A Remote Measurement and Control System for Greenhouse Based on GSM-SMS

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Abstract: A remote measurement and control system of large-scale greenhouse was developed based on GSM-SMS. The whole system consists of a central station and base stations. The central station is composed by a PC server along with its application software, the GSM module, and the database system. The base station consists of a microcontroller, sensors, the operation administer, and GSM module. Modularization is adopted in the design of the system hardware; and the software exploitation is realized by embedded operating system, all of which make the system easy to be extended, maintained and transplanted. The remote monitoring system can also realize remote real-time data analyzing and processing.

Keywords: greenhouse, GSM, remote measurement and control system.

1   Introduction

As a new planting mode, modern greenhouse installations are marked by their high efficiency and uniformity in production of vegetable, fruitage, flower, medicinal materials, etc. The new mode breaks the restriction of region, environment, climate and other factors, and has become an incomparable planting mode. It can efficiently improve the agriculture ecology and production condition while promoting the scientific exploitation and reasonable use of agriculture resource. Moreover, output rate of earth as well as working efficiency is enhanced, and good social and economic benefits are received. Survey and control of greenhouse environment parameter is the key part in the realization and development of greenhouse installations. The first Survey and Control System for Greenhouse, named CECS was first developed in Netherlands in 1974[1]. In 1978, a comprehensive control system for Greenhouse environment parameter was worked out in Tokyo University. In recent years, many control technique for water, fertilizer and the greenhouse microclimate were developed[2-5]. Now Japan, Netherlands and America can manipulate multiple environment parameters of greenhouse according to feature of different crops. In this paper a remote greenhouse measure and control system based on GSM-SMS is presented which conquers the problems of excessive investigation in wire transmission net of large greenhouse group and inconvenience of maintenance.

2   GA-BP Algorithm

The system functions relying on mobile communication between computer and microcontroller based on GSM technique. The system comprises a centre station and some base stations. The central station consists of a server, a GSM module and a database system, and the base station consists of a microcontroller, sensors, actuators and a GSM module. Fig. 1 shown the architecture of the system.

In practical operation, the central station receives and sends messages through GSM module. Criterion value of parameters to be measured in every base station is set by central station, and then in base stations parameters including the air temperature, the air humidity, the intensity of illumination and the CO_2 density are sampled and sent to central station to be registered according to which the criterion value of

these parameters is modified and retransmitted to base stations. Base station receives and sends messages through GSM module; it samples environment parameters and compares them with criterion parameters sent by central station, and yields relevant control signals according to the comparing result and sent these signals together with the sampled parameters to actuators. Acquired temperature, humidity and CO_2 density are obtained by ventilation, sunlight shelter, water spray, automatic water sprinkling and CO_2 supplementing equipment.
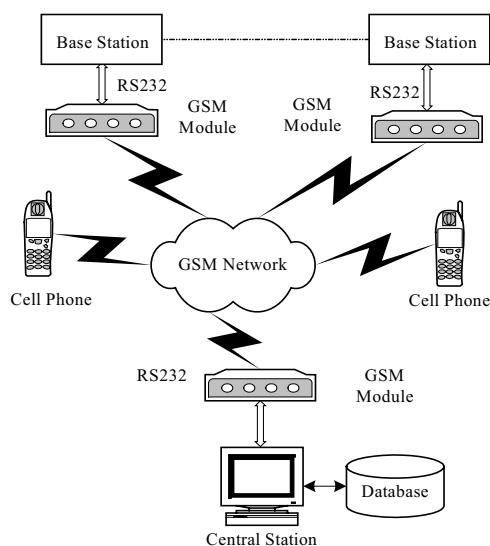

Fig.1 The System Architecture

3 Hardware

3.1 Central Station

Central station comprises of GSM module and a server. GSM module adopts modem TC35 of SIEMENS which can work at frequencies of EGSM900 and GSMl800. TC35 can transmit sound, data, message and fax, it has a RS-232 interface, its work voltage can reach $8V\sim30V$ except for data transmission period when the work voltage is $5.6V\sim30V$, and it supports GSMphase2 / 2+ and AT instructions, moreover, it has standard industrial interface and the whole SIM reader card.

3.2 Base Station

Base station is developed by using a microcontroller, GSM module, sensors and actuators.

The microcontroller adopts MSP430F149 series of TI, which has features of ultra low work voltage, ultra small scale power consumption , 16-bit RISC, compact instruction core composed of 27 pieces of instructions, table-checking process style of high efficiency, A/D translator of high precise, watchdog, Timer A/B, synchronous and asynchronous serial communication interface USART, permitting 7-bit or 8-bit stream to move in or out of MSP430F149 at speed preprogrammed or set by external clock; and it implements serial communication with TC35 by setting baud rate.

Measurement of temperature adopts LM-35D module, which is a temperature sensor with output in direct proportion to centigrade temperature. LM-35D has features of low output impedance, with no peripheral elements, no need to be adjusted. CHM-01 module is also adopted in measurement of temperature, which outputs PH of $0\sim99\%$. In measurement of illumination, illumination sensor composed by sensor with silicon solar battery and light filter converts illumination signal ranging from 0 to 150000LX into voltage signal which later on is amplified into range of $0\sim5$ V. Density of CO_2 is tested by infrared gas sensor. This kind of sensor has high precise, good selectivity and broad range of detection, it can convert density of CO_2 ranging from 0 to 1000ppm into voltage of $0\sim5V$. Outputs of every sensor is transferred to amplification circuit and then into built-in A/D of high precise. MSP430F149 series have 12-bit ADC which can acquire precise up to$1V/212=0.2mV$.

Parameters of temporary, humidity, illumination and density of CO_2 is controlled by opening and closing the clearstory, unfolding and folding the shade, turning on and off the sprinkler, the circulative ventilator and the CO2 generator. CO_2 generator is controlled by electromagnetically operated valve and when opened, vitriol and ammonium bicarbonate stored in it begin to react and generate CO_2. Fig. 2 shown the hardware architecture
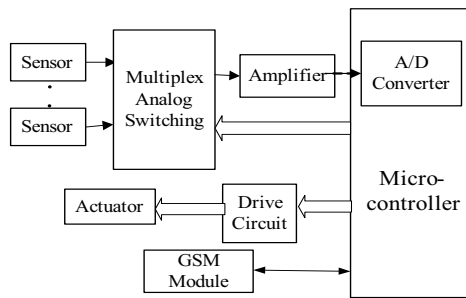
of base station.

Fig.2　The Architecture of Base Station

4 The Software

TC35, the system GSM module, controls mobile communication by AT instructions. Date is transferred in message. The system software contains the central survey and control program and base station program. Central program is expressed in Visual Basic 6.0. MSComm provided by Visual 6.0 is a general mode to realize serial communication; its software consists of central controller interface, initializtion applets, message receiving and sending program as well as data processing and saving program which is the main task of central survey and control program. C430 integrate exploiting environment which formerly is built for MPS430 serial microcontroller by IAR is adopted as the exploiting platform of base station receiving and emitting program.

4.1 Central survey and Control Program

Message receiving and emitting program is implemented by AT instructions. When the central station sends a message, firstly the message central number, the number of the receiver and the content of the message are encoded into PDF format, then the length of the message is figured out and AT+CMGS=<lenght><CR> is sent. Here <CR> represents carriage return or ASCII code 0X0D. Wait until ASCII character"〉"is returned then data of PDF format can be input which ends up with ASCII character"〉". After the message is sent, TC35 module returns <CRLF>OK<CRLF>. Messages are received in timer-realized periodic queries of serial data interface. When a message arrives, the server receives

<CRLF>+CMTI："SM"，INDEX(message saving address)<CRLF>, and then AT instruction AT+CMGR=INDEX<CRLF> is executed by TC35 module to get the received data of PDU format, after this pc server decodes the received message to get the number of the message sender (corresponds to the serial number of the base station), the sending time and the content of the message (data surveyed by sensors in base stations). All of these are showed and saved in the database.

4.2 Base Station Program

Base station surveys and controls the greenhouse environment parameters in real time and encodes the data sampled into messages periodically which is sent to central survey and control station by TC35 module. Meanwhile the criterion value of environment parameters is modified according to instructions from central station. microcontroller receives and sends messages basically the same way as pc server. What's different is that messages of PDF format must be converted into ASCII characters before being sent to GSM module TC35. microcontroller controls TC35 by serial communication of RS232 to receive and send messages. MSP430F149 provides USART which can realize serial communication.

Base station software mainly consists of initializtion applets, parameter survey and control program as well as message receiving and sending program. Initializtion applets finish the initialization of the essential parameters, the timer and the serial communication interface. Parameter survey and control program mainly finishes sampling of parameters and controlling of actuators. Messages are received in queries. When a message arrives, receiving program of serial communication interface is called to decode the message. In the procedure of message sending, which is performed periodically, first parameters registered in ADC12MEM are encoded into messages, after that message sending instruction is called and then the messages are sent to central survey and control station.

5 Conclusion

A greenhouse environment measurement and control system based on GSM-SMS was developed in this paper. The system adopted mobile communication between computer and microcontroller; it comprises a centre station and some base stations. The central station consists of a server together with its application software, a GSM module and a database system; the base station consists of a microcontroller, sensors, actuators and a GSM module. Modularization design procedures were taken in hardware and embedded operating system in software development, which make it easy to extend, maintain and update the system.

Reference

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