VISIR federation: Initial building steps

PILAR experience – work in progress

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***Abstract*—Collaborative working as well as sharing resources and knowledge represent key points in today's development in all fields, including education. Know-how transfer and collaboration in learning and teaching are aspects promoted and sustained by institutional management as well as the European initiatives. Thus, leading to the idea of a federation which will facilitate engineering education. A consortium formed by five European universities decided to join efforts to provide to the community a federation, which could be used by different stakeholders interest in teaching, learning or developing new skills in the field of electronics. The proposed remote system, Virtual Instruments System in Reality, or VISIR in short, offers the possibility of working with real equipment and obtain the real-world/ real-time measurements. By developing such a VISIR federation some of the constraints of using remote labs, the ones associated with development and maintenance costs, and scalability, will be minimized.**

This paper aims to present the initial steps for developing a VISIR Federation, which is also the primary goal of PILAR - Platform Integration of Laboratories based on the Architecture of visiR project.

Keywords—VISIR, federation, remote labs

I. INTRODUCTION

The VISIR system developed by the Blekinge Institute of Technology (BTH), Sweden, provides an extraordinarily flexible environment for students to construct and test different electronic circuits. The modularity of the VISIR hardware allows for some flexibility level concerning the resources (circuit components and lab equipment) students have at their disposal to construct and test circuits. Beyond this, the VISIR platform is remarkable in the interactivity it presents to students. Electronic circuits can be built and tested by students with a degree of freedom normally associated with a traditional, hands-on electronics laboratory [1].

The idea of building a federation of VISIR nodes emerged from the actual need of high schools, universities and other education institutions, to increase their knowledge in electronics through real remote electronics experiments covering from simple to more sophisticated ones. Specifically, students and teachers need to increase their practical knowledge without the problems associated with the maintenance and physical restrictions of real electronics laboratories. For these reasons, VISIR is being considered as an important development system for online teaching, and represented the core element of four different EU projects:

- OLAREX: pupils from secondary schools from different countries in Europe have used VISIR to learn basics principles of electricity [12];
- GoLab: in this project, the system was used for developing Inquiry Learning Spaces as innovative teaching tools not only for secondary school but also for university purposes at bachelor level [10];
- eScience: where VISIR was presented and tested by students from consortium members from Maghreb during a training period in Villach, and afterward one university during the project lifetime decided to install their VISIR and start to include it in their teaching process;
- iCoop: in the framework of this project a VISIR system was established at a partner university in Georgia to improve education in technical field at master level [11];
- VISIR+: is a project that aims to install new VISIR nodes in Latin America, and adds additional members to the federation.

Based on the experience from the mentioned projects and the acceptance and interest in VISIR, the idea of a federation emerged. This was also the starting point of PILAR project. Five of the eight VISIR nodes (university developers) decided to join their efforts to bring to the world wide community a sophisticated, yet flexible teaching tool in the field of electronics.

II. PILAR FEDERATION - OBJECTIVES

The VISIR system is based on two parts, namely hardware and software, both running on a web server. Therefore, in case that the web server is not accessible, the VISIR cannot be accessed either. In a typical web scenario, it is possible to mirror web servers to avoid such situations. However, due to the hardware part, this approach is not feasible. Creating a

federation of VISIR systems thus emerges as a possible solution. Under actual conditions, if a VISIR system is down, both teachers and students have to manually inspect which other VISIR systems are up and have the same experiments available as in the inactive system. Federating the existing nodes, plus the ones that will be installed in the VISIR+ project will allow swiftly routing the clients' requests to whichever node can respond. Notice the evidence available on the use of the current VISIR systems from all parts of the world [3-9].

With the remote labs federation proposed by PILAR each of the institutions will be able to offer:

- A much larger set of practices, oriented to different and tuned needs, for students starting from schools until universities levels;
- A much more efficient and effective use of the individual VISIR resources, thanks to the transparent work-balance of users and experiments provided by the federation. The federation of remote labs will also make it simple to add new experiments to PILAR, actually turning VISIR into an easy, scalable and maintainable platform;
- A service level agreement (SLA) type for each of the remote lab services offered;
- A much more innovative practical part of subjects related to electronics at high school up to master university levels;
- A more flexible and reliable environment, especially taking into account the troubles faced by many students related with the need of moving to where the laboratories are.
- A more appropriate control of the students' learning process when they carry out real practices on electrical and electronics experiments through the remote laboratories provided by PILAR.

From this point of view, building this federation multiplies and empowers the positive effects of using a remote lab as VISIR. The integration of VISIR resources will result in a federation in which the global result is much more than the sum of the enumeration of each of the services.

This will allow multiplying the different circuits VISIR offers at different academic levels. Because VISIR offers remote experiments with real components, one single system is not capable of accommodating all the experiments that are done in a single degree. The VISIR federation envisions to allow surpassing this current limitation with no additional equipment investment.

In order to start building a federation a two-phase approach involving consortium partners has recently started. The first one addresses a detailed state of the art at the institutional level to be provided by each partner. In such way, the consortium will know for sure on top of what the federation may be built, i.e. exactly what each partner may bring in. For further development of the federation, at a second phase, each member of the consortium has to present possible subjects on which plans to include VISIR, as well as a time line of these implementations. The responsible for these activities have been the Polytechnic of Porto (IPP) and the Carinthia University of Applied Sciences (CUAS).

III. PHASE 1 – VISIR STATE OF THE ART

The need to first elaborate a VISIR state of the art on the different partner institutions derives from the fact that, although similar, there are still considerable differences between the VISIR systems of all partners.

From a course integrator or developer point of view, the information about each system is not easy to find as it is not present on a common format and/or location. From a purely technical perspective, integration into each teaching environment also has differences and particularities that require the analysis and adaptation of different web access and user authentication techniques and policies.

From the students' point of view, support and pedagogical documentation are very different across systems and access to each experiment is not transparent nor uniform.

All these issues make it fundamental to start by establishing the current state of the art on each partner institution in terms of VISIR systems installed, its technical and accessibility characteristics, usage statistics and actual available pedagogical and laboratorial components. In order to do so, all partners institutions were asked to answer an internal questionnaire to assess this data. From an analysis of the responses the task coordinator will assess the need for additional data or clarification.

This questionnaire was divided in 4 parts, namely:

- System Setup and Configuration
- System Management
- Accessibility
- Experiments / Courses

Each part may contain information relating to the past (history) or the present (actual).

The System Setup and Configuration is intended to assert each individual installation physical characteristics and integration into the learning environment. As such, questions in this part address the number and type of systems, the specific software versions, language implementations and also the characteristics of the component and instrumentation boards. Additionally, the network connection details are also requested in order to understand how each system is connected to the web.

In the System Management section we intend to analyze the number of persons involved with VISIR in the different roles, the timeline of system evolution and a quantification of system availability both presently and over deployment timeframe.

The Accessibility section addresses user access mechanisms and policies with particular attention to integration with existent institutional user accounts and/or learning systems. Additionally, the access and availability of each

VISIR system implementation details are also requested in order to evaluate the ease of integration of external institutions.

The final Experiments/Courses section intends to list and describe all the courses where VISIR is or was used on each institution as well as the specific areas of study where it was applied.

The results of this questionnaire will allow a complete analysis of VISIR present state and past evolution and particularly will help determine how PILAR can enrich and innovate both on the technical and pedagogical points of view. The analysis will describe the availability, technical issues and experience gained with different kind of practical works and courses presently in use (or used in the past) and show the different ways that were proven to be functional to interconnect a VISIR federation nodes and implement the practical works made available by it.

IV. PHASE 2- ACTUAL AND FURTHER USE OF VISIR

In order to obtain detailed information about the training as well as learning/ teaching activities which could be covered with the existing hardware and also the direction of development at each partner a new questionnaire was developed by CUAS team and agreed with the consortium. The result of this work will generate a catalog of practices using VISIR on different age levels.

This questionnaire was divided into 2 sections:

- Present work with VISIR
- Future plan on implementing VISIR.

On the first sections consortium members need to provide information about subjects in which they are currently using VISIR and the appropriate age for each experiment and learning material.

Further, on the second section of the questionnaire, each partner team has to decide on special subjects in which VISIR may be suitable for teaching purpose, research or optional training inside projects. The aim of the second step is to gather ideas from consortium members in order to:

- Better use of hardware without replicating the same experiment
- Support collaborative working/ learning/ teaching
- Find common understanding which may be integrated into federation policies
- Improve the quality of learning materials in order to provide innovative teaching tools.

A brief analyze of the answers given by the five project partners concerning the present work with VISIR are showing of the following:

- All experiments have guidance or learning material developed as support material for users;
- The main fields are: electricity, basic analog electronics, electronics and power electronics, and physics;
- Most frequent topics are Kirchhoff's laws, Ohm's law, power dissipation, RL circuit, teaching transistors, operational amplifiers, passive filters, etc.;
- The education level on which the experiments are used: high school (15 – 18/19), bachelor, master;
- Maximum users: 15 – 60 depending on the experiment, which extends to an overall of 250 users on the available experiments

The preliminary conclusion of this section is that basic electronics experiments are available on every VISIR system, meaning, all partners have developed Kirchhoff's laws, Ohm's law, and RL circuits.

Concerning the section partners' plans in further developments around VISIR shows that:

- The main fields which present interest are: power electronics, electronic communications, analog computing;
- Potential topics are: PLL circuits, switched power supplies, converters, PTCs/NTCs & Resistors, Several resistors, 2/ 3 dc power supplies, circuit analysis, diode operation;
- The education level on which the experiments are going to be suitable is: bachelor and master.

As a conclusion of this section, it is visible that partners feel the need to develop experiments concerning topics which are already available on other partners systems.

The main finding of this work underlines, even more, the need of a VISIR federation and the idea of sharing experiments. As overall, the results of this questionnaire are going to represent an important step and help to determine the aspects on which PILAR could empower the use of VISIR from a technical and pedagogical points of view.

V. FURTHER DEVELOPMENT

The VISIR federation developed in the framework of PILAR project will provide a substantial learning resource and large educative gains that will be available to a wide range of education levels, vocational schools and up to enterprises to support lifelong learning, specialization at the workplace. In order to facilitate the accessibility to the federation a document containing the policy on how to enter to VISIR federation, both as a provider and as a user will be defined.

The document will be created by consortium members. For an effective and efficient collaboration, each university is planned to have as a team member one teacher and one technician. This approach enables the development of a complete document containing the two essential teaching components, namely the technical and the pedagogical perspective. For this, connecting to PILAR as a member of the project will imply that:

- There will be at least four different levels of access: user, teacher, administrator of the node and federation administrator;

- On the client side are going to be minimum technical needs;
- The issues which may emerge due to different concurrent activities in the federation will be fixed.

It will also specify the technical needs of any institution interested in the use of PILAR as a tool for implementing electronics practices, at the high school and university levels.

VI. CONCLUSIONS

Developing strong bases and clear structure of the VISIR federation by collecting valuable information from the most experienced VISIR nodes will generate a sustainable structure, reduce system limitations and increase quality in teaching by using remote labs as VISIR not only at consortium members' level but also to the educational community.

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