Applied Research of Internet of Things Technology in Agricultural Greenhouse

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Abstract. The application of the Internet of Things technology to agricultural electrification production, especially agricultural greenhouse cultivation, can greatly improve the quality of agricultural products. This article summarizes the application technology of the Internet of Things technology in five aspects of agricultural greenhouse insulation, electric rolling shutters, electric drainage and irrigation, electric supplementary light and electric ventilation. Deep integration with agricultural production to improve agricultural planting benefits.

1. Introduction
"Accelerating the development of modern agriculture" is an important historical task in China's modernization process. The level of agricultural electrification directly determines the level of modern agriculture. The development of agricultural greenhouse electrification technology is an important part of the construction of agricultural electrification level. It played a very important role in the entire construction process. Greenhouse electrification is a new type of planting technology aimed at new construction, expansion, and transformation of traditional greenhouses. It is a new technology based on the growing environment and actual needs of crops, while ensuring reliable, stable operation and economic requirements.

The Internet of Things is an intelligent network that uses intelligent sensors, radio frequency identification and other information sensing equipment and systems to exchange information and communicate any item with the Internet in accordance with agreed protocols to achieve intelligent identification, monitoring, and management. Combining the Internet of Things technology with agricultural electrification technology can greatly improve the quality of agricultural products, and increase agricultural output value and profits.

2. The Main Application of Iot Technology in Agricultural Greenhouse Cultivation

2.1. Agricultural Greenhouse Insulation Technology
Agricultural greenhouse planting is to increase the yield by providing suitable growth environment for crops in the greenhouse unsuitable season for plant growth. Therefore, reliable and stable thermal insulation equipment plays a very important role in greenhouse cultivation. Affected by economic factors and facility conditions, from the perspective of the thermal insulation equipment currently on the market, most of the agricultural greenhouses in China use coal combustion for heating. Workers need to frequently measure the temperature, add and reduce materials, and control the temperature, while manual operation will inevitably cause errors and errors, which will inevitably affect the growth of crops to a certain extent. In addition, coal-fired heating has low utilization of thermal energy and
high coal consumption, and also generates a large amount of dust and exhaust emissions. The transportation, storage, and disposal of coal ash will cause pollution to the surrounding production and living environment. With the development of modern agriculture, the development of electric energy instead of coal has become an increasingly important issue in agricultural greenhouse production. Electric heating technology can be divided into three types: direct heating, heat storage, and heat pump according to different conversion methods and technical routes.

Direct heating electric heating directly converts electrical energy into thermal energy through electric heating elements, and directly heats in the form of convection or radiation heat dissipation. According to the heating scene and heating area, it can be divided into direct heating electric boiler and direct heating electric heater.

Regenerative electric heating converts electrical energy into thermal energy through the valley period, and stores the thermal energy in a thermal storage medium. When needed, the stored heat is released for heating. According to the heating scene and heating area, it can be divided into regenerative electric boilers and regenerative electric heaters.

Heat pump electric heating uses a small amount of heat energy to transfer heat from a low-level heat source to a high-level heat source through a heat pump system to meet heating needs. It can be divided into air source heat pump and ground source heat pump.

Compared with other insulation technologies, the electric insulation system is stable and safe, has a high degree of automation, low operating and labor costs, and has no pollutant emissions. Electric heating used in agricultural greenhouse insulation can greatly improve crop yields and economic profits.

2.2. Electric Shutter Technology for Agricultural Greenhouses

Covering the greenhouse with insulation materials such as roller shutters can effectively reduce the heat loss of the greenhouse when the ambient temperature is relatively low, and maintain the temperature in the greenhouse within a relatively suitable range for crop growth and development, and meet the indoor crop growth And development needs, and the roller shutter can be used to shade or provide necessary protection to crops in rainy or snowy weather when the sun is too strong during the day.

Traditional roller shutters are manually operated. Due to the large area of the shed, they rely entirely on manual retracting operations, which is time-consuming and difficult to meet the light time required for crop growth, which affects crop growth and is not suitable for large-scale operation. In order to meet the market demand, electric roller shutter technology was produced. The electric roller shutter can reduce the manual labor intensity, greatly reduce the rolling shutter operation time in the solar greenhouse, and because of the fast speed of the mechanical roller shutter, it can realize early rolling and late curtain, and increase the exposure time of the crops grown in the shed, which is effective. Increase the thermal effect and promote the growth and development of crops, thereby improving the economic benefits of greenhouse production.

At present, there are many types and types of electric roller shutters on the market, but according to the different types of roller shutters, they can be divided into two categories: rear-mounted rope rope pull-up roller shutters and shed surface self-propelled roller shutters.

The rear roll-up pull-up roller shutter machine, also known as "traction type" and "pull-up", is the earliest type of roller shutter machine. Its technical principle is to drive the mainframe to rotate the rope rod, wind the rope, and pull the rope to pull the roller blind, so that the roller blind is rolled up; when the roller blind is laid, the weight of the roller blind is used to naturally fall along the slope of the shed. The driving device is generally installed in the middle of the rear wall or at a position on one side thereof. The output shaft of the driving device is mostly consolidated with the rope winding rod on the bearing bracket through a flange to realize the transmission of driving force.

Shed surface self-propelled roller shutter machine, also known as "self-propelled roller shutter machine", compared with the rear-mounted rope-type pull-up roller shutter machine, it is not necessary to lay the traction rope on the shed surface in advance, but to set up an auxiliary bracket. Relying on the traction of the roller shutter itself and the friction between the roller shutter and the shed surface, the power unit drives the reel and the power unit to move along with the thermal
insulation material along the shed surface. The rolling and laying of the roller shutter have power support. Limited by the slope of the shed.

Electric roller shutter technology is convenient and efficient, but it is highly dependent on the reliability of the power grid and needs to rely on good surrounding rural distribution network conditions. The rear roll-up pull-up roller shutter machine is suitable for greenhouses with various shed lengths, and can even be used for solar greenhouse roller shutters with shed lengths up to 200m; its rolling shutters rely mainly on its own weight and have no driving force. Existing, so it cannot be used for rolling shutter operation in greenhouses with a small slope. However, the overall cost is low, and the rear roll-up roll-up roller shutter is applicable and widely used. Shed surface self-propelled roller shutter machine is suitable for small and medium-sized greenhouses, not limited by the slope of the shed, and the price is relatively high.

2.3. Agricultural Greenhouse Electric Drainage and Irrigation Technology

The greenhouse is a relatively closed production facility, and natural rainfall cannot be used directly. The moisture required for the crops in the greenhouse depends entirely on artificial irrigation measures. Traditional flood irrigation and gully irrigation have a large waste of water resources, low utilization rate, and cannot accurately supply the water required for crop growth, which hinders the healthy growth of crops. With the development of agricultural science and technology and the shortage of water resources in China's arid regions, electric and automatic irrigation technology has become a development trend.

Electric drainage and irrigation is the use of electric motors as pumps to extract water, and irrigate crops in different scenarios through pipes, valves and sprinklers. According to the different transport irrigation methods and crop cultivation methods, electric drainage irrigation is divided into sprinkler irrigation, drip irrigation, micro-spray irrigation, and so on.

In the process of using the above-mentioned electric sprinkler irrigation technology to control the humidity of the air in the greenhouse, it is mainly based on experience to judge the temperature and humidity. There is no objective and accurate measurement of temperature and humidity data, and the amount of water spray cannot be accurately controlled according to the actual temperature and humidity (Ordinary motors and pump systems cannot achieve precise water spray control).

Therefore, based on the research of microelectronics and communication technology of the Internet of Things, electric sprinkler irrigation technology can be combined with an automatic control system to achieve real-time accurate monitoring of temperature data and dust concentration data in agricultural greenhouses, and precise control of spraying according to temperature, humidity and dust concentration. The amount of water sprayed by the pump enables one-click spraying in the greenhouse.

Automatic sprinkler system, mainly composed of soil, air humidity sensor, data processor, water storage tank, sprinkler head and detection terminal, etc., can be used to timely detect environmental conditions in the greenhouse (such as temperature, humidity, light, etc.) And the growth of crops, the system's central processor can automatically calculate the amount of replenishment water required for crop growth after receiving data from the sensors, and automatically perform irrigation, fertilization, etc., and greenhouse management. According to the parameter information provided by the automatic control system, the personnel timely adjust the environment in the shed, so as to ensure that the crops in the shed are always in the optimal growing environment.

Compared with the previous flood irrigation, electric drainage and irrigation technology is an agricultural technological innovation, which has the advantages of saving water resources, land resources, and labor.

2.4. Electric Light Supplement Technology for Agricultural Greenhouses

Light environment is one of the important physical environments indispensable for plant growth and development. Controlling plant morphology through light quality regulation is an important technology in the field of cultivation.

Electric supplemental light technology is an electrical energy replacement technology that uses halogen, sodium, LED, LD laser plant growth, etc. to provide the energy needed for growth and development of greenhouse plants photosynthesis based on the principle of plant photosynthesis. Low
light environment has many adverse effects on crop production and development. Low light will slow down the photosynthetic rate characteristics of plants, affect crop nutrition, and cause poor growth. Under long-term light conditions, flowers will cause flower fall and crops will cause fruit drop. The main reason is that low light reduces pollen. Vitality in turn reduces the quality of the fertilized eggs. The photosynthesis of plants will be reduced, which will affect the formation of chlorophyll in plants, which will lead to a reduction in the number of chloroplasts of plants, which is manifested as disease.

There are a lot of positive meanings in applying electric light to plants: shortening the delivery period and greatly increasing yield; improving the quality of flowers and crops and increasing income; having harvest throughout the year, which can control the delivery period and being planned; making full use of space and allowing three-dimensional planting; As crops grow vigorously, disease resistance is significantly enhanced.

According to the light required for photosynthesis of plants, the plant lamp is made into a combination of red and blue, three forms of all-blue and all-red, covering the wavelength range required for photosynthesis. Visually, plants and the like combined with red and blue appear pink. Red light promotes plant germination, flowering and fruiting, and blue light promotes plant growth. Can choose more suitable wavelength and color ratio to promote plant growth.

Electric supplement light technology is suitable for customer groups engaged in plant tissue cultivation, crops, flower cultivation, horticulture cultivation, etc.

2.5. Agricultural Ventilation Technology
The growth of crops is inseparable from a good ventilation environment, and the greenhouse is a relatively closed key. How to ventilate the greenhouse and which ventilation method is the most suitable is a very important issue. Some areas are large and the natural ventilation conditions are poor. In the greenhouse, the traditional ventilation window ventilation method cannot meet the ventilation conditions. Electric ventilation can effectively and effectively overcome the limitations of natural conditions and provide reliable ventilation conditions.

Negative pressure fans are electrical equipment commonly used to cool and cool greenhouses. The ventilation principle of the negative pressure fan in the greenhouse is: when the negative pressure fan is powered on, the fan is rotated by the motor to convert the electrical energy into mechanical kinetic energy, and the air in the greenhouse is forced to convect. The popular understanding is that when the negative pressure fan is powered on, a strong exhaust air volume is quickly generated by mechanical kinetic energy, and the stagnant and slow-flowing air in the greenhouse is quickly discharged to the outdoors with the exhaust direction. When a pressure difference is generated, negative pressure quickly develops in the shed. Naturally, fresh air with strong pressure outside the shed will be introduced into the room through air inlets such as doors and windows for forced convection exchange, thereby achieving the effect of smooth air flow in the greenhouse.

Negative pressure fan has the characteristics of low investment cost, large air volume, low noise, small energy consumption, stable operation, long life and high efficiency. The blinds are automatically opened and closed to be dustproof, waterproof, and elegant; both wind and air can be used, which is the best choice for modern cooling and ventilation.

Compared with traditional technology, electric ventilation has the following advantages:
(1) Significant ventilation effect
The ventilation speed and ventilation volume can be set according to the needs of the environment in the greenhouse, and the ventilation effect can be controlled humanely.
(2) Low cost and low use cost
The installation of negative pressure fans for ventilation is the smallest investment in the current greenhouse ventilation solution. It does not need to modify the original fixed structure of the greenhouse, does not require a lot of expensive materials, does not require a lot of labor, etc., and the cost is very cheap. Is just the power consumption of the fan motor.
(3) The construction and installation of negative pressure fans are simple and easy to implement
The installation process of the negative pressure fan only needs two or more people who can use power tools.
(4) Does not occupy space and is less destructive to the site
Generally, the installation position of the negative pressure fan is on the wall of the greenhouse or the original ventilation window. It does not occupy the space in the greenhouse at all, and it will not damage the building structure of the greenhouse.

3. Technology Implementation Path of IoT Technology in Greenhouse Cultivation

Actively apply IoT technologies and equipment such as full-spectrum LED supplementary light, ground source heat pump, interventional energy monitoring, mobile Internet, video monitoring, environmental monitoring, etc. in greenhouse planting, and electrify the traditional agricultural equipment to improve labor productivity and reduce The labor cost, its technical realization path includes three parts: transforming the smart greenhouse, assisting in the development of smart planting, and developing the application of greenhouse planting.

(1) Transformation of smart greenhouses. Collect electric power usage data of electric shutters, fans, wet curtains, sprinklers, drip irrigation machines, plant lighters, carbon dioxide supplementers, hot blast stoves, electric heaters, and water and fertilizer integrated equipment in the greenhouses in the pilot park. Install energy controllers to collect environmental information such as air temperature and humidity in the greenhouse in real time; realize full control of the operating status and operation level information of crop production equipment in the greenhouse; combine monitoring data in the greenhouse to assist users in determining the optimal electrical equipment usage plan and provide Energy saving recommendations.

(2) Assist in smart planting. At the key nodes such as heating and cooling, sunrise and sunset, fertilization, crop growth, etc., through energy analysis, users are pushed to the production status and completion of equipment such as greenhouse shutters, heat fans, environmental controllers, irrigation controllers, and nutrition supply devices. Degree information to assist users to determine the optimal electrical equipment operation plan and provide energy-saving recommendations, to achieve energy-using equipment monitoring, video monitoring, and fault alarming.

(3) Development of greenhouse planting applications. Through terminals such as mobile phones and computers, farmers can learn about the environmental conditions in the greenhouse in real time and monitor the greenhouse's electrification equipment; provide related query functions such as energy consumption, energy efficiency, power distribution equipment operation status, power outage information, and account manager. Provide "one-click" equipment fault reporting and repair services.

4. Conclusion

This article summarizes the application technology of the Internet of Things technology in five aspects of agricultural greenhouse insulation, electric rolling shutters, electric drainage and irrigation, electric supplementary light, and electric ventilation. The method can effectively guide scientific research institutions and colleges and universities to carry out research work on Internet of Things technology in rural electrification production.

5. References

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