Design on Cucumber Traceability System Based on the Internet of Things

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Abstract. With the development of science and technology, the problem about the quality safety traceability of agricultural products has already become the hot topic of researchers in various fields. Cucumber is one of the main vegetable crops in China. It is convenient for eating and contains various beneficial minerals. With the constant expansion of the planting areas, it plays a more and more important role in the development of agricultural economy. However, the cucumbers sold on the market at present have residues of pesticides and growth hormone and many other problems. In this article, firstly, the author analyses the feasibility of the application of internet of things and electronic label technology in cucumber traceability system. And then, the author puts forward basic requirements of design on cucumber traceability system according to domestic and overseas research situation; Based on this, the author makes the whole design on cucumber traceability system, together with the specific design on three-layer structure and function of the internet of things and the research and development of the enterprise management system and the internet service system of cucumber traceability system. Finally, the author integrates cucumber traceability system based on the internet of things and realizes the traceability management of the whole process of cucumber planting, sales and monitoring, and provides effective technical support for production and sales management.

Keywords: Food safety, The internet of things, Cucumber, Traceability system.

1 Introduction

Cucumber, originated in the equatorial rain forest area of South Himalayas, belongs to the gourd family of cucumber. It is one-year rampant herb and has a cultivation history of more than 2000 years in China. Cucumber is convenient for eating, rich in

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D. Li and Y. Chen (Eds.): CCTA 2011, Part I, IFIP AICT 368, pp. 199–208, 2012.

vitamins A and C, and contains a variety of useful minerals. It is one of the main vegetable crops in China. In recent years, with the rapid development of China's economy and the agricultural and industrial structure adjustment, cucumber cultivation in China also experiences great changes. These changes include that planting areas expanded rapidly; variety gets richer; the division of cultivation of crop rotation is more detailed; and annual production was realized. Cucumber is a common kind of vegetables but the distribution of cucumber cultivation areas in China is very uneven in the past, mainly concentrated in the provinces where there are good climatic conditions and natural environment, such as Shandong, Henan and Hainan province. In recent years, the distribution of cucumber cultivation areas in China spreads gradually. Almost every province has some great cucumber production bases around every big city. Regional production is getting increasingly prominent. By the end of 2002, cucumber cultivation area reached 1.253 million hectares in China, which is nearly 3 times of that in 1980. It accounted for about 10% of the national vegetable area. 58% of the cucumber was planted in the outdoors.

At present, the main problem of cucumber sold in the markets is the residues of pesticides and growth hormone. In 2008-2009, the Green Peace Organization of the World conducted sampling tests on 17 kinds of vegetables and fruits in many supermarkets in Beijing, Shanghai and Guangzhou, which showed that pesticide residues of the cucumber ranked the first, containing 4-13 different kinds of pesticide residues. Losses often happened due to heavy pest and disease infestations in the cultivation process of the cucumber. Farmers still use chemical pesticides to control pests, but this often causes serious excessive pesticide residues in cucumber although pests and plant diseases are wiped out. In production, pesticide residues are often caused by unreasonable and improper selection of pesticide and fertilization, such as nitrate toxic residues in fruits, which can cause food poisoning after eating.

Now an important cause of frequent food safety issues is that the consumers, and even managers do not know the food sources of their own consumption, either can they trace back when a problem occurs. This puts illegal businessmen who are manufacturing and trading fake goods and drugs and the consumers in totally unequal positions. How we shall control the food quality and production process effectively has become a problem to be solved urgently. Food traceability system as a means of information communication can collect food quality-related information from field to fork, and realize the delivery and sharing of information between related subjects to overcome information asymmetries. It is convenient for managers to monitor, and the consumer can query at anytime. The producers can keep a record of the relative information during the production, transport and processing of cucumbers, which ensures that the quality control and quality security of the products can be traced back from production to the final of the entire sales process. This is also helpful to the quality control and the management of products in library [1].

At present, the key technology of food traceability is the quick and accurate capture, transmission and data processing of all kinds of information. The internet of things can solve these problems. Therefore, internet technology’s application in food traceability will achieve better supervision results, providing effective means for food

safety responsibilities. This article is to structure a cucumber traceability system based on the internet of things to address food safety problems of cucumber.

2 Application Analyses on Technology of the Internet of Things

The internet of things means to implant embedded chips and software that have perception, calculation ability and executive ability into the physical world entity and make it an intelligent object. It can realize information transmission, collaboration and processing through network facilities, and then realize the association between things and things, or between things and people. It can realize the links at any time, in any place and between any objects, making people to manage production and life in a more delicate and dynamic way to achieve “wisdom” state and improve resource utilization and productivity level. It can improve the relationship between human and nature and enhance the whole social informatization ability. Thus, the technology of the internet of things provides technical support for food safety problems.

The internet of things contains perception layer, transport layer and application layer. Electronic label technology, also named Radio Frequency Identification, is applied in perception layer. The Chinese Items Coding Center of China Standardization Institute has been trying to apply the bar code technology to domestic food traceability for years, and promotes the application of the bar code technology in our country's food traceability though “China Bar Code Push” project. It realizes the internet of things in the entire process of agricultural logistics, and creates RFID tag for the agricultural products, establishing the tracking and monitoring of the whole progress of agricultural products’ planting, production, processing, transportation and sales. It realizes the quality traceability system of the entire process from the fields to the table.

In general, the technology of the internet of things can realize the quality control of the entire process of vegetable production from planting and harvesting to transportation and sales, as well as realizing quality tracking, production file management, conversion between FID labels and bar code information, Bar code label printing and the tracing and inquiring functions of vegetable quality safety based on web site, telephone and mobile phone text messages [2].

3 Demand Analysis and System Design of Cucumber Traceability System

Tracing system relies on modern database management technology, network technology and bar code technology. It records, collects and inquires the entire link information of the whole food chain from production, processing, packaging, storage and transportation, distribution to sales. It can trace back to the food source and the flow of it. When food has problems, it can inquire back to each link and provide effective supervision for food safety.

3.1 Demand Analysis of Traceability System

Tracing system reefers to the tools and hardware facilities applied to carry out trace target, and it combines material flow with information flow through the automatic identification technology and records the production information throughout the whole supply chain. It completes information transmission and release in each link of the supply chain by using the network technology and achieves the purpose of real things' traceability. Tracing system should also meet the following requirements:

① It features low cost, convenient operation and easy to promote. In the food safety field, if we implant a RFID into every piece of vegetable or fish, its cost will be so high that consumers would not pay for the extra spending.

② The structure of the internet of things is reasonable and the function is powerful. It not only involves sensor, processor and other hardware, but the software and agreement. Most of these are far from being perfect and even in a state of blank. Domestic device, the domestic agreement and domestic related software products are highly needed [3].

③ It requires to set up the whole process monitoring and management information system. At present, although there is relevant domestic tracing system, its application scope is limited, most in meat and poultry products. Nowadays, how we shall use the information technology services and application system to improve vegetable quality tracking system and establish the whole process monitoring and management information system "from field to table" is still the common goal for researchers in agricultural information technology and products safety fields [4][5].

④ It also demands information visualized expression. In order to change traditional origin information management mode simply by text statistics, it is urgently needed to realize visual expression of spatial information of origin planting block using GIS technology and return to the specific space position and attributes information of the origin of agricultural products in a graphical way [6].

⑤ Traceability information is standard enough to reach the purpose of the resources sharing. Because the development goals and principle of the existing tracing system are different, traceability information is not standard, while the information flow is not consistent and system software is not compatible, which causes it impossible to share and exchange traceability information [7].

3.2 The Overall Design of the System

The system will realize the traceability management of the whole production process of cucumber, including planting, sales and monitoring through the technology of the internet of things, and will realize visual search function through the help of GIS technology and further enrich the query information of cucumber traceability by using three-dimensional encoding technology. Through scanning the traceability code on vegetables product packaging, market terminal inquire system will accurately show the whole information of the cucumber. The system structure and working principle are shown in figure 1.

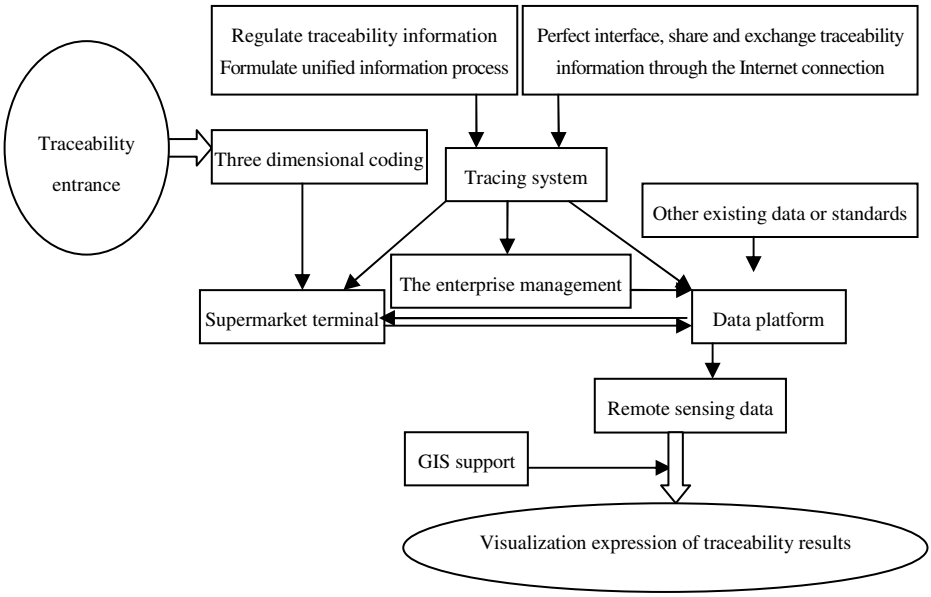

Fig. 1. System structure and working principle diagram

This system mainly includes the enterprise management information system, food safety and quality data platform and terminal inquire system.

(1) The enterprise management information system uses a certain information technology and bar code technology for cucumber production enterprises, and enter area server online. As to the information during the production process with multiplied entries, inconvenient online entry, and a small amount of data, automatic acquisition of the three-dimensional code information stored on the RFID attached to the product packaging is conducted through handheld wireless devices. And then the wireless terminal determine geographical locations automatically through the GPS location positioning technologies and send information like three-dimensional information, the name of the company that collects the information, acquisition time, place and responsible person, etc. to the regional server remotely via GPRS. The system controls the process of production and conducts a computer management from cultivation and sales to processing and packaging.

(2) Food safety and quality data platform mainly receives various information from enterprises, inspection bodies and certification bodies. The application of this platform can ensure that end-market (supermarkets) receive the latest information every day.

(3) In the supermarket terminal, by scanning the traceability code on vegetable product packaging, terminal inquiry system will accurately display the basic situation of the company, farmers, vegetable cultivation, drug use fertilizer, acquisition time, processing workers and processing dates, testing information and other data[8-9].

3.3 Designs on the System of the Internet of Things

Tracing system is designed to make effective logo of all links of the cucumber production processing and complete the automatic acquisition and storage of information. After the collection of information, the system will make full use of modern database technology to complete automatic management and preservation of mass information and automatically generate file management files. For the convenience of information collection, sharing and effective management, the traceability system is also required to make full use of modern computer network management technology.

The real-time monitoring and real-time decision of cucumber tracing system from "nerve" to the entire operation must be supported by the internet of things. When any nerve end of the system receives an entry information, this system can respond in a very short time and quickly call data and make related information feedback.

Through the use of RFID technology and EPC standards in information collection, transmission and processing, the system can provide agricultural product safety information for each step of cucumber traceability, realize non-contact interaction and processing make fast and efficient convert, processing and feedback and constituent the internet of things. The function design of the three layers of the internet of things is shown in figure 2, and the internet of things throughout the whole process of traceability system is shown in figure 3.

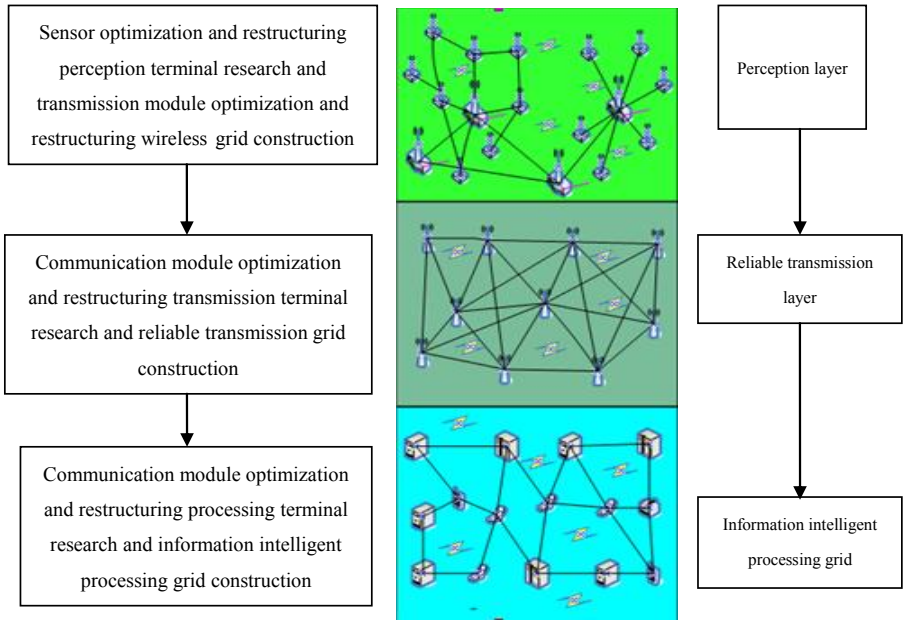

Fig. 2. The function design of the three layers of the internet of things

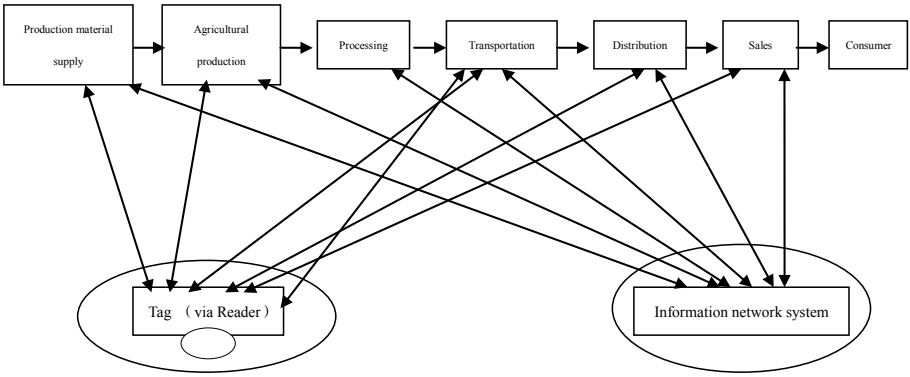

Fig. 3. Tracing system that runs through the whole network

3.4 Designs on the Enterprise Management Systems

The core part of the system is the enterprise management system, which is shown in figure 4. As the current information provided by the tracing system is too superficial and the value of the information provided by traceability code is too small, the system collects cucumber-related data including foundational geographic data, origin environmental data, data of added things during production process, data of main harmful materials, technology data of processing/circulation process, quality analysis, testing results data and so on, and then puts them into corresponding database and uses three dimensional coding technology with rich information to sign on the label for abundant traceability information.

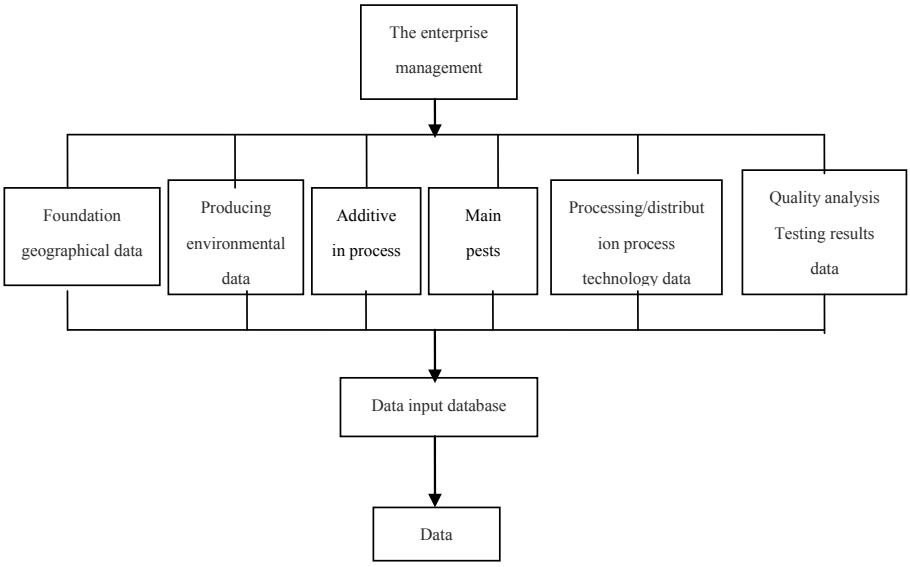

Fig. 4. The composition of the target enterprise data

Single server in performance can not effectively support real-time asynchronous information collection and traceability, as the number of the enterprises and products involved in the cucumber supply chain is very big and food traceability information needed for collection in time and space is scattered. As for the information collection of large space scope, the system introduced in this thesis set respective area server connected with the central server according to the division of the geographical location, which is shown in figure 5. As for large quantity of stable information such as enterprise information, products information and structural information, related enterprises will input them into areas server online. As for the product process information with many entries, the online entry is inconvenient and data quantity is small. The system uses a handheld wireless terminal to settle that based on related technology of the internet of things.

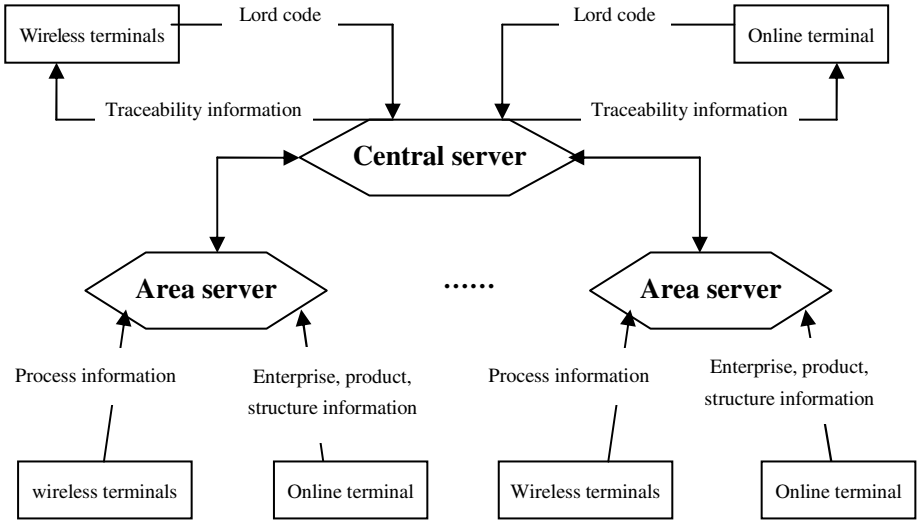

Fig. 5. System information collection and way back

4 Conclusions

This system uses the internet of things and three dimensional code technology to realize traceability management for the whole "from field to fork" production process of cucumber including cultivation, sales and detection. The features are as follows:

① Three dimensional code technology makes the label has more information. Three dimensional coding is based on EAN · UCC global coding system. Code system is used world wide, both for domestic use and international exchange. It can be used in international tracing in food industry, and can get rid of potential barriers in trade. In terms of the content, as the primary code not only contains the GTIN codes that identify the manufacturer and product items, but also includes the batch

number telling the batch information, which can meet the requirements that take the batch number as the unique identification of products when actual dates back happens [10].

② The system can record security information of cucumber's production and sales process. From key control points of the supply chain to the ultimate consumer, the farm enterprises, acquisition, processing and sales of transport enterprises involved in this processes, can form a complete set of agricultural product supply chain network. The production archive of the cucumber purchased will be seen as long as the security bar codes be scanned when consumers put it before the multimedia queries machine. The archive will include the provenance, origin, producer, production environment, the drugs used in the production process, materials processing and certification information, quarantine and other related information.

③ Based on GIS technology, the system realizes visual query. In order to change traditional management mode which shows origin information by simple text figures, the system realizes the visualization of the spatial information in planting blocks through the use of GIS technology, and returns a specific spatial location and attribute information of origin of agricultural products in a graphical manner to meet the urgent need for safe production and date back.

④ The system develops data standards, ensures the stability of the system and improves the sharing and exchange of information. As the development targets and principles of the existing traceability systems are different, traceability information content is not standard, the information flow is not consistent, and the system software is not compatible, causing the difficulty of trace information resources' sharing and exchange. In order to solve this problem, this system gets improved during the design phase. It achieves better sharing of information and exchange function through the interface standards design and information process of unity and traceability information standard. The data in the huge central database of this system can be collected and stored rapidly, and data collection does not affect producers and processors' production technology. It strives to achieve the target that all users are able to use the data in a central database efficiently with no impact on commercially confidential data.

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