Design of fresh food sensory perceptual system for cold chain logistics

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Abstract. According to the present stage low-level information of China's cold chain preservation, designed a kind of fresh food sensory perceptual system for cold chain logistics based on Internet of things. This system highly integrated applied many technologies such as the Internet of things technology, forecasting technology for fruits and vegetables preservation period, RFID and Planar bar code technology, big data and cloud computing technology and so on.Designed as a four-layer structure including sensing layer, network layer, control layer and user layer. The system can implement the real-time temperature and humidity environment parameters monitoring and early warning of the whole cold chain logistics for fresh agricultural products from picking, storage, transportation and processing link. It greatly improved the information level of cold chain circulation in our country and has a strong marketing value.

1 Introduction

Cold chain logistics refers to all kinds of special supply chain systems which can make fresh agricultural products remains in the low temperature environment in the nodes of the product processing, storage, transportation, distribution, retail and other various supply chain and furthest extent possible to ensure product quality and safety, reduce the loss after the origin of harvest of fresh agricultural products such as meat, eggs, poultry, the aquatic products, fruit and vegetables [1]-[3]. At present, the development of cold chain logistics in our country is still in the start-up stage, and the large-scale, systematic, intelligent cold chain logistics system has not formed, which still has a gap compared with the demand of the modern agriculture development, the residents' consumption improvement and the agricultural export expansion. fruits and vegetable products in our country loss as high as 20% ~ 35% due to the storage, transportation and sales under the natural environment condition, the annual loss as 180 billion yuan, while only 1% ~ 5% in developed countries. Therefore, it is urgent to establish the perfect cold chain technology system and perfect cold chain information management technology system in our country [4]-[7].

Cold-chain information will gather various elements in the cold-chain to the database, for in-depth development and rational utilization of cold chain resources using modern

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sensor technology, communication technology, network technology and database technology[8]-[10]. Cold-chain information technology is the combination of cold chain logistics and information technology, which is a kind of solution of cold chain logistics cost reduction, and at the same time is an important guarantee of food quality and safety. Many developed countries have set up virtual agricultural cold chain logistics supply management system, to achieve the all-the-way tracking, dynamic monitoring of all kinds of goods, at the same time connect the demand information and product information through the network and improve the operational efficiency of the cold chain logistics. The informatization process of the whole logistics industry in China starts late, which has not high overall level, especially specific to cold chain logistics. This paper designed a kind of fresh food sensory perceptual system for cold chain logistics based on Internet of things, RFID and Planar bar code technology, big data and cloud computing technology, which mainly includes three parts that the front information awareness, information embedded real-time monitoring and data collection, information sharing center. It realized real-time dynamic information collection, analysis, transmission and intelligent early warning for the agricultural products from warehousing, transportation, sales and other links of the remote monitoring. It greatly improves the modern cold chain logistics information level and the operational efficiency of the cold chain logistics.

2 Fresh food sensory perceptual system design

The block diagram of fresh food sensory perceptual system is shown in figure 1. In order to achieve the whole seamless real-time monitoring of the cold chain, the system uses a four-layer structure: sensor layer, network layer, control layer and user layer.

The sensor layer is mainly responsible for acquisition and processing of environmental parameters such as the temperature and humidity, carbon dioxide, oxygen, etc. in cold storage or refrigerated trucks. Applying RFID electronic tag technology, the system combines the RFID card information with the monitored fresh goods, which is used for the input and processing of agricultural products information and identity identification. At the same time, through RFID and two-dimensional code binding, so that consumers in the market can be traced back to the whole situation of fresh food safety.

The network layer is mainly responsible for collecting and uploading real-time environmental information. The network connection adopts the wired link mode of TCP/IP for the refrigeration house, which has the advantages of mature technology, fast link speed and stable network. For the refrigerator car, the remote real-time information monitoring, collection, analysis, transmission and intelligent warning of agricultural products from warehousing, transportation, sales and other links are realized, by using 4G/3G network transmission and GPS technology.

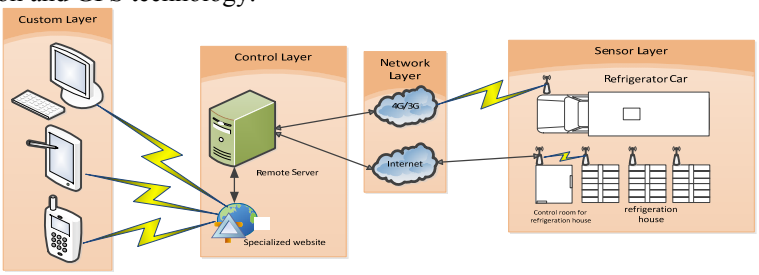

Fig. 1. The block diagram of fresh food sensory perceptual system

The control layer collects the identity of agricultural products, real time environment and other information, combined with the preservation model of vegetables, fruits and other

agricultural products, to forecast, sharing and intelligent warning of important information as fresh keeping period of agricultural products. Achieve the centralized analysis, query, management and online sales of information.

The user layer is designed with a special website and mobile phone special APP for different information terminal, through the user interface, the user can carry on fresh food whenever and wherever possible online information query, full traceability, network consumption etc.

3 Sensor layer and network layer design

In order to realize the real-time monitoring of the whole cold chain circulation process of fresh products, cold storage and transportation links as an important part of the whole chain of cold chain is the key. Therefore, the sensor layer and network layer of Fresh Food Sensory Perceptual System is designed which combines with RFID, the two dimensional code recognition technology, 4G/3G network transmission technology, and has the function of GPS, provides technical support for the realization of seamless real-time monitoring throughout the cold chain. In the design of sensor network layer, Fresh Food Sensory Perceptual System uses 4G/3G network and remote server for real time data exchange. The block diagram is shown in Figure 2.

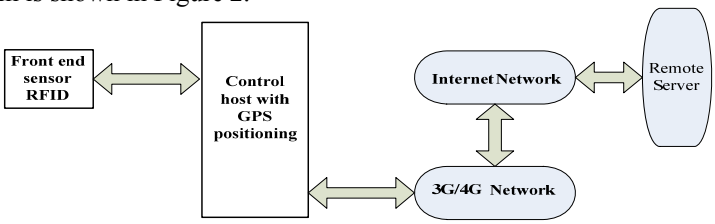

Fig. 2. The block diagram of sensing network layer

4 Control layer and user layer design

The control layer is responsible for receiving the transmission information from the control host and achieves intelligent forecasting and early warning based on the received information. In order to achieve effective data transmission and storage, a dedicated transmission data structure is designed. The structure diagram is shown in Figure 3. In order to ensure the uninterrupted transmission of information, the link structure parameter information is also designed in the data structure. The parameter information records the real-time link, disconnection and other information and when the disconnection information reaches the warning value, the intelligent host can be disconnected or restarted, thus ensures the continuity of communication.

Start code	RFID information code	Temperature and humidity information	Oxygen and carbon dioxide information	Cold storage / vehicle identification information	Shelf life prediction information	Link parameter information	End code

Fig.3. Transmission data structure diagram

The user layer is the information exchange interface of the user and the system. Two main user interfaces are designed according to the different terminal. For the end computer user special information website is designed, which has a multi-level user management system and can query and record real-time data according to user permissions. The website can also carry out the whole process of fresh goods traceability and shelf life prediction inquiry, which provides certain basis for consumers to buy fresh products. Furthermore, in

order to adapt to more and more demands of all kinds of smart terminals such as the mobile phone and tablet computer this system designs a special APP software Cooperating with the website, so that users can query possible information online and achieve online payment and other operations through mobile phone and other portable terminal browsing.

5 Monitoring and early warning process design

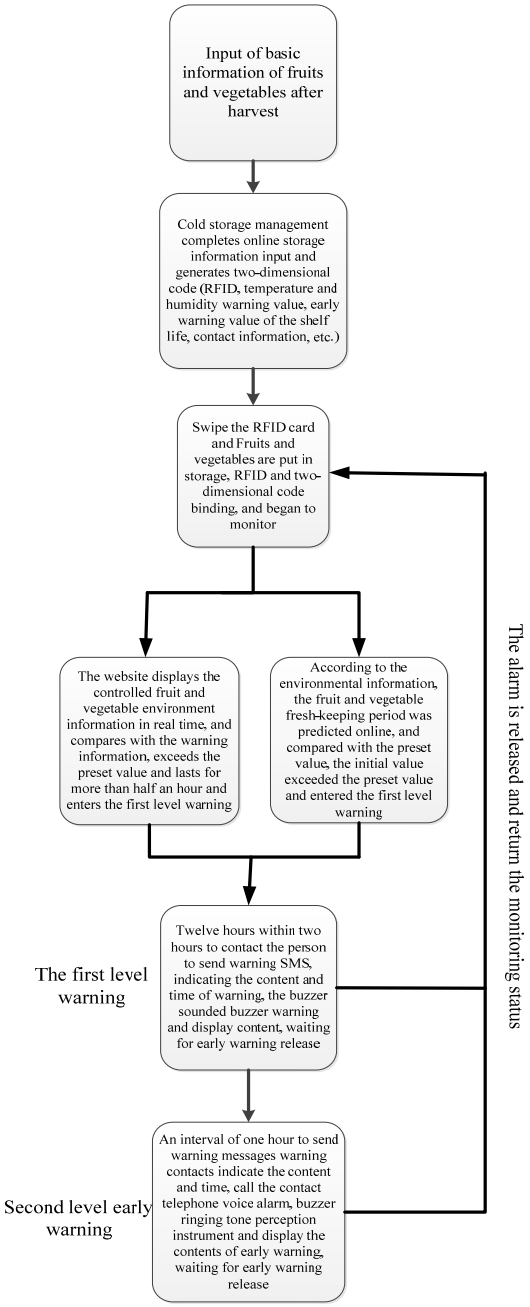

Fig. 4. The flow chart of monitor and early warning

In order to realize the full time and space online monitoring and early warning of fruits and vegetables, on the basis of Internet of things perception instrument hardware, it also established a special data management center and special website, and designed a complete monitoring and early warning process. The process from the fruits and vegetables after the information input to storage information filling, RFID and two-dimensional code binding storage, monitoring and early warning level and content are introduced in detail, as shown in figure 4.

6 System implementation and technical parameters

According to the above design, we build a complete perception system of fresh products by using STM32F103VCT6 as the main chip and combining the sensors of temperature and humidity, oxygen and carbon dioxide concentration, RFID and 3G/4G modules.The system consists of a Fresh Food Sensory Perceptual System(as shown in Figure 5 and a dedicated web site (as shown in Figure6.The system has realized the monitoring of the uninterrupted environmental parameters of the whole cold chain of fresh products. The specific technical parameters of the system are shown as table 1.

Table 1. The system specific technical parameters

Parameters	Values
external temperature	-40~100°C
built-in temperature	-20~60°C
humidity	0~100%RH
temperature accuracy	±0.5°C
humidity accuracy	±3%RH
Record interval	2 seconds ~24 hours
specification of power supply	DC12V 1A
The power consumption	less than 0.24W
Applicable environment	-20~60°C

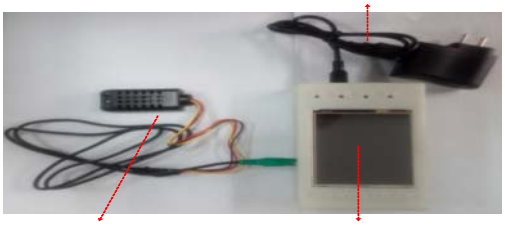

Fig. 5. Fresh food sensory perceptual system

Fig.6. Special website for fresh food sensory perceptual system

7 Conclusion

Aiming at the problem of low information level of cold chain preservation in China, a kind of fresh food sensory perceptual system for cold chain logistics based on Internet of things is designed. This system highly integrated applied many technologies such as the Internet of things technology, forecasting technology of fruits and vegetables length for preservation, RFID and Planar bar code technology, Big data and cloud computing technology and so on, which has four layer structures including sensing layer, network layer, control layer and user layer .The system can implement the real-time temperature and humidity environment parameters monitoring and early warning of the whole cold chain logistics for fresh food from its picking, storage, transportation and processing link, which greatly improving the information level of cold chain circulation in our country and has a strong marketing value.

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