

Design and Development of the Temperature Detection System

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Abstract

Mini2440 domestic microprocessor is used as the hardware platform and DS18B20 temperature sensor driver is developed through embedded Linux systems. BOA technology, CGI technology and network communication technology is used to achieve the hardware remote control. Through analysis of the demand for system functions, to achieve an effective detection and collection on the ambient temperature. The outcome is writing a program to implement the corresponding function of temperature data collection and through network to show and feedback the data of temperature.

Keywords: Mini2440, hardware platform, DS18B20 ,BOA, CGI, driver

1. Introduction

Embedded system is a special computer system that takes the application as the center, takes the computer technology as the foundation, suitable for the application of the system function, reliability, cost, volume, power consumption [1]. The system uses mini2440 development system as operating environment, the host computer as development environment. The host communicates with the target machine through the Ethernet interface or serial [2].

The system is a temperature detecting system, it is composed of mini2440 development system, the DS18B20 temperature sensor, BOA server, virtual machine. DS18B20 temperature sensor is used as a temperature data acquisition element to collect data from the surrounding environment. The sensor sends signal to the mini2440 development system through sequential computing and register data calculation. mini2440 development system transfers temperature data to the BOA server through TCP/IP protocol, and the webpage response through server, and eventually temperature data will be shown on the website. Unlike other systems, this system can not only display the output data in embedded development system end, but can display it on web site through BOA server. Measuring temperature range can reach 55 to +125 DEG C, the inherent temperature error is 1 DEG C. DS18B20 suite most of the temperature measurement, the function of mini2440 processor is overall, with a variety of interface module, can be connected with the temperature sensor DS18B20.

DS18B20 is a kind of digital temperature sensor, it is produced by DALLAS company. It applies unique 1-Wire interface, and can realize communication through a pin, providing 9 to 12 bit (set) temperature readings. Each DS18B20 has a 64 bit serial number when it is out of factory, therefore the plurality of DS18B20 can be linked in a bus without confusion, the application of distributed temperature detection is simplified by multi point and parallel capability. Power can be supplied by data line, also can be supplied by external power supply (3V to 5.5V), the temperature measurement range from -55 DEG C to +125 DEG C, in -10 DEG C to +85 DEG C

within the accuracy of plus or minus 0.5 DEG C, the user can set the non-volatile temperature alarms value, the maximum temperature transformation time of 750 milli seconds [3].

Data transmission, communication with the server and correspond to the server requires PHP technology and CGI technology. CGI is interface used to communicate HTML forms and the server application programming .CGI can be used to solve the problem that client could not, such as remote database, in this system, the CGI program will deal with forms and contents submitted by web, download the current temperature data have been detected from the data files stored in server, and then transmit the data in a text document back to the web form.

The main function of CGI [4] is in the WWW environment, it can transfer some information to the WWW Server from the client browser, and then by the WWW Server to start the CGI code to complete the corresponding work. CGI is like gateway, it can build a bridge between the server and the client, executes input instruction of the client and also generates and returns the information required by the clients.

In the management and interaction of embedded equipment, the application based on Web is the current mainstream, namely B/S structure. runs a Web server that support CGI function in embedded devices, to generate dynamic pages, PC machine can monitor room temperature remotely through Web browser flexibly. For the limitation of processing power and memory capacity of the embedded system, the possession of storage space and the running space of the embedded Web server should be small. Boa is Web server running in the class Unix system, it has small size, fast response speed, safety and reliability, it supports for CGI, is a HTTP server with single task [5]. The system uses Boa to build embedded Web server.

2. The Overall Design of the System

In the system, user can login to browser the current temperature through the Web Server. Temperature detection system consists of four parts: the need of driver program and application program of DS18B20 temperature sensor, TCP/IP communication module, BOA server, web site building detection. Figure 1 is the overall block diagram of temperature detection system.

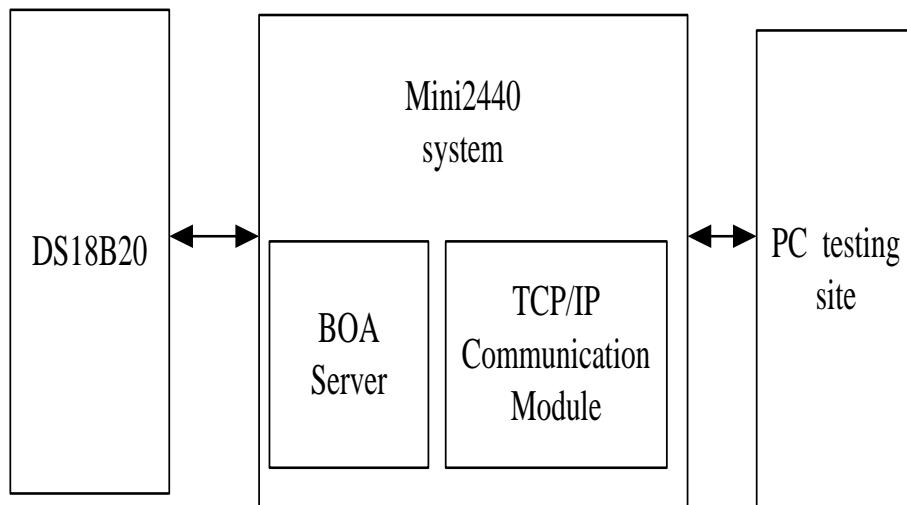


Figure 1. The Overall Design of the System

Figure 2 is a flow chart of operation DS18B20.

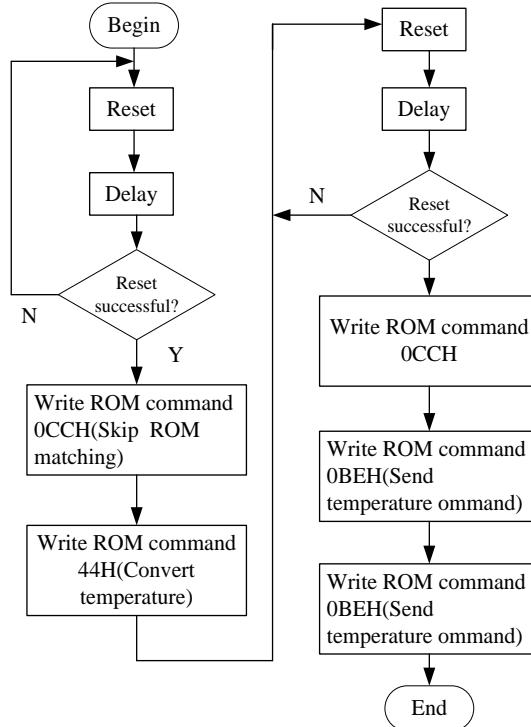


Figure 2. Operation Flow Chart of DS18B20

(1) Reset: As shown in Figure 3, the controller transmits low level signal to DS18B20 single bus at least 480us. When DS18B20 receives the reset signal, it will send back existence pulse of a chip after in 15~60s.

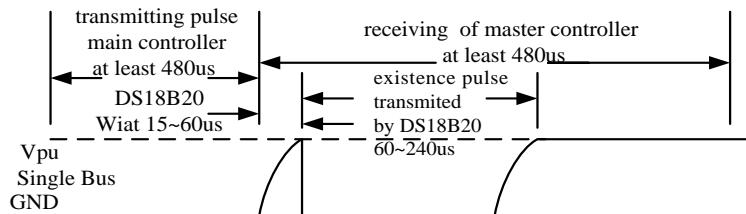


Figure 3. Timing Reset Map

(2) Existence Pulse: The existence pulse signal is a 60~240us low level signal, as shown in Figure 3. after the end of the reset level controller, single bus of data should be pulled high by controller, in order to receive the existence pulse after 15~60us, the two sides of communication has reached a basic agreement, the data communication between the controller and the DS18B20 will be the next communion. If the time of reset low is shortage or single bus circuit break, it will never receive the existence pulse.

(3) The Controller Send ROM Commands: ROM instruction totally have five, each working cycle can only send one, the main purpose is to distinguish multiple devices articulated on bus and process. Multiple devices can hanged on single bus at the same time,

and through ID number of each device to distinguish, when hanging a single DS18B20 chip can skip ROM command.

(4)The Controller Sends the Memory Operation Instruction: After the ROM command is sent to the DS18B20, then a memory operation instruction will be sent. There are six operating instructions, memory operation instruction function is to control the work of DS18B20, it is the key of chip control.

(5)Execution or Data Read and Write: The instruction execution or data read and write will be conducted after a memory operation instruction end, this operation should be considered by memory operation instruction. If a temperature conversion instruction is performed, controller must wait for the DS18B20 to execute its commands, switching time is 500s. For the implementation of data read and write instructions, it need to strictly follow the DS18B20 read and write timing operation.

If you want to read the current temperature data, you need to perform the two working cycle, the first period is resetting, skipping ROM command, performing a temperature conversion memory operation instruction, waiting time temperature transformation for the 500s. The second period is resetting, skipping ROM command, performing a memory operation instruction, reading RAM read data.

3. DS18B20 Driver

Embedded Linux is Linux operating system of cutting version, which is composed of a kernel and some system module composited and customized according to need, kernel is generally a few hundred kB, even with the other necessary applications and modules, the required storage space is also very small [6]. It has the merit of multi thread, multi task, its source code is open.

According to its related work sequence diagram and principle diagram, In the DS18B20 driver, the data read, write function most important, the pin definition and reset function, we know that it's the timing and temperature measurement principle diagram from the working principle of the above DS18B20, then we will write the related procedures of the Linux driven programming.

3.1. The Definition of Pin

Related pin of DS18B20 should be defined to facilitate future driver writing, it is definition input and output of data and related pin of GPIO. According to the related header files in the kernel by GPF (3) is selected as a transmission pin.

3.2. The Writing of Driver

In Linux, the driver is part of the kernel, it shields the details of hardware, is the foundation of the operating system. The combination of driver and the Linux kernel has two ways: when the kernel is compiled, the driver is statically linked into the kernel; when the system is running, the driver is loaded into the kernel by module.

DS18B20 is a single bus temperature sensor, the host can only visit it by bit. Therefore, in the Linux system, the DS18B20 as a typical char device to be accessed. If the driver can operate normally, and obtain the real time temperature value finally, the key issue lies in whether reset program, reading program and writing program can properly be written. The flow chart of reset program, reading program and writing program is as Figure 4, Figure 5, Figure 6.

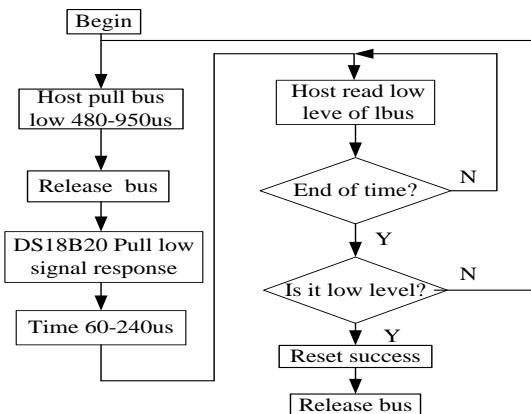


Figure 4. Flow Chart of Reset

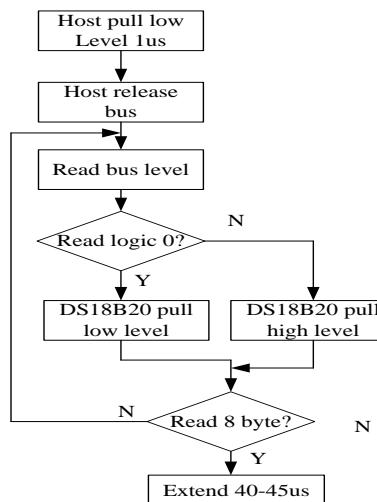


Figure 5. Flow Chart of Reading

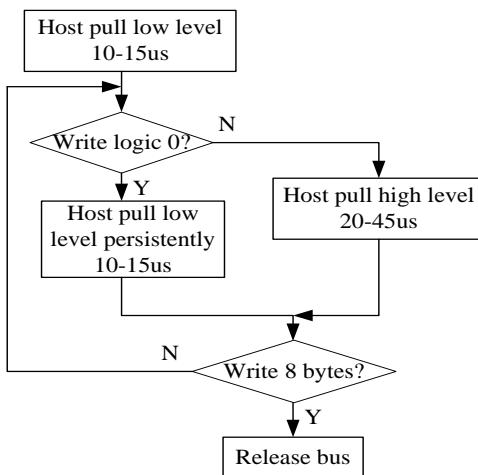


Figure 6. Writing Chart of Reset

4. Test Procedure of DS18B20 Temperature

Based on the measurement principle diagram of DS18B20 and the driver program, the test program is compiled. It need to communicate with bottom protocol to obtain data in the register of DS18B20. Computing and storage of DS18B20 is a 16 bit form, data in the register by the array will be programmed to store. Linux equipment exits in the form of a document in the organization, so fopen () function class is used to open the device file. Figure 7 is Flow chart of DS18B20 temperature reading function.

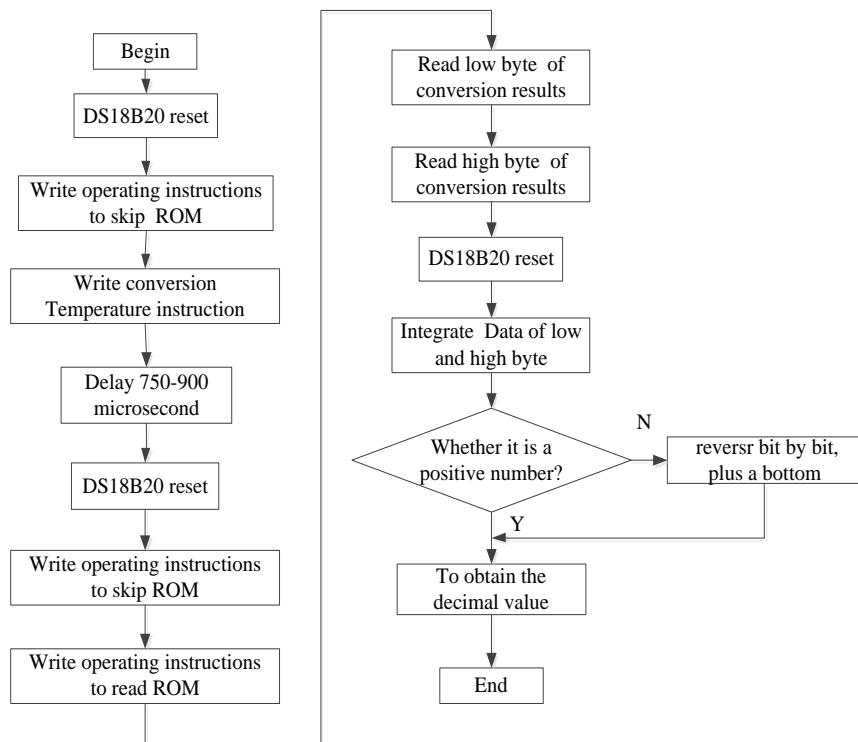


Figure 7. Flow Chart of DS18B20 Temperature Reading Function

5. Realization of Connection and Temperature Measurement of DS18B20

Wiring diagram of DS18B20 temperature sensor are as Figure 8.

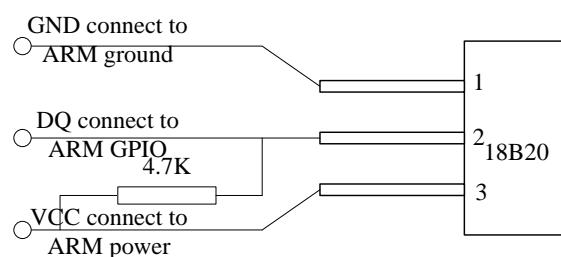


Figure 8. DS18B20 Connection Diagram

According to the GPIO pin definition of the distribution of GPIO interface in the mini2440 development board and DS18B20, the specific connection method of DS18B20 and mini2440 development board is determined, the physical connection diagram as Figure 9.

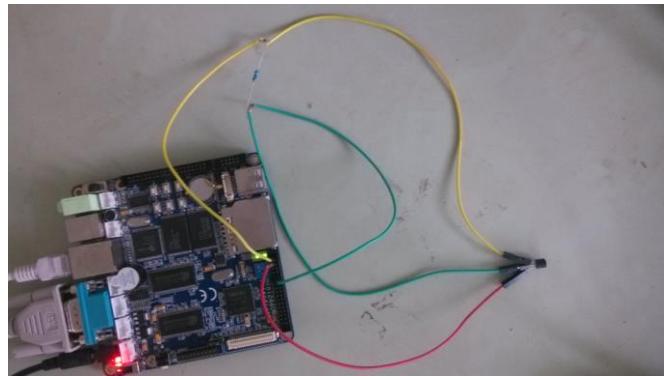


Figure 9. Connection Diagram of Material Object

When the driver program is loaded, the test program is run, the ambient temperature can be tested by DS18B20. After the realization of the temperature testing function of DS18B20, test data can be shown on the website through network communication method. Therefore, communication between development board and remote control terminal will be realized. In the realization BOA server, HTML language, PHP technology and CGI technology.

6. Realization of Static Webpage

Static webpage is used as platform to receive display data and communicate with the server, and achieve HTML language. Webpage is divided into three modules, namely the main page, and a temperature control system and about. The main page is written through the frame, it is divided into two parts, the frame part is the name of the website, the lower half part is three button, can respectively reach want to sub page. The specific page as shown below.

The relationship between CGI and server and client diagram as Figure 10.

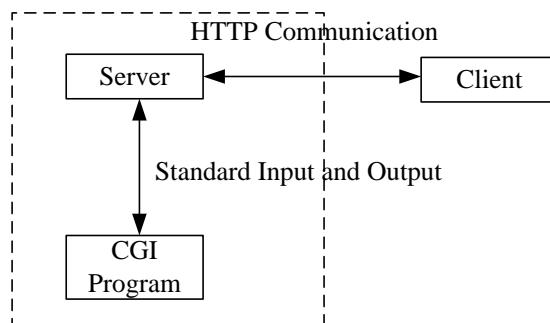


Figure 10. Communication CGI

The real-time monitoring temperature data saved in server are saved in a text document, through the PHP program its contents will be displayed in a web page. fopen () function is used to open the document and fgets method is used to read the data line, and finally through

the echo function of the data will be output, and the relevant content will be displayed on webpage.

By PHP code the static web page can be converted to dynamic web pages, and the site and server are connected, transmit the relevant command to the server, the server can timely response. CGI will inform server what data are needed and what file format need to return. Data is read and displayed through the PHP program, by PHP program transmission and testing of temperature data will be displayed in the website.

7. Conclusion

This system can successfully realize the acquisition and network communication function of temperature data, and send the collected data to the remote website display data via the web server. Its superiority lies that it has complete function, can meet the demand system developers and users well. Likewise, in some occasions that need remote detection or inconvenient to field detection, the system has the superiority. The temperature detection can be used for various occasions of social life and production, there are more resources of module and more GPIO in mini2440 development system can be applied. Development can be carried out by other modules, such as mode conversion, smoke sensor, added to the remote detection system, the system has to be expanded and improved, so that the system has more extensive application.

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