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Global Data Access Safeguarding Patient Health Records Using Smart Contracts and Web 3.0

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ABSTRACT : Health information security is a critical element of the Insurance Portability and Accountability Act regulations. Around 750 data breaches occurred in 2021, with the top seven opening more than 193 million personal records to fraud and fraud. Data security refers to the method of protecting data from unauthorized access and data corruption throughout its life cycle. Data security includes data encryption, hashing, tokenization, and key management practices that protect data across all applications and platforms. The security system used today uses data encryption software to improve security. Effectively securing data by using an algorithm (called encryption) and an encryption key to convert plain text into encrypted cipher text. The encrypted data cannot be read by unauthorized persons. Only this user can decrypt this data with a certified key. While nowadays the improvement of data insecurity leads to the loss of sensitive data since the secret is easy to hack thanks to the use of a algorithm, it is also difficult at the airport to search for who is vaccinated or not and vaccinations given in different countries do not seem to be easily validated. To overcome these problems, this paper introduces an efficient data security system using smart contracts and WEB 3.0 play an important role in securing information. Also, it offers complete data security where the information cannot be tampered with by the hacker in any way. A framework called WEB 3.0 is being developed which has a built-in blockchain framework to protect information in the back-end. No encryption or decryption secret is required to access the data, eliminating the fear that the hacker will hack or tamper with the information.Therefore, this method represents an extreme to end the data security of a hospital's medical records and effectively find a vaccinated person using the information.

KEYWORDS : Blockchain, WEB3.0, Data Security, Encryption, Smart Contract, Medical Records.

I. INTRODUCTION

Throughout its life cycle, data security refers to the method of securing information from outlaw access and information corruption. It includes encoding, hashing, tokenization, and key management square measure all data security ways that safeguard data across all applications and platforms.

To protect their essential assets, businesses all over the world are actively investing in information technology (IT) cyber security capabilities [4]. Whether a company needs to protect its brand, intellectual property, or customers, People, processes, and technology all play a role in incident detection and response, whether it's to defend organizational interests or to provide controls for vital infrastructure.

Smart contracts and WEB 3.0 play a key role in safeguarding data in the Efficient Data Security System. Furthermore, it guarantees comprehensive data security, ensuring that the data cannot be tampered with in any way by a hacker[1]. A smart contract is a two- or more-party agreement that is stored on a blockchains [2], such as Ethereum or EOS. The Solidity programming language is utilized in the construction of smart contracts in our paper, and it is used to create end-to-end secured contracts. Then there's functionality testing, which is done with the Remix IDE[13]. The data is integrated at the front-end using the truffle framework integration. WEB 3.0 is a framework that has a built-in blockchain structure for securing data at the back-end.There is no need for an encryption or decryption key to access data, which eliminates the risk of data being hacked or modified with by a hacker. The output from the entire development will then be collected by the test network. It will be installed on a local platform and integrated with a blockchain network, which will verify the smart contract's practicality.

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1.1 BLOCKCHAIN

Blockchain is a way of storing data in such a way that it is impossible to alter, hack, or cheat it. A blockchain contains digital log of transactions that is distributed and duplicated across the blockchain's complete network of computer systems[1]. Each block on the chain contains a numerous amount of transactions, and whenever a new transaction occurs on the blockchain, a record of that transaction is added to the ledger of each participant. Distributed Ledger Technology refers to a decentralized database that is administered by many parties (DLT). Blockchain is a sort of distributed ledger technology (DLT) in which transactions are recorded and it uses an immutable cryptographic signature known as a hash. This means that if one block in a chain was modified, it would be immediately obvious[7]. Hackers need modify every block in the chain across all the distributed versions of the chain if they wanted to corrupt a blockchain system. Blockchains like Ethereum and Bitcoin are constantly growing as new blocks are added to the chain, It increases the security of the ledger dramatically.

1.2 ETHEREUM

Ethereum was intended to let developers to write and publish smart contracts and distributed apps (dApps) without the danger of downtime, fraud, or third-party interference. "The world's programmable blockchain," according to Ethereum. It is completely different from Bitcoin it is a programmable network that acts as a marketplace for financial services, games, and apps, all of which can be purchased using Ether cryptocurrency and are free from fraud, theft, and censorship.

Ethereum's platform may be used to "codify, decentralize, secure, and trade just about anything," according to the company. A number of projects are in the works to put the concept to the test[8]. Ethereum Blockchain as a Service (EBaaS) will be available on the Microsoft Azure cloud thanks to a collaboration between Microsoft and ConsenSys. Its goal is to provide a single-click cloud-based blockchain developer environment to Enterprise clients and developers. Ethereum, like any other blockchain, is a decentralized database of data that is supposed to be impenetrable[10]. The cryptocurrency Ether, or ETH, is used to execute blockchain transactions.

Unlike traditional databases, information in a blockchain is arranged as a chronological "chain" of data "blocks." Every transaction involving an Ether token, for example, must be confirmed and recorded as a new block on that coin's blockchain[12]. The technique of documenting each transaction in order is why a blockchain is frequently compared to a ledger. The Ethereum blockchain holds more than just Ether transaction records. It enables software developers to create and offer games and commercial apps, known as dApps[14], to customers. Those users wish to take advantage of the relatively low dangers associated with storing sensitive data on the Internet.

1.3 CONSENSUS ALGORITHM

A consensus algorithm is a method in which all the peers in a Blockchain network reach a consensus on the current state of the distributed ledger. Consensus algorithms achieve blockchain network resilience and creates a trust amongst unknown peers in a distributed computing environment in this way[11]. In essence, the consensus protocol ensures that every new block added to the Blockchain is the only version of the truth that all nodes in the Blockchain agree on.

The Blockchain consensus protocol has several specific goals, including reaching an agreement, collaboration, cooperation, equal rights for all nodes, and each node's mandatory participation in the consensus process. As a result, a consensus algorithm seeks to identify a common ground that benefits the entire network.Consensus algorithms must expect that some processes and systems will be unavailable, as well as that some communications will be lost, to handle this reality. Consensus algorithms must be fault-tolerant as a result[12].

They commonly presume that just a percentage of nodes would reply, but demand a minimum response from that portion, such as 51%.Consensus algorithms are used in the following situations:

1. Deciding whether or not to commit a distributed transaction to a database.
2. Appointing a node as the leader of a distributed task.
3. Assuring consistency amongst state machine replicas by synchronizing them.

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Google's PageRank, load balancing, smart grids, clock synchronization, and drone control are all supported by consensus algorithms. Proof of Work (POW), Proof of Stake (POS), and Practical Byzantine Fault Tolerance[10] are the three primary types of consensus algorithms used in Blockchain networks to reach a distributed consensus (PBFT).

II. RELATED WORKS

A. DeepKeyGen: A Deep Learning-Based Stream Cipher Generator for Medical Image Encryption and Decryption

DeepKeyGen [1] was proposed by Yi Ding, Fuyuan Tan, Zhen Qin, Mingsheng Cao, Kim-Kwang Raymond Choo, and Zhiguang Qin to protect the privacy of patients' medical imaging data, for example. As a stream cipher generator, an unique deep learning-based key generation network (DeepKeyGen) is presented to produce the private key, which can then be utilized to encrypt and decrypt medical images.

To produce the private key in DeepKeyGen, the generative adversarial network (GAN) is used as the learning network[13]. In addition, the transformation domain (which reflects the "style" of the private key to be generated) is intended to assist the learning network through the process of private key production. DeepKeyGen's purpose is to figure out how to transfer the original picture to the private key via a mapping relationship. The assessment results and security analysis reveal that the proposed key generation network can generate the private key with high security [1]. The fundamental disadvantage of this system was that it only used medical photos to provide security.

B. Privacy-Preserving Collaborative Analytics on Medical Time Series Data

Surya Nepal, Xiaoning Liu, Yifeng Zheng, Xun Yi, and Xun Yi suggested a concept for an unique system that allows for privacy-preserving DTW-based analytics on distributed medical time series datasets [2]. It is based on a careful synergy of techniques from both the cryptography and data mining domains, with the fundamental idea being to use findings from plaintext DTW analytics (e.g., clustering and pruning) to enable scalable computing in the ciphertext domain through tailored security design.

Extensive tests on real medical time series datasets show that this system can perform well, for example, it can complete a secure DTW query calculation across 15K time series sequences in 34 minutes [2]. The main drawback of this system was that the deployment of the DTW based medical analytics system in practice is heavily impeded due to acute privacy concerns.

C. Privacy-preserving Medical Treatment System through Nondeterministic Finite Automata

Yang Yang, Robert H. Deng, Ximeng Liu, Yongdong Wu, Jian Weng, Xianghan Zheng, and Chunming Rong proposed it. P-Med makes use of NFA's nondeterministic transition feature to express a medical model that includes sickness states, treatment strategies, and state transitions induced by varying treatment methods. To provide telemedicine service, a medical model is encrypted and outsourced to the cloud[3]. P-Med allows for on-the-fly patient-centric diagnosis and therapy while maintaining the confidentiality of the patient's ailment states and treatment recommendation outcomes. In addition, P-Med presents a new privacy-preserving NFA evaluation approach for obtaining a confidential match result for the assessment of an encrypted NFA and an encrypted data set, avoiding the time-consuming inner state transition decision. P-Med makes treatment procedure recommendations without disclosing personal information to third parties[3]. The fundamental flaw in this method is that privacy-preserving NFA evaluation is required to perform outsourced regular expression and pattern matching without exposing personal information to the cloud server.

D. Lightweight RFID Protocol for Medical Privacy Protection in IoT

A lightweight RFID protocol for Medical Privacy Protection in IoT[4] was proposed by Kai Fan, Wei Jiang, Hui Li, and Yintang Yang. It proposes a simple RFID medical privacy protection solution that ensures the security of acquired data through secure authentication[4]. According to the present communications, obtaining any meaningful previous information is tough for the attacker.

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E. Efficient Design of a Novel ECC-Based Public Key Scheme for Medical Data Protection by Utilization of NanoPi Fire

Dariush Abbasinezhad-Mood and Morteza Nikooghadam suggested a new anonymous ECC-based self-certified two-factor key management method that not only satisfies the needed security features, but also outperforms other recently-published schemes. The most significant disadvantage is that this system does not allow for real-time implementation.

F. Private and Secured Medical Data Transmission and Analysis for Wireless Sensing Healthcare System

Haiping Huang, Member, Tianhe Gong, Ning Ye, Ruchuan Wang, and Yi Dou proposed a healthcare system (HES)[6] design framework that collects medical data from WBANs, transmits it through an extensive wireless sensor network infrastructure, and then publishes it via a gateway into wireless personal area networks (WPANs). HES employs the GSRM (Groups of Send-Receive Model) strategy for key distribution and safe data transmission, the HEBM (Homomorphic Encryption Based on Matrix) scheme for privacy, and an expert system capable of automatically analyzing scrambled medical data and reporting the results[6]. The disadvantage of this method is that many e-/m-healthcare systems fail to make data transmission straight from WBANs to wireless personal area networks feasible.The following are the significant disadvantages from the aforementioned reference papers:

1. In the current system, only medical photos are considered for security purposes[1].
2. Private privacy issues have hampered the implementation of the DTW-based medical analytics system in practice[2].
3. Many e/m-healthcare architectures fail when it comes to data transmission from WBANs to wireless personal area networks[6].

III. PROPOSED MODEL

The Health Insurance Portability and Accountability Act (HIPAA) Rules emphasize the protection of healthcare data. In 2021, there were over 750 data breaches, with the top seven exposing over 193 million personal details to fraud and identity theft. Throughout its life cycle, data security refers to the process of safeguarding data from unwanted access and corruption. Data encryption, hashing, tokenization, and key management are all examples of data security procedures that safeguard data across all applications and platforms.

Data encryption software is used in today's security systems to successfully enhance data security by converting plain text into encrypted cipher text using an algorithm (called a cipher) and an encryption key. The encrypted data will be illegible to an unauthorized individual. With an authorized key, only that user can decrypt the data. Whereas, as data security improves, sensitive data is lost because the key is simply hackable due to the use of a single algorithm.

Furthermore, it is difficult to determine if a person has been vaccinated or not in an airport, and vaccinations administered in different countries are difficult to verify.To address these issues, this paper proposes an Efficient Data Security. System, in which smart contracts and Web 3.0 play a crucial role in data security. Furthermore, it guarantees comprehensive data security, ensuring that the data cannot be tampered with in any way by a hacker.

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WEB 3.0 is a framework that has a built-in blockchain framework to safeguard data at the backend. There is no need for an encryption or decryption key to access data, which eliminates the risk of data being hacked or modified with by a hacker.

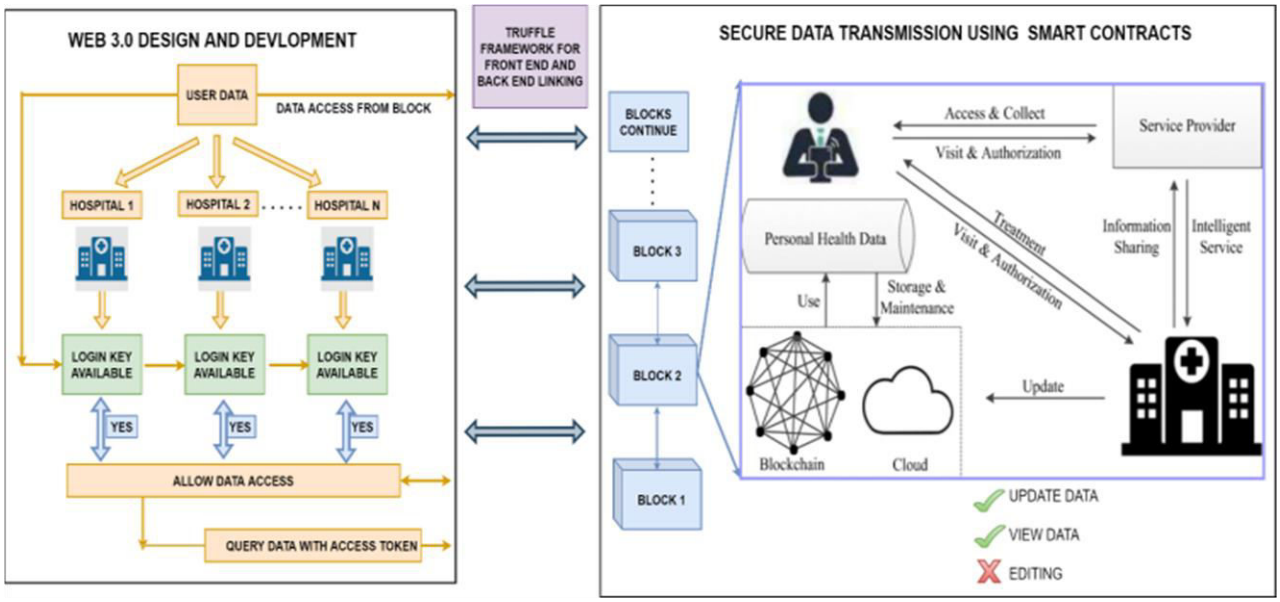

Figure 1Proposed System Architecture

3.1 SMART CONTRACT DEVELOPMENT:

The Solidity programming language is utilised to create smart contracts in this project. A smart contract is a digital contract between two or more parties that is stored on a blockchain like Ethereum or EOS.Every such contract contains a set of preset rules and conditions that must be followed in order for it to be performed. The unanimity of the entire blockchain network guarantees these contracts. The content cannot be modified unless the entire network agrees to the modification.As a result, smart contracts are the safest and most effective instruments for forming agreements between parties.Smart contracts are just programs that run when certain criteria are matched and they are usually stored on blockchain. They usually automate the execution of an agreement under certain circumstances so that all parties can be certain of the conclusion right away, without the need for any intermediaries or time waste.They can also automate a workflow, when certain circumstances are satisfied it starts automatically

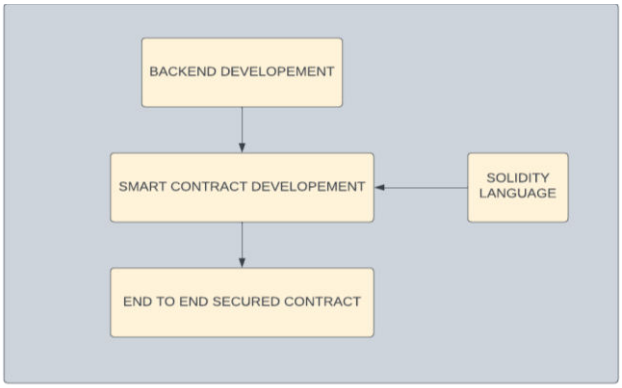

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Figure 2 Smart Contract Development

3.2 TRUFFLE FRAMEWORK INTEGRATION:

Truffle is a world-class development environment, testing framework, and asset pipeline for Ethereum Virtual Machine (EVM)-based blockchains that aims to make the life of a developer easier.With over 1.5 million lifetime downloads, Truffle is usually regarded the most popular tool for blockchain application development. Truffle helps developers throughout the life cycle of their projects, whether they're using Ethereum, Hyper-ledger, Quorum, or one of the many other platforms Truffle supports. The Truffle suite of tools, when combined with Ganache, a personal blockchain, and Drizzle, a front-end dApp development kit, claims to provide an end-to-end dApp development platform. For Ethereum programmers, Truffle is the most popular development tool. Smart contracts can be easily deployed and communicated with their underlying state without the need for complex client-side code. This library is very useful for testing and iterating Ethereum smart contracts. Decentralized applications (dApps) are programs that do not rely on traditional servers. Instead, dApps use Blockchain to host data that was previously saved on servers. The information is stored across the Blockchain's network of nodes. Truffle provides a basic framework for building dApp projects. Truffle allows users to generate the smart contracts needed to build blockchain functionality, develop unit tests for the functions, and design the dApp's front-end design.

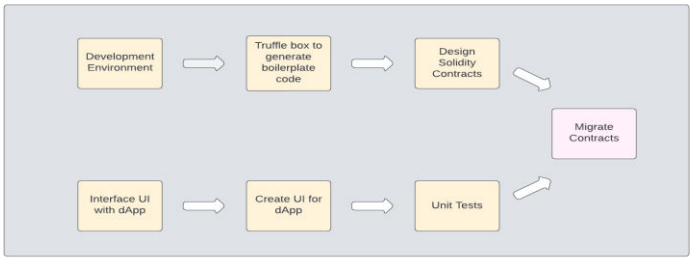

Figure 3 Truffle Framework Integration

3.3 WEB 3.0 FRONT-END DEVELOPMENT:

Web 3.0 applications (also known as "DApps") have an entirely different architecture from Web 2.0 applications. Web 3.0, unlike Web 2.0 applications like Medium, removes the middleman. There is no centralised database for storing application state, and no single web server for hosting back-end functionality.Users can develop smart contracts that specify application logic and deploy them onto the decentralised state machine in Web 3.0. This means that everyone who wants to create a blockchain application must use this common state machine to do it. Blockchain will usher in a new era of database and information technology innovation. Distributed ledgers have the potential to enable large-scale collaboration and usher in Web 3.0.Collaboration and decentralised innovation are accelerated with Web 3.0, also known as the Semantic Web in some situations. First, advanced data mining, natural language processing (NLP), and text analytics approaches will make acquiring and comprehending unstructured data much easier. Second, with artificial intelligence and machine learning, machines will be able to directly collaborate. Machines will eventually be able to teach one another. It entails a shift from a purely informative source to one that is both informative and participatory. It has a semantic and intelligent nature to it. More importantly, Web 3.0 is the driving force behind the rapid use of mobile devices.

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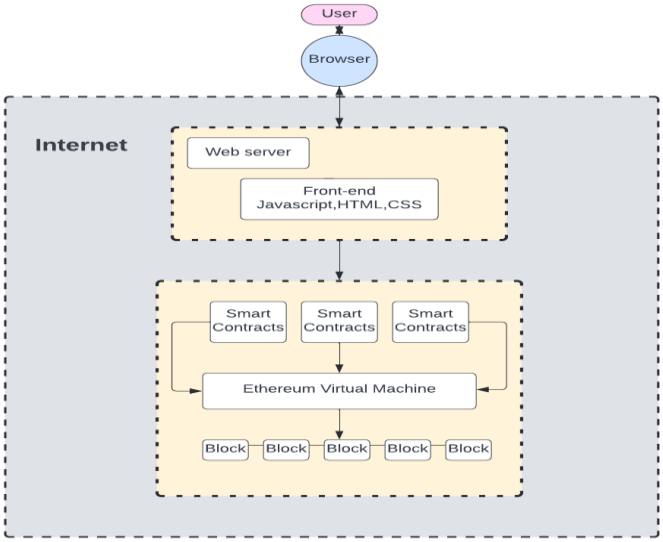

Figure 4 Web 3.0 Front-end Development

3.4 METAMASK INTEGRATION:

MetaMask is a Chrome addon that lets users use Ethereum-compatible apps and websites. Metamask serves as a token wallet, allowing users to securely manage their identities as well as store and send their Ether. It also makes it possible for websites and apps to connect to the Ethereum blockchain. It manages the user's account and connects them to the blockchain. MetaMask is a tool that helps users maintain their accounts and keys in a variety of methods, including hardware wallets, while keeping them separate from the site's context. For developers, we just interact with the globally available Ethereum API, which recognises users of web3-compatible browsers (such as MetaMask users), and if we seek a transaction signature, MetaMask will prompt the user in the most understandable manner possible. This keeps consumers aware, and attackers are forced to focus on phishing individual users rather than mass hacking. MetaMask allows users to securely connect to decentralized applications, save and manage account keys, broadcast transactions, send and receive Ethereum-based coins and tokens, and store and manage account keys using a suitable web browser or the mobile app's built-in browser.

Figure 5 Metamask Integration[15]

Advantages In Proposed System

1. High data security due to absence of encryption/decryption key.
2. Secures from hackers as it is not stored in any public/private database.
3. Data cannot be tampered at all without the permission of the main user.
4. Easily find the vaccinated person using vaccinated data.

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IV. CONCLUSION

The Med-chain system and immunisation data, in which the patient's data may be securely seen using any hospital or lab with great security and the patient's authorization, where Ethereum blocks play a significant part. Only medical photos are considered for security in the current approach, and it is not extensible to other application areas. One type of algorithm is aimed at generating a key for safeguarding easily hackable data. One type of algorithm is aimed at generating a key for safeguarding easily hackable data. Data storage in a public or private database that allows for simple access to data and can be readily modified with because the decryption key is available.

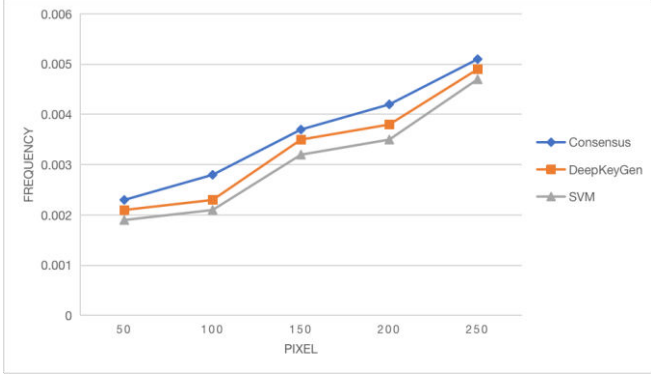

Figure 7 Frequency to Pixel graph

Comparison of Consensus, DeepKeyGen and SVM algorithm along Frequency and Pixel.

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