Communication and Control in Home Gateway

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Abstract

This paper introduces the design of home gateway communication control part, including the network interface circuit, network interface driver, client / server (C/S) mode of communication, embedded server programming, remote client programming .The server uses LPC2290 as the processing chip, the transplantation of uClinux operating system, in the redhat9.0 environment, developed the core control program, and terminal subroutine; client software is designed by VC++ , running on Windows platform, convenient for the user to control the home gateway, and the operation of network appliances. As a result, the server program runs stably and reliably, the client software control network appliance normal operation, can meet the needs of intelligent home control system.

Keywords: Home Gateway, communication   control

1. Introduction

With the rapid development of information and network, intelligent home system has been quietly rising. Intelligent home system, through some transmission media inside the family (such as power line, twisted pair, coaxial cable, radio, infrared) , connect all kinds of electrical equipment and electrical system, to realize the sharing of information resources, through the gateway and the external network (such as: Ethernet, ISDN, ATM), realize external information exchange [1,2].

The key of the intelligent home system is the home gateway, it implements Ethernet exchange of information and network appliance centralized control of [3,4].The current network communication with the router only data exchange and communication, no household appliances control function and data reporting function. Based on the above ideas, we want to design a home gateway with control function. This paper mainly introduces the family gateway communication and Control part of the design, using 32 processor LPC2290 as control chip, set up the hardware platform, design the interface circuit, and its driver, design the control program of server and client,

realize the information collection, transmission, storage and other functions, provides a user-friendly operation interface, not only can control the independent electrical work, feedback home state, but also has a monitoring alarm function, the realization of home network convenient, fast, efficient control and management.

2.The System Structure of the Home Gateway

2.1 The Hardware Composition

The system hardware block diagram is shown in Figure 1, Philips company LPC2290 chip as the core, through the network module connecting external internet , can realize the appliance data report, can also achieve remote control of the electrical appliances; Bluetooth module, connected the internal home network, achieves communication of the network household appliance; Liquid crystal display module using the touch screen, through the LCD module will be the current state of network appliances, through the touch screen display, can also realize local controls of the home network [5-7] .
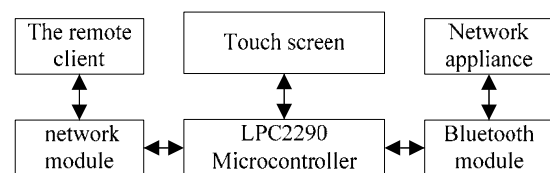

Fig. 1 The system composition block diagram

LPC2290 is the Philips company launched a micro control chip based on 16/32 ARM7TDMI-S core, with the support of real-time simulation and tracking functions, using the LQFP144 pin package, 16K bytes of on-chip static RAM, through the external memory interface can be allocated memory into 4 groups, each group is up to 16Mb capacity, data width is 8/16/32, two 32-bit timers, eight 10-bit AD converter, by configuring the bus provides up to 76 GPIO, serial communication interface with a wide range of

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applications, and therefore suitable for various types of communication gateway.

Network control chip DM9000E produced by DAVICOM company. DM9000E is MAC, PHY and MMU three fast Ethernet highly integrated a control chip, with 10/100M adaptive, 16KB large capacity FIFO, four multifunctional GPIO and full duplex operation functions, in full duplex mode, and can simultaneously send and receive. It has 3 levels Power saving mode, in full duplex mode can be connected to a switch or hub, receive and send data, is ideal selection for green computer network equipment. Based on the above consideration, in this paper, the home gateway Ethernet interface design based on DM9000E.

Touch screen complete data display and data input, convenient for users to query and set in the local state. It is a 5.2 inch, resolution of 320×240 color LCD touch screen. because the LPC2290 chip itself is not a color LCD controller and touch screen controller, so it needs an external color LCD controller and touch screen controller. Here, color LCD controller adopts EPSON dot matrix graphic LCD controller S1D13503, touch screen controller FM7843 is a four wires resistive touch screen input control chip, power supply for 2.7~5V, owing to LPC2290 pin voltage is 3.3V, so the FM7843 operating voltage is 3.3V, the AD reference voltage is also 3.3V.

The system uses 8MB SDRAM, 16MB NAND Flash. Among them, the 8MB SDRAM memory storage system for runtime user data stack, 16MB NAND Flash memory used for storing user application program has been debugging, embedded operating system or other user data need to be stored in the system after power off.

2.2 The Establishment of Development Environment

Application development environment based on uClinux operating system is composed of the target board and host, target board running operating system and application software, the host executing operating system kernel compilation, application program development and debugging, connection is established through the serial port or Ethernet interface.

On the host to install RedHat Linux 9, building the cross compile environment, install arm-elf-gcc compiler for ARM and uClinux, and patch the LPC2200, select LPC2200 option in the uCLiunx kernel configuration, carry Menuconfig, and "Make" commands after configuration, generate the kernel image burned into the target board, when the system is reset or when the power is on, the kernel starts running.

3. The Network Interface Circuit and Driver

3.1 The Hardware Circuit of Ethernet Interface

The basic block diagram of interface design as shown in Figure 2, the LPC2290 and the DM9000E connect through the address bus, data bus and control bus, and then through the joints of RJ45 to Ethernet, The development of Ethernet driver in Linux environment, completes the data transmission, realize the data interaction [8-10].
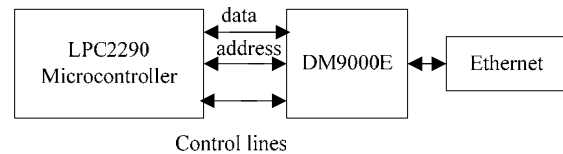

Fig. 2 Ethernet interface design basic block diagram

The hardware circuit of the home gateway Ethernet interface as shown in Figure 3, including a 10/100M Ethernet interface circuit, control circuit uses 16-bit bus, the LPC2290 data bus D0-D15 and DM9000E chip SD0-SD15 connection, DM9000E address bus SA4-SA7 grounded, SA8-SA9 3.3V, The chip select line IO_nCS1 and DM9000E AEN connection. address lines A2 and enable terminal CMD is connected.
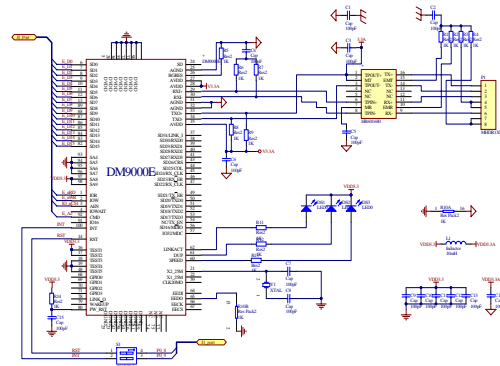

Fig. 3 Circuit connection diagram

3.2 DM9000 Ethernet Interface Driver

There are two ways to use the device driver in the uClinux operating system: directly compiled into the kernel; loaded at run time (i.e., the kernel module).

Directly compiled into the kernel, the user can call to it at any time without the need to install, but it greatly increased the kernel space. Loaded at run time, is a loadable kernel module, which is a modular structure,

convenient to program design and debugging. The design adopts the latter.

The DM9000 driver design using uClinux source code, and combined with the hardware to make appropriate modification, can meet the requirements. DM9000 driver consists of 4 documents, they are config.h; dm9000.h; dm9000.c and makefile.

The config.h contains a variable data type definition, and also some hardware configuration information; the DM9000.h file is the content related hardware, including all the header files in driver program dm9000.c, hardware interface define such as: chip registers macro definition, byte pattern definition, physical layer parameters definition.
etc.

Dm9000.c is the main program, the main functions include: init()(initialization function), net_cleanup()(clean function); interface functions to application program include: stop () (stop function), set_config(configuration function); makefile save some compiler related information, such as the goal and the source file name, header file path, the compiler environment, compile parameters, etc.

Compilation is completed, according to the need to "load" or "uninstall" driver program.

4. Communication Control Program Design

4.1 Network Communication Program Design

UClinux operating system provides the TCP/IP protocol stack and the Socket programming interface, gateway remote control is based on the C/S structure, the home gateway and remote client communication program using the socket call, use the data frame format to encapsulate data, to achieve reliable transmission and control of data through the TCP/IP protocol[11-13], the home gateway and remote the client Socket communication process is shown in figure 4.

Client: after the remote client and family gateway the connection is established, the home gateway electrical node number, state parameter data is encapsulated into a data frame, sent to the remote client. In the monitoring interface can display various intelligent electrical node state parameters; when the remote control, remote client will control command data frame is sent to the family gateway to the agreed protocol encapsulation.
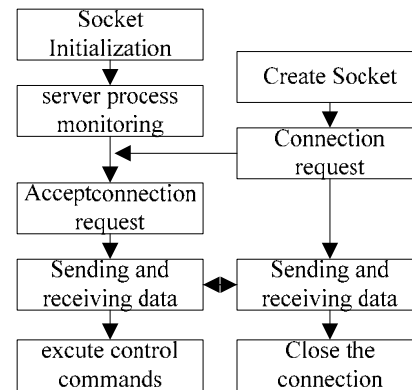

Fig. 4 C/S communication flow chart

4.2 The control program design of server

In this design, the client sends the application process request information to the gateway, the gateway will handle the request information, then according to the request complete the operation scheduled, i.e., the client sends control information into the command, control the corresponding network appliance operation, and modify the display status gateway, then put the result back to the client [14,15].

In order to realize the multiple control of household electrical appliances, must be unified coding, so that the transmission control information can be reduced when the channel flow, improve channel utilization, more important is the guarantee to realize the accurate control, convenient modular design, achieve more programmers collaborative programming.

We use two-byte to delivery control status word. Provides high seven is used to control the home appliances category, realize the control of the 128 kinds of home appliance, can fully meet the needs of the future family; eighth to achieve control of the server, the server open provisions into 1, closes into 0; the lower eight bits are used to control the household device specific functions, the realization of control of 256 functions. The washing machine control design as an example to introduce the code.

As shown in Figure 5 the lower five bits for the home appliance mode control bits, sixth bit is a home appliance start / stop control bit, seventh bit is a home appliance switch control; eighth is a local / remote control bit, Ninth bit for the server control, high seven bits reprent home appliance type.

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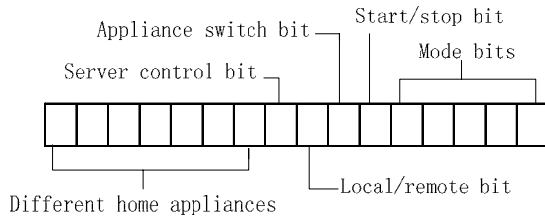ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
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Fig. 5 Schematic diagram of control program code

In data transmission and recognition, we require: identity authentication information string at the beginning and end of the automatic "#", while the control information of the string at the beginning and end of the automatic "&".The client in this frame, the server identifies, judges and controls subroutine in this way.

We can call multiple processes in the server, to realize multiple users visit the home gateway at the same time. The client can realize multiple users access to the server at the same time, the server can realize multitasking. vfork function in the uclinux realize the process call.

4.3 The control program design of client

The client program is composed of the communication program, the user login procedures, main control program and a number of control object program. In order to improve the portability of applications, using API programming, asynchronous communication congestion.

The first communication connection, creates a socket, bind IP and PORT, if the connection is successful, it will be sent to enter the username and password to the server side, If verified, then establish communication, into the main program interface; if it does not pass the verification, it closes the socket, reconnect.

In the main control program, we consider a home appliance control, automatic meter reading, safety and protection, home environment detection, program development using a structured design method. The washing machine control as an example, we define a uniform interface in the main control program, namely the string variable ll_send is used to send control information, ll_recv is used to receive feedback information. Using the above mentioned encoding rules will control command code, and then assigned to the ll_send, sent to the server. Server identifies the code, and implements the corresponding operation.

5. Conclusions

This paper designs the communication control part of the home gateway, the system adopts the client / server model, structured programming design method. The server adopts uClinux operating system, developed the server communication control program. The client program design using VC++ technology, makes the running efficiency of the program is higher, run faster. Experiments show that, the effectiveness of the system, reliability, flexibility, convenience can satisfy the system requirements.

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