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Healthcare Management using Blockchain

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Abstract

Healthcare management using blockchain technology refers to the use of blockchain to improve the efficiency, security and privacy of healthcare data management. Blockchain enables the creation of a decentralized, tamper-proof database that can be shared among healthcare providers, patients, and other stakeholders. This can enhance the coordination and sharing of healthcare data, streamline the administrative processes, reduce costs, and improve patient outcomes. This abstract provides an overview of healthcare management using blockchain, highlighting its benefits and challenges, as well as its potential applications in healthcare. The major reason that paves way for the exploration of blockchain in health care management is its capabilities to secure the information's from cyber-attacks, fraud, and unauthorized access and allow an equitable and transparent data management without the need for a central authority or intermediary, making sure that patients have greater control over their own data. This method can also enable the secure exchange of health data between different healthcare systems and providers, promoting interoperability and improving patient care, by removing the need for intermediaries, blockchain can help streamline the administrative processes, reducing costs and improving the efficiency of healthcare delivery and tracking of medical products and devices throughout the supply chain, helping to prevent counterfeiting and ensuring patient safety. Overall, the use of blockchain in healthcare management has the potential to improve the quality of care, reduce costs, and increase patient satisfaction. However, there are also challenges to be addressed, such as regulatory compliance, interoperability, and scalability.

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1. Introduction

Healthcare management using blockchain technology refers to the application of blockchain in the healthcare industry to enhance the efficiency, security, and privacy of healthcare data management. The healthcare industry faces challenges such as data fragmentation, lack of interoperability, data breaches, and data privacy concerns. Blockchain technology can address these challenges by providing a secure and decentralized platform for the storage and exchange of healthcare data.

Blockchain is a distributed ledger technology that records transactions and stores data in a tamper-proof and transparent manner. It allows for the creation of a shared database that can be accessed by multiple parties without the need for a central authority or intermediary. Blockchain can provide a high level of security and privacy to healthcare data by using cryptographic techniques to ensure data integrity and authenticity.

The use of blockchain in healthcare management has the potential to streamline the administrative processes, improve patients' outcome, reduce healthcare costs, and increase patients' satisfaction. Blockchain can facilitate the secure exchange of healthcare data between healthcare providers, patients, and other stakeholders, enabling a more coordinated and efficient healthcare system.

However, the implementation of blockchain in healthcare management also presents challenges such as regulatory compliance, interoperability, and scalability. Despite these challenges, the healthcare industry is exploring the potential of blockchain to transform healthcare management and improve patient care.

1.1. Working of Blockchain in Healthcare Management

Blockchain-based medical record management works by using a decentralized and secure platform to store and manage medical data. The data is collected from various sources, such as medical examinations, laboratory tests, and prescriptions, and is recorded in a secure and standardized format. The collected medical data is stored on a decentralized blockchain network, which is comprised of a network of computers. This ensures that the data is stored in

a secure and transparent manner, making it accessible only to authorized individuals. Medical data can be shared with authorized individuals, such as healthcare providers, using secure and encrypted methods. This allows for seamless exchange of medical data between different healthcare providers, improving patient care and outcomes. Blockchain-based medical record management often uses smart contracts to enforce the rules and regulations around accessing and managing the medical data. For example, a smart contract could be used to ensure that medical data is only accessible to authorized individuals, and it is stored in a secure and standardized format. The decentralized ledger of a blockchain network provides a transparent and immutable record of all transactions, including the flow of medical data. This makes it easier to track the flow of medical data and prevent fraud.

2. Related Work

Blockchain is a decentralized and distributed digital ledger technology that allows for secure and transparent record-keeping. The use of blockchain in the health sector has the potential to improve data management, reduce costs, and enhance patient care. There is a potential use of blockchain in the health sector, various researchers have completed the exploration on this area, this examination focus around the way that whether utilizing blockchain for medical care area is tenable or not. They too recognize the benefits, dangers, issues or difficulties associated by the use of this innovation. A few researchers yet talked about the difficulties that would be looked while as a matter of fact executing this for a bigger scope.

2.1. Blockchain-Based Research in Health Sector

The author Asma Katoon [1] in his manuscript put forthA blockchain based smart contract system for health management" utilizing the smart contract in Ethereum and DApp along with DFS for backend.

The author Hui Li Wang [2] presented his work on "Blockchain based medical record management with biofeedback information". The method utilized the Smart contract and its types on Ethereum for medical record management with biofeedback information.

The research work of Bhalaji, Aishwarya, Krithika Balaji [3] published in December 2020 in ISMAC. proposed the Blockchain Hyperledger Fabric framework, docker, and REST client architecture to manage the medical data.

Ch. Srinath, K. Srinivasulu, K.V. Pavan [4] in his manuscript "Medical report management and distributed system on blockchain". has utilized the SHA 1 algorithm and Hyperledger for medical record management.

The research work of Anton Hasselgren, Katina Kraleusks, Danilo Gligoroski, Sindu A Pedersen, Arlid Faxvaag [5] published in 2020. proposed the "Blockchain in healthcare and health science" using few consensuses mechanism like PoW and PoS, smart contract on Ethereum.

Anushru Islam, Amandeep Dhir, A K M Najmul Islam, Matti Mantymaki [6] proposed the "Blockchain in healthcare". The technology used a test network and consensus algorithm enhancing the performance of the blockchain in healthcare

Rim Ben Fekin and Mariam Lahami [7] in the research work on "Application of Blockchain Technology in healthcare" Worked with Proprietary framework on Ethereum using DApp and ensured the data management capability of the blockchain in managing the healthcare information

Andrew Hoo Sun Fang, Kai Sun, Daniel Sho Wei Tang and Alex Tiang Hung Sia [8] in the research work on"Blockchain Application in healthcare for covid-19 and beyond" used Ethereum and Hyperledger on blockchain technology and also used big chain database.

Ariel Ekblad, Asaph Azaria, John D Halama, and Andrew Hippman [9] in "A case study for Blockchain in healthcare: "MedRec" prototype for electronic health records and medical research data". used consensus algorithm of proof of work and proof of stake and smart contract.

Laure A Linn and Martha B Koo [10] in the research on "Blockchain for health data and its potential use in health IT and health care related research" used shared ledger and bitcoin technology on distributed network to ensure the potential use of block chain in health IT and health care related research

Faheem Ahmad reege, Salwani mohd, Zaid hakami, Kaeser Kareem Reeger, in his research on "Towards Trust Worthiness of electronic health record system using blockchain". proposed an EHR frameworks using solidity and using MD-5 algorithm.

R. Sangeetha, B. Harshini, A. Shanmugapriya, T. K. P. Rajagopal [12] proposed "Electronic health record system using blockchain". The proposed methodology used SHA-256 Algorithm and etherscan of Ethereum, Smart contract, frontend contract, truffle framework and Mist browser.

Halima Mhamdi, Manel Ayadi, Amel Ksibi, Amal Al-Rasheed and Sakli Hedi [13] put forth the "SEMRA chain: A Secure Electronic medical record based blockchain technology". the technology proposed is Implemented using MetaMask, node js, and ganache.

Koshechkein K. A, Klimenko G. S., Ryatkov I. V., Kozhin P. B. [14] proposed "Scope for the application of blockchain in the public health care of the Russian Federation utilizing the Vue js, typescript, and MetaMask on the Ethereum network

Peng Zhang, Jules White, Douglas C Schmilt, Gunther Lenz and S. taent Rosenbloom [15] proposed a "FHIR chain: Applying blockchain to securely and scalable share clinical data". The methodology used is MD-5 and SHA-256 algorithm on Smart contract on Ethereum languages.

3. Proposed Work

The health records management system using blockchain aims to improve patient care and healthcare system efficiency and it allows for the decentralized storage of patient health information, which can be accessed by authorized healthcare professionals across different locations and care settings. The two entities of the proposed system are user and the administrator. For the proposed framework, users are further split into two categories doctor and patient. The administration role is handled by the administrative staff of the hospital. The administrator is capable of accessing and assigning roles to the users. As a first task the administrator assigns role to the user defining the name of the role and including the account specifics of the user to whom the work is assigned. On completion of the role allotment by the admin every user will have unique roll name and an account information. For the purpose of validation that is required in subsequent phases, a certain role's name and account address are maintained in a roles list. The following figure 1 explains the workflow:

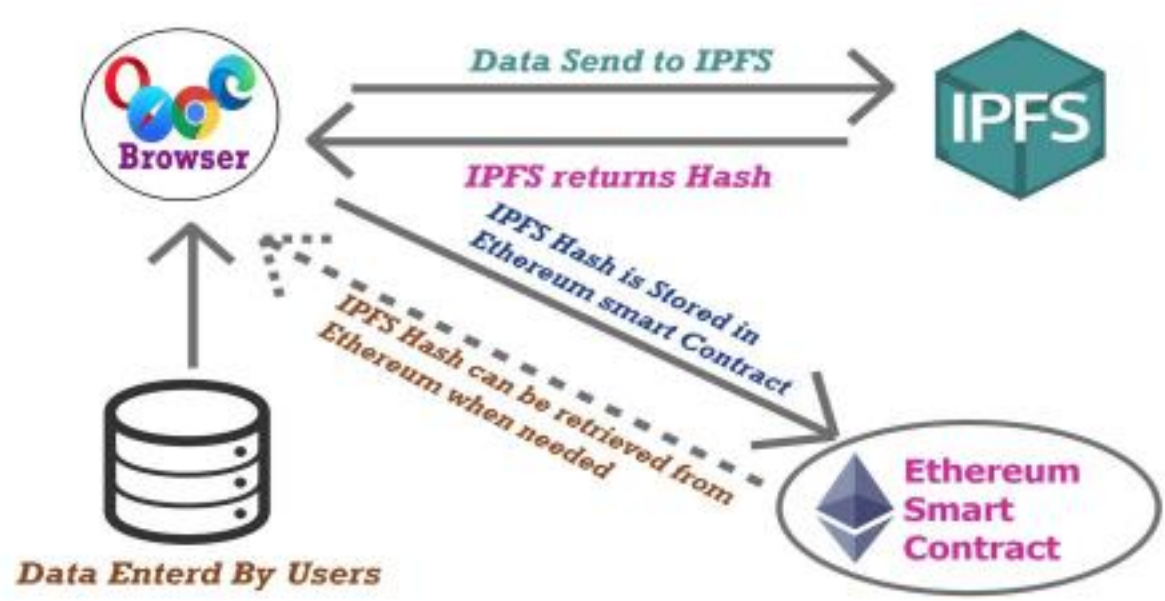

Figure 1. Workflow of DApp

3.1. User Layer

In an Electronic Health Record (EHR) system, the user layer refers to the interface that allows healthcare professionals to access and interact with patient data. The user layer is the part of the EHR system that clinicians use to view patient charts, enter new information, and retrieve data for analysis and reporting.

The user layer includes security features that allow users to control access to patient data, ensuring that only authorized personnel can view and edit sensitive health information as shown in figure 2.

3.2. Blockchain Layer

The blockchain layer in an Electronic Health Record (EHR) system refers to the underlying technology that enables secure and decentralized storage and sharing of patient data. Blockchain [16-19] is a distributed ledger technology that allows multiple parties to access and update a shared database without the need for a central authority.

In an EHR system, the blockchain layer can be used to create a tamper-proof and secure system for storing patient data. Patient data is stored in a block, which is linked to other blocks in a chain using cryptography. Each block contains a unique code called a hash, which makes it impossible to alter or delete data without leaving a permanent trace.

3.3. Transaction Layer

The transaction layer in an Electronic Health Record (EHR) system refers to the layer that handles the processing and recording of transactions related to patient data. These transactions can include the creation and updating of patient records, the sharing of data between healthcare providers, and the management of access and permissions.

The transaction layer typically involves a set of rules and protocols for managing transactions, ensuring that patient data is handled in a secure and standardized manner. These protocols may include encryption and decryption techniques, digital signatures, and other security measures to protect patient data from unauthorized access or tampering.

The transaction layer in an EHR system can also facilitate the integration of different healthcare systems, enabling seamless sharing of patient data between different providers and organizations. For example, a transaction layer may allow a hospital to securely share patient data with a primary care provider, or enable a patient to grant access to their medical records to a specialist.

3.4. Algorithm

```
function accessPatientData (patient_id, requester_id) {
 require (msg. sender == healthcare provider || msg.sender == patient); // Check if the requester is authorized to access the patient's data
if (msg. sender == healthcare_provider) {
 require(checkAuthorization(patient_id, requester_id));
}
 // Retrieve the patient's data from the blockchain
 PatientData patient = blockchain.getPatientData(patient_id);
// Log the access to the patient's data
blockchain.logAccess(patient_id, requester_id);
return patient;
```

```
}
// Define the rules for sharing patient data
function sharePatientData(patient_id, requester_id, recipient_id) {  require(msg.sender == healthcare_provider || msg.sender == patient);  // Check if the requester is authorized to share the patient's data  if (msg.sender == healthcare_provider) {
require(checkAuthorization(patient_id, requester_id));  }
// Retrieve the patient's data from the blockchain
PatientData patient = blockchain.getPatientData(patient_id);
// Log the sharing of the patient's data
blockchain.logSharing(patient_id, requester_id, recipient_id);
// Update the recipient's access to the patient's data
updateAuthorization(patient_id, recipient_id);
return true;
}
}
// Define the functions for managing patient data on the blockchain blockchain {
// Add a new patient to the blockchain
function addPatientData(patient_data) {
PatientData patient = new PatientData(patient_data); blockchain.addPatientData(patient);
return true;
}
// Retrieve a patient's data from the blockchain
function getPatientData(patient_id) {
```

```
PatientData patient = blockchain.getPatientData(patient_id);  return patient;
}
// Log the access to a patient's data
function logAccess(patient_id, requester_id) {
AccessLog access_log = new AccessLog(patient_id, requester_id); blockchain.addAccessLog(access_log);
return true;
}
// Log the sharing of a patient's data
function logSharing(patient_id, requester_id, recipient_id) {
SharingLog sharing_log = new SharingLog(patient_id, requester_id,  recipient_id);
blockchain.addSharingLog(sharing_log);
return true;
}
}
```

4. Results and Discussion

4.1. Admin Module

The admin module in an Electronic Health Record (EHR) system refers to the set of tools and features that enable administrators to manage and configure the system. The admin module is typically accessible only to authorized personnel, such as system administrators, IT staff, or designated EHR managers.

The admin module also enables organizations to customize the EHR system to meet their specific needs, improving efficiency and productivity as shown in figure 2.

4.2. Doctor Module

The doctor module in an Electronic Health Record (EHR) system refers to the set of tools and features that enable doctors and other healthcare professionals to access and manage patient data. The doctor module is designed to provide a user-friendly interface that allows clinicians to quickly and easily view patient information, document clinical notes, and manage treatment plans as presented in figure 3.

The doctor module is designed to improve the efficiency and effectiveness of clinical workflows, enabling doctors to spend more time with patients and less time on administrative tasks. The module also supports collaboration and communication among healthcare providers, improving the coordination of care and the quality of patient outcomes.

4.3. Patient Module

The patient module in an Electronic Health Record (EHR) system refers to the set of tools and features that enable patients to access and manage their own health information. The patient module is designed to provide a user-friendly interface that allows patients to view their medical records, communicate with healthcare providers, and participate in their own care.

The patient module is designed to empower patients to take an active role in their own care, improving patient engagement and outcomes as shown in figure 4. The module also supports communication and collaboration between patients and healthcare providers, improving the quality of care and reducing healthcare costs.

4.4. Project Development Environment

Front End: ReactJS, HTML, CSS, JavaScript.

Back End: NodeJS, Ganache (Blockchain), Truffle Framework, MetaMask Browser extension (Connect Browser to Blockchain), Some NodeJS Libraries.

IDE: VSCode

4.5. Results

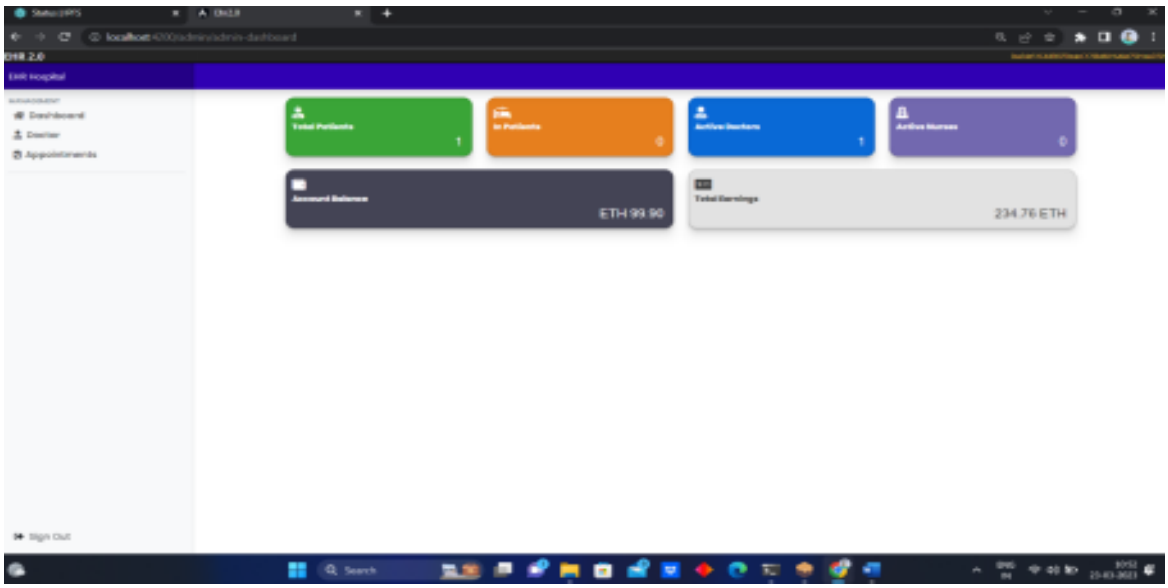

Figure 2. Admin Dashboard

The admin dashboard allows them to oversee and maintain the system's operations, security, user management, and other administrative tasks.

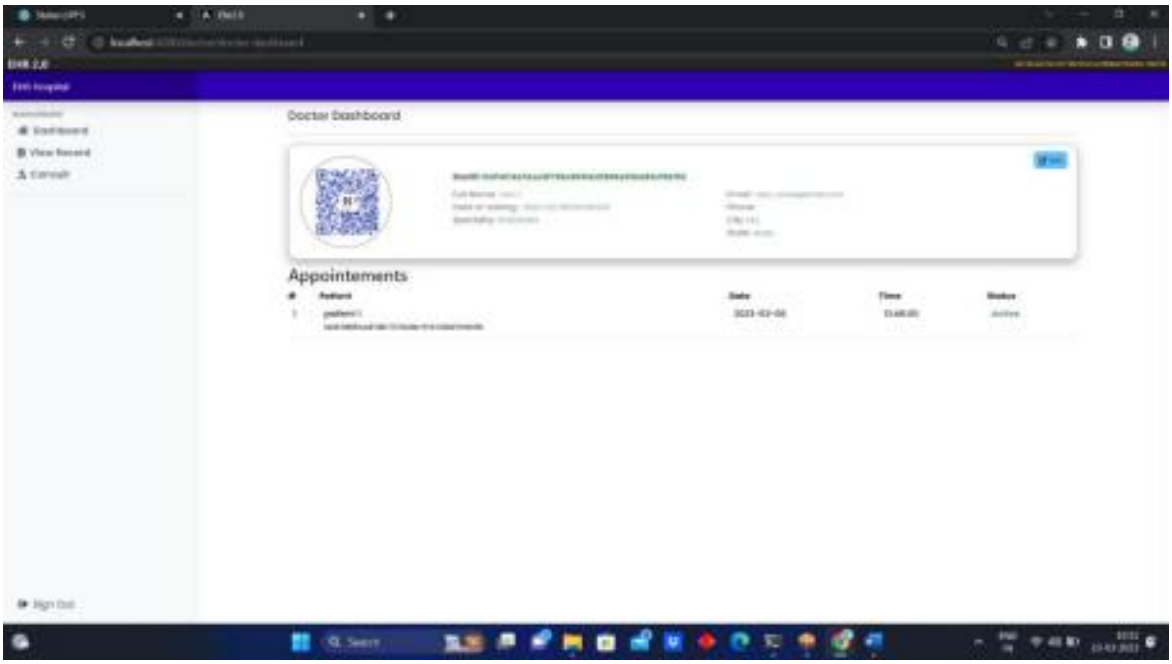

Figure 3. Doctor Dashboard

The doctor dashboard serves as a dedicated interface for healthcare doctors to manage patient information, make clinical decisions.

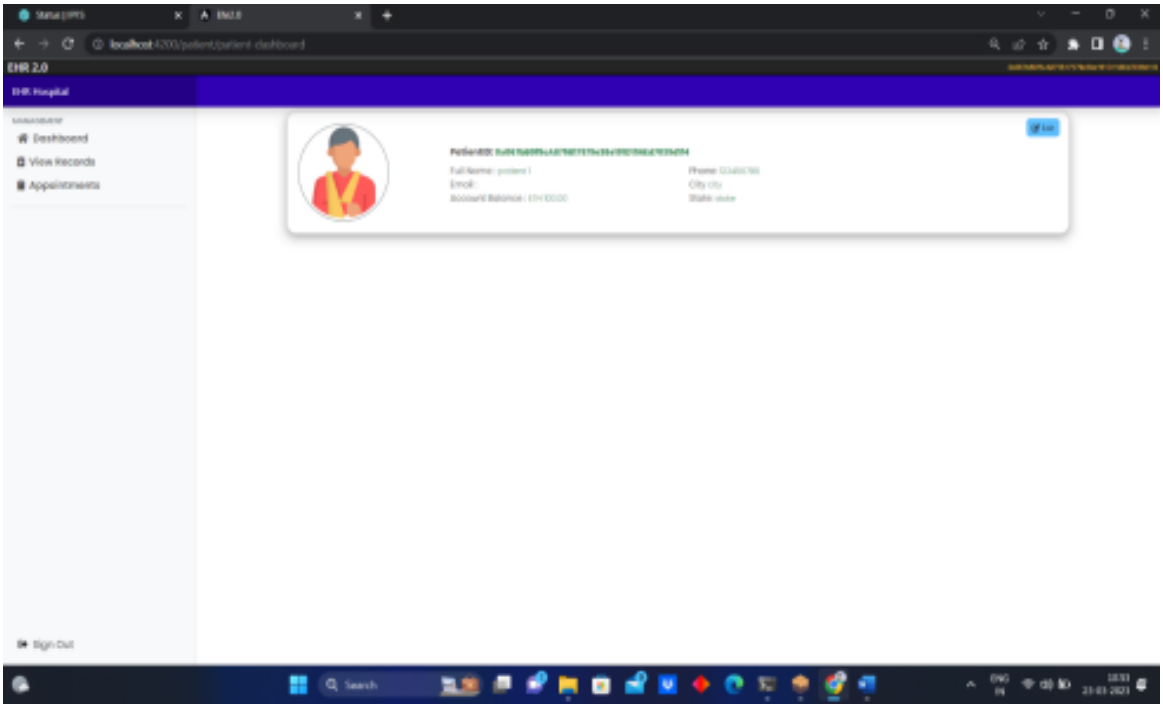

Figure 4. Patient Dashboard

The patient dashboard provides patients with access to their own health information, empowers them to actively participate in their healthcare.

5. Conclusion

In conclusion, the use of blockchain technology in electronic health records (EHRs) has the potential to revolutionize the healthcare industry by providing a more secure, transparent, and efficient way of storing and sharing patient data.

The use of blockchain can provide a tamper-proof and decentralized system for storing EHRs, ensuring that patient data is secure and accessible only to authorized individuals. This can help to prevent data breaches and unauthorized access to patient information.

Moreover, the use of blockchain can enable patients to have more control over their health data and facilitate easier sharing of their medical records with healthcare providers, thus improving healthcare outcomes and reducing costs.

Despite its potential benefits, the adoption of blockchain technology in healthcare is still in its early stages, and there are several challenges that need to be addressed, such as interoperability issues, regulatory concerns, and the need for standardization.

Overall, the use of blockchain in EHRs has the potential to transform the healthcare industry, and with further research and development, it could become a standard solution for storing and sharing patient data securely and efficiently.

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