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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSI*net*

Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

System of Remote Irrigation Based on GPRS

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Abstract: Because the GPRS (General Packet Radio Service) applied in remote monitoring system has the characteristics of utility, real-time, efficient and its wireless network is wide covering, it especially suit the application of polydisperse point and cross-boundary. Users can run it by low-cost and little maintenance cost which makes it has practical application significance. In order to improve efficiency of farm irrigation, this study introduces the design and implementation of monitoring system of remote farm field irrigation based on GPRS in detail. This system consists of several measurement and control terminals with wireless sensor. Every measurement and control terminal manages an area. It uses GPRS module's wireless communications and Internet's access function to transmit locale temperature and humidity data. Center computer deals with these data and sends irrigation control command to every area. It also can store and show the data and diagrams in the computer by exclusive managing software in order to find out the state of locales measurement and control terminals. In addition, it can have special operation by manpower, direct the management of irrigation and make a prefigure irrigation according to weather.

Key words: Wireless communication, wireless sensor, module, center computer, singlechip

INTRODUCTION

China is a leading agricultural nation, it has a vast region. The flood control and drought-relief plays positive role in the local agricultural production. With the development of economy, the primary management can not adapt to production. There are several problems hardly solved: Because information processing is not in time, lead to the water resource waste and drainage of stagnant water is not in time. Thus, we establish roboticized irrigation control system to improve availability of irrigation water. This is very important to relieve the lack of water resource.

Wireless sensors network is a new information technology, it consists of a group of random distribution integrating that are sensor, data processing cell, wireless communication module and energy supply modules minisize sensor node according to necessary. It integrates information processing technology, microelectronics technology, computer technology and wireless network technology (Du, 2010). This attracts great attention of many countries ministry of agriculture, military department, industrial circles and academe (Du and Chen, 2008). Wireless sensors network technology based on GPRS utilizes China Mobile Communication Corps GPRS network. Its coverage area is almost 100% in central city and above 80% in jumping-off (Hu, 2008). GPRS has the characteristics of fast and low-cost and its network

constructing is flexible and extends easily. Beside these, it also has advantages that its maintenance is simple and its cost performance is high (Liu, 2009).

Wireless sensors network which applied in farming irrigation, utilize wireless communications to have unified management by center computer. Thus users can have parameter setting and statistics of irrigations situation. They also can find out the state of measurement and control terminals in worksite, then store and show the data and graph in computer. Sensor nodes can adopt low power consumption MCU to extend nodes maintenance time (Wang *et al.*, 2005).

System uses AT89S51 singlechip computer as the host controller of sensors node. It connects data of the temperature and humidity circulating collected by digital sensors through singlechips serials and GPRS module GTM900C. By the use of AT command, we can set up UDP data server in module and utilize GPRS modules wireless communications and Internet accessing function to transmit data. After these, center computer deals with data collected in each node and then send irrigation control command to every node (Liu *et al.*, 2004).

SYSTEM ARCHITECTURE

Sensors network consist of two important parts that are center computer and sensors' node. Center computer has the function of managing and controlling the whole

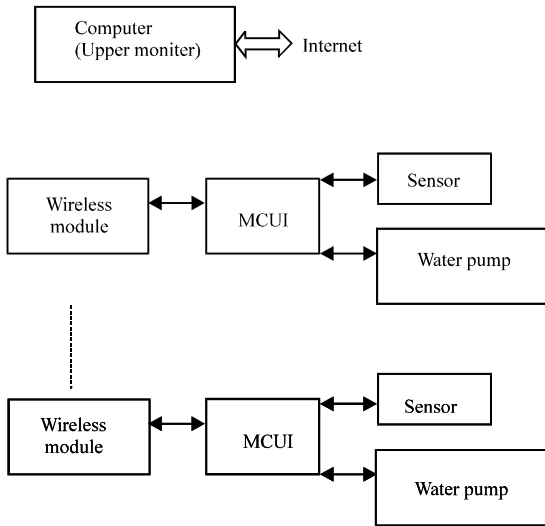


Fig. 1: System structure

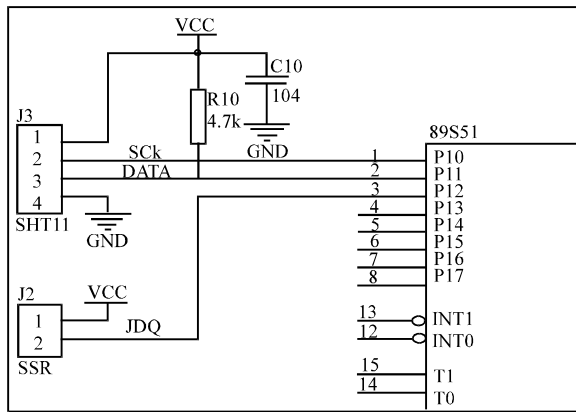


Fig. 2: Data collection interface circuit diagram

network. The sensors node distributes in each monitor worksite commonly. System utilizes sensors function, sends the sites true information, such as temperature and humidity to center computer by the use of GPRS wireless communication in digital way (Cui *et al.*, 2004). Figure 1 shows the system structure of this system.

Hardware design of system: System hardware uses AT89S51 singlechip and GTM900C wireless communication module as core. The collection of data employs new-type temperature and humidity sensor SHT11 that based on CMOSens™ technology brought out by Helvetic Sensirion company (Hu and Li, 2010).

Collection circuitry of sensor's data: As it is shown in Fig. 2 which is sensors interface circuitry, powers input needs filtering. Power supply is about 2.7-5.4 V and the impedance of R_{10} is 4.7 K-10 K. It supplies pull-up resistor,

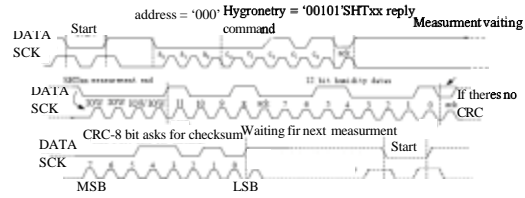


Fig. 3: Measure timing diagram

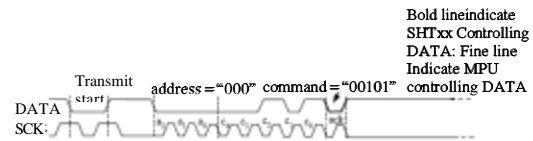


Fig. 4: Command timing diagram

pull down the level of data line in order to transfer data. Because sensor is based on I2 C bus, SCK is clock pulse signal and DATA is data transmission port, these two lead pins follow I2 C bus protocol and their sequence chart is showed in Fig. 3. P1.0 of singlechip connects clock signal SCK of STH11. P1.1 connects clock signal DATA of STH11. Then singlechip simulates I2 C bus protocol to read temperature data and humidity data from STH11. The command timing diagram is showed in Fig. 4 which shows when the SHT××× controls DATA line and when the MPU controls DATA line.

Singlechip must first sent command sequence before SHT11 measuring, it means writing 8 data bits into SHT11 and reading SHT11's affirance bit which is 0 when it received correctly and 1 when it failed to receive in ninth SCK cycle. According to SHT11 two wire mode of operation, singlechip should first output low level in P1.0 to trigger SHT11 and then output a command data in every DATA, finally give SCK high level to trigger SHT11 to latch data. The output SCK cycle must meet the requirements of SHT11 data setting up and maintaining least time (110 nsec). After sending commands, it should read returned bit in each SHT11 data link in succession and use it as the basis for whether or not to send over again.

Reading data: After measuring of SHT11, singlechip reads the result of measuring according to reading and writing data rule by the following mode: First clock line is set low level to ensure latch in SHT11 outputting data and time delay for a while (longer than data stationary output time 250 nsec) to wait data transmission is stable. Then it reads data again, repeat doing steps above until receiving the last data and the response bit given by ninth clock.

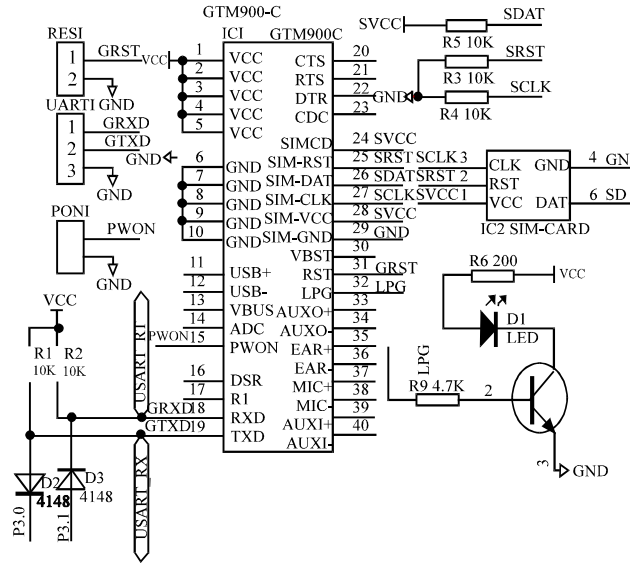


Fig. 5: GTM900C module circuit diagram

Control of pump system: The irrigation pump system uses three-phase AC power supply. And it adopts three-phase solid state relay (SSR) SSR-3-S380V-25A to be controller. As showed in the Fig. 2, P1.2 of singlechip is connected to the SSR. When system receives irrigation command, control signal will be low and open SSR to power the pump to irrigate farmland. When system receives stop irrigation command, control signal becomes high and system stop irrigation.

GTM900C wireless communication module: The wireless transceiving of system uses HUAWEI Corporations GPRS module GTM900-C to complete. We do not need to consider the design of GPRS module because that nowadays many corporations can produce extremely steady GPRS integrated package (Guo, 2004) and we can directly use existing ripe production.

Communication protocol between GPRS module and computer is some AT instruction sets. AT instruction set is some character strings which start with AT and end with character. Whether AT instructions response data packet successfully executed or not in every instruction all have corresponding return. For other unexpected information such as someone calling or circuitry does not have signals and so on, module will prompt some corresponding information and receiver can deal with it correspondingly. The principle of GTM900C module circuit diagram is shown in Fig. 5. As showed in Fig. 5, GTM900C module adopts 4.5V power supply SIM-CARD is SIM card socket. RSE1 is reset switch. UART1 is TTL level. UART communicates with singlechip with AT command. PON1 is a control signal of power on/power failure. LED D1 is indication of GPRS network.

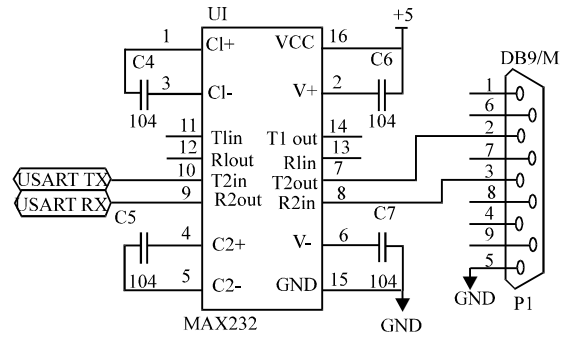


Fig. 6: Serial port communication module circuit

Interface of upper computer and singlechip: Sensor node realizes data exchange between itself and GPRS module under the control of master control singlechip (Cui *et al.*, 2004). Systems serial communication program will be realized by MAX 232 chip. This chip provides conversion between TTL level and RS 232 level. It boosts capacitor to generate positive/negative voltage that RS 232 needs. Figure 6 shows serial port communication module circuit made up of MAX 232 and DB/9M.

SOFTWARE DESIGN OF SYSTEM

Systems software design can be divided into the following sections. Collect sensor nodes temperature data and humidity data (Sunaryo and Yoshimasa, 2001). Drive wireless transmission. PC upper computers communication and interface display. The protocol stack built in GTM 900 C module brings great convenience to users development.

Programmer for the sensor node module: Sensor node modules functions mainly are inquiring notes; drawing availability IP address and port in notes; connecting GPRS network by using TCP protocol; connecting server and port; inquiring whether receive data packet or not and drawing control information of upper monitor; checking lower computers data information and sending them through GPRS network after packing.

During programmer, it may lose data or disorder data and some unexpected responding data of module when using serial receiving data. For example, there is no ERROR in data of feedback after module connected network, characters or some instructions does not have character of checking data frames such as OK. If we do not make some special processing, it will lead the following data incorrect or singlechip under some unexpected state

such as infinite checking loops. So we adopt reading serial port data and timer to protect data. It means startup timer after serial port receiving data, if singlechip do not receive data in a long time and the timer was time out and then timer interception made received data to be data frame to let singlechip will not wait for whole data frame in infinite loops (Moneneclae, 1998). Software designs main program flow chart is shown in Fig. 7.

Software design of upper computer: Nowadays, there are tow familiar methods in the software engineering of monitor system. One kind of it utilizes object-oriented program language such as VB and VC to develop. Another kind of it utilizes configuration software to complete (Yu and Feng, 2010). The hardware driving function supplied by configuration software can directly accessing hardware to communicate and utilizes its

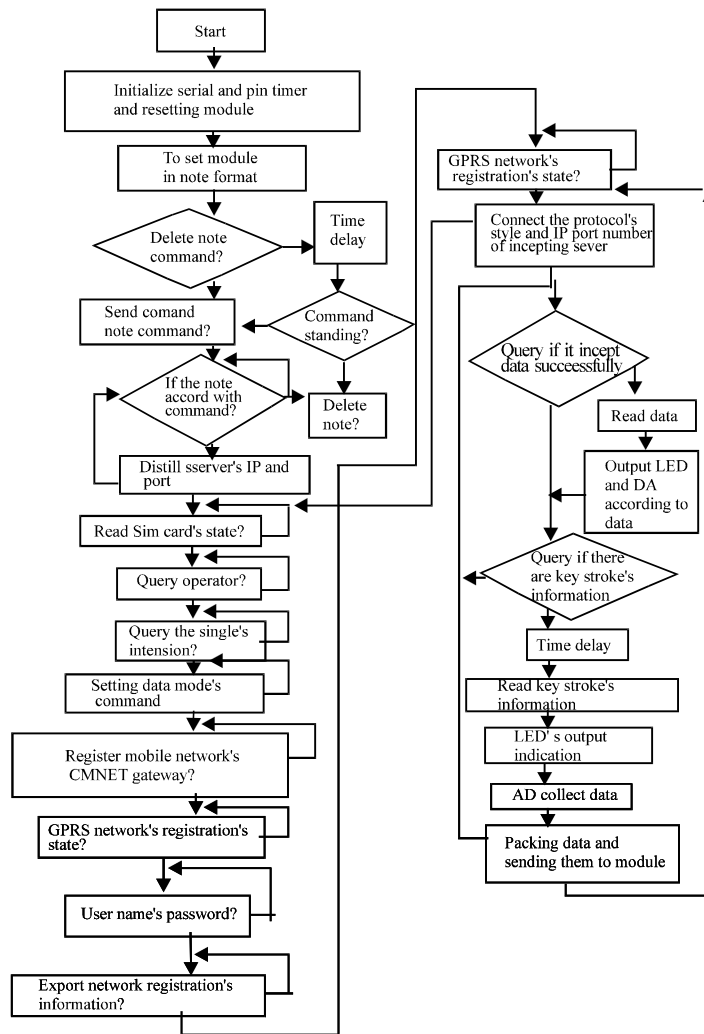


Fig. 7: Main program flow chart

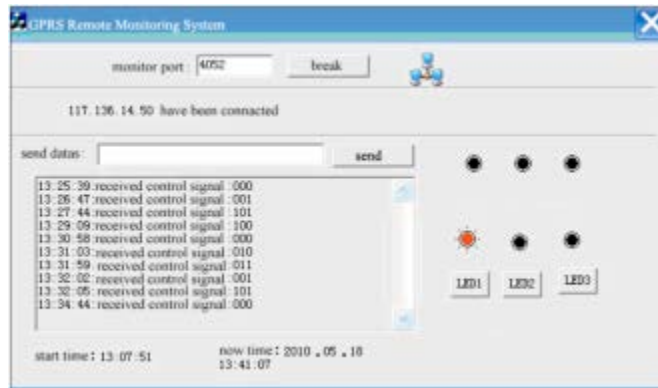


Fig. 8: Monitoring system state display

imaging tools to realize monitoring interface. The former ones design of software is a heavy task. The latter one has heavy dependence on hardware. When configuration software did not support correlative hardware the latter method will be restricted (Li, 2010). So it is a good choice to combine these two methods. Using VB and VC provide powerful data communication and processing function to realize data collection, control and processing. Using imaging tools of configuration software to realize interface design. We can realize data switching between data acquisition programme and monitoring software by dde connecting. Using plentiful figures and configuration tools supplied by KING VIEW, we can realize display of irrigation process flow diagrams instant data refurbish, all kinds of curve and alarm or other things. This method can give full play to the advantage of VB and KING VIEW. It uses capacity of VB that data communications and processing and graphic tool of KING VIEW to make monitoring system softwares development more simple and flexible.

DEBUGGING AND EXTENDING OF CIRCUIT

We should first install GTM900C wireless communication module, antenna and SIM card. SIM cards GPRS operation should be available and startup GTM900 C when power on. After GTM900 C is started up in right way, system can send AT command to control GTM900C modules working (Liu, 2010).

Operation steps in detail are as follows:

- Finding out your Intranets IP address by using CMD+ipconfig/all, such as 192.168.1.50
- Entering router, then appending a port in forwarding rules. The address is your IP address 192.168.1.50, its port is 4052 and validates it

- Finding out your external networks address in www.ip38.com. For example your IP address is 117.136.14.50
- Connecting module and singlechip and getting module to work ordinarily first. Turning on MFC in computer and starting up server. Then sending note 219.131.12.116 and 4052 to SIM card in module and then waiting

Then starting up upper computer software of MFC in PC computer and showing the IP address and port number connected to external networks is 117.136.14.50 and 4052. Data center is in the state of monitoring as shown in Fig. 8.

CONCLUSION

This system is designed based on China Mobiles GPRS network, it avoids the troubles and high cost of reconstructing network. The monitoring system of human-computer interaction adopts KING VIEW which is widely used and easy to be mastered. These make system more economical and practical. This study analyzes sensor data collection circuit, connection between wireless communication module GTM900C and singlechip. It closely combines temperature humidities collection and wireless communication and realizes upper computer monitoring through Internet. We can have a prospection of wireless sensor networks nice application foreground by this design.

ACKNOWLEDGMENTS

This work was supported by National Natural Science Foundation of China under Grant 60961002 (Jan, 2010-Jan, 2012).

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