

Research on Optimizing Anti-jamming Software Approach of Single Chip Computer System Based on Data Acquisition

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Abstract: In the single-chip microcomputers which are installed on the equipment and play a controlling role, the work of single-chip microcomputers is affected by the frequent start and stop of the equipment, the fluctuation of the voltage of the power grid, the disturbance of magnetic field when the large-scale equipment is running, and so on. Data acquisition system is used to convert analog signals into digital signals that can be recognized by computer. The purpose of this system is to facilitate the monitoring and control of some physical quantities. Based on the anti-interference performance test of the main components of the microcomputer, several effective software anti-jamming countermeasures are proposed in the single-chip microcomputer, and the principle and design method of the anti-interference program are explored. The system can automatically complete the displacement, pressure collection, analysis and data processing work at the work site, real-time display, and can be widely used in intelligent instrumentation and scientific research. The utility model has the advantages of high acquisition precision, strong anti-interference, reliable performance and low price, and has good application prospect and practicability.

1. Introduction

Monolithic microcomputers were first invented in the late 1970s. With the rapid development of micro-computer technology, single-chip computer system is more and more widely used in the field of measurement and control in various industries, effectively improving production efficiency and product quality, but also improving economic efficiency [1]. Monolithic microcomputers are widely used in automatic control systems and intelligent systems because of their excellent cost performance. However, once used in the field, the system will produce unexpected erroneous actions or display, even lead to the basic failure of the previous research results, waste valuable time and human and material resources [2]. When the single-chip microcomputer system is used in the industrial field, due to the complicated environment, there are often a large number of electromagnetic equipment starting, stopping and power waveform distortion and other factors, so that the single-chip system is interfered, can not operate normally, and even control failure, causing a major accident. The anti-interference of computer systems cannot be completely solved by hardware. Therefore, the research on software anti-interference problems has attracted more and more attention.

In an engineering design, there are many variables, displacement and pressure are the two most important parameters. In order to ensure the safe and reliable operation of the engineering work process, the displacement and pressure must be tested [3]. To this end, we designed a data acquisition system based on single-chip microcomputer. Data storage and management use memory to store the collected data, establish a corresponding database, and manage and call. The data acquisition system composed of the three-bus method has an outstanding problem that the bus is pulled out and is susceptible to interference, resulting in a decrease in system reliability. At the same time, it also brings some problems, such as high wiring density, large circuit board space, more peripheral components, complex timing, etc [4]. Therefore, in the process of system development, the anti-interference ability of single-chip computer determines the success or failure of system development, which has increasingly attracted the attention of scientists and technicians [5]. The design of data acquisition chip C8051F005, which integrates A/D conversion, FLASH memory and timing/counter circuits, can greatly reduce the development time and cost of the

system, reduce the volume of the equipment, and improve the reliability and electrical performance of the system.

2. Methodology

The main factors affecting the reliable and safe operation of the measurement and control system are various noise disturbances from inside and outside of the system, as well as system structure design, component selection, installation, manufacturing process and external environmental conditions. It mainly comes from external power supply, PCB self-interference, ambient electromagnetic field interference, and external interference is caused by input through I/O port. Power supply interference has the characteristics of difficult to quantify the frequency band, complex interference reasons, difficult to determine the impedance of power supply and load, and changeable interference modes. The single chip computer belongs to the digital system. Each logic element has its corresponding threshold level and noise tolerance. As long as the external noise does not exceed the tolerance value of the logic element, the whole system can maintain normal. In MCU control system, the output of control state often depends on the input of some conditional state and the result of logical processing of conditional state. Data processing is to delete the relevant interference noise, irrelevant information and necessary information from the collected raw data, and extract important information reflecting the characteristics of the measured object. In order to achieve safe, reliable, stable and real-time operation of the system, a monitoring module must be added to the measurement and control system. The monitoring module of this system uses MAX813L. The MAX813L is an external "watchdog" circuit with a reset microcontroller, voltage monitoring, watchdog timer, and manual reset that can be directly connected to the microcontroller's I/O port.

Control signals are generated by the microprocessor and status feedback is performed by a data acquisition system including an analog/digital converter. Time delays may occur in data acquisition and data transmission; These delays are considered known and constant. Figure 1 is a schematic diagram in which simulation illustrates this situation, even with a small sampling period, so that the system can be approximated to continuous time.

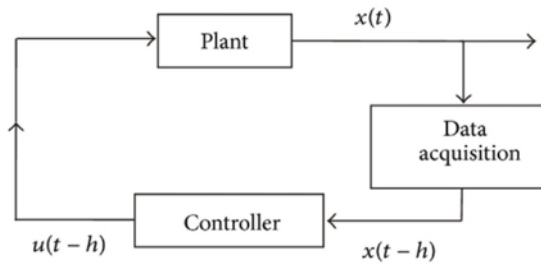


Fig.1. Representation of data acquisition delay by simulation

The system takes C8051F005 as the core to complete data acquisition and processing, provides a good man-machine interface through the LCD module RT12864M, and implements the interaction between MCU and PC through the USB interface chip D12. The content of control register is modified by interference signal, which will lead to initialization failure, addressing failure, and even system paralysis. Special function register SFR directly affects various IO ports, working mode registers, stack pointers and data pointers [6]. The electromagnetic noise generated by the system itself and its application environment is still a common interference factor. The main sources of noise are: the switching process of digital circuit, the transmission of high frequency radio signals, the action of relays and switches. When a current flows through the ground, a voltage drop occurs across the line, causing a potential difference between the ground of the I/O interface circuit and the ground of the microcomputer, that is, there is a common mode voltage. Therefore, when analyzing the cause of interference in a computer system, attention should be paid to its storage or retention characteristics for noise signals. The data of a certain point is continuously collected multiple times, and the average value is calculated as the sampling result of the point. This method can reduce the

impact of random interference of the system on the acquisition results.

Figure 2 shows the microstructure of a single instruction version. Four phases are used in this processor, for example, instruction fetch, decode, execute, and write back phases. The next instruction will be fetched and should wait until the result of the current instruction is written back to memory (register/data memory).

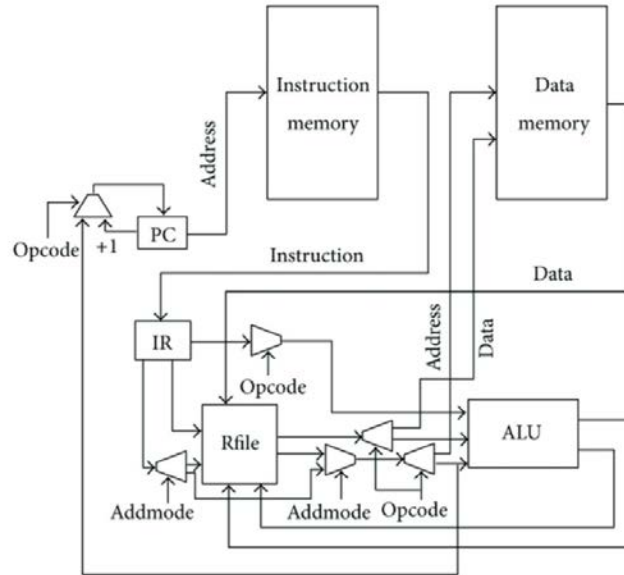


Fig.2. Single clock cycle architecture

Use a timed interrupt to monitor program run status. The timer's timing time is slightly longer than the normal program running one cycle. The timer time constant refresh operation is executed during the main program running. Thus, as long as the program runs normally, the timer will not have a timer interrupt. After the data acquisition system acquires the data, after a series of data processing, storage, encoding, and data compression, the result needs to be transmitted to the PC for further processing. Due to the small amount of data processed, we use the serial port communication method for data transfer is the simplest. After comparative analysis, the common anode dynamic display mode is adopted in the design and the segment end of the digital tube is directly connected to the output port of the single chip microcomputer. Each analog signal is switched by CD4051 analog switch. One of the analog signals is followed by OP-77 voltage, and then converted to AD652. The output digital frequency is driven by pull-up resistance. After being isolated by TIL113 photoelectric coupling, the analog signal is sent to MCU counter 0 for counting. In order to provide real-time display function of acquisition signal, understand the operation of the system and carry out necessary manual intervention, the LCD display function is expanded. The device integrates the battery, crystal oscillator and power management circuits needed for real-time clock into the chip. In the case of power failure, the clock can also be guaranteed to run.

3. Result Analysis and Discussion

The single chip computer system used in the industrial environment, although in the hardware design to try to improve its anti-jamming ability, but in practice there will still be a variety of unexpected environmental noise and power fluctuations. Whether it comes from outside the system or from the noise generated by the system itself, it mainly enters the system through coupling mode, thus affecting the sTable operation of the whole system. The interference between signal lines and between signal lines and power lines. Because of the stray capacitance and distributed capacitance between wires, the alternating signal can be transmitted to adjacent lines through the coupling of these capacitors to form interference. After the MCU system is disturbed, the content of the program counter PC is wrong, so that the program "runs away", the program will execute a series of meaningless instructions and an "infinite loop" occurs, and the output is confusing, causing the

system to lose control. When the program runs out of order, the timer time constant cannot be refreshed in time to cause a timer interrupt, and the system is reset by the timer interrupt service routine. The entire device is shielded in the iron box and has a good grounding to avoid interference from spurious electromagnetic waves in the space.

As shown in Figure 3, in this study, the Micro Blaze soft core PE is configured in a partially reconfigurable area of the FPGA using the Xilinx EDK, and the remaining reconfigurable areas are used to configure multiple RLUs, memory, and communication protocols. In the implementation of RHSCS, Micro Blaze is a 32-bit RISC architecture. Its instruction and data cache memory are 4 KB each, which is used to store instructions and data in the execution of tasks.

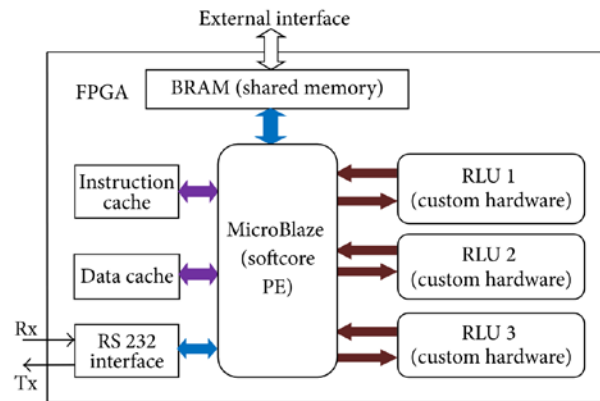


Fig.3. On-chip reconfigurable high-speed computing system

A device driver is a software component that sits between hardware and user applications, providing a bridge between communications. However, it is worth noting that the simple hardware interface of serial extension technology is at the cost of complex interface timing. Therefore, the operation timing of the device must be strictly observed in software programming. For interference noise that has invaded the microcontroller, corresponding measures must be taken to ensure the function of the system. Therefore, the programming should be based on the characteristics of the hardware selected by the system and the functions that the microcontroller must achieve, and the software compensation in the anti-jamming system will further improve the system. When the insulation resistance between adjacent components and conductors decreases, some electrical signals are coupled to the input of logic elements through this reduced insulation resistance. However, because the filter has a good ability to suppress high-order harmonics and a poor ability to suppress low-order harmonics, especially those below 20 kHz, the circuit has a weak ability to suppress low-frequency interference. Repeated execution is required to ensure the reliability of the signal. In order to achieve this goal, important instructions can be designed as a timing scanning module, which can be repeatedly executed during the cycle of the whole program. In this way, even if the interference signal rewrites the instruction content, it can automatically return to normal within the reaction time of the controlled equipment.

In practical application, the choice of method should be determined according to the law of signal variation, so as to achieve satisfactory results in eliminating data acquisition errors. When there are deviations in the individual data of the measurement results of the control system, in order to eliminate individual erroneous data, the comparative selection method can be used, that is, sampling each sampling point several times continuously, according to the variation law of the data collected, to determine the choice, so as to eliminate the deviation data. In programming, important data should be placed in on-chip RAM. If not, non-volatile memory should be extended for data storage. In the computer measurement and control system, the most common direct coupling phenomenon is that the interference noise is coupled into the computer line through the power line. Therefore, all I/O ports must first be set to a safe state to prevent the situation from expanding, and then the system residual information can be checked and corrected. If the interference enters the system, it will affect various control conditions, causing control output errors, or directly affecting the output signal, resulting in control errors. Therefore, the software implementation requires

real-time interrupt interception of the abrupt signal, multi-task real-time response processing, in order to ensure the real-time nature of the system, while adopting digital filtering processing, related parameter breaking method, to minimize interference signal to data acquisition. Influence to ensure the accuracy of the measured data.

4. Conclusions

The above introduces the design of the data acquisition system with the single chip as the core. The system has the functions of data acquisition, data processing, communication, anti-interference, real-time display, etc., which makes the pressure and displacement detection intelligent, and it has small volume. High precision, fast response and good stability. The design uses the LPC2214 chip to overcome the shortage of resources and limited processing power caused by the original 8-bit microcontroller processor. Bus and two-wire serial bus, and through software programming to achieve communication functions with peripheral devices, serial expansion technology simplifies the complexity of system interface design and improves the reliability of system operation. It greatly improves the reaction speed of the system. The whole USB data acquisition system has stable performance and comprehensive functions. Its portable and practical characteristics make it widely used in many occasions. In the process of developing industrial control system, we should actively draw lessons from the research results of new devices and technologies, and use various ways to improve the anti-interference ability of single-chip computer from both software and hardware, so as to meet the requirements of industrial environment for the reliability of control equipment. Design and good anti-jamming technology to reduce the impact of noise on the system, ensure the normal operation of the system, and meet the requirements of electromagnetic compatibility.

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