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Intelligent Temperature Control System at Greenhouse

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Abstract
This study is designed for microcontroller-based system to monitor the data greenhouses, especially to ensure that a constant temperature inside the greenhouse to ensure the crop. The desired value in embedded database system set up in an ideal environment for data greenhouse temperature control, greenhouse crops in the process of growth under control. To address the growth of greenhouse crops in the process of temperature controlled environment is not ideal; at the same time improve the efficiency of control and cost-effective system. This project focuses on the structure of the control system, hardware, software design and system control strategy. The control system has a simple hardware structure, cost-effective, easy to use and maintenance, temperature and humidity data, and other advantages of good stability.

Keywords: Intelligent temperature control, Greenhouset, Cooling and heating

INTRODUCTION

With the people's living standards increasing, modern, a large number of agricultural production, such as vegetable using greenhouse to cultivate. The temperature and humidity monitoring are two key factors which used to control the growth of crops, due to different growth of greenhouse crops need different temperature and humidity and require stability in a certain temperature range. Relying on the artificial management of the regulation of temperature and humidity is not timely, inaccurate, and affecting crop growth and waste of human resources and so on. Therefore it requires a temperature control system, which has ability of greenhouse temperature and humidity detection with sufficient accuracy and real-time control, to replace manual operation, if possible, with a lower cost, such product has practical value [1].

The greenhouse environment is the non-linear, the distribution parameter, time-variable, the long delay, the multivariable coupling and plurality of controls object system. In the greenhouse cultivates the different crops to need the different habitat. Establishes the greenhouse environment embedded database system's goal in the greenhouse temperature and humidity control system to lie in: [2] experiences the expert with user's actual need unifies, nimble and the automatic production suits the specific cultivation object the monitoring strategy; [3] has not provided the cultivation crops which regarding the system the expert experiences, the user may through control system's use operation the way independently establishes the monitoring database, and long-term preservation; [4] the monitoring strategy data which establishes has been possible to carry on the optimization and the revision regarding the system by the user. In this paper, the intelligent design of the greenhouse temperature control system based on DS1820 and the PIC16F877A can call the historical data records and analysis, and can meet as a greenhouse temperature monitor and control requirements.

MATERIALS AND METHODS

A. System Hardware Components

This design is an automatic detection and automatic temperature control system [5], lower computer system hardware mainly contains: PIC16F877A microcontroller, temperature sensors, LCD displays, fan, lamp, LED indicators, and voltage regulator. Block diagram is shown in Fig. 1. The microcontroller used in this system is PIC16F877A, which acts as a processor to process the data read by the IDE sensor and displays the result on LCD display. PIC16F877A has many function modules, hence selecting it as a microcontroller can make the circuit design more concise, increase the reliability of the circuit, and reduce the power consumption of the whole system [6, 7].

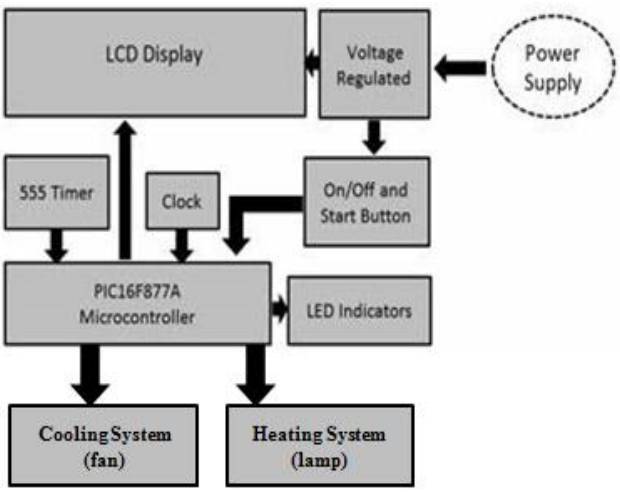

Figure 1: Block diagram for sensing system

B. The Working Principle of Temperature sensor

The working principle of temperature sensor DS1820: As shown in Figure 2, DS1820 pin I/O-bit data input/output (single wire bus) is an open-drain output. If connected to an external pull-up resistor, this is often the case is high. VDD 5V power supply terminals can be used for an optional external power supply, often require ground when not in use. GND is the ground pin and NC is empty feet.

Figure 2: The pin map of the DS1820

C. The Schematic Diagram of the System

Greenhouse temperature control system is based on intelligent 32-bit embedded ARM7 processors, combined with jingdian pengyuan PIC controller liquid crystal display module as a graphics display, through DS1820 one-bus digital temperature sensor to achieve an intelligent control system of greenhouse temperature. Figure 3, is a schematic diagram of the who system structure.

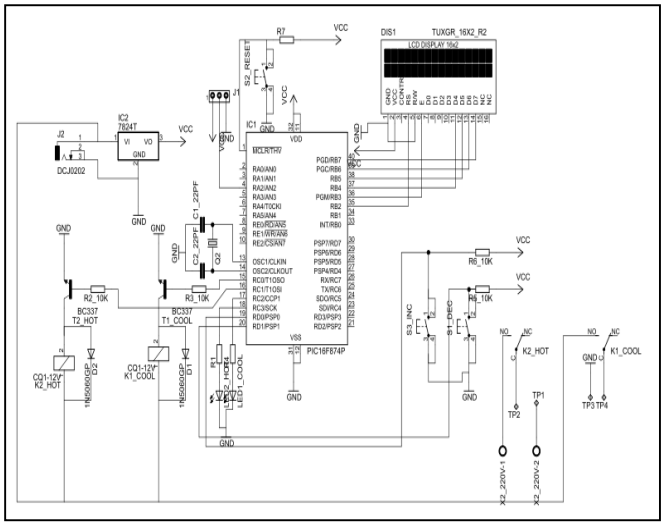

Figure 3: The schematic diagram of the whole system

The system is working as shown in the flowchart Figure 4. The temperature sensor DS1820 was measured the around temperature, then send this to the microcontroller in order to process and compare with the desired value temperature. Then the microcontroller captured and read the value input and did the analyses based on the wanted value. The results of temperature are then displayed on the LCD display. Thus, the cooling system (fan) or heating system (lamp) will work.

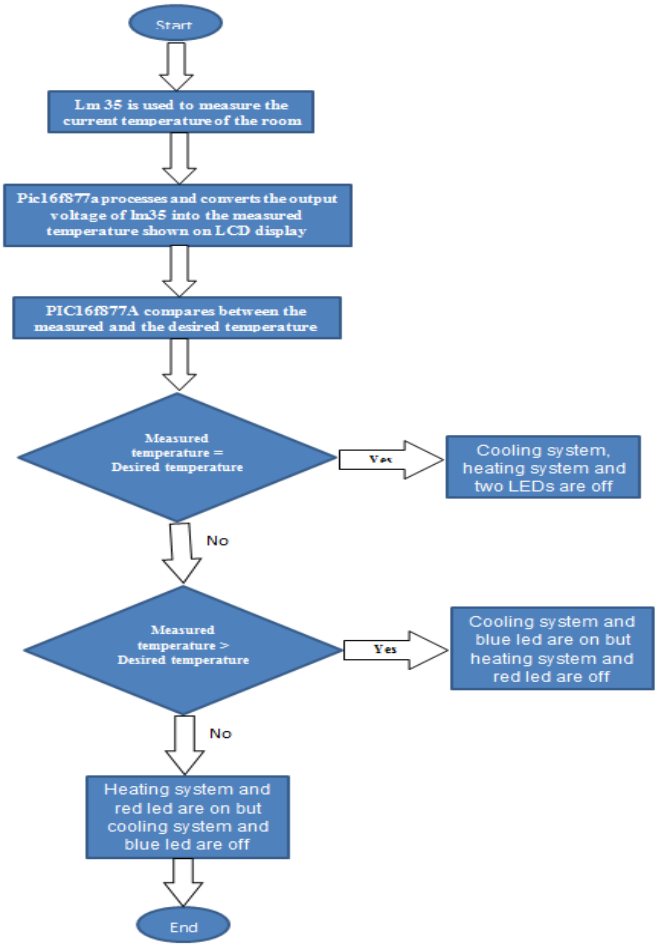

Figure 4: Flowchart of the system operation

RESULTS AND DISCUSSION

A. Heater Control Circuit

In order to simplify the hardware structure of the output channels, taking into account the heating system itself has a large thermal inertia of the system using a solid state relay, no contact, no phase modulation, if we confine our single-chip output control on the grid does not cause waveform distortion; opt coupler triac on–off signal control, thyristor instant AC phase is random; this will cause a lot of high-frequency component of the pollution in the power circuit power and generate electromagnetic interference that may affect other devices. May also interfere with the control circuit, affecting the normal operation of the system. The system uses the inherent zero solid state relay trigger circuit, not only retains the advantages of solid state relays, but also makes the issue is satisfactorily resolved.

Table 1: Role of Fuzzy control

EC	B	M	S
P	B	M	S
O	B	B	M
N	M	B	S

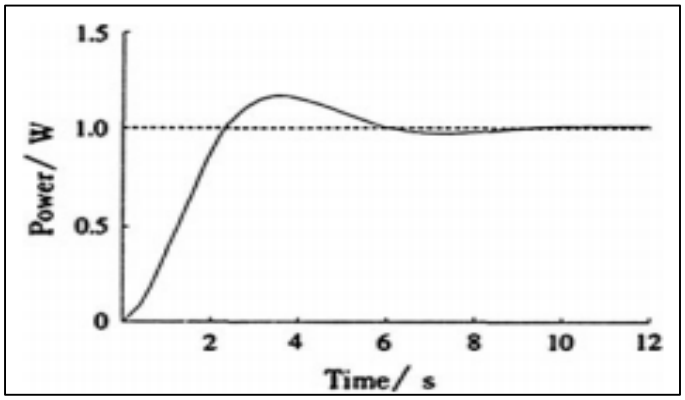

Figure 5: Curve of imitation system

B. Control Algorithm

To improve the regulation time, overshoot and static error, the temperature control process is divided into two sections; the actual greenhouse temperature away from the set temperature using fuzzy control, in order to shorten the adjustment time close to the set temperature, the PID control to reduce overshoot and static error [8]. Fuzzy Control Fuzzy controller input signal for the temperature error E and error change rate EC, the output control is U. The input E and the language of the EC and the output U of variable values and symbols as follows: the error E: B (large), M (middle), S (small); error variation EC: P (positive), O (zero) N (negative); control variable U: B (large), M (), S (small).

System cooling equipment: It is not temperature overshoot. Exceeds the set temperature, turn off the heater. So, there is no need to consider higher than the set temperature of the error, E, according to size file can be. Determine the boundaries of the sub-file and the control state table for debugging based on the actual effect. PID Control When E B 20 C, transferred to the PID control stage, the same method as the basic requirements, but the parameters need to re-tuning. The parameter tuning emphasis on decreasing the overshoot and static error. PID control stage, the temperature settings mutation or environmental change, E[20 C, then transferred to the fuzzy control stage.

System Debugging The main task is to calibrate the temperature value and be prepared for the tuning parameters. System assembly is completed, the digital display vegetable greenhouse air temperature data, with the thermometer measured data, and there is no fixed error. Adjust the temperature in the conversion process parameters, fixed error basically eliminated, but there is a nonlinearity error. Based on the measured data to determine the nonlinear calibration data, in this way, the measurement error range of 10–95 C B 0.5 C. Through trial and error to determine the control parameters of the fuzzy controller sub-file boundaries as follows: error: B (large), [5 C; M (), 2–5 C; S (small), \2 C. The error variation: P (positive),[0.2 C; O (zero), -0.2–0.2 C; N (negative),\-0.2 C. The amount of B (large), 250; M (), 180; S (small), 100 (control = 250 full power heating, electric stove power and proportional to the amount of control) was controlled. Fuzzy control rules are shown in Table 1. MATLAB for system simulation, the simulation curve shown in Figure 5, can be seen that the system has better control and tracking performance, high precision temperature control. The system also can be and the host computer, two computer-controlled system, to facilitate centralized management of production [9].

C. The Hardware Development

The hardware development of this project has been built successfully as illustrated in the figures 6. This project includes temperature sensor to measure the temperature from the around and microcontroller in order to process and compare between the measured and the desired temperature value. Also contains 3 LEDs with red color, yellow colors, and green colors to indicate the circuit operation and cooling and heating system.

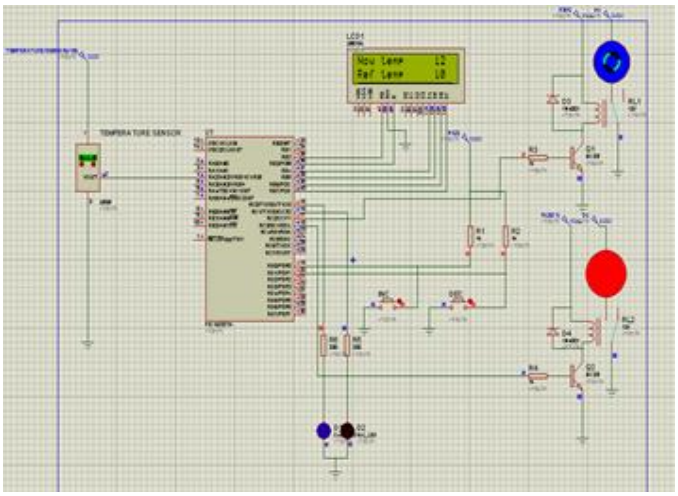

Figure 6: The completed circuit as shown in the simulation

CONCLUSION

In this paper, through embedded control system for greenhouse-related technology research, a practicality and high levels of greenhouse technology embedded intelligent control system, including systems architecture, systems software and hardware design. This article focuses on practical research. The aim is to design a highly practical and technical level of greenhouse intelligent embedded control systems. The use of manual analogue system of control and improve the reliability of control. The adoption of the output corresponding to a set of equipment for the handling of state control, and simplifies the operation and control procedures, so that control is easy to implement, so that a reliable system operation, equipment control systems to avoid a state of conflict. At the same time, this control system can also be used for other automatic control temperature with better prospects.

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