Online Laboratory

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Abstract : The online laboratory offers a convenient, less expensive, and more efficient means of providing laboratory experiments to students using the Internet. The experiments can be accessed anytime and anywhere with limited access to a traditional campus setting. However, online laboratory presents educators with a host of new challenges. This paper presents a brief introduction and challenges of online experimentation.

Keywords: online laboratory, virtual lab, remote lab, online experiments

I. Introduction

Online laboratories are becoming important and common for two reasons. First, laboratories have become indispensable tools for teaching, training and learning in science, engineering, and technology. Engineering, in particular, is all about hands-on learning of concepts and needs an effective laboratory courseware to complement the theoretical courses. Second, online learning has become a part of the educational landscape. It is growing in scope and acceptance because of the flexibility for the learner and cost-effectiveness for the institution. Online education needs virtual laboratories that can meet the needs of modern science education for their students.

The online laboratory (OL) (or laboratory at distance) provides the possibility of students conducting scientific experiments in a virtual environment. Internet-based experimentation permits the use of resources, knowledge, software, and data available on the web. It is bringing laboratory into the home. This can cater to students at the undergraduate and graduate levels. The motivation for developing online laboratory is to make the whole experience of a laboratory more accessible, more convenient, less expensive, and more efficient. Also, providing the resources necessary in the traditional physical laboratory setting is challenged by increasing budgetary and space constraints. Delivery of online laboratory is a potential cost-effective solution to the problem. Compared to their offline (or onsite) equivalents, online experiments are more customizable and scalable.

Online laboratories are no longer just a science fiction dream. Many institutions of learning have started to implement them into their learning process. Online lab is offered in electric circuits, electronics, communication, control systems, computer science, electrical engineering, mechanical engineering, civil engineering, biomedical engineering, physical sciences, medicine, and psychology.
There are two types of online laboratories: (1) Remote lab provides students with the opportunity to collect data from a real physical laboratory setup. It uses real plants and physical devices which are teleoperated in real time. (2) Virtual lab simulates the real equipment. Simulations have evolved into interactive graphical user interfaces where students can manipulate the experiment parameters and do some exploration. The two types of lab can be combined to support specific learning activities.

II. Elements Of Online Lab

An online lab will generally consist of hardware-based remote experiments. Since there are many ways to offer online laboratories, it is difficult to provide a general outline. The following tips are helpful in understanding what an OL consists of. A sound OL should have [1, 2]:

- Clearly stated learning objectives
- List of equipment
- Key theoretical concepts needed to perform the experiment
- Clear and precise step-by-step instruction on how to perform experiments
- Use Graphical User Interface design approaches.

An online laboratory includes web-based multimedia and interactive resources.While there are many possibilities to format transmitted data, the data exchange formats most widely used by web developers are XML (eXtensible Markup Language) and JSON (JavaScript Object Notation). JSON has the advantage of being easier to read and map to variables not only in JavaScript.

The mass adoption of smart devices automatically means that their users may need to have access to online laboratories from them. Today mobile laboratories constitute the most appropriate way to implement Massive Open Online Laboratories (MOOLs). A mobile laboratory is possible using a mobile smart device. Educators across the globe can contribute to the laboratory and access the lab courseware created by other fellow educators.

III. Challenges

Limitations and challenges exist with OL as with any new idea. Motivating Internet users to participate in a web-based experiment can be a resource-intensive and difficult task. Online experiments require a great deal of technical expertise to create and maintain.
For an online laboratory to work properly, certain requirements must be met. It must be modular; it should be possible to add a new device or replace an old one to keep up with the ever-changing world of modern technology [3].

For a proper scheduling of an OL, an efficient lab management system is important for remote lab. Such a system will ensure that the experiments meet the requirements of an individual student. It will also keep track of the progress and performance of the learners [4].

Quality instruction in an online lab is different from instruction in the traditional, brick-and-mortar lab. There is a need of standardization of online laboratories. Attempts have been made to share online laboratories among institutions, to unify online laboratory experiments. The efforts would be eased by means of standard methods for accessing the online laboratories [4].

IV.   Conclusion

The online laboratories allow the sharing of material resources, hardware, software, and expertise over computer networks such as the Internet. They seem to offer student a practical and real world experience, but they do so at a cost that is reasonable to the online learner.

Since the main objective of an online laboratory is to make knowledge more accessible, it would make sense to add a social-networking feature. It encourages users to share their experience and help each other. Online laboratory is conducive to the 21st-century education where creativity and collaboration are encouraged. It provides flexibility to an active, techno-savvy generation.

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