Using embedded instruments to design weblabs

An FPGA-embedded oscilloscope based on the IEEE1451.0 Std.

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***Abstract*— The existence of digital instruments able to be remotely accessed justifies the appearance of weblabs in engineering education. Currently, weblabs adopt digital stand-alone and/or modular instruments to enable the conduction of remote experiments. Although, the evolution of digital processing techniques and the dissemination of reconfigurable devices, such as FPGAs, can be seen as an opportunity to reduce costs and to increase the flexibility in the design of digital instruments and, therefore, in the development of weblabs' infrastructures. This paper explores the use of other type of digital instruments to create weblabs, named embedded instruments. It starts contextualizing those instruments, and suggests some architectures for their adoption in weblabs' infrastructures. Latter, it points out the importance of following the IEEE1451.0 Std. to design embedded instruments able to be reconfigured in FPGAs, which can be the main elements of a reconfigurable weblab infrastructure. An example of an embedded oscilloscope implemented in a FPGA and described according to an architecture based on the IEEE1451.0 Std. finishes the paper.**

Keywords: Weblabs, Embedded instruments, FPGA, IEEE1451.0 Std., Oscilloscope.

I. INTRODUCTION

In the last decades technology evolution has been changing the adopted instrumentation in electrical engineering laboratories. At the beginning analogue instruments were the only available solutions to measure or generate electrical signals. These instruments were typically large and heavy, providing a reduced number of features, which difficult a more detailed analysis of the electrical signals. It was hard to observe particular phenomena and to get or specify specific signals' characteristics, e.g. overshoots, average or root mean square values, etc. Moreover, in general, the analogue nature of the instruments does not enable their control using external devices, such as personal computers, which would provide the required flexibility and resources to handle all the acquired measurements and/or to generate specific signals to apply in a particular electrical circuit. Since the appearance of digital processors, new digital processing techniques emerged, promoting the replacement of analogue instruments by digital ones.

Digital instrumentation allows the acquisition of measurements in digital formats, facilitating, this way, the use of personal computers for their characterization and classification. Additionally, it becomes possible to generate different signals supported by computer algorithms, facilitating, this way, the test and verification of particular characteristics in electrical circuits.

Nearly two decades ago, analogue instruments were essentially adopted to operate in traditional laboratories that use real equipment locally accessed. Since the use of digital instruments, a new type of laboratories, denominated weblabs, appeared. These laboratories use digital instruments remotely accessible to enable the conduction of real experiments through the Internet. It was the ability to control digital instruments through personal computers operating as instrumentation servers, that promoted the appearance of weblabs, today considered by the educational community as an important resource to complement and, in some situations, to replace the use of traditional laboratories in electrical engineering courses [1][2].

The use of digital instruments is therefore mandatory to create a weblab, since they provide the required interfaces to enable their remote access. The setup flexibility of digital instruments and the simplicity they offer to gather measurements in digital formats facilitate, this way, the observation and classification of electrical signals, which is very important for the conduction of every remote experiment. Moreover, the development costs are reduced when compared to analogue instruments, since manufactures may create different models supported by the same chassis, because some of these instruments may be programmatically changed through the redefinition of software algorithms in their internal processing units or in their panel interfaces.

It is therefore important to classify and contextualize instruments, in particular the digital, since they are traditionally used in weblabs. As represented in figure 1, while analogue instruments are commonly classified as stand-alone, digital may be divided in the three main groups: i) stand-alone; ii) modular or iii) embedded.

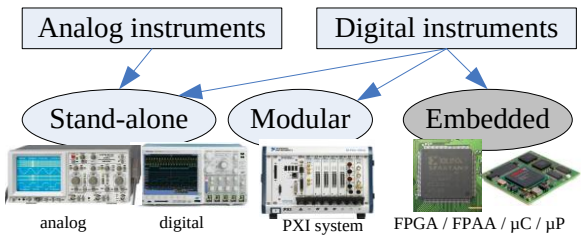

Figure 1: A possible classification of instruments.