Live Webcast of a Nuclear Engineering Laboratory

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INTRODUCTION

Utility of a laboratory class can be extended by webcasting it. Using newly available technology, laboratory experience of a remote student — though still not the same as that of an in-lab student — can be significantly enhanced. Webcasting modules of two lab experiments have recently been reported [1, 2]. These are now being extended to cover and webcast all the experiments in the Nuclear Engineering laboratory (NPRE 451), a class offered at the University of Illinois at Urbana-Champaign. Work reported earlier took advantage of webcam, audio links, and live webcasting of data using LabVIEW [3]. LabVIEW is a platform for programming developed by National Instruments to acquire data, control and automate instruments. In our work, LabVIEW is used to measure data, share data, and display live data over the Internet. With the webcasting modules developed, remote students have live two-way audio and video link with the lab where the experiment is being performed. LabVIEW is used to display data locally and to webcast for remote students [2]. While extending this work to all the experiments in the course, two additional features have been added. These include the use of a software, webcamXP; and a newly developed webpage for the lab. Extensive work was needed to webcast the data measured in different experiments.

NPRE 451 is a lab class in the Department of Nuclear, Plasma, and Radiological Engineering at the University of Illinois. Practical laboratory experience aims to help students understand principles and applications of radiation interactions with matter and ionization of matter by charged particles. Eight experiments are conducted in the course.

1. Steady-state heat transfer
2. Gamma-ray spectroscopy
3. Nuclear instruments
4. Radiation detection and counting
5. Gamma-ray attenuation
6. Geiger-Mueller counter operation
7. Alpha particle spectroscopy
8. Neutron and gamma-ray shielding

The first two experiments can be webcast in real-time with the earlier work. The other six experiments can be webcasted with several data acquisition devices (DAQs).

DESCRIPTION OF THE ACTUAL WORK

Work reported here can be divided into two parts: generic enhancement of the lab experience; and individual experiment-specific work.

Generic developments

Two new features, webcamXP and the laboratory website, have been added. WebcamXP integrates all of the webcams located in the lab. The laboratory website provides additional resources for local as well as remote students.

WebcamXP

A generic software called webcamXP is introduced in the framework of the distance lab. Rather than separately manipulating several windows on the monitor, webcamXP [4] provides a friendly environment to integrate the function of all webcams. Remote students can enlarge the image of any webcam; or zoom and pan. Fig 1a. shows the web browser window of webcamXP. Remote students can also capture the image or record the video at any time. Besides, online talking space, Live Chat, of webcamXP can be used by the remote students to communicate with personnel in the lab.

Laboratory website

A lab website is developed for local as well as remote students. General lab safety and radiation safety information is provided. The website includes separate links for all of the experiments in NPRE 451 and provides references and links of relevant information about each experiment. The course outline and the handout for each experiment are available. Video of the lectures and the experiments can be made and uploaded to the website. Data can also be put on the website to share with other students. A frequently asked questions (FAQs) section is developed for each experiment.

Specific work on particular experiments

While webcams, webcamXP, audio link and website are generic features common to all experiments, the need to webcast data, as it is gathered, requires experiment specific work. This is due to the fact that data may be in

analog or digital format, and the data display mode in the lab may not be suitable for webcasting. Data from experiment number 3 through 7 are displayed on an oscilloscope. To webcast, the signal needs to be digitized and displayed using LabVIEW. The noise in some of these experiments needs to be subtracted (or eliminated) from the data. Webcasting of the noise elimination steps also require special treatment. Both of these needs are satisfied using DAQs, a digitizer and a sampling analog input module**.** DAQs help webcasting the experimental data by displaying the data from the local lab in LabVIEW, and simultaneously on the Internet.

The digitizer

The oscilloscope is used in experiment number 3 through 7. The oscilloscope is replaced by the digitizer, NI USB-5132, a DAQ device manufactured by National Instruments. The digitizer not only has all the same features as that of the oscilloscope, but it can webcast the data over the Web simultaneously. Fig. 1b. shows the LabVIEW window of the wave signal on the computer. Remote students can see and save the data in exactly the same format as the local students, via the Internet.

DAQs to subtract noise

Noise subtraction is needed in experiment number 2 through 5. The procedure currently being used in the lab is described first. The single channel analyzer (SCA) output of the amplifier is connected to the counter. The pulser amplitude is varied to change the amplitude of the pulses and determine the value of the lower-level discriminator (LLD) of SCA that stops these pulses from being counted. The value of the LLD and the amplitude of the corresponding signal displayed in the oscilloscope are recorded. Repeating this for several different pulser amplitude settings, data is collected, and the pulse amplitude is plotted against the LLD cut-off level. This calibration is used to discriminate against the noise of the gaseous ionization detector and the scintillation detector.

For the gaseous ionization detector, the oscilloscope is used to determine the noise level of the signals in volts. The LLD is then set at a value above this level to make sure that noise is cut out. For the scintillation detector, the oscilloscope is used to observe the amplifier gain. The LLD is then set to filter the noise. [5]

Webcasting the current procedure has the drawback that remote students see the data through webcams. The numbers are to be recorded by hand to plot the calibration line of LLD. The goal for the distance lab is to webcast all the data in a form suitable for easy calibration. To accomplish this goal, a pulser is used to provide external voltage to control the value of the LLD. Through a DAQ device, NI 9215 (a product of National Instruments), the LLD cut off level is displayed in a LabVIEW window, which is accessible to local as well as remote students. Remote (and local) students can then proceed with the calibration step since both the digitizer and the LLD data are available in tabular form in LabVIEW, and can be easily plotted. Once the calibration is complete, it is easy to filter the noise of the gaseous ionization detector and the scintillation detector.

Fig. 1a. Multiview web browser window of webcamXP.

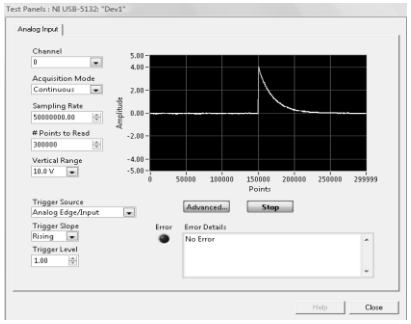

Fig. 1b. The digitizer window of a wave signal.

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