AC 2012-5393: DEVELOP A CROSS BROWSER COMPATIBLE DSP REMOTE LABORATORY WITH ZERO PLUG-IN INSTALLATION

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Develop a Cross Browser Compatible DSP Remote Laboratory with Zero Plug-in Installation

Abstract

In this paper, a framework for implementing Virtual and Remote laboratory (VR-Lab) is presented. The framework includes three components which are hardware, software and development tool. The hardware includes the network infrastructure such as server and network switch, web camera, workstation, data acquisition and lab devices. The software component provides web interface for user to conduct the virtual and remote experiments, experiment management, and experiment data management etc. Development tools are software packages which are used to develop the software component for the VR-Lab framework. To achieve the cross browser compatibility and zero plug-in installation, the Web 2.0 technologies are used. A Digital Signal Processing (DSP) remote laboratory has been implemented in the framework. A user friendly web interface has design to conduct the remote DSP experiments in any web browser without any plug-in installation.

Introduction

Online education has played an important role in high education. Latest Report from the Sloan Consortium shows that over 6.1 million students were taking at least one online course during the fall 2010 term, an increase of 560,000 students over the previous year[1]. However, with the growing popularity of online education, it is inevitable reality and necessity of Internet enabled experiments in engineering and other Science, Technology, Engineering, and Mathematics (STEM) fields. In general, there are two approaches to conducting experiments online, namely virtual laboratory and remote laboratory[2]. The virtual laboratory is based on software such as LabVIEW (short for Laboratory Virtual Instrumentation Engineering Workbench), Matlab/Simulink, Java Applet, Flash or other software to simulate the lab environment. Remote lab, by definition, is an experiment which is conducted and controlled remotely through the Internet. The experiments use real components or instrumentation at a different location from where they are being controlled or conducted.

Several Digital Signal Processing (DSP) remote laboratories have been reported recently. Hercog *et al*[3]. presents a framework for rapid remote experiment implementation in the field of automatic control. In their framework, it has a remote experiment book system for users to reserve the time slots in advance. The proposed solutions are formed on the embedded control hardware and Matlab/Simulink and LabVIEW. The Matlab/Simulink is used for experiment control algorithm development, while LabVIEW is used for the user interface and remote control. Based on the framework, a remote DSP-based remote control laboratory is designed. Barrero *et al*[4]. developed a framework named as eDSPlab for remote accessing and controlling the DSP devise real instrumentation. It provides debugging and testing DSP experiments by using the LabVIEW. To remote access and control the DSP devised through LabVIEW, it is required the user to install the LabVIEW runtime engine. The common issue of LabVIEW runtime engine is the compatibility. A unified remote laboratory framework has been proposed and developed by

Omli *et al*[5,6]. This framework is based on the LabVIEW web service and the latest Web 2.0 technologies such as JavaScript, jQuery, etc.

In the paper, a cross browser compatible DSP remote laboratory with zero plug-in installation is presented. The user can directly run the remote DSP without installing any plug-in. Moreover, the user interface is compatible with any web browsers and especially optimized for portable devised such as iPad and smart phones.

Virtual and Remote Laboratory Framework

The Virtual and Remote Laboratory (VR-Lab) at Texas Southern University (TSU) is shown in Figure 1. With the support from NSF CCLI, IEECI and HUCB-up programs, we have successfully developed DC virtual experiments, Data Communication Virtual and Remote experiments, DSP virtual and remote experiments and Smart Vibration Platform (SVP) remote experiments. In the VR-lab architecture, the VR-Lab server works as the web publisher, the data and database manager and the Scheduler Web Server (SWS). SWS is to manage, authenticate and schedule users and experiments. The user connects to the Scheduler Web Server with the assigned credential for scheduling a future time slot with one of the available experiments listed on the scheduler web server. When the time comes, the user will be provided with a customized direct link to the chosen experiment. The virtual experiments are developed by using Java and LabVIEW. These virtual experiments are accessible for public without log in. However, Java runtime engine is required to run the Resistor Color Code virtual experiment, and NI LabVIEW run time engine is required to run the virtual DSP experiments and virtual Data Communication experiments.

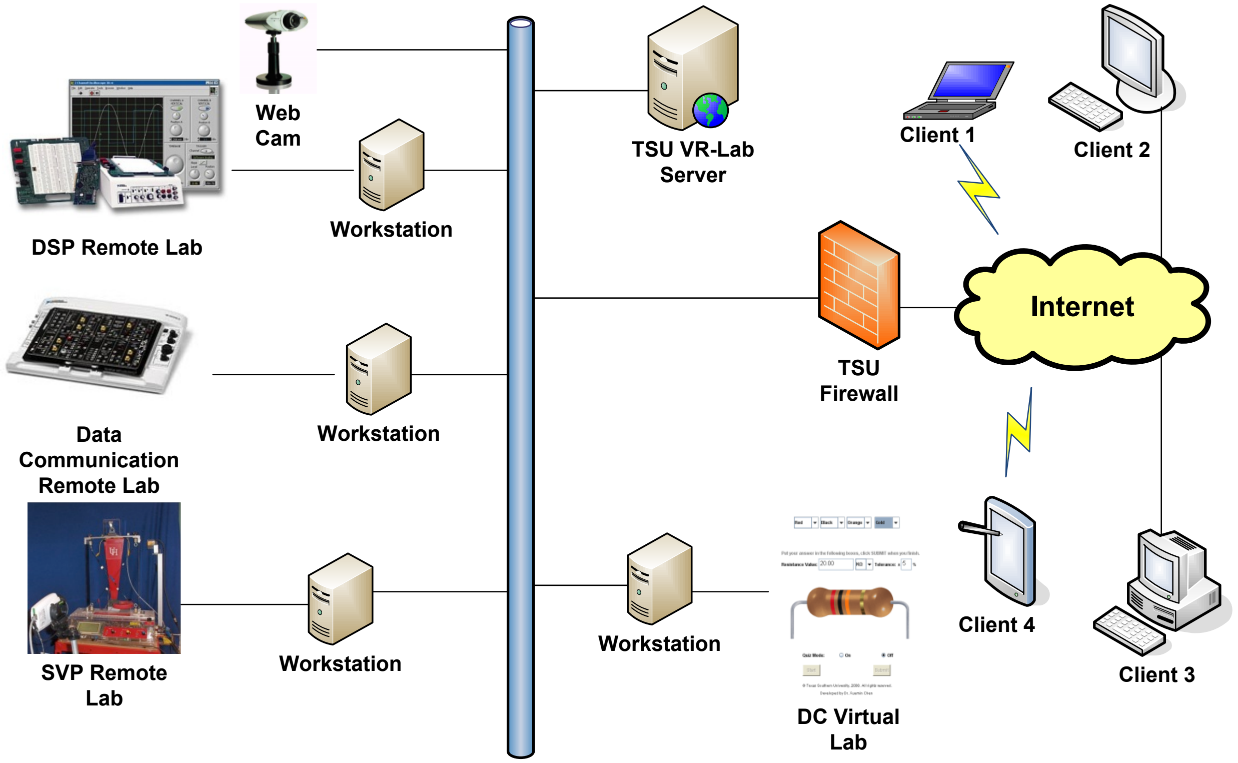


Figure 1. Virtual and remote laboratory (VR-Lab) at TSU.

The workstations are used to execute the users' requirements and control the lab devices such as the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) to conduct the experiments. The camera will let the user to see the system response in real time. The users can use the client computers to do the experiments virtually and remotely.

The VR-Lab framework is shown in Figure 2. The framework includes three parts: hardware, software and development tool. The hardware includes the network infrastructure such as server and network switch, web camera, workstation, data acquisition and lab devices. The lab devices include NI SPEEDY 33 for DSP experiments, NI DATEx for Data Communication experiments, Smart Vibration Platform (SVP) for control and data processing experiments. The SVP was developed in the Smart Materials and Structures Laboratory at University of Houston (UH). The software component provides web interface for user to conduct the virtual and remote experiments, experiment management, and experiment data management etc. Development tools are software packages we used to develop the software component for the VR-Lab framework. In the VR-Lab as shown in Figure 1, the software packages we used include the NI LabVIEW, Java, MySQL, JavaScript, JSON, jQuery, Flot, HTML, PHP, and CentOS.

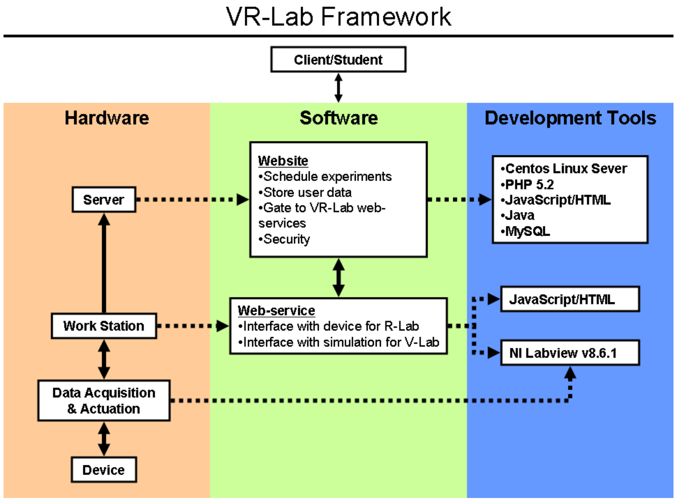
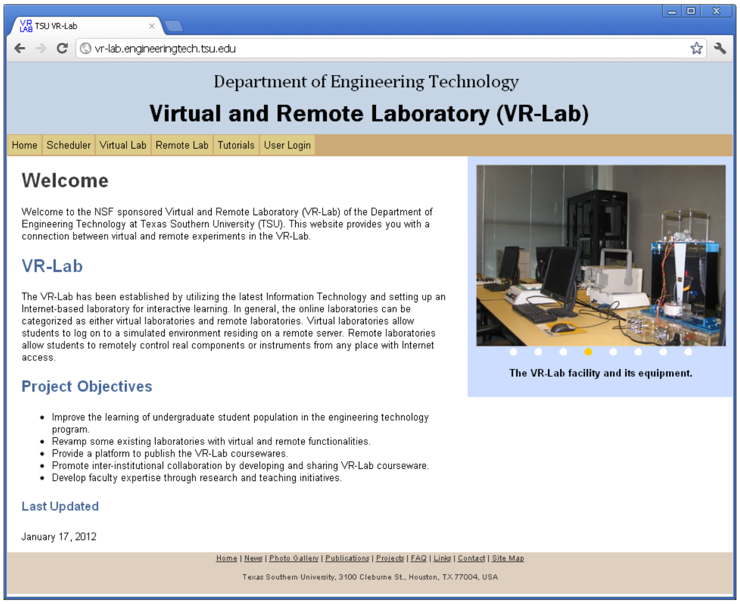


Figure 2. VR-Lab Framework.

All of the developed virtual and remote experiments are hosted at VR-Lab website (http://vr-lab.engineeringtech.tsu.edu/). The user interface is shown in Figure 3.



Department of Engineering Technology

Virtual and Remote Laboratory (VR-Lab)

Welcome

Welcome to the NSF sponsored Virtual and Remote Laboratory (VR-Lab) of the Department of Engineering Technology at Texas Southern University (TSU). This website provides you with a connection between virtual and remote experiments in the VR-Lab.

VR-Lab

The VR-Lab has been established by utilizing the latest Information Technology and setting up an Internet-based laboratory for interactive learning. In general, the online laboratories can be categorized as either virtual laboratories and remote laboratories. Virtual laboratories allow students to log on to a simulated environment residing on a remote server. Remote laboratories allow students to remotely control real components or instruments from any place with Internet access.

Project Objectives

- Improve the learning of undergraduate student population in the engineering technology program.
- Revamp some existing laboratories with virtual and remote functionalities.
- Provide a platform to publish the VR-Lab coursewares.
- Promote inter-institutional collaboration by developing and sharing VR-Lab courseware.
- Develop faculty expertise through research and teaching initiatives.

Last Updated

January 17, 2012

The VR-Lab facility and its equipment.

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Texas Southern University, 3100 Cleburne St., Houston, TX 77004, USA

Figure 3. VR-Lab Website.

Integrate the Digital Signal Processing Experiment into VR-Lab Framework

As we mentioned in the VR-lab framework, the NI SPEEDY 33 is used for conducting DSP experiments as shown in Figure 4. Both of the NI ELVIS II and NI SPEEDY 33 are connected to workstation USB ports. The digital I/O port of NI ELVIS II is used to select which the DSP experiment will be run. Currently, there are two ways to send the signals to SPEEDY 33. One way is to load the signal file to SPEEDY 33. Another way is to generate the signal by using NI ELVIS II. After receiving the signal, the SPEEDY 33 will process it and send the processed data to workstation through USB port. Then, the workstation sends the data to VR-Lab server through Ethernet for display.

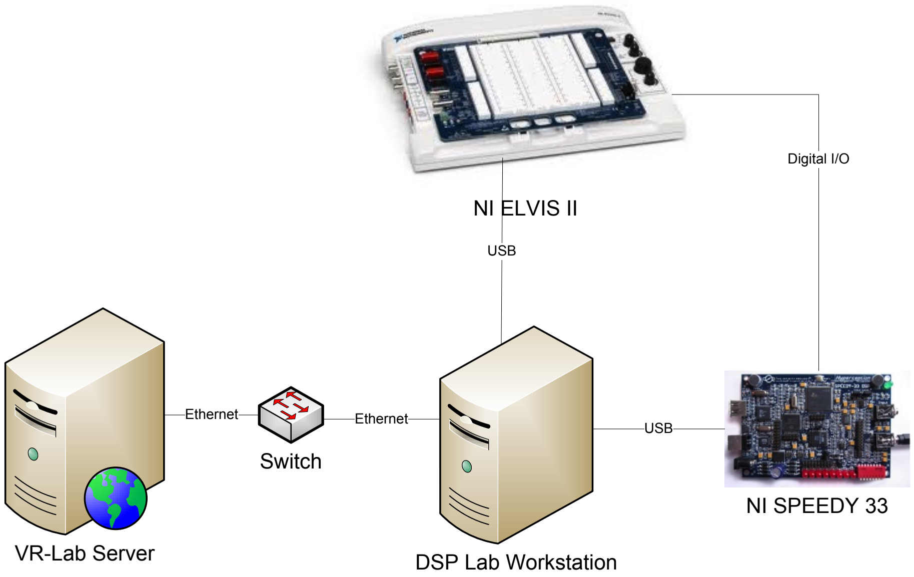

Figure 4. The Remote DSP Laboratory Implemented in the VR-Lab.

To integrate the DSP experiment into the VR-Lab framework, the following steps are used:

1. Map or diagram all the information what will be communicated between the user web-page and the experiment platform;
2. Create the LabVIEW web-service that will control the experiment platform and send instrumentation data back to the user. It should handle any data logging functions;
3. Create the remote lab web-page that user will use to display the data from LabVIEW web-service and send instructions to it;
4. Create any required PHP scripts to service the features of the web-page that the LabVIEW web-service cannot do directly, such as large file transfers;
5. Add a new experiment entry to the Scheduler Web Server that is linked to the newly developed remote lab web-page.

The remote DSP Lab webpage is shown in Figure 5. Upon setting the parameters properly, the outputs of low pass filter experiment are shown in Figure 6.

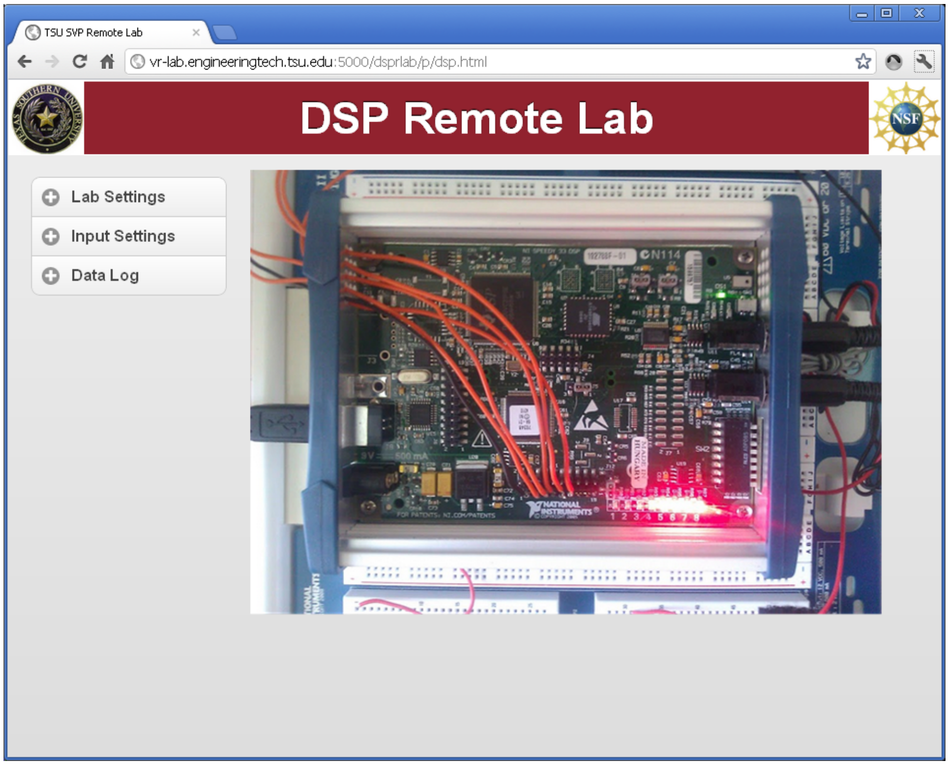

Figure 5. The User Interface of Filter Experiment.

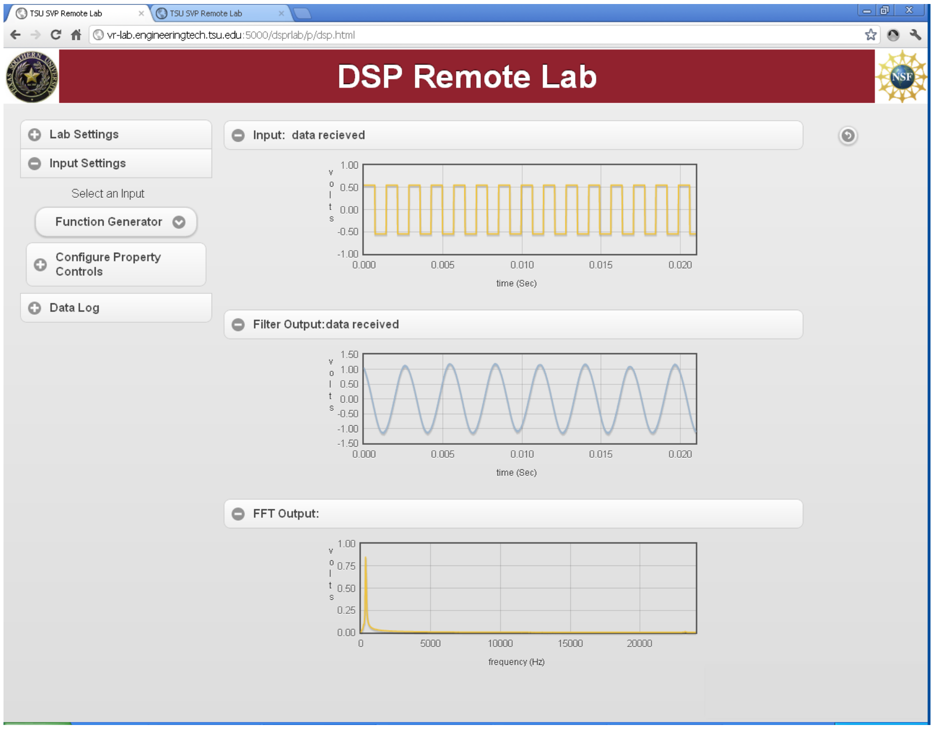

Figure 6. The Output of Filter embedded in NI SPEEDY 33.

Simple Guidelines of VR-Lab Security

The security is considered in the VR-Lab framework. The general rules are:

1. Open as few ports as possible;
2. Use as few proxies as possible. Proxies will generally let developer avoids opening ports the host institution's firewall but they may make the system less secure. Try setting up a proxy *before* opening a port in the host institution firewall.
3. For all VR-Labs, both their web-pages and LabVIEW web services should repeatedly communicate with the Scheduler Web Server to re-authenticate the experiment session while in use.

Conclusions and Future Works

A flexible virtual and remote laboratory framework was presented in this paper. A digital signal processing remote experiment was integrated into the VR-Lab framework. The user can conduct remote experiment without install any plug-in or third party product since the web 2.0 technologies were used to design the framework software package. The framework is open and scalable. It can be used for other subjects of STEM areas if the developer simply follows the procedures to let the scheduler web server manage these experiments, open an unused port on the firewall if the workstation is behind the firewall, and register this port in proxy server for port forwarding if it is inevitable.

Our recent development efforts have made clear the need for near Real-Time Data Streaming of audio/video and instrumentation data. We are currently exploring implementations of real-time video transcoding, Ajax Push server for streaming instrumentation data, and fast client-side, JavaScript based cross-browser graphing/plotting.

Acknowledgments

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