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Smart Agricultural Internet of Things Remote Control System

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Abstract: The agricultural problem is the fundamental problem affecting the national economy and people's livelihood, is the basis of the national economy. However, China is now in a critical period of transformation from traditional agriculture to modern agriculture, information technology represents the development direction of today's advanced productive forces. Intelligent agriculture takes information knowledge as its core, combining modern information technology, intelligent devices and intelligent robots, such as emerging remote sensing networks, the Internet of things and artificial intelligence applications in agricultural production. Processing, management and service of the whole industrial chain, to achieve precision farming and Internet sales as well as intelligent decision-making and social services. To form a mode of modern agricultural development characterized by digitization, automation, precision and intelligence. But overall, smart agriculture research in China is still in its infancy, many key technological issues remain unresolved. And on that basis, this paper will systematically sort out and summarize the literature of intelligent agriculture research. The key technologies and application fields of intelligent agriculture research are expounded systematically. The remote control system of intelligent agricultural Internet of things is studied and realized. It conforms to the design principle of "real-time, stable, applicable, expandable, cheap and easy to operate". It has high practical value for extracting database data, drawing graphs to verify the correctness of the system scheme and the good performance of the control system.

1. Introduction

With the advancement of agricultural science and technology, the rapid development of Internet of Things technology, Zigbee wireless communication technology, intelligent technology, video surveillance technology. These technologies make it possible to achieve agricultural information interactions and remote control of crop environmental parameters, and their combination can increase the temperature and humidity of crop environmental parameters [1-2]. The measurement accuracy of light intensity, carbon dioxide concentration, soil pH value, etc., and characteristic information in the measurement environment parameters can be extracted by data processing [3-4]. Based on a variety of emerging technologies, intelligent agriculture will play an important and unique role in this period, providing an unprecedented opportunity for China's agricultural modernization. The level of agricultural automation in China is still very low, and labor demand is still relatively large [5-6]. This reality shows that China urgently needs to develop intelligent agriculture, improve production efficiency, save resources, and solve the "three rural issues." Intelligent agriculture supported by technologies such as the Internet, Internet of Things, big data, and cloud computing will promote the tremendous development of agricultural modernization.

The agricultural Internet of Things can be broadly interpreted as the use of various sensing devices to measure environmental status information, growth status information, meteorological information, etc. [7]. The measured rich sensing information is transmitted to the corresponding network storage cluster through the communication component module provided by the sensor, and then the collected information is further analyzed and processed in the cluster, and the analysis result is used to determine the working state of the corresponding hardware device. . Research on the IoT business model and value chain shows that M2M is becoming a telecommunications company or service provider. Obtain an important entry point and carrier of interest in the Internet of Things [8-10]. Precision agriculture is the development direction of agricultural modernization. On the one hand, it clarifies the spatial variation of soil properties and farmland productivity, and on the other hand mobilizes soil productivity by determining crop production targets, achieving equal or higher incomes and improving the environment with minimal or most economical investment. In the past, access and control of agriculture was extensive and unreliable based on experience and perception. Precision agriculture cannot be fundamentally realized. Through the Internet of Things technology, accurate measurement of agricultural growth factors can be achieved, and precision agriculture can be truly realized [11]. Internet of Things technology is the key technology to achieve precision agriculture.

The development of the growth factor environmental monitoring system and the growth factor acquisition device on the unified platform of intelligent agriculture can realize the refinement of the control process and the intelligentization of the environment. The intelligent agriculture platform can achieve effective supervision of the crop growth environment and comprehensive full-time detection of the crop growth process, as well as reasonable control of growth factors. This is of great significance for the study of agricultural production efficiency and the promotion of agricultural development. There are greenhouse control systems in Canada that regulate climate and automatic watering [12-13]. It is a practical method at that time to be able to fuse a variety of parameters and transmit data through sensors. The server sends corresponding control commands based on the data collected by the sensors. Israel manages the parameter management interface through microelectronics technology [14]. The system can calculate the received data online, reducing the probability of occurrence of pests and diseases, thereby reducing production costs and increasing farmers' income [15-16]. The intelligent agricultural platform not only improves the management and production of crops, but also improves the rational use of water, fertilizer and other consumables in the production process. The digital tracking and management of agricultural products has been realized, ensuring the safety of various agricultural products and improving food safety.

At present, sensors commonly used in agricultural Internet of Things, such as carbon dioxide, plant stem flow, etc., have a large working power and cannot be powered by micro batteries for a long time. Affected by the power supply conditions of the farmland production environment, large-scale open-air farmland is often not equipped with utility power. At this stage, the agricultural Internet of Things is applied in the field, and the solar power and battery are used to form a power supply system. However, in the case of the Meiyu weather, higher requirements are placed on the stable power supply of the sensor. The low power consumption and high stability of sensor nodes are the main bottlenecks of agricultural IoT sensors. Based on the systematic summary of the wisdom agriculture research literature, this paper deeply analyzes the research progress and application status of the intelligent agriculture core field such as agricultural perception, and scientifically forecasts the future development direction of smart agriculture. It is very important to study and design a practical agricultural intelligent monitoring system with low input and high output. This paper studies the existing control methods, and the intelligent agricultural Internet of Things monitoring technology has a wide application field and a great practical effect. On the one hand, it can accurately grasp the environmental parameters, ensure the growth of crops, increase the yield of crops, and at the same time improve the level of agricultural intelligence, leaving a basis for subsequent expansion research.

2. Proposed Method

2.1. Internet of Things

The Internet of Things is one of the most promising industries. However, due to the continuous development of the Internet of Things, China lacks key technologies and innovations in related technologies, which not only leads to product grade problems, but also causes price problems. The backwardness of technology will limit development, and the lack of key technologies such as RFID will inevitably limit the development of China's Internet of Things. Therefore, the hotspots of the domestic Internet of Things are mainly focused on sensors, sensor gateways, RFID and cloud computing. IoT technology is used in many industrial sectors, and different industrial sectors often have different industry requirements and technical forms. However, among these different technology systems, the Internet of Things technology consists mainly of four main systems. These four systems are awareness systems, network systems, computing and service systems, and management and support systems.

(1) Perception system

Perception and recognition technology is the most basic component of IoT technology and the foundation of IoT technology. The identification technology is mainly composed of technologies such as RFID and GPS. Perceptual techniques are similar to the use of their ears, nose, nose and nerve endings to gather information and identify animals of different object origins. The main function of sensing technology is to collect relevant data. The most important part of the identification technology is to mark the traceability of individual traceability.

(2) Computing and service system

For the transmission of a large amount of sensory information, IoT technology calculates and processes it, and displays the data in a more intuitive form for operator reference and analysis. The ultimate value of information is used to analyze references and improve deeper values. Services and applications are key ways in which IoT technology can be used to realize the value of information.

(3) Management and support system

It is precisely because of the management and support capabilities of the Internet of Things that the further development of technology has been promoted. Management and support technology is the key to ensuring the efficient operation of the Internet of Things. It mainly includes measurement and analysis, network security and security.

2.2. Data Storage Related Technology

In system design, the choice and formulation of data storage policies usually depends on the response speed required by the parties in the system that need the data, the size and length of the data storage. After the communication model processes the data in the storage policy, the data storage block should ease centralized access to the database. At the same time, coordinate the parties that need access to real-time data and reduce the speed of request response when accessing the database frequently.

NewSQL mainly refers to the improved SQL database with scalability and superior performance. Because it is based on the original SQL database improvements and innovations, this New is compared to the original SQL database technology. Because it is an innovation and innovation of SQL technology, it still has the function of traditional SQL, supports SQL query, and meets the transactional and consistency requirements of database query. At the same time, the improved NewSQL database also has the scalability and flexibility similar to the NoSQL database. NewSQL databases can be divided into different types of improved technologies, such as redesigning the database supporting the architecture, improving the MySQL storage engine, and improving the characteristics of the distributed computing environment. Redesigning the database supporting the architecture NewSQL database technology uses a new database platform to run on a distributed cluster system to meet the needs of big data. It uses a shared-nongthing architecture, and each node only has data. a subset of. Typical databases using this method are Google Spanner, MEMSQL, etc., whose architecture uses shared-nongthing. The MySQL storage engine is improved and the database is improved. Compared with the traditional MySQL built-in engine, it has high performance and good expansion. Using this technology, GenieDB's database-as-a-service (DBaaS) product, called Globally Distributed MySQL-as-aService, builds large-scale, cross-regional, multi-node high performance by using the MySQL database cloud service provided by GenieDB. application. The database improved for the characteristics of the distributed computing environment has a high availability and high redundancy cluster database MySQL Cluster. It uses the NDBCluster storage engine to run multiple MySQL servers in a single cluster. Other databases that use new data structure models, data segmentation, and more. The NewSQL database is characterized by the fact that although the internal structure of the system changes greatly, SQL is still used as its main interface, and both support the relational data model. Its strengths are real-time, complex analysis, instant query and developability.

2.3. Wireless Sensor Network

The wireless sensor network is a network composed of a large number of sensor nodes self-organized by wireless communication technology, and has the characteristics of small size and low cost. Collect, process, and transmit information about perceived objects within the network's coverage to perform tasks such as monitoring, control, and data collection for remote physical environments. Widely used in smart furniture, environmental testing, medical military and military fields, has broad prospects for development. Wireless sensor network systems typically include management nodes, aggregation nodes, and sensor nodes. A large number of sensor nodes are randomly deployed in the target detection area, and the sensor nodes can form a network through self-organization; the collected data is transmitted to the aggregation node along other nodes in a hop-by-hop manner. Each aggregation node connects to the Internet through a gateway and finally sends data to the management node. In addition, when the management node sends information to the sensor node, it needs to first forward the information to the sink node through the gateway, and then send it to the sensor node by the sink node. Through the management node, administrators can obtain collected monitoring data, send task commands, and configure and manage sensor networks.

The sensor module is mainly responsible for data acquisition and preprocessing, and sends data according to the command of the monitoring center; the processor module is responsible for controlling the operation of the entire sensor node, data storage and processing, and data sent by other nodes; the wireless communication module is responsible for other sensors Communication of nodes, etc.; the energy supply module primarily uses batteries to increase the energy of the sensor nodes to ensure proper operation. The WSN nodes can be randomly deployed in the monitored area to form a network in a self-organizing manner, and each node location is determined by a GPS positioning or a node self-localization algorithm. Zigbee is a very mature IoT data acquisition wireless connection protocol. The Zigbee Coordinator is not only responsible for establishing the wireless sensor network in the application, but also for the aggregation nodes of the wireless network. That is, the data for all nodes in the network will eventually be uploaded to the coordinator, which is then sent by the coordinator to the gateway device. Zigbee's Mesh network has significant advantages over other low-power wireless transmission protocols such as Bluetooth 4.0. Although the network technology of Bluetooth 4.0 is also proposed, it is far from the maturity of Zigbee technology. Generally, the software protocol of a Zigbee device is divided into four layers, namely, a MAC layer, a Zigbee network layer, an application support sublayer, and an application layer. The Zigbee Alliance has defined some typical applications, such as smart homes and smart power supplies. The definition of these application layers is called Profile. Sensors in the agricultural Internet of Things typically implement protocols at the MAC layer and the network layer, and then define private application protocols on the network layer. Of course, the simple MAC layer can also communicate with the MAC, but due to the lack of intelligent network capabilities, the scope of application is limited. The communication scheme between the sensor and the Zigbee transceiver module is shown in Table 1. The first one is Zigbee compatible and doesn't make any sense. The second sensor can be received with the first module, but additional software is required to parse the Zigbee stack. TrueZigbee is compatible with the second and third sensors. The second module accepts the standard Zigbee protocol, so this article chooses the second receiver module, which directly balances compatibility and development convenience.

Table 1. Zigbee sensor and transceiver module pairing matrix

Program	Module	Module	Module
Sensor 1	Need another protocol to resolve	Not support	Not support
Sensor 2	Need another protocol to resolve	Direct support	Not support
Sensor 3	Need another protocol to resolve	Need another protocol to resolve	Direct support

3. Analysis of Crop Parameters and Needs of the Intelligent Agricultural Internet of Things Platform

Simple greenhouse facilities have poor controllability to the environment and cannot provide high-yield, high-quality, high-safety crop production. To increase production, it is necessary to meet the nutrient requirements of greenhouse crops for providing growth, and also to meet the production environment of crops. Requirements such as humidity, temperature, carbon dioxide concentration, etc. The optimum environmental parameters for some crop growth are shown in Table 2. Table 2 can clearly compare the most suitable air humidity values, air temperature values, and light intensity values at different growth stages of crops. Different plant growth stages require different environmental parameters. In order to promote the accumulation of matter, germination, seedling, flowering, and fruiting, the temperature requirements of each time period are changing.

Table 2 .Optimal parameters for crop growth

Type	Period	Temperature(℃)				Humidity(%)
		Lowest temperature (day)	Optimum temperature (day)	Highest temperature (night)	Optimum temperature (night)	
Tomato	Germination	9	27-31	34	16	50-64
	Seedling stage	13	28-32	33	17	50-64
	Flowering period	15	25-26	35	17	50-64
	Result period	15	25-28	35	16-20	50-64
Chili	Germination	10 15-27	33	18	60-80	
	Seedling stage	12	17-29	35	18	60-80
	Flowering period	10	20-29	34	18	60-80
	Result period	10	20-30	34	18	60-80

Temperature is the most important parameter factor affecting crops. The temperature directly and directly affects the quality and yield of greenhouse crops. The regulation of temperature is the key to the rapid and slow growth of crops in the greenhouse, and it is also the most basic growth factor. It can be compared from Table 4.1 that different crops have different preferences for temperature, and different regions and seasons have different temperature requirements. The crops grown in the normal temperature zone are not required to have a high temperature, and the general development temperature is about 25 ℃. The warm-growing crops that grow in the subtropics generally have a development temperature of about 28-32 ℃. The cold-growing crops that grow in high altitudes are generally suitable for developmental temperatures of 15-18 ℃.

The intelligent agricultural Internet of Things remote control system studied in this paper uses sensors such as humidity, temperature, carbon dioxide concentration, and intensity of care to monitor the environmental parameters of crop growth in the greenhouse in real time, and transmits the collected data to the control center to provide the greenhouse administrator for use. When the greenhouse environmental parameter value is higher or lower than the set target parameter value, the corresponding intelligent control will be automatically performed, and the processed result will be notified to the administrator through the network and the short message. For real-time and effective monitoring, the monitoring data needs to be collected once a minute, and a large amount of data will be stored every day, so the requirements for the database are extremely strict. The system should be designed to collect environmental parameters in the greenhouse in real time, including air humidity, air temperature, carbon dioxide concentration, light intensity, soil moisture and soil temperature. Users and administrators can log in to the system to view the data parameter values collected by the node. The personnel management level is assigned different permissions, mainly the management rights of the administrator account and the basic user rights of the ordinary users. The administrator can not only have all the rights of the ordinary users but also can increase and delete the ordinary users according to the changes of the personnel in the park.

The system can intelligently control the control equipment in the greenhouse, compare the detected data value with the original set value, complete the automatic adjustment of the control equipment in the greenhouse according to the result and the decision model, realize automatic management; automatically when the data detection value is abnormal The alarm informs the person on duty. The data for each greenhouse per day can be automatically aggregated. In order to facilitate the user's observation, the system can display the collected environmental parameters such as air humidity, air temperature, carbon dioxide concentration, light intensity, soil moisture and soil temperature, and also perform curve analysis. The integrated management section should include basic configuration information for system and control monitoring. The remote control of the intelligent management center is essential for remote management of the greenhouse in the field. In order to facilitate subsequent research, the system should have historical data query and map browsing functions.

4. Design and Implementation of the Intelligent Agricultural Internet of Things Platform

4.1. Video Remote Control Operation

The monitoring interface of the remote control center can set related environment parameters and system contents. The remote control operation sets and sends the query node, threshold parameters, time, etc., and configures the alarm period and threshold range of each node sensor. , upload delay, etc. In addition, the remote control center interface can provide two forms of data representation of tables and curves in real time, which makes it easier to grasp the dynamic and comprehensive monitoring of environmental parameters and to store historical data at regular intervals. Through the above sensor technology and operation of the actuator, collection of crop growth environment information and real-time display of data can be realized. And WIFI technology can be used to store data information. The design uses Internet video surveillance, accesses the Internet after data image acquisition, relies on the Raspberry Pi for data transmission and storage, and performs real-time online monitoring through the PC. The operation process of the overall video surveillance technology system is shown in Figure 1. The operation process of the entire video surveillance technology system is shown in Figure 1. The video surveillance system is mainly composed of four parts: video acquisition, network transmission, data storage and intelligent monitoring constitute a unified monitoring overall, monitoring and processing crop growth.

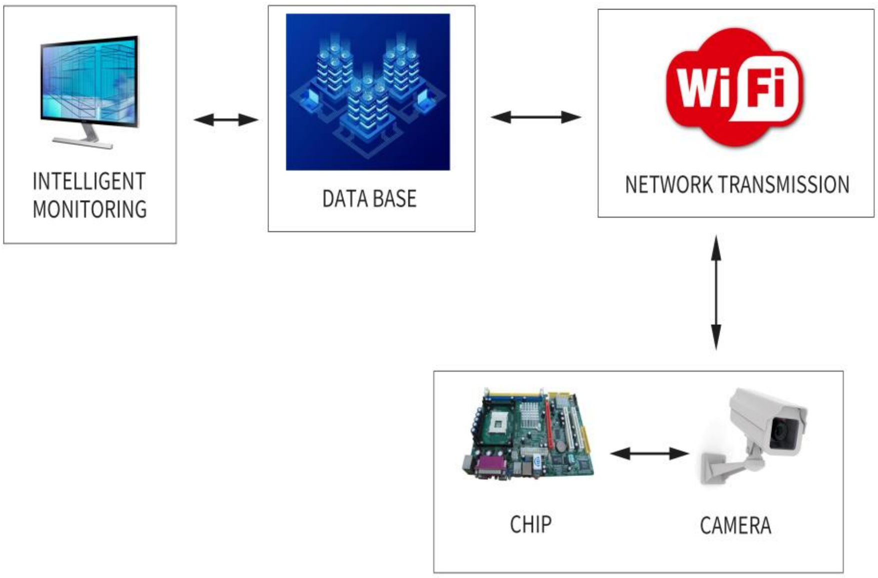

Figure 1. System practice operation process

4.2. Wisdom Agriculture Internet of Things Platform Implementation

The development of the greenhouse temperature control system mainly includes three parts: (1) gateway programming, (2) client programming, and (3) deployment application design. The gateway program and middleware run in the same runtime environment, and the gateway program directly calls the software middleware. The client application runs on the Windows operating system and interacts directly with the end user of the temperature control system. The main function of the client application is to provide a visual interface that allows end users to view temperature data in real time, as well as download historical data and set control strategies. The format of the temperature data packet is the key to temperature sensor and gateway communication. The resolution of the temperature packet format has been integrated into the temperature acquisition module of the software middleware. Gateway and client applications need to extract the required temperature data from the temperature data through code. This data format is designed for specific Zigbee temperature sensors and can be modified to accommodate a wider range of temperature sensors.

The front-end interface is mainly based on the macro and micro environmental impact factors of agricultural production, mainly showing the computer interface, and the mobile phone end serves as an auxiliary display interface. Mainly in the greenhouse situation as the main form, view the configuration in the auxiliary separate settings. The smart greenhouse view is mainly temperature, humidity, etc., including real-time viewing and historical viewing. The remaining views include weather forecast viewing, video surveillance viewing, and user settings. Environmental information includes information such as temperature, humidity, and a list of devices that cover the specific transmission and reception times of each device. The environmental information interface is shown in Figure 2.

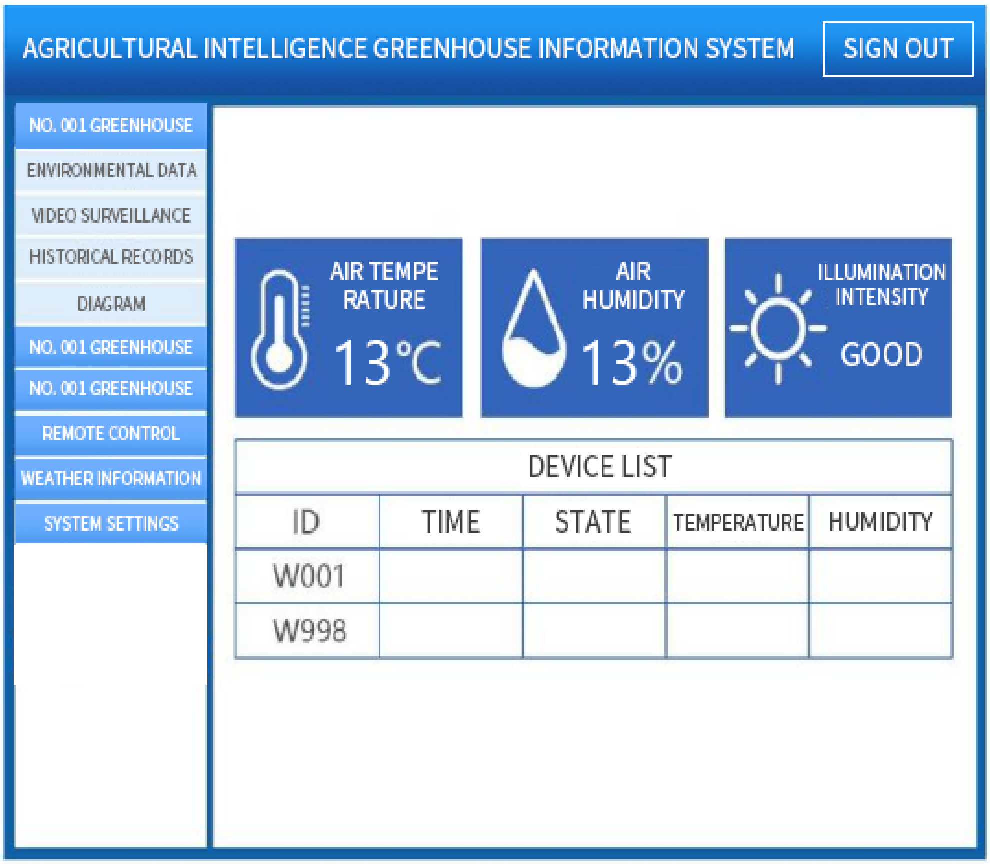

Figure 2. Environmental Information Interface

The main interface is the initialization interface of the system and is the layer interface of the system. The main real-time display system's four most important parameter values, indoor temperature and humidity values, light intensity values, carbon dioxide concentration values, can dynamically display dynamic data in front of the operator, if the operator wants to control the system, you can pass Click the main menu to enter the menu bar to operate. The content contained in the setting interface is the core content of the stable operation of the whole system. The setting selection interface includes target value, fan, carbon dioxide, nutrient solution, alarm setting and so on. In the setting, the setting can be combined according to the actual growth condition of the crop and the actual demand at the site. The setting value must be saved when the setting is completed. If the setting value is not ideal, the above steps can be repeated to complete the operation. Can return to the main interface. The results of the query can be displayed by curves. The curves are intuitive and clear, and can quickly reflect real-time curves and historical curves. The real-time curve shows the trend of the parameter data during monitoring, while the historical curve shows the curve composed of historical parameter data, which is the guidance for the current environmental parameters, which can provide data support for the current planting plan, and better support some planting plans and timely improvements to the existing environment. The remote monitoring interface is shown in Figure 3.

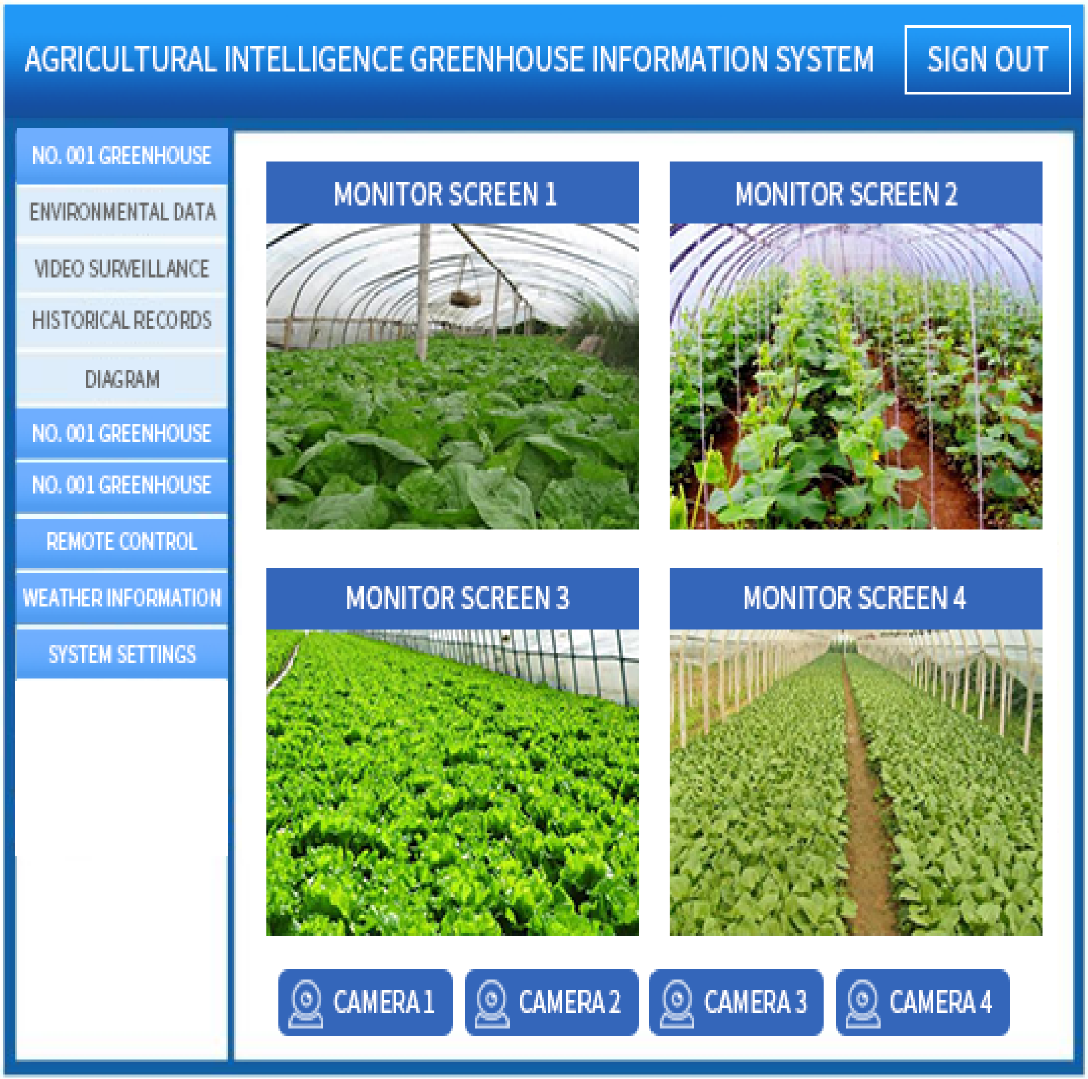

Figure 3. Video monitoring interface

4.3. Smart Agricultural Internet of Things Remote System Performance Test Analysis

In the process of continuously generating data from the data source system, there may be cases where the amount of data is too large. At this time, the computing power of the Storm system will drop. In severe cases, the entire system may crash. In order to test whether the Kafka message queue in the system can temporarily buffer data when the data surges, multi-threading technology is used to test its performance. Each thread produces the same amount of data, verified by a comparison of the number of threads and computational efficiency. The test data source is sensor data in an agricultural greenhouse. By repeating the method of continuously transmitting data, the requirement of large data volume is reached. The storm system accumulates the abnormal values in the transmitted data to test the performance system of the storm. The result of the implementation is shown in Figure 4.

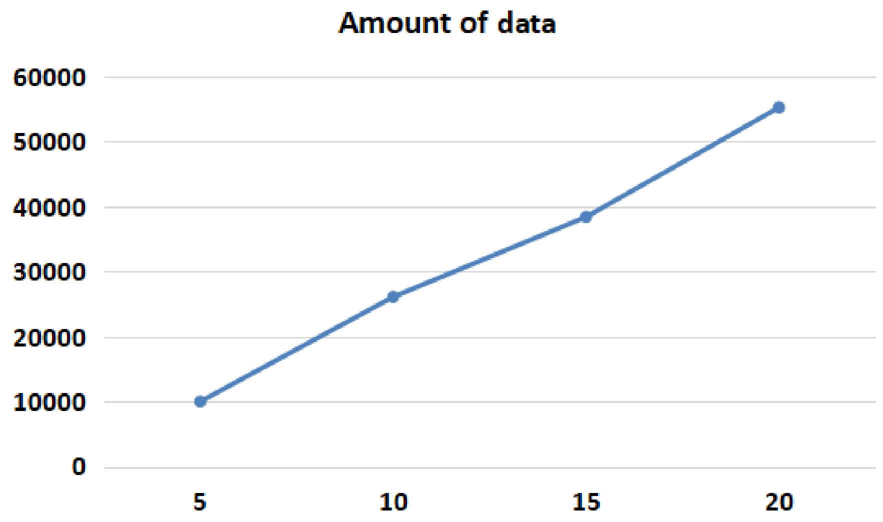

Figure 4. Relationship between Storm computing performance and number of threads

It can be seen from Fig. 4 that as the amount of data calculated increases, the calculation time curve of Storm does not show geometric changes, but an approximate straight line is presented. Therefore, it can be concluded that the increase in the amount of calculated data does not impair the computing power of Storm. It shows that under the action of Kafka components, the data is effectively cached, which ensures the smooth and efficient operation of the Storm system.

For the test of reading performance, when 100,000, 1 million records have been written in the data table, it is necessary to test 100, 1000, and 10000 records from the data table. The system response time is shown in Figure 5.

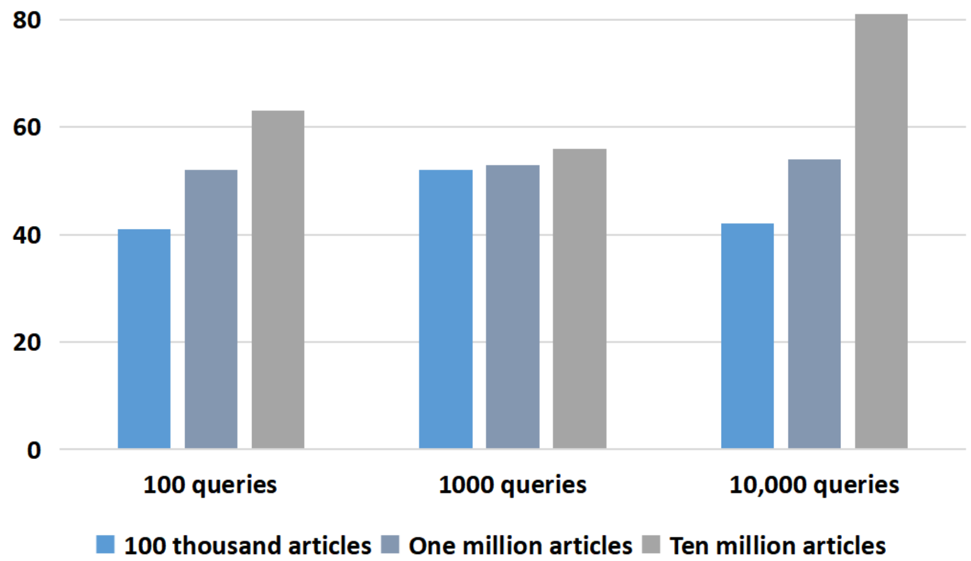

Figure 5. Data query performance test results map

As can be seen from the test results in Figure 5, the response time of the data query is generally maintained at the millisecond level. When querying in the same data table that stores data records, the system time-consuming increases as the query data increases. When the number of records in the data store is different and the records of the number of queries are the same, the system response time increases as the total number of stored tables increases.

5. Conclusions

With the continuous development and advancement of sensor technology, communication network technology, computer network technology, etc., agricultural Internet of Things technology has also been rapidly developed and improved. The application of Internet of Things technology in agriculture is becoming more and more common and widespread. In the Internet of Things, through numerous data collection terminals, data information on all aspects of agriculture can be collected accurately and in real time. The intelligent agriculture and Internet of Things remote control system studied in this paper can realize the production control management in the agricultural production process, and process the obtained environmental parameter information data to guide the agricultural production. According to the experimental data, the comparison line chart can be used to visually and effectively reflect the system performance, and build a software monitoring platform to set parameters and control the execution equipment to achieve the overall monitoring effect. The main research results of this paper are reflected in the following aspects.

(1) Through the analysis of the overall application and development situation of smart agriculture, and through the research on the status quo of the intelligent agricultural Internet of Things at home and abroad, the advantages of the Internet of Things in the field of agricultural control are summarized, and the remote monitoring system of the intelligent agricultural Internet of Things is proposed.

(2) According to the performance indicators realized by the system, through the demonstration of key technologies and the overall requirements of system functions, the overall design scheme of remote monitoring of intelligent agricultural Internet of Things is proposed.

(3) The analysis and verification of the experimental data is the verification of the overall performance index of the system. Through system debugging, performance index testing and data extraction in the database, and plotting the graph, verify the correctness of the system scheme, and analyze the actual data. Fully verify that the system solution is correct and feasible, the hardware structure construction effect is good, and the software design meets the system requirements.

Internet of Things technology has become a new driving force for the development of various industries in this era. Relying on Internet of Things technology to achieve agricultural transformation and innovation has become a must for all industries. However, the research in this paper is still relatively simple, and there is no in-depth study on the issues related to control management, especially system cost. In terms of security, versatility and flexibility, it only discusses the feasibility of system design and development. The related issues of in-depth research and development are still the main research directions of agricultural information systems under the Agricultural Internet of Things.

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