Development and application of Internet of things technology in Greenhouse

He Gong[1,a], Hongyan Ju[2,*b], Zhongwei Zhao[2,c] and Bin liu[2,d].

School of Jilin Agricultural University, Changchun, 130118, China

[*b]didiaoxiaoju@163.com

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Abstract. This article introduces the application situation and development history of the greenhouse network technology in greenhouse, analyzes the application situation of foreign and domestic networking technology in greenhouse. Finally, summarizes the main problems existing in this field, put forward the personal outlook. The exploration for the greenhouse technology mainly focus on intelligent and precision and energy conservation in the world, to solve the optimization technology of modern greenhouse from various aspects, mainly to solve the parameters collection and data transmission and remote control and gateway design problem.

1. The history of the development of greenhouse

At present can refer to the earliest on the greenhouse of literature is the ancient Rome philosopher Seneca (Sceneca), it is about how to use the mica production earlier cucumber, but with the Rome times's demise, this technology also disappeared [1]. Until fifteenth Century, a simple greenhouse began to appear in France. France first appeared in a simple glass greenhouse in seventeenth Century. In eighteenth Century, the United States began to build an ornamental greenhouse [2]. In nineteenth Century, the greenhouse in Holland, Britain and the United States has already been developed during the Dutch started very common use of greenhouse production of muskmelon and grapes. By the end of nineteenth Century, greenhouse began to spread around the world and has been developed rapidly. Since 1920, the plastics industry has developed rapidly, and the plastic film has been widely used as the covering material for the ground and the greenhouse. The emergence of new type of greenhouse covering materials accelerates the spread of the greenhouse in the world.

China is the earliest place of the origin of the greenhouse technology, which has experienced three stages: primitive, development and modern. People began to use simple facilities to plant and protect vegetables two thousand years ago, it was the original type of greenhouse in China. After the founding of new China, the agricultural productivity has been greatly liberated, the greenhouse has been greatly developed. In 70s, China began to implement the reform and opening up, many foreign technology began to flow into China, China's greenhouse into a period of rapid development, the main development of the solar greenhouse is made of plastic film as a covering material. The introduction of greenhouse from abroad at the beginning of 1979, mostly from Holland, Japan, the United States, Romania, Bulgaria and other countries [3]. At the same time, China designed the first large-scale greenhouse named Beijing Yuyuantan greenhouse [4]. Our country has introduced 24 sets of greenhouses from 6 countries in 1987. Because only the introduction of hardware equipment, the matching technology has been neglected. The actual situation of our country has been neglected, and most of them have failed.

2. Development and application of Internet of things technology in greenhouse

2.1 Development and application in foreign countries

At present, some developed countries in the greenhouse technology has been developed to a relatively high level, the most developed in Europe, Asia is relatively backward. Greenhouse technology continue to develop, at present, the main research work is a breakthrough in the aspects of intelligent, precision, energy conservation and so on.

Intelligence

Intelligent greenhouse technology is the inevitable result of the application of Internet of things technology in the greenhouse. More and more advanced technology is applied to greenhouse development, such as intelligent robot in greenhouse environment monitoring [5], which can flexibly move to achieve all-round monitoring of the environmental parameters in greenhouse, people can use advanced technology to realize the "dialogue" with plant to know that plants want to say [6], with environment information acquisition regulation, plant information collection, pest control and other functions to determine whether mature fruit.

Precision

Precision mainly refers to the research on the precision of the collection and control of the environmental parameters of the greenhouse. There are currently on the market a lot of related hardware, some top international Brand Company such as Schneider of France, Turck of German, Baumer of Switzerland, Honeywell in the United States, Autonics of Korean, Omron of Japan and so on. are committed to the development of the latest and most advanced products, introduction of these more advanced hardware facilities will continue to improve the level of greenhouse environmental control technology. Precision control not only depends on the advanced hardware equipment, but also depends on the design of the control system [7, 8].

Energy conservation

In the development process of the greenhouse, energy consumption has been an urgent problem to be solved, it directly affects the income of the greenhouse, to reduce the waste of energy, scientists try to find the best solution. Power consumption is an important factor affecting the waste of energy, the design of the multi power system [9], the system to obtain self-sustained operation, to a certain extent, save energy. In addition, the waste of resources such as light, water, fertilizer and so on are also the factors which cause the waste of energy. More and more low-power hardware products appear to provide a basis for resolving the waste of energy, but the relatively high cost of hardware.

2.2 Development status and application at home

2009, Premier Wen Jiabao's visit to China in Wuxi, "Perception of China" speech to the development of China's Internet of things. In 2015, Premier Li Keqiang put forward the "Internet plus" action plan in the government work report, it has provided the new power to the development of the China greenhouse. Internet of things technology has developed rapidly, the application of the technology in agriculture has greatly accelerated the pace of the development of China's greenhouse industry. It is mainly to solve the problem of parameter acquisition, data transmission, remote control, gateway design.

Parameter acquisition

The parameters of the data are collected by the sensor. Considering the various factors of price and performance, the current sensor types on the market common higher price mainly include digital temperature and humidity sensor SHT10 and SHT11, temperature sensor DS18B20, light sensor BH1750, LSL29010 and TSL2550, carbon dioxide sensor S-100H and B-530, in addition to other types of sensors.

Data transmission

Data transmission mainly rely on wire transmission and wireless transmission. In order to avoid the cumbersome wiring the research of wireless transmission is more popular. At present, there are many ways of wireless transmission are ZigBee, Wifi, GPRS, and so on.

Design of measurement and control system of facilities vegetables based on internet of things was designed by GongHe [10]. It is based on the JN5148 module as the core and set up a wireless network through JenNet. And it can monitor data including temperature, humidity, light intensity and carbon dioxide concentration in real time, at the same time, through the GPRS gateway remote control dimmer and pump work, the system is stable.

There are some research on greenhouse data transmission based on Wi-Fi. Such as Shen Dili and other research monitoring and control system of greenhouse based on Wi-Fi [11]. It based on 51 single-chip STC11 system center control chip, sensor monitoring data will be transmitted to the

Wi-Fi module through the RS232, and then through the wireless LAN data stored in the SQL database, monitoring client terminal to access the database through computer network monitoring and control. The system avoids the problems of short transmission distance and low communication rate in the ZigBee wireless network transmission, and the design is simple and economical and practical.

Another GPRS data transmission through the greenhouse design, such as Yue Hongwei, who designed the GPRS based greenhouse virtual monitoring system [12]. Based on enhanced 8051 MCU MSC1210Y3 as the core, it accepts multi-channel sensing information, through the serial port and GPRS module Q2406B connected. Accept control commands for ventilation, heating or water pump switch operation. Monitoring center through the GPRS network to receive monitoring data, send control commands, the use of LabVIEW development environment for virtual monitoring instrument design, greatly reducing the construction cost to meet the management needs.

Remote control

The remote control includes the control center and the remote operation. The control center is mainly based on ARM or PLC. Greenhouse environment data acquisition and control system design based on ARM was designed by Miao Fengjuan and others [13]. The central control module uses ARM microcontroller LM7805 series voltage regulator integrated circuit, data acquisition used temperature and humidity sensor DHT11, to detect if the data exceeds a predetermined range of temperature and humidity that signals using ultra sonic and polarizer realize humidifying cooling using high power bulb to greenhouse heating. The system can work effectively and has good popularization value in the greenhouse. Design of automatic control system of temperature and humidity based on PLC [14] designed by Chen Huilian and others. The system uses the high cost of the Mitsubishi FX2N series programmable controller to achieve automatic control of greenhouse, the main control object is the temperature and humidity of the greenhouse. With over temperature and humidity integrated sensor LTM8901 to obtain data, PLC received data and set the value of the preset and control, including the spraying mechanism, shutter mechanism, exhaust fan, the automatic regulation and control window.

With the development of virtual technology, LabVIEW powerful function in all aspects of the show, in recent years has also been applied to agriculture. Hou Bo, who designed a remote monitoring and control system for greenhouse environment based on LabVIEW and GSM [15]. The system collected by the sensor temperature, humidity, light intensity and carbon dioxide concentration data, through the LabVIEW software program, select the CB-68LP type terminal board PCI-6023E type data acquisition card and supporting the 6 relay module respectively fan control equipment, heating equipment, spraying equipment, ventilation windows, LED lamps and irrigation equipment, using TC35i type GSM module, using GSM network short message service transmits the data to the management center. The system has the advantages of simple operation, stable operation and low price.

Gateway design

There is no unified standard on agricultural internet of things communication protocol, and it is urgent to solve the problem that the communication protocol of agricultural internet of things is not consistent. A communication protocol suitable for agricultural internet of things AGCP was proposed by Liao Jianshang. Using Cortex-A8 processor and CC2530 processor to complete the environmental data acquisition of sensor nodes, using ZigBee to build wireless sensor network. The realization of ZigBee protocol by CC2530, respectively in the coordinator node and terminal ZStack stack, wireless transmission is responsible for the greenhouse environment information data and control, get good application effect in the monitoring system of greenhouse environment based on the Internet of things [16], to verify the feasibility of the protocol and system effectiveness.

3. Existing problems

Supporting equipment is not complete, low degree of mechanization. Some of our modern greenhouse adopt imported equipment, but not all of the introduction of equipment and technology, and the introduction of expensive cost and difficult to follow up the maintenance service restricts

the rapid development of the industry seriously.

High energy consumption, resulting in higher operating costs. In temperature control, ventilation, water and other aspects of energy consumption, energy utilization is low, resulting in high operating costs.

Poor adaptability. At present, the forming of greenhouse can't adapt to the complex geographical environment in China. Temperature difference between north and south of China, there are mountains and plains of the points, more desert, plateau, basin and other regions. The current greenhouse can't be very good to adapt to special geographical environment of China, only for the implementation of individual environmental areas, there is no effective solution for each of the different environment.

4. Expectation

Greenhouse technology tends to be systematic, different systems to adapt to different environmental areas. Including greenhouse structural materials, covering materials, environmental testing equipment, automatic control equipment, related software tools, related technical services, and gradually become more and more perfect, to become a complete set of greenhouse system. According to the environmental characteristics of different regions to provide the adaptation of the greenhouse system, toward the direction of the development of the greenhouse model.

The development of the technology of the greenhouse has been tending to the large-scale, mechanization, automation and intelligence. With the popularization of computer and development of modern high-tech industries, the greenhouse environment parameters monitoring and control by computer and mechanical coordination, meet the demand of crop cultivation in each phase, completely without manual operation.

Clear integration. Things not only done in the greenhouse environment monitoring, control, alarm, but also can complete the agricultural expert remote diagnosis, agricultural sharing between enterprises, through online sales platform sales, remote video on-demand delivery of fruits and vegetables, visualization of safety traceability, forming a whole industry chain structure.

Acknowledgments

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