The remote DSP experiment integrated with Moodle online learning environment

R. Krneta[1], Dj. Damnjanović[1], M. Milosevic[2] and M. Brković[1]
[1] University in Kragujevac/Faculty of technical sciences Cacak, Serbia
[2] BADEN, Cacak, Serbia

Abstract— In this paper we presented an educational usage of remote experiment, carried out within master course in DSP on Faculty of Technical Sciences in Cacak. The experiment is based on the National Instrument's CompactRIO platform and it is integrated with LabVIEW software for visualization. Students are able to access the laboratory experiment remotely through Moodle block called Remote Lab View (RLV), which is created to do experiment time scheduling and to enable communication between teachers and students during the experiments. This approach enriches blended learning mode and is highly beneficiary for master students who live and work away from University.

Index Terms — e-learning, Moodle, remote experiment, signal processing, adaptive filters

I. INTRODUCTION

Laboratory classes play a crucial role in engineering studies. Good pedagogical reasons, such as illustrating and validating analytical concepts, introducing students to professional practice and to the uncertainties involved in no ideal situations, developing skills with instrumentation, and developing social and teamwork skills in a technical environment motivate the need for their inclusion in the curriculum.

Learning theoretical concepts of digital signal processing (DSP) theory is difficult for the engineering students. This difficulty is a result of the gap between understanding mathematical formalisms of these concepts and student's abilities to connect these theoretical concepts with practical engineering applications. Visualization of DSP theory is one of the many solutions for solving this kind of problems. Remote labs create perfect solutions for improvement of student practical skills.

At the master study course in Advanced Digital Signal Processing at Faculty of Technical Science Cacak University of Kragujevac we use remote DSP experiments on the NI CompactRIO platform integrated with LabVIEW software in our DSP lab for "visualization" of some course topics.

II. REMOTE DSP EXPERIMENTS IN DSP LABORATORY

The main objectives of our DSP course are to gain the knowledge of advanced signal processing techniques and to use a combination of theory and software and hardware implementations in solving practical signal processing problems.

Considering that some of our master students are from the cities dislocated from Faculty site and some of them are employed, we use blended delivery mode for teaching and learning on this course. The course comprises theoretical lectures, placed on the Moodle LMS system, lab and computer sessions.

Web-based remote experimentation assists remote users to develop skills, which deal with real systems and instrumentation with the added advantage of providing broader access to expensive specialized equipment at any time and from any location [1]. When students interact remotely with the laboratory plants they have the opportunity to verify what happens when they alter and manipulate the experiment.

As a result, the one remote laboratory exercise is created. For better understanding of theory of course topic in adaptive filtering, this lab experiment illustrates implementation of LMS (Least Mean Square) algorithm on NI cRIO 9074 FPGA hardware platform. NI 9205 as an input module and NI 9263 as an output module are also used as additional hardware components. The used hardware platform NI CompactRIO is an advanced embedded control and data acquisition system designed for applications that require high performance and reliability. The LabVIEW suite is used to implement the hardware architectures for signal processing [2]. The laboratory environment for LMS adaptive algorithm hardware experiment is shown in Fig. 1

Adaptive filtering is one of the inevitable topics in advanced DSP courses. LMS algorithms are a class of adaptive filter method used to mimic a desired filter by finding the filter coefficients that relate to producing the least mean squares of the error signal. It is a stochastic gradient descent method in that the filter is only adapted based on the error at the current iteration [3].

The hardware experiment for adaptive filtering carried out by using of sine wave input signals that was compromised by noise.

The described experiment processed on the web and control remotely. The remote laboratory, accessible from anywhere through the internet connection, has been built according to the general methodology to control instruments through internet [1]. LabVIEW has its internal web-publishing of the created models and algorithms. This option allows us to control remotely cRIO platform as well LMS adaptive algorithm implemented on the platform. By using Web publishing tool option we assign the URL address to our application. The result of remote hardware experiment on the remote user side is shown in the Fig. 2.

This paper is a result of activities within the project 543667-TEMPUS-1-2013-1-RS-TEMPUS-JPHES "Building Network of Remote Labs for strengthening university-secondary vocational schools collaboration" supported by The Education, Audiovisual and Culture Executive Agency (EACEA).

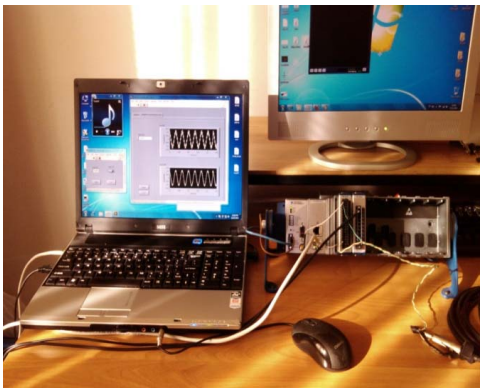

Figure 1. The laboratory enviroment for LMS adaptive algorithm hardware experiment

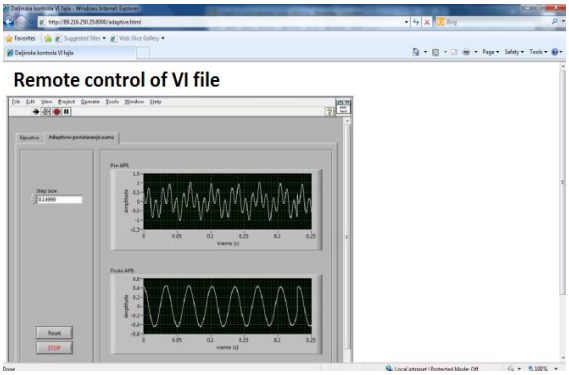

Figure 2. The results of remote experiment on the remote user side

A system is said to be adaptive if it tries to adjust its parameters in order to meet a well-defined goal or target that depends upon the state of the system and its surroundings. So the system adjusts itself so as to respond to some phenomenon that is taking place in its surroundings [3]. In this case we can said that "surroundings" is noise (first graph in the Fig. 2) and when the process of adaption is done, smooth sine wave signal will appear on the output of the adaptive system (second graph in the Fig. 2).

III. MERGING REMOTE EXPERIMENTS AND MOODLE

The expected next step in using remote experiment is to integrate it with the learning management system (LMS) [4]. The aim was to help students in accessing exercises at same place where they learn – the LMS and enable scheduling of experiments and collaboration.

Scheduling is a crucial to be carried out as there is no concurrent access to the equipment, since there is only one set at remote experiment site.

A Moodle block, called Remote Lab View (RLV) is created in order to enable these tasks. Figure 3 shows the student's view.

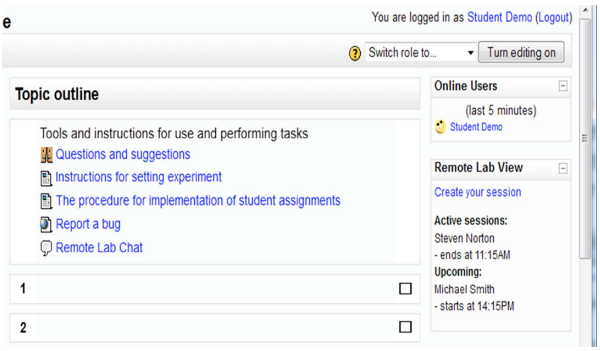

Figure 3. Remote LabVIEW block RLV integrated into Moodle LMS

Student is able to apply for the unoccupied time interval, according to the calendar. Time slots are set to 20 minutes by default, but that value is adjustable. When the time has come, student got his link to experiment. That is an exclusive link, which only prescheduled users may obtain. During the experiment, student may use chat in order to get help or comment the activity. After doing the experiment, he may come back to Moodle and discuss the results, share images and so on.

IV. CONCLUSION

Remote experiments using cRIO and LabView platform provide an advanced method in acquiring knowledge and practical skills about specific processes in DSP without need to be present during on-site experiment.

We presented just one DSP remote experiment created by using cRIO platform and LabVIEW software. Besides it, there are several others DSP experiments that we plan to set up, such as remote measurement of signals, remote optimal filtering, remote signal measurement of the signals in different environment and therefore cover a broader subject area.

The remote experiments integrated with online learning environment (particularly Moodle) completes the e-learning experience and happens to encompass the subject area and gather both the theoretical and practical matter.

Further work presumes advanced integration using web-services and gathering experiment results in a centralized fashion.

REFERENCES

[1] X. Yue, E. M. Drakakis, J. Harkin, M. J. Callaghan, T. M. Mcginnity, L. P. Maguire,"Modular Hardware Design for Distant-Internet Embedded Systems Engineering Laboratory", *Computer Applications in Engineering Education*, Vol. 17, Issue 4, pp. 389-397, December 2009.

[2] National Instruments: CompactRIO cRIO-9072/3/4 (2013, July 10h). *Operating instructions and specifications*, [PDF Manual] Available at: http://www.ni.com/pdf/manuals/374639e.pdf.

[3] D. G. Manolakis, V. K. Ingle, S. M. Kogon, "Statistical and adaptive signal processing", McGraw-Hill book, ISBN 13: 978-1-580053-610-3, 2005.

[4] C. A. Jara, F. A. Candelas, F. Torres, S. Dormido, F. Esquembre, "Synchronous collaboration of virtual and remote laboratories", Computer Applications in Engineering Education, Vol. 20, Issue 1, pp. 124–136, March 2012.