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Design and Development of EDA Online Experimental Platform Based on FPGA

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Abstract. Due to the development of science and technology, the support of the government, the intelligent construction of universities and the frequent outbreak of various infectious diseases in recent years, online learning mode has become the mainstream learning mode in recent years. At present, domestic research on online experimental teaching is vigorously carried out, mainly focusing on how to conduct online experiments in real time and accurately, and how to transmit information between online experimental platform and actual experimental platform remotely. Therefore, this paper proposes an online learning solution for EDA experimental courses - the design and development of an EDA online experimental platform based on FPGA. Through the development of the foreground and the design of the background, and the optimization of the data compression algorithm, the EDA online experimental platform has been built, which improves the learning efficiency of students, and can conduct electronic experiments without having to be in the laboratory, thus contributing new ideas to the comprehensive intelligent construction of colleges and universities.

Keywords: FPGA · online experimental platform · online · EDA · the data compression algorithm

1 Introduction

In recent years, various epidemic infectious diseases are highly frequent, and colleges and universities have to carry out online teaching experiment. Online learning is not limited by time and space, and students' learning is not limited to school. However, for some engineering majors, especially those with strong experimental requirements such as electronic engineering, online teaching has greatly affected the learning efficiency of students. In order to solve the problem that online experimental teaching is difficult to carry out, the EDA online teaching management system proposed in this paper is based on the B/S architecture, integrating advanced technologies such as HTML5, CSS3, jQuery, Json, remote experimental technology, virtual instrument technology, database technology, back-end development, etc., which can display the experimental results of experimental instruments for students in real time. Students can complete the online experiment by performing the experiment operation at the front desk.

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2 Overall System Design

The EDA online experimental teaching management system based on FPGA designed in this paper consists of EDA online experimental platform, MySQL database, data acquisition control circuit and experimental response circuit [1].

2.1 Data Acquisition Control Circuit

The most important part of remote experiment platform is remote dynamic reconfiguration [2]. The remote dynamic reconfigurable part of the system is realized by data acquisition control circuit. The data acquisition control circuit is composed of a data interaction FPGA model EP4CE26E22C8N, a remote configuration control ARMv7 series chip and their peripheral circuits. The remote configuration control ARM chip communicates with the PC and the server respectively. The ARMv7 applications include remote interaction program, instruction parsing and execution program and FPGA information interaction program. The ARMv7 application mainly processes the Socket information received from the server or PC side, and analyzes the information. According to the information type, it jumps into the corresponding subroutine for information processing, and then calls the corresponding driver to operate the FPGA. The Ethernet circuit module is responsible for the remote communication of the system. The configuration control circuit module mainly completes the PS configuration of the experimental response circuit by ARM to achieve the purpose of the experiment. The data interaction circuit is directly connected in series with the data interaction FPGA chip pin through the ARM pin, which is used to control the FPGA simulation input and output device by ARM. The data interaction FPGA controls the response of the experiment through Write 1 module, Write 2 module, and Read module, the experimental board opens the corresponding experimental module for the experiment. Other peripheral circuits are mainly to supply power to the circuit and provide functions such as key control. The structure diagram of data acquisition control circuit is shown in Fig. 1.

2.2 Experimental Response Circuit

The experimental response circuit includes an experimental board FPGA and a backplane. The FPGA model of the experimental board is EP4CE26E22C8N. The bus transceiver 74HC245 controls the switch of the sub-module, the latch 74HC573 reads back the data of the experimental sub-module. The backplane is designed as LXI bus structure, with simple and clear circuit design and high reliability. The experimental response circuit mainly receives the instructions of the data acquisition control circuit to make corresponding response and complete the experimental operation. The experimental response circuit is shown in Fig. 2.

2.3 EDA Experiment Management Platform Software Development

The EDA experiment management platform is mainly based on the B/S architecture. It is mainly responsible for providing the virtual interface of the FPGA experiment circuit,

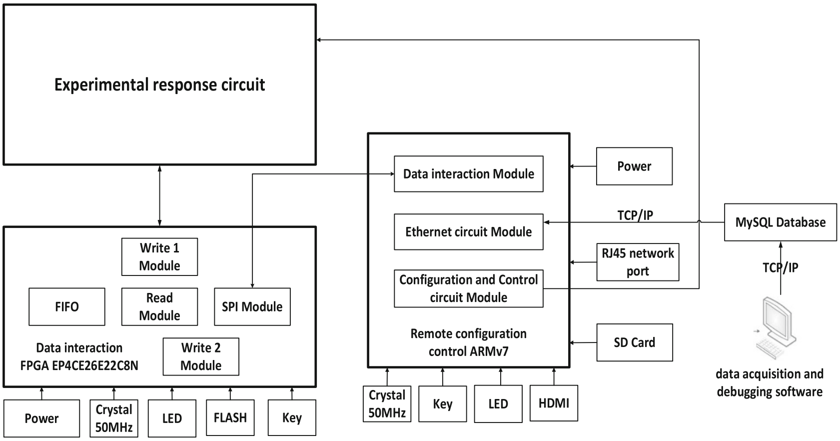

Fig. 1. Data acquisition control circuit

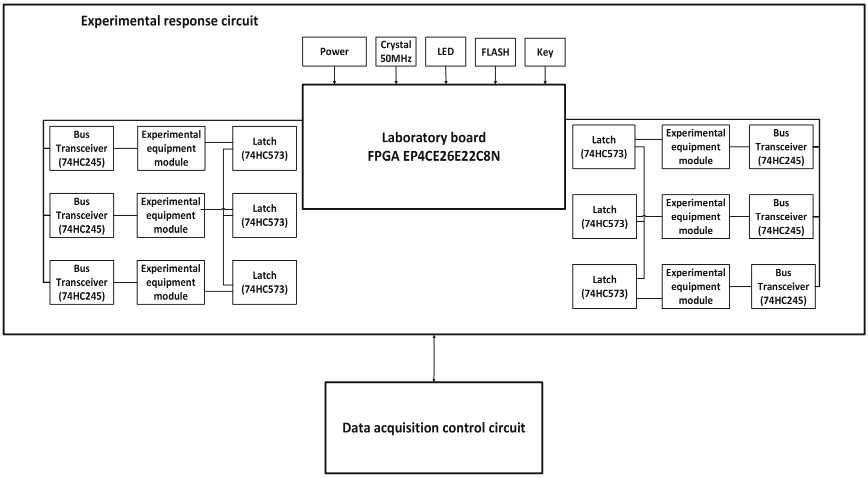

Fig. 2. Experimental response circuit

and can interact with the server and ARM controller. In addition to HTML5 language, JavaScript, CSS3, jQuery, Json and other technologies need to be introduced to develop the web interface of FPGA remote experiment system. EDA experimental management platform is a simulated FPGA experimental platform. The virtual components on these interfaces provide users with the interface to operate the real FPGA experimental platform, and the real experimental results of these operations are reproduced to users on the virtual platform [3]. The experimental interface is shown in Fig. 3.

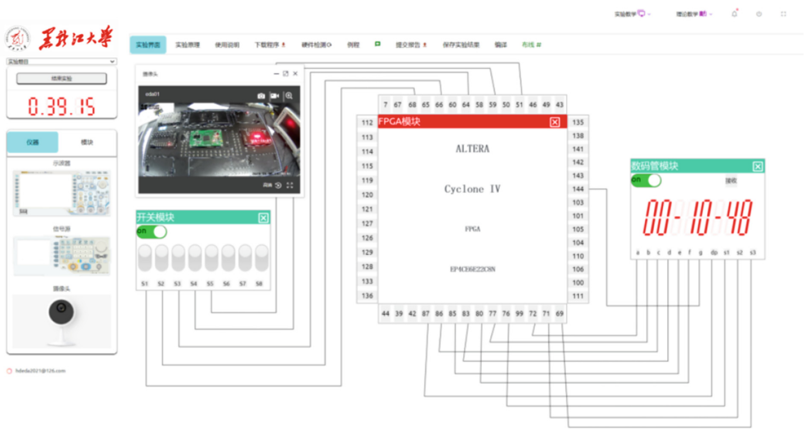

Fig. 3. Student experiment interface

2.4 System MySQL Database

The system database is the core of the remote experimental system of the EDA experimental platform, which is responsible for controlling the operation of the experimental system. It is responsible for the scheduling and management of the EDA experimental platform, allocating the idle experimental platform to the experimental users (clients), and needs to be able to connect hundreds of ARM controllers and clients as the information transfer station between the ARM controllers and clients. According to the comprehensive requirements of the system, the database is developed using Django framework and MySQL database. WebSocket protocol communication technology is used in the communication connection between the database and the data acquisition control circuit.

2.5 Processing Method of Collected Data

The experimental system uses data compression algorithm to compress data [4]. Zstandard data compression algorithm is used in this system. The ping-pong operation improves the efficiency of data processing and transmits data accurately and stably. The main compression flow of the Zstandard algorithm is shown in Fig. 4.

After the optimization of data compression algorithm and ping-pong operation, the system reduces the bandwidth requirements, improves the data transmission efficiency, reduces the occupation of front-end memory, and reduces the load of the client host, the same amount of data after compression and before the size gap is a lot, the memory occupation rate increases, the required bandwidth is reduced. The Table 1 shows the comparison of data recorded before and after optimization.

3 Performance Test

In the era of rapid development of remote experiment technology and virtual instrument technology, high requirements are put forward for the reliability and stability of remote data transmission. After the circuit connection of the client, the experimental platform

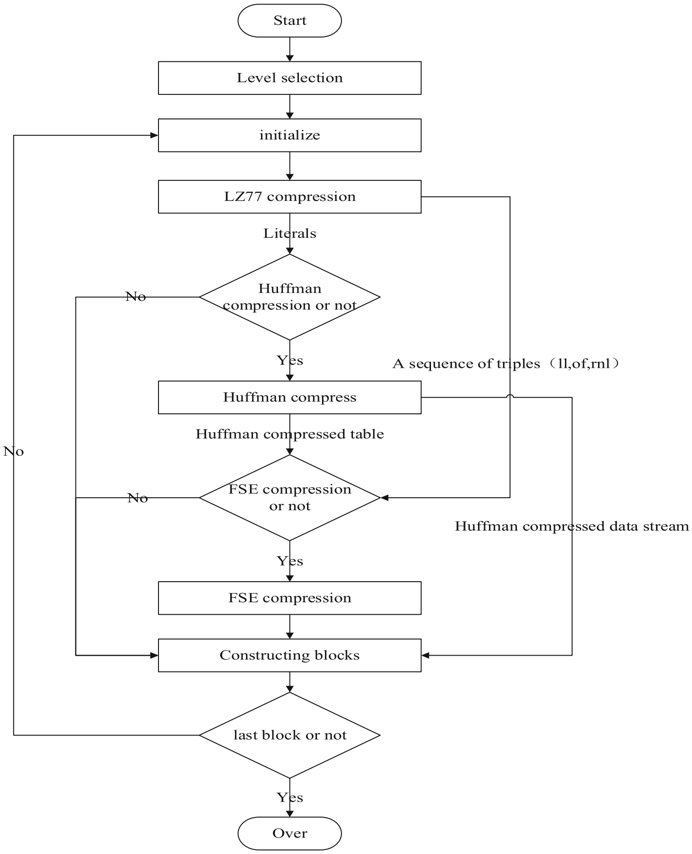

Fig. 4. The main compression flow of the Zstandard algorithm

should make corresponding response and ensure that the data can not have problems. After the experimental module is inserted, the online EDA experiment is carried out at the front desk, and the experimental results are correctly displayed in the experimental response circuit. The physical diagram of hardware for testing is shown in the Fig. 5.

After the correct experiment wiring operation on the experiment page of the online experiment platform, the data is completely transmitted to the experimental hardware platform, and the experimental platform makes the correct response. Logic analyzer is widely used in the debugging and inspection of digital system operation, the simultaneous tracking and correlation of multiple digital signals, the detection and analysis of timing violations and instantaneous state events on the bus, and the execution trace of embedded software. The data collection of the system uses the self-designed logic analyzer, the logic analyzer designs and implements the Web page software, uses HTML5+JavaScript+CSS technology to realize the whole page of the wireless logic analyzer, and uses HTML5 for data transmission Websocket for communication, design and implement logic analyzer driver interface function. The logic analyzer is used to collect the data of the hardware experiment platform to read back the bus data. The digital tube experiment data is

Table 1. Data comparison before and after system optimization.

	CPU temperature (°C)	Memory usage (%)	Upload speed (kb/s)	Download speed (kb/s)
Before optimization	38.459	51.2	446.52	101.63
Before optimization	38.459	51.2	345.78	100.05
Before optimization	38.459	51.2	498.26	118.24
Before optimization	38.946	51.2	383.83	137.67
Before optimization	38.946	51.2	582.58	131.62
After optimization	40.407	72.5	15.88	95.57
After optimization	40.894	72.5	122.44	104.2
After optimization	40.894	72.5	21.07	121.83
After optimization	40.407	72.5	148.09	134.83
After optimization	40.407	72.5	21.81	135.38

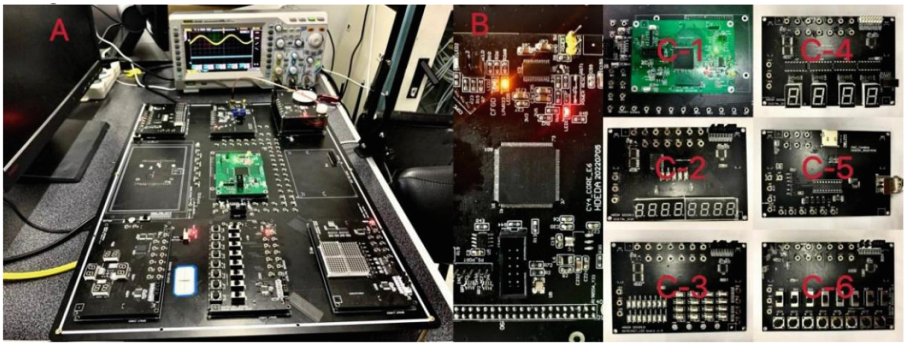

Fig. 5. Physical diagram of tested hardware

complete and correct. The experimental platform data collected in real time by the logic analyzer is shown in Fig. 6. It can reflect the reliability and stability of the experimental platform data.

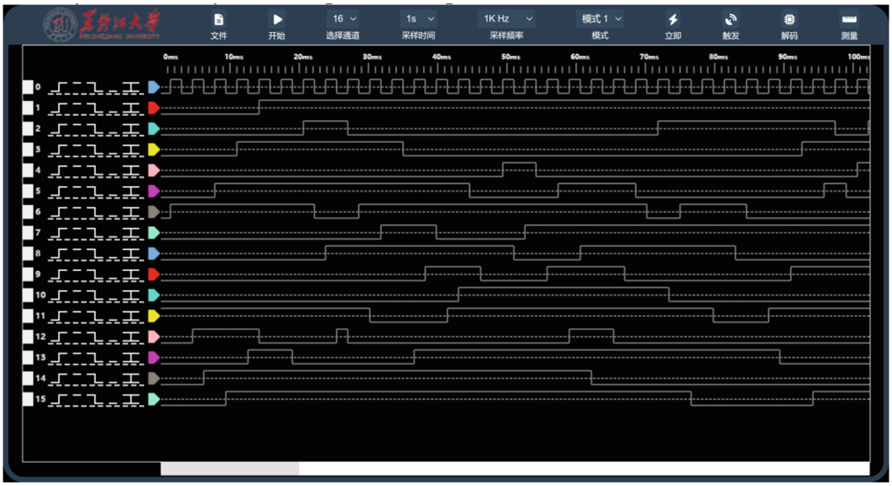

Fig. 6. Online logic analyzer (for digital system debugging)

4 Conclusion

In order to solve the problem that it is difficult to carry out the online experiment course of electronic specialty, this paper proposes a solution, that is, to establish an online EDA experiment platform. First of all, it introduces that online learning is a common teaching method at present, and gives some problems faced by online experimental courses. Secondly, through the combination of software and hardware, a set of EDA online experimental platform based on FPGA is developed, and the specific design scheme is given. The system is optimized by data compression algorithm. Finally, the online experimental platform is tested and its performance is normal. It can be used in practical experimental teaching to achieve effective learning objectives.

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