DEVELOPMENT OF A FLEXIBLE REMOTE LABORATORY ENABLING AUTOMATIC ASSESSMENT

A. Adda Benattia[1], A. Benachenhou[2], M. Moussa[2]

[1] *University Ibn Khaldoun of Tiaret (ALGERIA)*
[2] *Université de Mostaganem (ALGERIA)*

Abstract

In the last decade, performing experimentation over remote laboratory became possible. Therefore, pedagogical scheme must be adequate for this new situation. Otherwise, the whole system must be revised. This paper presents a new approach to develop a flexible remote laboratory. In fact, we elaborated a pedagogical scheme especially for remote experimentation. Besides, we developed an automatic assessment system to evaluate remote practical work experimentation for a large class. The proposed hardware setup including servers, measurement instruments, electronic circuits and the software architecture based on web development tools are illustrated. Moreover, we used Moodle LMS to embed pedagogical material for our system. A case study for remote experimentation is illustrated; students manipulate a resistance measurement workbench remotely. Results are carried out and discussed. The remote laboratory is accessible online from any connected PC. Different students can connect to the remote lab and performs experiment while receiving personal and appropriate results from the shared equipment. They can perform auto test with customized interfaces while accessing to the same platform. Implementation of this remote laboratory system is expected to contribute to improving efficiency and lowering the system's costs in the case of large class.

Keywords: Remote laboratory, automatic assessment, Moodle LMS, online experimentation.

1 INTRODUCTION

Remote laboratory experimentation is a new innovation in the development of instrumentation equipment that can be accessed remotely. The development of remote instrumentation has been started since the invention of Internet technology; most of them utilize commercial solutions such as LabView application [3].

The main innovation of the proposed remote lab, compared to others, focuses on the flexibility and the reusability of experiment material, besides, a customized user interface is implemented using web programming tools in order to allow us insuring a large class. An automatic assessment is used to give autonomy and active experimentation to develop competencies and consolidate knowledge and skills [5] [7].

This paper is organized as follow: Section 2 presents the hardware and software structure. In section 3, the procedure of the remote experiment for a given basic experimentations is presented. Finally, conclusions for our work and some perspectives are given.

2 REMOTE LAB ARCHITECTURE

2.1 Hardware Setup

Our proposed remote laboratory based on embedded system is designed so that it supports multiuser access. Fig. 1 shows the hardware setup of the designed remote laboratory. The hardware setup includes some measurement instruments such as oscilloscope, signal generator, dual power supply and digital multimeter; besides, the practical work circuit is plugged to the flexible matrix switch which is managed with an embedded system single board computer pcDuino [10]. This matrix switches establishes connections between the experimental circuits components and measurement instruments.

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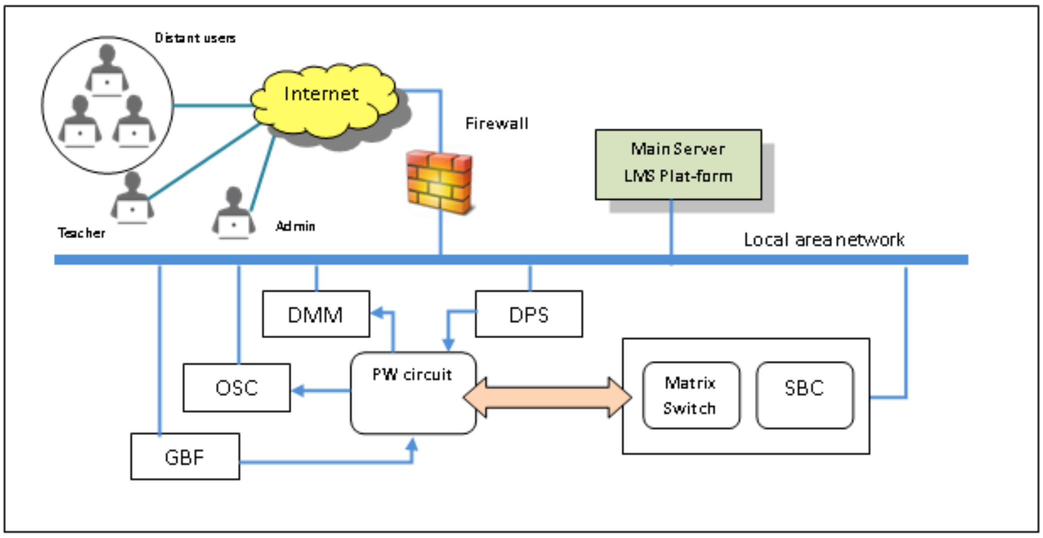

Figure 1. Remote Lab Hardware Architecture.

2.2 Software architecture, using Moodle

The software architecture is divided into two parts, backend and front-end parts. Both parts communicate with other over Internet. The front-end is developed using HTML5, CSS3 and JavaScript (jQuery), however the back-end is implemented over PHP, Node.js and Python. Communications between different software parts are made using TCP sockets and Ajax technique. Moodle LMS is used to manage classroom and user authentication and access the whole remote experimentation system.

3 EXPERIMENTATION SCENARIO

To manipulate the remote experimentation according to a pedagogical scheme, the distant user selects a circuit configuration in the web graphical user interface; the front-end software sends the connections status of the circuit as a digital code. This code is sent to the flexible switching matrix via the manipulation server by using Ajax technique, which is implemented in PHP language [8]. After submission of data input for the appropriate practical work circuit, the measurement instrument embedded server receives specific request to execute a set of commands and sends back the results of measurements, which are displayed on user interface. Our system uses client/server TCP socket technique to guarantee communication between web user interface and the instrument embedded servers (Fig.1).

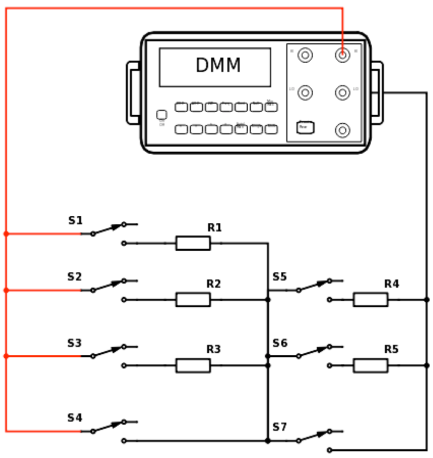

Figure 2. Resistors measurement setup.

4 AUTOMATIC ASSESSMENT ELABORATION

Our system can be used in large class environment. In fact, an automatic assessment technique is implemented so that one user manipulates experimentation with specific parameters; in this case, his response is evaluated according to these specific parameters. In other words, user manipulates a customized experimentation, and by the way it is assessed automatically according to this customized setup. According to figure 3, a user has to provide a value by calculating an equivalent resistor, the proposed interface for the user contains in background some configuration of switches closed, in this way a value of the equivalent resistor is measured and compared with the user response, thus, a formative feed-back is shown on the user screen.

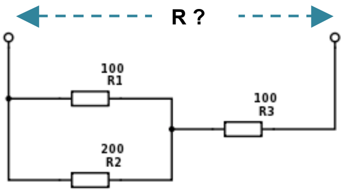

Figure 3. Typical user question.

4.1 Customized User Interface

In a remote laboratory, managing a large class of user is a pedagogical challenge, the basic idea behind our conception is to customize the content of the user interface by implementing specific parameters for each user, and implement automatic assessment according to a specific configuration. Thus, managing a large class becomes feasible.

4.1.1 User Interface

The user interface includes different parts, it contains a specific circuit setup, text input field to input responses and buttons to submit response. Other requests such as switches configuration, commands for measurement instrument are made in background. Each user has his appropriate interface.

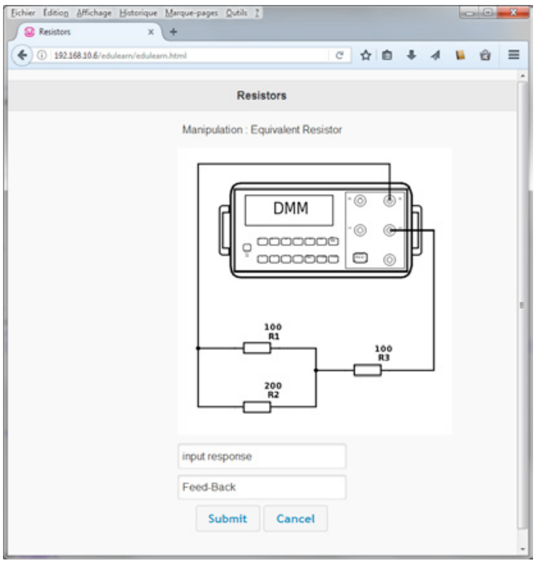

Figure 4. User interface

4.1.2 Application

For testing our system, this experimentation aims to calculate the equivalent resistor according to a specific setup configuration such as in serial, parallel or both. This application utilizes a digital multi-meter, the practical work circuit and the flexible matrix switches.

User has to calculate the equivalent resistor manually, input the result and submit his response, in the same time on background; the circuit configuration is submitted to the matrix switch server managed by node.js, to establish the circuit connections, besides, a request is sent to the embedded server of measure instrument to perform a read operation and feedback the result. The instrument feedback is compared with the user response and according to such a tolerance a formative feedback is displayed on the user interface (Fig 5).

4.2 Automatic Assessment

In the user interface, both question and response are implemented in a customized web page. The user manipulates the experimentation according a specific pedagogical scheme which is implemented in the same web page. Thus, each user performs his own experimentation and gets his own results and will be assessed automatically by the system.

5 CONCLUSION

In this paper, a new approach for handling remote laboratory is presented. A customized user interface is implemented around a single practical work board, thanks to the flexible matrix switch, and an automatic assessment system is used. This allows us to use our system in a large class environment. Based on the obtained results of flexibility and assessment, in the future we will implement other circuits with different component in order to maximize and diversify variants for a given configuration setup.

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