An Agri-product Traceability System Based on IoT and Blockchain Technology

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***Abstract*—This paper starts from the food quality problem and proposes a traceability system for agricultural products based on Iot and blockchain technology. The architecture of the system is given and some existing problems are discussed. By using the consortium blockchain as the basic network and the IoT devices as the recorder, a more reliable, trustable and extendable traceability system can be achieved.**

Keywords—traceability, IoT, blockchain

I. Introduction

The quality of agricultural product has always been a social issue of concern to governments. Realizing the traceability of agricultural product can reduce the existence of fake and inferior commodities. A simple solution is to manually record the product information, save them to a certain database, and provide a visually query interface for customers. However, there are two problems that are difficult to solve in the implementation of this scheme. On one hand, the data is recorded by human beings, and it is difficult to guarantee authenticity, so the credibility is low. On the other hand, the data is stored in a centralized data center that is easy to tamper with and difficult to monitor.

By combining the Internet of Things(IoT) and blockchain technology, the above problems can be solved to some extent[1-2]. IoT technology can make devices intelligent and realize automatic measurement and transmission. The use of IoT equipment instead of manual record not only saves labor costs, but also improves data credibility. The blockchain is a distributed ledger technology, with the feature of decentralization, transparency, privacy and security. Using the blockchain technology can prevent data tampering to a certain extent and make the system more trustable.

This paper proposes an agricultural product traceability system based on the IoT and blockchain technology. From the moment of the birth of agricultural product, it can track the whole process, which can greatly enhance consumers' trust in the food and make the brand protection work better.

II. System Design

A. System Structure

The overall structure of the system is shown in Figure 1. It is mainly divided into three parts: client, server and blockchain.

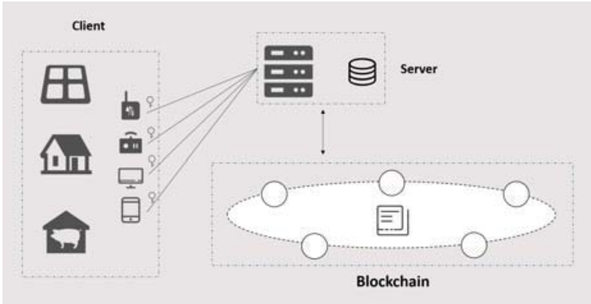

Fig. 1. The overall structure of the system

The client part is in charge of the collection of information. According to the data that needs to be recorded, sensors can be arranged on the farm. The sensor has a built-in processing chip, which mainly includes a network module and a data processing module. The former is responsible for implementing the network function and communicating with the server. The latter is responsible for the processing of measurement data, including data formatting, data encryption and decryption, etc. It should be noticed that the chip here contains a key pair for the blockchain network, typically based on an elliptic curve cryptographic algorithm. The key pair represents an identity of the device, and the data can be tracked by registering the device in advance. In addition, there may be some data that needs to be manually recorded. Therefore, the system also provides a manual recording interface that can be operated by application software.

The server part is responsible for the processing of business logic. It mainly includes four modules: employee management, IoT device management, system management, and measurement data management. The first two modules mainly provide unified management functions for relevant personnel and devices of the enterprise, which facilitates operations such as authorization and registration. The system management module is related to system parameters and security. The last one provides the management functions for the measurement data.

As for the blockchain part, it contains the function of data storage, consensus, encryption and decryption, verification, etc. Besides, it runs smart contracts to execute the corresponding logic at specific points in time, which can increase scalability, simplify processes and reduce costs.

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B. Software Architecture

The software architecture of the system is shown in Figure 2. It includes four layers.

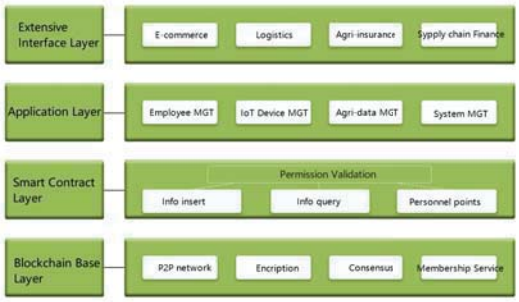

Fig. 2. The software architect

The blockchain base layer includes peer-to-peer networks, consensus services, encryption algorithms, and membership services. We use Hyperledger Fabric to build a consortium chain that requires authorization to join. The nodes are deployed in multiple enterprises and communicate through peer-to-peer networks.

The smart contract layer is the entry for the blockchain. It needs to verify the authority. The core consists of the data insert and query. Only the registered identity can invoke the method. In addition, it also includes user points operations, which are set according to pre-defined requirements. The user points system provides support for some extensive functions.

The application layer is responsible for the invocation of business logic and connecting the client and the blockchain network. When receiving the request from the client, the program execute the authority verification and preprocessing, then return the processing result to the client.

The extensive interface layer provides support for further functional expansion and facilitates access by other systems, such as e-commerce systems, logistics systems, agricultural insurance, and supply chain finance.

C. Lifecycle Management

This system can track the product from the beginning. The lifecycle of the product can be divided into three stages of production, transportation and sales.

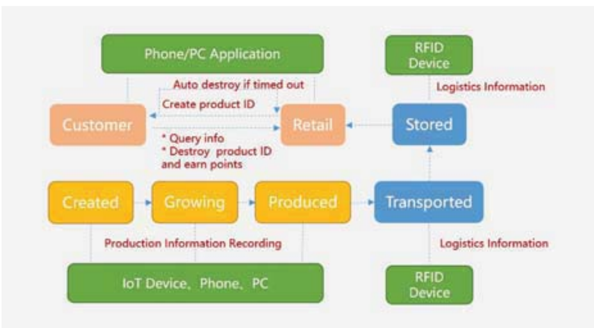

Fig. 3. The lifecycle of the product

Production information should only be recorded during the production stage, including the inherent information and production log information. The former is definite when the product information is created and will not be changed, such as the product name, origin, etc. The latter is recorded in the process of growing and needs to be written multiple times.

The transportation stage involves multiple roles such as logistics, warehousing and dealers. Relevant personnel can write data through the application provided by the system, and use RFID technology combined with GPS technology to achieve anti-counterfeiting and ensure data reliability.

Generally speaking, the information query of the traceability system can be implemented by means of product number, two-dimensional code, etc. These methods are easy to forge and difficult to guarantee uniqueness. Therefore, the management of agricultural product information is very important for traceability systems. If the agricultural product information can be destroyed in time to prevent id reuse, the anti-counterfeiting capability can be greatly improved.

In the case of chicken, the growth information of each chicken can be recorded, and one chicken is also sold as a minimum unit. This situation is easy to manage. When the product is sold, this data should be marked as destroyed, ensuring that the data for each chicken is used only once, which can largely prevent counterfeiting. In another case of crops, information is usually recorded as a unit of crops in a planting area, and sales usually correspond to several units of products. In this scenario, the former method is no longer valid. Instead, we can combine the dynamic allocation and rewards, that is, the retailer dynamically generates a query code every time the product is sold. The code has a certain validity period. The consumer can scan the code after purchase and enter the page to execute the destruction function so that he can get a certain point reward. If it is not operated after the expiration date, it will also be destroyed automatically. For the retailer, the contract is signed with the supplier, and all operations are recorded in the blockchain network, so the risk of counterfeiting is big. For consumers, the point reward mechanism can motivate them to feedback, even if not, the validity period can be used to avoid the reuse of the same query code.

III. Conclusion

In summary, the above-mentioned traceability system can effectively realize the product traceability requirements. The IoT technology is more realistic and reliable than the traditional manual recording, and the blockchain technology is more credible than the traditional database. Because the system is based on a consortium chain composed of multiple organizations, the cost of cooperation between enterprises is lower, which can effectively reduce operating costs and improve economic efficiency.

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