secure, and efficient environment. Blockchain facilitates seamless information exchange among providers, improving continuity of care and enabling informed treatment decisions. A. Mukherji et.al., [4] Blockchain technology offers significant potential for enhancing security, privacy, and efficiency in healthcare. Doctors can update patient records within the while patients use public keys to access their data, ensuring only authorized users can view or modify information. Blockchain's decentralized registry enhances data integrity and security, preventing unauthorized tampering, facilitating quicker decision-making. S. Singh et.al., [5] Blockchain technology is rapidly gaining traction in the digital age, offering a secure and efficient solution for managing electronic health records (EHRs). Blockchain also facilitates collaboration between healthcare providers, improving data integrity, reducing redundant tests, and enhancing patient care. N. Poonguzhali et.al., [6] Blockchain technology offers significant potential in healthcare by providing a secure, transparent, and immutable system for managing medical data. The transparency and immutability of blockchain foster trust among patients, physicians, and researchers, leading to more effective collaboration, enhanced drug utilization, and ultimately, better patient outcomes. B. L. Radhakrishnan et.al., [7] Electronic health records (EHRs) contain crucial patient information, making them a prime target for cyberattacks. By combining these measures with real time threat detection, healthcare data security is significantly enhanced, protecting both patient information and overall system integrity. V. Mahore et.al., [8] Blockchain technology offers significant potential in healthcare by providing secure, transparent, and immutable data management. This approach fosters trust among patients and stakeholders, enhances drug development, streamlines clinical operations, and ultimately improves healthcare delivery. I. Srivastava et.al., [9] The implementation of Blockchain for storing and managing healthcare records offers a promising alternative to traditional cloud-based storage, providing enhanced reliability and security. By combining the Proof-of Authority mechanism with smart card-based access, the proposed system enhances the security and efficiency of

medical record management while ensuring that patient data remains private and accessible only to authorized users. J. G. Ponsam et.al., [10] Blockchain technology is poised to revolutionize healthcare by offering a secure and transparent platform for managing electronic health records (EHRs). This innovative approach enhances data privacy and security, reduces the risk of errors and fraud, and improves the efficiency of healthcare processes. Implementing blockchain in healthcare can significantly improve care quality, patient outcomes, and cost- effectiveness, paving the way for a more secure and efficient healthcare system.

III. METHODOLOGY

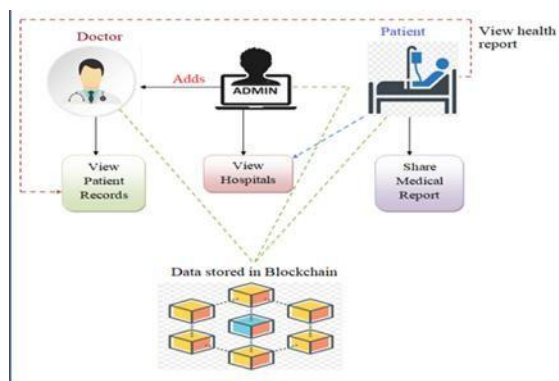
A. Problem Statement

Existing Electronic Health Record (EHR) systems, despite their efficiency in managing patient data, face significant security challenges. These challenges include vulnerabilities to data breaches, unauthorized access, and data tampering. This compromises patient privacy, data integrity, and public trust in healthcare information systems. Furthermore, current EHR systems may not adequately address issues related to data ownership and control by patients. This research aims to address these critical issues by exploring the potential of blockchain technology to enhance the security and privacy of EHR systems.

B. Proposed solution

The proposed system aims to leverage blockchain technology for healthcare data management, addressing the shortcomings of the existing centralized systems. The integration of blockchain introduces several advantages that enhance the security, efficiency, and accessibility of healthcare data. The proposed system utilizes a decentralized approach, distributing healthcare data across a network of nodes. Blockchain's append-only structure and cryptographic hash functions ensure the immutability and security of healthcare records. The proposed system allows authorized individuals, including patients, to access healthcare data securely. We aim to Enable patients to control the sharing of their medical records with specific hospitals using blockchain-based permissions, ensuring data privacy and control.

We want Utilize the Solidity programming language to create smart contracts on the Ethereum blockchain. These contracts manage essential healthcare data securely and transparently, including patient records, doctor information, and hospital details.



System Architecture

The proposed system architecture leverages blockchain technology to facilitate secure and transparent healthcare data management. At its core, the architecture consists of three main actors: doctors, administrators, and patients.

Doctors are granted access to view patient records, enabling them to retrieve essential medical information for diagnosis and treatment. Administrators oversee hospital operations and are provided with access to view hospital-related data stored on the blockchain, ensuring efficient management of healthcare facilities. Patients have the ability to view their health reports and share medical records securely with authorized individuals or entities.

The blockchain serves as the decentralized ledger where healthcare data is stored in an immutable and tamper-proof manner, ensuring data integrity and security. Each transaction, such as accessing or sharing medical records, is recorded as a block on the blockchain, providing a transparent audit trail. This system architecture facilitates seamless data sharing and access while maintaining patient privacy and confidentiality.

C. Admin Module:

C.1 Add Doctor/Hospital Details

Within the Admin Module, administrators possess the authority to input and oversee vital data pertaining to doctors and hospitals. This functionality enables them to efficiently manage information, including doctor profiles, contact details, and hospital credentials. By facilitating the seamless addition and management of such essential details, administrators streamline the process of updating and maintaining crucial healthcare provider data within the system. This ensures that accurate and up-to-date information is readily available, contributing to the effective functioning of the healthcare facility.

C.2 View Hospital Details

Administrators possess the capability to access comprehensive information regarding hospitals within the system. This encompasses details such as hospital names, addresses, specializations, and other pertinent

information. By having access to this comprehensive data, administrators gain a holistic overview of the healthcare network within the system. This facilitates informed decision-making and efficient management of healthcare resources. Furthermore, it enables administrators to effectively coordinate and allocate resources based on the specific needs and capabilities of each hospital, thereby optimizing the delivery of healthcare services.

D. Patient Module:

D.1 New Patient Signup

In the Patient Module, new patients are enabled to register for the Electronic Health Record (EHR) system. This process entails the creation of user accounts, where patients furnish requisite personal details, establish login credentials, and set up their profiles. This initial step facilitates patients' access to and management of their healthcare data within the system, laying the foundation for personalized healthcare management and engagement with healthcare providers.

D.2 View Hospitals

Patients are empowered to access a comprehensive list of hospitals integrated into the system, facilitating informed decision-making regarding the sharing of their medical records. This feature furnishes details about diverse healthcare facilities, aiding patients in selecting the most suitable option for their needs. By offering transparency and accessibility to hospital information, patients can make well-informed decisions about their healthcare management and collaboration with healthcare providers.

D.3 Share Health/Medical Report

Within the Patient Module, a key functionality empowers patients to share their health and medical reports selectively with designated hospitals. Patients retain control over their data privacy by specifying which hospitals are granted access to their records. This feature ensures enhanced data security and confidentiality, fostering trust and collaboration between patients and healthcare providers. By facilitating controlled data sharing, patients can streamline healthcare management while safeguarding the privacy of their sensitive medical information.

D.4 View Health Report

Patients have the ability to conveniently access and review their health reports and medical records within the system. This feature empowers patients with easy access to their healthcare information, facilitating the review of their medical history at their convenience. By providing patients with direct access to their records, they can stay informed about their health status and readily share relevant information with healthcare providers as required, fostering proactive healthcare management.

E. Doctor Module:

E.1 View Patient Reports

In the Doctor Module, doctors are equipped with the capability to access patient reports, streamlining the retrieval of medical records for patients who have authorized access. This functionality enables doctors to efficiently review relevant patient information, facilitating personalized medical care delivery. By providing seamless access to patient reports, doctors can make informed clinical decisions and offer tailored treatments, ultimately enhancing the quality and efficiency of healthcare services provided to patients.

F. Blockchain Integration

Instead of relying on a single central location to store healthcare records, we harnessed the power of blockchain. Think of blockchain as a highly secure digital ledger. It records each piece of data as a block, and these blocks are stored on many computers (nodes). Users, such as patients, have control over who can access their medical records. This control is made possible by creating specific rules using blockchain technology. Users can specify which hospitals or doctors are allowed to view their data. This capability gives them privacy and authority over their information.

We used a programming language called Solidity to create smart contracts on the blockchain. These smart contracts act like digital agreements that enforce rules. In our case, they oversee how healthcare data is managed and who can access it.

This transparency guarantees that every action involving data is recorded, fostering accountability and trust among users. Data integrity is maintained in the system through the utilization of the SHA-256 algorithm (Secure Hash Algorithm 256-bit). Each block in a blockchain is linked with a unique code. These blocks are maintained across multiple nodes or servers. Before storing new records, blockchain verifies the code of each block. If any block data is modified, it results in a different code, triggering security alarms and ensuring the integrity and immutability of the data. Therefore, any attempt to tamper with the voting data, such as altering a vote or changing voter details, would be immediately visible on the blockchain.

IV. RESULT AND DISCUSSION

To run project first double click on 'run button' file to start python Django server and to get below fig.no 1. In below fig.1 python server started and now open browser and enter URL as 'http://127.0.0.1:8000/index.html' and press enter key to get below home page.

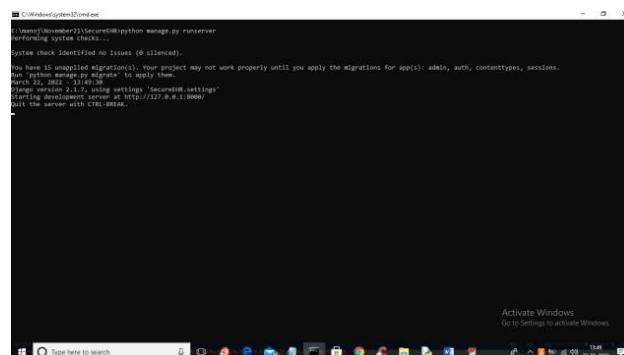


Fig.no 1

In below fig.no 2 click on 'Admin' link to get below admin login screen.

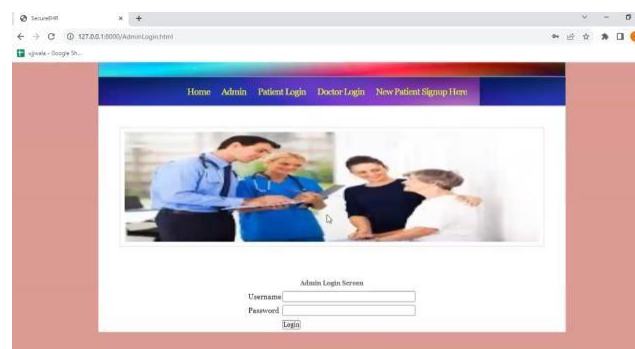


Fig.no 2

After login into admin login we will get some data regarding related to Admin login usage and what are the different things to do in that login page. After that we get page as below mentioned to signup of Hospitals and Doctors through this signup task.



Fig.no 3

After registering hospitals and Doctors we just moved to take new patient details through signup process. patients have registered by their signup process.



Fig.no 4



Fig.no 5

After login patient details patient can add health details and he/she has to select hospital that has to visit based on health issue in that mentioned by patient it refers to Doctor with same specialist has data recorded in doctor portal.

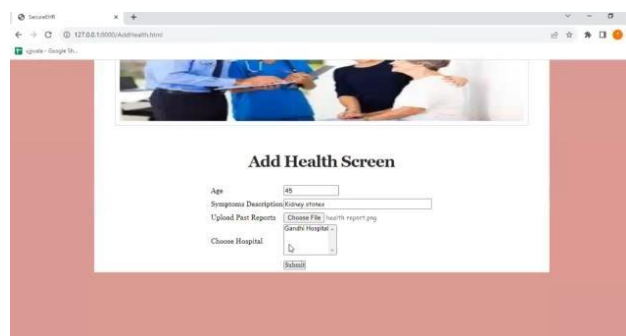


Fig.no 6

Later we can upload previous receipt related to health issues in patient health data. After doctor has to visit patient, doctor has to seen in doctor portal after checking the patient he has to give prescription related to patient health and suggest some medications to cure the disease or illness that patient suffered.

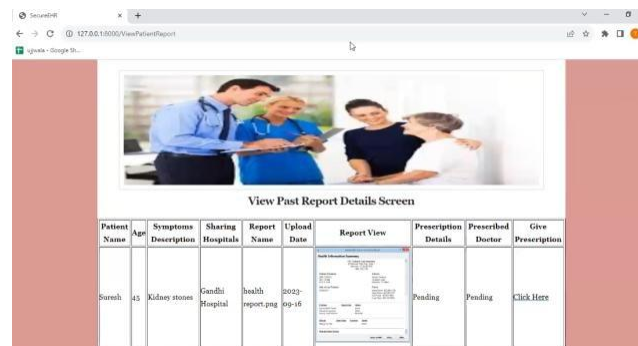


Fig.no 7

In below fig.no 8 doctor can access/view that patient details and based on those details he will prescribe treatment. Similarly any number of doctors or patients can use this application to share medical reports. In above screen you can see we are displaying “Prescription Details and Prescribed Doctor” and doctors has not given any prescription so its displaying ‘Pending’ and now doctor can click on ‘Click Here’ link to give prescription like below screen

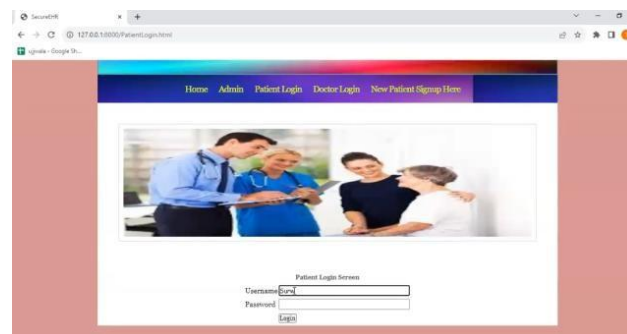


Fig.no 8

In below fig.no 9 we can see now “pending” is replaced with “Prescribed medicine details” and displaying name of doctor who prescribed those medicines and now logout and login as patient to view that prescription



Fig.no 9

V. CONCLUSION

In conclusion, the proposed system represents a significant advancement in healthcare data management, leveraging blockchain technology to address critical challenges and enhance the security, efficiency, and accessibility of healthcare data. By adopting a decentralized infrastructure, the system minimizes the risk of single points of failure and unauthorized access, ensuring the resilience and integrity of patient information. The immutability of healthcare records achieved through cryptographic hash functions in stills confidence in the integrity of patient data, making electronic health records highly resistant to breaches and tampering. Additionally, the system empowers users with control over access to their healthcare data, promoting personalized and patient-centric care. With a scalable architecture and user-friendly interface, the system is poised to accommodate the evolving needs of healthcare networks and users, facilitating seamless interaction and enhancing the overall user experience. Cryptographic hashing ensures healthcare record immutability, bolstering patient data integrity and significantly reducing the risk of breaches and tampering in electronic health records. Overall, the system represents a significant step forward in revolutionizing healthcare data management, offering immense potential to improve patient outcomes and healthcare delivery.

VI. FUTURE SCOPE

The future scope for integrating blockchain technology with emerging technologies such as artificial intelligence (AI) and the Internet of Things (IoT) holds immense potential to revolutionize healthcare. By leveraging AI algorithms and IoT devices, blockchain can be optimized to enable predictive analytics and personalized medicine, enhancing diagnostic accuracy and treatment outcomes. Furthermore, the refinement of smart contracts and decentralized applications can facilitate seamless integration with AI for automating healthcare processes and improving patient care delivery.

Continuous advancements in cryptographic techniques and consensus algorithms will further bolster the security of blockchain networks in healthcare. Exploring post-quantum cryptography can future-proof healthcare data against emerging threats, ensuring robust protection against cyberattacks and data breaches. Additionally, ongoing research and development efforts aimed at enhancing interoperability and scalability will enable the seamless integration of blockchain into existing healthcare systems, fostering greater collaboration and data sharing among stakeholders. Overall, the convergence of blockchain with AI, IoT, and advanced cryptographic techniques promises to unlock new opportunities for innovation and transformation in healthcare delivery and patient outcomes.

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