

Remote Lab Generator (RLGen): A Software Tool Using Auto-Generating Technique to Develop a Remote Lab

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Abstract—Recent Remote Lab development shows that there are many implementation models and architectures which can be used to develop a remote lab. A technique which aims at generating and automating processes and tasks can simplify this development. A new software prototype named Remote Lab Generator (RLGen) uses this technique to demonstrate how the development process of a remote lab can be made easier for lab instructors.

Index Terms—Remote Lab, Virtual Lab

I. INTRODUCTION

Remote lab by definition is the experiment/lab which is conducted and controlled remotely through the Internet and the experiments use the real components or instrumentation at a different location from where it is controlled or conducted. It must be distinguished from Virtual lab which uses Virtual Reality, Flash, Java Applet or other software to simulate the lab environment.

Engineering courses normally include the laboratory components. Although hands-on lab is essential, the use of technology in the form of remote lab facility could assist the learning process. Remote lab uses a real lab component and instrumentation and is conducted by students from scattered remote locations through internet medium. It is suitable for engineering courses offered within distance learning and e-learning environment. It differs from simulation approach which employs programming code to simulate the result of the lab experiment. Examples of remote labs which have been successfully developed those such as by Basher et. al.(2004) which used Labview, Dixon et. al.(2002) and Casini et. al.(2003) which used Matlab and Das et. al.(2006) which used Visual Basic 6.0 with Measurement Studio 6.0. With the advancement of Internet, control and measurement technologies, and networking technologies, there are a number of implementation models that can be used in order to implement a remote lab such as the one written by Hasnim & Abdullah(2006) and Mergl(2006).

There is no intention to replace the traditional hands-on lab but it can be as a supportive tool that can be used before or after a lab session to enhance the learning/lab concept and theory. By combining it with simulation tools such as Pspice or Electronic Work Bench, students will benefit more. By using remote lab as a new tool and a part of an e-learning engineering program, the offering of

engineering courses in distance learning will be nearly completed.

Normally lecturers use multi-purpose software such as Labview which is specifically made for measurement and control in engineering field. To develop a remote lab that can be used by student, lecturers need to do certain task such as computer interfacing programming, creating client side connection, preparing a web page for lab experiment information, a booking or a que system for a remote lab because only one experiment can be done at one time. Based on a requirement study conducted previously, there are certain needs from lab instructor for an easier lab documents preparation, student management features, lab report pass-up and marking system and less preparation on creating student websites. Because of this, software tool which can have great features in measurement and control such as Labview and packaging it together with the requirement of lab instructors will minimize work load to develop a remote lab. National Instruments provide Measurement Studio 6.0 which is a set of activeX for measurement and control equivalent in its features with Labview. Using this activeX for measurement and control and pakgaging it together with the requirement of a lab instructor, a software tool called Remote Lab Generator (RLGen) was developed.

The rest of the paper is organized as follows. The next section describes the common tasks and processes in developing a remote lab while Section 3 introduces the Remote Lab Generator (RLGen), a software tool to help lab instructors to prepare a remote lab. The last section is the conclusion.

II. PROCESSES IN DEVELOPING A REMOTE LAB AND THE IDEAS

There are many tools which can be used to develop a remote lab. However, there are some common tasks and processes in developing a remote lab. To examine the processes, a development of a simple Op-amp experiment as an example of a remote experiment was conducted. It used MS Visual Basic 6.0 and activeX of Measurement Studio 6.0 from National Instruments as a developing tool. Active Server Pages (ASP) and MS Access as database were used. The objective of the experiment is to understand the task or process involved in developing a remote experiment. To develop a remote lab, an instructor must at least be involved in this common task. The results of the observation are listed below.

1. Designing and connecting experiment circuit by adding switching element such as a relay.
2. Designing and building the control programming in PC controller at the lab.
3. Designing, building and connecting user interface on students' web browsers to control programming of a PC controller. (Some measurement software has feature to automate this part).
4. Designing a related web page for the experiment.
5. Preparing the booking system with the use of database.

In step 1 the lecturer will design and manually connect the experiment in the lab. In step 2, the lecturer will design the experiment and do some interface programming. Step 1 and designing process in step 2 are tasks that must be performed manually. It is a task where nothing can be automated. From there onwards, which is interfacing programming in step 2 toward step 5, the tasks can be automated so that the burden of the instructor can be made easier. To demonstrate the ideas, a software tool packaging the features of measurement and control provided by Measurement Studio 6.0 plus the features to simplify the tasks to be done in process to create a remote lab such as lab documents preparation and a booking system was developed.

The layout of the ideas to develop the new software tool is listed below.

- The software will use an easy to use editor.
- The value setting will be made easier 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 intructors to manage student accounts such as login username and password.
- Generate ready to use student website based on the input from lab intructors.
- 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.

Based on this idea, the focus is to create a tool which can control and measure, for this purpose, a simple electronic experiment. The complexity of the electronic experiment is not yet entertained because the initial goal is to build a working conceptual system.

III. REMOTE LAB GENERATOR (RLGEN)

A software tool called Remote Lab Generator was developed to demonstrate the idea. The software was designed to look like MS Visual Basic 6.0 Editor which has proven as an easy editor to use. The software 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 below.

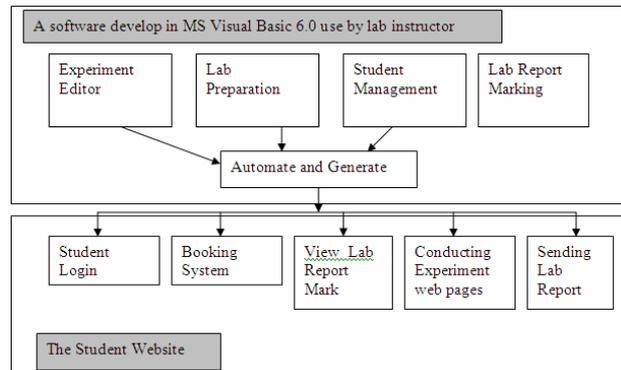


Figure 1. The components of the software

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 whereby the activeX can be created by the developer or using other 3rd party activeX. RLGen has a scalable feature whereby the developer can add controls when the need arises. The editor will have two running mode which are Edit mode and Run mode. As an editor with a toolbox, the instructor will select and place the control in the Form to make the design for the experiment. Four 3rd party activeX user interfaces from National Instruments are used and by using wrapping class some properties are exposed to the intructor in the property pages and some new properties are then created to make setting interfacing tasks with the experiment easier. Setting the values of control properties can be performed in two ways; it can be set directly in the property pages or using a wizard if more than one value needed to be set.

Since the student will only conduct the experiment and not executing the design, the circuit diagram will be in the form of a picture to make the task of the instructor to design the experiment easier. RLGen will generate another copy of the experiment with the connectivity and the input of HTML documents from the instructor will be a student webpages to conducting the experiment. The activeX will be embedded in HTML file as .ocx file. Shown below is the generated client side activeX control with connectivity which was created by the software. Data Socket Server by National Instrument is used for this purpose.

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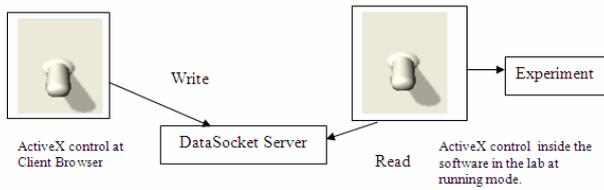


Figure 2. ActiveX control was generated with connectivity

Shown below is the Experiment Editor used by the instructor to design the experiment.

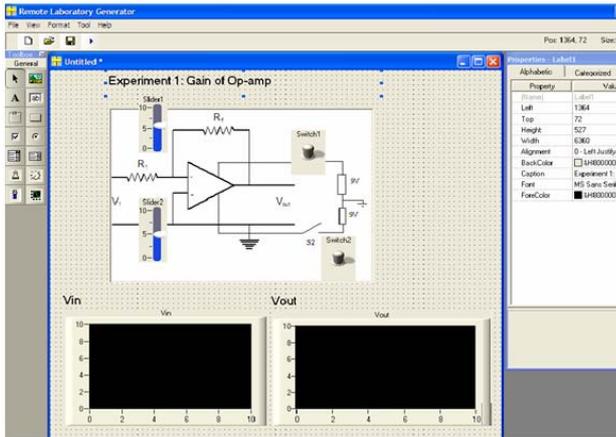


Figure 3. Experiment Editor

After designing the experiment, the instructor will prepare the lab documents to be used later by the students. The Lab Preparation is the module where lab instructors do the necessary preparation and assign the lab document such as introduction, note, lab sheets and the experiment in the HTML format. The Student Management is the module for lab instructor to manage student information such as username, password and other information. Included in RLGen is the form for instructor to grade a student's lab report.

Based on the design and the HTML documents for the experiment, RLGen will auto-generate the student's website where the student will then take the experiment through internet by accessing it from a web browser. The student's website consists of five main units which is 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 where the student can take the experiment as prepared in the Lab Preparation module. Before the student begin the 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 finished the experiment, the lab report in .doc format can be sent in Sending Lab Report section and the .doc file will then be updated to the view table in the software for the instructor to view whether or not the student has submitted the report. The student can also check their lab report score from student website if the instructor has finished evaluating their lab report using RLGen.

IV. CONCLUSION

By using this concept which used automation and generator technique in developing a remote lab, RLGen can save an instructor's time and simplify their task. The Remote Lab Generator (RLGen) as a prototype system is a new tool for a lab instructor to develop a remote lab, however the creation of this software at this stage is only to prove the concept. To make it more reliable and adaptable to more experiments, features enhancement with more activeX controls will be needed.

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