Design of Embedded Network Human Machine Interface Based on VR Technology

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Abstract. In order to reduce the number of embedded network control pins in human-computer interface and enhance the reliability of embedded network human-computer interaction interface, a design of embedded network human-computer interaction interface based on virtual reality technology is introduced. In terms of hardware, the controller uses tms320lf28035 DSP chip, and its EVM board is used as the extended digital interface and display module. In terms of software, the keyboard adopts timer interrupt management to save DSP hardware resources and complete human-computer interaction. The circuit meets the requirements of general frequency converter for data input and output display. The serial parallel conversion chip can save hardware resources and provide reference for frequency converter to realize more control functions.

Keywords: VR technology · Embedded · Human-computer interaction · Network interface

1 Introduction

With the development of embedded system and the wide application of FPGA, SOPC based on FPGA is more and more popular with designers because of its flexible design, programmable hardware and software, scalable and tailorable. The MicroBlaze soft core processor embedded in FPGA is configured in the form of IP core [1]. By combining with other peripheral hardware devices, it can quickly complete the design of the whole embedded system, greatly shorten the development time of the system and improve the resource reuse rate. Some scholars have designed the hardware platform of the system development, researched and designed the embedded human-computer interaction interface based on FPGA, and realized the control of the modem through human-computer interaction. The results show that the design of man-machine interface can be realized by FPGA, and the selection and configuration of modem internal modulation mode, code rate and frequency converter parameters can be realized by man-machine interface. Human machine interface is the medium of transferring and exchanging information between human and computer. The rise of embedded system application provides a broader platform for the design of human-machine interface. However, the number of embedded network control pins in the current human-machine interface is large, which

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leads to the decline of the reliability of human-machine interaction interface in embedded network [2].

In order to solve the above problems, the network man-machine interface based on VR technology and embedded system is studied. The design of embedded network human-computer interaction interface based on VR technology is realized by CGI program in uClinux operating system on the target circuit board and boa web server which is responsible for processing CGI program. Remote users use Internet browser to input parameters and trigger CGI program on boa web server to process parameter data. Experiments show that using this method and designing a good HTML page, we can quickly design a simple, friendly and user-friendly human-computer interface.

2 Design of Embedded Network Human-Computer Interface

2.1 Configuration of Embedded Network Human-Computer Interface

Embedded system is an application-centric, computer technology-based and software and hardware can be tailored dedicated computer system [3]. Based on the advantages and practical requirements of Qt/Embedded, the human-computer interface of the monitor is designed by Qt/Embedded.

Adopt software and hardware collaborative design, in which, the software part includes uClinux, Boa and CGI program written; the hardware is a self-made Niosi processor development board, mainly composed of FPGA chip EP1C6Q240C8, Ethernet interface chip DM9000A, necessary memory (such as DRASM, FLASH chip) and debugging interface (such as JTAG, RS-232). The interface board based on ARINC429 is composed of five main parts, namely, DSP core system, oscillating clock system, ARINC429 transceiver interface, dual port RAM and logic decoding part. The specific structure diagram is shown in Fig. 1.

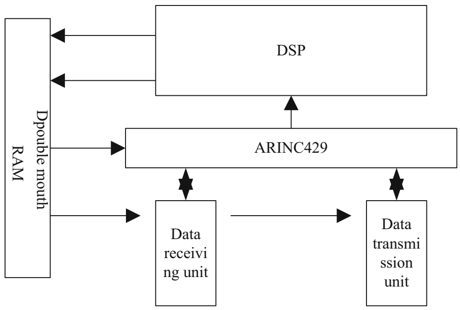

Fig. 1. Configuration structure of human-computer interaction interface in embedded network

As an important core part of the entire interface board, DSP needs to fully consider the real-time performance and data throughput capacity of the system. Therefore, the TMS320LF28035DSP chip is selected as the central processing unit of the system. This chip can provide high performance for the design of the embedded low-level software test platform. Low-consumption processing effect [4]. The login verification design of the embedded low-level software test platform is to verify whether the user's identity is correct by logging in to the verification platform, and whether it can be consistent with the user name and password in the database, which provides protection for the security of the client. Only through identity verification can it be carried out. The main page of the software testing platform. The main reason is that the platform has good confidentiality and security performance. For no registered account, the identity verification design of the test platform is as follows: First, the administrator should design an embedded low-level software test platform based on the ARINC429 interface board Security functions, such as login user name and password, and then assign the set user name and password to different users, and save them in the database server. Finally, in order to realize the safe login of users, encryption algorithms are needed to ensure the storage of user information Safety.

Perform periodic and continuous automatic collection of embedded bottom software data, transfer the collected data to the data processing center through the data transmission center in the test platform, and organize the data that the bottom software needs to run into the database for storage and management Through the display of the operating information of the embedded underlying software, personnel can monitor the operating status of the software in real time [5]. The data query of the embedded low-level software test platform is mainly by querying the specified software running time and type, and receiving the data of the embedded low-level software running through the server, using a table or broken line to show the result of the query, which can be Provide support for the diagnosis of software evaluation data.

2.2 Optimization of Inverter Equipment Based on VR Technology

Modern general frequency converters mostly use diode rectifiers and PWM inverters composed of IGBTs or smart power modules to form AC-DC-AC voltage inverters. The inverter circuit is divided into four parts: rectifier circuit, intermediate DC link, inverter link and control circuit [6]. The main circuit adopts a typical voltage-type AC/DC traffic inverter structure, and the control circuit mainly includes a DSP digital controller, including DSP, drive circuit, detection circuit, protection circuit and auxiliary power circuit. This circuit is composed of inverter and keyboard parallel circuit. Complete data input, parameter setting, data exchange, selection of display information, menu selection, real-time monitoring data viewing and other operations. The software dynamically scans the keyboard and ledVR technology combination to manage key input and data output display. Sensors are the core equipment of wearable devices, the "core" of communication between people and things, the gate of the "perception era", and an important hardware for product functional differentiation.

According to requirements, this design needs to configure and remotely control the modem through the PC, so the Ethernet interface is designed to realize this function [7]. This design uses Wiznet's W5500 chip, which is a full hardware TCP/IP embedded Ethernet controller, which integrates the TCP/IP protocol stack, and the 10/100M Ethernet physical layer and data link layer. It enables users to use the chip to expand network connections in their applications, and provides a simpler Internet connection scheme for embedded systems [8]. W5500 has built-in 32K bytes on-chip buffer for Ethernet packet processing. The full hardware TCP/IP protocol stack supports TCP, UDP, IPv4, ICMP, ARP, IGMP and PPPoE protocols, so this design only needs to pass some Socket programming. Realize Ethernet applications. Users can use 8 hardware sockets for independent communication at the same time. Its main features are as follows:

Because the multi-channel serial communication system has relatively weak signal acquisition and processing capabilities under actual conditions, it is necessary to strengthen the processing of the multi-channel communication conditioning circuit interface, and combine the VR technology to collect and convert information to ensure that it is in digital The communication process effectively performs digital conversion and quickly converts analog communication signals into digital transmission signals [9]. In this way, the influence of noise is avoided and the information is transmitted accurately and at a high speed. The design of the multi-channel serial communication interface circuit based on VR technology can effectively avoid the impact of data transmission delay and information damage caused by software interruption, avoid the problem of data conflicts caused by excessive information during system operation, and improve system operation stability. Combining the above design, design the operation flow of system modules such as priority and trigger conditions of the multi-channel serial communication system [10–13]. XCL bus is a high-performance bus form designed for accessing external memory. MicroBlaze's cache interface directly connects the storage controller and the integrated FSL buffer. It has two types of interfaces, DXCL and IXCL, respectively responsible for data and instruction data transmission. In the design process of VR-based multi-channel serial communication interface, different module loops play different functions during operation. In order to better understand the role of system modules, the specific multi-channel serial communication interface function display module as shown in Fig. 2.

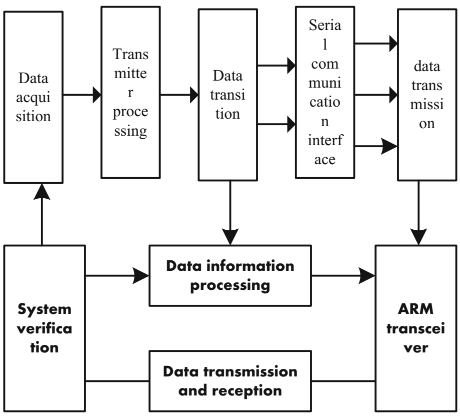

Fig. 2. Multi-channel serial communication interface function module

In order to improve the efficiency of the microprocessor's instruction execution, and to ensure the correct detection of the button value, and to eliminate jitter, only software can be used. Therefore, in the button management, the timer interrupt method is used. The timer interrupt program checks the button at regular intervals. State, and store the return value of the key in the buffer. When the key is detected, a mark about the key is set up. When the key mark is detected in the main program loop, the key is pressed. The timer is about ten milliseconds. The detection interval can effectively filter the jitter of the keys, realize the debouncing of the keyboard, the key value acquisition and the long and short recognition of the key time. The MicroBlaze soft core processor is a powerful 32-bit microprocessor. It uses a configurable RISC streamlined instruction set and optimizes the Xilinx FPGA chip. It is the fastest in the industry's soft processor IP core solutions. Comply with IBM's CoreConnect bus standard, with reusability and compatibility, the most streamlined core only needs about 400 Sfice. In order to cooperate with the software debugging tool based on JTAG, the MicroBlaze soft-core processor introduces a debugging interface, which is usually called a background debugging mode debugger. MDMCXilinxMicroprocessorDebugModule is connected to the JTAG port of Xilinx FPGA, and the MDM core is connected to the debug interface. Multiple MicroBlaze scenes can also be debugged by connecting multiple processes with a single MDM.

In the whole system design, the main function of the software design is to realize the control of the internal modules of the modem through the human-computer interaction interface, and to realize the data communication between the PC and the modem through the Ethernet interface and the DART interface. The main content of the design includes the driver of the keyboard chip, the driver of the LCD module, the configuration program of the inverter, the driver of the Ethernet interface and the driver of the DART interface. In the software design of VR technology display output, the dynamic scanning control of VR technology can make the characters to be displayed by different positioning VR technology. Cache the spatial location point information of the human-computer interaction device, set a strategy within certain conditions to form an input information trajectory, and perform segmentation processing on the trajectory to make it a primitive. Assemble and classify the segmented trajectory, and identify the action behavior input type. According to the different behavior input types, connect the segmented trajectory, analyze the trajectory information according to the human-computer interaction application attribute, and perform surface projection operations on it to form the interaction principle. Language, lay the foundation for the establishment of the information control model of human-computer interaction equipment. The information control model design of human-computer interaction equipment is shown in Fig. 3.

In the human-computer interaction control model shown in Fig. 3, interaction capabilities and execution performance are reflected to facilitate users to understand the interaction process. The description of user goals can complete the description of target interactive tasks, and design buttons and move mouse operators can provide basic operation capabilities for the execution of user goals. Choose the prediction method to decompose the sub-goals and make decisions for the user's goal state. Derive the specific execution method from the control model, use the short-term estimation memory method to analyze the state behavior. Each module loopback structure contains three information transceivers to meet the requirements for accurate processing of multiple complex data loops in time. In the information processing module, the data is configured and

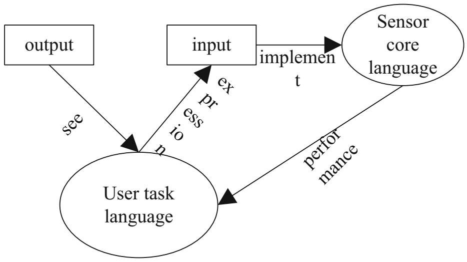

Fig. 3. Information control model of human-computer interactive equipment

compressed and sent to the VR transceiver, and then the big data is detected and stored by the VR transceiver and then sent to the data receiving module. In order to ensure the accuracy of the data, all data must be decompressed in the data verification module, the received data and the generated data are compared and verified, and finally the verified data is encrypted and transmitted to the data receiving end And stored in the designated folder. During the operation of the verification module, once the two data is found to be abnormal, it will immediately send the original primary instructions for deployment, compare the original data to observe, determine the location of the error information and modify it in time. To ensure the accuracy and timeliness of multi-channel serial communication.

2.3 Optimization of Embedded Network Human-Computer Interaction Control Panel

The control panel is selected as the second stage of the embedded network human-computer interaction interface processing. According to the keywords and parameters extracted in the decision-making problem understanding stage, the corresponding decision model is found in the model library and the model with the best correlation is returned., That is, choose a problem solving model that matches the goal of the decision-making problem. This stage is divided into three processes: model type selection, model structure selection and model instance determination. The control panel can provide a man-machine interface for inverter users. There are different function keys and indicator lights on the panel to help users realize functions such as start, stop, steering, parameter setting and real-time information query. The control panel consists of a display screen composed of VR technology, LED indicators and 8 function keys. Its functions include parameter setting and modification, motor control command group, real-time information display, etc. The DSP continuously scans key modules, compares the received key values, and then executes the corresponding function functions stored in the program to achieve the expected execution effect. Based on the hierarchical processing of human-computer interaction space information, surface behaviors and mixed behaviors are uniformly processed in a continuous interaction space. The specific processing flow is shown in Fig. 4.

It can be seen from Fig. 4 that the construction of the hierarchical model is based on the interactive space, corresponding to the input of the air movement form, the surface

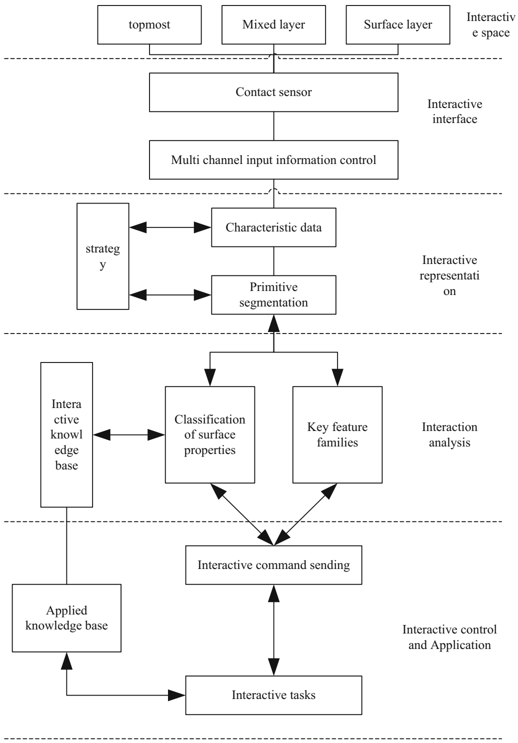

Fig. 4. Continuous interactive space layering process

movement form input, and the multiple device form input respectively. The human-computer interaction device can be responsible for obtaining input perception and output feedback information. Multiple sensors can sense real-time spatial position information of different levels of behavior input. For the same action behavior input, multiple inertial sensors are needed to sense. Therefore, there are only multiple Data can be freely matched only under the condition of inertial sensor sensing, and data can be collected for different levels of spatial gestures under multiple inertial sensors, and then the input position points can be converted. Test according to the functions and variables obtained from the test database, and call according to the architecture of the system. If the position of the function call is the beginning and end of the compilation, then the branch and loop in the statement can be determined as the beginning of the entire compilation. And the end. The driver and application are designed by calling the required API functions. The software design is carried out in the EDK tool, including the keyboard chip driver, the LCD module driver, the inverter configuration program, the Ethernet interface application program and the DART interface driver, etc., based on the hardware, through the driver program to achieve and hardware Communication, through calling the interface to support specific applications, realize the function of human-computer interaction. This model is a low-level physical model that can decompose high-level interaction behaviors, and form low-level physical operation behaviors through re-mapping, which is convenient for predicting the time spent in the execution stage of a low-level interaction task. The data expression is as formula (1) shows:

$$T_e = T_1 + T_2 + T_3 + T_4 + T_5 + T_6 \tag{1}$$

In the formula: T_1 represents button or mouse operation time, T_2 represents state positioning time; T_3 represents reset time; T_4 represents moving action time-consuming; T_5 represents decision time; T_6 represents response time. For the user's execution, it needs to be extracted from various human operating behaviors to ensure that the model outputs characteristic indexes that characterize human operating activities. By analyzing the time of different stages, it can effectively control the information of wearable human-computer interaction devices based on inertial sensors.

The realization process of human-computer interaction is that the DSP calls the corresponding key processing function according to the input information of the key, and then displays it with VR technology according to the display program, thereby displaying the real-time status and fault information of the inverter. When the inverter is powered on, whether it is running or not, the VR technology will display the corresponding information. The interface displays real-time output frequency, real-time current, voltage and fault type prompts. Short press the S6 key to start the inverter operation. Short press S1 to enter the first level menu of the control panel. Long press S1 to return to the upper menu. S3 and S4 are the addition and subtraction of the set value in the corresponding menu respectively. Short press or long press these two keys to increase or decrease the data step by step or to increase or decrease quickly continuously. Press the S2 key to save the corresponding value or parameter; while the inverter is running, press the S5 key to sequentially display the real-time monitoring values of the inverter. When modifying parameters, this key represents the optional parameter modification position. When the inverter is running or malfunctions, press the S7 key, the inverter will decelerate to stop, and the fault can be reset in the fault alarm state; press S8 to indicate that the inverter is switched between forward and reverse; S7 + S6 combination, when running and deceleration stop are pressed at the same time, the inverter will stop freely.

The most important part of the embedded low-level software test platform based on the ARINC429 interface board is the design of a complete set of platform development tools. GNU Tools contains the embedded application system. Its comprehensive source code can provide a tool chain for the embedded environment. The use of this tool can provide tools for the development of code compilation, structural testing and software engineering. The three are combined to form a tool chain, which can meet the independence requirements of the test platform. By using the tool chain, the automatic insertion test function can be added to the compiler. The compilation process is shown in Fig. 5.

It can be seen from Fig. 5 that various source codes can be compiled into assembly codes through the compilation process. Based on this, the effective design of the network human-computer interaction interface is realized to ensure the operation effect of the equipment.

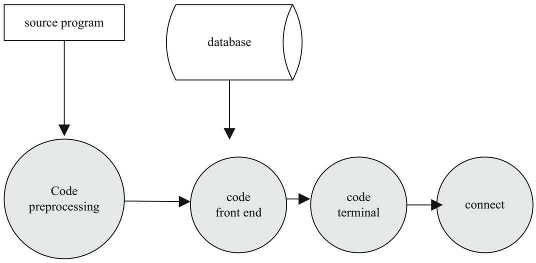

Fig. 5. Compilation process

3 Analysis of Experimental Results

By choosing the method of optimizing and improving the keyboard key circuit, the circuit is optimized. The control panel keyboard is composed of 8 normally open buttons, and the output display adopts four-digit VR technology. In the process of data input and output, serial parallel conversion is adopted, which saves DSP hardware resources. The most concise operation is adopted to realize the expected related functions, and the related data is displayed in the VR technology while realizing the functions. Although only 7 DSP pins are used for input and output display in the design, it can control 6 LED status indicators, detect the input of 8 buttons, 4 bits, 7 segment VR technology and 4 VR technology control bits, which greatly saves The cost of DSP hardware resources. The test platform processing needs to collect user login information, historical data information, real-time data, network information, etc., as shown in Table 1 and Table 2.

Table 1. Information processing rate for traditional interfaces (%)

Serial number	Serial number	Serial number	Serial number	Serial number
1	30.00	45.15	28.55	48.22
2	30.15	46.23	30.15	49.01
3	31.01	45.90	30.38	46.23
4	29.35	46.28	29.35	45.18
5	28.22	47.22	29.13	47.25

Based on the data collected above, the processing rate of the platform designed in this paper is compared with that of the traditional platform. Because the embedded low-level software test platform based on the interface can collect the data in real time, the software can be collected by the database server and the application server processing center. All parts were tested. Data collection can realize offline testing and online testing of the embedded underlying software; for the logical processing of the business and the connection between the database, the collected data can be processed; by transmitting the data, the operating data of the embedded underlying software can be completed

Table 2. Information processing rate for this article interface (%)

Serial number	Serial number	Serial number	Serial number	Serial number
1	80.13	62.15	61.36	82.85
2	79.28	63.24	62.25	79.28
3	78.31	60.98	61.88	78.51
4	77.52	65.13	63.23	76.35
5	77.15	64.14	65.15	76.98

Acquisition, processing, transmission and application on the client side, so using the test platform designed in this paper can improve the processing rate of the platform. In order to verify the performance of the test platform in this article, the frequency of data collection (MB/s) is used as a standard to measure the performance of the traditional test platform and the test platform in this article. The results are shown in Fig. 6.

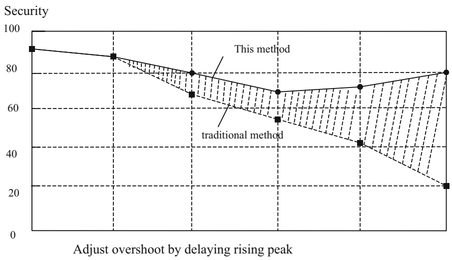

Fig. 6. Comparison of test results

It can be seen from Fig. 6 that the method designed in this paper can continuously collect data in the software and can quickly collect a large amount of software information in a short time. Therefore, at the same time, the collected data is also better than the data collected by the traditional test platform. need more. Practice has proved that the hardware meets the actual application requirements, ensures the working efficiency of the keyboard, saves the hardware port resources of the DSP, and improves the efficiency of the DSP port. The interface design makes the human-computer interaction interface friendly and operable. Realize offline testing and online testing of embedded underlying software through collection, and test each part of the software through the database server and application server processing center. It can complete the logical processing of the business and the connection between the databases, and process the collected data. Regarding the packet loss rate of the test platform in this article, the method designed in this article is obviously more accurate than the traditional method, and at the same time, the data collected is more than that of the traditional test platform. Therefore, the method designed in this article can be used in Save a lot of time in real life and effectively improve test efficiency.

4 Conclusion

The human-computer interaction interface of the monitor is planned with a unified modeling idea, and the state of the module program is decomposed by the finite state machine method. Using VR technology to design the embedded network human-computer interaction interface, research has confirmed that this method has certain reference value.

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