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PC & ARM-based Design of Remote Control System for Intelligent Home

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Abstract

The core processor of this system is S3C44B0X, the kernel of which is ARMTTDMI. External extension Flash, SDRAM and an Ethernet interface are used to provide remote PC Internet access. Self-made Humidity & wind speed sensor is used to collect environmental data, with stepper motors and relays as the executing agency to control the plant object. With regard to software, vectoring procedure boot loader and operating system uClinux are transplanted to development platform. Meanwhile, an embedded web server is built by way of Boa and CGI to uclinux. Website programs based on embedded web server are written to receive user requests, return to the page and call the relevant subprograms (collection and control) and ultimately meet intelligent home system requirements for remote network control.

Keywords: *PC; ARM; intelligent home; remote control*

1. Introduction

In recent years, along with the rapid development of Internet technology and information communication technology, the spot for research is how to combine computer technology, control technology and communication technology and apply them into traditional household electric appliances to enable them have intelligence and can be connected to the Internet. In this situation, the appearance of the 32-bit embedded micro-computer (such as ARM) enables embedded Web to become true. People can remotely monitor each unit of home network via Internet. Compared with the traditional household Central control unit, this system can reduce equipment costs and realize unlimited extension of the intelligent home network node through the main line.

2. Control Process and System Specifications

The remote control system for intelligent home adopts ARM7 microprocessor and embedded operating system uClinux to build a Web site of embedded Web server, which can make any PC with Internet access visit the website after the status authentication, browse the real time operation condition of electric home appliances and edit homepage parameter to carry on the remote control to the electric appliance. The system selects smart windows, air conditioners and rice cookers as actual electric appliances to control, uses relays to control switches of the air conditioners and rice cookers, uses the Stepper Motor to control the opening and closing angle of windows and measures humidity and wind speed in order to automatically close the windows. The real time operation condition of electric home appliances can be sent to the internet through ARM and users can visit websites to browse pages to know the operation condition of electric home appliances and have access to modify the Web page to adjust the electrical parameters. Figure 1 shows the system assumption diagram.

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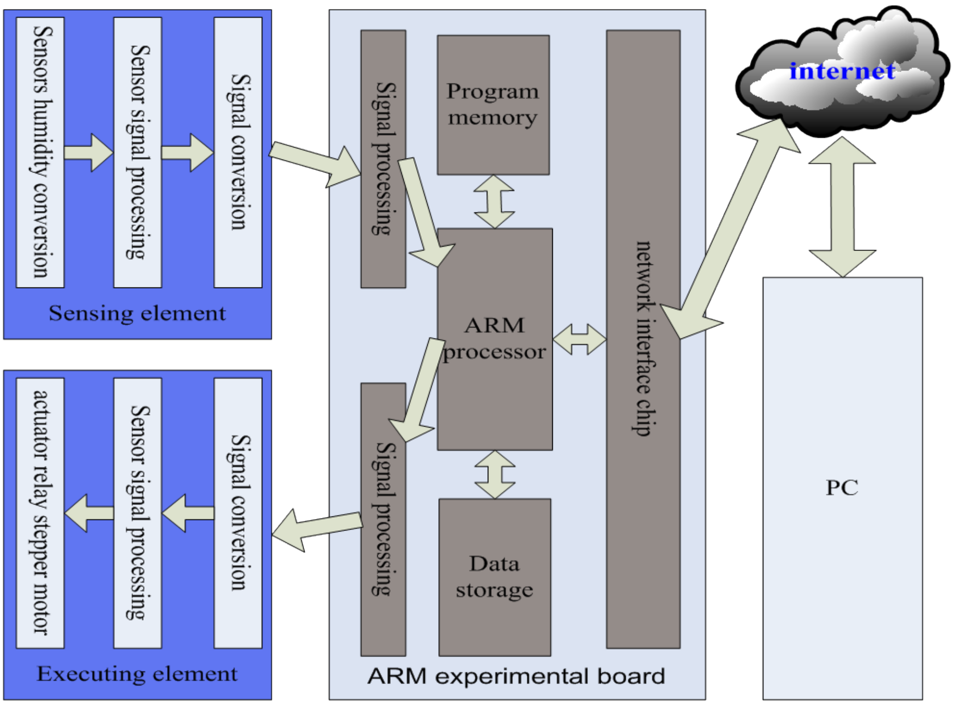

Figure 1. The System Assumption Diagram of Remote Control System for Intelligent Home

To reach the goal of remote control of intelligent home appliances through embedded Web server system based on ARM, stepping motors, relays and other implementing agencies, the system should meet the following specifications:

(1) real time detection of environmental humidity, wind speed data;
(2) saving the state data of stepping motors and relays;
(3) automatically adjusting stepping motor rotation, according to the ambient humidity and wind speed to switch windows;
(4) accessing the embedded Web server via the Internet Web pages and browsing the state of home appliances
(5) setting parameters via the Internet, adjusting the stepper motor rotation and controlling the switches of relays to realize remote control

3. System Hardware Structure

3.1. The Overall Structure

This system uses 8-channel input module and 8-channel output module to simulate the control of the switches of air conditioners and rice cookers. A two-phase-four-step stepping motor is used to simulate the control of the opening and closing angle of windows. Sensors of self-made humidity and wind speed are used to measure humidity and wind speed. Digital signals are output from the digital input and output units to control relays and stepper motors. The analog signals from measurement of ambient humidity and wind speed are input by the motor interface and processed by CPU (ARM) after converted into digitals by the self-contained 10-bit A/D analog digital converter. The embedded Web server within CPU releases the operation conditions of the electric appliances to the network for users to browse, receives the orders from users and calls the associated program to control relays and stepper motors. Figure 2 shows the overall structure of the system hardware.

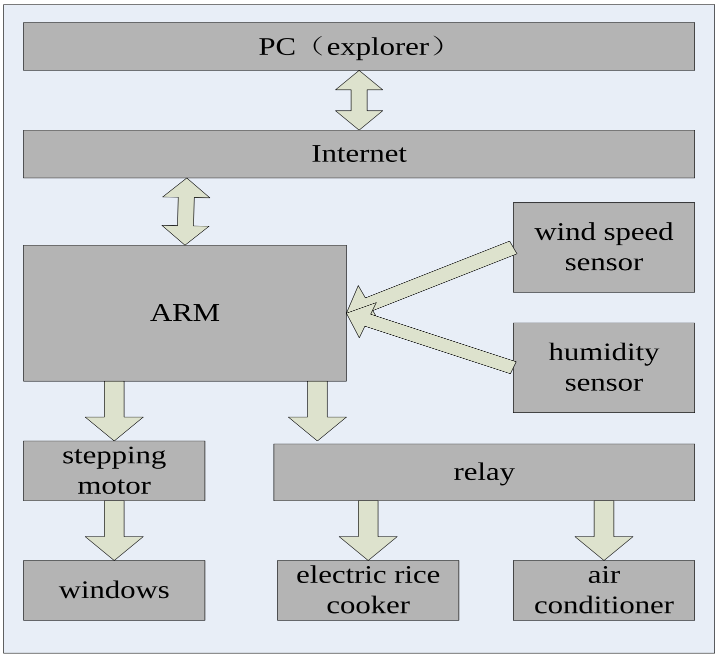

Figure 2. The Overall Structure of the System Hardware

3.2. Hardware Circuit

The hardware circuit of the remote control system for intelligent home is divided into three parts: detection segment and control segment. The core processor of the core board is S3C44B0X dominated by ARM, with extended peripheral memory chips, such as Flash CMOS SST39VF160, SDRAM chip HY57V641620, ethernet controller chip RTL8109AS. Figure 3 shows the function of the core board

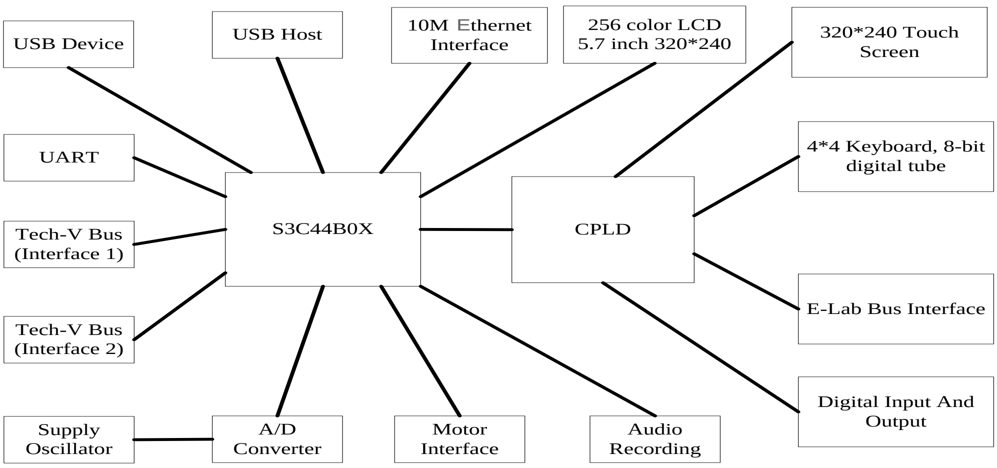

Figure 3. The Function of the Core Board

The detection segment is mainly used to measure humidity and wind speed. The anemometer is wind-Cup, therefore, the impact of wind direction on the sensor don't have to be considered. The sensor of speed selects the photoelectricity type because this type of sensor has the characteristics of being non-contact, high sensitive as well as having quick response and so on. Circuit design is as shown in Figure 4, when there is shelter, optical transistor is in an on-State, that is, high-resistance State. The voltage on R2 is approximate to zero and the output voltage is lower than the low levels required by ARM after Operational amplifier.

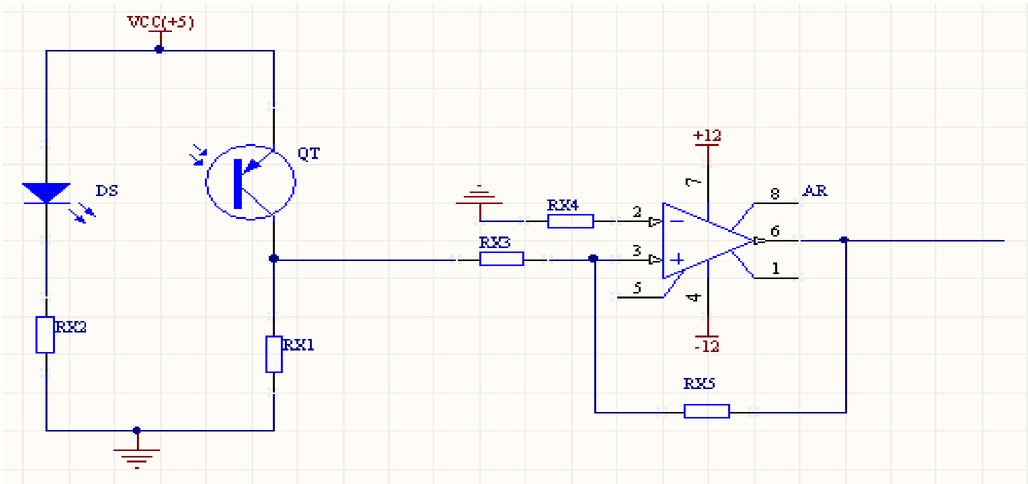

Figure 4. Anemometer Photoelectric Detection Circuit

4. Software Implementation of Intelligent Home Remote Control

The Software system of remote control system for intelligent home is divided into five parts: the boot loader, uClinux operating system, web services program, ADC drivers and user application program.

4.1. Implementation of Embedded Web Server

Under the condition of UCLinux, three Web servers are provided: httpd、 thttpd and Boa. Httpd is the most simple and vulnerable Web server, and it does not support authentication or CGI; while thttpd and Boa support authentication and CGI. If the system's security is to be improved, it is necessary to interact with users. When it comes to data inquiry or real-time condition inquiry, dynamic Web technology must be used and either thttpd or Boa can be chosen to implement the task. This system adopts Boa and CGI to build a Web server as is shown in Figure 5.

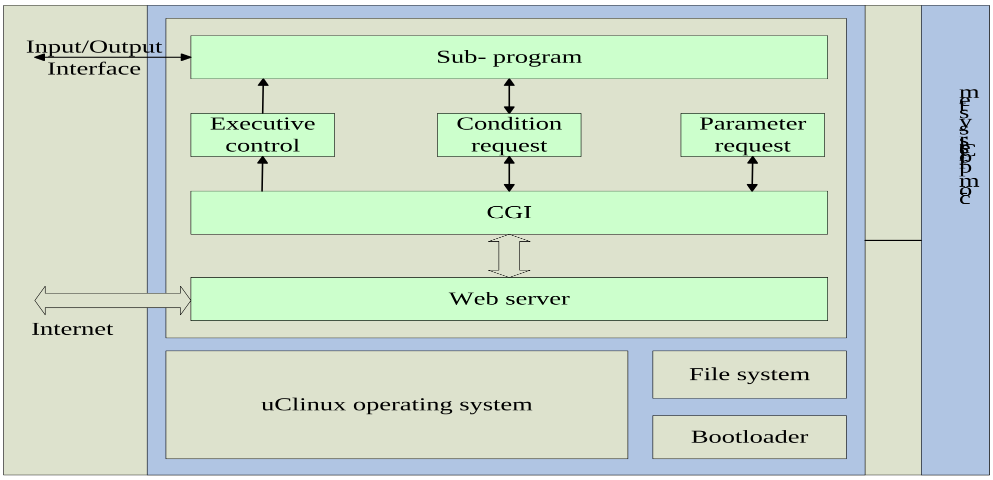

Figure 5. The Diagram of Building Web Server Software

4.2. Realization of Remote Control System

Design of the remote monitor system can be divided into: form/page design and CGI programming. The form/page is used to provide function selection page and system control function page. In the design process, he JavaScript script is inserted in the standard HTML language for the simple control of the browser end. For example, when a user is setting a parameter to the browser, it is possible for him or her to input an incorrect parameter (such as a letter is input at the time value) or unreasonable parameters, if this type of errors are submitted to the server for processing, time will be wasted and network bandwidth will be consumed because of the sending and receiving of messages, meanwhile, processing pressure of the server will be increased. Therefore, JavaScript can be used on the parameter-set HTML page. Before users submit form data to the server, the parameters are tested for validation. Control system page is shown in Figure 6.

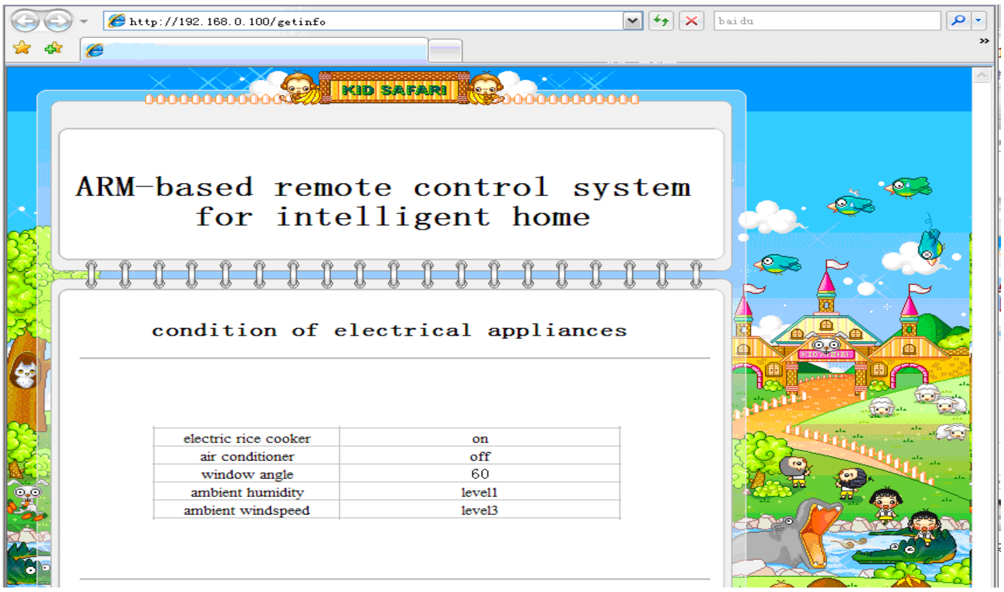

Figure 6. Condition Page for Electrical Appliances

CGI responds to users' requests through Web server, implements related operations and completes' monitoring tasks. In this system, CGI mainly completes the following two functions: (1) responding to users' inquiry requests, checking environment humidity, wind speed and the condition of stepping motor and relay and providing users with field information by page form; (2) receiving users' request for action control, calling the appropriate sub-program after decoding, implementing control action and saving it to a file. The Web Server page files of this remote control system and CGI program are shown in Figure 7.

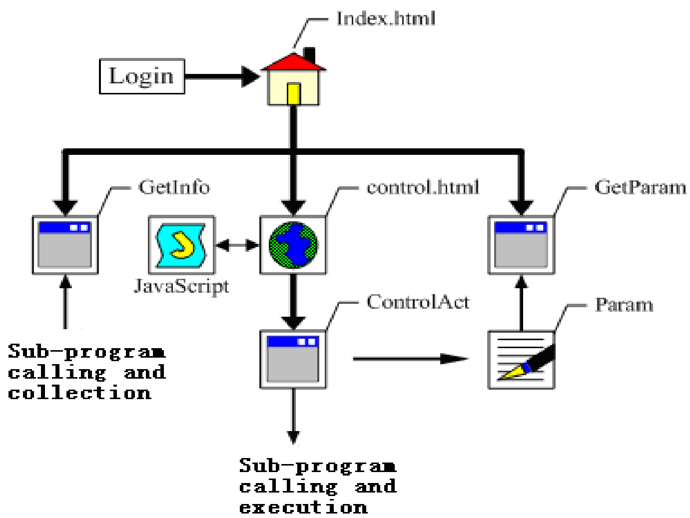

Figure 7. Web Server Page Files and CGI Program

5. Conclusion

This article introduces the hardware and structure of the remote control system for intelligent home. The design method of main modules, as well as the structure diagram of the software implementation and the concrete implementation of the control system is also introduced in this article. There are many interfaces in this system. Along with the development of broadband wireless communications technology, network technology and microprocessor technology, the remote control system for intelligent home will be perfected and developed. Intelligent home is a sign of improvement in living standards in recent years. With today's rapid development in information technology, the remote control system for intelligent home can connected to the Internet and enabling users to achieve the remote monitoring and control becomes the trend of household electrical appliances.

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