Research on flexible and credible traceability system model of agricultural products based on blockchain technology

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Keywords: Blockchain; Agricultural products; flexible traceability; credible traceability; Traceability system

Abstract: Blockchain originated from Bitcoin. Bitcoin system is an electronic cash system, in which the concept of blockchain was put forward. Then blockchain technology was applied to Ethereum until the enterprise-level development platform super ledger appeared. Faced with the problem that agricultural products information resources are too scattered, the combination of blockchain technology and Internet of Things technology has solved the bottleneck of traditional agricultural products traceability system in data transmission, data storage and security mechanism. This paper constructs a flexible and credible traceability system model of agricultural products based on blockchain technology. The architecture model includes application layer, platform layer, data center and other parts. In the data access layer, each link of agricultural products supply chain needs to input the industrial and commercial information of the corresponding enterprise, and some of the information is accessed through the Internet of Things, which mainly includes the growth environment and logistics information of agricultural products raw materials. Smart contract is the chain code installed on the blockchain, and its main function is to provide the interface for operating blockchain services. The system performance test shows that the system meets the requirements of practical application.

1. Introduction

Traceability system of agricultural product quality and safety is a system that applies modern network technology, links the relevant information of production, processing, circulation, testing and sales of agricultural products, and implements the whole process of supervision. It is a branch of government e-government construction that can effectively improve the management, service and coordination ability of government functional departments. In terms of traceability of agricultural products, the introduction of blockchain technology can effectively solve the practical defects of agricultural products' supply chain, such as insufficient resilience against external impacts and fragile quality assurance system [1-3]; Faced with the problem that agricultural products information resources are too scattered, the combination of blockchain technology and Internet of Things technology has solved the bottleneck of traditional agricultural products traceability system in data transmission, data storage and security mechanism [4].

The traceability system of agricultural products based on blockchain technology refers to the comprehensive application of a variety of network technologies, bar code identification and other cutting-edge technologies. At the same time, it realizes the information management of the whole production, processing and circulation process of agricultural products and the traceability management of agricultural products' quality by means of distributed storage, decentralized accounting, encryption technology, non-tampering and non-forgery. In this paper, combining the characteristics of super ledger with the credibility and flexibility requirements of agricultural products traceability, a model design scheme of flexible and credible traceability system for agricultural products based on blockchain technology is proposed.

2. Blockchain technology

Blockchain originated from Bitcoin. Bitcoin system is an electronic cash system, in which the

concept of blockchain was put forward, and then blockchain technology was applied to Ethereum. It was not until the enterprise-level development platform super ledger appeared that blockchain really broke away from the bondage of electronic money, making it possible for other industries to apply services [5-6]. Narrowly speaking, blockchain is a linked list of trading blocks connected by hash pointers [7]. Broadly speaking, blockchain is a distributed ledger storage technology. Let's first look at the structure of blockchain. As shown in Figure 1:
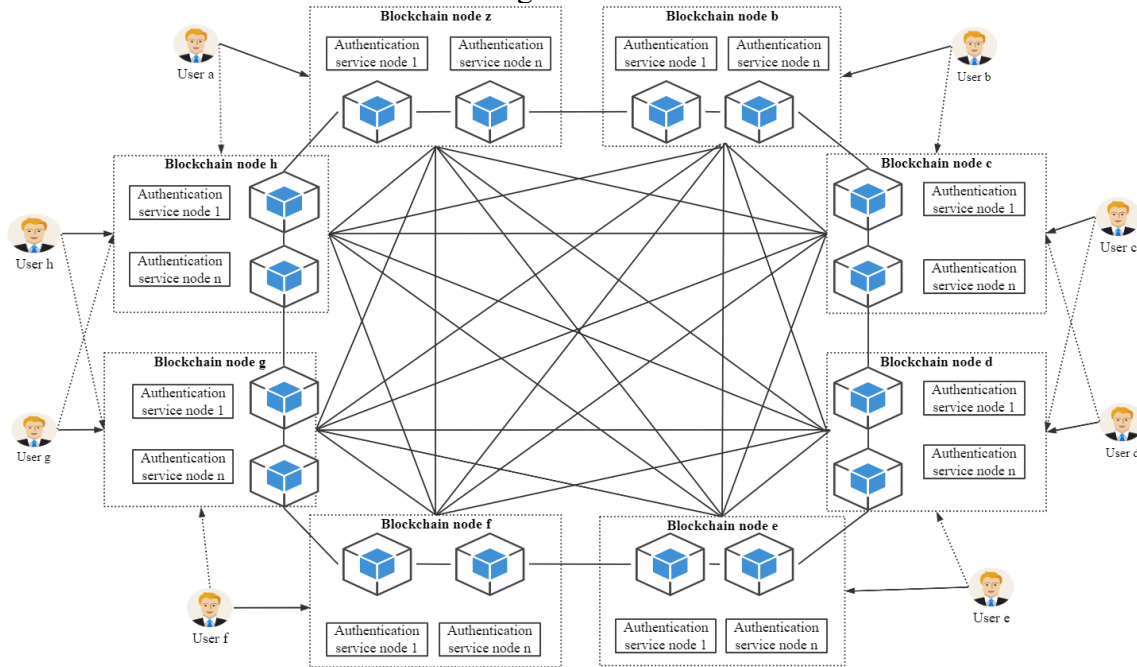

Figure 1 Structure of blockchain

Each block consists of a block header and a block body. The block header includes the hash value, time stamp, Merkel root and other information of the parent block, and the block body includes all the transaction lists. If we want to tamper with a transaction in the blockchain, we have to change the hash value of each blockchain, which is unrealistic, thus ensuring that the blockchain cannot be tampered with.

Blockchain has four characteristics: decentralization, openness and transparency, consensus mechanism and anonymity. Blockchain technology does not depend on centralized hardware or management organizations, and the permissions of each node are equal. The processes of data verification, storage, transmission and maintenance are all realized on distributed systems, which is the most prominent and essential feature of blockchain.

In the traditional centralized network, when any node sends a message to other nodes, it sends the message to the server, and then the server forwards it to the target node. In the decentralized blockchain network, any two nodes can communicate directly with each other, and there is no central server to centrally control and forward messages [8-9].

3. Problems existing in traditional trusted traceability system of agricultural products

3.1. Insufficient flexibility

The traditional traceability system of agricultural products usually traces the agricultural products of a specific variety, place of origin and manufacturer. This limitation will lead to the narrow application scope and relatively fixed traceability process of the traceability system, while the supply chain of agricultural products will be flexible due to market changes and technological upgrading, which makes it difficult for the traceability system to flexibly adjust the traceability process and expand the traceability links according to the actual production situation.

3.2. Low data credibility

Traditional traceability systems of agricultural products generally adopt centralized data storage scheme, and supply chain links such as planting, logistics, processing, warehousing and sales directly interact with centralized database. This method can reduce the difficulty of system development and ensure the uniqueness of data, but it will threaten the security of traceability data. On the one hand, enterprises may tamper with data for their own interests, on the other hand, the damage of storage media will make data permanently lost, so the authenticity and credibility of traceability results will be questioned.

In addition, most of the data in the traditional traceability system of agricultural products rely on the network database to record and transmit information, and the agricultural product market is a typical "lemon market". Consumers' suspicion of the traceability of agricultural products is also regarded by enterprises as a gimmick to make false propaganda [10].

Asymmetric information reduces consumers' trust in traceability information of agricultural products quality and safety, and increases the difficulty of popularizing traceability system of agricultural products quality and safety. At present, there is no relevant legal basis for mandatory enforcement of traceability system. Therefore, it is suggested that the government should introduce perfect laws, norms and standards as soon as possible, and supervise the normative implementation of the traceability system of agricultural products quality and safety through laws and regulations.

4. Construction of flexible and credible traceability system model of agricultural products based on blockchain technology

4.1. Overall system design

This paper intends to design and implement a flexible and credible traceability system model of agricultural products based on blockchain technology. Using the combination of Internet of Things, blockchain, smart contract and other technologies, we can quickly locate the illegal and fraudulent behaviors in the production and circulation of agricultural products. The system mainly includes five functional modules. They are: login management module, agricultural product management module, agricultural product information input module, traceability code traceability module and after-sales feedback statistics module. The specific functions of each module are shown in Figure 2.
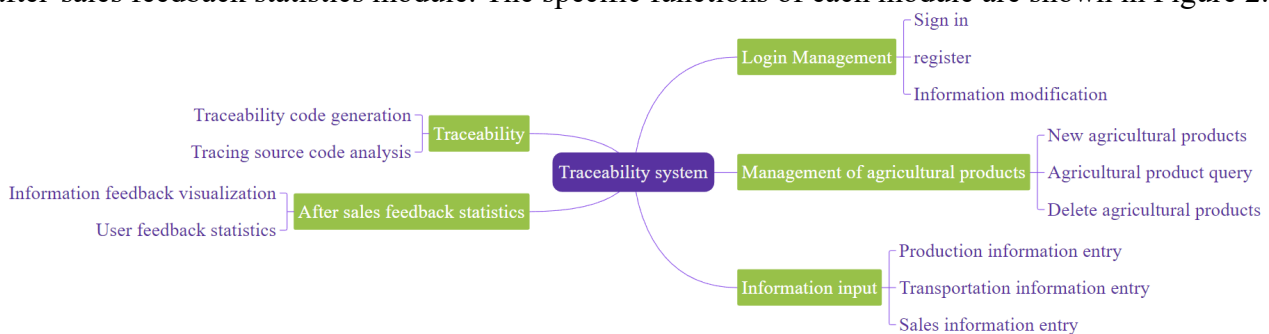

Figure 2 System function

As a supplement to the functional requirements, non-functional requirements refer to another kind of requirements that are not directly related to the functional requirements of the system. Non-functional requirements relate to the availability, reliability, throughput and storage space occupied by the system. The correlation and dependence between different modules in the system should be reduced as much as possible, and the internal processing of methods should be transparent to the outside world. It is not necessary to pay too much attention to internal implementation, but only to call and return.

The education level of users of this system is uneven, among which many agricultural products are supplied by local poor households, and they are not skilled in the use of intelligent devices and information systems. Therefore, the user interaction page of this system should be concise, easy for users to operate and give users a good experience.

In addition, the speed of reading and writing data from the blockchain will be slower than that of the database, and there will be a high system response delay when a large number of traceability queries are performed. It is possible to consider setting a cache to store hot data and improve the throughput of the system.

The architecture model of agricultural products flexible and trustworthy traceability system based on blockchain technology in this paper includes application layer, platform layer, data center and other parts. The specific architecture design is shown in Figure 3:
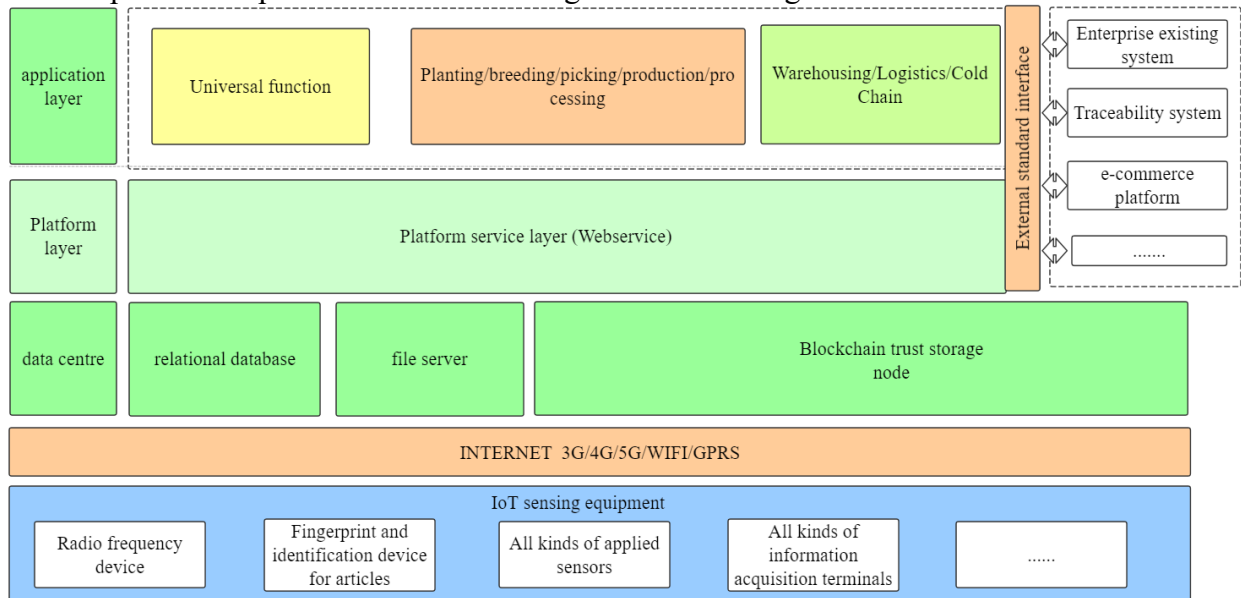

Figure 3 Model of flexible and credible traceability system of agricultural products based on blockchain technology

The service layer builds the blockchain network environment through Hyperledger fabric. Its main function is to store the agricultural product information collected by the data access layer in a distributed way, and to ensure the security of users and data through encryption and identity authentication, so as to provide data services for the user layer. Intelligent contract is a chain code installed on the blockchain. Its main function is to provide an interface for operating blockchain services and act as a bridge. Data access layer and user layer write and read data to the blockchain data service layer through the chain code.

In the data access layer, each link of agricultural products supply chain needs to input the industrial and commercial information of the corresponding enterprise; Part of the information is accessed through the Internet of Things, which mainly includes the growth environment and logistics information of agricultural raw materials. The growth environment information is mainly obtained by sensors, while the logistics information is obtained by GPS positioning system.

4.2. System implementation

In this paper, under the Ubuntu operating system environment, HyperledgerFabric1.0 infrastructure, Docker, Git and other tools are adopted, and Go language is used to deploy the blockchain background environment through GoLand compiler. Use SSH framework, MySQL database and Tomcat server, and use Java language to deploy in MyEclipse compiler.

Smart contracts should be compiled before deployment. This paper uses Remix to compile and compile smart contracts. Here, Owner.sol is taken as an example to introduce the compilation and deployment of smart contracts. After compilation, you can click Compilation Details to view the details of contract compilation, including ABI(Application Binary Interface) information and ByteCode (binary code) information. After the contract is deployed, you can view the information of the contract in the console, including the contract status, transaction hash value, contract address, the account that initiated the transaction and the set gas amount.

The four modules of agricultural operation, quality inspection, warehousing and transportation

information have the same logic, and they are collectively referred to as traceability information of agricultural products. After the system administrator reviews the data on the data review page, the reviewed data will send a transaction request through the Fabric Java SDK, and the data will be written into the blockchain. The reviewed data cannot be edited or deleted. The sequence diagram of information tracing, input and audit is shown in Figure 4 below.
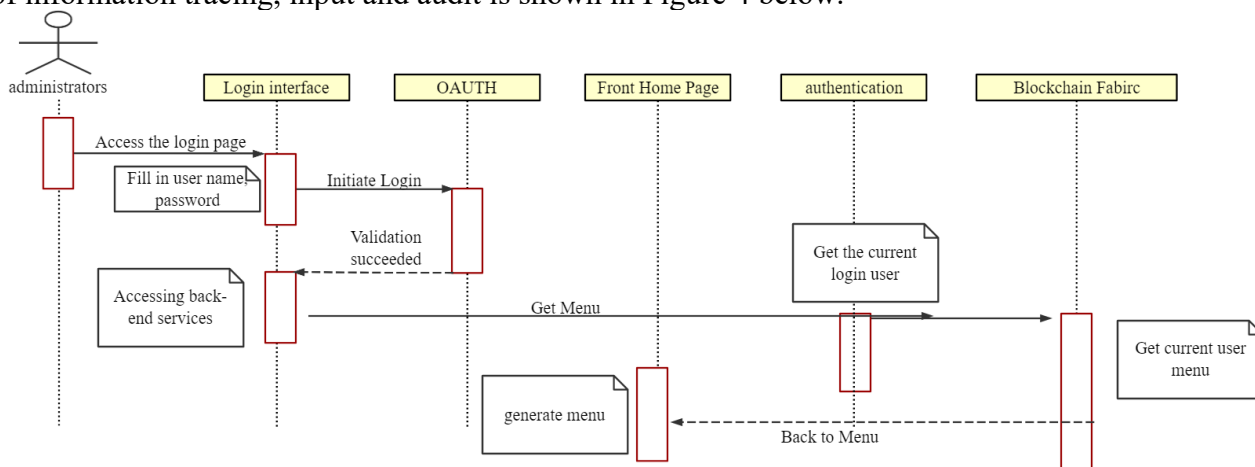

Figure 4 Sequence diagram of traceability information input and audit

Table 1 Performance test results of agricultural product traceability system

Subscriber number	Average response time(ms)	Peak service response time(ms)	Test conclusion
100	1.5994	1.6266	Pass
500	2.0007	2.6124	Pass
1000	2.1137	2.8294	Pass

The traceability system of agricultural products studied in this paper adopts three working conditions of 100 people, 500 people and 1000 people, and the test results are shown in Table 1. It can be seen that the system meets the requirements of practical application.

5. Conclusions

Based on distributed storage, decentralized accounting, encryption technology, non-tampering and non-forgery of blockchain technology, the information management of the whole production, processing and circulation process of agricultural products and the traceability management of agricultural products quality can be realized. The architecture model of agricultural products flexible and trustworthy traceability system based on blockchain technology in this paper includes application layer, platform layer, data center and other parts. The smart contract is the chain code installed on the blockchain, and its main function is to provide the interface for operating blockchain services, which acts as a bridge. The data access layer and user layer write and read data to the blockchain data service layer through the chain code. The system performance test shows that the system meets the requirements of practical application.

References

[1] Jing Xu, Liu Ziyu,&Qin Yuanze. (2022). Traceability Model of Cluster Agricultural Products Supply Chain Based on Blockchain Relay Technology. Journal of Agricultural Engineering (038-

011).

[2] Wu Xiaotong, Liu Pingzeng, & Wang Zhihua. (2021). Research on the traceability system of agricultural products based on blockchain. computer applications and software, 38(5), 7.

[3] Zhou Xiong, & Zheng Fang. (2019). Exploration on the construction of traceability system of agricultural product quality and safety based on blockchain technology. Journal of the Party School of Fujian Provincial Committee of the CPC.

[4] Liu Qiqi,&Xia Chunping. (2019). Construction of agricultural product quality traceability system based on blockchain technology. High-tech Communication, 29(3), 9.

[5] Zhang Li, & Tong Zhou. (2019). Research on the traceability system of agricultural products based on blockchain technology. Jiangsu Agricultural Sciences, 47(13), 5.

[6] Liao Ding 'an. (2022). Research and implementation of a trusted platform for agricultural product traceability based on blockchain technology. Hubei Agricultural Sciences, 61(7), 5.

[7] Tipirneni, L. , & Patan, R. (2021). A study on privacy preservation of medical certificates using blockchain technology. Recent patents on engineering, 2021(6), 15.

[8] Kouhizadeh, M. , Saberi, S. , & Sarkis, J. (2021). Blockchain technology and the sustainable supply chain: theoretically exploring adoption barriers. International journal of production economics, 2021(7), 231.

[9] Zhang Caiming, & Yang, L. (2021). Study on blockchain technology from an information system perspective. High-tech newsletter: English version, 27(2), 7.

[10] Yang Zhaoxin, Ruizhe, Y., Meng, L.I., Fei, Y.R., & Yanhua, Z. (2022). A Load Balance Optimization Framework for Shared-Blockchain Enabled Internet of Things. High-tech Newsletter: English Version, 28 (1),22.