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En conjunción con el Congreso Español de
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17-20 de septiembre de 2013

Facultad de Informática de
la Universidad Complutense
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Remote Laboratories embedded in an Official Engineering Master's Degree Program

Mohamed Tawfik, *Graduate student Member, IEEE*, Elio Sancristobal, *Member, IEEE*, Rosario Gil, *Member, IEEE*, Sergio Martin, *Member, IEEE*, Felix Garcia-Loro, *Student Member, IEEE*, Santiago Monteso, Clara Pérez, Alberto Pesquera, Antonio Robles, *Member, IEEE*, Agustin Caminero, *Member, IEEE*, Salvador Ros, *Senior Member, IEEE*, Roberto Hernandez, *Senior Member, IEEE*, Gabriel Díaz, *Senior Member, IEEE*, Juan Peire, *Senior Member, IEEE*, Manuel Castro, *Fellow, IEEE*

Abstract—This paper reports on a new inter-institutional online master degree program in Information and Communication Systems (ICS). The program is funded by the European project Remote-labs Access in Internet-based Performance-Centered Learning Environment for Curriculum Support (RIPLECS) from “Lifelong Learning Programme/Erasmus Programme”. It is developed and delivered by five European institutions from four different European countries. Addressing labor markets and industry needs is the main focus of the program. Thus, experimentation and remote laboratory access is a substantial element for all its subjects, which makes it a unique of its kind. In this paper, we discuss the project rationale and its organization.

Index Terms—Biometric; Distance Education; Login; Moodle; Verification

I. INTRODUCTION

Demands and needs of labor markets and industry have always been seldom concerned by providers of educational programs. Most of the educational curricula revolve around the theoretical concepts and their evolution without contemplating their deployments and applications. This is common in most of the engineering and applied science curricula. On the other hand, among the remarkable reasons that are struggling the European sustainable growth objectives and are working the unemployment situation in Europe are the deficits in qualified and skilled graduates and professionals. The following recommendations from the report “Investing in the Future of Jobs and Skills” [1] specifically address education and training needs in the computer, optical and electronics industrial sectors: Enhance the flexibility in education and training by promoting modularization; facilitation of Life-Long Learning; know-how transfer learning and establish learning networks; Enhance flexibility in e-learning and blended learning; Supply special courses dedicated to a sector characteristics.

M. Tawfik, E. Sancristobal, R. Gil, S. Martin, F. Garcia-Loro, S. Monteso, C. Perez, A. Pesquera, G. Diaz, J. Peire, and M. Castro are with the Electrical & Electronics Engineering Department, Spanish University for Distance Education (UNED), Madrid 28040, Spain (mtawfik@ieec.uned.es; mcastro@ieec.uned.es).

A. Robles, A. Caminero, S. Ros, R. Pastor, and R. Hernandez are with Communication & Control Systems Department, Spanish University for Distance Education (UNED), Madrid 28040, Spain

In response to the above mentioned issues, an online official inter-institutional master's degree program in Information and Communication Systems (ICS) has launched. It is conducted by Five European institutions from four different countries and oriented to labor market needs. The program aims to prepare qualified professionals warranting learning flexibility and efficiency. The program is funded by the European project, Remote-labs Access in Internet-based Performance-centered Learning Environment for Curriculum Support (RIPLECS) [2-4]; a project from “Lifelong Learning Programme/Erasmus Programme”. In general, the project works towards providing Open Educational Resources (OER) for virtual campuses by ensuring that organizational, technical and quality-related issues are addressed in order to share content, and make it easily accessible at European level and developments of the European Higher Education Area (EHEA) objectives for 2020, according to the Bologna process [5].

The master's program is targeted to engineers, technicians and scientists with interest on up-to date topics in the area. This master's degree title gives a deeper and complete formation in the ICS research areas, as well as development activities linked to professional sectors. Recent advances in electronics components and systems, advanced design, advanced communication electronic systems or application techniques in industrial sectors are shown. Students acquire skills focused on industrial field like production organization, design of products, processes and installations, quality management or multidisciplinary teams' management. Additionally, different training and educational activities focused on research processes related to the electronics engineering field will be carried out.

Enterprises in the sector of ICT need design and production engineers and scientists skilled in more than just one area of research which should be able to work with the newest technological equipment. Thus, part of the project management includes contacting and collaboration with enterprises in the sector to respond to the labor market needs.

The rest of the paper is structured as follows: Section II discusses the methods of delivery adopted in the master's degree program. Section III provides an overview on the program's organization and structure. Section IV provides a brief description on various developed remote laboratories [6] to be integrated in the master degree program and their role

in the master's degree program. Finally, a conclusion is drawn in Section V.

II. DELIVERY

The project partners have already been working for the last five years on integrating Information and Communications technologies (ICT) in higher education and applying performance-centered methodology in university education, training and vocational education starting with IPSS_EE Minerva project [7], and then continuing with DIPSEIL [8] and IPLECS projects [9]. Throughout the previous above mentioned projects. A distributed performance-centered adaptive Learning Management System (LMS), so-called DIPSEIL, was set-up with 50 performance-centered courses in five languages has been added to the DIPSEL platform and a whole Master degree program has been implemented at one university and some courses from the program has been implemented at the other four universities. Five DIPSEIL servers in four countries in Europe has been installed, as shown in Figure 1. The master's program relies on the DIPSEIL platform, enabling world-wide distribution of learning resources and lab-experiments, by utilizing multiple Web servers at several universities in Europe, within a single network topology. Instructors from different European countries can take the advantages of conducting the program and deploying remote lab experiments in their native language and personal educational point of view.

III. STRUCTURE

The project partners are the following Institutions:

- Electrical & Computer Engineering Department, Spanish University for Distance Education (DIEEC-UNED), Spain.

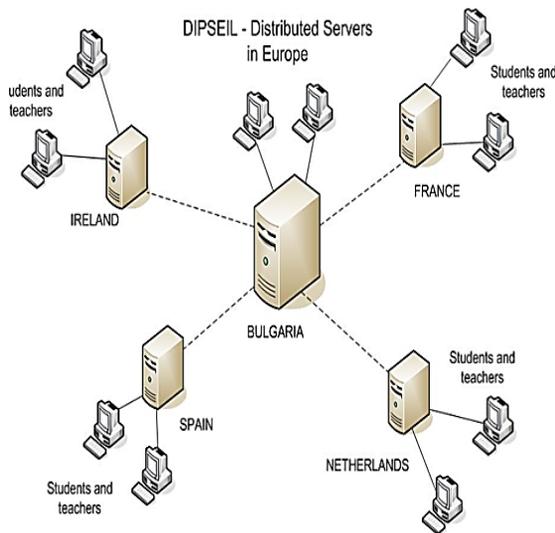


Figure 1. Five DIPSEIL servers in four European countries.

- Communication & Control Systems Department, Spanish University for Distance Education (DSCC-UNED), Spain.
- University of Plovdiv (PU), Bulgaria.
- Cork Institute of Technology (DEIS), Ireland.
- Technical University of Sofia (TUS), Bulgaria.

- Institute for Technical Informatics, Graz University of Technology (TUGraz), Austria.

The program started in the academic year 2013/2014 and will be delivered as many years as the labor market needs ICT specialists and students want to enroll for the master degree curriculum. The curriculum courses are based on ECTS and it is conducted among the five universities and accredited initially in Spain, by the Spanish ANECA accreditation Agency [10], as part of the official courses conducted at Spanish University for Distance Education (UNED). This is owing to the vast historical experience of UNED in delivering online educational programs - UNED is the second distance education university in the Europe in terms of number of “online” enrolled students [11] after the Open University in United Kingdom, the actual number of enrolled students is 260.079. In addition, a certification from all partner universities will be included. The consortium unites universities teaching engineering and science, and open universities, with groups specialized in different application domains, including mathematics, physics, microelectronics, information technology and telecommunications. The master program is of one year (2 semesters) and 60 ECT, and is composed of three modules; fundamental module, specialized module, and final project module. The subjects are of 5 ECT, and the final project is of 10 ECT. All subjects are taught in English and any student around the world can be registered and enrolled in the master. The program curriculum is organized as shown in Table 1.

TABLE I. Curriculum of the RIPLECS Master Program

	Subject	Provider
Semester 1 (Fundamentals) October-February	▪ Introduction to Information and Telecommunication systems	PU
	▪ Industrial and Real-time Communications	DIEEC-UNED
	▪ Internet Technology for ICT	DEIS
	▪ Electronics for ICT	TUS
	▪ ICTs research and engineering competence skills	DSCC-UNED
Semester 2 (Specialized) February-June <i>Two of electives</i>	▪ Microprocessor Techniques	PU & DIEEC-UNED
	▪ Wireless Communications	PU & TUGraz
	▪ Multi Media for ICT	DEIS
	▪ Power Supplies for ICT equipment	DIEEC-UNED
	▪ Microelectronics	PU
	▪ Satellite and Mobile Communications	PU & DIEEC-UNED
	▪ Computer Modeling and Simulation of Electronic Circuits	PU & DIEEC-UNED
	<i>Final Project</i>	

IV. ROLE OF REMOTE LABORATORIES

Remote laboratories forms an integral part of the subjects of the master's program. This promotes cross-institution cooperation and offset costs and burdens. Students at one university can access remotely to a laboratory made

accessible by another university. By this way, the partners' organizations share the cost of expensive laboratories and physically establish them at a convenient location. Students have the possibility to have practical work in labs in different countries, in which labs are usually very expensive– in some cases they are even unavailable for public universities. So far, the developed remote labs that are integrated in the master's subjects are the following:

- **Remote Lab for Wireless Sensor Networks (WSNs):** for configuring and programming WSNs online. This is a remote lab from TU Graz for the subject "Wireless Communications" [12].
- **Remote Lab for GSM and 3G Telecommunications:** for measuring the radiation patterns of various types of antennas to get a clear picture on their radiation characteristics, and measuring characteristics of wave propagation in mobile communications identifying parameters such as fading, phase delay, standing wave, and Doppler frequency. This is a remote lab from PU for the subject "Wireless Communications" [13].
- **Embedded Systems Remote Labs:** Embedded systems remote labs are a collection of mounted boards such as Field-programmable Gate Array (FPGA), Microprocessor, and microcontroller, which are totally administrated, controlled, and monitored online for education and experimentation boards. The students use these types of boards in order to program them online by programming languages such as VHSIC hardware description language (VHDL) and to monitor the results through a connected Webcam. This is a remote lab from UNED for the subject "Microprocessor Techniques" [14].
- **Virtual Instrument Systems in Reality (VISIR):** VISIR [15] is a remote laboratory for wiring and measuring electronic circuits on bread board online. This is a remote lab from UNED from the subject "Power Supplies for ICT" [16].

V. CONCLUSIONS

Despite the lackage in skilled and qualified graduates in comparison with the high requisites of the industry and labor markets, few initiatives have been done to address these needs. The presented master's degree program response to the demands imposed by the labor markets and industry enabling an ubiquitous pool of learning resources and lab experiments from multiple European institutions. The variety of partners form diferent European institutions enriches and augments the program contents and will deliver experiences and outcomes that are in accordance with the European education requirements. The fact that this program is conducted by European partners doesnt impide students from all over the world to be enrolled and being an online program makes it compatible with the different life styles of the predominating students. Putting all these factors together makes the program unique of its kind. Thus, its successful implementation would pave the way for further initiatives of this kind, which are not only confined neither to ICS nor Engineering, but for many other disciplines of science.

At the end of this academic year 2013/2014, the effect of practical tasks performance and performance-centered learning resources on knowledge, skills and attitudes of

different types of learners will be evaluated as applying some classical methods such as observation, surveys through questionnaires and interviews, and analysis of information flow from the discussion forum through grounded theory techniques and content analysis. The observation protocols, questionnaires and the interviews' forms will be tested for validity and reliability.

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