A Smart Cloud Repository for Online Instrument

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ABSTRACT: *During The last few decades, remote laboratories have been integrated into education and research in all fields of engineering. Remote access gives users hands on experience with direct control over instruments and devices, and allows them to be accessed 24 hours a day from anywhere. It appears to offer a simple solution to problems of distance, expensive equipment, and limited availability. The concept of remote lab is to make instruments available and ready to use for any kind of situations and experiments over internet. Currently, one of the challenges is how to find the appropriate instrument which responds to user's requirements and constraints in order to conduct a given experiment. The most significant reason of this problem is the lack of information about online instruments that provides potentially interested parties the ability to achieve such a mission. Moreover and till now, it is impossible to use simultaneously, and for the same experiment, instruments that belong to different providers. Thanks to the semantic web technology, a significant step forward can be made in terms of general description model in order to make possible the utilization and cooperation of instruments belonging to different providers.*

Consequently, we propose in this paper a semantic web technology based model which attempts to solve the mentioned problems.

Keywords: E-Instrumentation, Semantic Web Technology, Repository

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1. Introduction

The goal of online experiment is to provide users the ability to conduct experiments via Internet. Actually, institutions cannot afford to pay all the experimental equipment that they would like to have. So, in such situation the access to online experiment can enhance the online learning for example and give the distance use of real time experience. Physical experimentation is most of times expensive, hard to maintain, and need on most of the cases a specific guidance through the experiment in order to avoid malfunctions or injuries to the user. That could lead to an increasing use of online experiment. Current online experiment fall into two categories [18]: virtual laboratories provide a simulation environment in which students conduct experiments; and remote laboratories, with real instruments and equipment at the remote sites called Einstrumentation which is the scope of our research.

Local laboratory can be composed of several instruments that create an experimental workbench when connected together. But until today remote laboratory can control one instrument at a time. To provide complete workbench to the user, remote laboratory need to connect different instruments. In other words, create a workbench which is geographically distributed among different information system. So users are not supposed to know where the instrument they are actually handling is. It has to be noticed that technologies involved in remote laboratory platforms are heterogeneous that is the reason why interoperability is mandatory for using remote laboratory and connect already existing systems together. Another exciting possibility is to begin a session on a first distributed workbench and to finish it on another if the first one is no longer available and the transition from one instrument to another would be transparent for the user.

2. E-Instrumentation: Overview and Challenges

E-instrumentation refer to access to real equipment or devices in remote online laboratory. Providing remote access to instruments in laboratory via the internet is an evolutionary change that offers a range of potential benefits with 24 hour, 7 day access, expensive resources can be shared between faculties, across different institution and even across different countries. We will go through a literature review on what has already achieved on the deployment of e-instrumentation in real condition.

In Australia, Many universities have developed or been developing real access to online laboratories for different reason. The first project is Telerobot in 1994 [20] and has been improved by [21]in 2003. This can be regarded as the first world project to make teaching laboratory equipment available to users via the web. Netlab [15] is another projects that enables users to cooperate while conducting remote experiments via the internet on both domestic and international levels [16]. In Europe, many studies have explored einstrumentation through various projects. The project "*Web analyzer*" [2] aims to propose for a distant user to act directly and in real time on distant instruments using commands reproduced on the screen of his computer. So it makes available for universities a park of instruments usable via Internet. It offers opportunities for students and researchers to produce their own real-time remote measurements. The project E-merge [18], the aim of this project is to develop a platform through an Internet browser: the client (student, remote training class, professor) can access to the platform and make real measurements. There is also the project ILAB [9], iLabs is dedicated to the proposition that online laboratories - real laboratories accessed through the Internet - can enrich science and engineering education by greatly expanding the range of experiments that students are exposed to in the course of their education. Unlike conventional laboratories, iLabs can be shared across a university or across the world. The iLabs vision is to share expensive equipment and educational materials associated with lab experiments as broadly as possible within higher education and beyond. The PEARL (Practical Experimentation by Accessible Remote Learning) project is aimed at the development of systems enabling students to conduct real-world manufacturing engineering and digital electronic experiments [21].All these projects aim to make accessible for the user to benefit from remote instruments.

The number of papers found in literature addressing einstrumentation has been increasing during the last few years, as can be concluded from [14] and all universities around the world cannot be stopped because their relative advantages over traditional experiments [7] [3] [10] [11] [19][25]. Einstrumentation covers several scientific domains physics, Automatics, electronics, robotics, etc. This means that is not restricted to a single topic.

The following table 1 summarizes the most important project of E-instrumentation.

So all existing project rely on the same software architecture. Thus, we will try to propose a new model that can help users to manipulate instruments remotely. In the literature review, several papers underline that the use of remote instrument is very expensive. Indeed, it requires a large amount of time, money and skills. In practice, local experiments can be composed of several instruments that can be connected together. As a matter facts, today remote access to instrument only address the remote control of one device at a time. So, why not imagining remote access to more than one instrument that can be distributed among different places and belonging to different providers. Users, here, are not supposed to know where the instrument actually handling is. Also, there is another possibility, it would be possible to begin experiment on a first instrument and to finish it on another one is no longer available. The transition from one instrument to another would be transparent for users. So, Thanks to the semantic web technology, a significant step forward can be made in terms of general description model in order to make possible the utilization and cooperation of instruments belonging to different providers.

3. The Proposed Archtecure

On the first steps to make use of the semantic web technology is to create an ontology, or in another words a generalized, formal

Project	Year	Description
Elab [13], [23]	University of Bordeaux 2002	Elab is dedicated to electrical engineering education. It is designed to perform remote measurement on electronic devices with high tech instruments. This projects is the continuity of Retwine [26]
E-Merge[18]	European Project 2002-2004	The aim of this project is to develop a platform through an internet browser. So the user can access to the platform an d make real measurments
Ilab [9]	MIT's Institute Since 1998	Ilab: Internet access to real labs anywhere at any time. This project enables students to use real instruments, rather than simulation, via remote online laboratories using their browser.iLabs can be shared and accessed widely by students and other audiences across the world that might not otherwise have the resources to purchase and operate costly or delicate lab equipment.
PEARL [21]	European project 2001	Pearl is the acronym of Practical Experimentation by Accessible Remote Learning. Il is an EU funded project that is aimed at enabling students to conduct live experiments remotely over the Internet.
Cyberlab[27]	International project 2003-2007	The aim of this project is to provide easy access to any laboratory equipment by developing a method for distance laboratory training.
Telelabs [22]	Australian project Since 1994	This project aims to make teaching laboratory equipment available to users via the web.
NetLab [16], [17]	Australian project 2002	This project was developed from the beginning as a collaborative learning environment that enables students to cooperate while conducting remote experiment vie the internet.
Web Analyzer [2]	Telecom Saint – Etienne 2006	This project aims to propose for a distant user to act directly and in real time on distant instrument.
Oceleot [4],[5],[6]	European project 2007	Ocelot is the acronym of Open Collaborative Environment for the Leverage of Online instrumentation. It aims to bring faster remote instrumentation solutions to the end-users
LiLa Project [1]	Initiative of eight university and three entreprises 2009	LiLa is the acronym of "*Library of labs*". Lila is a repository of virtual and remote experiments that can be accessed and executed from the internet requiring a web browser only. This project is extended to include booking system reservation [24].
Lab2GO [8]	Carinthia University of applied Science	Lab2go is a Web portal that aims at bringing online lab developers, researchers, professors and students a bit closer together by offering a common Web environment where people can share expertise and experience in the field.
WebLab-Deusto[28]	University of Dusto 2005	It makes possible to offer real experiments to a certain group of users through any computer network, such as Internet. so any University or Company can easily serve its own experiments remotely and make advantage of them: Authentication, Reservations, Queue management, Scalability, Security, Deployment, Logging and Administration.

Table 1. Project Description

representation of the domain. This general model consists of various properties, data types and relationships representing various types of online instruments. To make a model which is understood by the final user, it is essential that this model is easy, well-structured and very close to the real world.

When started with the model definition, a lot of question about very principal things come up. For example how an online instrument is defined? Should we differ between an experiment and an instrument? These questions are very important and with the right definitions of the description model can maturate to the right direction. In our model, the following terms are used to describe an online instrument:

Property	Description
URI	The property URI is the Unique Identifier of the online instrument
Name	The property title describes the name of the online instrument which has not to be the same (An online instrument can represent in different languages)
Owner	The property owner represents a person or an organization (like universities or companies) which offers the online instrument.
Service Location	This property describe the location of the instrument
Type	The property type describethe different type of instrument
Instrument	Status Defines whether the instrument available or not.
Cost	This property represents the access cost
Qos	This property defines the quality of service offered by the instrument In terms of response time and available rate.

Table 2. Properties of an online instrument

Our proposed approach consists in three different parts:

- Users;
- Provider of instruments;
- And a smart cloud repository.

All users can manipulate online instruments for a specific experiment. These instruments have their providers. These should be able to publish online instrument in a smart repository. Of course, this repository includes all informationabout instruments and possible experiments. In addition to that, it should be able to analyze user's request and also it can propose different proposals concerning a specific experiment. Nevertheless, all proposals should include:

- The cost of the instrument which is determined by its provider according to the quality of service, the availability, the ability of cooperation and operation with other instruments and the duration of use;
- The use conditions;
- The possibility of interoperability with another instrument which belongs to another provider.

So, a user's request may be issued by someone who is not specialist for example a beginner student. In this case, the request must include the unique identifier of the experiment. Consequently, we assume that users and providers have a complete list of possible experiments each of which is identified by a unique identifier.

The smart repository is supposed to be able to:

1) *analyze the user request;*

2) *prepare a list of scenarios each of which includes the set of instruments to be used for the requested experiment, the corresponding providers, the detailed features of each instrument and the corresponding price list;*

3) *Reply the list of scenarios to the user.*

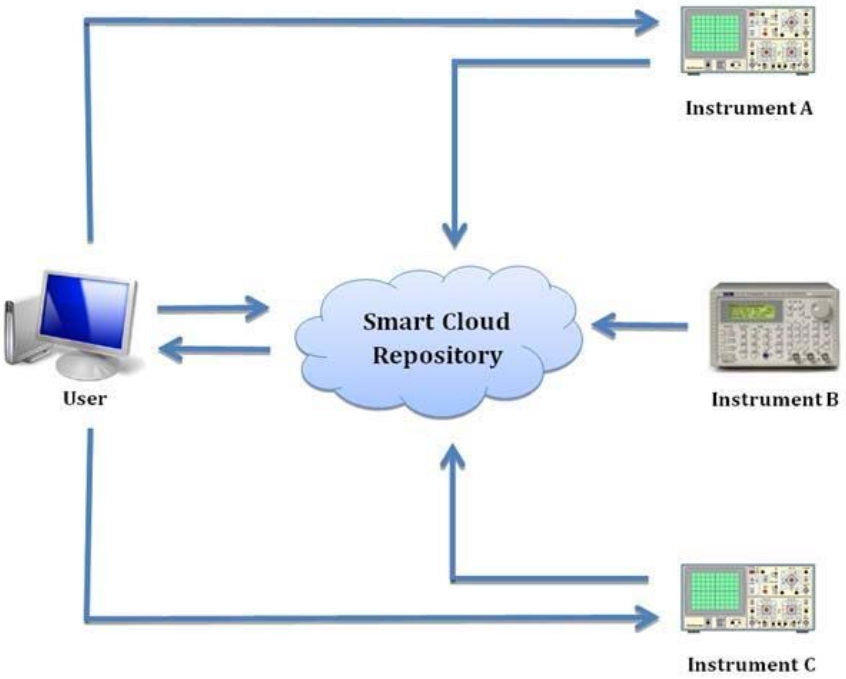

Figure 1. The mechanism of the proposed solution

The proposed architecture has the advantage to help users to make the adequate decision about the experiment they would like to conduct. The repository should work as a cloud service in order to reach good performance and consequently reduce the response time. Figure bellow shows the mechanism of the proposed solution.

4. Conclusion

Semantic Web Technology is a very broad field that can be applied in many distinct Areas. In this paper, we used specific terms to describe online instruments and we propose a new solution that attempt to help users to find adequate instrument that respond to their real needs. Several investigations are understudy, especially the implementation and the real evaluation of our proposal on a specific case.

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