Design and Implementation of Embedded Web Server

Jie Xiao
Department of Information Science & Engineering,
Hunan First Normal University,
Changsha, 410205, China
Email: xiaoflyfox@163.com

FenShi Zeng
School of Information Science and Engineering,
Central South University,
Changsha, 410083, China
E-mail: zengfenshi@163.com

Abstract : **With the development of internet and the coming of the post-PC era, the embedded systems is becoming the center of interest in the current IT industry and exhibiting broad potential market. In the meantime, the access of embedded systems into the internet has become an important direction of the present internet development. By analyzing the adoption of ARM-based embedded Web server, it introduces the design and implementation of its key technical line, and by simulating the application to verify availability of the design finally.**

Key Words: **Embedded System ; ARM ; Embedded Web Server**

Ⅰ INTRODUCTION

With the rapid development of modern communication technology, Web technology has been widely used and was a great success. As the continuous development of information society, increasingly mature network technology applied to the embedded system has become a necessary tendency. With its good generality, platform independence and interactivity, Web technology is the inevitable choice of embedded system network process. With Web access ability of the embedded devices will get rapid development, the application in communication equipment, information home appliances, instruments remote management and other fields. Embedded Web server for embedded devices provide network interface, to realize the remote management and control, which is an important technology of the network embedded equipment [1]. This article introduces the structure of the Web server, the design and realization of a suitable for embedded system embedded Web server this embedded Web server to S3C2410 as a platform to embedded Linux operating system as the foundation, unifies the related embedded Web technology, use the resources of the pretreatment method, Web resources and Web server with itself become whole, through the design internal application program interface and virtual file system to realize the Web server functions. This task will be to reduce the cost of complete use of the limited resources to achieve the embedded Internet provides effective basis; for the system expansion and remote monitoring, control, diagnostics and other functions to provide a favorable technical support.

Ⅱ THE OVERVIEW OF THE EMBEDDED WEB SERVER

Embedded Web server (EWS) refers to the Web server will be introduced to the field test and control equipment, in the corresponding hardware platform and software system, with the support of the traditional test and control equipment for a change in the TCP/IP for the bottom communication protocol, Web technology as the core based on the Internet network testing and control equipment Embedded Web server to simplify the traditional server system structure, in Embedded equipment and to realize information transmission and the function of the network interface.

A. General Structure of Embedded Web Server

Embedded Web server design usually to general Web server system structure as the foundation, according to the characteristics of the embedded system is optimized. Embedded Web server hardware system includes the Web communications function of the microprocessor or microcontroller system, it can and front application system integrated together directly, or through the field bus and application system linked.

A complete hardware system by microprocessor, FLASH memory, DRAM memory, network interface and front application system of hardware. Microprocessor is responsible for all of the operation and management, FLASH, ROM memory used to store real-time operating system kernel system, TCP/IP protocol stack, all kinds of Web documents; DRAM memory for system is running use; The network interface implementation and Interne/Intranet connection; Front application system hardware finish of a traditional application function [2].

Embedded Web server software system usually include center processing module, HTTP engine, file system, configuration module, security module, application program interface. The server is the core of the central processing module, it is the control and the scheduling, HTTP engine realize the HTTP protocol, the file system access to resources, configuration module and security module implements the server configuration and security mechanism, application server interface implementation and application interaction. Application program interface module common are CGI (common gateway interface), SSI (server side contains) and HCPA (HTML-to-C preprocessor facilities), element order, custom, API interface and other forms, there are no corresponding realize standards.

B. Embedded Web server advantages

In equipment embedded Web server, make equipment can with today's biggest Internet network seamless connection, need not special line; Transmission content not only limited data, and images, sounds, and other multimedia information; Communication protocol (HTTP) is a standard and is open, independent of the system platform; The use of HTML (hypertext markup language) language has unity; Standardization independent of the client software interface hardware platform, greatly saves client development work; Use Web framework, openness and platform independence can greatly reduce the system design work. Embedded Web

server is versatile, to be embedded into any of the equipment.

Embedded Web server is application in embedded systems Web server architecture. It is currently the main application equipment management and enterprise application network expansion. Embedded Web server as a background process in embedded equipment operation directly; the user through the network to the equipment configuration, control, monitor, to ensure that equipment is effective and efficient operation. Web interface allows the user can be in any one have Internet access ability of the Web browser with the device access to the embedded equipment. Embedded Web server is very good provides Internet network connection, the application and the Web interface combined, is application network good solutions [3].

III SELECTION AND DESIGN OF THE HARDWARE PLATFORM

In the embedded system, the master control module chips to the whole system performance of the performance and the realization of the function of plays a very important role. Considering the whole system in all aspects of the factors, can realize the function of the reservation, give full play to the performance of the system in the other modules, has long stable working effect, to upgrade the subsequent leave space. This system choice of development board chip is S3C2410 processor, S3C2410 is an ARM920T kernel based on the 16/32 a RISC processors. It's a 32-bit RISC processor of Samsung Corp.

A. S3C2410X Introduction

When S3C2410X microprocessor by Samsung Corp for a handheld device design of the low power consumption, high level of integration of the ARM920T nuclear microprocessor, in order to reduce the total cost of the system and reduce the peripheral devices, the chip has integrated the following parts: 16 KB instruction Cache, 16 KB data Cache, MMU, external memory controller, LCD controller, NAND Flash controller, 4 DMA channels, 3 UART channels, 1 IIC bus controller, a IIS bus controller, 4 PWM timers, 1 internal timer, general I/O interface, real time clock, 8 channel 10 ADC and touch screen interfaces, master USB, slave USB, SD/MMC card interface and so on, widely used in PDA, mobile communications, routers, industry control, etc. S3C2410X provide all kinds of interface control, can support large operating system, so high frequency, senior storage management and rich peripherals interface is in full compliance with this system design requirements.

B. Hardware Design of the System

Usually the embedded system is the hardware architecture embedded microcontroller processor as the core, the CPU interface and hardware platform expansion of support, the numerous peripherals unit to the whole system integration, and through the CPLD such logic change device and other hardware circuit module and a complete foreign and control operations. Based on S3C2410X hardware platform design the main work is the peripheral circuit design, including the system bus, piece of choose, storage system, input and output design. Because of S3C24l0X gates become a lot of equipment controller, peripheral circuit design of become very simple. This system uses S3C2410X excellent performance and rich kernel external interface to construct a platform of embedded system. Figure1 for the design of this paper said embedded Web server hardware structure diagram.

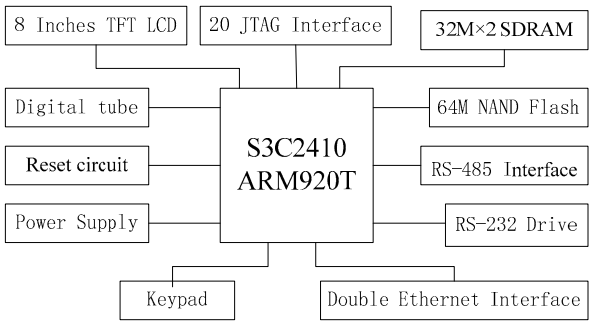

Figure1 hardware structure of the system

The main functions of the module description:

1) CPU unit: S3C2410X 16/32-bit ARM920T kernel, internal with all the performance MMU, has the open design, high level of integration, extensibility, low power consu -mption characteristics.

2) Memory unit: 64 MB NAND Flash, 64 MB SRAM

3) Power management unit: for the system to provide the 5 V, 3.3 V, 1.8 V power supplies.

4) Reset circuit: including electricity reset and means reset, and keep at least four clock cycle of effective low level to ensure that the system is reliable reset.

5) The clock circuit: external 12 MHz clock input, the internal frequency to 200 MHz PLL times and 32.768 kHz RTC clock input.

6) The network interface: for the system to provide the Ethernet access physical channel.

IV SOFTWARE SYSTEM DESIGN OF THE SYSTEM

Embedded hardware platform design software platform after success is the design, embedded hardware platform is, in fact, a common platform, based on the platform embedded Web server, must consider its versatility and for the hardware can be handling. Based on this consideration, this paper three layers building Web server software embedded system: the establishment of the ARM Linux; Boa server transplantation and building; the expansion of the CGI programs.

A. ARM Linux Builds

ARM Linux builds on the U-Boot implementation, it actually is the establishment of the Linux kernel in the process of transplantation in S3C2410, mainly divided into three steps: establish cross-compiling environment; Compile the kernel; to generate and configuration root file system [4] [5]. Below are a brief description and the realization of the three steps.

1) Establish cross-compiling environment: establish cross-compilation is the process of environment of actual cross the compiler compressed package solution package of process. In this paper, all the software source packages in the tools/directory, solution package instructions in the sequence used do not say, the solution package of path for/usr/local /arm_cross.

2) cross-compiling Linux kernel: in the cross before setting, the compiler options configuration is very important. Execute the "make menuconfig" orders, into the Syetem Type options. This paper chooses to support the S3C2410 system board, then configuring FileSystem and Blockdevice. Save configuration to change after Make-file documents, that is the path of the cross-compilation specified in this article for the installation of specific directory, change statements for: CROSS_Complie = / usr/local/arm_cross / 3.4.1 track of/bin/arm-Linux-. Finally through make dep; Make clean; Make zImage command compile the kernel, get the kernel image compression zImage.

3) To generate and configuration root file system: to generate and configuration file system basically has the following several steps of complete: installation busybox kit (first decompression busybox compressed package, in modify Makefile file decompression directory, and then Make use of in-stall complete installation); Creates a file system of the image file (first img directories, and then create into the root directory to create empty the image file to load the file system, create, and copy files system in the necessary documents); The configuration file system (after the above steps has been produced the file system need some documents, but need to set up the root directory, namely in the root directory must be under the add directories, files and right to set properties).

B. Transplantation and Building of Boa Server

Under Linux embedded Web server mainly has: httpd, thttpd, Boa to wait for a few kinds. Httpd is the most simple a Web server, its function most weak, does not support the authentication, does not support CGI. Thttpd and Boa all support the authentication, CGI, etc, the function is all. In order to realize the dynamic Web page, here we choose to realize a support of CGI, which is very suitable for embedded system Boa server. Boa is a single task http server, the source code open, performance is high; the advantages of the Boa are in its efficiency and reliability. This design, operating systems use ARM Linux operating system, server choose open source Boa.

Based on the Boa establish embedded Web server can be divided into the following steps to complete:

1) Establish cross-compiling environment and download Boa source packages unzipped: cross-compiling environment in constructing the ARM Linux has already established, compiled using the same here Boa cross the compiler, so don't need to build again. Boa source packages can be from http://www.boa.org download and unpack.

2) Installation and compiles Boa source code: in before compilation, need to be in/Boa/SRC/configure file to join CC and CPP instructions, and modify the CC=Makefile/usr/local /arm_cross/3.4.1 track of/bin/arm-Linux-and specify the Web server root directory path (SERVER_ROOT), and the specific method is: enter /boa/src/directory, in defines.h file adds #define ERVER_ROOT "/ home/httpd". And then compile #. /configure, modify Makefile files, find CC = gcc, to CC = arm-Linux-gcc, find the CPP = gcc-E to CPP = arm-Linux-gcc-E, save exit.

Make and then run the compilation, get executable programs for Boa, and debugging information will be stripped off.

make

arm-Linux-strip boa

In the boa/src directory will create boa file, the file is the boa server executable files.

3) Configuration Boa server: in order to be able to run in the hardware platform Web server Boa, it also needs to its operation environment, parameters, such as setting, and will eventually the configuration files of the Boa.conf on an appropriate location. Through changing the configuration file Boa. Conf can be used for Web server configuration, part of the configuration for: protected reliably against detective ports use 80 port; Log AccessLog visit stored in/var/log/boa /access_log; ErrorLog is located in the error log/var/log/boa /error_log; File the root directory of Docu-mentRoot in /home/httpd/; The value of the KeepAliveMax amended as 50; Keep-AliveTimeout value change for 10; CGIPath sets for /cgi-bin/etc; In the Boa. Conf last plus ServerNameEm -Server, will soon EmServer as a server name. The last will modify a configuration file Boa. Conf stored in the embedded system root file/etc/Boa directory. Through the mirror make tools executive order genromfs-fromfs. Img-drom-disk romdisk generated the image files romfs. Img, it wills romfs. Img through the Boot-loader download to flash memory.

4) Test of the Boa operation: in order to ensure the normal operation of the Boa, use simple test program test the running situation of the Boa. In the directory/home/httpd/, establishes the index. HTML documents used to test main screen, images of various pictures for storing the directory. According to the boa.conf configuration, will cross in front of the compiled embedded database also on/home/boa /cgi-bin directory, and then run the boa. Set the IP address of the ARM for 211.69.77.71. In PC operation platforms, in the address bar to input the target system IP, that is, 211.69.77.71, can see the relevant pages, said Boa can normal for the page.

C. Expansion Design of CGI

Common Gateway Interface (CGI) is the abbreviation of, it is the Web server hosting with external expansion application interaction of a standard Interface. Its main function is in Web environment, from the client transfer some information to the Web server, the Web server receives the information into the environment variable, and then to start specified CGI scripts to accomplish a specific work, a CGI script from environment variables in get information to run, finally in HTML format output corresponding implementation results returned to the browser. Because the customer can send different parameters to the CGI scripts, so CGI technology makes between the browser and the web server interactive [6].

The expansion of the CGI is that development in config. C for the expansion of function increase a command yards flag, and the processing of the designated it response function. And then in the cgihead.c to complete the processing of the response function of the code can [7]. Through the Web server realize setting embedded system IP

address to illustrate the expansion of the CGI method and process of development:

1) First in the left. The menu bar in HTML added a: "Settings IP". That is in: / home/HTTPD/HTML/left. HTML, increase a:

< tr > < td align = center > < a href = / cgi-bin/config. Cgi? Flag = 85 target = main > Settings IP < / a > < / td > < / tr > here for his user can allocate a command yards flag = 85.

2) In the config.c for the command in code, 85 designated the processing function, by adding code: else if (STRCMP (string. Stringout [0], "85") = = 0)

Showsetip ();

3) In the cgihead.c showsetip function complete code: this command the processing function is dynamic generation of a set of IP page, the real IP set is the user in this page by clicking the "confirmation" only after treatment.

Users in this dynamic generation on the page of the click after confirmation call another CGI ordered the processing function, it is in the showsetip function is composed of the following a line designated: < input type = hidden name = flag value = 83 checked > it specifies the user clicks on the processing order confirmation code for 83.

4) In the config.c for the command in code, 85 designated the processing function, by adding code:

Else if (STRCMP (string. Stringout [0], "83") = = 0)

Setip ();

5) In the cgihead.c setip function completed in the code. The handling code with vfork + execl executive ifconfig /route orders, complete the IP set work, and a return shows the operation, provide the user to restart. After the restart the IP address of the board is the IP address of the change.

D. Verification of the Scheme

This paper designed a simulation application to verify the design of usability. Through the operation in the distant ordinary PC browser visit operation in hardware experimental platform Web server, through the function of the server offers to experimental platform of I/O Interface on access and control. Through visiting different web pages, server running corresponding "program" to get results and back to the client. The PC's browser http://211.69.77.71/ input to enter Web server management page.

V CONCLUSION

The realization of the embedded Web server lets the user through the browser remote set the parameters of the embedded system and control the operation of the embedded hardware. This paper introduces a kind of embedded Web server design and realization method, the operation results show that the scheme is running well, interface design is reasonable, function expansion is convenient. With the deepening of the Internet application field, embedded Internet technology will get more extensive application and development, the design of the embedded Web server will also play an active function and role.

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