Application of Internet of Things Technology in Vegetable Greenhouse Production

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Abstract: On the basis of explaining the Internet of Things technology, the concept, key technologies, and application status of the agricultural Internet of Things are analyzed, and the system construction, main functions, and application methods of the vegetable greenhouse at all stages are finally given

1 Iot Technology

1.1 Concept of the Internet of Things

The Internet of Things concept was first proposed by Professor Ashton of the Auto-ID Research Center in the United States in 1999 on the basis of item coding, RFID technology and the Internet. Its essence is the combined application of RFID technology and the Internet. Later, with the development of network technology, communication technology, and artificial intelligence technology, the definition and scope of the Internet of Things have changed, not just referring to the Internet of Things based on RFID technology. In 2005, the International Telecommunication Union (ITU) expanded the concept of the Internet of Things in ITU Internet Report 2005: Internet of Things. It believed that in addition to the application of RFID technology, sensor technology, fuzzy identification technology, intelligent terminal technology, etc. More widely used, human beings in the world of information and communication

The world will gain a new dimension of communication, thereby forming a "ubiquitous" network environment, which will extend from the communication connection between people in the Internet era to the communication connection between people and things, and between things. At present, the international concept of the Internet of Things is defined as: information sensing equipment, such as RFID, infrared sensors, global positioning systems, laser scanners, etc., according to an agreed protocol, connecting any item to the Internet for information exchange And communication to realize a network concept of intelligent identification, positioning, tracking, monitoring and management [1].

1.2 Features of the Internet of Things

The essential characteristics of the Internet of things are mainly reflected in three aspects: the core of the Internet of things is the extension and extension of Internet functions. The manifestation of its extension and expansion lies in the fact that it not only realizes the information exchange between people through the Internet, but also realizes the interconnection among people, people and things, and things and things, making the Internet more powerful. If the Internet is through the network technology, communication technology to realize the exchange of information, people, then, the Internet of things is on the basis of the Internet, through information sensing technology, the intelligent data processing technology and the exchange of information and communication, as well as interactive phase of the harmony between people and things, to the person's normative reply

for identification, make a plan. The Internet of things has the characteristics of communication and automatic recognition. Its user application extends and extends to any item for information exchange and communication, that is, "things" included in the Internet of things must have the function of automatic recognition and object communication (M2M) to realize object perception. The Internet of things has intelligent characteristics. The Internet of things makes use of cloud computing, artificial intelligence, pattern recognition and other intelligent technologies to analyze, process and process meaningful data from the massive information obtained by sensors, and realize human-to-object management by identifying, locating, tracking and monitoring things. Therefore, the Internet of things is regarded as the application expansion of the Internet, application innovation is the core of the development of the Internet of things, and the innovation centered on user experience is the soul of the development of the Internet of things.

1.3 Technical Architecture of the Internet of Things

The technologies used in the Internet of things are constantly developing, but the technical system and structure of the Internet of things have been generally recognized. According to the technical architecture of the Internet of things, it can be divided into three layers: information perception layer, information network layer and information application layer [2]. The goal of the Internet of things technology architecture consists of three aspects. This means using RFID, sensors, qr codes, gateways, cameras and real-time positioning systems to obtain information about objects anytime and anywhere. The second is to achieve reliable transmission. Through the fusion of various communication networks and Internet, the information of objects can be transmitted to the data center in real time and accurately. The third is to realize intelligent processing. Various intelligent computing technologies such as cloud computing technology and fuzzy recognition technology are used to analyze and process the massive data and information in the data center and implement intelligent control over objects.

Table 1. lists the technical architectures of the Internet of things.

The structure layer	content	function	Major technical applications
Information perception layer	Sensors (temperature, humidity, CO2, qr code tags, RFID and readers), sensor gateways, access gates, cameras, positioning systems	The main function of the Internet of things is to collect physical events and data in the physical world	Sensor technology, RFID technology, M EM S technology, R T LS real-time positioning technology
Information network layer	Various networks (Internet, mobile communication network, satellite communication network, cable television network), network management center and information center, cloud computing platform	Transmit and process the information acquired by the perception layer to achieve wider interconnection functions, and transmit the perceived information without barrier, with high reliability and security	Mobile communication technology, Internet technology, cloud computing technology, fuzzy identification technology, artificial intelligence technology

Information application layer	The interface between the Internet of things and users, including the supporting platform sub-layer and the application services sub-layer	The support sub-layer is used for information cooperation and interconnection across industries, applications and systems. The service sub-layer includes intelligent transportation, logistics, power, home and digital agriculture, digital city and other fields	Middleware application technology, data exchange and processing technology, information portal technology and data standards

2. Agricultural Internet of Things and Its Key Technologies

2.1 Concept of Agricultural Internet of Things

Agricultural iot is the specific application of iot technology in agricultural production, operation, management and service. According to the technical framework of the Internet of things, the agricultural Internet of things still realizes its application in agriculture through the "sense-transport-application" approach. "Perception" is to use all kinds of sensors, such as temperature sensor, humidity sensor, light sensor, PH sensor, CO_2 sensor devices, such as widely collected field planting and gardening, livestock and poultry, aquaculture and agricultural products logistics facilities and the environment temperature, relative humidity, PH, light intensity, soil nutrient, physical parameters, such as CO_2 concentration information; "Transmission" is the establishment of data transmission and format conversion methods, through local wireless network, Internet, mobile communication network and other communication networks to achieve the effective transmission of agricultural information; "Application" is to obtain the huge amounts of agricultural information fusion and processing, make the technical personnel to control the number of greenhouse environment monitoring and intelligent management, ensure the growth of crops has a good, suitable for the environment, to increase production, improve quality, the purpose of regulating growth cycle, improve the economic benefit, and realize intensive agricultural production, high yield, high quality, efficient, ecological and safety goals.

2.2 Key Technologies of Agricultural Internet of Things

According to the technical framework of the Internet of things, the key technologies of the agricultural Internet of things mainly include agricultural information perception technology, agricultural information transmission technology and agricultural information processing technology based on the existing technology research [3].

2.3 Effective Application of Internet of Things Technology in Agricultural Production

Although agricultural Internet of things technology is gradually maturing and has a broad prospect in agricultural development and application, the application cost of Internet of things technology is relatively high, and it is obviously difficult to promote the market for low-profit and low-benefit agriculture. Therefore, Internet of things technology is generally applied in facility agriculture. Facility agriculture has the characteristics of high input and high yield, capital, technology and labor intensive. It use artificial building of agricultural special facilities, the traditional agriculture gradually get rid of the bondage of nature, scale, factory into a modern agriculture, promote the ecological, environmental protection and safety of agricultural production, at the same time through out fresh produce market, break the seasonal restrictions of traditional

agriculture, enhancing the economic benefits of agricultural products, meet the needs of market diversification, multi-level consumer demand. Its main facilities include glass or PC board greenhouse (plastic greenhouse), exterior sunshade greenhouse, plastic greenhouse, solar greenhouse, small arch greenhouse (awning), etc., used for vegetable, fruit, flower planting and breeding. Plastic greenhouses are widely used in agricultural production in north and south China. The structure of plastic greenhouses is divided into bamboo and wood structure, whole bamboo structure, mixed steel and bamboo structure, steel pipe assembly structure, steel pipe (welding) structure and cement structure. Because the cost of plastic greenhouses is lower than that of solar greenhouses, the effect of ventilation and light transmission is better, and the use life is longer, farmers' professional cooperatives and farmers are easy to accept. Application in plastic greenhouses, therefore, the Internet of things technology, can change the natural environment and provide relatively controlled for crop production and even the most appropriate temperature, humidity, light, water and other environmental conditions, thus to some extent, get rid of the dependence on the natural environment, production management, effectively is the most vigorous new modern agriculture.

3. Application of Internet of Things Technology in Vegetable Greenhouse

Greenhouse is mainly used for the season not suitable for vegetable growth, simulating the natural conditions of vegetable growth, and providing an environment suitable for vegetable growth. However, the realization of this environment should not depend on feeling, and Internet of things technology should be introduced to solve the controllability of vegetable growth environment, so as to achieve the goal of improving vegetable production efficiency.

3.1 Construction of Vegetable Greenhouse Greenhouse Control System

A complete automatic control system of vegetable greenhouse includes data collection, data transmission, data analysis and production operation system, each part has different functions in vegetable production, and these functions are combined to complete the whole process of vegetable production. Figure 1 shows the automatic structure diagram of vegetable greenhouse greenhouse based on Internet of things technology.

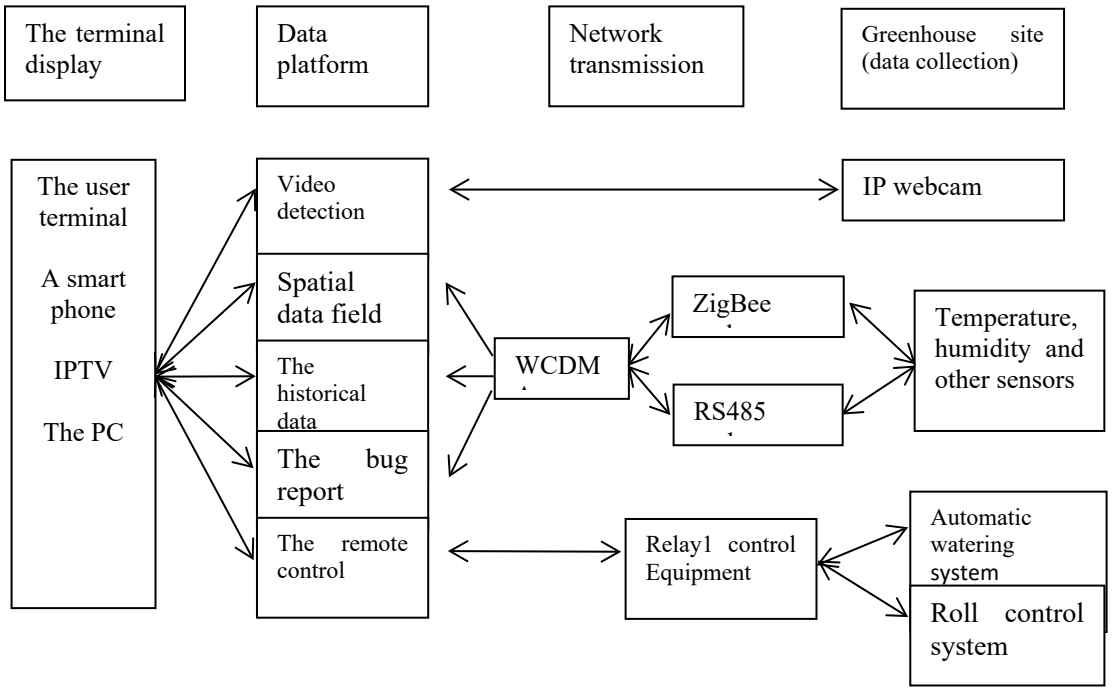

Figure. 1 Automatic structure diagram of vegetable greenhouse greenhouse [4]

The automatic control system of Internet of things in vegetable greenhouse mainly includes the following subsystems:

3.1.1 Data Acquisition System

The data acquisition system consists of wireless transmitting module, solar panel, support, battery, etc. On-site monitoring components include temperature monitoring, humidity monitoring, CO_2 concentration monitoring components. The data acquisition system is mainly responsible for the inside of the greenhouse

Data collection and control of light, temperature, humidity and soil moisture content as well as video.

3.1.2 Data Transmission System

The data transmission system consists of data acquisition sensors, including temperature sensor, humidity sensor, light intensity sensor, photosynthetic effective radiation sensor, soil temperature and humidity sensor, CO_2 sensor, wind sensor, etc. Transmission mode: the external network is transmitted based on IP network technology and GPRS communication network; The internal network USES the short distance, low power ZigBee wireless communication technology. Based on ZigBee wireless transmission mode, the sensor data sent via ZigBee module sent to the center node, at the same time, the user terminal and integration between controller transfer control instruction is transmitted to the center node, edge center node through the gateway to the sensor data and control commands sent to the PC business platform. Technicians can access the upper computer system business platform through wired network/wireless network, monitor sensor parameters at the greenhouse site in real time, and control relevant equipment at the greenhouse site [5].

3.1.3 Data Analysis System

The data analysis and display part includes computer, software, wireless receiving module and alarm system. Different control schemes are implemented according to different environments, crops and growing periods.

3.1.4 Production Operating System

The irrigation control system includes drip irrigation system and micro-spray system, realizing remote automatic irrigation. The soil environment monitoring system USES soil moisture sensor and soil moisture sensor to acquire soil moisture and humidity data in real time, providing environmental information for irrigation control system and temperature and humidity control system. The temperature and humidity monitoring system can use high-precision sensors to collect the growth environment information of crops and set the environmental index parameters. When the environmental index exceeds the parameter range, the fan cooling system, water heating system and air internal circulation system can be automatically started to adjust the environmental temperature and humidity [6].

3.2 Main Functions of Vegetable Greenhouse Greenhouse Control System

The main function of the vegetable greenhouse constructed with the Internet of things technology is to build a greenhouse to control the growth environment of vegetables, so that vegetables can get the best growth environment and increase the yield, so as to achieve cross-season vegetable cultivation. According to the functional requirements of Internet of things technology, the main functions of the greenhouse control system for vegetables [7] include:

(1) Monitoring and warning functions. Real-time monitoring and alarm of greenhouse is the basic function of vegetable greenhouse based on Internet of things. Wireless sensors can be used to collect environmental factors in the greenhouse in real time, including air temperature, air humidity, soil moisture, soil temperature, light intensity and other data and video image information, and then transmitted to the data center through GPRS network, providing a basis for data statistical analysis. Automatic warning of environmental conditions unsuitable for crop growth.

(2) Disease and insect pests early warning function. Monitoring the key factors affecting the occurrence of diseases and pests in the greenhouse, establishing the model of diseases and pests in

the greenhouse, using the intelligent algorithm, realizing the prediction of diseases and pests, and carrying out targeted control guidance.

(3) Plant maturity prediction function. According to the model of accumulated temperature of crop growth, the maturity and harvesting degree of plants in each growing period were predicted.

(4) Remote facility control function. Through the website, remote control of vegetable greenhouse greenhouse facilities, heaters, film coiler, ventilator, drip irrigation and other equipment remote control, agricultural facilities remote manual or automatic control, so as to change the growth environment of vegetables in the greenhouse.

(5) Remote production guidance function. According to the crop growth model database, the real-time environmental monitoring data of the vegetable greenhouse were compared and analyzed, and the system would automatically warn if the data were higher than the upper limit of crop growth or lower than the lower limit of crop growth.

(6) Remote production activity tracking function to track the completion of vegetable production activities according to the report of on-site activity monitoring terminal.

3.3 Application of Vegetable Greenhouse in Various Stages of Vegetable Production

According to the growth characteristics and laws of different vegetable varieties, agricultural experts or technical personnel should develop appropriate vegetable planting plans according to the conditions required for the growth of this variety of vegetables, such as temperature, humidity, light, etc., and use Internet of things technology to adjust and control

To improve the efficiency of vegetable planting and strengthen the fine management of vegetable planting.

In each stage of vegetable production process, the following work should be done well:

(1) In the preparation stage of vegetable planting, technicians use sensors distributed in the greenhouse to analyze real-time soil information so as to select appropriate vegetable varieties.

(2) in the seedling cultivation stage, technicians can collect temperature and humidity information with internet of things technology for efficient management, so as to cope with environmental changes and ensure the growth of vegetable seedlings in the optimal environment. Such as through the temperature control equipment, the greenhouse for heating and cooling regulation.

(3) in terms of the growing environment of vegetables, the internet of things can be used to monitor the environmental information, nutrient information, diseases and insect pests of vegetable growth in real time. Use relevant sensors to obtain soil moisture, environmental temperature and humidity, and light conditions accurately and in real time, and cooperate with the control

Vegetable growth environment is systematically regulated to improve the vegetative state of vegetable growth, and the outbreak period of diseases and pests is found in time to maintain the optimal growth environment.

(4) in terms of vegetable production management, technicians can use the operating system of vegetable production in greenhouses to automatically or manually control the watering, fertilizing, heating and rolling of vegetables in each greenhouses, which can reduce the labor cost and improve the benefit of vegetable planting.

(5) in the harvest stage of vegetables, technicians can also use the information of the internet of things to collect all kinds of information collected about vegetable growth and feed it back to the front end, so as to make more accurate calculations at the planting and harvest stage of vegetables and provide basic information for vegetable sales.

4 The Knot Language

Agricultural application of Internet of things technology can solve the information of the spatial distribution of agricultural production in a series of in wide-area, efficient and reliable information transmission and interconnection, oriented to different application requirements and application environment of the system integration of intelligent decision making problems in science and technology, will become the realization of traditional agriculture to modern agriculture change

booster, become to promote our country agriculture to "high-yield, high-quality, high efficiency, ecology and safety" of the development of the important driving force. The application of agricultural Internet of things is of great significance and broad prospect for changing the current situation of China's traditional agriculture, which is characterized by high production cost, low efficiency, extensive production and operation mode, and low added value of agricultural products. Although the extensive application of Internet of things technology in agriculture is severely restricted by the expensive introduction cost and the difficulty in following up the maintenance service of Internet of things technology, with the progress of technology and the development of industry, the cost of Internet of things technology will be gradually reduced to realize the extensive application of Internet of things technology in agriculture. Therefore, it is of great practical significance to explore the application of Internet of things in agricultural production.

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