A Study on The Potential of Using Remote Labs for E-Learning Engineering Courses in Malaysian Universities

ABDULLAH MOHD ZIN and HASNIM HARUN
Faculty of Information Science and Technology
Universiti Kebangsaan Malaysia
43600 Bangi, Selangor
MALAYSIA
amz@ftsm.ukm.my

Abstract: - Remote lab has been considered as method that can be used to enhance e-learning, especially for engineering courses. However, in Malaysia, the application of remote labs is considered new and in most cases "unavailable". This paper describes a study that has been carried out among Malaysian universities electrical and electronics engineering lecturers to explore the reasons for this phenomena. The result of the study shows that administrators and lecturers support the use of remote labs an alternative to traditional labs. Among the reason cited for not using this technology is the difficulty in developing remote labs. The study found that most of the lecturers are lacking in IT skills and hardware interfacing skills. They also do not have the expertise in developing webpages and other related tasks. To solve this problem, we have propose the development of Remote Lab Generator (RLGen), a software tool to assist lecturers to develop remote lab.

Key-Words: - **E-Learning, Remote Lab, Sofware Tools, Remote Lab Generator**

1 Introduction

E-learning is now considered to be one of the alternatives for higher education. To enhanced e-learning, a number of open universities have been established in many countries. Many traditional universities are also offering courses through e-learning. While many e-learning courses are restricted to the area of arts and business, some universities are also offering e-learning courses in the area of science and engineering.

Engineering courses normally include the laboratory components. For the laboratory sessions, most of these e-learning universies will have to rent laboratories belonging to other institutions of higher education (such as universities or polytechnics) close to students' learning centers. For example, for some courses in electrical and electronics engineering, the lab sessions are normally conducted in two full days to cover 5 to 8 experiments required for a course. This type of arrangement is certainly not sufficient. Students need to have more hands-on experience in order to acquire all the necessary skills required by the course. One of the approach being considered is the use of software simulators such as Pspice or Electronic Workbench. However, using software simulators does not provides the same experience as conducting the real experiment. Many universities are now considering another option, that is the use of remote labs.

A remote lab by definition is an experiment which is conducted and controlled remotely through Internet. Experiment in remote lab use real components or instrumentation, that are located at a different location. A configuration of a remote lab is shown in Figure 1. Remote lab is not the same as Virtual lab, which uses Virtual Reality, Flash or Java Applet to simulate the lab environment.
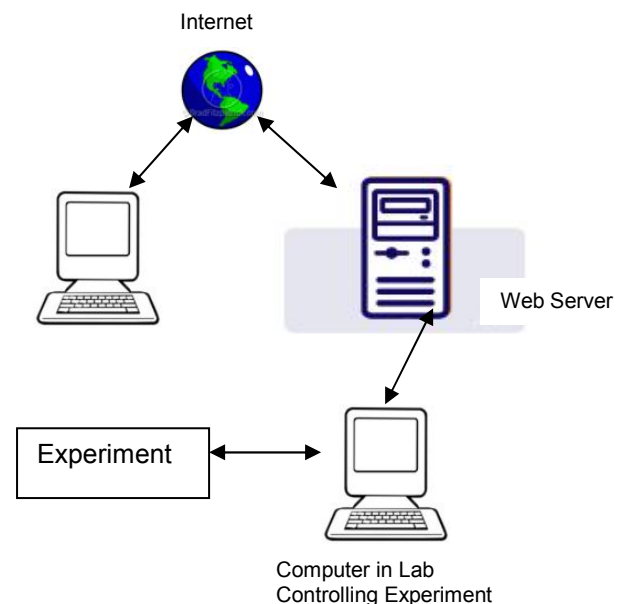

Figure 1: The configuration of a remote lab

A number of remote labs have been successfully developed. Some of the developers are Basher et. al.[1], Dixon et. al. [2], Casini et. al. [3] and Das et. al. [4]. With the advancements of Internet, control

and measurement technology, and networking technology, there are a number of implementation models that can be used to implement a remote lab. Some of the implementation models are descibed by Hasnim and Abdullah [5] and Mergl [6].

In this paper, we are going explore the possibility of using remote labs for offering electrical and electronics engineering courses through e-learning in Malaysia. The second part of this paper describes a survey research that has been carried out among engineering administrators and lecturers in Malaysian universities. The third part describes a possible solution to the problem discovered in our survey research. The last part of this paper is the conclusion.

2 A survey on remote lab implementation in Malaysian Universities

Although the concept of remote lab has been introduced for some time, it is not yet being used in Malaysian universities. This survey research has been carried out to explore the reason for this phenomena.

2.1 Research Methodology

The survey research consists of three parts. The first part of research was to determine the perception of university administrators towards remote lab. The perception of university administrator is critical and important element toward the development of remote labs since they are responsible for making decision as well allocating manpower and financial support for the developing of remote labs. This part of the research was carried out by interviewing Heads of Department of Electrical and Electronics Engineering from four Malaysian universities.

The second part of the research was to find out about the perception of the lecturers towards remote labs and to determine whether they have the necessary skills to develop remote labs. For this part of the research, questionnaires were distributed to about 200 lecturers in the Malaysian universities. The questionaire consisted of 3 parts: computing and IT skills, computer interfacing skills and perception of lecturers toward the usage of the remote lab in engineering education. For computing and IT skills and computer interface skills, lecturers were asked whether they were familiar what the particular skill. If they did, they were asked to identify the level of skills that they had, based on the following likert scale:

1 – not skillful

2 – quite skillful
3 – moderate
4 – skillful
5 – very skillful

The third part of the research was to gather opinions from the experts regarding the implementation of a remote lab in Malaysia. For this purpose, the 2 round Delphi Technique was used. In this technique, using e-mail, the experts were asked to identify important criteria for a remote lab implementation in Malaysia. The feedback from the experts were carefully collected and listed. The list was then sent back for the experts. This time, they were asked to indicate the priority for each item listed in the list. The expert chosen consisted of senior lecturers who have at least 5 years experience in their field.

2.2 Interview With Administrators

Four heads of Department of Electrical and Electronics Engineering from Malaysian universities were interviewed. Nine issues were raised and the summary of the responses is given in Table 1.

Table 1: Summary of the Interview Results

.	Questions	Summary of Interview Result
1.	Is there any problem to offer engineering lab locally? Is it suitable for some of the labs to be offered through Remote Labs?	- Labs are offered based on requirement and demand. Until now, there is no problem. - Remote Labs are not suitable for undergraduates, it may be suitable at upper levels. Undergraduate needs hands-on lab. Certain labs may be suitable to be implemented for undergraduates in 3rd and 4th year. - Safety issue and expensive instrumentation may easily breakdown.
2.	Is there any possibility to develop a Remote Lab in your institutions.	-Yes - Should be a value added but not as a replacement. - Suitable as post lab exercise. - Suitable as pre lab exercise.
3.	Can remote labs replace conventional hands-on labs?	- No
4.	Is the university network and Internet sufficient for delivering Remote Labs?	- Not sufficient but will be sufficient soon. - Speed of Internet not yet stable in in our university.

5.	Is the cost to develop a Remote Lab an important factor?	- Cost is not the problem. - Should be based on Cost and Benefit analysis.
6.	Is human resource available and ready to develop remote labs?	- Should be developed by a group of teams. - Needs a retraining in human resource.
7.	Are students ready to use this new medium?	- Believe the students have sufficient skills to use remote labs.
8.	Reasons for not using remote labs.	- Engineering curriculum has bond to engineering body such as Board of Engineers (BEM) – requiring certain hands-on lab experiment. - To replace some labs with remote lab have to be approved by National Accreditation Board of Malaysia.
9.	Other issues, requirement and justification to develop Remote Labs.	- Because of the impossibility to have fully automation, a staff need to be assigned to take care of the remote lab.

2.3 Questionnaire to Lecturers

Out of 200 questionnaires that were distributed, we received 65 responses. This section describes the analysis of the responses.

The first part of the questionnaire enquired about computing and IT skills of the lecturers. The summary of the responses is given in Table 2. This table is divided into 5 categories. The first one is about the skills in using programming language. Only 20.00% have got the experienced of using any of the programming languages, among those who have, the mean of their ability is 2.90. The second category is Electronic supporting software. The percentage of lecturers who are familiar with this software is 37.85%, and the mean for their ability is 3.09. Only 24.62% of lecturers are familiar with the use of HTML editing software, and the mean for their ability is 2.85. The ability to use Internet scripting among electronics lecturers is only 0.77%, and the mean for their ability is only 0.75. Lastly, 35.38% are familiar using MS Access database package, and the mean for their ability is 2.51.

Table 2: Computing and IT Skills

Computer and IT Skills	% Not Use	% Use	Mean Use (Skill)
VC++	67.69%	32.31%	2.95

VB	75.38%	24.62%	2.63
C	92.31%	7.69%	4.00
Java	96.92%	3.08%	2.00
Other programming language	67.69%	32.31%	2.90
Mean		20.00%	2.90
Electronic Work Bench	64.62%	35.38%	3.30
Pspice	61.54%	38.46%	3.16
Labview	87.69%	12.31%	3.00
Matlab	26.15%	73.85%	3.04
OrCad	70.77%	29.23%	2.95
Mean		37.85%	3.09
HTML	56.92%	43.08%	2.89
Frontpage	64.62%	35.38%	2.78
Dreamweaver	89.23%	10.77%	2.57
Other HTML editor	90.77%	9.23%	3.17
Mean		24.62%	2.85
Perl	96.92%	3.08%	3.00
ASP	100.00%	0.00%	0.00
Servlet	100.00%	0.00%	0.00
Other scripting language	100.00%	0.00%	0.00
Mean		0.77%	0.75
MS Access	64.62%	35.38%	2.48
MySQL	92.31%	7.69%	2.40
Dbase III+/IV	90.77%	9.23%	2.67
MS SQL Server	98.46%	1.54%	2.00
Oracle	98.46%	1.54%	2.00
Other database	96.92%	3.08%	3.50
Mean		9.74%	2.51
AVERAGE	81.28%	18.72%	2.47

Summary of the computer interfacing skills of the lecturers is given in Table 3. From the table, it is clear that more than 60% the lecturers do not have the skill in computer interfacing. Among the 40% of lecturers who have the skill, the mean of their ability is only 3.12, which coukd be considered moderate.

Table 3: Computer Interfacing Skills

Computer Interfacing	% Not Use	% Use	Mean Use (Skill)
Serial and Parallel port skill	46.15%	53.85%	3.03
A/D and D/A skill	58.46%	41.54%	3.00
Data Acquisition skill (DAQ)	84.62%	15.38%	3.50
General Purpose Interface Bus Skill (GPIB)	87.69%	12.31%	3.13
Computer hardware interfacing	35.38%	64.62%	2.93

AVERAGE	62.46%	37.54%	3.12

The lecturers' perception on remote labs is given in Table 4. From the table, the means for both questions are 3.35 and 3.38. This implies that lecturers are positive on using remote labs, but they still do not have the confident to use this technology.

Table 4: Lecturers Perception on Remote Labs

Question	Mean
A Remote Lab should be considered to be used in e-learning	3.35
A Remote Lab would facilitate students in e-learning	3.38

2.4   Expert Opinion

The result of the 2 Round Delphi Technique with the experts is given in Table 5. This table listed the criteria and priority for developing remote labs to be used by Malaysian universities.

Table 5: Criteria and Priorities in Developing a Remote Lab

Criteria	Priority
Easy to setup	1
Functional	2
Access time to be consider	3
Suitable as replacement to traditional lab	4
Lab skill and knowledge are delivered	5
Less programming	6
User friendly	7
Accurate and acceptable experiment data	8
Data security and fraud free	9
Compatible with lab component and instrumentation	10
Balance between cost and benefit	11

3   Remote Lab Generator

The study shows that while administrators and lecturers are positive about using remote labs in electrial and electronics engineering courses, there are a few problems that need to be overcomed before remote labs can be used. The most important problem for the lecturers is the lack of computing and IT skills as well computer interface skills. In order to solve this problem, there is a need for a software tool that can help lecturers in the process of developing remote labs. In this section, we are going to describe our proposed software tool, called Remote Lab Generator (RLGen).

3.1 Software Requirements

Based on the experience of developing remote labs and from the analysis of the study described in the previous section, the software requirement for RLGen are as follows: .

- The software supports an easy to use editor.
- The value setting must be made as easy as possible by using property pages and wizard.
- Use market-available activeX for measurement and control purposes.
- Make the process for creating client side with TCP/IP or data socket connection to PC controller easier.
- Include features for intructors to prepare lab documentations such as introduction, note, lab sheets and the experiment.
- Include features for lecturers to manage student accounts such as login username and password.
- Generate ready to use student website based on the input from lab lecturers.
- Include a booking system for student in the generated student web site.
- Include the the lab tasks and interaction such as sending report and marking report features.

3.2 Software Implementation

To demonstrate the idea, we have developed a proptotype for RLGen. It consists of modules such as Experiment Editor, Lab Preparation, Student Management, Marking System and the Student Web Site which consist of Sending Report System and a Booking System as shown in Figure 2.
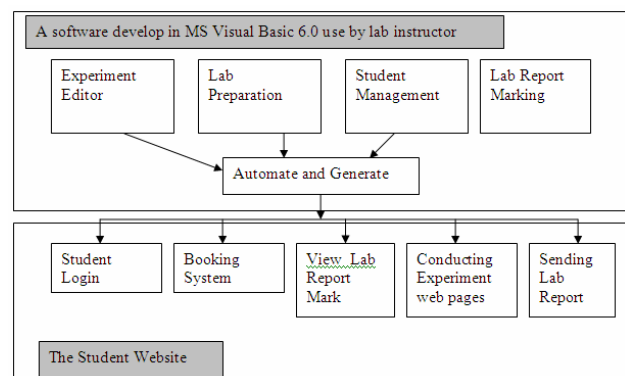

Figure 2: The components of RLGen

The Experiment Editor has the Toolbar, Form and Property Pages like VB 6.0 editor. It also has the common features such as move, resize and delete. This editor uses activeX as a software component. Figure 3 shows the Experiment Editor used by the lecturers to design the experiment.

The Lab Preparation is the module that provides support for lab lecturers to do the necessary

preparation of lab documents in the HTML format. The Student Management is the module for lab lecturers to manage student information such as username, password and other information. Included in RLGen is the form for intructor to grade a student's lab report.
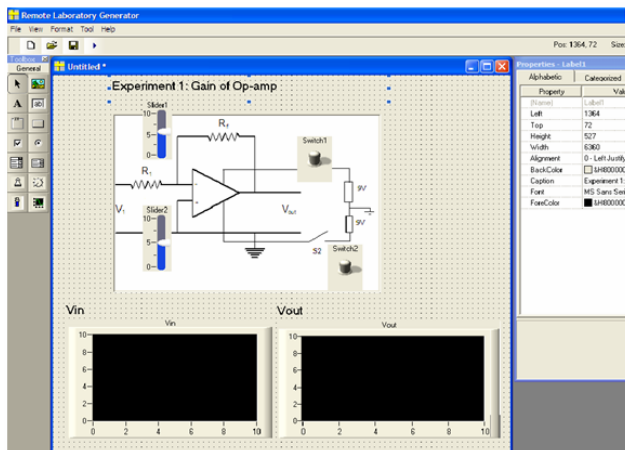

Figure 3: Experiment Editor

Based on the design and the HTML documents for the experiment, RLGen will auto-generate the student's website. The student's website consists of five main units: Student Login, Booking System, View Lab Report Mark, Conducting Experiment Web Pages and Sending Lab Report. If the Login is successful, the student is directed to Conducting Experiment Web Pages. Before the student begins an experiment, they must book the experiment time slot since only one experiment can be conducted at one time. The login process will fail should they try to login without booking that particular time. When the student completed the experiment, the lab report in **.doc** format can be submitted to the lecturer. The student can also check their lab report score from student's website after it was graded.

4 Conclusion

The research was started in order to explore the reasons for the lack of usage of remote labs in Malaysia. The result of the study indicates that administrators and lecturers showed positive attitute towards the use of remote labs an alternative to traditional labs.   However, they are using this technology due to the difficulty in developing remote labs. The study found that most of the lecturers are lacking in IT skills and hardware interfacing skills. They also do not have the expertise in developing webpages and other related tasks.

In order to solve this problem and hence to encourage the use remote labs, we propose that a software tool to assist lecturers in the process of developing remote labs to be developed. This sofware tool is called Remote Lab Generator (RLGen). A prototype of RLGen is already developed. However, we still need to work further in ensuring that the software tool is reliable and hence suitable to be used by the lecturers in developing remote labs.

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