Design and Realization of An Environment Monitoring System Based on AVR microchip

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Abstract. According to the requirements of the laboratory，a set of Long Distance Environment Monitoring System was designed based on AVR Microchip and Ethernet. This paper interdicted the design of hardware and software about AVR Microchip in detail，and the long distance monitoring system software was briefly described. Through the application testing, this system was excellent in operation with stable performance.

1. Introduction

With the rapid development of modern electronic science and technology, electronic testing technology, radio product manufacturing industry on the laboratory environment and equipment safety issues put forward higher requirements, laboratory environmental monitoring issues are increasingly important. This system is based on AVR microcontroller and Ethernet communication technology to design a set of remote environment monitoring system, the system can achieve real-time monitoring of the power quality, temperature and humidity, security technology status, waiting or timed to send monitoring status information to the host computer, Parameter abnormalities in time through the sound and light alarm, GSM alarm message, to the host computer to send an alarm signal to inform the staff of the corresponding disposal.

2. Hardware Design of Environmental Monitoring System

As shown in Figure 1, the system is mainly composed of AVR microcontroller, power quality monitoring module, GSM communication module, communication protocol conversion module, temperature and humidity sensor, vibration sensor, sound sensor, sound and light alarm and other components. The ATmega16L microcontroller is the main controller of the system, which is responsible for collecting, processing, displaying and judging the monitoring data of each sensor. When the monitoring data is abnormal, the alarm signal is sent by sound and light alarm and GSM SMS alarm. The output switch signal is driven by solid state relay Air conditioning, humidifier or dehumidifier to control the environmental status, and real-time to the serial server to send the monitoring environment of the integrated data.

The power quality monitoring module is a digital sensor with controller. After receiving the data request command sent by the controller, it will automatically return the monitoring data to the controller without A/D conversion. The serial server sends the environment comprehensive state information collected by the controller to the Ethernet by TCP/IP protocol, which facilitates the remote device acquisition and manages the environment comprehensive monitoring data. GSM

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communication module is responsible for receiving and sending remote command information and alarm information, so that the system has a wireless management capabilities.

The internal communication mode of the system is based on the RS485 bus structure design. The bus is equipped with power quality monitoring module, GSM communication alarm module, RS485 to TCP/IP protocol gateway, each module has unique address information, and the system communicates with each module Information recognition is completed.

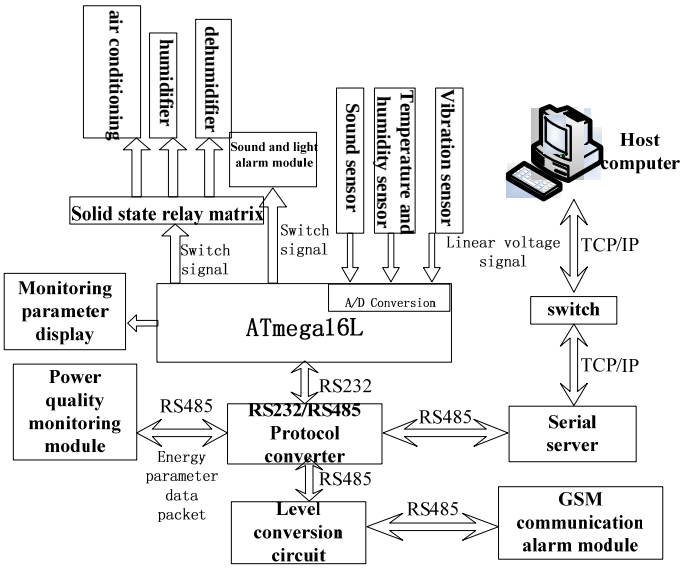


Figure 1. The overall structure of environmental monitoring system

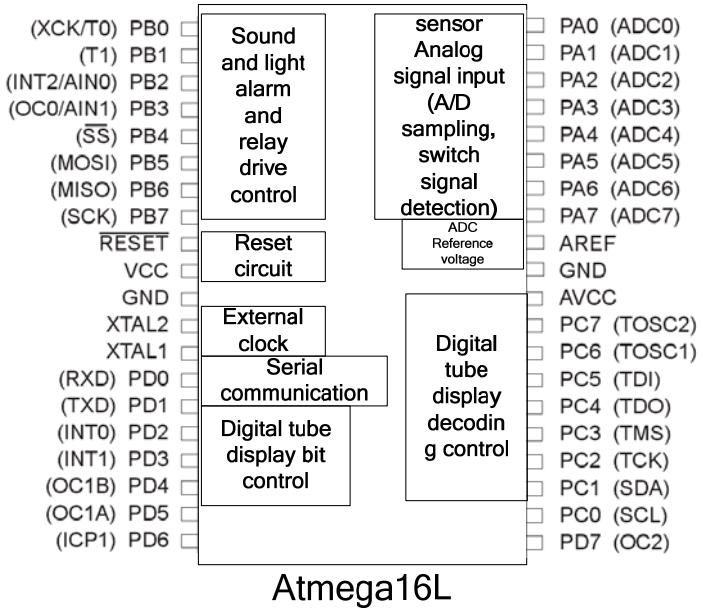


Figure 2. System resource allocation structure

2.1. Single Chip Computer Resource Allocation

The Atmega16L microcontroller is a high performance, low power 8-bit AVR microprocessor with two 8-bit timers/counters with independent presale and comparator capability, one with presale,

compare function and capture function 16-bit timer/counter, 8-channel 10-bit ADC, two programmable serial USART.

Single-chip I/O port PA0 ~ PA7 is defined as "port input" mode, the pull-up resistor is turned off, the sensor switch input signal, the microcontroller through the timing I/O port scan mode to check the input signal changes; the sensor analog input signal, Timing A/D sampling mode, access to sensor input information, ADC reference voltage to I/O port (AREF) as a reference. PC0 ~ PC7, PD0 ~ PD7, PB0 ~ PB7 are defined as "port output" mode, PC0 ~ PC7 are changed by changing the output level to complete the digital design. The system monitoring parameters are 4 digital display, digital control common anode design, I/O port PC0 ~ PD2 ~ PD5 through the cycle to change the output level to complete the digital display bit strobe. PB0 ~ PB7 initial value output is low, according to the need to output high level strobe sound and light alarm or relay drive module.

SCM timer T1 is used to monitor the parameters of the timing acquisition, data transmission design. I/O port PD0, PD1 is designed for serial communication data transceiver port, the system uses an external clock.

2.2. GSM module level conversion circuit

GSM module using Siemens industrial grade module TC35i design, module UART level is 2.9VTTL level, cannot directly communicate with the ATmega16L, MAX232 to use the signal level conversion, the circuit shown in Figure 3. As the TC35i on the power requirements are higher, when the power supply voltage drop of more than 400mV, the system will automatically reset, and send data during the current peak will reach 2.5A. To ensure the normal operation of the circuit, communication security, in the TC35i power supply side in parallel with a 3300uF electrolytic capacitor to stabilize the supply voltage, in the RXD, TXD communication line in series with a 1kΩ resistor for current limiting protection.

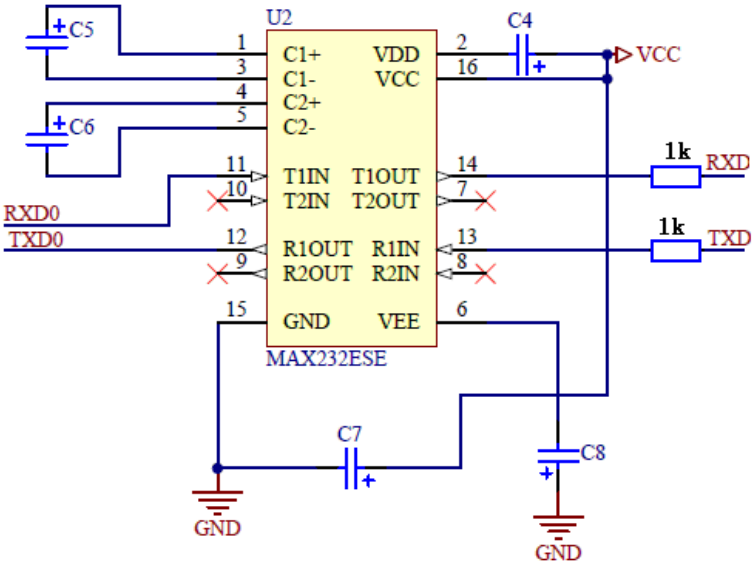


Figure 3. TC35i level conversion circuit

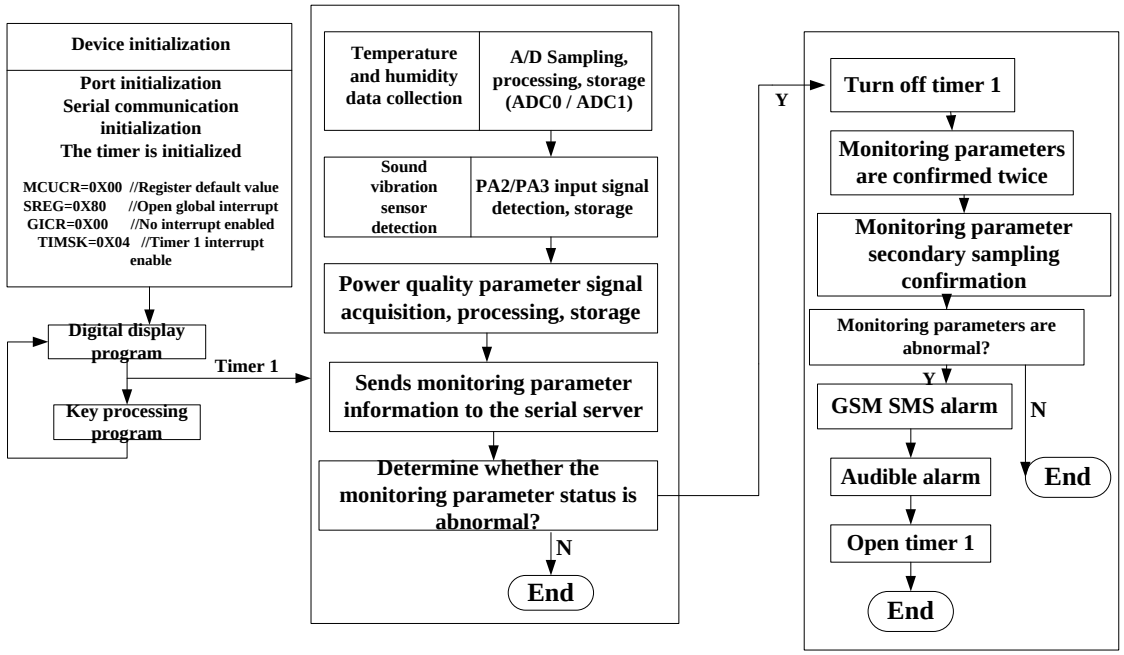


Figure 4. SCM program flow chart

2.3. Other circuit design

ATmega16L microcontroller performance is very strong, other circuit design, including monitoring parameters of digital display circuit, sound and light alarm and relay transistor drive circuit, clock circuit, etc., because these circuits are more reference and technical maturity, no longer elaborate.

2.4. Hardware circuit debugging

The debugging of the hardware circuit should be carried out on the basis of the principle of point to face, that is, the performance of the circuit as a basis, and gradually test the function of the new circuit is implemented, troubleshooting problems, until the entire circuit debugging is completed.

Single-chip circuit debugging work, first of all to determine whether the power supply module is accurate and stable; followed by the minimum system of single-chip start to build, commissioning, each building should be a part of the function to determine the normal and stable before the next step to build the circuit work The Communication module function debugging work, the microcontroller and the communication module, respectively, through the RS232 interface and the development of PC communication test to determine the correct send and receive characters, the signal level match, and then the communication between the modules to test the work to accurately find the Module may exist problems, improve debugging efficiency. The functional verification of the sensor circuit can be carried out by simulating the on-site environment, comparing the monitoring state, and timely discovering the problems existing in the monitoring, sampling and analysis of the field data to ensure the accurate and reliable data monitoring.

3. Software Design of Environmental Monitoring System

Monitoring system software is divided into single-chip program and remote monitoring and management information system programming two parts. SCM program to complete the sensor data acquisition, monitoring parameters display, relay module and sound and light alarm module control, GSM short message transmission and other work, remote monitoring and management information system program to complete the monitoring data reception, storage, analysis, display and so on.

3.1. Single Chip Microcomputer Program Design

SCM program based on ICCAVR integrated development environment design, using C language, the main software workflow shown in Figure 4. After the main program initialization register (set the I/O port input/output mode, external interrupt register, serial communication protocol, etc.), and finally open the interrupt enable. When the scene environment is abnormal, the alarm program is started. When the timer 1 is started once, the state variable is set once to realize the rolling display of the monitoring parameters. The underlying system includes multiple data acquisition units, including A/D acquisition unit, switch acquisition unit and multi-channel sensor data receiving unit.

3.1.1. ADC sampling program design and debugging. The ADEN bit of the ADCSRA register can be used to start the ADC operation. The Atmega16L ADC conversion result is 10 bits and is stored in the ADC data register ADCH and ADCL. The default format of the register is right-justified. AD program preparation usually according to: select the reference power, select the acquisition channel, select the AD conversion clock, enable the AD module, start conversion, wait for the end of conversion, read data and other steps.

In the development process, the system needs to collect two AD signals, in the debugging process found that the two AD signals were collected separately, AD conversion work properly, the collection of data is also normal. However, if the two signals are combined for continuous acquisition, the second signal acquisition results are abnormal, and always with the first signal acquisition results the same. In order to ensure that the conversion result is not lost, once the ADCL is read, the addressing of the ADC to the data register is blocked. After reading the ADCL, it is only once before reading the ADCH. ADC conversion is completed; the data register data will not be updated. The reason for the two-way signal acquisition is abnormal because the program reads the ADCL after reading the ADCH. Therefore, when the second AD conversion is performed, the data register data is not updated and the read value is the result of the first conversion. Therefore, in the development process, should first read ADCL data, read ADCH data.

3.1.2. Timer programming. Timer 1 interrupt program in each response, the need to complete the monitoring signal on the acquisition and analysis, through the serial server to the remote host computer to send on-site monitoring data, field monitoring parameters abnormal alarm program, display state variables flip work, The program work time is longer, the timer 1 reset time should be based on the interrupt program running time and system data acquisition real-time needs to consider the design. The system in the monitoring parameters under normal circumstances to interrupt the program execution time <2s, monitoring parameters of the interrupt program execution time <10s, the system will reset the timer 1 time is designed to 3s, that is, every 3s system monitoring parameters once Sampling, analysis, when the monitoring parameters are abnormal, the alarm program will shut down timer 1 interrupt enable, after all the alarm program is completed, enable the interrupt enable, timer 1 to resume work.

The UART communication mode of the MCU is not used in the interrupt trigger mode. In order to prevent the microcontroller from receiving the digital sensor communication with the controller, the program stays in the UART reception wait state. Before the communication program starts, the system starts the watchdog timer and the communication program ends after the timer is turned off in time.

3.2. Environmental Monitoring Management Information System Program Design

Environment monitoring and management information system based on Visual Studio 2008 environment development and design, the use of C # language, socket programming based on the network transmission data batch collection, the use of database technology to achieve data storage and query in the SQL Server database, the use of C # in the Data Grid control, Data Combo control, ADO control to achieve data display, query.

4. Summary

Ethernet communication technology as a stable, low-cost communication can facilitate the networking and communication, remote monitoring for the communication provides a good choice, single-chip control technology is mature, stable performance and low price is small intelligent control system design preferred.

Based on the needs of laboratory environment construction, a remote environment monitoring system is designed based on AVR microcontroller and Ethernet communication technology. The system realizes the real-time acquisition, analysis and display of the sensor data of the monitoring site through the AVR single-chip computer. When the scene monitoring data is abnormal, the control sound and light alarm module and the GSM communication module carry out the abnormal alarm, and send the scene to the remote host computer based on the Ethernet Data, easy to control the center to grasp the laboratory's environmental monitoring parameters, to achieve a unified monitoring of the status of the laboratory information, control and management. The system in the measurement unit of the test room to monitor the environment to be applied, the system is stable, good performance.

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