Traceability System of Agricultural Product Based on Block-chain and Application in Tea Quality Safety Management

Yuxin Liao and Ke Xu*
College of Computer Science, South-Central University for Nationalities, Wuhan 430074, Hubei, China.
Email: yuxinliao_lyx@foxmail.com, cole.xu@gmail.com

Abstract. In recent years, with the increase of consumers’ attention to the quality of agricultural products, reliable and reliable traceability technology of agricultural products has been paid more attention. This paper proposed a block-chain traceability system based on smart agriculture with the integration of wireless sensor network. The system has realized the agricultural product traceability system based on Ethereum. After farmers access to the system, data acquisition front-end data storage to block-chain system, the use of block-chain itself has the characteristics of decentralization, tamper-resistant, security encryption, combined with the backend database management and traceability QR code to provide consumers with safe, reliable and real farm products traceability information. Building a holographic database of the tea whole industry chain from farmland to table, adopting the food risk assessment and safety traceability technology based on the hazard factor to design the multi-role, multi-link and multi-factor intelligent management system to realize the efficient control of food quality and safety.

1. Introduction
Nowadays, People pay more and more attention to the food safety because of the rapid economic development and the improvement of people's standard of living[1]. But food safety crises have always existed, such as tainted milk powder, lean meat, dyed steamed bread. Consumers living in an asymmetric food information environment are unable to access all the information in the food supply chain, creating high risks[2]. Tracking has become a very important part of the food supply chain. The main objectives of tracking food the source can be known, the destination can be found, the quality can be checked, and the responsibility can be investigated[3]. Safety traceability of food through information sharing ensures the safety of all foods.

In this paper, we propose to combine block-chain technology with agricultural product trading platforms. Block-chain is a global public distributed ledger that records all transactions between users (stakeholders)[4]. Block-chain has the characteristics of decentralization, collective maintenance, consensus trust, and reliable database[5]. It can be completely transparent in system operation, enabling consensus trust between nodes; and the asymmetric use of block-chain Encryption and hashing algorithms allow data to have non-transferable features[6]. Therefore, traceability of agricultural products can be achieved. The rest of this article is as follows In Section 3, we describe the methods and architectures of this system. Section 4 describes the systems design and applications for the entire system, and finally Section 5 summarizes the paper.

2. Related Work
At present, the block-chain is gradually being applied to various fields. As consumers pay more attention to food quality, the credible and reliable supply chain traceability system has received...
everyone's attention. For food security issues, the system can respond to resource constraints and complement the sustainable food system with other technologies[2]. IoT devices are used to replace manual recording and inspection as much as possible, and intelligent contract technology using blockchain technology is used in the whole system[3]. Bhuiyan proposes the use of blockchain technology in conjunction with big data to manage personal health data and share user information across organizations, including researchers, hospitals, insurance companies and patients. All participants in the system are known and trusted to protect the privacy and security of the data[1]. This can solve the existing trust problems with low cost and high efficiency.

To improve government transparency, prevent fraud and build trust between the people and the public sector, Batubara suggested that blockchain technology could be applied to solve these problems[7]. Alexander proposed a way to protect existing ideas and early concepts in the development of the work. By setting up a decentralized tamper-proof means of record keeping, the entire innovation chain from the first delineation to the beginning of production is certifiably stored[8]. Chakravorty proposes to apply the blockchain to solve the network environment. With the peer-to-peer functionality of blockchain technology, a truly distributed, secure, anonymous and traceable content distribution network can be achieved[9]. It will greatly protects the rights and interests of creators, and strengthens the authority of copyright authentication.

3. Method and Architectures

3.1. Blockchain Structure

The system will generate non-transferable data blocks, according to the effective information which has passed the consensus mechanism, and each block forms an information chain in the form of chain. As shown in figure 1, the trading information generated in each link of the industrial chain is arranged in chronological order, the adjacent two trading records are sequentially spliced and using the SHA-3 algorithm to generate irreversible Hash value, the block body is recursively generated layer by layer. The root node will be filled in the block header, that is, the Merkle root; when the Hash of the former block is filled in the "pre-block" in the head of the block, the data blocks will connect together[2].

![Figure 1. Blockchain Structure](image)

3.2. Architectures design

The agricultural product traceability system proposed in this paper and its application in tea quality management adopt B/S framework, which consists of three parts: data layer, business logic layer and
presentation layer. And the data layer includes the Geth and Mysql databases, which form the logical layer of the block-chain data together, and mainly complete the storage function of the agricultural product information in the traceability system. The business logic layer is built using the Java SSH framework, and the corresponding business processing is performed according to the transmitted data requirements. The presentation layer design interacts with each participant and the block-chain system. The layers are connected to each other to ensure the high efficiency and reliability of product traceability and interaction, as shown in figure 2.

![Figure 2. Architectures design](image_url)

The system chooses Ethereum as the underlying architecture of the block-chain and adopts the Go language. Geth will be used as the development environment for the block-chain part of the trading platform. The traceability platform is developed based on the Java development integration environment Eclipse-neon, using JSP technology to implement business logic and data presentation, and the development framework selects Spring.

4. Systems Design and Applications

4.1. System Flow

In the tracing platform of this paper, according to the types of agricultural products, the process of production, management, processing, order acquisition and delivery and distribution of the agricultural products are analyzed. The collection of traceability information is generally completed by the grower, the inspector, and the processing and packaging operator. According to the business process, the collection process of the traceability information is shown in figure 3.

(1) Create and complete a production plan

The growers carry out production plans according to the production requirements set by the agricultural enterprises, and record information on the types of agricultural products, fertilization during planting, and pest control. After the agricultural products are mature, the basic information of the agricultural products at this time is recorded at the time of picking.

(2) Product quality inspection

The quality inspector shall carry out quality inspection on the harvested agricultural products according to the production requirements of the enterprise, record the warehousing information and send it to the warehouse.

(3) Sales processing

The packaging processing operator generates the agricultural product identification code and the packaging identification code according to the requirements of the enterprise, and packages the agricultural product packaging and records the packaging information.

(4) Product quality inspection
The quality inspector shall inspect the quality of the packaged product according to the production requirements of the enterprise, record the inbound information and send it to the warehouse.

(5) Order delivery

Through the acquired network orders, the sales products are delivered and the logistics information is recorded. Information support takes many forms, including pictures, videos, and documents. Consumers can see the source information on the e-commerce website and the detailed information of each link. At the same time, consumers can also make complaints to the regulatory authorities through the feedback menu of the website. After the investigation and processing, the supervision department will timely report the processing results to the consumers, which greatly saves the time cost and ensures the normal operation of the traceability system.

Figure 3. System flow

4.2. Database Design

The database uses Microsoft SQL Server 2008 software. The following data entities are designed with tea as an example. The planting base first records the batches and types of tea seed, and records all the information of agricultural management during the planting process—irrigation, fertilization, pest control and disease prevention. Picking inbound records to store information—warehouse environment, product quality and other information. When processing the buds of tea trees into tea leaves, the processing links need to record operating environment, operating procedures and other information. Transport information needs to be recorded during the transportation phase. According to the market sales, the quality of the agricultural products are packaged and the packaging information is recorded. Finally, the sales need to record the warehouse storage information and sales information.

According to the above process, the following entities are summarized: tea seed, planting, bud, warehousing, processing, tea, packaging information, fresh storage information, and sales information.
In addition to the data entities, the following five entities are required: planting bases, transport vehicles, maintenance workers, sales units, and regulatory authorities.

4.3. Traceability Coding Design

In this design, taking tea as an example, the traceability mark will use a two-dimensional code, and the consumer can scan the two-dimensional code to obtain the product traceability information. If the whole process of the tea supply chain is hierarchically represented, the processes of the first layer $ID_m$ supply chain are the main nodes, the second layer is the branch node $ID_{mn}$ of the first layer, and the third layer is the branch node $ID_{mnk}$ of the second layer. As shown in the traceability information map of figure 4, for example, the first layer of product material is used as the primary node $ID_1$, and the tea tree seed $ID_{11}$, planting $ID_{12}$, bud $ID_{13}$, storage $ID_{14}$, etc. are used as the second layer node, and the variety $ID_{111}$ in the seed, source $ID_{112}$, quality $ID_{113}$, etc. as the third layer node, continue to divide according to the specific details.

![Figure 4. Traceability coding information association diagram](image_url)

4.4. Main Function Realization

According to the needs of platform users, the functions are divided into entry information and information inquiry and verification.

1. Entry information

   Information entry mainly includes all information input of agricultural product cultivation and sales, consumer complaint information input and basic information input of regulatory department management.

2. Information inquiry and verification

   In the information query, the consumer is the target user. By scanning the product number of the agricultural product, you can query all the information before the sale of the agricultural product and use the block-chain technology to verify the information. This ensures the integrity and tamper resistance of the traceability information of agricultural products and solves the credit problems existing in the trading platform. The realization principle is mainly to input the corresponding data from the database by inputting the product number of the agricultural product. For the operators in the planting process, the use of the query function is not much, mainly in information recruitment. However, the information that is queried will include the address of the product corresponding information stored in the block-chain, by which the query interface can be called to find the data fingerprint for the information. The code implementation aspect is shown in figure 5. The user compares the original data fingerprint obtained from the block-chain address with the new data fingerprint generated by the information sheet. If the same, it is not tampered with, otherwise the data has a problem. This achieves the authenticity verification of the data.
5. Conclusions
The block source-based agricultural product traceability system uses agricultural products as the main source of traceability. It can record and store information in the whole process of agricultural product production. The block-chain is applied to the agricultural product traceability system, and the distributed ledger using block-chain technology. Features such as decentralization, consensus trust and reliable database can effectively reduce the cost of agricultural product traceability system and ensure the safety and reliability of agricultural product traceability information. We hope to innovate business trust and build a block-chain credit society.

6. Acknowledgments
This research is supported by the Natural science foundation of Hubei province (No. 2017CFC840), and the 2018 college student innovation and entrepreneurship training program of South-Central University for Nationalities (agricultural products trading platform based on block-chain). Liao is currently an undergraduate, Ke Xu is the corresponding author and an instructor in SCUN.

7. References
[1] Lin J., Z Shen, A Zhang, et al. block-chain and IoT based Food traceability for Smart Agriculture. Proceedings of the 3rd International Conference on Crowd Science and Engineering, Singapore, 2018: 1-6.
[2] Yang W L, Chen P S. E-food traceability Learned by Consumers, Proceedings of the 3rd International Conference on Industrial and Business Engineering Sapporo, Japan, 2017: 20-22.
[3] Muralikumar M D, Nardi B A, Addressing limits through tracking food. Proceedings of the 2018 Workshop on computing within Limits, Toronto, ON, Canada, 2018: 1-9.
[4] Thai P, Njilla L., Duong T., et al, A Generic Paradigm for block-chain Design. Proceedings of the 15th EAI International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services, New York City, NY, USA 2018: 460-469.
[5] Bhuiyan M Z A., Zaman A, Wang T, et al, block-chain and Big Data to Transform the Healthcare. Proceedings of the International Conference on Data Processing and Applications, Guangdong, China, 2018: 62-68.
[6] Hilt M, Shao D, Yang B j, RFID Security, Verification, and block-chain: Vulnerabilities within the Supply Chain for Food Security. Proceedings of the 19th Annual SIG Conference on Information Technology Education, Fort Lauder dale, FL, USA, 2018: 145.
[7] Batubara F R, Ubacht J, Janssen M, Challenges of block-chain technology adoption for e-government: a systematic literature review. Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age, Delft, Netherlands, 2018: 1-9.
[8] Scönhals A, Hepp T, Gipp B, Design Thinking using the block-chain: Enable traceability of Intellectual Property in Problem-Solving Processes for Open Innovation. Proceedings of the 1st Workshop on Cryptocurrencies and block-chains for Distributed System, Munich, Germany, 2018: 105-110.
[9] Chakravorty A, Rong C, Ushare: user controlled social media based on block-chain. Proceedings of the 11th International Conference on Ubiquitous Information Management and Communication, Beppu, Japan, 2017: 99-104.