Computer Hardware Experimental Teaching Based on MOOC

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Abstract

There are some shortcomings in current Computer hardware experiment platforms, such as limited functions, low speed, and lack of reliability and stability. These shortcomings are inherent of the design of the platforms. As the needs on teaching experiments increase and computer hardware experiment technologies develop rapidly, these shortcomings have become strong barriers that block the development of computer hardware experiment courses.

Since the old platforms have so many shortcomings, the author proposes a remote computer hardware experiment system after exploring the trend of current experiment platform design development. The paper consists of several parts shown as follows:

- The author proposes and designs a computer hardware experiment platform based on FPGA and embedded computer. An Embedded Control Model is invented.
- The author proposes and designs the server application and the client application for the platform. A set of computer hardware experiment operating protocols is proposed.
- 3. The author proposes and designs series of computer hardware experiment samples based on the experiment system.

- 4. The functionality, efficiency, reliability, stability of the remote experiment system is analyzed and tested. Four system feature evaluation formulas are obtained.
- Economic benefit of the experiment system is analyzed and proved. A formula for calculating the engineering benefit is obtained.

Keywords: computer hardware experiment, FPGA, embedded solution, remote experiment system, experiment sample

With development and popularization large-scale of MOOC (massive open online courses), more and more computer software courses have joined the MOOC family. Through online courses, all the students of the world can perform online programming, compiling and executing to check learning results of their own software courses, so as to achieve learning while doing experiment for consolidating. However, the computer hardware courses require a lot of computer hardware support, and students need to perform site operation of computer hardware to achieve complex line connection, chip programming, simulation testing, logical analysis and other steps which can not be achieved in online courses. As a result, it is rather difficult for computer hardware courses to do experiment via online teaching platforms. Accordingly, Department of Computer Science and Technology of Tsinghua University developed a set of network-supporting remote computer hardware experiment platforms. The platform consists of experimental FPGA, control FPGA, network interface, server software system, and WEB Service for client service.

The experimenter can apply for a hardware experimental equipment by using the B/S (browser/server) mode through network, transmit finished hardware design codes to the hardware experiment equipment, a server controls the running of the codes, and the intermediate and final results of running are transmitted in real time back to the computer of the experimenter to perform check analysis on the experiment results, thereby completing the hardware experiment. The platform also supports online remote logic analyzer, remote PS2, USB, VGA input and output and other functions, all of which have been granted with Chinese national patent.

MOOC

Online computer hardware experimental teaching system

Online hardware experimental teaching system consists of experiment FPGA for the experimenter to write in code, control FPGA in charge of system write-in code, controlling on-board circuit, and providing support and monitoring for experimental chip, download CPLD responsible for downloading program to the experimental chip and the control chip, memory for controlling communication transferring, storing related experimental test courses and data, tumbler switch (except that of memory) mounted on a data bus, indicator light and digital tube, USB communication interface and serial port, FLASH memory for the download chip to store download content, various computer hardware experiments, and a server responsible for distribution of experimental platforms.

The experimental platform satisfy not only verification experiment but also open and innovative experiment, and achieve support for experiment of computer hardware courses via network-based hardware platform.

experimenter writes hardware design codes locally, uploads The generated experimental code files which are in file format of RBF to the the browser, the server through server assigns a hardware experiment equipment for separate use of the experimenter, at the same time, the server downloads the codes to the hardware experiment equipment, and controls the experiment FPGA on the experiment equipment to run the uploaded experiment codes by sending one or more clock cycles to the hardware experiment equipment, and performs real-time monitoring on the control FPGA via the experiment FPGA, obtains and stores the intermediate results and final results. and then transmits to use the the experimenter, and can remote logic analyzer of the online experiment platform to carry ou analysis on these data, in order to get logic relationship between hardware running.





The experimental interface

Hardware equipment cabinet



Logic diagram of experimental system



Browser Interface

Remote logic analyzer

Logic analyzer at present are needed and hardware directly connected, will be collected by the signal real-time display to the logic analyzer on the screen, which is equivalent to a logic analyzer can only be used or a hardware device, and only to the laboratory for analysis, greatly limits the hardware design of time and space. Remote logic analyzer of the invention will hardware designers from laboratory and hardware equipment, let the designer can be anywhere in the network, as long as the installation of client software, will be able to design their own hardware logical analysis, found the problem, improve their hardware design.

The overall design:

"Signal acquisition FPGA" is the user the experimental operation and experimental data processing terminal. " Transit signal service software " matching service program, responsible for the management of equipment and the user, the user the experiment operation and data transfer. The client is responsible for supporting the login server, client, receive and send signals. The remote logic analyzer structure chart run Arm+linux Control Center.

The control module is embedded ARM solutions, it is a mature module, linux system and the device driver, the designer only needs to application layer in the module of Linux is developed. This module is responsible for FPGA collecting signal and server communication. to establish a communication channel, will be responsible for signal acquisition, real-time transmission equipment operating conditions to the server. The module can be used. if USB directly connect not the module can use to the server computer, it will run the control logic of EPLD signal is forwarded to the server.

The need to store the test program and data in the experiment, we will code via the data bus and address lines written in the memory. SRAM read and write signal is composed of signal acquisition FPGA conversion chip. The SRAM interface signal 5. One is the active low enable EN signal FPGAB_Ram_EN. The second is the active low enable input OE is connected with the signal acquisition, FPGA FPGAB_Ram_OE. The third is to read and write signal RW, connect to the FPGAB_Ram_RW . Fourth , bidirectional data bus Data 16, is connected with the signal acquisition of FPGA FPGAB_Ram_DATA. The 18 bit address bus is connected with the signal acquisition, FPGA FPGAB_Ram_Add. 2 pieces of SRAM using the common address connected to the signal acquisition chip, sending and receiving signal chip to unified signal. Module acquisition signal FPGA, in addition to the address bus, read and write control signals, data bus via acquisition signal chip transit way.

Signal	Signal	
acquisition FPGA	acquisition FPGA	Description
Name	Attribute	
FPGAB_Ram_Add	18bit, out	SRAM address bus
FPGAB_Ram_Data	32bit, inout	SRAM data bus
FPGAB_Ram_EN	1bit, out	SRAM enable signal
FPGAB_Ram_RW	1bit, out	SRAM read and write signal
FPGAB_Ram_OE	1bit, out	SRAM output enable signal

Supported Courses

Online computer hardware experimental teaching system supporting the digital logic, computer composition principle of computer courses, system structure, embedded computer and the computer hardware.

logic: half adder, full adder, four bit Digital full people adder, encoder, decoder, seven vote, four responder, BCDdisplay decoder, multiplex seven segment data selector, register design, frequency divider design, design of 74LS160 counter, eight bits of seven digital tube dynamic display circuit design, a simple state machine design, sequence detector design.

Design simple digital clock.

Principles of computer composition: coding experiments, computing experiment, CPU memory experiment, comprehensive experiment.

Computersystem structureexperiment: singlecycleCPU experiment, CPU experiment, comprehensiveexperimentonline with CPU, open CACHE processor design.



Effect

The online computer hardware experimental teaching system, learners

can in any corner of the world, through the MOOC online education system, apply to join the online teaching of computer hardware, you can apply online to a computer hardware experiment equipment, design their own from the digital logic to the CPU computer hardware, and online debugging, accept feedback the results came back, design compared to their call, remote on-line logic analyzer, modify their hardware design, eventually get the hardware design of the correct. This solves the computer hardware courses must have hardware equipment in the local, to occupy a lot of space, occupy a lot of hardware equipment, and can support 24 hours online, can make computer hardware design.

The remote experiment system, the existing experiment can remote support digital logic, principle, system structure, CPU design course. After the expansion of subsequent development, the system will also support remote experimental interface logic, local support embedded experiment.

Refference

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