Demonstration of Collaborative Features of Remote Laboratory NetLab

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***Abstract*—In this presentation we would like to demonstrate collaborative aspects the remote laboratory NetLab. Many universities worldwide have developed remote laboratories that are now common part of laboratory component used by their students. NetLab is one of them, and is used by undergraduate students to perform experiments on electrical circuits. Unlike majority of other laboratories NetLab is from the beginning designed as an interactive collaborative environment where a number of students can access the equipment remotely from different places in the world and collaboratively wire circuits, connect and set up instruments and perform measurements. All users that are logged on concurrently have the full control of the system. Because NetLab is an interactive learning environment students are required to coordinate their actions. Unlike in a real laboratory where students see what everyone is doing, collaboration in remote laboratory is not a trivial task. To enable this collaboration NetLab has a number of features to support interactive collaborative work. In the proposed session these features will be demonstrated.**

***Index Terms*—remote control laboratory; on-line collaboration; engineering; electrical circuits; instrumentation.**

I. INTRODUCTION

The laboratory paradigm in engineering, technology and science education is increasingly moving toward incorporating to larger or lesser extent e-learning methods. Real laboratories with hands-on experiments on physical equipment are still an important part of the curricula but, increasingly, virtual laboratories – web-based simulations – both locally and remotely, and remote laboratories (RL), where experiments are conducted remotely on real equipment, are becoming a routine part of engineering programs worldwide [1].

A remote laboratory is a computer-based learning environment that allows students to access and perform experiments on real laboratory equipment from a distance via the Internet. As such, RLs are potentially excellent platforms for students to network and collaborate with students from other countries and through this interaction to learn skills that will prepare them for an international career at the global professional job market.

In this publication we describe and demonstrate the collaborative features of the RL NetLab, developed at the University of South Australia.

II. NETLAB DESCRIPTION

The development of the remote laboratory NetLab started in year 2001 after the UniSA awarded a Teaching and Learning Grant (AU$40,000) for its development [2, 3]. NetLab is now used in a number of courses both by on campus and off-campus students [4]. The laboratory is designed for electrical circuit analysis. It includes a number of passive circuit components, standard instruments and a controllable web camera.

NetLab allows any circuit that can be created from these components and instruments to be wired and configured remotely using an in-house developed software called Circuit Builder (CB). A sample of a circuit wired in CB is shown in Fig. 1. More details on technical aspects of NetLab can be found in our previous publications [5].

All concurrent users have equal level of privileges regarding the control of the system. This also includes wiring a new circuit. In case a new circuit is wired by one user (e.g. user1) all other concurrent users (e.g. user2 and user3) receive a message that the circuit has been changed also shown in Fig. 1. Pressing OK by user2 and user3 will cause the system to update the image of the CB graphical user interface (GUI) on their screens in order to show the new circuit.

As a synchronous collaborative environment NetLab must provide for communication between users. This is accomplished at several levels. The simplest one is a text based chat as shown in lower left-hand corner of Fig. 2

NetLab GUI includes also a window that broadcasts the actions of each user. This is placed in the lower right-hand corner of the GUI shown in Fig. 2. This way each user can trace actions of all other users. This eliminates a possible perception of the system misbehaving.

The system automatically discloses all users that are logged on and allows them to type messages in the chat

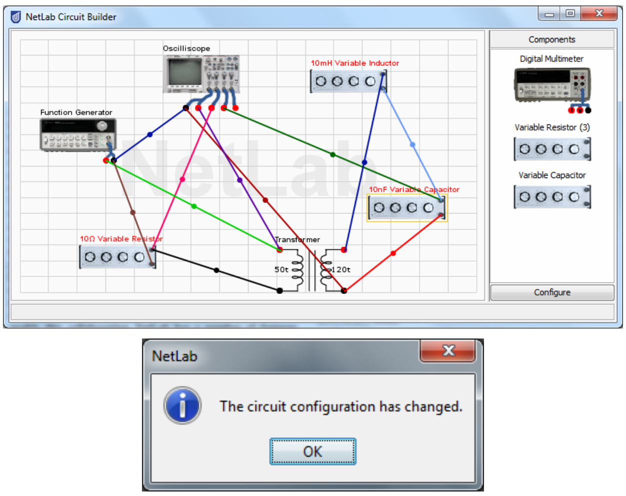

Figure 1. Circuit Builder GUI for remote wiring of circuits, and message other users receive when someone changes the circuit.

window. Although the number of concurrent users is not limited by the design of the system, the administrator can impose this limit to make collaborative sessions manageable. Currently this limit is set to three mainly because in real laboratories at UniSA students work in groups of 2-3.

To limit the number of concurrent users a booking system has been developed which allows up to 3 users to book the same 1 hour session. Fig. 3 shows the booking system where three green dots (seats) are available in each one hour for 3 users. However, a user can book all 3 seats if he or she wishes to work alone. Blue dots show booking of the particular user. Green seats are still available. Red seats are booked by other users. By placing the cursor over a booked spot the name of the user appears, so students can select the group partners for their experiments.

The system also displays time in the local time zone of the user who is booking the session.

Over the past years of utilization of NetLab we observed students attitude towards the use of collaborative features and concluded that students prefer to work either individually or collaborate by sitting and performing experiments from the same computer. Remote on-line collaboration is used rarely and almost only when no other option is available. An example of this is our project titled Enriching students learning experiences through international collaboration in remote laboratories, supported by the Australian Learning and Teaching Committee Competitive grant (AU$220,000) over two year period, 2009-2010, where students from different countries performed laboratory experiments collaboratively in order to gain intercultural experience and learn international collaborative skills.

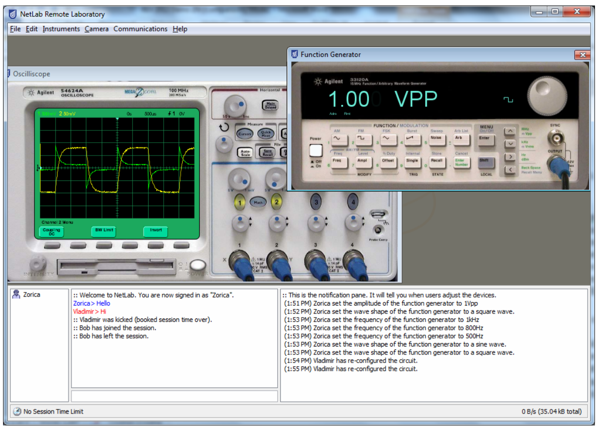

Figure 2. NetLab GUI that supports on-line collaborative interactive work between remote users

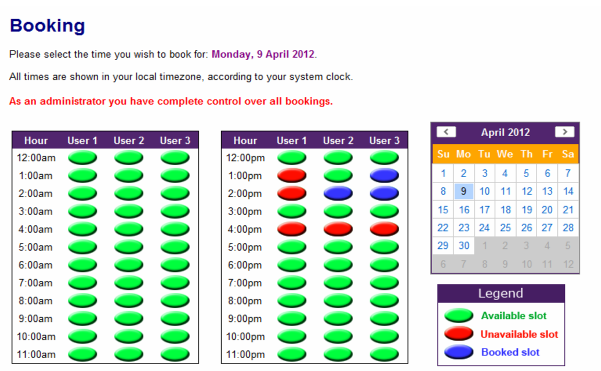

Figure 3. NetLab booking system

III. ALTC PROJECT

The ALTC project had a number of stages and involved ten academic staff from four partner institutions; two from Australia and two international partners.

A. *Recruitment*

In the onset of the project recruiting volunteers UniSA students from Adelaide and from Singapore enrolled in 3rd year course Signals and Systems to collaborate with each other on a common experiment for which the RL NetLab was used. The initial plan was to have four collaborating teams: two teams composed of two students from Adelaide and two students from Singapore (2x (2+2)); and two teams with one student from Adelaide and one student from Singapore (2x(1+1)). However, none of the students wanted to work alone with student(s) from other country, so we formed 4 groups of 2+2 students.

In the second part of the project students from Blekinge Institute of Technology, Sweden were recruited by the international partner to collaborate with UniSA students from Adelaide and Whyalla campuses. These students collaborated on a different experiment while enrolled in the 2nd year course Electrical Circuit Theory that can be expected to be a common fundamental course for all electrical engineering students worldwide.

It was also planned to run collaborative sessions that would involve Australian students and students from University of Porto, Portugal. However, this had not eventuated due to the difference in year scheduling of a common course on microcontroller programming. A number of options were considered, e.g. involving students from different courses, but it was finally decided not to proceed due to the high level of complexity of the context in which students will find themselves.

B. *Induction*

Students were inducted into the program with explanations of the aims of the project and their roles in the project. This induction gave students the opportunity to clarify all their concerns related to the project and especially in relation of the use of the recorded sessions in which they were to participate.

Then students in Adelaide were trained in the use of Centra® software by Saba® Ltd as a communication environment because it provided a suitable interactive collaborative environment and option of recording the sessions. It was decided to provide Centra® training only to students in Adelaide, in order to start the first collaborative session with a relatively easy task, i.e. Australian students teaching offshore students to use Centra software.

Online Collaboration

Students were provided a discipline specific task where they needed to discuss and to assign roles and tasks to members of the team. To complete the given task students needed to arrange several collaborative sessions, firstly to prepare for the laboratory session which may include analysis of the task and simulation of the system to be examined, secondly to work collaboratively on the experiment using RL NetLab, thirdly to analyze the measurement results, and finally to write a group report. It was noticed that some groups merged some of the sessions as it was more convenient for them to meet less frequently for longer sessions due to work and other commitments.

C. *Analysis of recorded sessions*

The collaborative sessions were recorded and students interactions were analyzed. It is important to note that students were not supervised during any of these sessions and that they have full control over the recording of the sessions. During the induction process students were advised to feel free to stop recording at any time if they felt a need to do so. Despite the risk of impeding the analysis of interaction, we felt the need to give the students this flexibility. We also concluded that it was impossible to control students' communication outside the recorded sessions, so we adopted the approach to survey the ways students communicated outside these sessions, rather than attempting to prohibit it.

This decision was made early in the project during the first meeting of the project management team including the international partners. In the course of the analysis of the recorded sessions it was taken into an account that some parts of the recorded sessions were deliberately or accidently omitted by students and not available to us for analysis. However, we felt it was an important decision to make in order to develop the trust and make students feel comfortable with their participation in the project.

The recorded sessions were analyzed in terms of three aspects of the international collaboration: discipline knowledge, use of technology and intercultural capability. A particular attention was focused on how each aspect affects the other aspects of the collaboration. In other words, the activities and interactions were analyzed within the context of situated learning within the full complexity of this particular collaborative environment.

From our pilot experiments evident are the attempts by students to minimize the divides between cultures which agrees with findings by Montgomery in [6]. However, this may suppress their attention to differences and jeopardize their opportunities in developing intercultural competencies including intercultural curiosity.

Analysis of recordings of the collaborative sessions show students practicing politeness, which is natural behavior in establishing and maintaining relationships, including intercultural relationship. However, this may have negative consequences in professional collaborative environment as politeness often induces considerable amount of ambiguity, uncertainty and indirectness. On the other hand, a caution should be exercised when encouraging directness in communication as it should not appear to encourage people to be rude to each other, but to be more tolerant to directness but less tolerant to misunderstandings and ambiguity in communication within the professional collaborative environment when it can have serious consequences on outcomes of joint international projects.

Consequently, students need to learn to balance clarity and ambiguity, understanding and misunderstanding, directness and indirectness in their communication. They also need to learn to balance their discipline task focus and intercultural learning focus to maximize their learning opportunities in the development of intercultural competencies in the context of professional intercultural collaboration.

IV. CONCLUSION

In this article we gave a short description of a number of unique features that support online collaborative work in remote laboratory NetLab and some details of a project where students had a unique opportunity to use this learning environment for advancing their international collaborative skills through on line collaboration with students from different countries.

This article is an outline of the live demonstration session during the conference.

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