

A Distance Lab Class for Nuclear Engineering

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INTRODUCTION

Using newly available webcast technology, laboratory experience can be significantly enhanced for students in remote locations. This webcast technology involves live two-way audio and video link between the students and the lab. It also allows remote students to work with data in the same format as used in the lab. These two features help make the lab experience vivid. In this paper we report the webcasting modules for the experiments of the Nuclear Engineering laboratory, a lab class offered by 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 during a semester long lab 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 listed above were webcasted in real time in work of Jain, Gu, and Rizwan-uddin [1, 2]. The other six experiments can be webcasted with several data acquisition devices (DAQs) and LabVIEW [3]. LabVIEW is a platform for programming, developed by National Instruments, and to acquire data; control, and automate instruments. In our study, LabVIEW is used to analyze and display live data in the lab and also in remote locations.

Earlier study took advantage of webcam, audio links, and live webcasting of data using LabVIEW. To extend to all experiments, three additional features have been added. These include a newly developed webpage for the lab and the use of two software packages, Skype [4] and webcamXP [5].

DESCRIPTION OF THE ACTUAL WORK

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

Generic developments

Three new features—the laboratory website, Skype, and webcamXP—have been added. The laboratory website provides additional resources for local as well as remote students. Skype allows communication between remote students and the person in the lab. WebcamXP integrates all of the webcams located in the lab.

The laboratory website

A lab website is developed for local as well as remote students. General lab safety, and radiation safety information is provided. Instructions to use Skype and how to navigate the web browsers of webcam XP are also on the lab website. In addition, 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.

Skype

Skype is free software used as a communication tool for remote students and local personnel. Not only is the software free, but Skype-to-Skype calls are free as well. Instructions for downloading the software, creating a Skype account and using Skype are available on the lab website. More importantly, Skype allows multiple remote students to communicate at the same time, which allow them to participate in an experiment simultaneously. Sometimes it is necessary to communicate via typing instead of speaking, such as to present some numbers. In this case, Skype also provides a window, Skype chat, for users to send data back and forth between the lab and remote users.

WebcamXP

Generic software called webcamXP is introduced in the framework of the distance lab. Rather than separately manipulating several windows on the monitor, webcamXP provides a friendly environment to integrate the function of all webcams. Live videos from them stream via the Internet through HTTP, Windows Media or to upload via FTP/FTPS or HTTP/HTTPS Post. In addition, webcam XP puts live webcam on the laboratory web page and is robust for 24/7 broadcasting. Remote students can enlarge the image of any webcam; or zoom, tilt and pan. Figure 1 shows the web browser window of webcamXP. Remote students can also capture the image or record the video at any time.



Fig. 1. Multiview web browser window of webcamXP.

Experiment specific developments

While the lab website Skype, and webcamXP 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. Two special treatments are introduced for the distance laboratory. First, signal from experiments 3 through 7 is displayed on an oscilloscope. To webcast it, a digitizer is used via a LabVIEW program. Second, in some experiment it is necessary to observe the change of voltages over a certain period of time to estimate the rates of nuclear reactions. This information can be webcasted through a LabVIEW program.

The digitizer

The oscilloscope is used in experiment 3 through 7 to present a graph of a voltage signal as a function of time. 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 simultaneously webcasts the data over the Web. Remote students do not need to install any software but simply open a web browser to see the data. They can then save the data in exactly the same format as the local students, via the Internet. Figure 2 shows the LabVIEW window of the voltage signal on the computer.

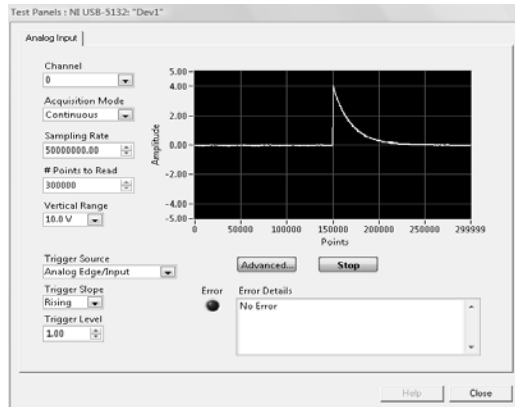


Fig. 2. The digitizer window of a wave signal.

Timer/Counter program

To reduce tedious recording work for local as well as remote students, a friendly timer/counter program is developed. The timer/counter is used in experiments 3 through 6. In these experiments, radiation detectors take advantage of interaction between radiation and material inside the detector. This interaction releases electricity through ionization, which causes the voltage to change. This change can be observed by the change of signal in the form of pulses. The pulse can be displayed via the digitizer. The level of radiation in the detector is then inferred by counting the pulses in a certain period of time. To get the pulse counts, the detector is connected to the pre-amplifier, the amplifier, the signal channel analysis (SCA), and the timer/counter. Before counting, the SCA needs to be calibrated. Then, according to the pulse shape of the digitizer, students in the lab use SCA to eliminate the noise from the signal. Students set the time interval (approximately 10 seconds), and record the counts. This is repeated several times to calculate statistical error.

For webcast, the procedure and connection of the equipment are changed. The detector signal is shaped and amplified by the pre-amplifier and amplifier. Then it is transmitted to the computer through the DAQ, NI 9215, which transfers the analog signal to digital signal. Then through the LabVIEW program, the pulse counts can be displayed in the lab as well as webcasted. In this program, students are asked to input the filter amplitude (in volts), the amount of time (in seconds) and the number of trials. As this program is running, it automatically records and tabulates all data. Students, remotely as well as in the lab, can then easily analyze and save the data. In addition, SCA calibration is no longer needed because the noise is filtered in the program.

Summary

With the webcast module developed, experiments in the Nuclear Engineering laboratory class are available to remote students. Laboratory procedure for some of the experiments is modified to fit webcast modules. Remote students can participate in the experiment conducted in the lab using audio and video links. They also can get real-time data and plot in the same format as that used in the lab. Because the new modules display all the data on computer monitors, which can be easily recorded in graphics or text form, need to write down the data is eliminated. This feature not only helps those at remote sites, students in the lab also benefit from this module.

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Brief Biographical

Wu Hsingtzu is a graduate student in the Department of Nuclear, Plasma and Radiological Engineering at University of Illinois at Urbana-Champaign. She is a research assistant in Virtual Education and Research Laboratory which is dedicated to modeling and simulation and the study of the virtual reality for nuclear education and training. She is also a teaching assistant for undergraduate nuclear engineering lab course.