Work-in-Progress. SiLaRR: Installing, deploying on Internet, and using a Robotics Laboratory Remote or in classroom with a few clicks

Dr. German Carro Fernandez P.E., UNED (Spanish University for Distance Education

Dr. on Electrical Engineering and Industrial Control, Spanish University for Distance Education (UNED), Madrid, Spain, M. Sc. on Research on Electrical Engineering and Industrial Control (Specialty on Telematics Engineering), (UNED), Madrid, Spain, Bachelor's Degree of Computer Systems Engineering Tech.(BCompSysEng) (UNED), Madrid, Spain, M. Sc. on Financial and Tax Administration, University of A Coruna (UDC) and Spanish Public Taxes School (EHP), A Coruna , Spain, Bachelor's Degree of Economics Science (BEconSc) (UDC), A Coruña, Spain, in 2014, 2012, 2010, 1997 and 1996 respectively. Member of IEEE since 2006 and of several of its Societies (IEEE Education, IEEE Computer and IEEE Robotics and Automation). He is currently a Research staff and Professor in the Department of Electrical Engineering, Electronics, and Control (DIEEC) of UNED since October 2012. His research interests encompass remote laboratories and its development and implementation, robotics and computer security, and the integration of these disciplines into the society from different fields: education, domestic, commercial, medical and social. Author of several publications in prestigious journals and conferences as IEEE Technology and Society Magazine, or EDUCON. He has collaborated and colaborates on several international and national research projects as eMadrid and Go-Lab (FP7-ICT-2011-8/317601) and outreach and promotion of technology among young students, as IEEE TISP project, or Techno Museum project (IEEE Foundation Grant #2011-118LMF) in collaboration with several universities, EduQTech and the National Museum of Science and Technology (MUNCYT). Won the "EDUCON Best Student Paper Award" in 2012 and the IEEE EDUCON "Certificate of Appreciation from IEEE" in 2011. Since 2006 he has been active in the IEEE Student Branch of UNED, coming to preside as Chairman along the years 2010 to 2012, that year the Student Branch won the "IEEE Spain Section Award 2012." He was Chairman of the Student Chapter of IEEE Education Society, member of Board of directors of Spain Chapter of IEEE Computer Society, Chair of IEEE AG Young Professionals (2012-2014), and Treasurer of IEEE Spain Section (2014). Also remains active as engineer consultor and developer freelance specializing in taxes, acounting and financial, consulting oriented computer hardware, software, robotics, IoT hardware (Arduino, Raspberrry Pi), network installation and security, software development and mobile applications, Web 2.0, Web 3.0, Augmented Reality, eLearning and technology in general.

Prof. Manuel Castro, Universidad Nacional de Educacion a Distancia

Manuel Castro, Electrical and Computer Engineering educator in the Spanish University for Distance Education (UNED), has an industrial engineering degree from the ETSII (Industrial Engineering School) of the Madrid Polytechnic University (UPM) and a doctoral engineering degree from the same University. He has received the Extraordinary Doctoral Award in the UPM and the Viesgo 1988 Award to the Doctoral Thesis improving the Scientific Research about the Industrial Process Electricity Application, as well as the 1997 and 1999 years UNED's Social Council Award for the Best Didactic Materials in Experimental Sciences and the 2001 Award for the Innovative Excellence in Teaching, Learning & Technology from the Center for the Advancement of Teaching and Learning. He works as researcher, coordinator and director in different projects, ranging from systems applications of simulation techniques, solar system and advanced microprocessor system simulation to telematics and distance learning applications and systems, as well as computer-aided electrical engineering (CAEE), acting now as and senior Technical Director. He is now with the UNED (Spanish University for Distance Education) as Professor of Electronics Technology inside the Electrical and Computer Engineering Department. He was previously UNED's New Technologies Vice-Rector, UNED's Information Services Center Director and Research, Doctorate Vice-director and Academic Affairs Vice-director of the Engineering School at UNED and Director of the Department. He worked during 5 years in Digital Equipment Corporation as senior system engineer. He publishes different technical, research and teaching books and articles for journals and conferences as well as multimedia materials and radio and TV programs. He belongs to the organizing committee of IEEE EDUCON, IEEE FIE (International and Europe Chair, 2000-2006), ISES, TAEE and SAAEI conferences as well

as program and planning committees' member and reviewer and chairman of several ones. He was co-chair of the conference EDUCON 2010 (Engineering Education Conference), TAEE 2010 (Tecnologías Aplicadas a la Enseñanza de la Electrónica) and ICECE 2005 (International Conference on Engineering and Computer Education). Is co-chair of the conference FIE 2014 (Frontiers in Education Conference) to be organized in Madrid, Spain, by the IEEE and the ASEE. He is co-editor of IEEE-RITA (Revista Iberoamericana de Tecnologías del Aprendizaje) and of the Electronic Journal of Spanish Chapter of the IEEE Education Society. He is Fellow member of IEEE (for contributions to distance learning in electrical and computer engineering education) and member of the Administration Committee (AdCOM) (2005–2012) of the IEEE Education Society and Past President Jr (2015-2016) of the IEEE Education Society; Founder and Past-Chairman (2004-2006) of the Spanish Chapter of the IEEE Education Society, and Chair of the IEEE Spain Section (2010-2011). He has been awarded with the IEEE EDUCON 2011 Meritorious Service Award (jointly with Edmundo Tovar), of the EDUCON 2011 conference; 2010 Distinguished Member Award of the IEEE Education Society; 2009 Edwin C. Jones, Jr. Meritorious Service Award of the IEEE Education Society; with the 2006 Distinguished Chapter Leadership Award and for the collective work inside the Spanish Chapter of the IEEE Education Society with the 2011 Best Chapter Award (by the IEEE Region 8) and with the 2007 Chapter Achievement Award (by the IEEE Education Society). He is Vice-President of the Board of the Spanish International Solar Energy Society (ISES)

Dr. Elio Sancristobal, UNED

Elio San Cristobal Ruiz has a doctoral engineering degree from the ETSII (Industrial Engineering School) of the Spanish University for Distance Education (UNED), 2010. Also he has a Computer Science Engineering degree by the Salamanca Pontifical University (UPS), Madrid 2002 and he has a Technical Engineering degree in computer networks (UPS), Madrid 1998. He has worked for the University Distance Education Institute (IUED) from UNED. Nowadays is working for the Computer Science Service Centre of the Spanish University for Distance Education (UNED). At the same time he is working as assistant professor in the Electrical, Electronic and Control department from UNED.

Dr. Francisco Mur Perez

Work in Progress
SiLaRR: Installing, deploying on Internet, and using a Robotics Laboratory Remote or in classroom with a few clicks

Abstract

In a technological society, as the present, teachers and educators should use all the tools at its disposal to extend education beyond the physical classroom to the borders of a laboratory. With that goal three years ago started a research project whose main idea established researching and finding a system that would use easily a robotics laboratory, both remotely and in classroom.

Since the philosophy of this project was to have as easiest as possible the installation and start-up of remote robotic laboratories, this work has focused on finding those existing alternatives within the free software and open hardware, and to integrate them into the system whenever has been possible, or, to develop specific tools, always using the philosophy of free software and open hardware. The aforementioned easy installation of robotics laboratories comes from the effort to disseminate knowledge not only from an academic level, but through schools, high schools, and businesses or even from individuals themselves whose have robotics as a hobby.

Not everyone involved in education have knowledge of electronics, web development, communications, but several of them have knowledge about robotics and many want to help others to acquire such skills in real time using their robotics equipment through the provision of them as laboratories. But at the same time the robotic equipment must maintain its capacity and functionality for use in a classroom laboratory if necessary. For this, with SiLaRR, the intrusion into systems of the robotic equipment has been reduced to the minimum. With that idea in mind it has been developed this system. As much as possible, the control and interaction with the robotic equipment has been made using low cost hardware or, directly, via software. Efficiency, reuse, flexibility and scalability have been the main features of this process.

Introduction

The expansion and usefulness of remote laboratories[1] in the educational environment is well known. The result of this work was called SiLaRR (System Integration for Remote Robotics Laboratories, for its acronym in Spanish). The following engineering factors and technologies must be having in account when we are targeting the integration of robotic equipment in remote laboratories[2]: communications, software development, web development, hardware control, integration of electronic equipment, send and get services to data collection services, databases, queue management access, and many others.

The results have demonstrated that the system has a wider application in new areas, not only in the field of robotics and can be used for different kind of laboratories. Generalization has been shown as another characteristic of this system. This research has helped to expand the knowledge on robotics using real time remote laboratories from anywhere in the world with a simple

Internet connection and a connected device ranging from a smartphone to a personal computer[3]. Remote laboratories allow the use of them for students from anywhere in the world accessing and using laboratories from mobile or static devices through Internet[4].

However to create and develop a remote laboratory requires knowledge from different disciplines[5] that use to make it difficult to develop and deploy them on Internet. SiLaRR is a system developed to facilitate this complete process.

SiLaRR is designed to install, configure and deploy robotic equipment and electronics laboratories. The system, designed for Windows operating system, allows a fast and easy way to connect laboratories with a hardware dongle; in this case Arduino UNO[6] and deploy them on Internet.

The objective pursued with SiLaRR is helping to generalize the deployment of remote robotics and electronics laboratories online. Thus the number of remote laboratories available will be increased and the students will have more and new tools to improve and continue their distance learning.

Difficulties and technologies to develop a remote laboratory

There are many ways to develop a remote laboratory of robotics and electronics, but throughout this article we will refer to only low cost technologies, using free software and open hardware[7].

From the point of view of usability, a remote laboratory must have tools that allow it an efficient management of access and users, a multimedia system that allows users to see what happens while they are using and an adequate and safe control of the robotic or electronic equipment on it[8]. We analyze each of these factors and their complexity.

- Access management: Requires a good knowledge of databases and implementation of safe system to ensure registration of users and laboratories, assignment of roles, booking of laboratories, loading useful data for learning analytics, etc. Of the different systems on the market, MySQL is an open option, and can perform this function efficiently. Major problem is that administrator has to know how to use, install and configure it.

- Multimedia systems: The simplest is to have one or more IP cameras providing visibility of the laboratory. Once you decide how to use them, you must provide the integration of the laboratory controls on the website, and deploy it. To do that, you may consider streaming technologies or integration options in HTML5. Again, these options require knowledge of programming and web development skills.

- Control of the laboratory: Each laboratory is different, which also has different needs and requirements of control[9]. Those require developing an interface for controlling the robotic equipment or electronics, on an user friendly way. This requires developing a user interface using; for example; tools like PHP, JavaScript and communication protocols that allow the robot connects to the server. Again adequate knowledge to plan, develop or

implement these systems is needed.

Anything seen above complicates greatly that a user without advanced knowledge of programming and hardware can deploy a laboratory easily.

Plug & Play philosophy for remote laboratories

In recent years it has spread increasingly Plug & Play philosophy[10]. This philosophy is particularly noticeable in Windows OS. Which user can install and configure hardware or software using only an installation interface and pressing an "Ok" button, has enabled both computers and mobile devices can be used by a large number of users without advanced computer or electronics skills.

SiLaRR continues this philosophy and moved it to remote laboratories. Through an integrated system (Figure 1), SiLaRR allows a user without programming skills can install a robotics or electronic laboratory by pressing several "Ok" buttons and connecting hardware used an Arduino UNO

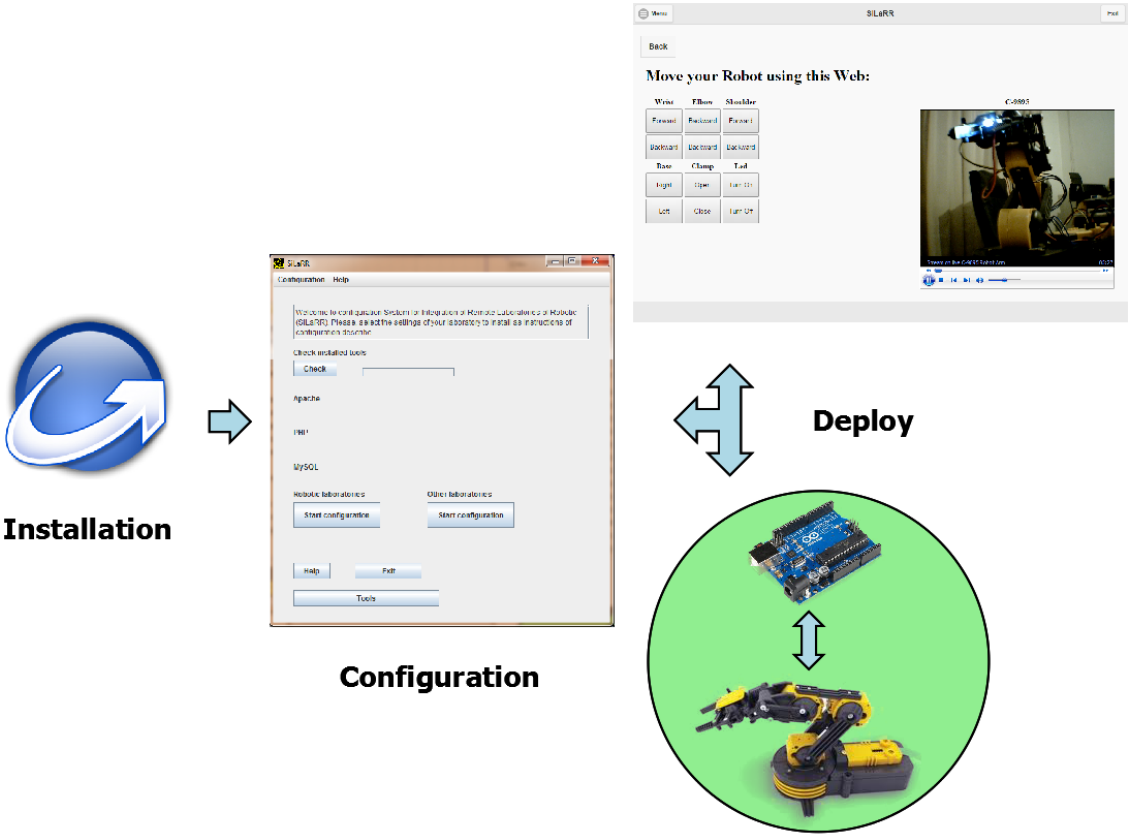

Figure 1. The architecture of SiLaRR system covers all the steps needed to deploy a laboratory easily and quickly.

- Guided installation mechanism: The system has integrated an Installation Wizard will act

as a path, asking you different questions and showing you screens that allow you to configure items such as database or access to laboratory. This mechanism installed on the PC administrator the necessary tools to deploy remote laboratory on Internet and manage it.

- Configuring remote laboratory: A suite of integration allows the user, also by a Configuration Wizard, connect the remote laboratory system and install and manage data base locally to control the whole system.

- Automatic deployment on the Internet: The system finally allows deploy the laboratory on Internet with a user interface that, from that moment, allows you to manage the database and laboratory on local and online.

In addition, SiLaRR allows configure and install unlimited remote laboratories, facilitating the creation of a pool of accessible and manageable laboratories on Internet through a single centralized real-time system and control remotely by one or more administrators.

Universal remote laboratories

During 2014 SiLaRR has been tested in schools of different levels, universities and colleges. While in the university environment is easier to find people with adequate knowledge of programming, not the case in schools, where often an amateur professor of electronics or robotics develops a laboratory on classroom for their sessions, but do not know how to deploy it on the Internet and how to manage it in an easy way.

It is in these cases when SiLaRR is a practical and simple option. Following Install Wizard messages, teacher, administrator or robotic hobbyist can connect a computer to the system, generate a user database and deploy them on Internet.

The tests were conducted with teachers from different educational areas with different skills. The result was in any case a correct installation of laboratory testing; a robot arm; and the only differences were reflected in a little more time in cases where teachers have less knowledge of computer/electronics.

Regarding the use of the system by the students, all of them accessed the system through a login/password traditional login and they could manipulate and control the robotic or electrical equipment both as a group; leaded by the teacher, or individually in slots of 15 minutes of duration or through a pre-booking system integrated into SiLaRR and that can be configured by the administrator and managed using the software.

To achieve the universalization of system we must consider several issues that will affect directly the degree of use of the system:

- Cost: On SiLaRR we are talking about free software and open hardware; Arduino UNO. That means that the cost of using this system to integration of laboratories is mostly

reduced, making it more attractive for training or educational environments.

- Ease of use: Plug & Play SiLaRR philosophy minimizes user interaction with the system, limiting it to accept or reject the options offers by Install Wizard that will show during the installation process.

- Reuse of equipment: SiLaRR is a not intrusive system and allows reuse robotic or electronic equipment for remote uses or for in classroom use just disconnect the equipment from the system. That system helps reusing and reducing cost and enables the mobility of robotic or electronic equipment in a quick way if needed.

At the same time SiLaRR allows managing several laboratories using the same interface, reusing the characteristics of each other without having to reinstall the entire system every time you want integrate a new laboratory.

- Save time: Centralized management of SiLaRR allows using the system for different activities such as assigning different levels of user roles, user management, add or delete laboratories, data management, learning analytics, integration of new laboratories, etc. And all with a single interface accessible both remotely and locally.

- Accessibility: The configuration and Web development of SiLaRR, the system is accessible both from a PC or laptop as from any mobile device, using a standard browser

All of those characteristics facilitate the use of SiLaRR performing scalability and ensuring the use as a powerful tool for deploying and managing laboratories, being available to any user, with amateur, intermediate or advanced technology skills.

Conclusions

SiLaRR is a complete system that allows integrating, managing, configuration and deployment systems for robotics and electronics remote laboratories. Collect the Plug & Play philosophy and seeks simplicity to allow everyone who wants to connect their laboratories to the system and deploy it on the Internet to allow access and control remotely via PC or mobile devices.

SiLaRR is an easy way to have a useful complete system to be used in training and education covering academic, university, school or business environment. The versatility of the system allows integration and adaptation in many robotic or electrical equipment, or even be customized if needed.

Based on these results and because SiLaRR is free software[11] the goal is universalize as much as possible the installation of remote laboratories and increase their accessibility and use for educational environments.

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