Research on Modern Agricultural Information Management based on Internet of Things Technology

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Abstract: Aiming at the problems of poor concurrent processing capacity and long response time of traditional modern agricultural informatization management methods, this paper studied the modern agricultural informatization management methods based on Internet of things technology. According to the needs of modern agricultural information management, the framework of modern agricultural information management method was designed. After reconstructing, cleaning and pre-processing the agricultural data, the pre-processing data was encrypted by the encryption algorithm based on the encryption vector. According to the relationship between entity attributes, data and entities, the e-r diagram was established to design a database for storing agricultural information data, and the design of modern agricultural information management method based on Internet of things technology was completed. Through the comparison experiment with the traditional method, it is proved that the response time of the management method based on the Internet of things technology does not change dramatically with the increase of the number of concurrences, and it has strong concurrent processing ability.

Keywords: Internet of things technology; Modern agricultural informatization; Management methods; RFID technology

1. Introduction

In recent years, Internet of things technology, as a representative of new technology, has been widely used in many fields. In the field of network communication and service of the Internet of things, the number of various application terminals of the Internet of things in China has exceeded 10 million, covering public security, transportation, agriculture, medical treatment, education, health, tourism, public services and other aspects. China is a large agricultural country, and the application of Internet of things technology in agriculture has a broad prospect [1]. In the process of accelerating China's agricultural modernization, improving the output and quality of agricultural products, promoting the circulation of agricultural products, ensuring farmers' economic benefits, and realizing China's dream of agricultural power, the application of the Internet of things in agriculture has become increasingly indispensable.

Agricultural informatization refers to the process in which information technology penetrates into rural production, life and other fields, enabling information resources to be fully developed and applied in rural areas and accelerating rural economic development and social progress. Agricultural informatization is not only an important part of the national informatization strategy, but also an important part of the construction of a new socialist countryside. It is of great strategic significance to promote the leapfrog development of rural productivity in China [2]. The traditional modern agricultural information management method based on CSS content aggregation focuses on the exchange of information and is one-sided, which is not suitable for the modern agricultural information management with accelerated development speed. Therefore, based on the above analysis, this paper will study the modern agricultural information management method based on Internet of things technology.

2. Design Modern Agricultural Information Management Method based on Internet of Things Technology

2.1. Design the framework of modern agricultural information management methods

The application of Internet of things technology in modern agricultural information management is mainly divided into four parts, namely, production safety monitoring of agricultural products, identification and tracking of agricultural products' production status, participation in refined production of agricultural products and circulation management of agricultural products. Therefore, according to the application of Internet of things technology in modern agriculture, the framework of modern

agricultural information management based on Internet of things technology is designed as shown in the figure below.

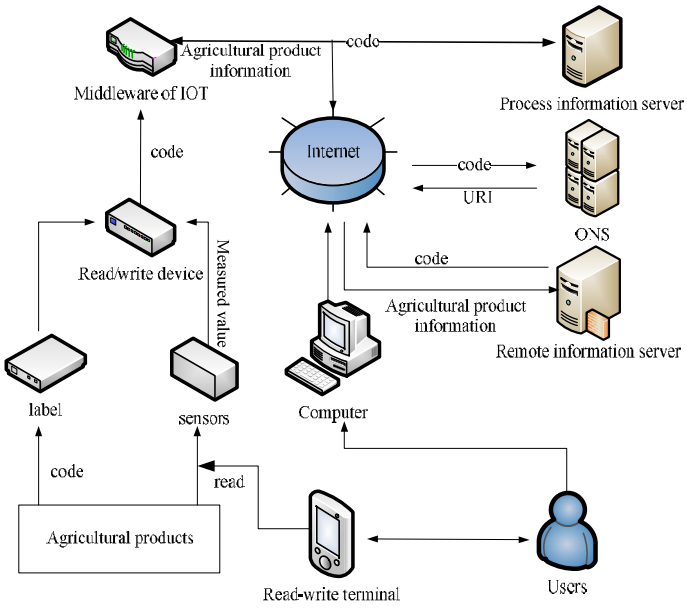

Figure 1. Framework of modern agricultural informatization management method

As shown in the figure above, each agricultural product is given a unique code, which is stored in the electronic tag attached to the item, and the corresponding details and attributes of the code are stored in the server of the RFID information service system. When objects from all aspects of production and circulation, were identified and recorded by ONS parsing information available items belong to the URI of the service system, then the code from the RFID information server through the network of information and attributes to identify items of logistics automatic tracking management of supply chain and to achieve [3]. After the framework of modern agricultural informatization management method based on Internet of things technology is determined, relevant functions are designed to realize modern agricultural informatization management.

2.2. Information data preprocessing

The data of modern agricultural informatization management is mainly different types of data collected by sensors in agricultural production management and other links as well as agricultural related information data from other data sources. In order to realize the effective management and transmission of these data, it is necessary to carry out uniform preprocessing operation for all data.

First, the data from different information sources are transformed into a unified XML file. The data of different data structure types are reconstructed, that is, the data is normalized according to the following formula.

$$x' = \frac{x - x_{\max}}{x_{\max} - x_{\min}} \quad (1)$$

In formula (1), x is the data to be reconstructed, $x_{\max}$ is the maximum value of the data to be reconstructed, $x_{\min}$ is the minimum value of the data to be reconstructed, and x' is the data after normalization processing. Due to certain gaps and duplicates in the data, as well as incorrect data that affect data transmission, analysis and processing, it is necessary to clean the data after normalization [4].

Global constant padding is used to deal with missing data, "Null" and "Unknown" are used to replace Spaces, and the average value of adjacent data is used to replace missing data. The Bin method is used to process the repeated data. The repeated data are sorted according to the size of the normalized value, and all the repeated data are divided into several Bin with equal height. Calculate the mean value in each Bin, and use the mean value to process repetitive data [5]. After data cleaning and processing, set the upload mode of data. The management method designed in this paper adopts the mode of trigger upload and timed upload to upload data.

In the agricultural production process, the data collected by the sensor responsible for monitoring the growth status of crops are constantly changing over a period of time. For this part of the data, the form of trigger upload is

adopted. When a data table required in the database changes, the changed data is first stored in the buffer, the trigger automatically captures the data changes, and the data is uploaded to the method database [6]. Data collected by sensors monitoring the growing environment of crops and agricultural information data updated regularly are uploaded to the database by the method of timing upload. Store these data separately in the local cache, wait for these change data to be stored for a certain time, then synchronize all data together into the database, so as to achieve real-time data synchronization between the database and the associated business data. In order to avoid being attacked by criminals in the process of data uploading, it is necessary to encrypt the process of data transmission.

2.3. Agricultural information data transmission encryption

The modern information management method designed in this paper requires the monitoring of agricultural equipment and the monitoring of the growth state and production environment of agricultural products. Agricultural information mainly comes from data monitored by various types of sensors. In the transmission process of agricultural information data, if the use of clear text protocol to transmit data, the data will be easy to be cracked by criminals, resulting in huge economic losses. Therefore, the data needs to be encrypted before it can be transferred.

This paper adopts the encryption algorithm based on the encryption vector to encrypt the managed agricultural information data. The key $K = key(n,m)$ is generated first. In the key space, select the key m with n security parameters, and set the generated key vector as $K = (K_1, K_2, \bullet\ , K_n)$. The perceptual data set M was encoded by network coding algorithm, and the generation matrix G and the encoded data vector Y, $(G,Y) = EnCode(M,n,k)$ were obtained, of which $G = (g_1, g_2, \bullet\ , g_n)$, $Y = (y_1, y_2, \bullet\ , y_n)$. The amount of data stored on each node i in the storage database is a binary group (g_i, y_i), where g_i is the encoding vector and y_i is the encoding data, and the relationship between the two is $y_i = Mg_i$. When the original data is recovered, the decoding algorithm adopted can be expressed as follows [7].

$$M = DeCode\left((g_i, y_i)^k\right) \tag{2}$$

Formula (2) indicates that, when entering the binary group (g_i, y_i) data stored on any k data storage nodes, the original data M can be recovered by solving the linear equation. To encrypt the encoded vector, the encryption algorithm adopted is as follows:

$$g_i' = E_n C_{K_i}(g_i) \tag{3}$$

Select K_i from the key vector to encrypt the encoding vector g_i, and you can get ciphertext g_i'. The decryption algorithm of recovery encoding vector is $g_i = DeC_{K_i}(g_i')$, key K_i can be used to decrypt ciphertext g_i', and the recovered plaintext g_i can be obtained. After encrypting the data, the encrypted data will be transferred to the database, and the data will be stored in the database waiting for the user's call [8].

2.4. Design agricultural information management database

The database is responsible for the realization of the information interaction between the client and the method, as well as the collection of sensor data and the storage of user-related information data. The database designed in this paper USES My Eclipse10.7 as the development tool, the JAVA language as the development language, the project deployment environment is Tomcat7.0, and the database service is MySQL5.5. The one-to-many relationship between the database and the data to be stored was analyzed, and the E-R diagram as shown in the following figure was established to describe the entity attributes involved in modern agricultural information management and the relationship between data and entities [9].

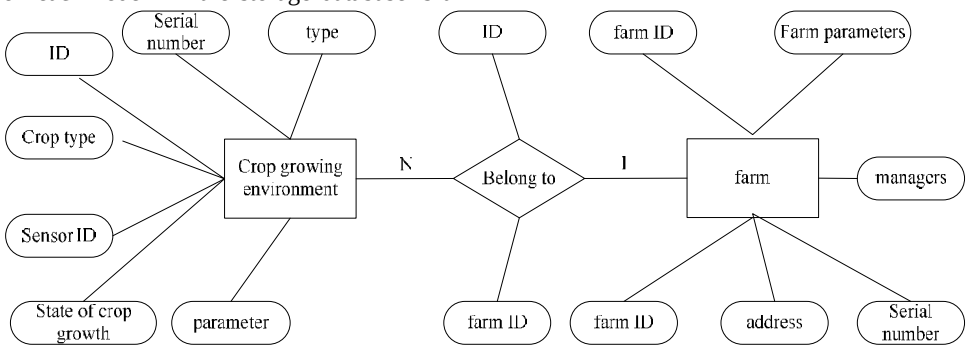

Figure 2. Database E-R diagram

After determining the E-R diagram of the database, determine the database table structure. According to the description of requirements analysis, the database table structure can be obtained. The entities mainly involved in the database include method administrators, users, sensor nodes, environment factors collected by sensors and the state of crop growth environment. The basic table of the database can be obtained according to the entities involved [10].

Table 1. Database base table

Column name	Data type	Constraint	Note
AID	LONG	NOT NULL, Primary Key	Administrator's number
NAME	Vachar（20）	NOT NULL	Name of administrator
PASSWORD	Vachar（20）	NOT NULL	Password
UID	Vachar（50）	NOT NULL, Primary Key	Users' id
Name	Vachar（20）	NOT NULL	Users' name
COMMENT	Vachar（500）	—	Introduction
HOUSECOUNT	Int	—	Creation time
HID	LONG	NOT NULL, Primary Key	Number of crops, agricultural products, etc
STATE	Int	NOT NULL	State
SENSOR_COUNTS	Int	NOT NULL, Primary Key	Number of sensor nodes
METADATA	VARCHAR(500)	NOT NULL	Used to record the last data value of all sensor nodes

According to the basic table of the database, the storage format of the data in the database is determined, and the database development tool is used in combination with the e-r diagram to complete the design of the database. Agricultural data is stored in the database, and according to the user's request to complete the method and the user's data interaction, to achieve the management of modern agricultural information. So far, the research on modern agricultural information management based on Internet of things technology has been completed.

3. Test Management Approach

This paper studies the modern agricultural information management method based on the Internet of things technology, which can improve the shortcomings of the traditional management method. Therefore, the performance of modern agricultural information management method based on Internet of things technology is tested by means of experimental verification.

3.1. Experiment to prepare

According to the demand analysis of modern agricultural informatization management method based on Internet of things technology, this experiment was verified in the test environment shown in the following table.

Table 2. Test hardware and software environments

Test environment	Server side	Client
Hardware configuration	CPU: 3.75GHz Memory: 32 GB Bandwidth: 100 MBPS	CPU: Above Intel core 2.0G Memory: 16GB
Software configuration	Windows Server 2003 32-bit Server 2008 Enterprise Edition	Operating system: Windows 8.1 Application environment :IE 9
Network environment	100Mbps LAN	100Mbps LAN

The experimental subjects were two modern farms of the same scale, with the same number of sensors, wireless network and user terminals. The agricultural information data collected from the two farms were taken as the experimental data of this test, and the experimental verification was completed according to the experimental process.

3.2. Experiment content and process

This experiment adopts the form of comparative experiment. The control group of the experiment is the traditional modern agricultural informatization management method, while the experimental group is the modern agricultural informatization management method based on Internet of things technology designed in this paper. The experimental test index is the response time of the two management methods when they are accessed by multiple users simultaneously. The concurrent processing performance of the method is judged by comparing the response time.

The two methods of comparison experiment were run on two computers with identical configuration, and the experimental data were input into two management methods. , using computer to simulate multi-threaded concurrent access of users, monitoring the response time stability of the two management methods of the experimental group and the control group. During the experiment, the experimental parameters except the experimen-

tal variables were kept unchanged, and the experimental data were recorded and analyzed.

3.3. Experimental result

The experimental results are shown in the figure below. Curve A represents the control group, while curve B represents the experimental group. Analyze the data relationship in the figure to judge the performance of the management methods of the experimental group and the control group.

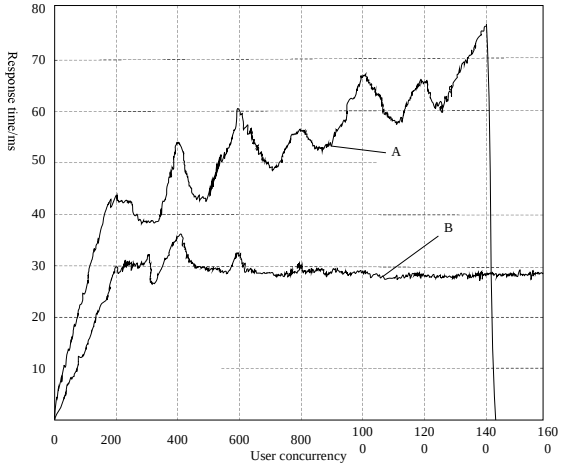

Figure 3. Experimental result

According to the figure above, with the increase of the number of concurrent users in computer simulation, both curves show an increasing trend to some extent. However, after increasing for a period of time, curve B showed a short fluctuation and remained stable after the fluctuation. Curve A, on the other hand, shows A rising trend with A large fluctuation range. The changes of the two curves indicate that the response time of the control group management method increases with the increase of the number of concurrent users, and the function of the method collapses after the number of concurrent users exceeds 1400. However, the response time of the management method of the experimental group increased first and remained stable after a short fluctuation, which did not change dramatically with the increase of user concurrency, indicating that the performance of the method of the experimental group was better than that of the control group. To sum up, the modern agricultural informatization management method based on Internet of things technology studied in this paper has short concurrent response time and good concurrent processing ability.

4. Conclusion

Modern agricultural information management is an important link to promote the development of agriculture in China. In view of the problems existing in the traditional agricultural information management methods, this paper studies the modern agricultural information management methods based on Internet of things technology. By comparing with the traditional method, it is proved that the management method of applying Internet of things technology designed in this paper has more practical application value.

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