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Medical Records Management with Decentralized Framework

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Abstract: ***The mystery between the emotional improvement of medical information protection interest and long periods of administrative guideline has eased back advancement for electronic medical records (EMRs). In this paper, we propose a efficient, secure and decentralized Blockchain system for data privacy preserving and sharing. This manages confidentiality, authentication, data preserving and data sharing when handling sensitive information. We exploitconsortium Blockchain and smart contracts to accomplish secure information storage and sharing, which forestalls information sharing without consent. The patient's historical data, medical record, patient's private information is very critical and needs to be stored and maintained securely. The proposed framework builds information security and eliminates the cost, time, and assets needed to deal with the medical care information records.***

Keywords: Healthcare Blockchain, Blockchain Technology, Data Security, Healthcare Data, Consensus Algorithm

I. INTRODUCTION

Health data is highly sensitive and valuable for institutes. It is troublesome for users when they have treatment in different hospitals as before because institutes and hospitals do not share data. The U.S. is poised to spend 20% of its GDP on healthcare in the near future.[2] Focusing on quality health care services means ensuring patient health management at a superior level at all times. However, in the health care sector, critical patient data and information remains scattered across different departmentsand systems. We cannot deny the possibility of private server data leak for commercial profits.[1],[3] Furthermore, the lack of (correct) information has been considered the primary cause of problems in health care, leading to medical errors and adverse events.[4] The issue of a single point of failure along with data security and patient's privacy risk prevailing still exist in cloud-based systems. According to the statistics provided by the Health Insurance Portability and Accountability Act (HIPAA), 13,236,569 medical records were breached in 2018 which were as twice as com- pared to 5,138,179 records breached in 2017.[5]

II. THE INTER-PLANETARY FILE SYSTEM (IPFS)

The Inter-Planetary File System, IPFS is a decentralized file sharing platform that identifies files through their content. Whena file is uploaded to IPFS, it is split into chunks, each containing at most 256 kilobytes of data and/or links to other chunks. Every chunk is identified by a cryptographic hash, also named content identifier that is computed from its content.

A. Properties

The properties of IPFS are as follows:

1) Node IDs

a) Public Key Hash.

2) DHT: S/Kademlia

a) It stores two different types of information.

b) First, whenever a file is uploaded through a node, the latter registers itself as a provider of the file's chunks.

c) Second, the DHT contains information on how to connect to a node with a specific identifier, for example by providingan IP-address.

3) Block Exchange

a) Like BitTorrent, but not exchange not limited to blocks in a torrent.
b) Incentivizing cooperation (different strategies: tit-fortat, currency-based etc.).
c) Per-node ledger for accounting transfers that is exchanged when nodes "connect".

4) Object Merkle directed acyclic graph (DAG)

a) An entire file can be identified by just using the root hash with the help of Merkle DAG.
b) On top of DHT/block exchange.
c) Objects are immutable.
d) Generalization of Git data structure.

III. PROPOSED MODEL

We base our system on the IPFS service which is a decentralized platform. IPFS integrates Merkle Linked structure withthe data addressability of P2P file sharing systems. We plan to store the actual medical records on a decentralized cloudstorage Each medical record will have a unique hash which will be combined with the decryption key. We also plan to include Versioning control mechanism. The approach we will be using for this project could be as follows:

1) The user will add their personal information, health records and medical history.
2) Hospital authority will submit the patient will be appended with the patient existing history.
3) A transaction will be generated which will be added to a block. That block will then be added appended to the existing chain.
4) The user can then access the data according to his will.

IV. SYSTEM DESIGN

A. System Architecture

Healthcare Data Storage Using Blockchain system which provides the top level security to all healthcare related data records and which removes cost, time, and other resources required for managing the all this information.

1) Patient Account: The user will add their personal information for creating their new account. It also contains their health records and medical history.
2) Report Submission: Hospital authority will submit the patient medical report. Submitted report will append with the patient existing history. Submission of one report generates one transaction.
3) Generate Transaction: From report submission to the billing process activity generates a number of transactions. All transactions are connected sequentially to each other like linked list.
4) Block Generation: A block contains more than 500 transactions on average. In this phase the generated block containsall transaction of the particular user/patients. The newly generated block is added into the existing blockchain. A block is composed of a header and a long list of transactions.
5) Block Header: It contains metadata about a block i.e. Previous block hash, mining competition, merkle tree root etc.
6) Transaction Verification: Insurance Company Officer will act as a validator. After raising insurance claim to the insurance company, the office will validate the patient transaction history.
7) Final Outcome: After validating the patient transaction officer will approve or reject the claim. And transfer claim money to the patient account.

B. Mathematical Model

Let us consider S be a Systems such that S= *{*U, M, I, T, EC ,DM ,Ds ,Ss*}*, where

1) U= U1, U2, U3. . . . . .Un — 'U' is a Set of all USERS U is the users of the system. Users of the system may grow as the system is used by more and more people. User isinfinite set.
2) H= H1,H2,H3. Hn — H is a Hospital Authority There may be number of Hospital Authority for submitting patient Medical Report in system. So this is the Infinite Set.
3) I= I1,I2,I3. In — I is a Insurance Company Officer. There is Insurance Company Officer will track Patient Data. So it is finite Set.

a) USERINFO = *{* FULL NAME, Email ID, USER Personal Information , User Medical Record is a set for storing User Data.*}*

b) Ds = *{* User Medical History — DS is a Set of data table for permanent storing of data on server*}*

c) BS = B*{* REG,Bs LOGIN, BS ADD — Bs is a Set of block chain server. BLOCK CHAIN SERVER will provide services like Registration, Login, Upload record. As this set also has finite attributes, so this is also Finite Set.*}*

V. IMPLEMENTATION

The systems GUI was designed using java JSP. Core Technologies used were Java, JSP. The overall development was donein the Eclipse luna and for DB we used MYSQL GUI browser.

A. Overview of Project Modules

In medical systems it is necessary to provide certain security mechanism to protect the heath related data as it containssome private information. The traditional method used for maintaining privacy of the data may leak the privacy and integrity while sharing the medical data with more stakeholders for various purposes. The proposed system provides reliable and secure healthcare scheme using blockchain by providing the top level security to all healthcare related data records. The main module involved in the project are as follows:

1) Patient Account.
2) Report Submission.
3) Generate Transaction.
4) Block Generation.
5) Transaction Verification.
6) Final Outcome.

B. Tools and Technologies Used1) JDK 1.8:

1) The Java Development Kit (JDK) is a software development environment used for developing Java applications and applets. It includes the Java Run- time Environment (JRE), an interpreter/loader (java), a compiler (javac), an archiver (jar), a documentation generator (javadoc) and other tools needed in Java development.

2) A Java virtual machine (JVM) is an abstract computing machine that enables a computer to run a Java program. Thereare three notions of the JVM: specification, implementation, and instance. The specification is a document that formally describes what is required of a JVM implementation. Having a single specification ensures all implementations are inter- operable.

C. Databses

a) The database basically used for user storing user details like Username and Password. The tool used for db functionalities was MYSQL GUI Browser.

b) SQL is used manipulate, define data, and to provide access control.

VI. TEST CASES AND RESULTS

A. Test Cases

Test case id	Test case description	Test steps			Test status (P/F)	Test prorit y	Defect severity
		Step	Expected	actual			
T1	Login with Personal Information And Password to The System	Enter login name and password	If Username and Password are correct then message "Login successful" and directed towards the next page.	Login successful	P	High	Low
		Enter invalid login name and password	If username or password are incorrect or any one of them is blank then show error message as "Please enter correct password".	Display error Message.	P	High	Low

Fig. 1. Test Case 1

T2	**Report Submission**	Submit The Patient Medical Report	Append With The Patient Existing History	Submission Of Generated Report	P	High	Medium
T3	**Generate Transaction**	Generating Transaction Of Billing Activity	Connect The Transaction sequentially	Same As Expected	P	High	Low

Fig. 2. Test Case 2 & 3

T4	Block Generation	Maintain Transaction record of Particular Patient	Block Generation With All this Detail	Same As Expected	P	High	Low
T5	Final Outcome	Verify The Patient Transaction	Validation By transaction Officer	Approve or Reject Claim	P	High	Low

Fig. 3. Test Case 4 & 5

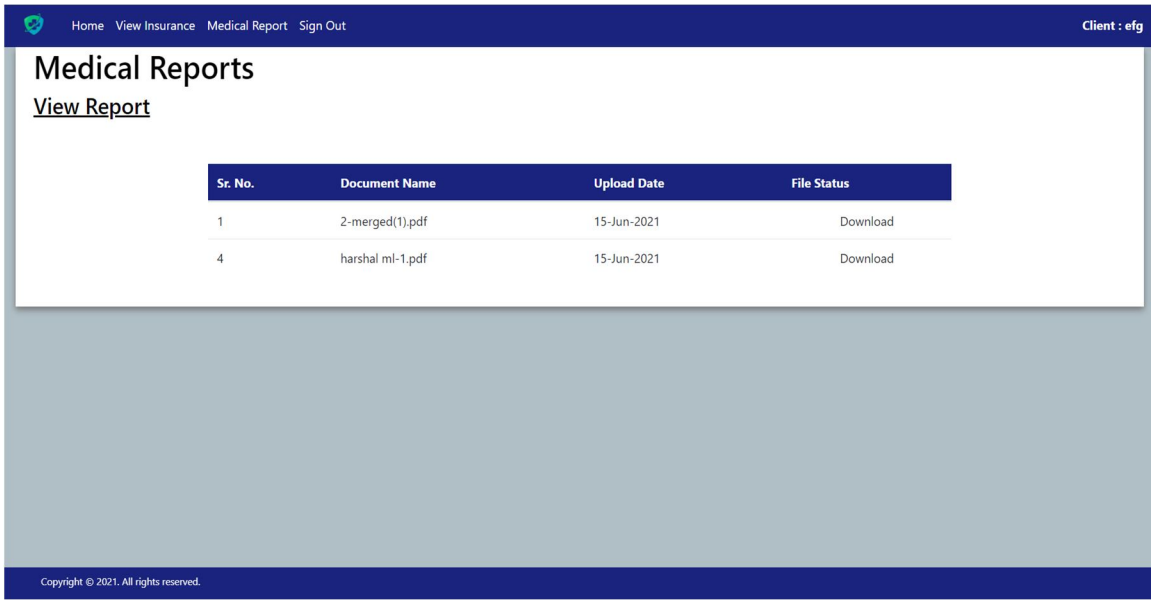

Fig. 4. Medical Reports

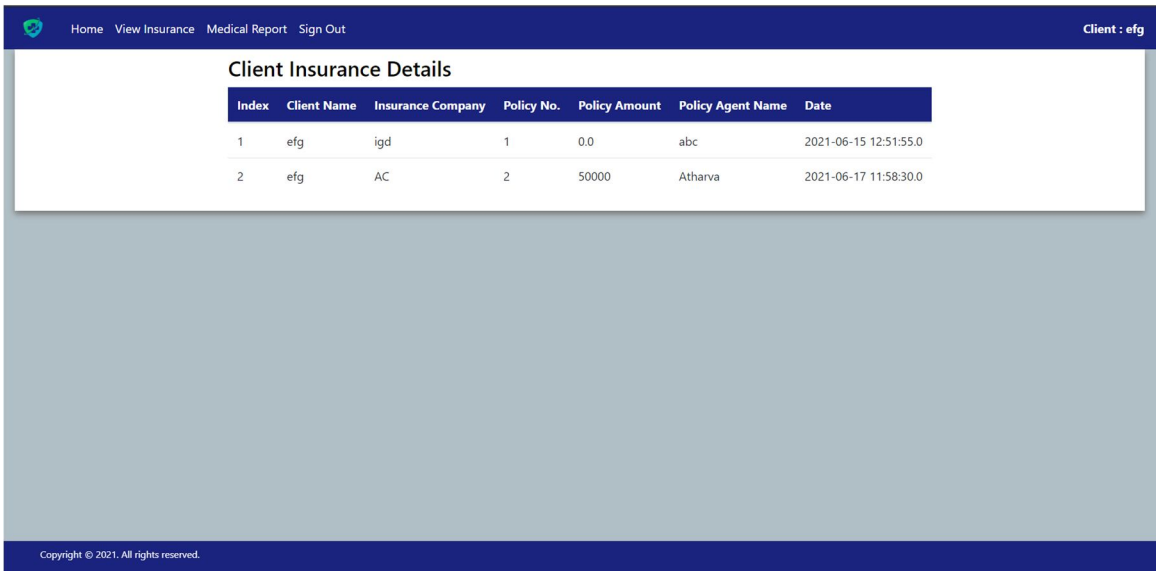

Fig. 5. Client Insurance

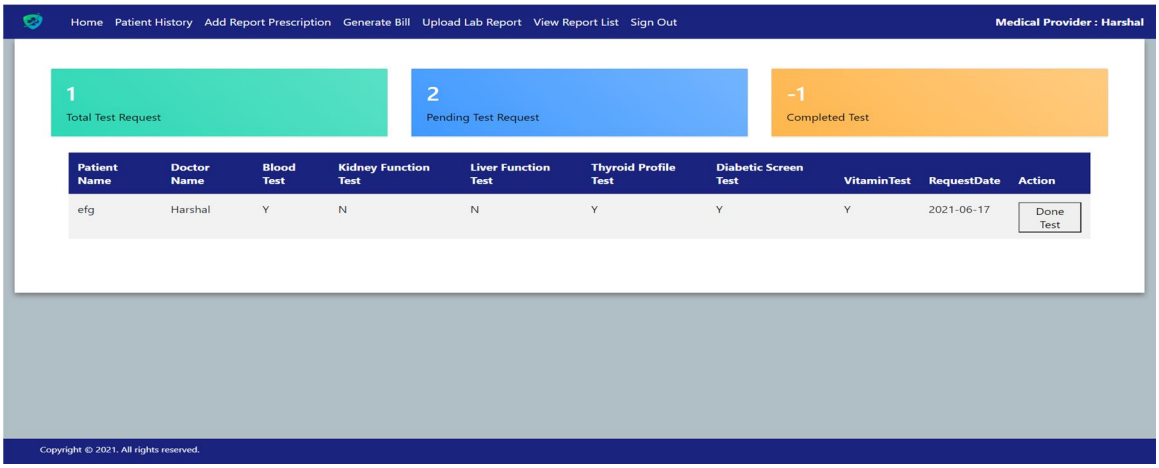

Fig. 6. Medical Provider Homepage

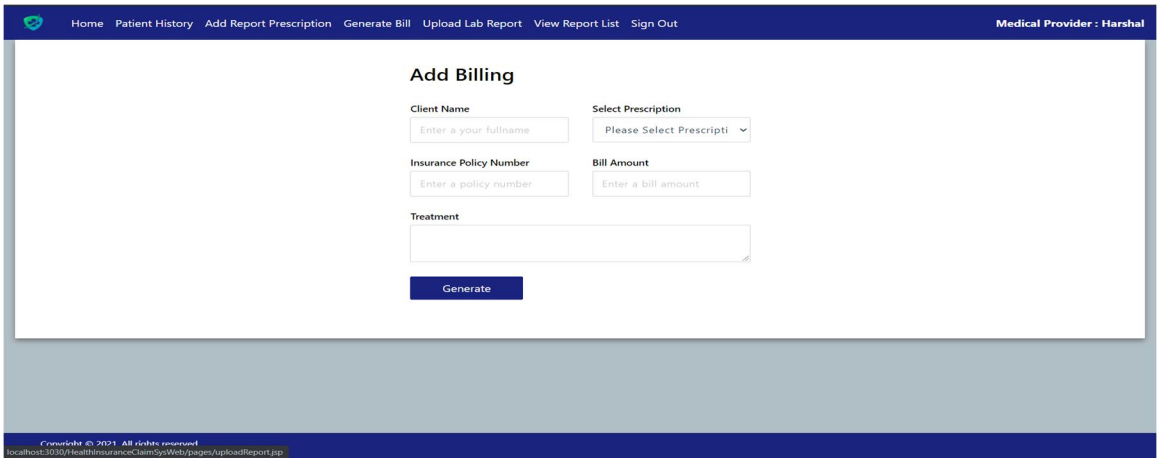

Fig. 7. Add Billing

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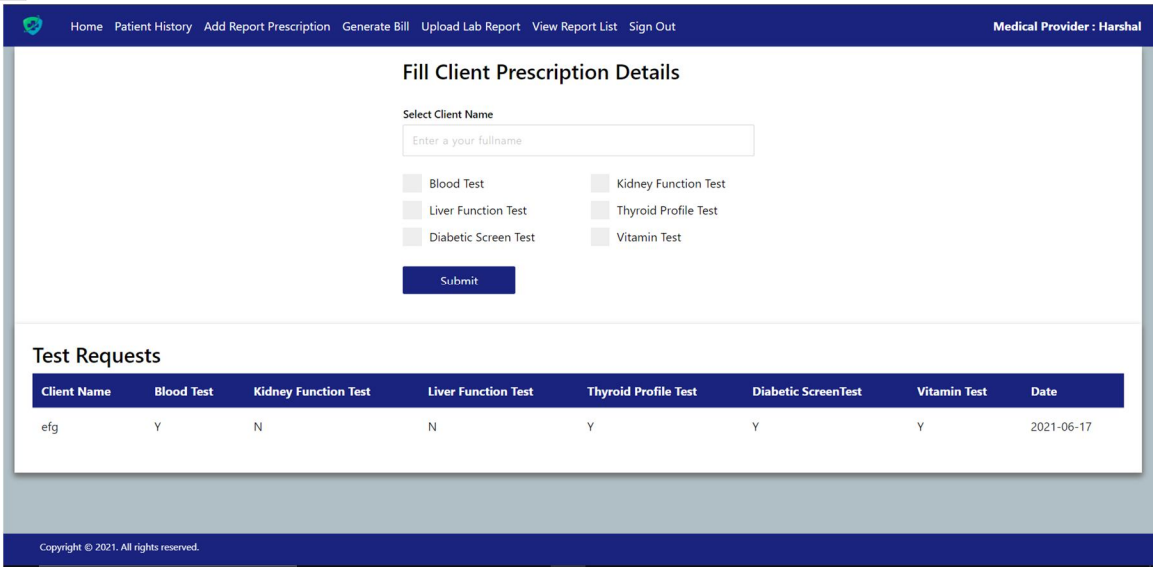

Fig. 8. Client Prescription

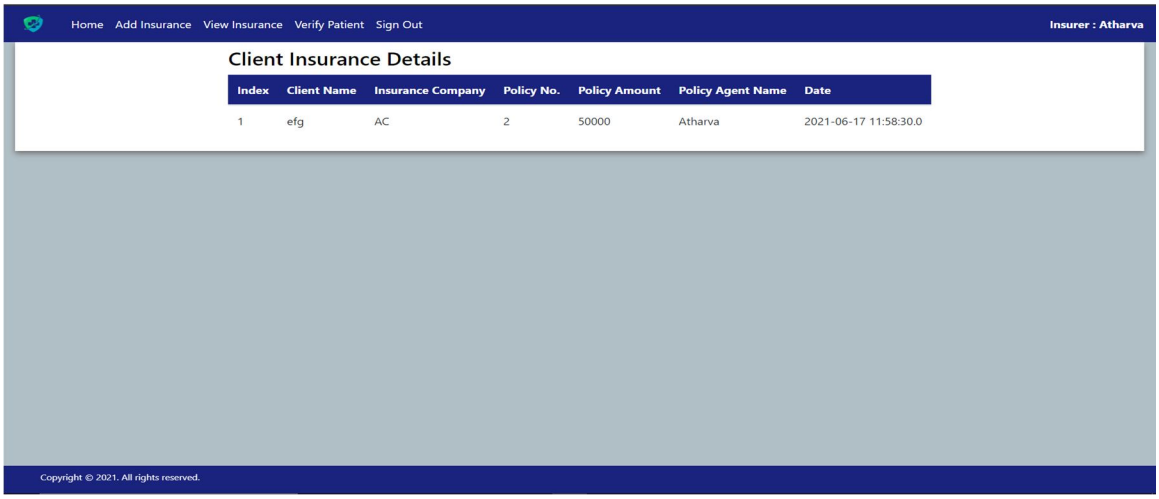

Fig. 9. Client Insurance Details

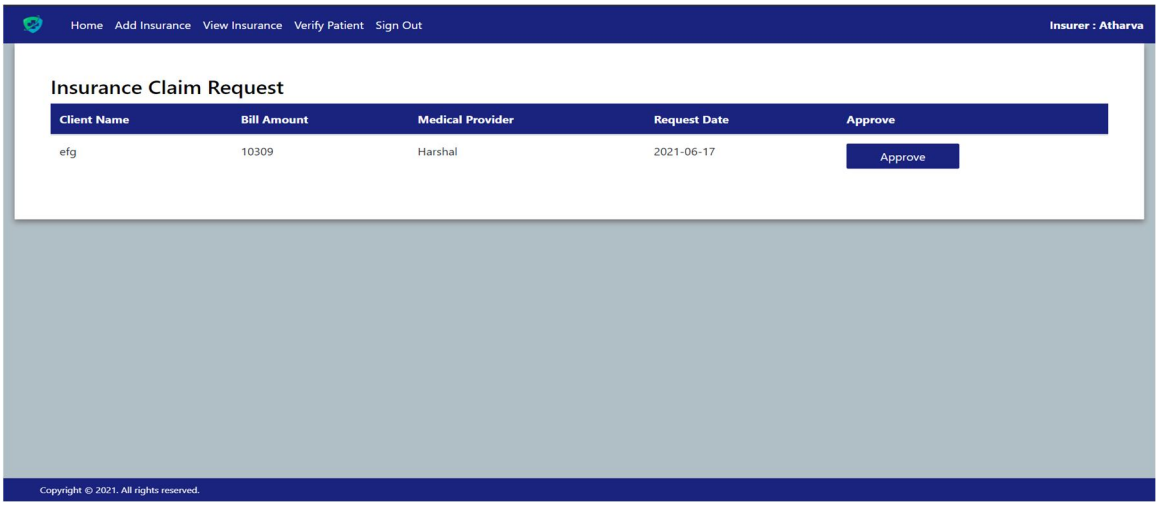

Fig. 10. Insurance Claim Request

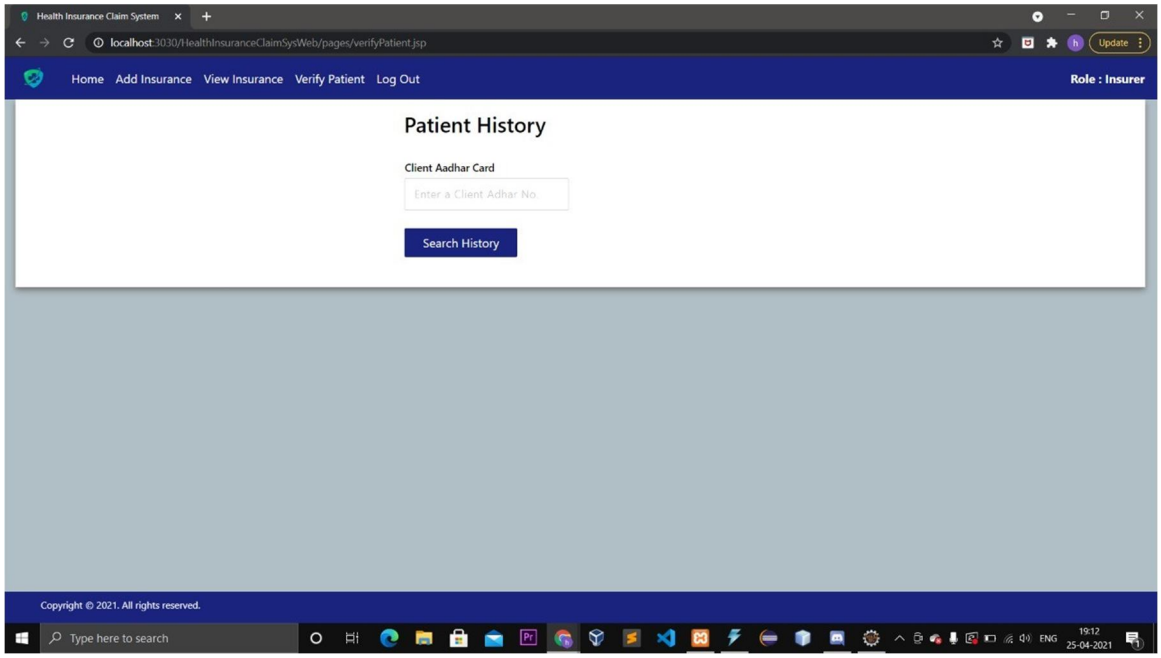

Fig. 11. Patient History

VII. CONCLUSION

Blockchain has shown its potential for transforming the traditional industry with its key characteristics such as decentral- ization, persistency, anonymity, and auditability. The proposed system provides reliable and secure healthcare scheme using blockchain that works in decentralized environment by removing the cost of resources such as cost, time to manage the healthcare data records. The system is able to maintain the privacy and provide top level security to healthcare data recordsas it contains some private information related to health. So such security mechanism explained here that protect the heath related data.

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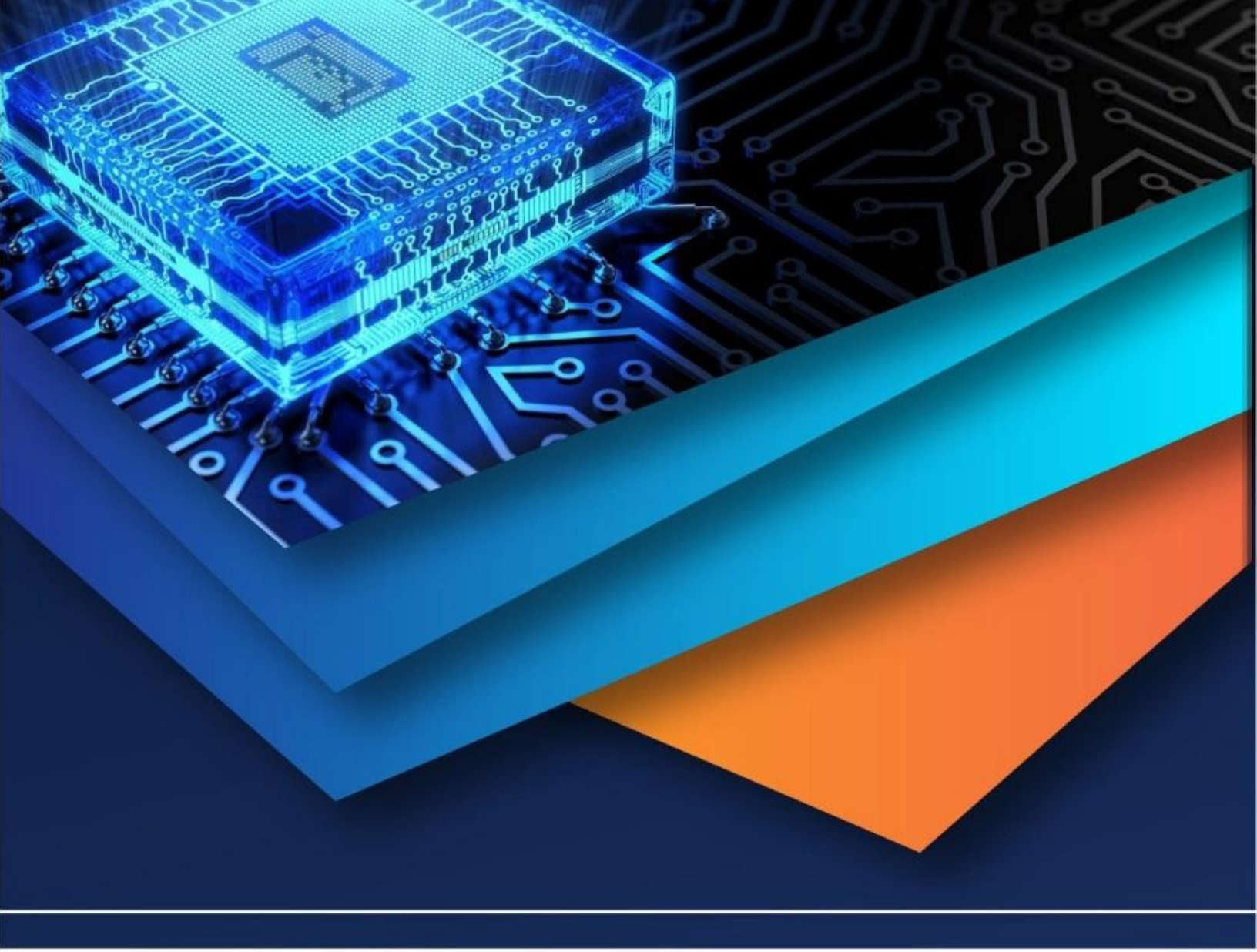

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