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Distance Reactor Laboratory and Virtual Tours

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INTRODUCTION

More than 600 students and teachers toured the University of Wisconsin reactor last year. However, reactor security and visitor safety requirements often restrict the outreach mission of these reactors. For example, radiation exposure dictates that the tours be performed while the reactor is shutdown. Hence, there is a need to make these reactors more accessible without risking the safety and security requirements. A second motivation to make these reactors more accessible comes from universities that do not have access to reactors on their own campuses and would like to take advantage of the educational goals of these reactors—specifically, to provide reactor operation labs to their students. Examples of such efforts include those at Penn State University [1] and NC State University [2].

University of Wisconsin at Madison (UWM) and University of Illinois at Urbana-Champaign (UIUC) are working towards developing and testing a distance reactor operations laboratory. Though the efforts started independently, the teams are now working together to ensure the best possible model for efficient outreach as well as distance educational mission of UWM reactor. When completed, the virtual control room console and visual access to different reactor parts as well as audio link will provide the students at UIUC (or for that matter, any other place with an internet connection and permission from UWM) to "participate" in reactor operation labs conducted by students on site. Obviously, the virtual console can also be used by on site students to enhance their reactor lab experience. The facility will also allow UWM to extend its outreach mission by, for example, adding reactor startup demonstrations in its tours.

VIRTUAL CONSOLE FOR DISTANCE LABS

UIUC has worked on two fronts to make distance labs a reality. First is a LabVIEW and webcam based facility to test simultaneous audio, video and data broadcast of (non-reactor) experiments [3-4]. The distance-lab has four components: local lab, LabVIEW, network camera, and remote client. "Local lab" includes experimental facility and personnel carrying out the experiment on site. "LabVIEW" is National Instrument (NI) software that allows signal acquisition, analysis, and data presentation. It also has a built-in capability for web-braodcasting. Network camera is a digital network camera installed in the lab that can capture the video and audio of the experiment and transmit them live over the internet. These cameras usually have zoom/pan/tilt capability that can be controlled by remote users as well. "Remote client" may be any computer connected to the internet. Figure 1 shows a schematic diagram of the system. With LabVIEW's built-in web-broadcasting feature and the network camera, the system can broadcast not only the live scenes of the laboratory, personnel and experiments, but also the real time data and graph being measured and displayed in graphical format. Remote clients only need LabVIEW and Java runtime engines.

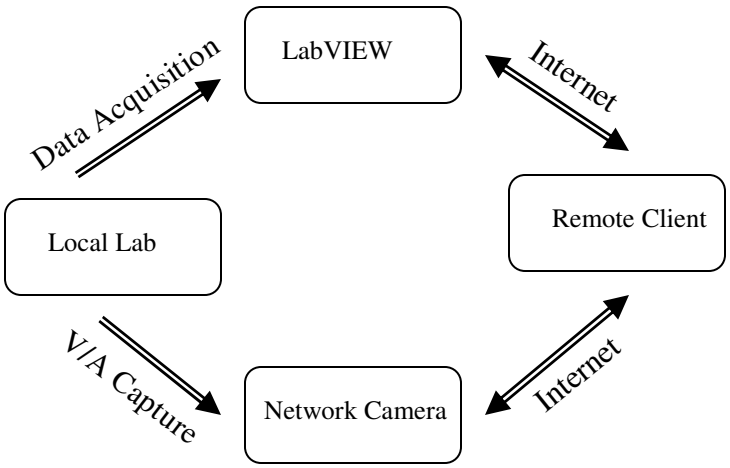

Fig. 1. Schematic diagram of the distance lab.

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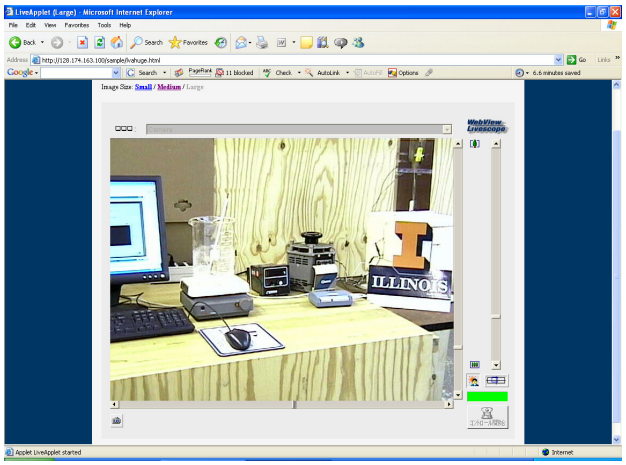
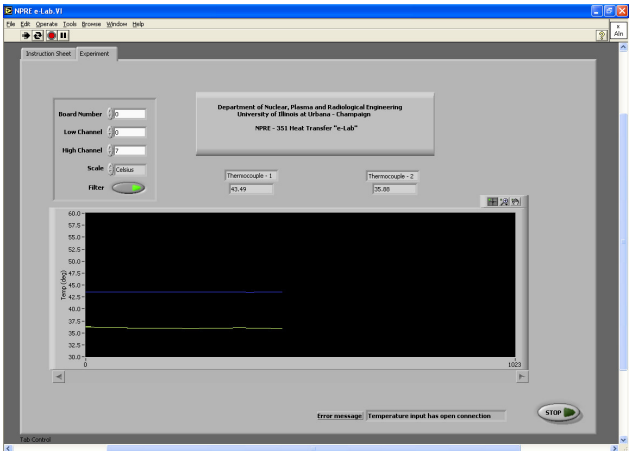


(a)

(b)



(c)

Fig. 2. (a) A live webcam view of the lab at the remote site. Users at the remote site can zoom, pan and tilt the camera view. (b) A picture of the heat transfer experiment. (c) LabVIEW data acquisition, display and web-broadcast of the two temperature readings.

Figure 2a shows a view of a computer screen at the remote site. It shows a boiling heat transfer experiment, with scroll bars that can be used to control the camera (zoom/pan/tilt). Figure 2b shows the hot sphere dipped in a beaker of hot water. Figure 2c shows the corresponding data (temperature measured by two thermocouples) in a LabVIEW virtual instrument (VI), also being viewed at the remote site.

In addition to the prototype distance lab module, UIUC has also developed a computer lab equipped with two large screen monitors and several computers. Figure 3 shows a picture of one of these large screens mounted on a wall. Web browser windows showing different shots of the laboratory and windows displaying the data being measured can be displayed on these screens for a large number of students/visitors to view. Several modalities for an audio link between the remote computer lab and the experiment site, including conference calling and audio transmission feature built-in in the webcam, are available.

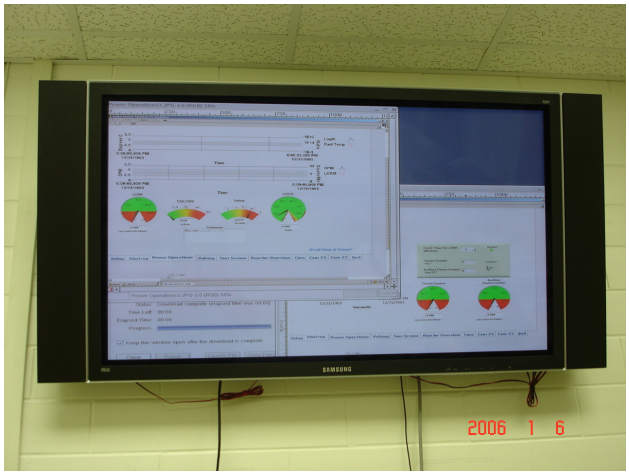
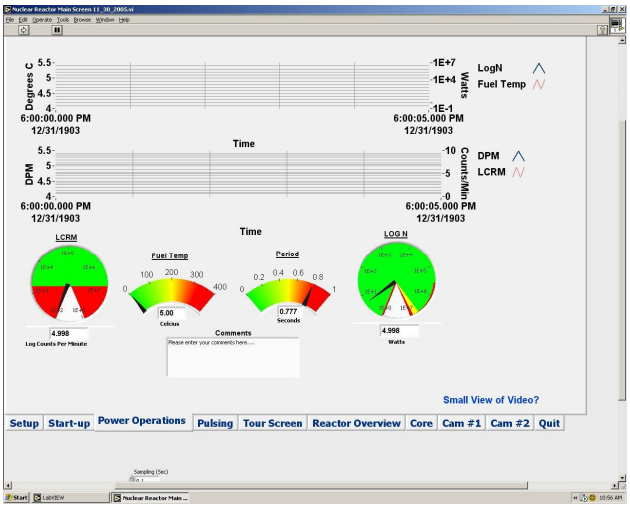


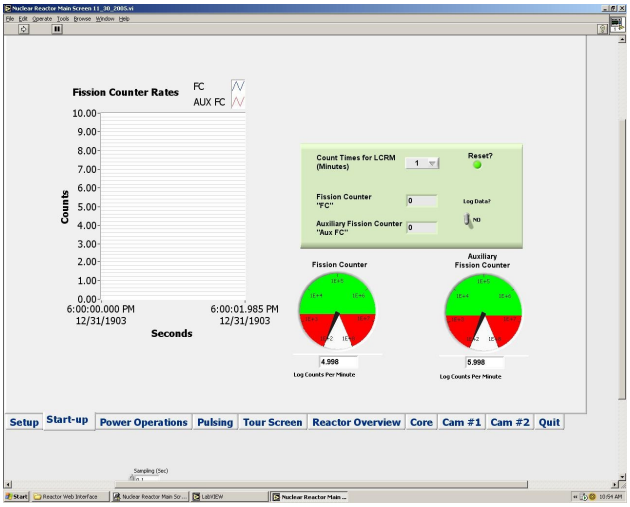
Fig. 3. A picture of part of the remote client facility showing (jpeg) images of the virtual console.

The Nuclear Reactor Laboratory at the University of Wisconsin – Madison is developing a real time internet-based virtual console using LabVIEW 8 for data and image acquisition. The project is developing a virtual control room that can be broadcast to remote sites allowing students to participate in reactor experiments. A LabVIEW BNC-2100 Series Connector Block was used for data acquisition. It has connections (BNC) for up to eight analog input channels. Some of the signals connected include reactor power, reactor period, pulse power output, fuel temperature. Remote students will view a virtual control room with nuclear instrumentation displays including reactor count rate, reactor power, reactor period and fuel temperature, etc. Examples of LabVIEW virtual instrument panels are shown in Fig. 4.

An image of the reactor core will be acquired with an underwater color video camera. Cerenkov radiation will be observed as reactor power increases. The connection to the control room will be further enhanced with a webcam. Experiments being planned for remote students include: control element calibration, reactor pulse and an approach to criticality (k-effective =1).



(a)



(b)

Fig. 4. LabVIEW VI panels for web-broadcast showing, (a) Power operations screen, and (b) Start up screen.

In addition to the lab classes, the virtual console will be used to enhance the outreach program as well. Simulations are being developed for various operations sequences. These will be integrated into the tours allowing the students to experience a reactor startup.

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