Remote FPGA Lab

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ABSTRACT

In this paper the authors discuss leading examples of the remote laboratory, based on FPGA. The architecture of Internet-accessible Automatic Test Equipment can be classified in two categories: internet-based ATE and ATE as a web service. The authors’ realization is based on the first architecture. Experiment management problems are discussed and some solutions, realised on user interface are presented.

Keywords: Automatic Test Equipment (ATE), Field-Programmable Gate Array (FPGA), Remote Laboratory, User Interface, Web Service

INTRODUCTION

The inventor of the most interesting association of three classes of electronic circuit’s memory, logic and microprocessor, existing today in the world of digital technology under the name FPGA (Field-Programmable Gate Array) devices Ross Freeman whether imagined and expected in the wildest of dreams that it will receive such a development. Today, the achievements in technologies for the production of integrated circuits and a merger interests of producers and consumers leads to unprecedented prosperity of these devices. These devices possess tremendous flexibility and logical possibilities and allow the user alone programs developed by its application many times, logical function or embed them in different IP cores.

With the increasing popularity and use of FPGAs, it is necessary to develop a mechanism for training a broad range of computing students FPGA technology. Training programming and use of FPGA devices requires access to expensive hardware equipments. The high cost of these instruments along with time consuming development process in individual students’ projects required within the educational process creates a significant bottleneck. The restricted university budget does not allow building of a several such development and test stands, and time schedule and university security conditions restrict the time when the stand can be accessible for students locally in a laboratory.

A solution of this problem could be to build a virtual or remote laboratory.

The aim of this paper is to describe hardware and software considerations necessary to build a remote web-based laboratory for FPGA development and testing. The system will open up for students who have a need for Internet based instruction. For students who prefer physical access to the laboratory equipment, the experimentation experience can be enriched by allowing more time for work. The Lab can also be used to enhance the learning

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experience in the classroom with experiments complimentary to instruction making for more interesting and fun lectures. The system could also be used to collaboration work of students.

APPROACHES FOR EXPERIMENTAL WORK

The introduction of widely available general-purpose computers and the Internet has opened new doors to experiments and education. Explained in this section are the different approaches to performing research work.

The general norm of performing laboratories is the traditional method where the students engage in prescribed tasks involving different physical components. In other words, the student has to be physically present to access the lab equipment. As in, to set up a traditional FPGA laboratory will include an on-campus space that has lab benches, developer boards, and expensive support equipment. The support equipment on every lab bench might include a power supply, clock frequency generator, logic analyzer, oscilloscope, and a PC/workstation. These labs involve physically setting up of the equipment every time the laboratory is performed. Must be stressed - the creation the program for programmable devices require long work time. This is important because many times, the lab space is shared among various courses. Although this method is the most elementary method to perform labs is limited in the case of FPGAs.

The experimental work in simulation laboratory is generally based on sets of software models that represent objects or systems in a given abstraction level. Most of them are web based. The students can use them at any time and any place. Also, they are very flexible in the sense that the simulation can be stopped at any step for review or if there has been a mistake. The problems here are with the accuracy of the behavior of the simulator representing a real system and speed of detailed simulation for complex systems. Often the real objects differ from their abstract model. In this case, the simulated objects cannot represent all details - features and behavior of real objects.

Unlike virtual laboratories, the work in remote laboratory is based on real hardware. Such laboratories are very convenient and effective for hardware design laboratory course. Hardware experimental environment is usually treated as an exclusive resource for single user usage. However, the actual test run time is rather short and most of the time is wasted leaving these costly resources idle. The combined use of FPGA/PC connected test hardware and PC-controlled measurement equipments such as logic analyzer, digital storage oscilloscope, etc. may open a way to develop a remote multi-user time-sharing system for hardware experiments, where students at remote terminals can perform actual experiments using real hardware equipments and tools remotely from home or students residence.

RELATED EFFORTS

With the growth of the Internet and increasing connectivity, the popularity of remote labs has surged. Many researchers are investigating the effectiveness of remote labs in their respective fields. Many of the labs implement FPGAs due to their flexibility and reconfigurability. Some interesting efforts are described below.

Hashemian and Riddley have a designed FPGA e-Lab, remote access system targeted for digital design courses using FPGAs. Based on Xilinx’s Spartan-3E Starter Kit the e-Lab uses Windows XP Remote Desktop connect the remote user with the FPGA, data acquisition hardware, and LabView. Integrating a webcam and GPIO (General Purpose Input Output) to connect LEDs, switches, and control hardware on the actual FPGA. An obvious advantage of such a system is the low start-up costs associated with acquiring the Spartan Starter Kit and software tools.
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