Remote Lab Experiments: Measuring and Monitoring of Temperature Changes

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Abstract—The physical training education systems of the faculties of science focus on practical manipulations. Remote Labs are a recent approach used for educating experimental manipulations by using the performance of information and communication technologies. This article presents a real remote laboratory using low-cost embedded systems addressed to engineering and undergraduate students. The manipulation is based on the electronic control system to change the temperature with a plate-form, which is developed to permit students and teacher access to this manipulation. Our purpose of this study is the development of a control system to improve current educational systems in Moroccan universities by managing practical manipulations for a large number of students, based on a web from anywhere and anytime. Measuring and Monitoring of Temperature changes is a new experience of a remote monitoring system that will be allowed the users to access the experiment thought a specific web site.

Keywords—Physics training, remote lab, experiments, temperature changes

1 Introduction

The traditional monitoring system has many shortcomings, such as high risk, high transmission bit error rate, high costs and small coverage. The rapid development of information technology (IT) has paved the way for the creation of new educational paradigms. The most important of these paradigms are remote laboratories. In recent years, the number of students enrolled at the Ben M'sik Faculty of Science has increased dramatically and Technical training in this faculty requires more space for practical work [1], [2], [3].

The Faculty faces serious problems managing the calendar with the large number of students and the lack of teachers and premises for the practical work. The scientific training programs offered by the faculty of science Ben M'sik, practical laboratory training is limited to the time available for the developed, making it necessary to look for options to strengthen the experimental work online. Nowadays Information and Communication Technologies (ICTs) offer a wide variety of tools that, once integrated into different educational systems, help to smooth the way of distance learning. Real experiments have already been conducted through Remote Laboratories [4],[5].

These are technological tools integrating software and hardware to create a real experience that is accessible remotely either via the Internet or through academic networks. The student can access a web interface to perform laboratory activities similar to activities taking place in traditional laboratory. Remote labs offer distance educators another tool to create a powerful laboratory component within Tele-TPs [6].

Because most of the actual physical analyzes in the industry currently use devices powered by a computer interface, remote control of these devices is not easy, but it enhances the opportunity for students to learn, practice and be exposed to the contents of "real labs".

E-lab Faculty of Sciences Ben M'sik and Hassan II University Casablanca are developing laboratories based on the control of instruments in real-time via an Internet connection. Experimentation laboratories must be part of any engineering program. We work in remote labs to integrate engineering fields into e-learning paradigm. Students conduct real-time experiments using modern, pre-equipped equipment, methods and skills to answer and examine their various theoretical questions. After that, Students get real results using real materials that enable them to understand real conclusions, as if they were present in the physical laboratory with equipment. This approach enables students to access useful scientific experiments, thus providing them with a useful pathway to upgrade their cognitive skills as they access the Remote Lab platform. This experiment includes Remote Lab Experiments: Measuring and Monitoring of Temperature changes[7], [8], [9].

2 Architecture of Remote Lab

2.1 General architecture of remote lab

Our previous research was based on use and construction of remote laboratory now we describe the technology that has been constructed, so that we will provide a context for the discussion of the assessment model for those who they are not familiar with remote laboratory. The Remote Laboratory Experimentation represents an extension to the ways in which people utilize the Internet. A remote laboratory for engineering education should achieve an integrated environment for the user controlling the actual device in the remote site and conduct the actual experiments in the remote laboratory via a computer network. The core of the Remote Laboratory is a set of general and / or specialized instruments linked to a set of personal computer systems connected to the Internet. With the ability to remotely configure instruments and data analysis through software, the laboratory will facilitate the sharing of expensive instruments and equipment [10].

The development of a remote laboratory includes the analysis of user requirements, remote control functionalities, simultaneous user operation, sharing the online data from an experiment, read data, change variables and controlling equipments. To achieve the above, a distributed client-server environment has been designed (the hardware architecture for the remote laboratory system is shown inFig.1 Using this architecture; the learners will be able to send themselves, orders through the web browser. Computers in the Remote Lab are connected to engineering instruments. When students log in to these machines over the Internet, they are able to control both the computer and the equipment [11]. A video camera can also be used to broadcast live what is happening in the physical world. It does not matter if the student is in a dormitory nearby or on the other side of the world [12].

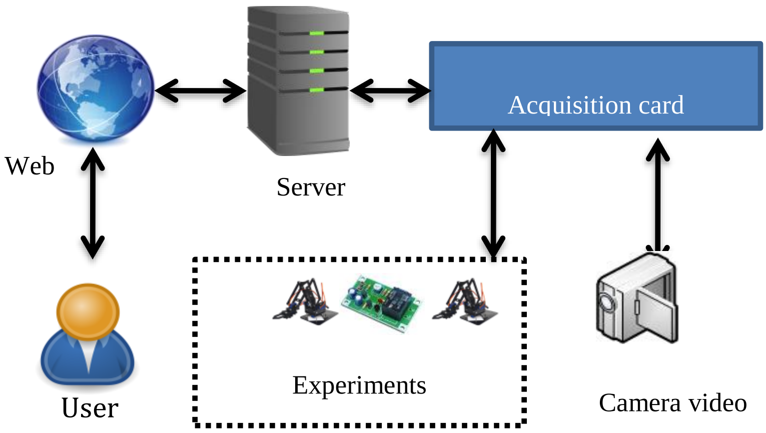

Fig. 1. General Architecture of Remote Lab

2.2 Architecture of measuring and monitoring of temperature changes

Heat is defined as the average kinetic energy of moving particles in matter, measured using a thermometer. They have different metrics and standards such as Celsius, Fahrenheit and Kelvin. In this work, we will apply remote temperature change. For that, we used a series of components: the heat sensor, the data receiver, the control unit, the heating and cooling unit, and the interface, through which the temperature is measured and controlled when the user changes the values in the interface.The Fig.2 illustrates the Architecture of Measuring and Monitoring of Temperature changes.

In order to implement the developed concept we used:

Temperature sensor: It transmits the electrical signal to a unit in the form of a current or voltage, depending on the type of sensor used. We used a temperature sensor that can be calibrated accurately and easily. It is represented as a two-terminal zener station, and the voltage is directly proportional to the absolute temperature at 10mV / ° K [13].

Acquisition card: the unit of data acquisition system is a collection of software and hardware that allows one to measure or control the physical characteristics of something in the real world, per example in this case the temperature.

Cooling and heating unit: The environment around the temperature sensor is cooled or heated through this component.

Relay board 4 channel 5 v: Use this 4 Channel Relay Module board to interface any Microcontroller with Electrical Appliances/Loads. Can also be used in driving high power motors. 4-channel relay output modules, relay output contacts 250A 10A. Input IN1, IN2, IN3, IN4, the signal line LOW effective. VCC, GND power input, can relay a separate power supply relay power input of JD-VCC [14].

Control unit: The process of analysis and processing of all signals received into the processor. It directs all input and output flows, collects code for instructions from precise programs, and directs other modules and models by providing control and timing signals. This module considers the therapist's mind because he makes orders about everything and ensures the correct execution of instructions [15].

Interface of use: The interface enables the user to control the experiments through the web, this interface programming by Lab VIEW.

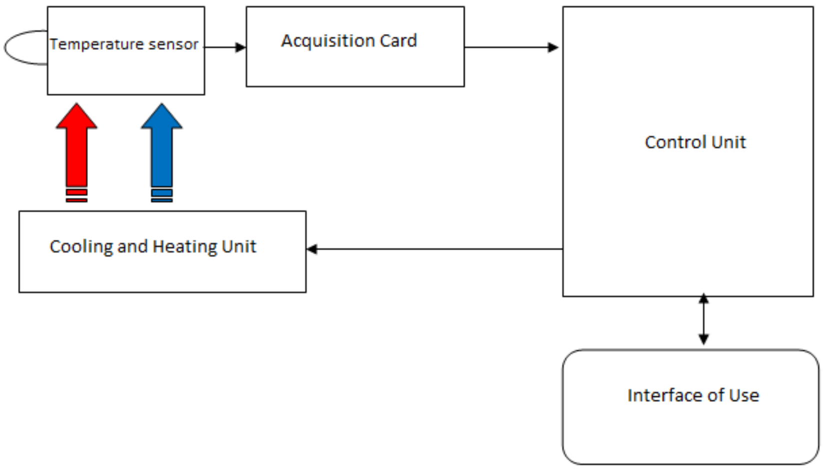

Fig. 2. Architecture of Measuring and Monitoring of Temperature changes

3 Experimental and Implementation The e-Lab FBSM System

The remote laboratory system requires requirements to enable the student to control the real laboratory equipment through the Internet, including the following:

- Ease of student access to the laboratory through a browser, and without an intermediate software, such as any web page must be accessed via a standard web browser.
- Compatibility in shared web protocols and security features.
- Coordinate and manage the sessions by the laboratory supervisor in order to monitor the safety of experiments.
- Develop a document and video tutorial showing sequential steps for the included experiments.

E-lab FSBM is a real scenario in which remote laboratory equipment is used. The experiment is followed from start to finish with a video camera that records the entire duration of the experiment. Students can use the device remotely and control it remotely via the platform [16][17].

According to the above requirements, we will describe our e-lab platform project, which is a remote control of the experiment of our Research Department. The main components of the e-Lab FSBM system are:

To realize our system we use the next compensates:

3.1 Equipment of use

- Acquisition card (Arduino) (A)
- Server
- Relay Board 4 Channel (B)
- Lamp 220V (C)
- Heating unit (D)
- Temperature sensor (E)
- Fan (F)
- Camera video (G)
- Wires

3.2 Software

- LabView
- Arduino 1.6.5

3.3 Mechanism of action

In order to create a temperature change and measurement experiment, we have facilitated the remote management of our system. Our model consists of a temperature sensor attached to the cooling and heating unit to convey changes caused by increasing or decreasing the temperature. This change is read in the form of digital data and diagrams on the user interface, the user can control the experiment by sending a command via the user interface. As shown in Fig.3

3.4 Acquisition card

It is a data acquisition unit, a compact electronic card. For this purpose, we are using Arduino. It is powered by 9V of power and programmed for selected applications using the open source Arduino software. In this experiment, we used three digital inputs to control the relays connected (fan, heating resistance I and heating resistance II), An analog Input to receive the measurements from the temperature sensor. These signals are transferred to unit control for data processing, analysis and display on the user interface.

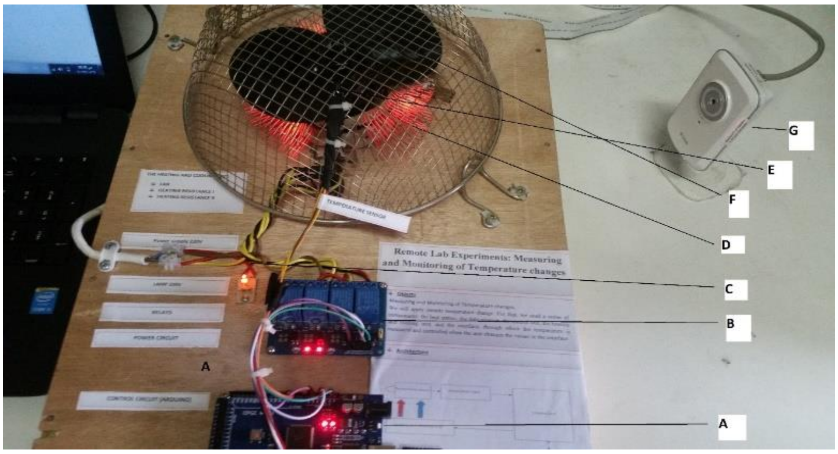

Fig. 3. Mechanism of Action

3.5 The user interface

The FSBM e-lab platform is designed and customized as a web application (as shown in Fig.4). The design includes two task areas: on the left side, control buttons (fan, heating resistance I and heating resistance II) that show what is happening in the laboratory room. On the right side of the graph screen shows the temperature and its changes, along the graph there is a thermometer that measures the temperature in the form of gradients.

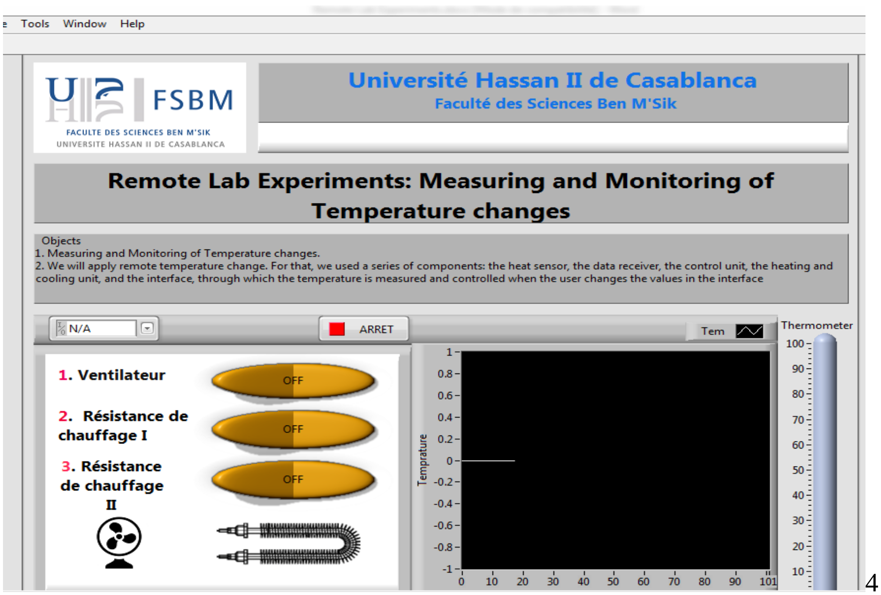

Fig. 4. The User Interface in mode OFF

4 Results and Discussions

The paramount importance of establishing remote laboratories is available to students, centered on creating an environment as easy and flexible as possible at their disposal at any time. The e-lab user interface is designed to be easy to use for all groups of students, who are accustomed to modern technologies (video games, chat and video conferencing) to be close to their preferences and match their daily practices. The technique described in this article also aims to reduce the financial and human resource costs of all institutions involved. As well as avoiding problems of the serious type of testing and manipulation difficult.

In this experiment the student can preview the progress of the stages of the process, the process is carried out gradually as follows: Measuring room temperature with indicator monitoring, turn on heating resistance 1, turn on heating resistance 2 until the temperature reaches the maximum ascending and then turn off the heating resistors and turn on the cooling fan until Heat to normal condition. Fig. 5 illustrates the remote laboratory in real time. The student can export the results obtained in the form of (Image, Clipboard and Excel CSV) (As shown in Fig.7).

We have created an algorithm that is interconnected to each other by means of a LabVIEW programming tool, consisting of many functions to create an integrated system that combines hardware and software and is shown in Fig.6.

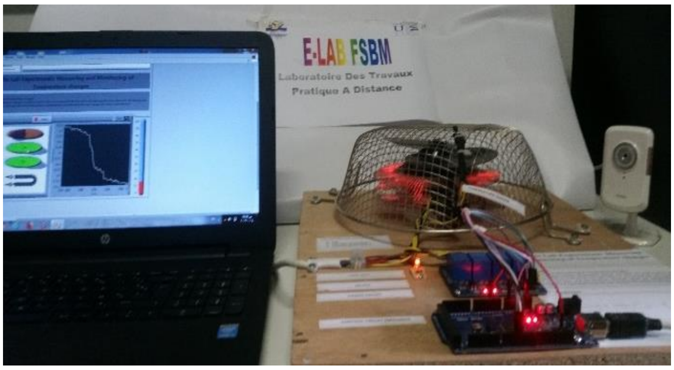

Fig. 5. The remote laboratory in real time.

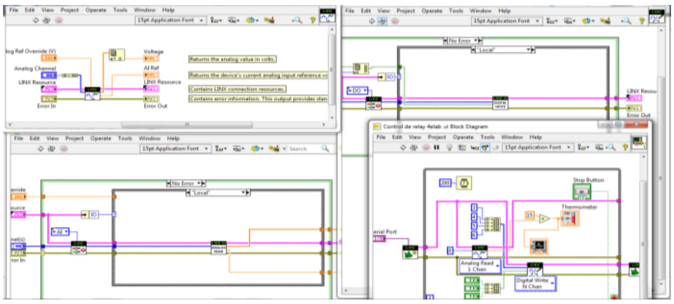

Fig. 6. The algorithm of experiment creates by LabView

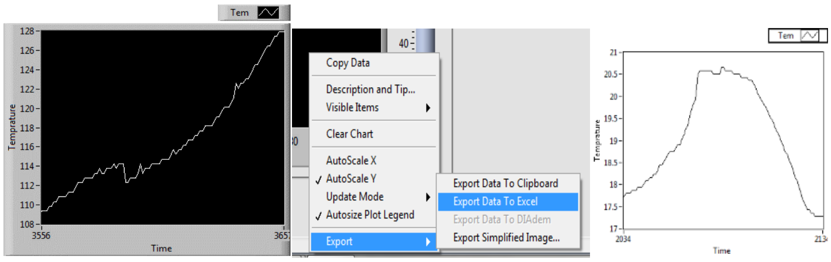

Fig. 7. The results export data in (Image, Clipboard and Excel CSV).

ELAB FSBM is a platform contains the documentation (theoretical study and a practical guide) of each experiment and their simulated animations which allow the user a clear idea and is born before passing to the experimental part, and also to protect the laboratory instruments at course of use. The Fig. 8 illustrates ELAB FSBM platform.

Fig. 8. ELAB FSBM platform

5 Conclusion

Moroccan universities are striving to develop the means and tools of education to move towards: making the most of technology, keeping pace with rapid development and integrating these developments into reality.

Online learning modules have been developed, including more complex live physics experiments than lecture modules. Remote laboratory have replaced the traditional laboratories environment.

This work aims to modernize the educational systems in Moroccan universities by facilitating the practical manipulation for as many students as possible and providing an open space in all colleges. In this project, temperature control has been suggested. This work will facilitate practical applications.

It does not require constant maintenance, in addition avoiding students to fall into the danger of high voltage in the power circuit. In the future, we look forward to creating a window of conversation with the supervisor in order to accompany the experiment.

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