ADVANCED AUTOMATIC CONTROL REMOTE LAB

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Abstract

In this work, an advanced automatic control lab is mounted and tested. The remote lab deals with physical experiments on undergraduate level for automatic control. The whole architecture of the remote lab is presented. More details are then given for each component. The included experiments can vary from conventional controllers such as PID regulators to more efficient advanced controllers. All the process of accessing and executing experiments by a learner is explained and illustrated.

Keywords: Remote Labs, automatic control, elearning.

1 INTRODUCTION

Thanks to the large diffusion of internet around the world, remote laboratories knows a growing success [1]. They allow sharing of experimental equipments by a large number of users spread along a wide geographical space. This is particularly interesting for high cost equipments. Also, remote labs users do not need to move to the Lab. Therefore, they allow a benefit on reducing displacement costs and reduce inactivity days. The work presented in this paper consist on a physical remote Lab for advanced automatic control laboratory works. It is initially designated for automatic control Master students. It can be exploited by any student following a course on automatic control or requiring new skills in automatic control. Even if many remote laboratories are designed in the field of electrical engineering, they deal generally with basic electric and electronic experiments [2, 3, 4, 5]. Automatic control design is an ubiquitous field [6], different disciplines can use it such as electrical engineering, computer science, physics, biology and so on. The presented remote lab can then be profitable for all these disciplines. This paper is organized as fellows: The remote lab architecture and components are described in section 2. Either the software and the hardware parts are cited and described. In section 3, the experiments included in the advanced automatic control lab are briefly described. Screenshots are given for each step of experiment access and launching by a remote student. The article ends by a conclusion that summarizes the work.

2 REMOTE LAB DESCRIPTION

A schematic representation of our remote laboratory is given in figure 1.

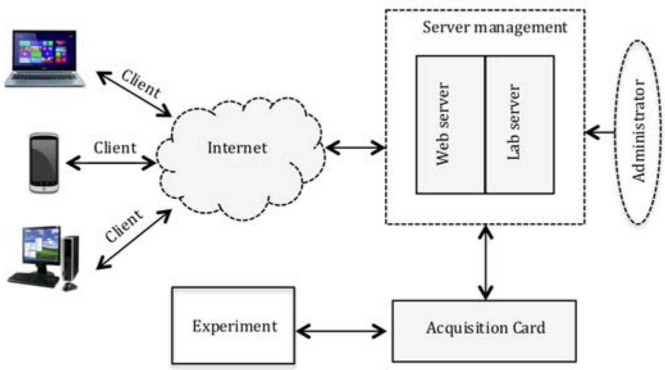

Figure 1. Online Lab architecture [7].

The remote lab is composed of software and hardware devices.

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2.1 Software Part

The *iLab* environment is used as a deployment platform for our remote lab. It is installed on a server machine at Constantine 1 university, Algeria. It is connected [8] to a dedicate internet line. iLab is an environment to implement remote labs. It is developed at the MIT, Boston, USA. It is based on web services and exploits the .NET framework. It is compatible with LabVIEW and web browsers (Microsoft internet explorer, Mozila Firefox, ...). The remote end-user needs only a web-browser and an installed plug-in to access to all the remote lab physical experiments via a GUI. Our remote lab is based on ISA architecture. The lab server design is interactive. The experiments designer needs to create a LabVIEW VI to drive its experiments and to place it on the server. The iLab architecture is based on web services. The *service broker* serves as a backbone for the remote lab. It is the conductor that leads the other services. These services manage students and instructors registration and rights. They also manage experiments registration, authorizations, associations with students, groups creation and management and many other features.

2.2 Hardware Part

All the experiments include the following parts:

Process to be controlled : It consists on a brushless DC motor with its power device. However, the DC motor can easily be replaced by other process (level tank, inverted pendulum, ...).

Data acquisition devices : National Instruments (NI) cards are used. They allow the acquisition of measurements from the process and to send control signals to the process to be controlled in real time.

Server : A server is used and all services are installed in. This include the iLab service broker, the lab server, the user scheduling server, and the lab scheduling server. The NI LabVIEW 2011 is then installed.

LabVIEW programs : The LabVIEW program includes two parts : The front panel that is a GUI for instruments control and data visualisation and a block diagram that is a graphical program that communicates with the experiment through the data acquisition card.

A detailed scheme of the remote lab including software and hardware parts is shown in figure 2.

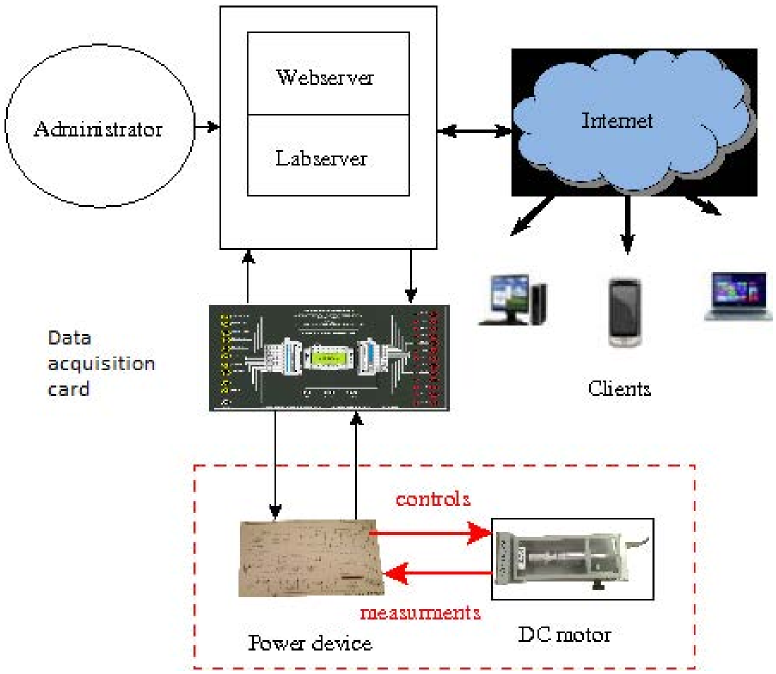

Figure 2. Complete remote lab architecture.

3 EXPERIMENTS DESCRIPTION

Many experimental setups are mounted. They give a practical aspect to theoretical course followed by the students. Each experiment concerns an advanced control strategy. The implemented control strategies are:

1. Optimal control [9],
2. Polynomial control [10],
3. State space control [11],

A classical PI/PID control strategy is added to serve as reference for comparison. All these control strategies are implemented as block diagrams on LabVIEW 2011 environment and placed on the server. An example for an optimal LQG controller is shown in figure 3.

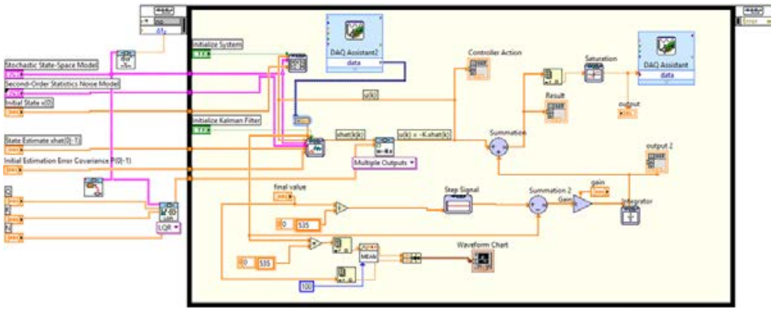

Figure 3. Optimal Gaussian controller block diagram for LabVIEW.

A user that wants to use the remote lab have to follow the same procedure. Once connected to the iLab, the user is directed to the home page to login or register (Figure 4).

Figure 4. Remote Lab home page.

The Constantine university remote lab is accessible through the university portal at: http://ilab.umc.edu.dz/ilabservicebroker.
Once logged, the user can choose an experiment and ask for a reservation time to lead the experiment (Figures 5 and 6).

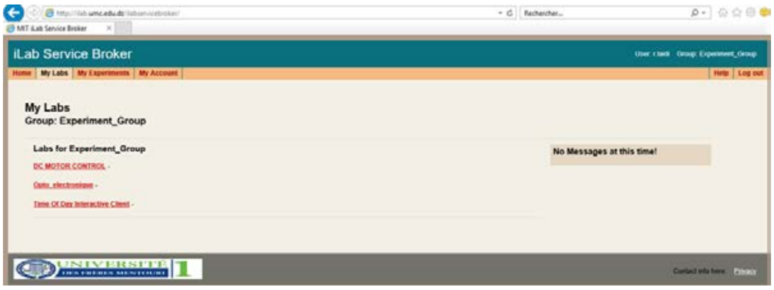

Figure 5. Experiment choice.

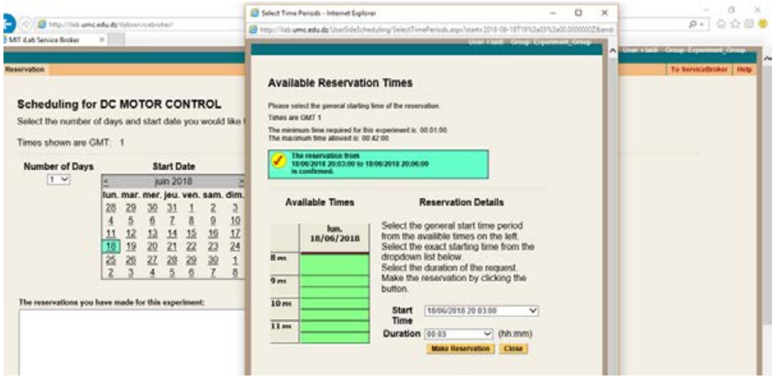

Figure 6. Remote Lab home page.

The user can then launch the experiment directly from its web-browser. It does not need any other software. A GUI is the shown on the web-browser for a remote drive of the experiment. An example of a GUI to drive an experiments are shown in figure 7.

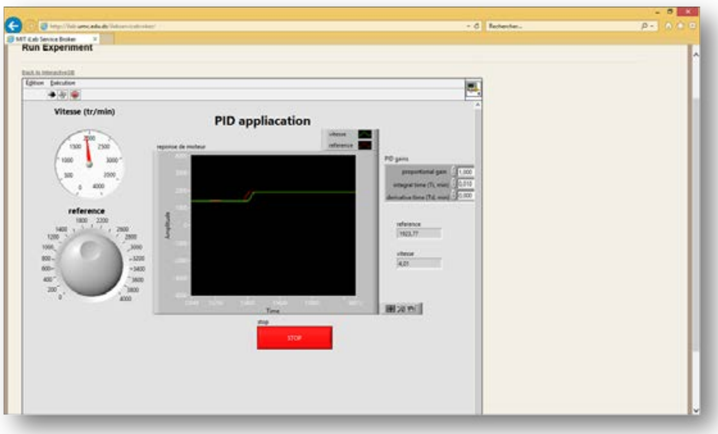

Figure 7. GUI for DC motor control.

At the end of the experiment, all the data generated during it are stored in the server. The data can be downloaded by the user and the instructor for analysis and evaluation. The instructor can also consult a journal including students connections historic.

4 CONCLUSION

A complete remote lab for automatic control is designed and implemented with many experiments. It allows remote users to do physical experiment and instructors to personalize their experiments and evaluate the remote students. A pedagogical evaluation of the remote lab is previewed in future work.

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