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An Innovative Design of The Internet of Things For Supply Chain Management of Fresh Agricultural Products

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Abstract.

Relevant theories of supply chain management (SCM) and information sharing are summarized, and current situations of SCM of fresh agricultural products are studied. On this basis, an innovative design scheme for the Internet of things (IoT) for SCM of fresh agricultural products is proposed. According to the IoT design framework, an information-sharing mode on the IoT is built. Moreover, the data-collection layer, shearing layer, and application layer in the IoT system for SCM of fresh agricultural products are analyzed. The Markov theory is used to establish the information flow model for the supply chain. Finally, the performance of the established IoT for SCM of fresh agricultural products is analyzed through simulation.

I. INTRODUCTION

China is a major producer and consumer of fresh agricultural products. However, problems frequently occur during these products' supply due to many producers, the small scale of participants, and the imperfect market in a perfectly competitive environment. These mainly include the co-existence of difficulties in buying and selling, frequently occurring quality problems, and low logistics efficiency of fresh agricultural products. According to goals of facilitating agricultural modernization and building a moderately prosperous society in all respects, how to guarantee the effective supply of fresh agricultural products has become a major problem needing prompt solution as it relates to agriculture development, improvement of people's living standard, and even social harmony and stability in China.

The radio frequency identification (RFID) and electronic product code (EPC) standards in the Internet of things (IoT) enable the effective collection, transmission, and processing of real-time information in the supply chain of fresh agricultural products, including processing, storage, transportation, delivery, and sales. For fresh agricultural products, their demands can be accurately predicted, supply chain planning can be balanced, and quality can be traced with the aid of big data. The intelligent control cloud platform of supply chains can eliminate information-isolated islands between enterprises on the supply chain of fresh agricultural products, thus effectively improving the supply chain's overall efficiency. Using emerging information technologies such as big data, IoT, and cloud computing, the supply chain of fresh agricultural products will certainly form a new industry characterized by sustainable and large-scale development.

II. CURRENT RESEARCH IN CHINA AND OTHER COUNTRIES

IoT brings about new changes to the supply chain of fresh agricultural products. It is an urgent need to establish a traceable management system for these products to guarantee product quality and safety in the process from field to table.

A. Research in other countries

The European Union stipulates that all imported foodstuff should be traceable. According to the requirement, a traceability system is built for beef products, which uses the latest technologies to enhance traced information reliability. In the United States, livestock must wear ear tags from birth to record information in the whole process from birth to slaughter to realize the traceable management of livestock products' whole supply chain. In Japan, a relatively perfect foodstuff traceability system has been built: it has established a traceability system for beef products, and the Positive List System for Agricultural Chemical Residues in Foods provides stringent reference standards for limits of residual pesticides and feed additives. Other countries are also actively promoting the construction of the foodstuff traceability system. For example, the livestock traceability system in the United Kingdom and the livestock tagging and tracing system in Australia have been widely used in the research on the traceability of livestock, poultry, fruit, and vegetable products.

B. Current development in China

Construction of the foodstuff traceability system in China begins in the early 21st century. According to the Regulation on Tracing of Exported Aquatic Products, substandard products should be recalled timely. It is clearly stated in Management Measures for Livestock and Poultry Tags and Breeding Records, all livestock and poultry should wear ear tags. In the Food Safety Law of the People's Republic of China, producers and operators are encouraged to use modern information technologies to collect food production and operation information to complete the traceability system. As to the construction of pilot traceability systems, the information query platform for edible agricultural and sideline products in Shanghai uses information technology and barcode technology to realize systematic management capable of monitoring the production process, testing information and identifying barcodes. The General Administration of Quality Supervision, Inspection, and Quarantine of the People's Republic of China has launched the barcode program to assign a unique identification number to some products.

III. RESEARCH PLAN

With the increasing awareness of the SCM of fresh agricultural products in China, the corresponding information support system is gradually established. The most important characteristics of the information support system are the SCM information system center and information platform. The system allows resource and information sharing within enterprises and access to external Web sites to communicate with the server through the browser. This provides dynamic information interaction and information services.

Based on the advanced IoT technology, an SCM platform for fresh agricultural products is designed. Besides, information can be effectively transmitted among suppliers, producers, distributors, dealers, and consumers through informationization, which improves SCM information accuracy and ensures convenient communication of various links (Fig. 1). Moreover, the supervision department, sanitary authority, and market regulator of fresh agricultural products are also allowed to monitor the whole process from the production, market access to quality safety of these products via information platforms such as portal websites. These departments can also release the latest international and national standards about agricultural products on the information platform to guide production.

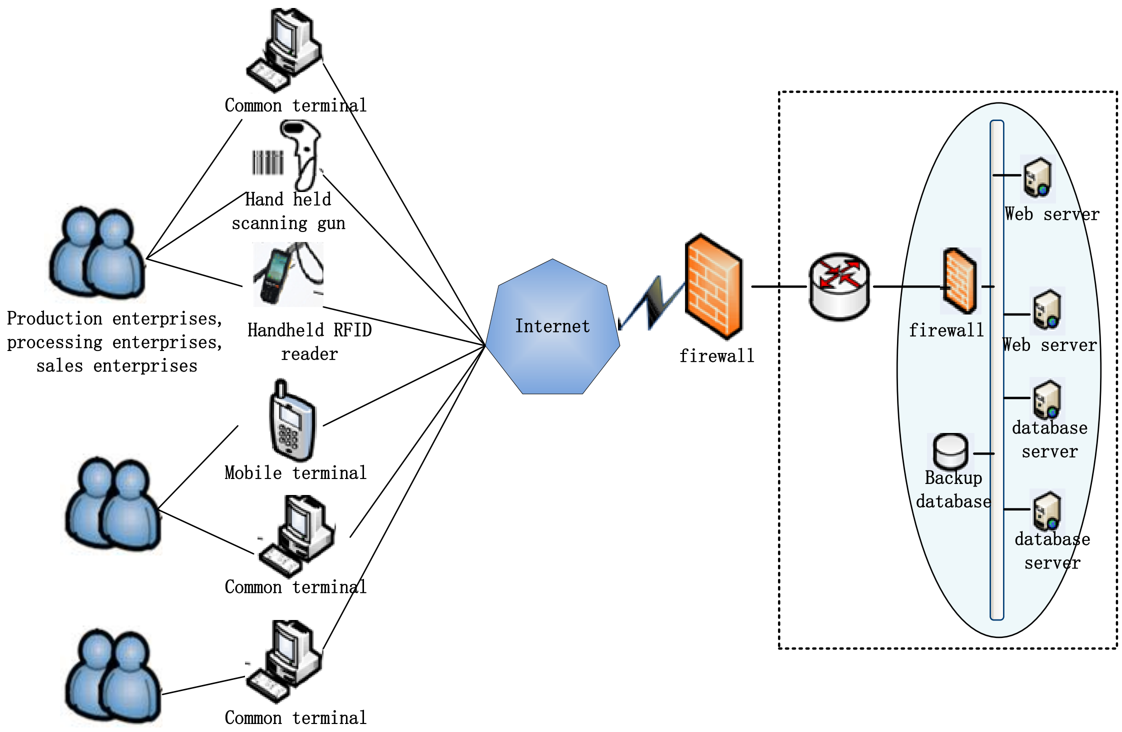

Fig. 1. The SCM platform for fresh agricultural products based on the IoT

The IoT for the supply chain of fresh agricultural products is designed. At first, the IoT is divided into the sensor, network, middleware, and application nodes connected to form a basic framework of the IoT. It enables comprehensive perception, reliable transmission, and intelligent processing of information on these supply chains. The basic structure is shown in Fig. 2.

The IoT design for the supply chain of fresh agricultural products and information sharing model is constructed for the supply chain and mainly consists of a data-collection layer, a platform layer, and an application layer (Fig. 3).

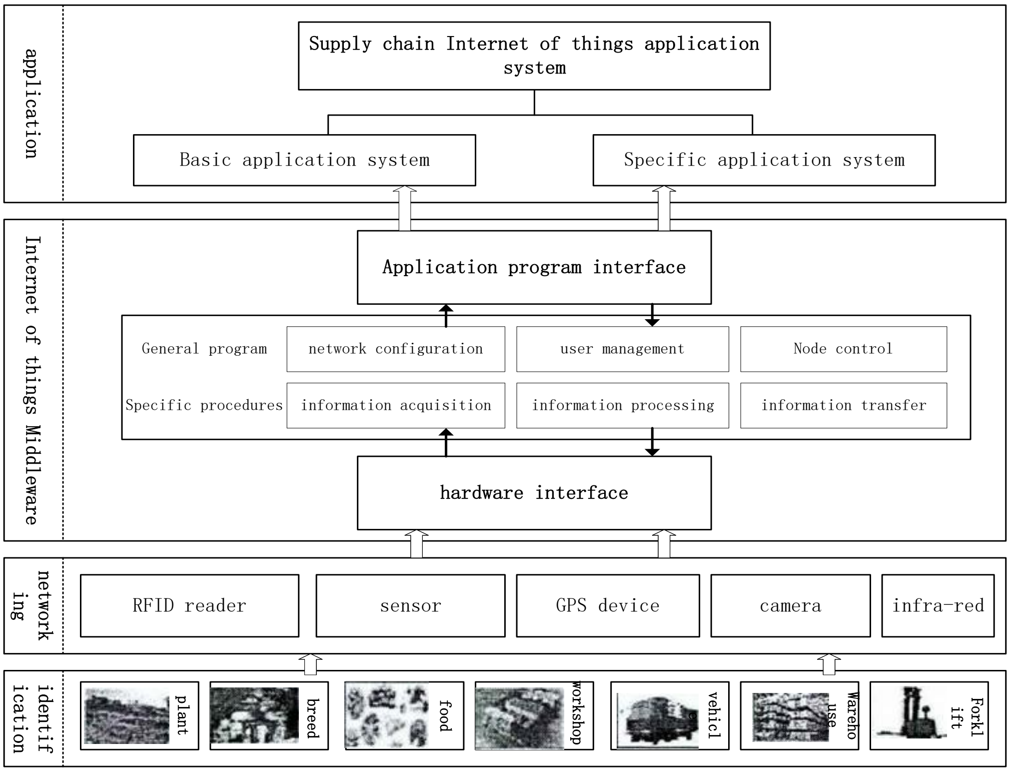

Fig. 2. IoT design for the supply chain of fresh agricultural products

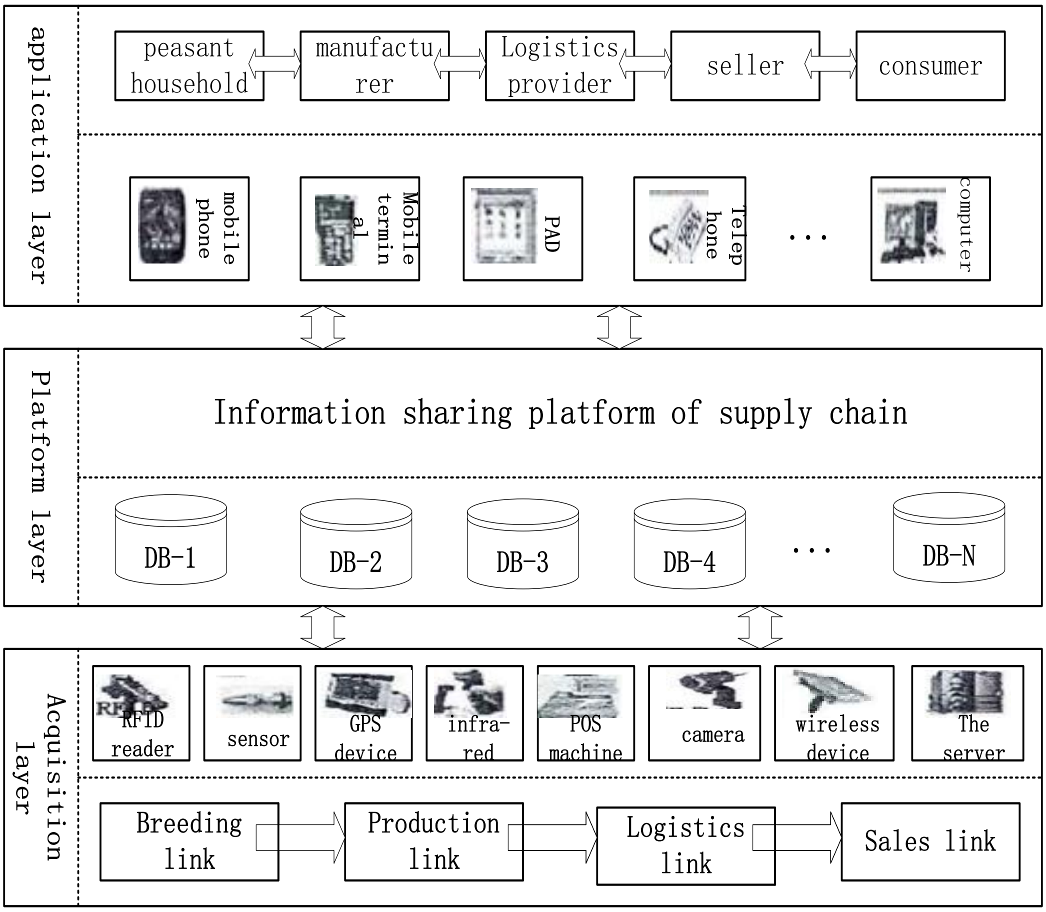

Fig. 3. The information-sharing mode for the supply chain of fresh agricultural products based on the IoT

IV. CONCLUSIONS

To solve problems including co-existence of difficulties in buying and selling, frequently occurring quality problems, and low logistics efficiency in the supply of fresh agricultural products in China, breakthroughs are made in key technologies such as the innovative design of the IoT for SCM of these products. Based on this, the intelligent control cloud platform for these products' supply chain in cities is developed. The research aims to build an intelligent control system for the supply chain of fresh agricultural products characterized by considering all links, networking, stringent standards, traceability, a new mode, and high efficiency. The system is expected to promote agricultural development further, improve people's living standards, and maintain social harmony and stability in China.

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