Research on Traceability of Cold Chain Logistics Based on RFID and EPC

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Abstract. In recent years, people placed great emphasis on food quality and safety. About half million people die of food hygiene problems every year in the world. How to effectively trace the source of various kinds of food with various origins has become the core issue of food safety research. Based on EPC, RFID and Baidu Map API, this paper designs a tracking and traceability platform and establishes a food life cycle model to ensure food safety and improve service level. The main research contents include: developing EPC coding system of the research object; solving the life cycle of the research object.

Keywords: Agricultural products; Cold chain; Traceability; EPC; RFID.

1. Introduction

With the development of economy and living standard, people's food consumption gradually changes from single to multiple of quality. People has paid more attention to the freshness, quality and safety of products. In recent years, food safety accidents have occurred frequently, such as melamine milk powder, Sudan red, toxic cucumber and so on. Due to the unscientific circulation process, the current fresh-keeping methods can not adapt to the fresh sale markets. In China, the loss of fruit is nearly 12 million tons every year, and the loss of vegetable is 130 million tons. According to relevant media reports, the value of rotten fruits, vegetables and other food during transportation is about 70 billion yuan each year, causing huge economic waste. Therefore, it is of great significance for promoting the development of food logistics industry, tracking and tracing the whole life cycle of food. Cold chain logistics aims to keep food fresh by refrigerating and freezing them throughout the whole transportation until arrive at consumers. Cold chain has been applied to many fields, includes: primary agricultural product, aquatic products, flower products, processed food and other packaging cooked food. The development of cold chain logistics can promote the circulation of commodities such as poultry meat, aquatic products, vegetables and fruits, reduce the loss of resources, and enhance the utilization rate of social resources. So, building traceability system of cold chain food would reduce the occurrence of food safety accidents in the distribution link, and build a reasonable and orderly food logistics distribution system [1-2].

Food tracking and traceability is the core issue of food safety. The European Union and other developed countries have successfully carried out tracking research on beef, fish, vegetables and other foods by adopting the global unified identification system (EAN-UCC coding system). Electronic product code (EPC) is the extended version of the EAN-UCC coding system, that aims to provide unique identification for every physical entity on the earth. Xiu et al. studied EPC-96 and applied it to the...
traceability of liquor products [3]. Liu et al. designed put forward a distribution scheme based on EPC-96, which provides a reference for food supply chain traceability [4]. Wang et al. designed food traceability system based on RFID and EPC technology. The system can trace food through smart phone app, wireless intelligent terminal, web browser and other forms [5]. Zhao et al. built the Internet of things system of a food distribution enterprise based on EPC coding system [6]. Cao et al. designed a traceability system of beef product supply chain is designed based on RFID and EPC technology [7]. Gao et al. put forward the IOT business traceability system based on RFID and EPC Internet of things technology, which organically embeds the commodity traceability function in the business process of IOT, and realizes the traceability of IOT business commodities [8]. Many food traceability system have some disadvantages, such as non-standard, free-style and information-isolation. This paper studies and designs a cold chain traceability system based on EPC and RFID technology. Our proposed traceability system can monitor the quality of the agricultural food from the harvest, processing, transportation, marketing and other aspects.

2. EPC Coding System
The EPC, stand for “electronic product code”, is the extended version of the EAN·UCC coding system. It can provide unique identification for every physical entity on the earth. Registration, authorization and distribution of EPC code is supervised by the EPCglobe Organization. By using EPC, enterprises and trading partners can easily track supply goods and ensure them arrive to the right place.

2.1. EPC Coding Structure
Current EPC code median of three kinds that are EPC-64, EPC-96 and EPC-256 [9]. Considering the amount of products and the costs of logistics, EPC-96 are usually used for traceability system. The encoding capacity of EPC-96 is shown in Table 1.

| Bits | The Max Capacity |
|------|------------------|
| Version | 8 |
| Domain Management | 28 | 268 435 455 (0.268 billion) |
| Object Classification | 24 | 16 777 215 (16.78 million) |
| Serial Number | 36 | 68 719 476 735 (68.7 billion) |
| The total number of food | 309 484 900 217 175 959 785 701 375 |

2.2. EPCglobal Organization
EPCglobal organization is a non-profit organization, which is responsible for the global standard of EPC network, so as to identify the goods in the supply chain more quickly, automatically and accurately. EPCglobal has taken the following measures:

- Assign, maintain and register. In order to ensure the uniqueness of every EPC code all over the word, there must be an organization as the unique manager to supervise the usage of EPC code.
- Training and Education. EPCglobal is responsible for helping customers to apply EPC correctly and master EPC technology quickly.
- Rule and implementation. EPCglobal is participate in the implementation of business cases and formulate rules of EPC network standards.

3. RFID
RFID is a common acronym for Radio Frequency Identification, and that is a generic term for technologies which use radio waves to automatically identify people or objects. Unlike barcode technology, RFID does not require contact or line of slight for communication. A tiny electronic chip of RFID technology has very larger storage. For example, a 0.3 x 0.3 mm chip can store from 16k to 64k bytes, greatly increased storage capacity compared to barcode. In the agricultural traceability system, each RFID tag stores a unique EPC code for special products.
4. Overall Structure of the Traceability System

The traceability system of cold chain based on the EPC and RFID technologies is described as follows: EPC codes applied from EPCglobal by enterprises are used as the retroactive marks for every commodity, and RFID tags are used to store EPC data. RFID tags scanner would be used to get the EPC codes from EPC tags.

4.1. The Overall Structure of the System

The traceability system of cold chain based on EPC and RFID is comprised of three levels: servers’ layer, network layer and application layer. As Figure 1 shows, there are three levels in the overall structure of the system.

As Figure 1 shows, CA identifies the certification authority centre, EPCglobal is a Globe Standard 1 (GS1) initiative to innovate and develop industry-driven standards for the EPC to support the use of RFID and allow global visibility of items, and ONS represents Object Naming Service, and that is a network service similar to DNS.

4.2. Analysis of the Traceability System

This agricultural cold chain traceability system consists of MIS of the agricultural production enterprises, food safety and quality monitoring platform, transportation and distribution schema, and terminal inquire system.

Step 1. An agricultural business that wants to take part in the traceability system should register its information into the traceability system.

Step 2. The traceability system login GS1 and asks EPCglobal organization for the scope of EPC codes given to the business.

Step 3. GS1 returns the business requirement back to the traceability system and publishes it on its own bulletin board.

Step 4. The traceability system sends the business needs to the business through the security channel.

Step 5. The business sets EPC codes for its production according to the given EPC information.

Step 6. In the growth stage, the agricultural production business sends the information collected from Internet of Things and other information to the traceability system. The traceability system stores the
information to database for late traceability.

Step 7. In product period, such as processing, transportation, distribution, storage and sales process, the information of temperature, humidity, time consumption and etc., collected from Internet of Thing is saved to the database similar to Step 6.

Step 8. Traceability. When consumers want to know the entire cycle of their commodity, first, they get the EPC codes of their commodity by RFID reader; and then, they obtain the entire cycle of information of the commodity from the data centre so as to ensure the safety of the goods.

4.3. An Example of the Traceability System

To prove our proposed method, we develop a small traceability system for some agricultural products. The system consist of two parts, one is data management system that is developed based on C/S model, two is data search system that is developed based on B/S model.

As Figure 2 shows, the agricultural business make EPC codes for their goods and save them to RFID tags. Figure 3 shows that during cold chain logistics period, the information of goods is collected to send to database center.

Figure 2. Generate EPC and write RFID tags.

Figure 3. Upload data to DB Center.

Figure 4 and Figure 5 represent the behavior of tracing back to goods. First, EPC code of goods are read from RFID tags and input into the text box. Second, select search button and the entire cycle of the good is published on the web page.

Figure 4. Input EPC
5. Conclusion
For food safety of agricultural fresh food, we put forward a traceability model for agricultural production based on EPC and RFID which are the basis technology the Internet of things. In our proposed approach, the traceability tags are effectively collected and distributed. It is easy for customers to monitor the whole cycle of their food so as to ensure the safety of them.

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