An educational remote laboratory for controlling a signal conditioning circuit with an LDR sensor

Ricardo Costa, Paulo Bastos, Gustavo Alves, Manuel Carlos Felgueiras and André Fidalgo
Polytechnic of Porto ISEP/CIETI/LABORIS;
rjc@isep.ipp.pt, paulo.mota99@gmail.com, gca@isep.ipp.pt, mcf@isep.ipp.pt, anf@isep.ipp.pt

***Abstract* - In the past few years, the technologic evolution of communication and information systems had a major impact in our lives. In education, this evolution broke some geographical barriers, facilitating students' access to real laboratories using a simple device connected to the Internet, contributing therefore to improve teaching and learning methods. To support this evolution, this paper describes a remote laboratory that provides students' access to a typical electronic instrumentation system. Through a set of webpages, users can remotely control a light intensity sensed through a Light Dependent Resistor (LDR) sensor connected in an arm of a configurable Wheatstone Bridge (WB), whose output differential voltage are amplified / attenuated by an Instrumentation Amplifier (IA) circuit. Through this laboratory, users are able to control several components of a typical instrumentation system, visualize changes and analyze some measurements, in the same way as they would do in a traditional hands-on laboratory. An overview of the developed remote laboratory and a contextualization within other available solutions are presented in this paper. At the end, some considerations for its adoption in education are described.**

Keywords— Engineering education, Remote laboratory, Instrumentation System, LDR, Wheatstone Bridge.

I. INTRODUCTION

An engineer must be able to create, invent, design, build, and maintain perfect structures, machines, devices, systems, materials and processes. Engineering education aims to give to engineers the ability to apply science and technology to the service of human needs. In addition to have a certain set of scientific and technological knowledge, engineers must know how to put it into practice. For this purpose, it is fundamental to design well-organized engineering courses providing, whenever possible, experimental activities similar to those that engineers will face in real life. The laboratory component is mandatory in every engineering course [1]. Unlike the theoretical component eminently expository and usually conducted in a traditional room, the practical/experimental component presumes the existence of several resources, such as physical rooms, specialized equipment and technicians for their maintenance, plus teachers for monitoring students' activities. The costs involved are much higher than those required for a traditional theoretical class, and the waste of resources and components are commonly an evidence, since students tend to damage the equipment. In a macro scale point of view this has a big impact in nature, since more resources are consumed and therefore the impact in sustainability issues are evident [2][3]. Additionally, compared to a theoretical class, in a laboratory class the number of attending students must be drastically reduced according to the available physical rooms and equipment, which most of the time contributes to decrease the practical activities and, consequently, the quality of the engineering courses.

In order to mitigate these situations, some solutions have emerged. One of them was to schedule open labs outside the class hours, with a teacher assigned for students support. However, this solution has the inconvenience of increasing the teachers' working-hours, making it impossible to carry out other activities. Additionally, the flexibility for students to attend those laboratory classes is sometimes difficult due to their classes overloading time and other potential activities that they may have (many students also have their own professional activities). A common solution is the use of simulators or virtual labs, which may decrease the involved costs, and increase the flexibility for conducting laboratory activities. Nevertheless, as already reported by many educational researchers in engineering, simulating is not the same as interacting with real equipment [4][5]. Despite the increasing quality of simulators, they do not include all unexpected situations that can occur in a real environment where specific electronic circuits run, which means that a direct contact with real equipment and components is required for every engineering student. To overcome these situations (no real results and lack of flexibility for attending the laboratory classes), distance-learning approach should be considered, providing to students the access to real laboratories and associated experiments in a 24/7 basis. Complemented by a wide range of tools, such as video lessons, tutorials, interactive activities, remote exams and others, the adoption of remote laboratories is currently seen as a the ultimate tool to provide well-designed engineering courses. Their importance is proved by the many publications in this area [6][7][8], as well as projects, such as the VISIR + [9] and the PILAR [10], whose main goal was to widespread the use of a remote lab named VISIR [11] around the world.

In this scope, this paper describes a remote laboratory of a signal conditioning circuit comprising a sensor named LDR connected in an arm of a configurable Wheatstone Bridge (WB), whose differential output voltage is attached to an Instrumentation Amplifier (IA). Students are able to remotely control the light intensity of a lamp that focus on the LDR sensor, and configure the signal conditioning circuit by changing resistive values of the WB and of the IA. By controlling these elements, students are able to understand the LDR and a signal conditioning operation according to three remotely accessible experiments: i) measure the LDR resistor according to the variation of the light intensity (lumens-lux) and the resistor value available in an arm of the WB; ii) validate the characteristic curve of the LDR (Resistance Vs light intensity) and; iii) control the IA gain according to a specified light intensity.

Besides this introductory section, this paper is divided in 4 other sections. Section II contextualize the developed system, presenting solutions commonly used in the market to verify the current operation of electronic circuits. Section III presents features of the developed system, and the educational activates with the associated web interfaces prepared for students

978-1-7281-6732-9/20/$31.00 ©2020 IEEE