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IMPROVING SEAL VERIFICATION SECURITY AND TRANSPARENCY USING BLOCKCHAIN TECHNOLOGY

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ABSTRACT

In recent years, the security and transparency of seal verification processes have become increasingly important, especially in the context of digital transactions and document authentication. This paper explores the potential of blockchain technology to enhance the security and transparency of seal verification processes. By leveraging the decentralized and immutable nature of blockchain, seal verification can be made more secure, tamper-proof, and transparent. This paper provides a detailed analysis of the key factors influencing the implementation of blockchain technology in seal verification processes, with a focus on enhancing security and transparency. The study also examines the challenges and limitations associated with the integration of blockchain technology in seal verification and proposes potential solutions to overcome these obstacles. The findings of this research highlight the significant benefits of using blockchain technology in seal verification, including improved security, enhanced transparency, and increased trust in digital transactions and document authentication.

Keywords: Seal Verification, Blockchain, Security, Smart Contracts

1. INTRODUCTION

Seal verification plays a crucial role in ensuring the authenticity and integrity of documents and transactions. Traditionally, seals have been used as a means of verifying the legitimacy of documents, contracts, and other important records. However, traditional seal verification methods are often susceptible to security breaches, fraud, and lack of transparency. With the increasing reliance on digital transactions and electronic documents, the need for a more secure and transparent seal verification process has become paramount. Blockchain technology, with its decentralized and secure nature, offers a promising solution to address these issues.

Blockchain is a distributed ledger technology that allows for the secure and transparent recording of transactions. Each transaction is recorded in a block, which is then linked to the previous block, forming a chain of blocks. This chain of blocks is immutable, meaning that once a transaction is recorded, it cannot be altered or deleted. This immutability, combined with the decentralized nature of blockchain, makes it an ideal solution for enhancing the security and transparency of seal verification processes.

This paper aims to study how blockchain technology can be effectively used to improve the security and transparency of the seal verification process. The study will explore key factors affecting the implementation of blockchain technology in seal verification, including benefits, challenges and potential solutions. Through a comprehensive analysis of these factors, this article uses blockchain technology to effectively apply it in seal verification and proposes a seal verification method to provide practical methods for practitioners and policymakers.

1.1. LITERATURE REVIEW

The literature review will delve into the existing research on seal verification, blockchain technology, and their potential integration. By examining relevant studies and case examples, this section will provide a comprehensive overview of the current state of seal verification security and transparency, as well as the advantages of blockchain technology in enhancing these aspects. The review will also identify the gaps in the existing literature and highlight the need for further research on the integration of blockchain technology in seal verification processes.

1) Seal Verification

Seal verification has been an important aspect of document authentication for centuries. Traditional seal verification methods involve physical seals, which can be easily tampered with or counterfeited. However, these methods still face security and transparency challenges. These methods include manual origami angle discrimination and human eye recognition, which are labor-intensive and low precision, making it difficult to identify counterfeit seals Yan et al. (2021). Research shows that traditional seal verification methods are vulnerable to various types of attacks, including forgery, copying, and unauthorized access Yan et al. (2021). Ensuring the security of the seal verification process is crucial as traditional seals can be tampered with or counterfeited.

2) Blockchain Technology

Blockchain technology, introduced with the advent of Bitcoin, has gained significant attention for its potential to revolutionize various industries. Blockchain is a decentralized, distributed ledger that records transactions in a secure and immutable manner. Each block in the blockchain contains a list of transactions, and once a block is added to the chain, it cannot be altered. This immutability and transparency make blockchain an ideal solution for applications requiring high levels of security and trust.

3) Integration of Blockchain in Seal Verification

Several studies have explored the integration of blockchain technology in seal verification processes. Researchers have proposed various frameworks and models to leverage blockchain's decentralized and immutable nature to enhance the security and transparency of seal verification. For instance, a study by Li et al. (2022) proposed a blockchain-based privacy-preserving verification system that ensures the authenticity and integrity of digital documents. Another study by

Pradhan & Singh (2021) demonstrated the use of smart contracts on the Ethereum blockchain to automate and secure the verification process. Pathak et al. (2022) proposed system also incorporates cryptographic techniques to enhance security and prevent unauthorized access. Khan et al. (2021) study highlighted the benefits of using smart contracts for seal verification, including increased efficiency, security, and transparency.

4) Gaps in Existing Literature

While existing research highlights the potential benefits of using blockchain technology in seal verification, there are still several gaps that need to be addressed. Most research has focused on the technical aspects of blockchain integration, with limited focus on practical challenges and implementation issues. Therefore, this study improves the seal verification system based on blockchain technology and conducts effective comprehensive research and verification in the real world.

2. METHODOLOGY

This section will outline the methodology used in this research, including data collection methods, analysis frameworks, and evaluation criteria. By adopting a systematic approach, this research aims to provide a rigorous and evidence-based analysis of the potential benefits of using blockchain technology in seal verification processes. The methodology will include both qualitative and quantitative research methods to collect comprehensive data on the implementation and impact of blockchain technology in seal verification. The following will explain the challenges of seal verification, the benefits and limitations of blockchain, and how to use blockchain for verification.

2.1. CHALLENGES IN SEAL VERIFICATION

Seal verification, whether traditional or digital, faces several challenges:

- **Security:** Ensuring the security of seal verification processes is paramount. Traditional seals can be tampered with or forged, while digital seals can be vulnerable to cyberattacks.
- **Transparency:** Transparency in seal verification processes is essential to build trust and confidence. Traditional methods often lack transparency, making it difficult to verify the authenticity of seals. Digital methods, while more transparent, can still face challenges related to the visibility of verification processes.
- **Scalability:** As the volume of digital transactions and documents increases, the scalability of seal verification processes becomes a critical concern. Traditional methods are not scalable, while digital methods can face challenges related to processing large volumes of transactions.
- **Regulatory Compliance:** Seal verification processes must comply with various regulatory and legal requirements, which can vary by jurisdiction. Ensuring compliance with these requirements can be complex and challenging.

2.2. BENEFITS OF BLOCKCHAIN TECHNOLOGY

The analysis reveals several key benefits of using blockchain technology in seal verification processes:

- **Transparency:** Blockchain provides a transparent and auditable record of all transactions, making it easy to verify the authenticity of seals.
- **Immutability:** Once a seal is verified and recorded on the blockchain, it cannot be altered or deleted, ensuring the integrity of the verification process.
- **Decentralized Consensus:** Blockchain relies on a decentralized consensus mechanism, which ensures that all participants in the network agree on the validity of transactions.
- **Security:** The cryptographic algorithms used in blockchain provide a high level of security, making it difficult for attackers to tamper with the verification process.

2.3. CHALLENGES AND LIMITATIONS

Despite the significant benefits, there are also several challenges and limitations associated with the integration of blockchain technology in seal verification processes. These include:

- **Scalability:** Blockchain networks can face scalability issues, especially when dealing with a large number of transactions.
- **Complexity:** Implementing blockchain-based systems can be complex and require specialized knowledge and expertise.
- **Regulatory and Legal Issues:** The use of blockchain technology in seal verification may raise regulatory and legal concerns, particularly in jurisdictions with strict data protection and privacy laws.

2.4. THE ROLE OF BLOCKCHAIN IN SEAL VERIFICATION

Blockchain technology offers a promising solution to address the challenges associated with seal verification. By leveraging the decentralized and immutable nature of blockchain, seal verification processes can be made more secure, transparent, and scalable. Key benefits of using blockchain in seal verification include:

- **Decentralization:** Blockchain technology eliminates the necessity for centralized authorities, thereby reducing the risk of single points of failure and enhancing overall security.
- **Immutability:** Once a seal is verified and recorded on the blockchain, it cannot be altered or deleted, ensuring the integrity of the verification process.
- **Transparency:** Blockchain provides a transparent and auditable record of all transactions, making it easy to verify the authenticity of seals.
- **Scalability:** Blockchain networks can handle large volumes of transactions, making them suitable for scalable seal verification processes.

By integrating blockchain technology into seal verification processes, organizations can enhance the security, transparency, and scalability of their verification methods, ensuring the authenticity and integrity of documents and transactions.

Figure 1

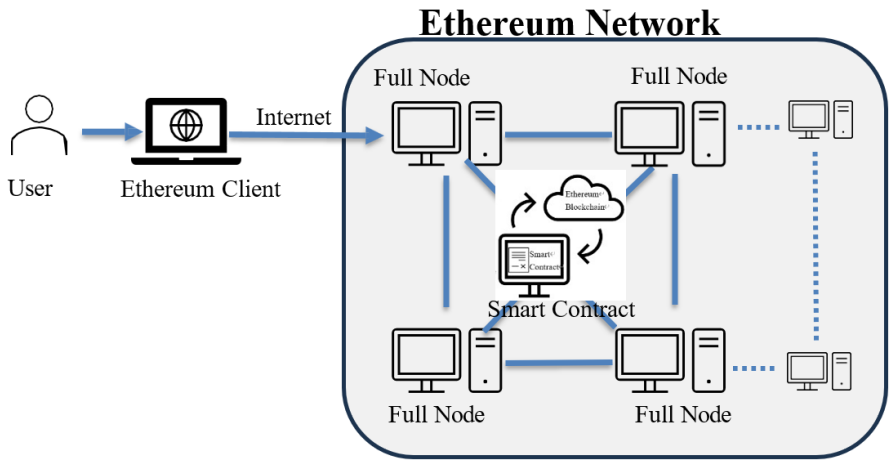

Figure 1 Proposed Seal Verification Architecture

2.5. PROPOSED SEAL VERIFICATION ARCHITECTURE

We propose an environment that uses the Ethereum network architecture to implement blockchain. This Ethereum network architecture is used to save seal information, and the saved data is stored in the blockchain. Therefore, this seal will maintain the immutability and transparency of information. Utilizing the decentralized architecture of the blockchain, the seal can be preserved to reduce the risk of loss and tampering and enhance its security. Figure 1. shows our proposed seal verification architecture.

Figure 2 Shows the architecture of the smart contract used for verification. We use the smart contract architecture provided by Ethereum to perform the steps of seal verification. When the manager wants to add or update the seal information, he only needs to upload the seal information to the blockchain of the Ethereum network to add or update the seal information. The seal information in can be uploaded by the manager in a unified format. The original seal image can be used or converted into feature values. The objective is to establish a unified format. Users can use smart contracts to automatically compare seals. During this process, the user cannot obtain the information of the original seal image. Therefore, the function of smart contracts can be used to protect the security of original data without worrying about the theft and forgery of original seal data.

Figure 2

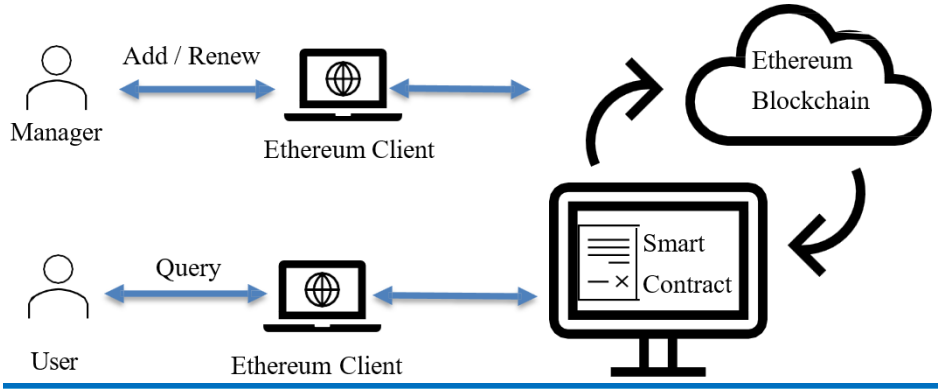

Figure 2 Smart Contract Architecture

3. RESULTS AND DISCUSSIONS

This section will present the experimental results, including key factors affecting the security and transparency of the seal verification process. Here we will introduce the data set used to verify the seal database. It not only demonstrates the transparency, immutability and decentralized consensus advantages of blockchain technology. And it proves that the experimental results obtained for seal verification using our proposed architecture can indeed be used in daily life applications in terms of security and transparency.

3.1. DATA COLLECTION

Data will be collected through a combination of surveys, interviews, and case studies. Surveys will be distributed to professionals in the field of document authentication and digital transactions to gather their insights and experiences with seal verification processes. Interviews will be conducted with experts in blockchain technology to understand the technical aspects and challenges of integrating blockchain in seal verification. Case studies of existing blockchain- based seal verification systems will be analyzed to evaluate their effectiveness and identify best practices.

The data collected will be analyzed using qualitative and quantitative analysis techniques. The survey's quantitative data will be analyzed using statistical methods to identify trends and correlations.

Figure 3

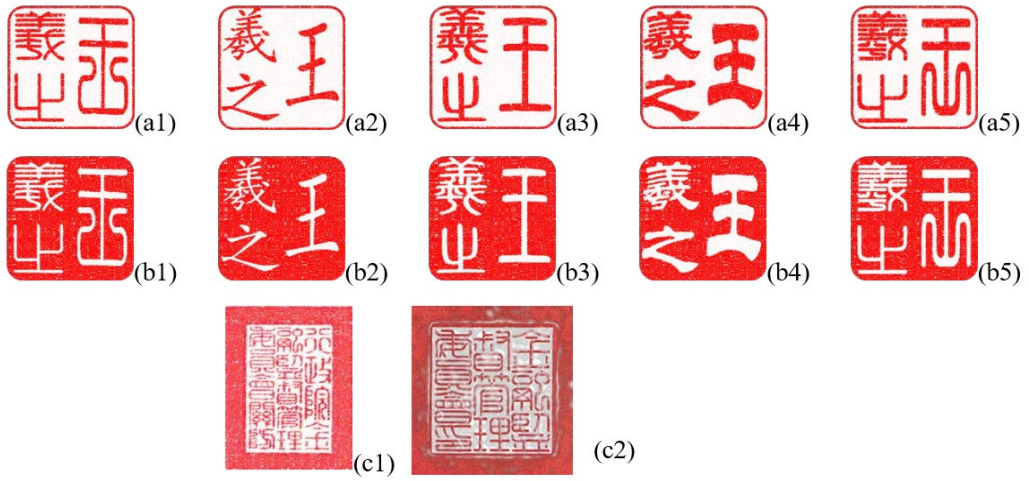

Figure 3 Seal Dataset Used in the Experiment.

Figure 3 shows the seal data set used in the experiment. The data set is divided into three categories. The first category is private seals with white characters on a red background, the second category is private seals with red characters on a white background, and the third category is a government agency seal with red characters on a white background. In Figure 3, a1~a5 are examples of personal seal styles with white characters on a red background. b1~b5 are sample styles of personal seals with red characters on a white background. c1~c2 are sample styles of government agency seal with red characters on a white background. A total of 100 samples were collected for each seal type. Table 1 shows that the seal data set has three categories: Sample_A, Sample_B and Sample_C, with a total of 300 samples collected.

Table 1

Table 1 Number of Samples for Each Seal Category

Category	Number of samples
Sample_A	100
Sample_B	100
Sample_C	100

3.2. EVALUATION CRITERIA

The effectiveness of the blockchain-based seal verification system will be evaluated based on several criteria, including security, transparency, ease of implementation and user satisfaction. These standards will be used to evaluate the potential benefits and challenges of using blockchain technology in the seal verification process. We have been tested by a total of 100 people, and the user satisfaction test result reached 98 points. Therefore, the proposed architecture can be based on the blockchain and use smart contracts for seal verification to achieve the purpose of Security and Transparency.

3.3. KEY FACTORS INFLUENCING SECURITY AND TRANSPARENCY

The results of the research demonstrate that blockchain technology has the potential to markedly improve the security and transparency of the processes involved in verifying seals. The decentralized nature of blockchain technology ensures that no single entity has control over the entire system, thereby reducing the risk of tampering and unauthorized access. The immutable nature of blockchain records guarantees that once a seal has been verified, it cannot be altered or forged.

4. CONCLUSIONS

In conclusion, this paper underscores the paramount importance of employing blockchain technology to enhance the security and transparency of seal verification procedures. The utilization of blockchain technology can enhance the security, integrity, and transparency of seal verification processes. This paper proposes further research and implementation of blockchain technology in seal verification processes, with the objective of enhancing security and transparency in digital transactions and document authentication. The experimental results of this study proved the ability of blockchain technology to completely change seal verification, and the user satisfaction rate reached 98 points. It can be concluded that the smart contract function utilizing the blockchain architecture of Ethereum is a more secure and transparent method of practical application in seal verification systems.

CONFLICT OF INTERESTS

None.

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