Use of Remote laboratories in E-Learning Environment

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Wider Objective

The wider objective of MUREE is to develop, integrate, accredit and evaluate a quality bachelor degree programme in Renewable Energy in Jordan with an appropriate laboratory component jointly taught by universities in Jordan, in accordance with the Bologna process.
Remote Laboratory: Introduction by Prof. Llanos Tobarra, Prof. Elio San Cristobal
Performing remote lab experiments
Remote laboratories are nowadays essential in distance learning, as our case is. Students are not able to use face-to-face traditional laboratories. These remote laboratories can be employed by teacher within virtual classrooms, so that students can carry out their on-line experiments. The main drawback of these kinds of laboratories is their cost; this is more noticeable in the field of renewable energy. For this reason, this work proposes the use of low-cost remote laboratories, aimed at the study of solar and wind.
The described remote laboratory is based on using the popular robotic kit, named Lego Mindstorms NXT v2.0. Robotic kit. This allows teachers to have flexibility when designing the laboratory and adapt it to the educational necessities of a course. The programming of these laboratories has been performed by using RESTful web services with LabVIEW, a novel approach that enables users the creation of multiplatform laboratories.

Remote Laboratories were being considered in the evaluation of a renewable energy course in the context of an engineering degree from several universities in Jordan. This is in line with the main objective of the MUREE project, which is concerned with the development, integration, and evaluation of a renewable energy course.
Examples of remote lab experiments:

1- Solar panel experiment

Objective is to observe the way in which the voltage, current and power panel varies with respect to different levels of Solar irradiance.
Access to the remote experiment
Experiments are availed by means of Moodle platform. Further details are provided by course lecturers. Students also should read the booking system guide.
Experiment interface

Once we get access to the experiment, the graphical interface is shown next:
If you just desire to minimize any of the elements (for example, one of the webcams), you can do it by clicking on the right icon - at the top of the element.

- **Run the laboratory.** In the status box, click on the button labeled as "Start" to start an experiment:
If the laboratory is being used by another student, an appropriate warning will appear and you will not be able to start it in that moment:

![Laboratory Current Status]

- **Adjust the light power.** Use the control dial to set a determined lighting value. Familiarize yourself with how to move the control, since the displacement is rotating. Observe the variation of light through the webcam and, also, the value taken in the status box.

- **Store the obtained results.** In the next graph box you can observe the temporary values of the measured variables. If you click on the legend of one of the variables, some graphical representation
alternately appears and disappears. If your pulse on the box on the right, just below the "-" icon, a menu to save the image data in different formats appears.
2- Wind Turbine Experiment

Objectives:

1. Find out the threshold values for the boot of the wind turbine and the starting point of useful power generation.

2. Observe the way in which the voltage, current, and power vary with respect to different levels of wind flow.
Access to the Remote Experiment
Experiments are availed by means of Moodle platform. Further details are provided by course lecturers. Students also should read the booking system guide.
Experiment Interface
Once we get access to the experiment, the graphical interface is shown next:
If you just desire to minimize any of the elements (for example, one of the webcams), you can do it by clicking on the right icon - at the top of the element.

Visit www.wawcam.com for more information.
<table>
<thead>
<tr>
<th>Voltage (in)</th>
<th>Current (in, mA)</th>
<th>Watts (in)</th>
<th>Fan Voltage (v)</th>
<th>m3/h</th>
<th>Pressure (pascals)</th>
<th>RPM Wind Turbine</th>
<th>Temperature (°C)</th>
<th>Humidity (%)</th>
</tr>
</thead>
</table>

Wait for a while, and try again later.
- Adjust the wind flow power. Use the control dial to set a determined wind flow power value. Familiarize yourself with how to move the control, since the displacement is rotating. Observe the variation of wind flow through the webcam and, also, the value taken in the status box.
Store the obtained results. In the next graph box you can observe the temporary values of the measured variables. If you click on the legend of one of the variables, some graphical representation alternately appears and disappears. If your pulse on the box on the right, just below the "-" icon, a menu to save the image data in different formats appears.
Conclusion

• The experience with remote labs had great impact on me and my colleagues.

• Remote labs cannot serve as a direct replacement for traditional lab classes because manual manipulation with the lab is not possible and direct sensations have to replace with various forms of information display. On the other hand remote labs offer students more opportunities to use equipment in closer synchronization with lecture and presentations because the normal timetabling constraints do not apply. This means that remote lab learning activities need to be designed carefully to use their advantages to full effect.

• In our opinion Remote labs indeed lowered the cost and allowed us to achieve the objectives desired from us in our study.

• We got huge knowledge from those experiments with lower cost, time and effort, in comparison with the real physical experiments as if we intend to apply them.
Conclusion

The online laboratory exercises can be integrated with weekly tutorial classes and lectures: each weekly exercises explores aspects of material covered in lectures in the same week.

Remote laboratories could be enhanced in different subjects and specially when the remote lab could lower the cost in comparison with the real lab.
Thank you