The VISIR Open Lab Platform 5.0 - an architecture for a federation of remote laboratories

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***Abstract*—This paper outlines a new laboratory learning infrastructure based on the VISIR (Virtual Instrument Systems in Reality) Open Lab Platform, which is an architecture for opening hands-on instructional laboratories for remote access 24/7 with preserved context. The aim is to embrace such laboratories in which telemanipulators can be used to remotely set up and/or start experiments and where the outcome can be observed remotely using instruments, video and/or audio transmission. As hands-on laboratories, VISIR ones can be used for exploring nature and for training laboratory workmanship. The current release (4.1) of the VISIR Open Lab platform can be used for opening electronics laboratories and laboratories for mechanical vibration experiments for remote access. Other subject fields will follow. So far, seven VISIR laboratories are online globally. The coming VISIR Open Lab Platform 5.0 will offer new functionality and will support a federation of VISIR laboratories.**

***Index Terms*—Laboratory, Remote labs, Lab infrastructure.**

I. Introduction

The amount of hands-on laboratory work in engineering education has bit by bit been reduced during the closing decades of the last century [1], [2]. The primary cause is clearly due to the task of handling the dramatically increased number of students, while staff and funding resources have not improved [3]. At the same time, the importance of physical experiments has increased. This fact is discussed in the next section. However, hands-on instructional laboratories are expensive to set up and to maintain and most universities cannot keep them open as many hours as would be desirable. Furthermore, students nowadays want extended access to learning resources and an increased freedom to organize their own learning activities, which is also one of the main objectives of the Bologna Process.

Today, the situation has improved thanks to Internet technology. Many academic institutions have created a variety of remote laboratories that support remotely operated physical experiments, which usually are accessible 24/7 [4], [5], [6], [7], [8]. However, most such laboratories provide a given set up for demonstrating particular phenomena in nature and only in a few it is possible for a remote student to set up or to thoroughly rearrange experiments and to perform genuine laboratory work such as train how to handle instruments [9]. The VISIR Open Lab Platform designed at the Department of Electrical Engineering (AET), the Blekinge Institute of Technology (BTH), Sweden, is an architecture for opening existing types of hands-on laboratories for remote access with preserved context in order to in the first place supplement and increase the accessibility and the capacity of them. A unique interface gives the student a feeling of being in the hands-on laboratory [10]. Some types of laboratories are easier to open for remote access than others are. So far, the current VISIR platform (4.1) supports laboratories for electrical experiments and for mechanical vibration experiments. Online laboratories based on the current VISIR platform are related to hands-on ones in section III. The next version of the VISIR platform (5.0) will support a federation of VISIR laboratories and include a repository for sharing learning material. It is outlined in section IV.

Why create a new infrastructure of remote labs? There is a number of laboratory infrastructures already available worldwide [11]. It is concluded in the last section that VISIR complements them and is an extension of hands-on instructional laboratories.

II. Physical experiments and simulations

For centuries, scientists have conducted physical experiments in order to understand natural phenomena and to create theories and mathematical models describing them. Professional engineers have these models in their minds and use simulators based on them to design prototypes. Thus, to be engineers, students must become familiar with theories and models. Hand calculations and simulations are the best tools to learn useful models because no noise or other imperfections not included the models will hide the expected result. However, engineers also carry out experiments, and that is mainly for two reasons [1]. First, in the design process they often “ask” nature when they suspect that a particular characteristic of a model to be used may not be accurate enough. The second reason is to determine if a prototype meets its specification and performs as intended in the environment where the product is to be used.

Experimenting can be compared to a kind of conversation with nature. Perform a physical experiment and nature answers. The tricky point is to formulate a useful question and to interpret the answer. Students need a lot of practice to become fluent in the language of nature to become engineers who are able to design goods and