The Design of Automatic Circulating Temperature Control System of SCM-based Greenhouse

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Keyword: SCM; Sunlight greenhouse; Intelligent Control

Abstract. With the development of society, science and technology in agriculture has gained more and more attention. The paper aims at sunlight greenhouse to design an automatic circulating temperature control system based on SCM--STC15F2K32S2. The system collects the greenhouse temperature passing to the SCM through analog temperature sensor so that the SCM is able to judge the detected temperature signal. If the detected real-time temperature goes beyond the user-set temperature range, then a control of motor on the air inlet will turn the greenhouse temperature into the set range. Besides, the system can also set the upper limits and lower limits of temperature warning in accordance with the users' demand. If the greenhouse temperature is above the ordinary line, the system will resort to GSM network to send an alert message to users. Meanwhile, the system also has two different operating modes, automatic dehumidifying and automatic shutdown and other functions according to different temperature needs from different crops.

INSTRUCTION

Sunlight greenhouse, mainly depending on solar radiation---the main heat source to maintain the room temperature without or less indoor heating, is a kind of greenhouse unique in the north of China. The greenhouse has advantages over low cost, good insulation properties, environmental protection and energy saving advantages etc and thus has been widely used in the north of China. Temperature has a direct effect on the growth and yield of crops. Therefore, it is critical to control the sunlight greenhouse temperature in the range suitable for crops growth in that too low or too high temperature may bring crop yields down. As far as the traditional greenhouse cultivation process is concerned, the temperature control in sunlight greenhouse is basically manual by means of a thermometer, humans' constant observation, opening and closing the air inlet which is not only inefficient, at the same time suffers not timely and inaccurate adjustment and so on and not suitable for large-scale and industrialization of sunlight greenhouse.Thus the incoming flourishing sunlight greenhouse is in need of a system, instead of manual operation, capable of engaging in accurate detection and real-time control on the sunlight greenhouse temperature thereby realizing large-scale and industrialization of sunlight greenhouse. For the sake of this, the paper adopts intelligent control technology, SCM and monitoring technology, GSM SMS technology etc to design a multifunctional automatic temperature control system based on SCM--STC15F2K32S2 which is conductive to temperature self-regulation, limits set for temperature and humidity, automatic monitoring, timer switch, alarm and SMS monitoring.

SYSTEM COMPONENTS

Geometric model

The system collects temperature data via analog temperature sensor with STC15F2K32S2 SCM as control core so as to carry out real-time detection on the temperature of sunlight greenhouse by virtue of digital sensors and can send alert messages to users via the GSM network when the temperature exceeds the warning line thus initially realizing intelligence and modernization of sunlight greenhouse cultivation. The system consists of three parts: First, analog temperature sensor targets at monitoring, LCD12864 display is used for displaying, STC15F2K32S2 is the core; Second, the motor mainly adjusts the temperature of sunlight greenhouse by opening and closing the air inlet; Third, it concludes communication modules with GSM network and TC35i as the core. System block diagram and physical view are shown in Figure 1.

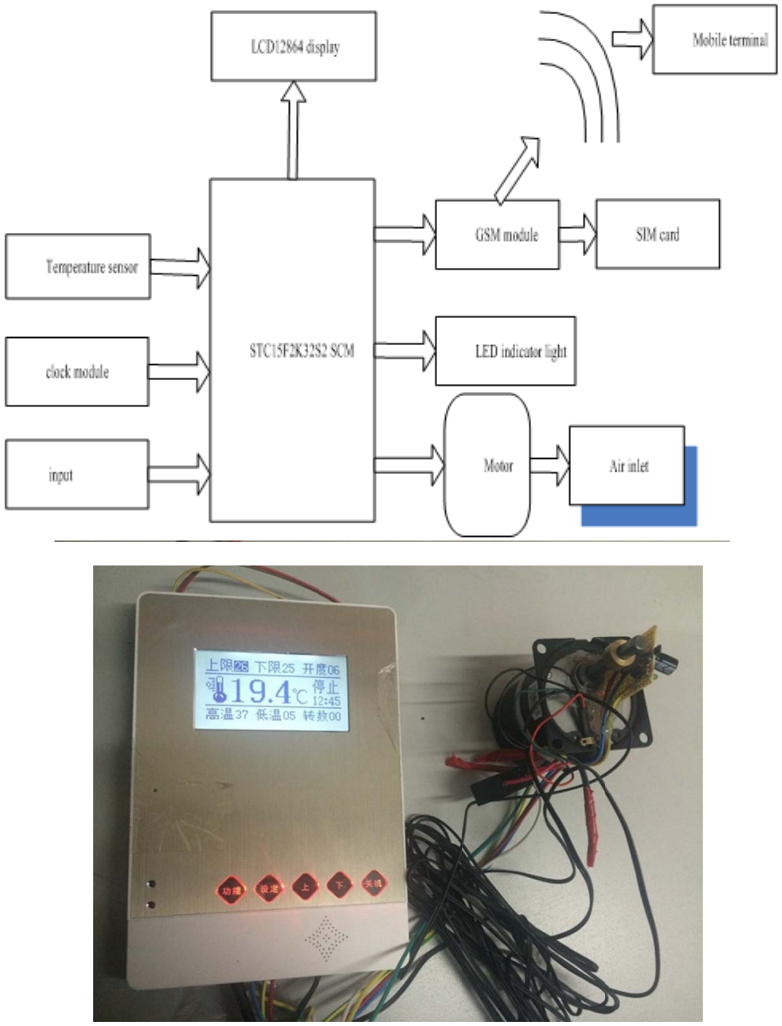

Figure 1. System block diagram (top) and physical view (below)

FEATURES

Automatic Circulating Temperature Control System of Greenhouse based on SCM makes use of simulated sunlight greenhouse temperature sensor for real-time temperature monitoring and then displays the results on the LCD12864 display, so that users can set suitable temperature in need for crop growth for a comparison with the real-time temperature. If the temperature sensor temperature goes beyond the set temperature range, the motor should be started to control the air inlet opening to regulate the greenhouse temperature motor control. What is more, users can set high and low temperature warning lines so that the system has chance to resort to GSM network to send short messages when the temperature exceeds the warning line. In addition, users can be free to choose different modes, decide timing starting or shutdown and other functions.

SYSTEM HARDWARE DESIGN

Display Module

The system module selects LCD12864 LCD display with more interface modes such as 4/8 bit parallelism, two-wire serial. Its display resolution is 128 × 64. This flexible interface can form a full Chinese MMI interface whose display can be divided into 3 interfaces. Interface 1 has something to do with temperature in real-time monitoring, temperature control range, high and low temperature warning limits, the motor running and the inlet opening; interface 2 is to set daytime and evening temperature range after the user's setting; interface 3 is linked to starting of automatic shutting and the starting time; interface 4 is to display about the humidity elimination. A click on the keyboard can switch the interface.

Interface 1 Interface 2

Interface 3 Interface 4

Figure 2. Display interface of LCD

Introduction to Key Input Module

The keyboard is an input device meant for man-machine interaction control which takes SB1 ~ SB5 as five independent input keys to respectively connect to IO of SCM whose keys have different functions. SB1 ~ SB5 are in charge of function keys, setting key, up key, down key and off keys. SB1 is used to switch the display interface; SB2 orients to achieve the temperature setting, time setting, mode selection, automatic starting or shutting, dehumidifying functions as well as the dehumidifying duration settings. SB3 and SB4 are used to control digital subtraction and addition in case of temperature and time parameters setting. In addition, a long press of SB3 for 3 seconds can force the motor to start and a long press of B4 for 3 seconds can force the motor to turn off; SB5 is used to control the system startup and shutdown.

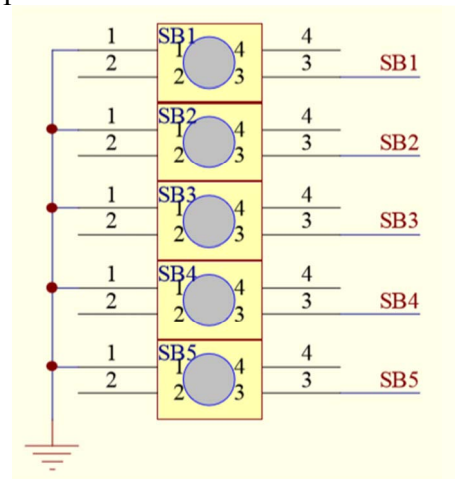

Figure 3. Circuit of system keyboard

Motor control module

The inlet opening and closing controlled by the motor in normal or reversing is conductive to temperature control. While the voltage reversing is achieved by H-bridge through T73 relay driven by 9013 transistor in the system. Motor control module works in the input voltage of 220V and uses D4148 diode with the view of preventing damage to circuit components. The motor control circuit diagram is shown in figure 4.

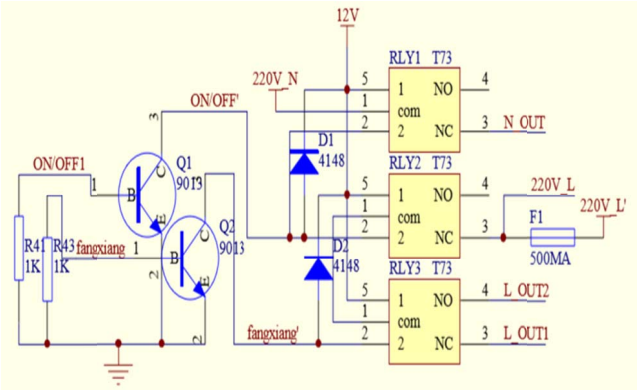

Figure 4. Circuit diagram for motor control

Communication module

The communication module of the system selects GSM communication module TC35i by Siemens, capable of sending short messages in the system plan in a fast, safe, and effective manner. TC35i module mainly includes GSM baseband processor, GSM RF modules, power supply modules, flash memory, ZIF connector, antenna interface and so on. STC15F2K32S2 SCM as the control core of the system is connected to TC35i module so as to realize the TC35i initialization and short messages. Text messaging system block diagram is shown in Figure 5.

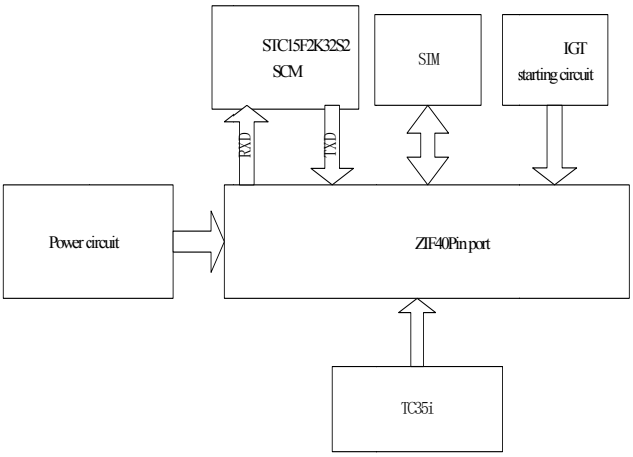

Figure 5 System block diagram of TC35i messages receiving/ sending

SOFTWARE DESIGN

The greenhouse temperature control software is designed and developed in keil through C language, including the initialized microcontroller I/O port, temperature sensor collection and uploading subroutines of temperature data, LCD display subroutines, temperature data processing and so on for the sake of mode selection of temperature data, collection, data transmission, display, keys input, automatic startup & shutdown. The flow chart of the main program is shown in Figure 6.

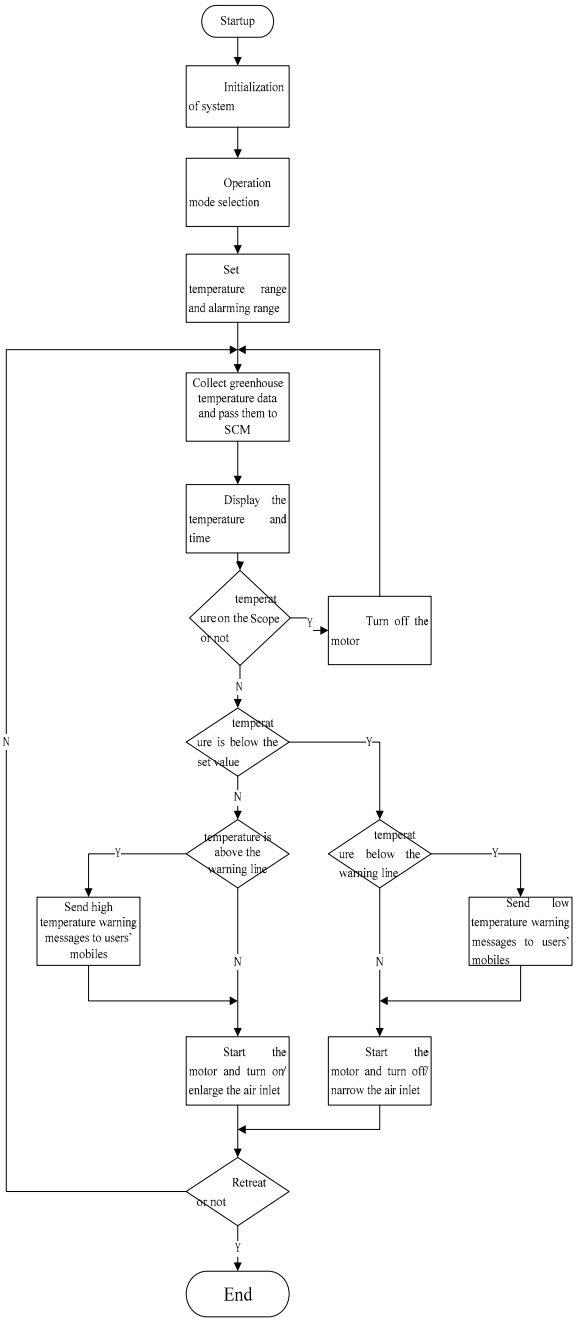

Figure 6. The flow chart of program under control of the system

Mode Selection

Different crops adapt to different temperature range, so some crops have different optimum temperature ranges during the day and night (such as watermelons, melons and so on are fond of high temperature, thus the optimum temperature falls into 25 ~ 30 ℃ in the day, 18 ~ 20 ℃ in the night) in crop cultivation in the greenhouse. Unlikely, some crops do not have too much temperature differences between day and night, thus two modes are designed. One mode is applied to little temperature changes between day and night and the user can set a temperature control range. The second model directs to crops with different temperatures in the day and night, thus day mode and night modes are designed to help users control the temperature. Users can select what mode they want in terms of their actual needs. Program flowchart is seen in Figure 7.

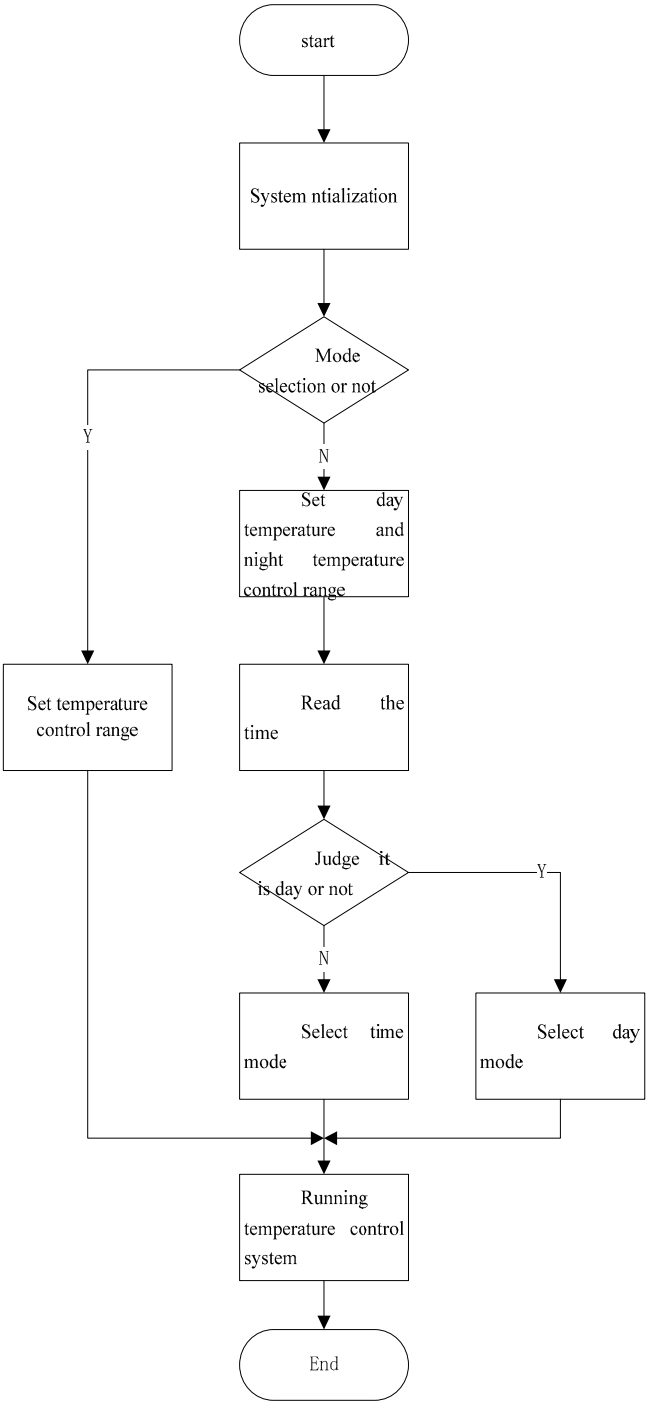

Figure 7. Program flowchart for system mode selection

Temperature Control

Temperature control mainly used to regulate greenhouse temperature is the key function of this system. Program judges the greenhouse temperature that the temperature sensor uploads: if the greenhouse temperature is above the upper limit set by the user, the program will control motor rotation to enlarge the inlet thus reducing the temperature inside the greenhouse. If it is below the set temperature down limit, narrowing or closing the inlet is favorable for increasing the greenhouse temperature.

Automatic dehumidifying and automatic shutdown

Automatic dehumidifying and automatic shutdown aim at the actual need. In case of dehumidifying in the greenhouses, the user can set the sustaining temperature for the automatic dehumidifying and inlet opening by the keys until the system returns to normal at the end of dehumidifying. If users need to close the greenhouse at fixed time, they should choose automatic shutdown function and automatic shutdown time in the advanced settings interface so that the

temperature control system goes off.

CONCLUSION

There is a new trend towards developing new agriculture by virtue of high-tech. Automatic Circulating Temperature Control System of Greenhouse based on SCM is specially designed for monitoring the greenhouse temperature with the purpose of real-time temperature monitoring and temperature setting within the range set by the user. The system design takes the needs of users into account and adds a number of useful features. For example, sending warning messages when the temperature exceeds the upper and low limits of the temperature, automatic dehumidifying and automatic shutdown and the like; It is simple, highly automatic and can be applied to actual production owe to low cost.

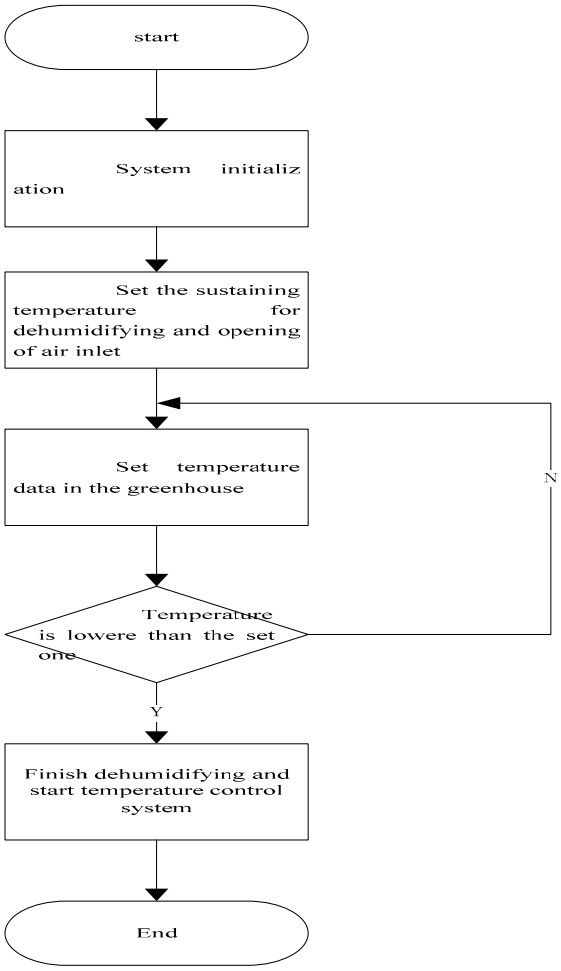

Figure 8. Flowchart of automatic dehumidifying in the system

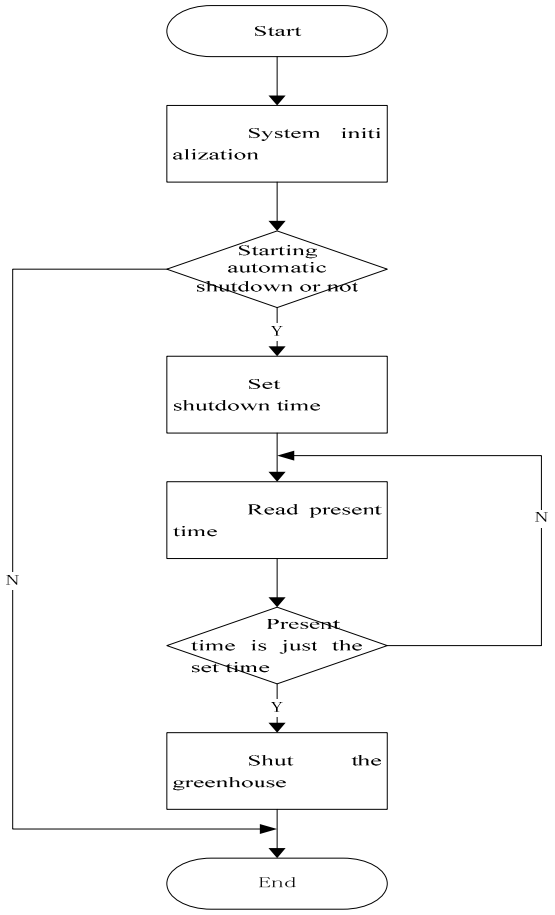

Figure 9. Flowchart of automatic shutdown in the system

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