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Design and implementation of intelligent anti-hail net system based on STM32

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Abstract: This research is dedicated to designing an intelligent anti-hail net system using STM32 microcontroller. The system integrates sensing technology and communication modules to monitor various environmental parameters in real time, analyzes the data through the STM32 processor, and realizes real-time intelligent control of the anti-hail network. The system design focuses on the collaboration of hardware and software, taking full advantage of the high performance and low power consumption of the STM32 microcontroller. Through actual tests, the feasibility of the system in improving hail prevention effect, real-time performance and automation was verified, providing reliable guarantee for agricultural production. This research provides a useful reference for the application and promotion of smart agricultural technology.

Keywords: Smart agriculture; STM32; Automation.

1. Introduction

As climate change continues to intensify, the threat posed by hail disasters to agricultural production has become increasingly prominent. However, although my country's agricultural disaster prevention system is increasingly improving, the popularity of hail prevention nets in the country is still relatively insufficient. Moreover, the material and structure of traditional anti-hail nets limit light transmission and ventilation [7-8], which may affect the photosynthesis and air circulation of crops, thus adversely affecting the normal growth of plants. Secondly, the construction and disassembly of hail nets is relatively cumbersome, requires a lot of manpower and time, and increases management costs. In addition, traditional anti-hail nets cannot provide real-time monitoring and intelligent control functions, so in some cases, anti-hail nets may be set up but fail to function in time, which directly or indirectly leads to economic losses for fruit farmers [1-4].

In this context, it is particularly urgent to design and implement an intelligent anti-hail net system based on STM32. The system can not only monitor meteorological changes in real time, but also reduce hail damage to farmland through intelligent control methods. Its significance is to provide a more reliable guarantee for agricultural production, reduce agricultural losses, and promote the process of agricultural modernization. This study aims to deeply explore the design and application of intelligent anti-hail net systems and contribute to the improvement of my country's agricultural disaster prevention system [5-8].

2. System hardware design

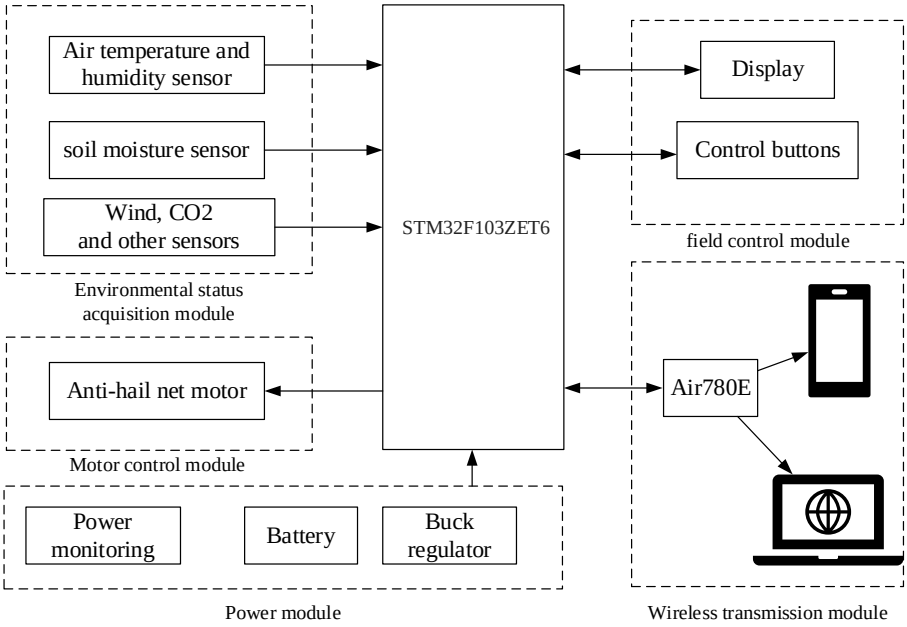

Fig. 1 System hardware architecture design

The hardware system development board uses STM32F103ZET6 as the main control chip. It is also equipped with various sensors, screen modules and communication modules required by the system, and divides

the overall hardware system into environmental status acquisition modules (including various sensors), motor control Module, power module, field control module, wireless transmission module (Air780E 4G communication module). Its architectural design is shown in Figure 1.

The functions each module is responsible for are as follows:

Environmental status acquisition module: Uses a series of sensors such as air temperature and humidity sensors, soil moisture sensors, wind sensors, and CO2 to achieve real-time monitoring of various environmental data.

Motor control module: Through the laying instructions issued by the on-site control module or communication module, the embedded STM32 main control board outputs a voltage signal to drive the motor to control the closing and laying of the net to achieve automated control.

Power module: The power circuit is a very important part of the entire system. If the power supply is unstable, the system may not work properly, or even burn out the chip and cause an accident. Efficient distribution of power to different components of the system.

Field control module: It also includes a touch-control display screen and control buttons to enable fruit farmers to make their own judgments and manually control the laying and removal of intelligent anti-hail nets on site.

Wireless communication module: adopts LTE Cat.1 bis wireless data transparent transmission module, the specific model is Hezhou A780E. Through this module, long-distance communication is realized and the collected data is transmitted to the host computer and Web client.

It allows users to view various environmental indicator data at any time, and at the same time receive weather forecast information from the public network, and comprehensively analyze whether there will be hail or other weather conditions in the near future. to determine whether it is necessary to lay anti-hail nets.

In the environmental status collection module, Due to the need to collect various data on site, this project selected a variety of sensors to collect on-site data, including temperature and humidity, atmospheric pressure, light intensity, wind speed and direction, etc. The specific sensor selection table is shown in Table 1.

Table 1. Sensor selection

Sensor model	Detection target	Detection range
SGP30	CO2 concentration	400~60000ppm
BMP180	atmospheric pressure	30-110 kPa
SHT30	temperature, humidity	10%RH~90%RH, 0℃-65℃
BH1750	light intensity	1-65535lx
ZTS-3000-FSJT-N01	wind speed	0-60m/s
ZTS-3000-FSJT-N01-360	wind direction	360°
HW390	soil moisture	10%RH~90%RH
Raindrop Sensor	Raindrop	Digital Switching Output

3. System software design

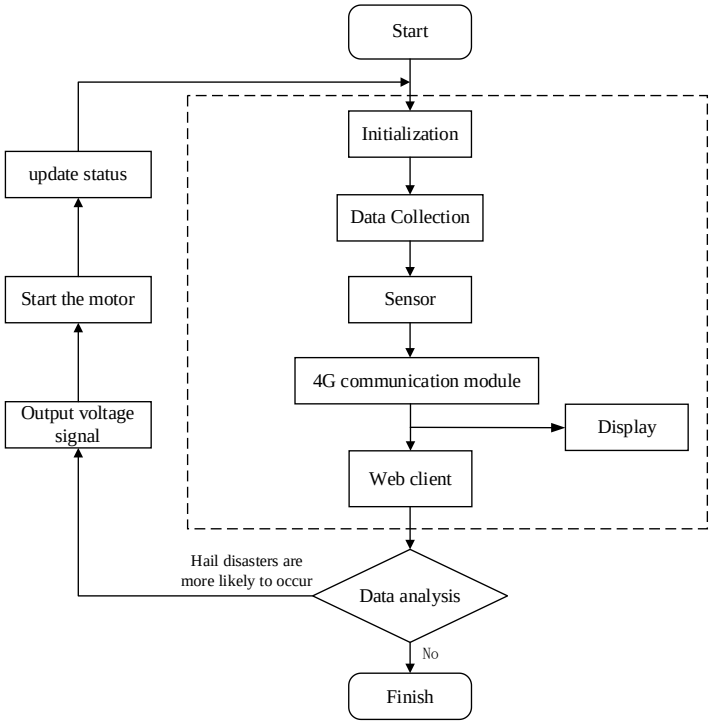

Fig. 2 System software architecture design

In order to realize real-time collection of multiple sensors and real-time updating of data on each interface, The system

first initializes, and then issues data collection instructions to collect data from the multiple sensors mentioned above through different communication interfaces, and obtain data such as temperature, humidity, atmospheric pressure, wind direction, and CO2 concentration and other data.The data is displayed on the touch screen on site and uploaded to the host computer and Web client through the 4G communication module Hezhou Air780E. Through data analysis, if there is a high probability of hail forming, the voltage signal will be output to cause the motor to lay the net. And update the hail net status. The time interval between data collection and upload is 5 seconds, that is, the collection of data from each sensor is performed every five seconds. The system software design flow chart is shown in the Fig. 2.

4. System test

After turning on the switch on the hardware side of the system, the various sensors deployed begin to monitor environmental parameters such as air temperature and humidity, soil moisture, and carbon dioxide concentration, and upload environmental monitoring data to the cloud server through the Air780E communication module.At this time, the user can view the environmental monitoring parameter information by opening the WEB terminal, as shown in the Fig. 3.

Fig. 3 Display of environmental monitoring parameters on WEB side

The system will also compare the monitoring data with the threshold set by the user. If the preset threshold is exceeded, the anti-hail net will be automatically laid and a mobile phone warning notification will be issued.

Allow users to grasp environmental dynamics and respond promptly.

5. Conclusion

This article designs and implements an intelligent anti-hail net system based on STM32.In order to solve the problems of inconvenient acquisition of on-site environmental parameters in orchards and the inability to remotely realize network deployment, this project completed the design and implementation of system embedded hardware and software.The system has functions such as multi-sensor data collection, long-distance data transmission, on-site and remote control, and automatic expansion of anti-hail nets. Improve the management efficiency and intelligence level of orchards.

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