Design and Implementation of Web Server Control System Based on STM32

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***Abstract*—In this paper, the key technologies of web server based on embedded light-weight TCP/IP Protocol uIP and high-performance processor STM32 are mainly introduced. This system provides a transparent channel for massive and high-speed data transmission in controlling the mainstream RS-232 device and data acquisition system. For the need of overcoming the contraction of the high-time sequence and none-interruption of uIP and the massive data transmission, this system introduces simple ring buffer with DMA technology. And the test show that the performance of the web server system is improved and the bit error rate is reduced.**

Keywords- STM32; uIP Protocol; Ring buffer

I. INTRODUCTION

In recently years, with the development of 3G era, there is a growing dependence on the Internet. Thus, how to remote control electronic equipment through the network has also become a key technology in remote intelligent control filed. This paper described the implement of embedded Web Server, and this system provides a new way for people to access the embedded devices thorough network.

II. SYSTEM OVERVIEW.

The MCU of this system was STM32; the lightweight protocol static uIP was embedded into STM32. It provided Web page services by accessing the internet via RJ45 interface. And also, this system could be used as transparent channel for network and serial port data.

III. HARDWARE DESIGN

Based on the functional needs, this system chose STM32F107 as the main controller. It has a strong performance in the micro-controllers which were introduced by ST Microelectronics. It is a 32-bit Cortex-M3 core chip, and it has 256KB FLASH and 64KB SRAM. The standard peripherals of the STM32 include ten timers, five serial ports that support DMA, and Ethernet block. The Ethernet block complies with the IEEE 802.3-2002 standard, has 10M/100M data transfer rate, supports full and half duplex mode of operation. So the STM32F107 is in full compliance with the requirements of this system.

A. *System hardware schematic*

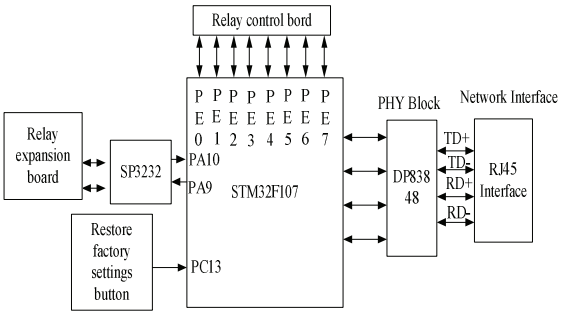

Figure 1. System hard schematic.

As shown in Figure 1, the frequency for this system was 72MHz, which was generated by external 25MHz crystal through internal frequency multiplier. In order to restore the factory settings, the system took PC13 pin as a port that connected external button. This system accessed 10 BASE-T Ethernet via RJ45 interface. The Ethernet PHY controller was DP83848, which is produced by U.S. National Semiconductor. The serial port data was send via SP3232. And the serial data could control the relay expansion board.

IV. SOFTWARE DESIGN

A. *Introduction to uIP protocol stack*

uIP is a TCP/IP protocol stack which is designed specifically for 8-bit or 16-bit microcontroller. It is completely written in C language, so it can be transported to a variety of different operating system. And this protocol provides the HTTP service. At transport layer, it provides the TCP/IP and UDP service, so the system can be configured as a TCP Client or a TCP server.

B. *Adaption of uIP protocol*

The STMicroelectronics official website has provided the example of successful transplantation program. But this system modified the related configuration of this protocol in order to meet the needs of the functions. The main changes were as follows: (1) Cancel the function of setting IP address by ping packets. (2)Configure the IP address, subnet mask and gateway in uipopt.h. (3)Configure the protocol to use a fixed IP address. (4)Configure the port 80 as the http service port, and the port 5000 as the data transmission service port.

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C. Adaption of the Embedded Web Server

The web pages were created by professional web authoring software such as Dreamweaver 8.0. Then they were converted into hexadecimal data, and stored into the FLASH or SRAM of the STM32. The configuration information was written into FLASH after they were updated, so the configuration information can be saved at the power-down moment. And the appearance settings were also stored in FLASH, and if the restore factory settings button was pressed for more than three seconds, the system would restore the factory settings. The flow chart of Web Server is as Figure 2:

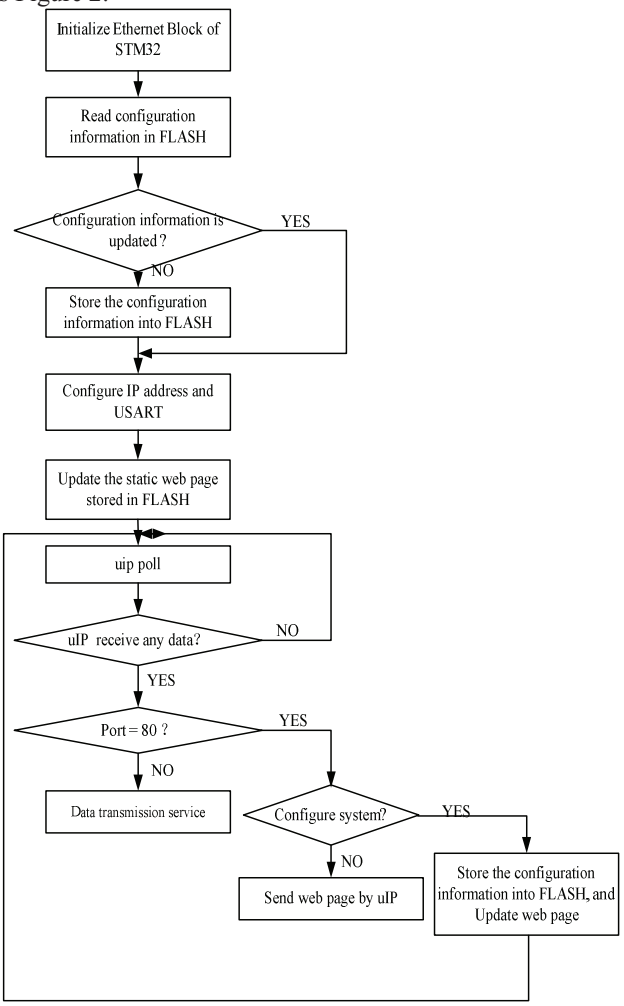

Figure 2. Flow chart of Web Server

D. The transparent channel for serial port data and Ethernet data

1) Simple ring buffer

The ring buffer is an important data structure in embedded system. And the ring buffer is applied to a single task environment in this system, so it was simplified. This simple ring buffer has retained 'in' and 'out' pointers in order to indicate that data is loaded in or popped out.

a) The process of loading data into simple ring buffer is as follows:

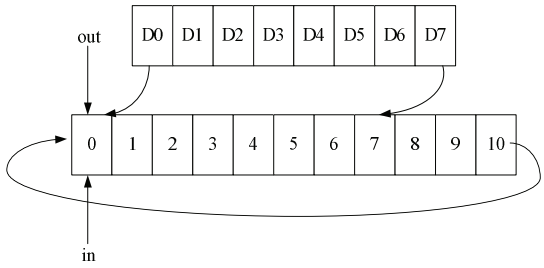

Figure 3. Status of loading data 1

If as shown in Figure 3, the data length is less than the free buffer length in ring buffer, all the data will be loaded into the ring buffer.

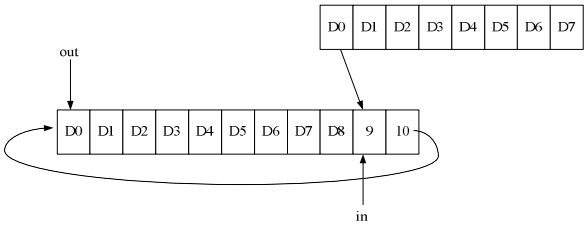

Figure 4. Status of loading data 2

If as shown in Figure 4, the data length is greater than the free buffer length in ring buffer, only the free buffer length head data can be loaded into ring buffer. And the remaining data will be dropped.

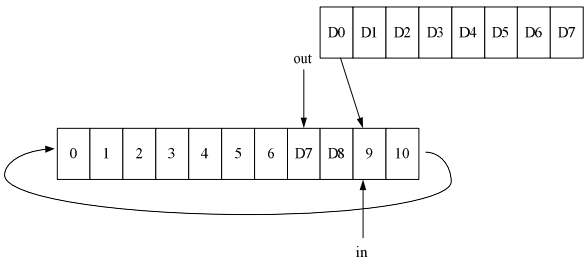

Figure 5. Status of loading data 3

If as shown in figure 5, the data length is less than free buffer length, the two head data will be loaded into the rear of ring buffer and the remaining six data will be loaded into the head of ring buffer.

b) The process of popping data out of the ring buffer is as follows:

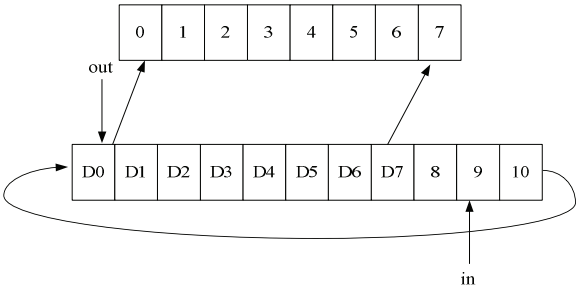

Figure 6. Status of Popping data out 1

If as shown in Figure 6, the length of memory is greater than the length of the data in ring buffer, all the data will be popped out of ring buffer..

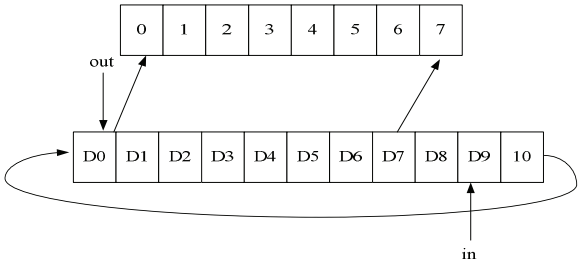

Figure 7. Status of popping data out 2

If as shown in figure 7, the length of memory is less than the length of the data in ring buffer, the length of memory data will be popped out of ring buffer.

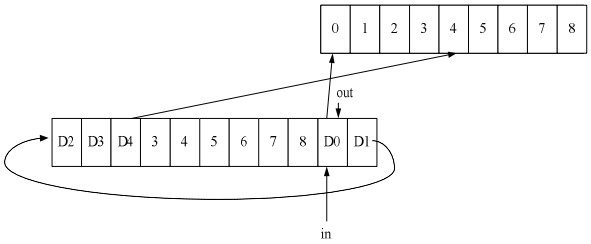

Figure 8. Status of popping data out 3

If as shown in figure 8, the length of memory is greater than the length of data in ring buffer, and in this case, the ring buffer will pop out data according to the position of out pointer.

2) Implementation of ring buffer with DMA

a) Ethernet send data to serial port.

First, initialize the ring buffer and configure the length of ring buffer as 2048. Second, initialize the DMA of USART. The uIP protocol used the mechanism of polling (uip_poll) to determine whether the system has received data from Ethernet. And if the port number was 80, the system would send web page to Ethernet. If the port number is 5000, the system would send data via USART to serial port devices. The flow chart is as follows:

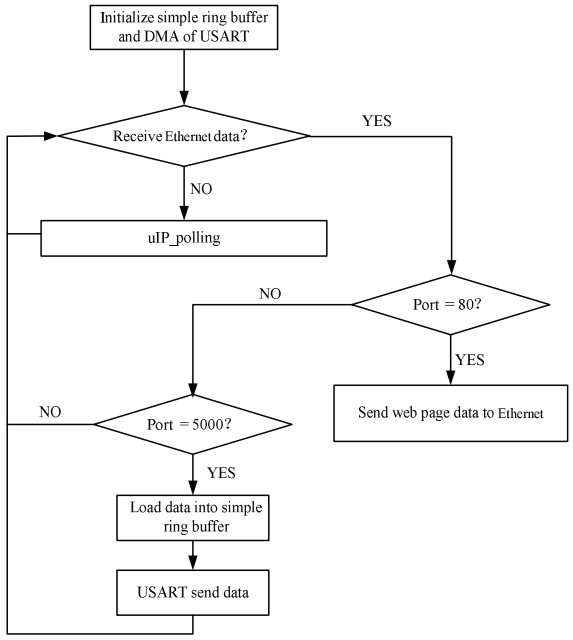

Figure 9. Flow chart of Ethernet sending data to serial port

b) Serial port send data to Ethernet

The USART worked in DMA mode. And the DMA is configured as peripheral to memory mode and circular mode. The uIP polled to determine whether there was data in ring buffer to be send to Ethernet. The flow chart is as follows:

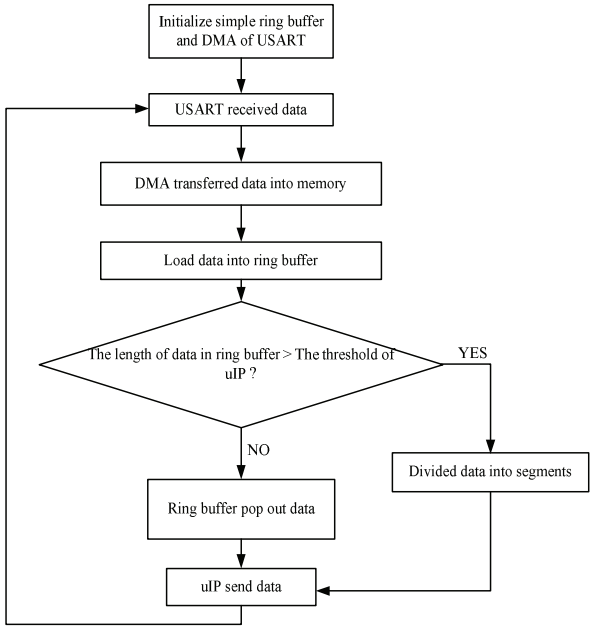

Figure 10. Flow chart of serial port data sending to Ethernet

V. SYSTEM TESTING

The web page service was tested in Microsoft Internet Explorer 6.0. And the network is LAN. The transparent channel for Ethernet and serial port data is tested by Serial port Assist and TCP Assist 1.9. The result is as follows:

Figure 11. Home page of Web Server

As shown in figure 11, the picture is home page after entering the IP address in the address bar. All of the configuration information was on the home page.

Figure 12. Configuration page of Web Server

As shown in figure 12, the picture is configuration page after entering the correct password. The link of changing password, IP Configuration and serial configuration is on this page. The related configuration pages could be landed after clicking the link address.

TABLE I. TRANSPARENT CHANNEL FOR ETHERNET AND SERIAL PORT DATA

Baud Rate	Serial port send data(byte)	Ethernet received data(byte)	Ethernet send data(byte)	Serial port received data(byte)
9600	214344	214344	260136	260136
56000	171720	171720	177444	177444
19200	256890	256890	693620	693620
57600	569596	569596	165566	165566
115200	9562345	9562345	9565623	9565623

As shown in table 1, the system effectively reduced bit error rate after using the simple ring buffer combined with DMA technology.

VI. COMMENTS

The adaption of uIP protocal meets the demands of this system. And the introduction of the technology of the simple ring buffer combined with DMA improves the performance of data transmission.

VII. CONCLUSIONS

This system successfully implemented the Web Server by a uIP protocol embedded in STM32F107. And the bit error rate of the transparent channel was reduced through the introduction of the simple ring buffer combined with DAM technology. So this system will provide a new reference for the development of remote and intelligent monitoring and control system.

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