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Cucumber Greenhouse Light Filling System Based on The Internet of Things

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ABSTRACT:

In view of the Problem of insufficient sunlight of vegetables in winter greenhouses in the north of China and the Problem that vegetable greenhouses in common areas cannot supplement sunshine in time sometimes, vegetable canker often occurs. It can't guarantee its normal Production Process. In order to solve this kind of Problem, a comprehensive system including central control system, automatic light supplement system, sensor collection system, alarm and monitoring system is designed, which is connected with upper computer software. It is named cucumber shed light supplement system. Its function Principle is to collect information through various sensors and transmit it through ZigBee technology to the central controller, the central controller combines all kinds of information received and compare it with the Preset value in advance. For example, when the sunshine is not enough, the automatic light supplement system will be started immediately. After the automatic light supplement system receives the signal, it uses the R / B ratio adjustable light supplement technology of red and blue LEDs to supplement the light in time for the shed. If the light supplement is not done in time, or the light supplement is not done If the system is abnormal, the alarm device will be started immediately, and the alarm information will be sent to the user terminal to remind the user to check the shed in time to ensure the smooth operation of the whole system. The method adopted in this Paper is based on single chip microcomputer and ZigBee communication technology, and can be applied to different kinds of vegetables or different growth Periods of the same vegetable. The system can be opened automatically according to the light intensity in the greenhouse. At first, the light intensity can be adjusted by adjusting the duty cycle of PWM signal to meet the growth needs of various vegetables. Therefore, the system can not only be applied to the use of light supplement in Cucumber Greenhouse, as long as the specific value of each vegetable is set to the light supplement system, the system will automatically adjust and compare, thus forming a multi-functional light supplement system for greenhouse vegetables.

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I. INTRODUCTION

As we all know, as we know, light is a natural production factor necessary for humans and even animals and plants, which need to be ingested every day, and in order to ensure stable growth, there are certain requirements for the amount of light. Without sufficient sunlight, it will cause the growth rate of plants to be slowed down, the assimilation rate of plants to varying degrees, and even the harm of death, which is why artificial light sources are particularly important. Therefore, it is particularly important to design a system that can sense changes in the external light source and can supplement the light source at any time. Because for the plant itself, suitable light conditions, sufficient water, suitable temperature, pests and diseases, etc. are several important factors for the normal growth of plants. Of all the influencing factors, light conditions play an important role as an important part of this. For the blue light source, its main role is to promote the growth of leaves, which will have a positive impact on the synthesis of starch, sugars and amino acids in plants. For the yellow light source, its main function is to produce a catalytic effect, so that the plant under the illumination of light and then photosynthesis, and then produce starch, amino acids, sugars and other nutrients, in a longer period of time to maintain a relatively stable state.

Why the importance of light is particularly important for plant growth. At present, the research on artificial light sources mainly includes whether the combination of red light, blue light and red and blue can produce different response effects on the regulation of plant growth, photosynthesis, material metabolism, gene expression and so on. Cucumber has different requirements for light intensity and temperature at different growth stages, and this paper studies the light filling control system of cucumber greenhouse by detecting, compensating and controlling the light intensity and temperature of cucumber maturity. Light is an important factor affecting the seed germination of crops, seedling growth, flowering and fruiting and other stages, in order to improve the quality and quantity of crop products, the greenhouse in the light quality, light density, light length control adjustment, in order to control the plant growth stages in the form including leaf area, plant height, stem thickness, etc., which is an important reform technology in the field of agricultural production in China. With the reform and advancement of science and technology in agriculture, agricultural production has made great progress in plant light filling.

For the study of the light filling technology in the cucumber greenhouse, for some places abroad began to focus on the study of a long time ago, the use of any technology is the first from the military to the civilian development process, in the military, has long been applied to the usual planting of any greenhouse. Among them, the most prominent performance is some countries with relatively leading technological levels, and the technology has been relatively mature, so it has begun to be applied to the process of agricultural development. Therefore, it is possible to manage and operate the environmental status of the greenhouse in a more scientific way. In some developed countries, the size of the greenhouses to which they belong is relatively large. Because of this, these greenhouses have a profound impact on some of the factors that affect their development during their material growth stage. Therefore, how to use a more appropriate and standard way to collect the required indicators will have different degrees of differences. The various information collected will adjust the optimal matching state of the relevant adjustment device to the integrated indoor lighting and other factors. And in the country by some technical reasons, as well as the system itself cost factors to consider, greenhouse light system, has not been widely used, at present some large greenhouse producers are gradually introducing different types of greenhouse light system, crop growth advantages have been significant progress, is moving towards a more advanced mode road.

This paper is based on the greenhouse as a research and analysis object, the study in the greenhouse if the lack of light time is encountered, resulting in the growth of its plants is affected, and by adjusting the relevant equipment to timely supplement the light source, to ensure the growth needs of plants. The greenhouse is full of various sensor nodes, used to collect environmental variables, after the collection is sent to the sensor collection simulation, the sensor module receives the signal to trigger the light module in time to fill the light of the greenhouse, but you for the smooth operation and operation of the entire system, the key is based on whether the entire network can be kept smooth, and whether the various sensor nodes can be integrated together to accurately collect the required growth indicators, and whether the central processor can quickly issue instructions to the control device.

II. System profile design

The cucumber greenhouse light filling system consists of two parts: hardware and software. At the same time, the entire system can be divided into five subsystems, as shown in Figure 1, the software control system on the computer written by the interface terminal combination; The hardware system includes LED lamp filling system and information acquisition and processing system. The LED lamp filling system adopts the most advanced R/B ratio principle. The data acquisition and processing system will be composed of temperature and humidity sensors, carbon dioxide sensors, light source sensors, etc.

The central control system is implemented by the remote user interface and the next computer interactive parameters and commands to achieve the management and control of the hardware equipment, and its role includes the real-time monitoring of the greenhouse and the overall preset parameters of the greenhouse are compared and adjusted and filled in time. Ensure that the luminosity of the entire greenhouse system is maintained at the most efficient value for plant growth. LED light filling system is a comprehensive variety of light sources for comparison, select the most suitable LED light source, while adopting red and blue LED R / B mutual ratio adjustable light filling measures, after receiving the instructions of the central controller will automatically open the light for timely supplementary light source, to ensure the light demand for plant growth, more effective photosynthesis, to ensure the overall growth process of cucumbers.

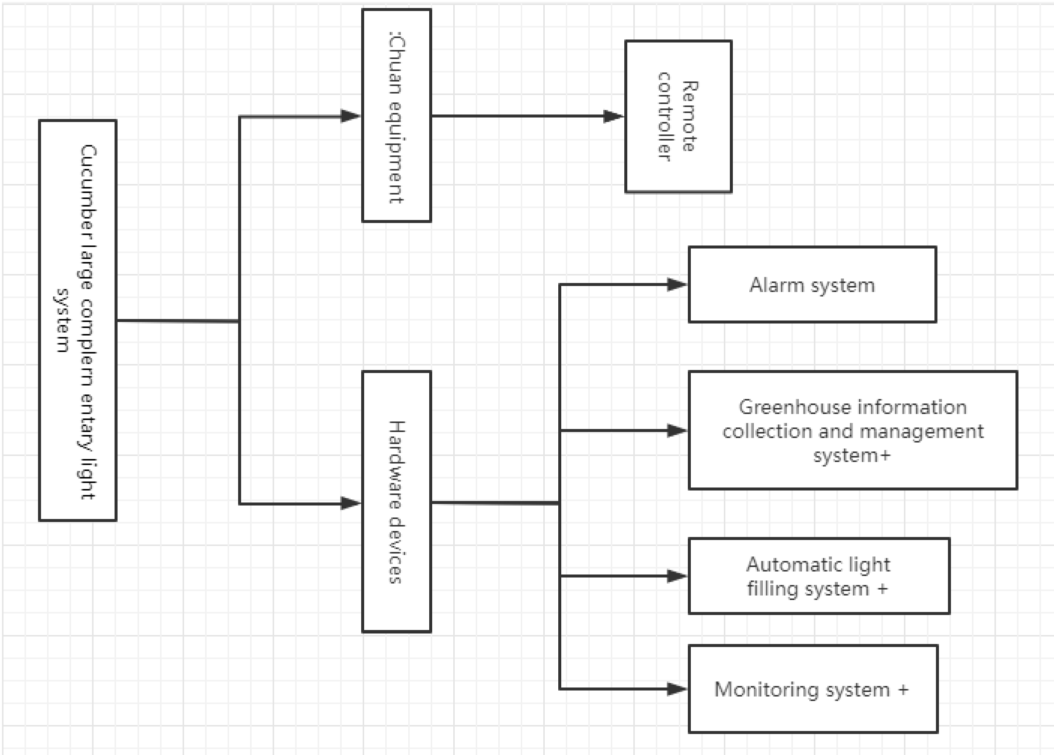

Figure 1 System Design Diagram

The system uses the stable circuit formed by the single-chip microcomputer, of which the AT89C51 single-chip microcomputer is the core part of the hardware of the greenhouse light filling system. The circuit design will be provided by the power module to provide the power requirements required by the entire circuit, a key module that can control the system to fill the light or add some other factors, a brightness detection module formed by the light group, a display module that displays the growth status, an alarm module that automatically alarms in case of emergency, a relay module, and a light-filling lamp module that can replenish the light in time when the light source is insufficient. AT89C51 microcontroller as the control core area of the system plays a pivotal role, The microcontroller P0.0 ~ P0.6 port 7-bit digital tube is connected, so that according to the display value of the digital tube, and then can indirectly show the R / B ratio; P2.0, P2.1 will be connected with the red LED and blue LED branches; P2.4 corresponds to the data drive system buzzer, when there is a problem abnormal will send an alarm message signal to notify the user; the user receives the information in time and reacts. For P2.5, the two ports of P2.6 will be in the red and green light types of light sources, respectively, with red as the indicator light, If its brightness is illuminated, it will prove that the entire light filling system is in the process of adjusting the light intensity to the management, and if the green indicator light is lit, it will indirectly tell the user that the entire microcontroller state is now and the connected light filling system is in a normal operating state; The control system of the selected microcontroller is shown in Figure 2.

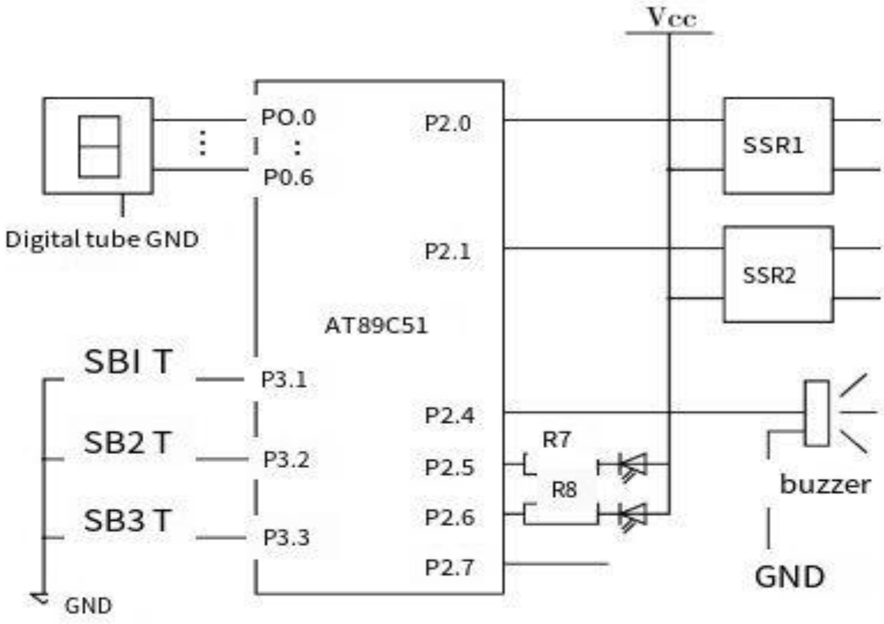

Fig. 2Six similar nozzles were fixed on 0.5 inch tube 40 cm diameter

The nozzle has outside diameter of 15 mm, inner diameter of 9 mm, 30 mm length, tapered into end top diameter of 10 mm and the orifice diameter 1.0 mm as shown in Fig. 4. The evacuated tube solar collector has a storage tank of 200.0 L volume, surface area is 3.0 m2, and its inclination angle is 250. The hot water from the collector was pumped by a pump having a power of 375.0 W. The water flow rate was measured using a rotameter having a range from 0.2 L/min. to 4.9 L/min. With a repeatability error of about 0.5%. A digital temperature indicator (Manufacturer: BK PRECISION, Model: 710, K-type) with 0.1 °C resolution was used to record the temperature which sensed by K-type thermocouple. Temperature measurements were recorded at eleven locations; saline inlet to the collector, saline in the tank of the collector, saline outlet from the collector, saline supply to humidifier, humidifier dehumidifier space, saline outlet from the humidifier, condensate water, water supply to cold the spherical dome, hot water exit after cooling the spherical dome surface to the tank, the spherical dome surface, built in double tank surface, as shown in Fig. 1. A hygrometer having a range (0.0–100%) with an accuracy of ±1% was used to measure the relative humidity. The flow rate of fresh water was measured by a pre-calibrated measuring jar having a range of (0.0 – 3 L) volume with an accuracy of 0.01 L. A solar power meter having a range (0.0– 1999 W/m2) with an accuracy of ±10 W/m2 was used to measure the solar radiation. Referring to Fig. 5, to get the electric power consumption to drive the motors of pumps, a voltmeter has a range of (0.0–750 V) with an accuracy of ±0.1 V was used to measure the voltage. An ammeter has a range of (0.0–20 A) with an accuracy of ±0.01 A was used to measure the current. The measurements were daily recorded from 8.0 am to 5.0 pm at an equal internal of one hour.

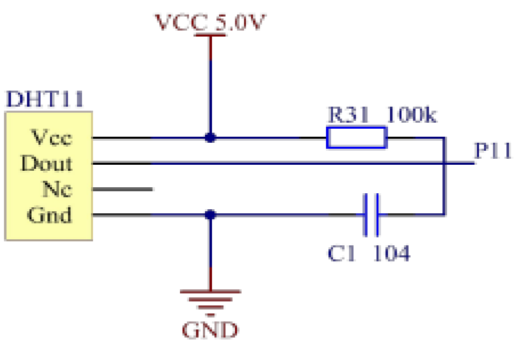

Figure 3 The DHT11 sensor is illustrated

Brightness detection sensor the main function of this module is to detect the value of the light source in the greenhouse. Its basic principle is to convert the perceived light information into a voltage signal, and the voltage signal is transmitted to a microprocessor for comprehensive analysis and processing. Brightness detection sensor is a kind of extremely sensitive sensing equipment, it is synthesized by complex electronic devices, through its internal adjustment, induction, can sensitively feel the external light source intensity changes, when the light intensity is relatively weak, the fill light port is opened, the light module quickly compensates the greenhouse where it is located, when the light intensity in the greenhouse reaches a certain value, the fill light port automatically closes to maintain its normal value. Carbon dioxide sensor: Plants in photosynthesis has an important gas factor, that is, the content value of carbon dioxide, the sensor receives the content in the greenhouse, showing that its content can also reflect the photosynthetic reflection state of the plants in the greenhouse. In the absence of this raw material, the progress of plant synthesis of organic matter will stagnate, and in the opposite direction, if the raw material is surplus, it will cause the stomata of the plant to undergo photosynthesis and cannot carry out normal breathing and metabolism. In this design, we use the MH-Z14A sensor as our user device. By measuring the carbon dioxide concentration in the greenhouse, the data information is transmitted to the sensor integrated processor, which is then compared with the preset carbon dioxide concentration, and in the event of an abnormality, the information is passed to the central processor. The circuit connection diagram of the sensor is shown in Figure 4.

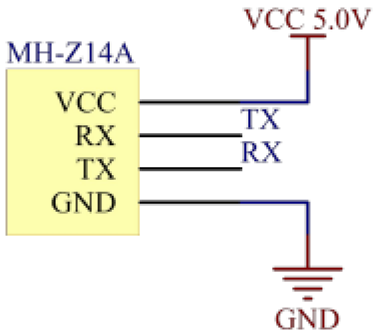

Figure 4 MH-Z14A sensorIII

In view of the real needs of the system, we will plan the software module of the entire greenhouse light filling system as follows. The use of programming and development tools to write software window, but also includes the function module design, that is, the sensor module for data acquisition, the device module according to the signal instructions transmitted by the former for the corresponding function implementation. Alarm module and network monitoring module has been in operation, LED fill light module once received the command, will immediately carry out light energy compensation, several modules of interconnection, composed of the entire system software part.

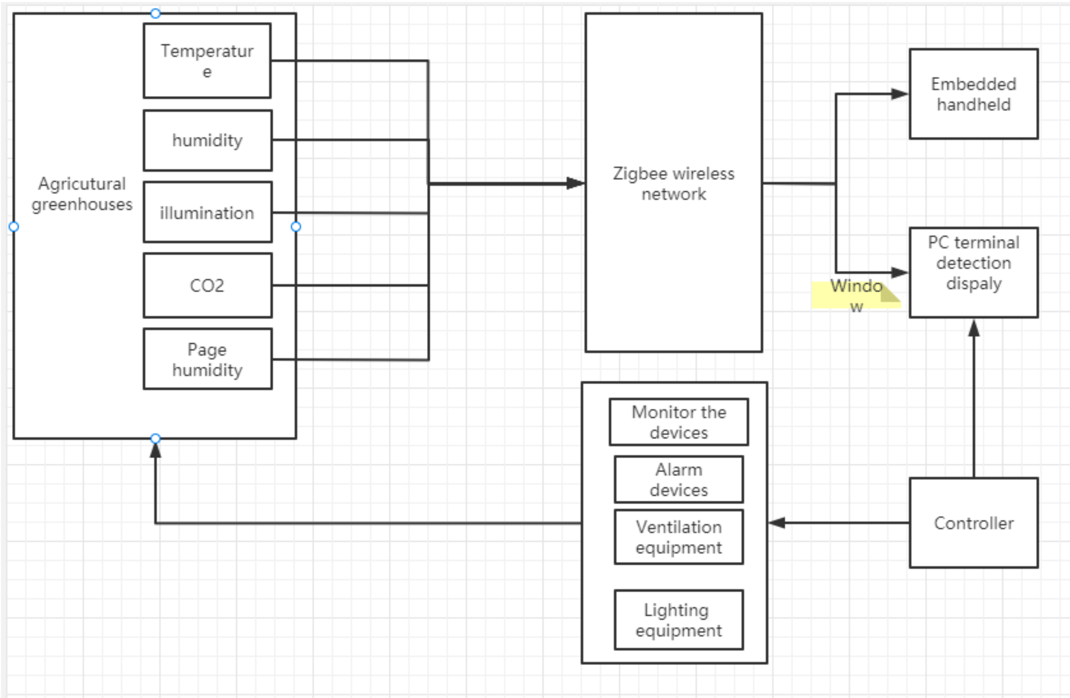

Figure 5 System device control diagram

III. Software design

Keil4 is now the mainstream programming tool for software development, and this software has many advantages, such as providing developers with a window management system to use, and also providing users with a large number of file libraries to generate hex files. The design of the system mainly uses the C language for hardware development, C is the most common and practical development design language, regardless of the convenience of use and widely used.

In order to ensure that the entire alarm system is both accurately transmitted information, and as far as possible to reduce the error, so the system will urgently need a remote can send alarm information to remind the user to improve the environmental variables in the greenhouse in time, the alarm scheme design adopts the way of sending SMS to remind the user, the SMS module adopts the SIM800C wireless communication module developed by Xinxun Wireless Technology, Sim800c is a four-band gsm /gprs module, and the obvious advantage of the module is high integration, strong interference and other advantages. Because its operating frequency band is more extensive, it can be applied more widely, such as voice, data and short message transmission. And can be adapted to a variety of products compact design requirements, and the module in the control function supports Bluetooth and serial port command control, its global and excellent performance characteristics can meet the various needs of the system design of this article. The sim800C module is shown in Figure 6

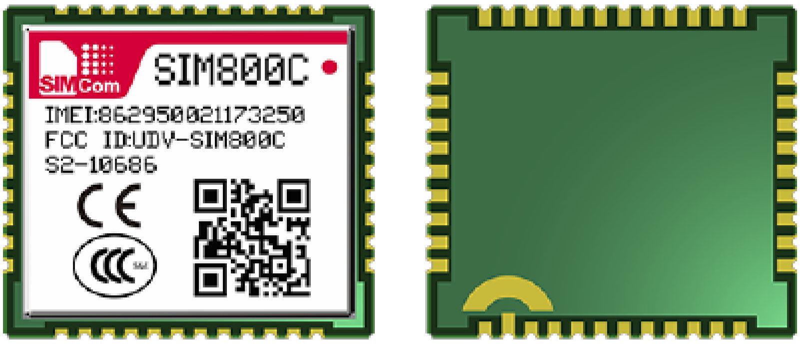

Figure 6 Sim800C module in action

The construction of the LED fill light module will be composed of two parts: the light filler group and the driving circuit. However, choosing a suitable source of fill light will produce a different chemical reaction to the experimental results. The two light-emitting devices based on this design are blue LEDs and red LEDs, two components of the same material. Two different colors of light sources their luminous intensity range is 4000mcd, but the wavelength peak has different differences, the wavelength of the blue LED is about 460nm, the wavelength of the red LED will be slightly longer than the blue, can reach 632nm for plant photosynthesis needs, blue and red light can meet all its needs. We are using a device of luminous materials, but a single LED lamp is not enough to complete the filling of the entire greenhouse, the effect is not obvious, which is attributed to the uneven distribution of the light source, cannot naturally form a natural light source effect. But we can take a special approach, which is to connect hundreds of LEDs together to form a large array. How to plan this array, we plan this array into a 16 * 16 way, and use the red light and blue light interval evenly arranged, each row of 16 red LEDs, 16 blue LEDs, a total of 16 rows, the number of red and blue is maintained in equal numbers, and the distance between the two lights is maintained between 10nm. Using this mash-up mode as above, by the obvious brightness uniformity advantage, is widely used. As shown in Figure 7, the LED constant voltage drive circuit is used.

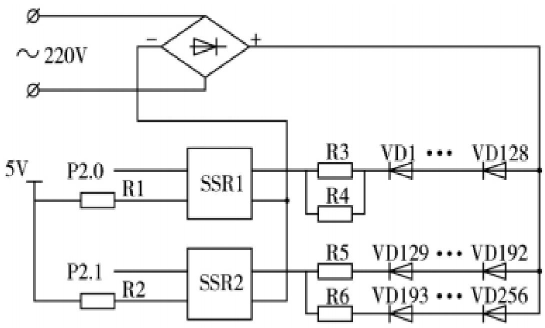

Figure 7 LED driver circuit

IV. Implementation and testing of the system

The various hardware equipment required are connected together with the simulator to start the simulation, the power module provides enough power to all other software, the LED lighting is interleaved to form a light group, the combination forms a light filling system, when the greenhouse needs to fill the light, the timely start device to fill the greenhouse. Greenhouse degree, carbon dioxide concentration, and light source intensity sensor to collect information, through the gateway to the central controller and the original set reference value for comparison analysis, if there is a big difference, through the gateway will continue to transmit the signal to the LED fill light module, for greenhouse light supplementation.
Enter the software login screen shown in Figure 8, enter the user and password as shown in the picture. Then the login success page will appear, click OK to enter the next interface

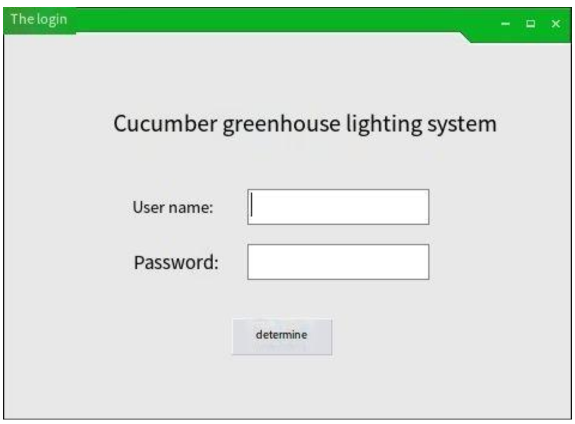

Figure 8 Login screen

After entering the main interface, the user interface as shown in Figure 9 consists of three functional modules. Open the port number, automatically display the IP address of the connected network, connect the network, and then click the data below to start detecting the button, and then the system will consciously start to collect data, and then the sensor will collect various parameters to the main control system for comparison, if the comparison value is low, then it will automatically open the light filling system, led light source open to achieve the effect of timely light filling. As shown in Figure 7 below:

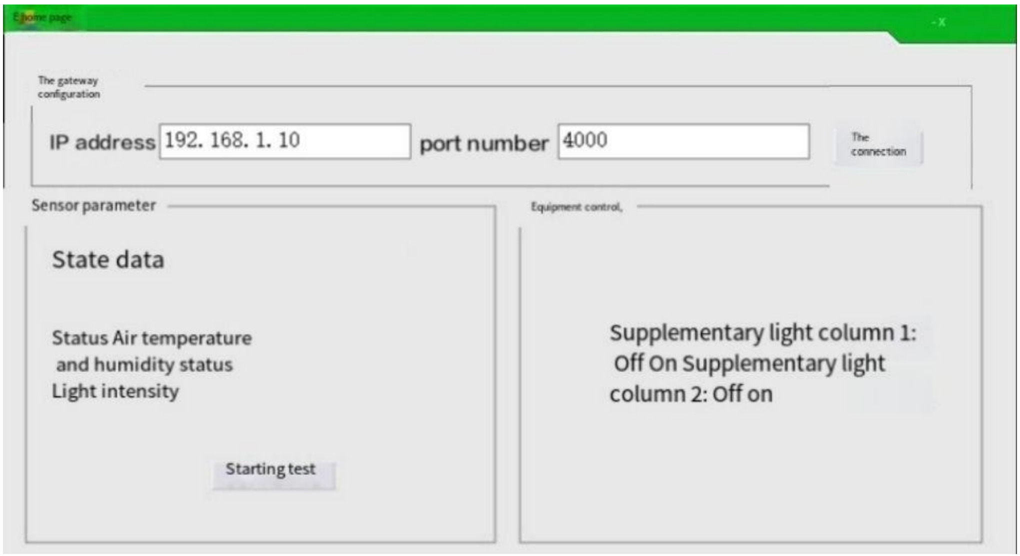

Figure 9 The main interface

The sensor parameters are displayed, temperature, humidity, light intensity parameters are displayed, the light intensity at this time is 300lux, but the fill light lamp is open, indicating that there is a large difference between the light intensity and the predicted value at this time, once the light intensity is low, the signal source is transmitted to the central processor with the ZigBee wireless sensing network, the central processor comprehensively analyzes the indicators, if it does not reach the preset value, it will control the opening of the automatic light filling system, and then the light source group opens, Give the greenhouse plenty of sunlight, to ensure its normal absorption value, and so on to reach a certain preset value, the sensor will then re-transmit the parameter value to the host computer, in a period of time in the greenhouse after sufficient sunlight, will automatically close the light system to restore it to a normal state.

V. CONCLUSION

The following thoughts are summarized for the detailed design and testing of the above systems. The system is created and put into use, the whole process is smooth and excessive, and the software can run stably, because the sensor nodes are arranged more, and the entire communication network sometimes stops. The data update has been delayed, but the alarm system is still relatively sensitive, and it can remind the user in time when encountering abnormal situations.

After repeated modification, demonstration, inspection, testing, and the formation of a complete greenhouse lighting operating system in the process of writing the whole text, through the collection and integration of data, the information processing of the central controller and the issuance of instructions to make other systems start to work, so as to achieve real-time accurate light filling according to the needs, advantageously solve the drawbacks of the greenhouse, and the entire control of the system is projected onto the user's mobile phone, the user can easily view their crops in time, eliminating manpower, material resources, and financial resources. It has realized the expectation of remote-control greenhouses and catered to the development trend of smart agriculture in the future.

Some of the design processes are slightly cumbersome, some systems and technologies can be adjusted according to different kinds of vegetables, reducing costs, but the popularity of intelligence is still lacking in China, the design of the system is to hope that the future one day can be applied to different fields, leading the trend of technology. The design scheme has obvious advantages, but at the same time there are some small deficiencies, and we should strive to learn scientific and cultural knowledge, master sufficient technical level, and apply what we have learned to the life zone.

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