Research on Data Acquisition and Control System Based on Singlechip

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Abstract. With the development of the society and the progress of technology, present singlechip is extensively applied in every field of the society. Therefore, nearly all fields have its trace, such as the control of all kinds of instruments on planes, homing device on guided missiles, data processing and real-time control in industry, full-automatic washing machine in articles for daily use, computer network and communication technology, droid pet and medical equipment etc. Singlechip affects every aspect of our life, which depends on data acquisition and the perfection of functions in control system in singlechip.

Introduction

In our practical work, singlechip is used in industry in most cases, such as automatic control, household appliances and chemical industry etc. With the development of society, people put forward higher requirements for singlechip, so data acquisition and control system of singlechip need to be more accurate, more effective and more reasonable.

Simple Comprehension of Singlechip

Definition of Singlechip

Singlechip is also called microcontroller, which integrates computer system to a chip. It is the core part of computer and a chip can constitute a computer. The computer we mentioned here is not personal computer (PC) we usually talk about but the microcontroller (singlechip) which gives intelligence to all kinds of machines and can implement simple arithmetic and control.

The Development History of Singlechip

The development of singlechip includes three stages: Single-Chip Microcomputer (SCM), Microcontroller (CMU) and System-on-a-chip (SoC). Singlechip developed from embedded system independently, then it solved the embedded application on chips as much as possible, at last, it became SoC naturally. Singlechip is featured by small volume, high reliability, high processing speed and strong functions and it is usually installed in abdomen functioning as human’s head, so the device will not work without it. As singlechip has many types, such as STC, PIC, EMC, AT89C51, AT90C51, TMS370, MSP430 and SONIX, the author mainly discusses MSP430F16 of TI Company in this thesis.

Research on Data Acquisition System of Singlechip

Data acquisition means the process of collecting information automatically from imitation and unit under test like sensor or other equipment under test. It is extensively applied in signal detection, processing and instrument. With the development of digital technology, the channels of data acquisition system are more and more, and data storage is larger, faster and more reliable. At the
same time, the said MSP430F169 belongs to 16-bit singchip with low consumption in Series MSP430.

**Features of Data Acquisition System**

1) It has quite low consumption with special clock design, so the total power can be controlled under 1W when it works.

2) It has high data operation speed, 16-bit data width, 40ns instruction cycle and multifunction hardware multiplying unit realizing digital signal processing, increasing DMA module and accelerating data transmission speed.

3) It has a watchdog timer (WDT), which can recover system rapidly when system program halts or loses control.

4) It has a real-time clock (RTC), which can keep it working when outage happens.

5) It has broad development environment. MSP430 has three types of devices, that is, ROM, OTP and FLASH. Their development methods are quite different, the first two types mask or program chips after using emulator development, while there is JTAG debugging interface in FLASH, which can erase and write its reservoir without programming unit and emulator, language can be developed by assembly language and C programming language. Therefore, it has quite convenient and wide development environment.

**Hardware Structure of Data Acquisition System**

Hardware of MSP430F169 singlechip includes power supply, keyboard, display module, serial interface circuit, artificial circuit, reset circuit, A/D, D/A switching circuit and crystal oscillator circuit. The chart of its hardware system structure is shown as follows:

![Hardware Structure Diagram](image)

The supply voltage it uses is 3.3v. The keyboard and display are important methods of man-machine interaction, when keys are pressed, we can read numerical value on display module. Reset circuit can implement reset, which brings convenience to debug system. Serial interface adopts MAX3221EAE chip enabling it to communicate with peripheral equipment and microcomputer conveniently. Module and DAC module adopt 16-bit conversion chip enabling it to extend out and output all kinds of voice frequencies and signals with waveform. Crystal oscillator circuit provides high-speed crystal and low-speed crystal, which can provides output with three different frequencies for different modules, high-speed crystal can satisfy requirements of CPU for
high-speed calculation, low-speed crystal can output ACLK with low frequency for real-time clock, and high-speed crystal can be turned off when CPU does not work.

**Software of Data Acquisition System**

Tasks of software of data acquisition system mainly include scan task, conversion module task, display module task and communication module task. Software of MSP430F169 is developed under the environment of assembly language and C programming language, and online emulation and programming are implemented by emulator and C complier provided by manufacturers. As software of data acquisition system is quite complicated and the length of this article is limited, the author only discusses several main modules of software.

Conversion module and researches on its programming. Conversion module featured by high universalizability and high precision is integrated by module ADC12. In the module, there is a temperature probe, a clock generator, four interior channels, eight external channels and four conversion modes. The conversion module adopts single channel mode with repeated conversion. A part of programming of ADC is presented as follows:  ```c
#include<msp430x16x.h>
#define Num_of_Results 12
Static unsigned int results[Num_of_Results] 
void main(void) 
{ 
static unsigned int index = 0;
results[index] = ADC12MEM0; //Results of Storage and CO
version
ADC12CTLO |= ENC+ADC12SC; //Next conversion 
} ```

Serial interface communication module and its program. This module has two pins, that is, sending pin and receiving pin. It is features by: sending and accepting data begins with the lowest order with the transmission capacity of seven or eight-bit data. It can send data independently or stop receiving with two independent input and output shift registers. Its program can be expressed as follows:  ```c
#include“msp430x16x.h”
#include "fpgacode.h"
#define WR24C512
#define LED1_1 (0x20) /* Port 3.5 Output -> LED1 */
#define LED1_0 (0xdf) /* Port 3.5 Output -> LED1 */
#define SDA_1 P3OUT |= BIT1 //Serial data line. SDA = 1->……
#endif
#define I2CSLA 0x50
``` 

Pressure acquisition mainly takes sample of pressure. Sampling is carried out ever 10 seconds and pressure data is sent in time. Its program can be expressed as:  ```
In site protection→ eliminating bit zone→ conversion→ read numerical value→ digital filtering→ quantitative calculation→ data storage→ setting up bit zone→ data storage→ RET display
``` 

**Research Based on Singlechip Control System**

**Advantages of Singlechip Control System**

The basis of singlechip control system is node intelligence module. The reliability and reliability of the whole system are strong, so it is mainly applied in automatic control system of industry. Most of its performance is the same as data acquisition system. We will go on learning control system by taking singlechip MSP430F169 for example. In real life, we know no enterprises will buy new chips without taking the price of singlechip into account. Most enterprises choose to upgrade the former chips. MSP430F169 we mentioned has great extended function, which can satisfy customers’ requirements for space. At the same time, it is 16-bit data with high transmission rate. And 27 core instructions and enough imitation instructions provide lots of advantages for this type. In detail, it has simplified instruction set, low consumption and mixed signal processor, which reduce requirements for environment and increase ability of anti-interference.

**Basic Structure of Singlechip Control System**

Each node intelligence module of singlechip control system should have independent operational capability, control center can finish the configuration of control system, testing and control. Its over-all structure can be expressed as: human-machine interface ↔ control center ↔ front-end processor of the system↔ node intelligence module ↔ controlled equipment. Of course, if we want to analyze a certain type singlechip, we should accord with its internal structure.

**Principles of Singlechip Control System**
At first, the composition principles of singlechip control system include the above cost principles of singlechip control system. The development of singlechip needs generalists and innovation. Although singlechip has had great development, it has many imperfect aspects which need to be improved. Then, it refers to the communication principles of singlechip. The communication we mentioned is different from the network communication we usually talk about. It is necessary for us to define types of data, the direction of flow and the form of structure for the communication of each intelligence module.

**Hardware and Software of Singlechip Control System**

The hardware in singlechip control system is similar to that in data acquisition system, which is equipped with PC control, input and output port, conversion module, keyboard, display, timer, data acquisition system and hardware multiplying unit etc. Its operating principle is interlinked to the said system of over-all structure.

Software in singlechip control system. Software control system of singlechip is also programmed by C programming language compiling. We will also take the workflow of singlechip MSP430F169 for example, whose workflow is shown in the following picture:

![Workflow Diagram](image)

The control system of singlechip can be expressed by this picture. Here, we will describe a part of control software. According to comprehension of communication protocol and hardware principles, it is concluded that software communication module is controlled by register establishment, while USART controllers include RX Control Register, TX Control Register and Adjustment Control Register. When input frequency of generator is not integral multiples as Baud rate, fractional part will be reflected by the content of Baud rate Adjustment Control Register, and integer part will be written in UBR register directly. In addition, SFR can interrupt Enable Register 2 and SFE interrupts Flag Register 2.

The clock source of software in initialization setting adopts sub-clock of system, the length of transmission character is 8 bit, Baud rate is 115200 bit, the circuit is free multi-machine protocol which can send, receive and interrupt enable. Serial communication adopts interrupt mechanism, RXD and TXD also adopt interrupt mechanism. If main program sends data, the interrupt signal can
be set as assess to interrupt to send data. If there is RXD, a signal will be set up to inform main program that data is coming. If we want to receive data, while the service program is interrupted, we can read data we want to get at RXD register and put this data into global variable buffer zone setting up a signal to inform main program there is data. The program checking and processing data is the main processor, which transfer correct data to main function of the system and calculate it, then responsive information will be sent to computer after packaging. If data is false, it will be sent to computer after packaging too, and data will be resent.

A singlechip includes data acquisition system and control system. The control system is to ensure data acquisition system works normally and give related instructions after analyzing and processing received data. The two are inseparable supplementing each other and promoting each other.

**Conclusion**

During such a period with rapid development, we are surrounded by all kinds of goods including TV, electro-mobile, washing machine, refrigerator, personal computer, car and mobile-phone etc. Besides, we can see both enterprises and hospitals around us depend on singlechip, which makes singlechip have so great effect that it is necessary to study its data acquisition system and control system profoundly. Our life will be more scientific and have higher quality by improving the performance of these core parts.

**Reference**


