

Chapter 4.10

An Online Virtual Laboratory of Electricity

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ABSTRACT

In this article, we describe a Java-based virtual laboratory, accessible via the Internet by means of a Web browser. This remote laboratory enables the students to build both direct and alternating current circuits. The program includes a graphical user interface which resembles the connection board, and also the electrical components and tools that are used in a real laboratory to build electrical circuits. Emphasis has been placed on designing access patterns to the virtual tools as if they were real ones. The virtual laboratory developed in this study allows the lecturer to adapt the behaviour and the principal layout of the different practical sessions during a course. This flexibility enables the tool to guide the student during each practical lesson, thus enhancing self-motivation. This study is an application of new technologies

for active learning methodologies, in order to increase both the self-learning and comprehension of the students. This virtual laboratory is currently accessible at <http://personales.upv.es/jogomez/labvir/> (in Spanish).

INTRODUCTION

The idea of Web-based virtual laboratories is not new (Hoffman, 1994; Potter, 1996; Preis 1997). However, this topic has received much attention over the last few years, due to the implementation of new teaching technologies in the classroom, and the widespread adoption of the Internet. Currently, a large number of virtual laboratories can be found online. These virtual laboratories cover different fields of study: measurement of hardness in metals (Hashemi, Chandrashekar, & Anderson,

2006), microbiology (Sancho, 2006), earthquake engineering (Gao, 2005), environmental applications (Ascione, 2006), manufacturing engineering education (Jou & Zhang, 2006), photonics (Chang, 2005), robot control (Sartorius, 2006), and electronic circuit simulation (Butz, Duarte, & Miller, 2006; Moure, 2004; Yang, 2005), to name but a few.

All of these virtual laboratories are based on computer simulations, and have been developed with different programming languages such as Java (Gao, 2005), Matlab (Sartorius, 2006), or Macromedia Flash (Hashemi et al., 2006). This article describes a virtual laboratory for electronic circuit simulation developed in Java and deployed as an applet which can be accessed through a Web browser.

One of the main topics of the Fundamentals of Physics for Computer Science subject at the Faculty of Computer Science (http://www.fiv.upv.es/default_i.htm) and HTS of Applied Computer Science (http://www.ei.upv.es/webei/english/in_english/in_english.php) at the Polytechnic University of Valencia (<http://www.upv.es>) is the study of elementary electrical circuits, with both direct and alternating currents. The electrical circuit is also an important topic in other engineering studies at many universities. These studies are performed both from a theoretical point of view and a more practical one through applied lessons in a laboratory.

In these lessons, the students become familiarized with a series of devices, tools, and techniques, and they learn to analyse data, thus achieving skills and expertise. However, the students also face a lack of tools for their individual work, since they are unable to perform electrical experiments outside the laboratory. In addition, some students cannot attend the laboratory during their allocated time slot. Furthermore, the financial costs related to maintaining and updating the laboratory with modern equipment is also a major handicap.

With the simulation software described in this article (Gómez Tejedor, 2002; Gómez Tejedor,

Barros Vidaurre, & Moltó Martínez, 2005), the students are supplied with a useful and versatile tool for performing some of the practical lessons online (Gómez Tejedor, Barros Vidaurre, & Moltó Martínez, 2007). One important question related to virtual laboratories is “Can the fundamental objectives of the instructional laboratories be met via software and computers?” (Hashemi et al., 2006). In order to overcome this problem, we propose that virtual lessons should be complemented with real ones. On the one hand, the students can train themselves in the virtual environment before working in the laboratory and even improve their skills before examination. On the other hand, different practical lessons can be available online which, due to timetabling problems, cannot be performed in the real laboratory.

The main novelty of this work is that the students can make electrical circuits in a similar way as they do at a real laboratory. Only the virtual laboratories of Butz et al. (2006) and Moure (2004) have this built-in feature. In addition, another original point of our virtual laboratory is the possibility of configuring the program by the teacher by only editing a file, where the main options of the program are defined. This easy approach to configure the virtual laboratory makes it ideal to perform different practical lessons, where the environment is customised. Besides, our virtual laboratory is friendly accessible through the Web by only means of a Web browser.

This article is related to teaching the Fundamentals of Physics for Computer Science through the Internet (Mas, 2002), which, since 2000/2001, has been part of the curriculum at the Faculty of Computer Science and HTS of Applied Computer Science at the Polytechnic University of Valencia. This approach is linked to the current trend of developing applications for active learning methodologies, to leverage self-learning and comprehension skills for the students. In this field, this work can be considered to be a pioneering one.

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