Soulbound Token (SBT) in healthcare system (Introduction to Blockchain 2024 Project)

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Abstract

Blockchain technology offers security, transparency, and decentralization as game-changing solutions to healthcare data management problems. This initiative investigates the use of soulbound tokens, a cutting-edge blockchain idea, in the healthcare industry. Soulbound tokens use the security characteristics of blockchain technology to give patients ownership and control over their medical data. This study illustrates the possible effects of soulbound tokens on patient-centered care, interoperability, and healthcare data management through literature and real-world case studies. This initiative gives stakeholders insights into the revolutionary potential of blockchain in healthcare by clarifying advantages and obstacles.

Github repo: https://github.com/markbc7/soulbound-healthcare

1. Introduction

Ensuring privacy and confidentiality while safely managing patient data is a major concern for the healthcare sector. These standards are frequently not met by conventional data management and storage techniques, raising questions about patient confidence, interoperability, and data security. Blockchain technology has surfaced as a potential remedy for these issues, providing a decentralized and unchangeable ledger system that has the potential to completely transform the handling of medical data.

Soulbound tokens are a distinct digital asset that are connected to a person's health information. In contrast to conventional data storage techniques, which grant centralized authority ownership and control over patient records, soulbound tokens give people ownership and control over their medical records. In-depth discussion of soulbound tokens' salient features and possible ramifications for medical data are provided in this section.

To sum up, soulbound tokens are a big step in the right direction toward solving the problems associated with healthcare data management. Soulbound Tokens, which leverage blockchain technology, provide a safe, open, and patient-focused method of handling private medical data. Soulbound tokens have the potential to completely change how patient data is shared, stored, and accessed as the healthcare sector develops, opening the door to a more connected and safe healthcare ecosystem.

2. Literature review

Patient-centric soulbound NFT framework for electronic health record (EHR).The context proposes a blockchain-based framework for storing patient electronic health records in a decentralized manner. It uses smart contracts and non-fungible tokens to create health card tokens for each patient, where patients own their health data. Doctors are allowed to mint tokens and add patient records, while retaining access rights. The framework is implemented and tested on Ethereum, Polygon and Binance Smart Chain testnets. Polygon is found to be the most efficient platform based on low gas costs, fast transaction speeds, and high scalability. The framework provides benefits like decentralization, global access, interoperability, privacy and security for health data. It takes a patient-centric approach by giving patients control over their records. However, further validation of doctor access and patient consent for record sharing is still needed. Overall, the study evaluates how blockchain can help address current issues with electronic health records.

Automated Medical Document Verification on Cloud Computing Platform: Blockchain-Based Soulbound Tokens.The proposed methodology introduces soulbound tokens for automated and secure medical document verification, leveraging blockchain technology and cloud computing for decentralized database access. This innovative approach aims to

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enhance the authenticity and efficiency of verifying medical records while reducing fraud and ensuring tamper-proof authenticity. By combining blockchain with deep learning algorithms, the system shows promise in revolutionizing healthcare record management and access. Despite challenges, such as the need for digital document conversion, the potential benefits of using soulbound tokens for document verification, including increased security, immutability, and efficiency, make them a promising technology for the future of healthcare data management.

3. Blockchain Technology

One of the most famous topics in recent years is blockchain technology. It has already had a significant impact on many businesses and industries, changing people's lives in some areas, and its potential will continue to have an influence in many other areas. While blockchain technology has the potential to provide us with more dependable and practical services, we also need to be concerned about the security risks and difficulties associated.

Blockchain acts as a secure and tamper-proof ledger, perfectly suited for storing sensitive medical data. SBTs are built on this foundation, leveraging blockchain's security to represent a patient's medical history while remaining untransferable. This unique feature ensures the information stays with the patient and cannot be misused.

4. Soulbound token

Tokens that are not transferable, referred to as "soulbound" tokens (SBTs), represent the credentials, commitments, and associations of individuals, referred to as "Souls," in a way that builds trust networks in the real economy and validates reputation. SBTs open the door to a number of ambitious applications, such as recovery of community wallets, governance that is resistant to Sybil attacks, decentralization-promoting procedures, and creative markets with shareable rights that can be partitioned. This ecosystem—dubbed "Decentralized Society" (DeSoc)—promotes a pluralistic social milieu in which people and groups naturally cooperate to provide a wide range of network resources and intelligence at different scales. Decomposable property rights and sophisticated governance techniques, including quadratic funding driven by correlation scores, are essential components of this social structure because they promote cooperation and trust while guarding against exploitation and domination.

Blockchain technology, with Soulbound Tokens at its core, can revolutionize healthcare. Patients can own and control their secure medical records, granting access to providers for seamless care coordination and improved outcomes. While challenges like adoption and regulation exist, SBTs offer a

future where empowered patients and efficient data sharing lead to a more secure and effective healthcare system.
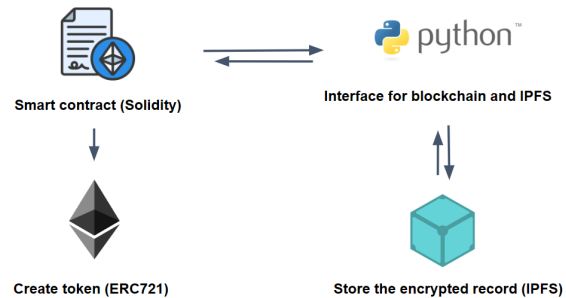
5. System and Results

Figure 1. System architecture.

5.1. System Architecture

Our system architecture (Figure 1) is designed to facilitate the secure and efficient management of health records. It comprises three main components:

1. **Blockchain Network**: Utilizes Ethereum to create and manage SBTs representing individual health records. Smart contracts enforce access controls and permissions, ensuring that only authorized parties can access or modify records.

2. **IPFS Storage**: Health records are encrypted and stored off-chain on IPFS, providing a decentralized and tamper-proof storage solution. The blockchain stores references (hashes) to these records, linking them to the respective SBTs.

3. **User Interface**: A python-based interface allows users (patients, healthcare providers, and insurers) to interact with the system. Users can add, access, and manage health records through intuitive workflows.

5.2. Results and Evaluation

Our pilot deployment on the Sepolia testnet demonstrated the system's effectiveness in managing health records. Key results include:

- **Decentralization and Security**: The use of blockchain and IPFS ensured that records are stored securely and resiliently against tampering and centralized control.

- **User Control and Privacy**: Patients have full control over their health records, including who can access or add information, aligning with patient-centered care principles.

- **Interoperability and Accessibility**: Demonstrated potential for integration with existing healthcare systems, facili-

tating better data sharing and accessibility.

Overall, our system represents a significant step forward in leveraging blockchain technology for healthcare data management, although challenges related to scalability and regulatory compliance remain areas for future work.

6. Conclusion and discussion

In summary, the introduction of soulbound tokens into the healthcare system shows a major improvement in patient-centeredness and data security. This project creates a decentralized and safe framework for medical record management by leveraging blockchain technology and IPFS for encrypted record storage.

The system maintains privacy and integrity while facilitating effective data management through the assignment of permissions to patients, providers, insurers, and administrators. Stakeholders can collaborate and share information easily thanks to the fundamental functions.

Although this initiative establishes a strong basis for blockchain-based healthcare systems, scalability and regulatory issues require more investigation. However, it has the potential to transform medical record keeping and promote patient autonomy in the medical field.

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A. Team member's contributions

Explicitly stated contributions of each team member to the final project.

Adithya Shetty

- Led the development and deployment of smart contracts on Ethereum, playing a pivotal role in the project's technical foundation.

- Designed and implemented the IPFS integration for secure and decentralized storage of health records.

Rattamet Boonwong

- Assisted with the development of the smart contracts, focusing on specific Solidity functions.

- Contributed to project documentation, including the presentation and final report, to ensure comprehensive and clear communication of project details.

Pattapon Tanankakorn

- Supported the project by assisting with Solidity code development and troubleshooting.

- Played a significant role in compiling the literature review and managing project documentation, enhancing the project's academic foundation and presentation.