Research on the Distribution System of Agricultural Products Cold Chain Logistics Based on Internet of Things

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Abstract. With the constant improvement of the people’s living standards, more and more people pay attention to the demand of the fresh agricultural products. However, frequent outbreak of food quality and safety problem caused the concern of consumers. How to improve the distribution efficiency of agricultural products cold chain logistics and ensure the freshness, quality and safety of agricultural products has become a focus of the current logistics research. We apply the Internet of Things to agricultural products cold chain logistics and introduce the three-tier architecture and key technologies of logistics network in this paper. The cold chain logistics distribution system of agricultural products based on the Internet of Things is established. Finally, we accomplish the real-time supervision of the agricultural products in the whole distribution process and strengthen the information communication of each distribution link to ensure the rapid and efficient distribution of agricultural products.

1. Introduction

With the rapid development of economy, people's living standards are improving day by day, and the requirements for food quality are getting higher and higher, especially the freshness and nutritional value of fresh agricultural products. As the main object of cold chain logistics distribution, agricultural products are getting more attentions. At present, China's cold chain logistics is still at the initial stage of development, and there is still a great gap compared with the western developed countries. The data shows that the cold chain circulation rates of fruits, vegetables, meat and aquatic products in China are 22%, 34% and 41% respectively in 2016. The cold chain transportation rates are 35%, 57% and 69% respectively. In developed countries, the circulation rate of vegetables and fruits in the cold chain is over 95%, and that of meat is almost 100%[1]. In China, the losses only caused by vegetable decay every year exceed 100 billion, which is enough to meet the demand of hundreds of millions of people for agricultural products.

We should keep the agricultural products in the whole supply process of cold chain in virtue of the seasonal, perishable, deterioration and so on. However, in the actual operation, the cold chain logistics of agricultural products is often broken, especially in the distribution process[2]. We spend 80% of the time distributing and transporting agricultural products from the origin to the hands of consumers. The loss rate is 25% - 30%. As a result, it not only causes economic losses, but also causes food safety accidents[3]. Therefore, how to achieve the real-time control of temperature in the process of agricultural product distribution, the reasonable planning of transportation routes and the timely...
feedback and connection of information has become the important factors restricting the development of agricultural product cold chain logistics. The Internet of things can effectively solve these problems. As a new industry in recent years, it conforms to the trend of rural information construction in the 13th Five-Year Plan. We apply the Internet of Things to the cold chain logistics of agricultural products. With the help of the Internet of Things we can integrate the cold chain logistics resources, improve the transportation speed of agricultural products, and reduce the damage rate of products.

2. The meaning of cold chain logistics of agricultural products

2.1. The summary of cold chain logistics
Cold chain logistics generally refers to a systematic project that the refrigerated food in the production, storage, transportation, sales, to all links before consumption is always in the low-temperature environment to ensure food quality and reduce food consumption. It mainly includes four links, namely, freezing processing, freezing storage, freezing transportation and distribution, freezing sales. Compared with normal temperature logistics, cold chain logistics has more stringent requirements on the temperature and humidity of transportation, which also increases the difficulty of its distribution.

2.2. The summary of agricultural products cold chain logistics
Agricultural products cold chain logistics mainly refers to ensuring that many links of agricultural products from production to sales are in a low temperature state, so that we can prevent agricultural products from perishable and deteriorating and add their value[4]. The agricultural products involved in this paper mainly relate to vegetables, fruits, meat, eggs, poultry, aquatic products, flowers and other fresh agricultural products which are difficult to preserve.

3. The application system of Internet of things

3.1 The summary of Internet of things
The Internet of Things (IOT) is a network system that intelligently identifies, locates, tracks, monitors and manages items by connecting all items to the Internet, exchanging and sharing information through information sensing devices such as radio frequency identification (RFID), global positioning system (GPS), laser scanner and so on, in accordance with pre-agreed agreements. It links physical space and information space together with various information sensing devices. It digitizes all things and realizes efficient information exchange between people and people, between people and things, and between things.

3.2 The architecture of Internet of things
The architecture of Internet of Things (IOT) includes three layers: perception layer, network layer and application layer. The technologies are correspondingly perception technology, network technology and application technology.

(1) The perception layer
As the perceptual layer of the Internet of Things, the information of agricultural products is transformed into digital information in the virtual world by detecting, identifying, locating, tracking and monitoring the state of agricultural products. In cold chain agricultural products we adopt RFID, bar code automatic identification technology to identify, classify and trace the state of agricultural products. GPS, RFID and video identification technology are often used in the transportation positioning and traceability of cold chain agricultural products. Temperature and humidity sensor, RFID and GPS are often employed in the quality control.

(2) The network layer
The network layer uses the Internet, mobile communication network, private networks and their fusion technology to transmit the perceived information without obstacles, with high reliability and security. We combine GPS with GIS technology in the logistics management and operation
information system of agricultural products enterprises. As a result we make the cold chain logistics transportation intelligent and automatic, and realize the visualization of vehicle dispatching and management. In order to achieve the aim of "connecting things", the network layer uses 3G / 4G, wifi and other communication technologies to finish the combination of wired and wireless, perception network and communication network.

(3)The application layer

The application layer is mainly responsible for converting all kinds of information collected into video, image, voice, text and so on. Finally it can monitor, display, manage and apply the information of goods. According to the different supply chain links of agricultural products, the application layer can be set to different forms. The production and processing enterprises of agricultural products can establish production management system. The third-party logistics enterprises can establish transport management system. The food safety inspection departments that provide services for consumers and regulatory departments can establish quality and safety traceability system[5].

3.3 The key technologies of Internet of things

(1)Radio frequency identification

Radio Frequency Identification (RFID), also known as electronic tags, uses radio frequency signals through spatial coupling (alternating magnetic field or electromagnetic field) to achieve non-contact transmission of information, and uses the data read from the electronic tags to achieve automatic identification of items[6]. RFID consists of four parts: tag, reader, antenna and computer.

Operational principle: at first the electronic label is attached to the surface of agricultural products or placed inside the agricultural products. Secondly when agricultural products carrying electronic tags enter the radiation range of electromagnetic waves emitted by the reader, the electronic tag actively transmits a certain frequency signal or the electronic tag receives the signal energy emitted by the reader and then converts its own induced current to send out the information of the goods carried. At last after receiving the goods information, the reader decodes and reads the information in a non-contact way, then transmits the read information to the computer control terminal, which further processes the information to complete the identification of the goods.

(2)Sensor technology

In the cold chain logistics of agricultural products, the main sensors are temperature and humidity sensors and access control sensors.

Temperature and humidity sensor is a kind of equipment or device that converts temperature and relative humidity into a kind of electrical signal which is easy to be measured and processed. Among them the relative humidity is the percentage of the amount of water vapor in a unit gas to the amount of saturated water vapor in a unit gas. In the cold chain logistics of agricultural products, we should pay attention to the control of humidity and temperature. Because the humidity is too high, the falling temperature will cause the water vapor in the air to condense into droplets. It attach to the surface of agricultural products and affect the quality of agricultural products. Excessive temperature will accelerate the propagation of bacteria, leading to the rot of agricultural products, affecting the freshness of agricultural products.

Agricultural products should maintain a constant temperature in the entire transport and distribution process. We set up a door sensor in order to prevent from opening the door or forgetting to close the door for a long time in the cold storage, the refrigerated vehicles and the low-temperature processing workshop. The working principle is as follows: sensors A and B are installed on the door and doorframe respectively. When the relative distance between sensors A and B is within a certain range, it means the door is closed, and when the relative distance between sensors A and B exceeds a certain range, it means the door is open. If the door is open for a long time, the sensor will send the signal to the alarm, which will alert the staff to close the warehouse door in time.

(3)Video surveillance technology

The video surveillance technology of agricultural products in the cold chain logistics mainly puts to use two kinds of technologies: real-time video surveillance and video playback. Video surveillance is
no longer simply local surveillance, but is gradually transitioning to remote surveillance. It is commonly used in the remote video control system, which is based on network server. Video monitoring technology realizes the visual traceability of the whole process. Consumers can check whether agricultural products circulate in the specified temperature and humidity environment by video monitoring technology, and whether agricultural products are processed according to the provisions of the operation. With its help consumers can know the whole process of agricultural product distribution so that they can buy comfortable agricultural products.

(4) Mobile communication technology

The main mobile communication technologies used in the agricultural products Internet of Things are Global Position System (GPS) and Geographic Information System (GIS).

GPS is a kind of radio space positioning system, which uses satellite navigation and ground stations to provide all-weather, high-precision, continuous, real-time three-dimensional coordinates (dimension, longitude, altitude), three-dimensional velocity and positioning information for the whole world. Any place on the earth surface can be used for positioning and navigation. The working principle is that the position of a satellite at a certain instant when it moves at high speed is regarded as the starting data (known), and the position of the point to be measured is calculated by using the space distance formula.

Supported by computer software and hardware system, GIS is a technical system for collecting, storing, managing, computing, analyzing, displaying and describing the geographic distribution data in the whole or part of the earth's surface (including atmosphere). Because of the use of spatial data and database connection, the traditional information management method has been changed. The traditional static record of the map has been changed into a dynamic electronic map with rich and colorful information, and the visualization of the data has been come true[7].

4. The construction of agricultural products cold chain logistics distribution system based on Internet of things

Agricultural products cold chain logistics distribution refers to fresh agricultural products such as fruits, vegetables, flowers etc, always in a suitable low temperature environment in a series of activities such as selection, processing, packaging, sorting, distribution, fitting and terminal transportation in accordance with the needs of users. It maximizes the quality and safety of fresh agricultural products and reduce damage. It is a logistical activities that punctually delivered to designated locations. Because agricultural products are easy to rot and deteriorate, the distribution of agricultural products has a high demand on all aspects of logistics. Although the traditional cold chain logistics can also preserve agricultural products to a certain extent, it is difficult to achieve the whole process of low temperature control, especially in the distribution link. If the distribution of agricultural products can not achieve effective links and strict temperature control, agricultural products will be vulnerable to bacterial erosion, accelerate the rate of decay, affect the quality of agricultural products, threatening the health of consumers. In addition, the traditional cold chain logistics distribution of agricultural products makes the distribution path selection unreasonable and waste the distribution time due to the lack of information collection and processing capacity. As a result, it can not be on time distribution. In this article we apply the Internet of Things to the cold chain logistics of agricultural products and establish a information management platform of logistics network. On the one hand, the real-time dynamic monitoring of temperature and humidity of agricultural products in the carriage can be carried out to reduce the phenomenon of chain breakage in cold chain logistics; on the other hand, GPS and GIS can be used to track and locate the vehicles, understand the running status of vehicles, road information and so on, and automatically optimize the distribution route, as shown in Figure 1.

(1) We put temperature and humidity sensor into the refrigerated vehicles of agricultural product to collect information within the maximum range of the detection area. Then the RFID temperature and humidity label is put on the agricultural product packaging, and the temperature and humidity in the carriage are recorded at all times. Through wireless communication such as GPRS, the information in
the RFID tag is transmitted to the remote monitoring center. Workers in the remote monitoring center can monitor the temperature and humidity of the carriage in real time by the transmitted data. Once the temperature and humidity become abnormal, the system will automatically send out an alarm signal. The workers promptly notify the driver and take emergency measures to reduce unnecessary loss of goods in the remote monitoring center.

(2) Each refrigerated vehicle of agricultural product with GPS can provide accurate vehicle position, running status, vehicle group number, the information of road condition, etc. So we can know the vehicle positioning and tracking, check whether the goods are safe on the way, and ensure timely delivery, etc. Once a accident occurs, the system will send an alarm signal to the backstage monitoring center. The managers receive the signal and quickly make decisions to ensure that the loss is minimized.

(3) GIS is installed on each refrigeration vehicle of agricultural product so we can transmit the location data of each mobile vehicle to the monitoring center by wireless transmission. GIS provides a graphical and operational human-machine interface. In addition to real-time monitoring of the vehicle, GIS can also arbitrarily enlarge or shrink the position of the vehicle and finally accurately display the position. GIS can update the road information in real time, and calculate it according to the information data of truck load, customer distribution, distribution order, real-time information of road condition and driver's personal experience for driving. Through complex data processing functions, it can automatically select and optimize the distribution route, guide the logistics freight, improve the operational efficiency and reduce logistics costs[8].

5. Conclusion
This paper studies the cold chain logistics of agricultural products and analyzes its current situation and shortcomings. At present, there is a low level of informatization and low transparency in the whole process in the cold chain logistics of agricultural products. At the same time we lack of effective control in transit. So in this paper we introduce the Internet of Things into the cold chain logistics of agricultural products, and put forward a logistics distribution system based on the Internet of Things. The system applies RFID, GPS, GIS and other technologies, and finally accomplish the real-time supervision of the agricultural products in the whole distribution process.
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