

Blockchain Based Health Care System: A Comprehensive

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ABSTRACT

Governments heavily rely on collected data to analyze the health needs and requirements of their citizens. However, this data is often scattered and collected by different agencies with varying goals and business models. This creates a burden for governments in planning adequate health bills that ensure the wellbeing of their citizens. Additionally, the lack of synchronization and real-time access to this data exacerbates the problem further. Therefore, it is crucial for governments to have a system that guarantees the integrity, accessibility, correctness, and security of medical data in a highly synchronized environment. To address this issue, we propose Smart-Health (SHealth), a blockchain-based health management system. SHealth is a private, multi-layered blockchain with a multi-tiered addressing scheme that defines the privileges and permissions of entities in the system. By using blockchain technology, SHealth ensures security, reliability, availability, resistance against tampering and malicious attacks, seamless integration, and easy data management. SHealth offers complete autonomy to its users through a user-friendly graphical interface. It utilizes smart contracts to initiate various requests and inquiries pertaining to patients, such as appointments, medical tests, medications, medical procedures, or history. The system is simple, robust, efficient, secured, and completely automated. All stakeholders in the system can access the health-related data stored in a distributed database without compromising its authenticity. SHealth covers all possible scenarios in health systems, and some of these scenarios are explained in this work. In summary, SHealth provides a solution to the challenges faced by governments in managing and analyzing scattered health data. Its use of

blockchain technology ensures data integrity and accessibility while providing complete autonomy to its users.

INTRODUCTION

In order to effectively allocate resources and provide adequate healthcare services, governments need access to comprehensive and accurate data on the health needs and requirements of their citizens. However, in many countries, such data is scattered among various entities such as hospitals and medical centre is, making it difficult for governments to gain a complete understanding of the health situation. This can lead to unrealistic projections when preparing healthcare budgets and expenditures, which can have negative impacts on the level of care provided to citizens.

Furthermore, without a unified national database, governments may struggle to analyze the spread and prevalence of certain diseases, as well as their impact on specific demographics or geographic regions. The lack of real-time access and synchronization of health records also poses challenges to healthcare management.

To address these issues, many countries have implemented national healthcare databases, either managed by independent health insurance providers or the government's health provider. These databases can provide a centralized location for comprehensive health records, which can be used to inform policy decisions and optimize healthcare services.

Overall, establishing a national healthcare database is crucial for governments to gain a comprehensive

understanding of the health needs and requirements of their citizens, and to effectively allocate resources to provide quality healthcare security. This paper presents the Smart-Health framework, a blockchain-based health system that aims to solve the challenges associated with the scattered nature of medical records, lack of patient involvement, and privacy and security issues. Smart-Health is a private blockchain that allows all entities involved in providing healthcare services to the patient, such as health providers and insurance partners, to securely access and maintain the patient's medical records. Each user in the system has a unique cryptographic key that enables them to access their records in read mode without obtaining consent from other nodes. Smart contracts further automate the system and reduce processing overhead, and the modular multi-layered design allows for easy addition or removal of entities without affecting the system's performance. Overall, Smart-Health is a lightweight and fully automated health management system that offers a user-friendly graphical interface for digital communication of appointments, requests, and inquiries.

RELATED WORK

In this section we briefly present some of the recent proposed health management applications and systems that are based on the blockchain technology. A proposal for a blockchain-based medical system for secure sharing, storage and access to medical data is introduced in [26]. The paper presents a lightweight scheme for sharing medical records among doctors from various hospitals while ensuring their security in terms of privacy protection and resistance to data manipulation. The proposed scheme also presents a mechanism to match similar symptoms exhibited by different patients in different locations. The system helps the patients create session keys for their future communication on the disease. A major drawback of this mechanism is that it relies on the delegated proof of stake consensus mechanism in order to maintain the sanity of the ledger. On the other hand, [27] proposes a privacy preserving data sharing system by implementing two blockchains: a private blockchain that hosts the personal health information and a consortium blockchain to hold

the indexes for the health records. The system provides a tamper-proof records' saving and a privacy protection. The security in the scheme is provided using three algorithms, including the SHA-256 algorithm (for computing hash values) followed by the Elliptic Curve Cryptography (ECC) algorithm (for generating asymmetric keys) and the Advanced Encryption Standard (AES) algorithm for encrypting data. However, the use of three different security algorithms makes the proposed system computationally very complex to support many requests. Furthermore, the mechanism lacks data integrity verification capabilities. BBDS is yet another blockchain-based data sharing paradigm for medical records in a cloud environment [28]. The paper presents a basic layout for a medical data system that allows the users mainly to access the medical records and sharing them while maintaining their privacy. The authors later presented MeDShare, a blockchain-based medical records system that is enabled to monitor malicious data access [29]. MeDShare tracks and records all activities in the system by employing smart contracts. Furthermore, the system revokes the access of entities that exhibit malicious or record-tampering behaviour. Both systems suffer a major drawback which is saving sensitive data on the cloud which exposes the system to several risk issues. The authors in [60] present another blockchain-based health record system that also relies on cloud storage. One key characteristic of the proposed system is having a machine learning capability for inspecting data. This data inspection is crucial to the elimination of noise in order to produce reliable data. Like other blockchain-based health schemes that system ensures that users can safely store their personal health records. All the above-mentioned schemes however have a major vulnerability as they save the sensitive data on the cloud which may expose the system to major security risks by third parties. Moreover, no mechanism to ensure the correctness of such records is discussed. Yet another health record sharing scheme based on blockchain technology is proposed in [61]. The presented system allows searchability functions based on symmetric encryption and attribute-based encryption. It stores the hash values of the personal

health records in the blockchain while deploying the smart contracts to save their related index. This, according to the authors guarantees the system having a high level of access control without relying on third parties. However, it is unclear how the system will handle the flood of smart contracts that roam in the network for the purpose of saving records and wait to be executed. SHealth like the above-mentioned schemes proposes a health management system that is based on blockchain technology. The system however principally differs in condensing its elements and entities into three major groups: users, nodes, and IoT devices. Furthermore, SHealth guarantees the privacy and the integrity of its clients records by associating each client with two addresses with different permissions and privileges. The first address allows the client to solely access his records in privacy without the ability to alter them. While the second address maintains the integrity of the clients' records by allowing new entries to be appended only by co-signing them with the concerned partner. Finally, SHealth is fully automated system with reliance on easy to-use API initiated smart contacts. Through a user-friendly graphical interface, clients can initiate reservations, doctors can request medical tests and medication, and medical instruments connected to the system through IoT interfaces can be commanded through request.

RESULT DISCUSSION

Patients have authority over their medical records thanks to blockchain [1]. Smart contracts based on the Ethereum blockchain allow patients control over their data in a decentralised, immutable, transparent, traceable, trustworthy, and safe way. To securely collect, store, and exchange patients' medical data, the proposed solution uses decentralised storage of interplanetary file systems (IPFS) and trusted reputation-based re-encryption oracles. Algorithms are presented together with complete implementation information. We assess the suggested smart contracts based on two key performance indicators: cost and accuracy. We also explore the generalisation elements of our technique and give security analysis. The suggested approach's drawbacks are outlined. On

GitHub, we make the smart contract source code openly accessible.

IPFS [2] provides a blockchain-based secure storage and access solution for electronic medical data. We built an attribute-based encryption scheme for safe storage and efficient exchange of electronic medical records in IPFS storage environment based on the ciphertext policy attribute-based encryption system and IPFS storage environment, paired with blockchain technology. Our method is based on ciphertext policy attribute encryption, which effectively regulates access to electronic medical data while maintaining retrieval efficiency. Meanwhile, we store encrypted electronic medical data in the decentralised Inter Planetary File System (IPFS), which not only provides storage platform security but also eliminates the single point of failure concern. Furthermore, we use blockchain technology is non tamper able and traceable characteristics to enable safe storage and search for medical data. Our approach delivers selective security for pick keyword assaults, according to the security proof. Our approach is efficient and viable, according to performance analysis and actual data set simulation studies.

Blockchain technology is being used to handle health records [3]. a patient-centered, entirely decentralised strategy that can detect data theft, prevent data modification, and gives patients control decentralised and distributed ledger, blockchain has the potential to affect billing, record sharing, medical research, identity theft, and financial data crimes in the future. Smart contracts in health care may help to simplify things even further. On the Blockchain, invocation, record generation, and validation will all take place. on a patient-driven model of record maintenance based on Blockchain technology, with smart contracts to be added in the future, allowing for more data sharing possibilities. Finding its vast reach, I hope that additional study will be conducted and actual applications will be realised.

A medical data exchange and protection method based on blockchain [4]. To enhance the hospital's electronic health system, a medical data exchange and protection strategy based on the

hospital's private blockchain was developed. For starters, the system may meet a variety of security requirements, including decentralisation, openness, and tamper resistance. Doctors will be able to retain medical data or retrieve patient history data via a secure approach that respects their privacy. A symptom matching technique is also provided between patients. It enables patients who have the same symptoms to complete mutual authentication and generate a session key for future disease communication. PBC and OpenSSL libraries are used to implement the suggested approach. Healthy Block is a blockchain-based IT architecture for electronic medical records that is resistant to network outages.

Reference No.	Methodology
Madine, Mohammad Moussa, et al [1]	A blockchain-based architecture to manage access control of PHR systems. Our proposed approach decentralizes all the patient-doctor interactions.
Sun, Jin, et al. [2]	In this system it proposes a new encryption scheme for secure storage and efficient sharing of electronic medical records based on the attribute-based encryption system, blockchain technology, and the Inter Planetary File System (IPFS) storage platform.
Harshini V M, Shreevani Danai, Usha H R, Manjunath R K [3]	Hospital admin as one end user and the patient as another party. There are three steps of executing the smart contract namely, Invoking, Record creation, and Validation. This paper suggests Blockchain technology as one of the possible solutions for the efficient maintenance of health records. implementation of

	Blockchain in all domains making the lives easier.
Xiaoguang Liu, Ziqing Wang, Chunhua Jin, Fagen Li, And Gaoping Li [4]	At the time of registration, the hospital or patient will be checked to ensure that all participants of the network are legitimate. After the hospital registers with SM, SM will generate a pseudo identity for the hospital. When one patient sees a doctor, doctor will also compute a pseudo identity for the patient. Thus, user privacy will be protected since the pseudo identity is used instead of identity in the subsequent processes.
Omar Gutiérrez, Giordy Romero, Luis Pérez, Augusto Salazar [5]	Healthy Block is proposed as an architecture based on blockchain networks that allows the development of electronic medical record systems shared between different clinical providers, with resilience in data integrity in the event of connectivity failures and with usability, security, and privacy characteristics.
Av. Bissaya Barreto, Bloco de Celas, 3000-075, Coimbra, Portugal. [6]	personal information is at stake, there is international guidance on regulating the respective databases. Several country-specific factors, namely data protection and privacy laws and regulations, are in accordance with requirements for global health monitoring. Different architectures have been proposed for storing health data.
Sharma, Yogesh,	A system to implement EHRs using blockchain technology

and B. Balamurugan [7]	and make EHRs more secure and private. The blockchain technology will keep control over access to information using its cryptographic techniques and decentralization. It will also maintain the balance between data privacy and data accessibility. Our main objective of this project is the framing of data privacy and security issues in electronic healthcare.
Abdelhakim Senhaji Hafid [8]	Aim the realization of holistic BC-based Electronic Health Records (EHR) and Patient Health Records (PHR). EHR and PHR are used to record patient data, such as the doctor's notes upon a visit and radiology images. Hence, they include critical information regarding patient's privacy and identity.
Mr. Anokye Acheampong Amponsah, Fiapre, Bono Region, Sunyani, Ghana [9]	This paper presents the conceptual view of the proposed system, sequence and use case diagrams, data management framework, smart notification system, and smart claim processing system. The system was evaluated using the DeLone & McLean Information Systems Success Model. It was used to validate the behavioural aspect of the system.
B. Zaabar, O. Cheikhrouhou, (F. Jamil, M. Ammi,	This paper presents a novel architecture for securing RPM and EHR based on blockchain technology. Based on the architecture proposed, a system will be implemented and a proof of concept will be

M. Abid [10]	tested to assess the validity of the proposed approach. Also, the performance of the tested system will be recorded to measure the efficiency and the effectiveness of the approach.
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CONCLUSION

There are many research directions in applying Blockchain technology to the healthcare industry due to the complexity of this domain and the need for more robust and effective information technology systems. From the more technical aspect, much research is needed to pinpoint the most practical design process in creating an interoperable ecosystem using the Blockchain technology while balancing critical security and confidentiality concerns in healthcare. Whether to create a decentralized application leveraging an existing Blockchain, additional research on secure and efficient software practice for applying the Blockchain technology in healthcare is also needed to educate software engineers and domain experts on the potential and limitations of this new technology. In some cases, a new Blockchain network may be more suitable than the existing Blockchains; therefore, another direction may be investigating extensions of an existing Blockchain or creating a healthcare Blockchain that exclusively provides health-related service.

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