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Project Oriented Teaching Approaches for E-learning Environment

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***Abstract* — Internet of Things is deeply integrated into all aspects of human life. This is also the case in higher education as well. Introduction of different e-learning tools requires from teachers and students deep knowledge in new emerging techniques. In the article there are considered the project oriented approach and 3 case studies on how new technology can improve the e-learning environment of HEI.**

Keywords — practical-orented study, project-oriented approach, internet of things, remote experiments

I. INTRODUCTION

The Internet of Things (IoT) refers to a global approach for the functioning/controlling of things. Things is anything which is used, controlled, measured and is connectable to the internet: all kind of devices and microcontroller systems that can read sensors, do some (preliminary) digital signal processing and send output over the Internet. The availability of powerful multi-core microcontrollers, large size memories and a wide variety of commercial of the shelf sensors enables this new and challenging market. The average amount of microcontrollers per person is rapidly growing and will continue to grow in the next few years [1]. In their new Internet of Things report, Businessinsider.com projects there will be 34 billion devices connected to the internet by 2020 [2].

It is clear that there are great job opportunities for specialists in this specific high-skilled field of expertise. These specialists should have a profound knowledge of both hard- and software aspects of the system, in interfacing with sensors, in using embedded operating systems or real-time operating systems, but also on networking.

The task for higher educational institutes (HEI) is to deliver highly skilled engineers and developers to the labor market who have the knowledge to design, build, operate, maintain and problem shoot these devices. Especially when one deals with Industrial Internet of Things, where these systems are deployed in an industrial environment to run process-critical applications, quality issues of the combined hard- and software become extremely important.

To introduce the knowledge of IoT in the study curricula of engineering students, authors looked on new possibilities and the use of remotely controlled experiments, to offer to students possibilities for experimenting and for shaping up their knowledge on the theme. A secondary reason to involve remote experiments is to cope with the shortage of manpower.

First some existing examples of a practical-oriented remote experiment are considered, which substitutes a real hands-on lab and a project oriented remote lab, for training students in a specific field of study and check the achieved learning outcomes. Second, we also considered some case-studies of what is achieved with students in the field of IoT through project oriented teaching/learning.

The goal is ultimately to learn how to expand the remote labs in the field of IoT and how to implement project work so that they are effective and efficient in achieving the necessary learning outcomes to make professionals in IoT.

II. REMOTELY CONTROLLED EXPERIMENTS

Any lab – including remote labs - should offer enough possibilities for students to experiment and offer measurable learning outcomes, associated with these experiments. In other words, care should be taken that the remote lab is more than a demonstration lab, but a real experiment – although controlled from a distance.

When developing remote experiments as a teaching/learning aid, one should bear in mind the same questions as when developing any other didactical method: namely think carefully on the learning outcomes and teaching approach. The learning outcomes will point out what and how students will need to learn and also point on how to evaluate. [4]

These observations clearly show that remote labs not only have advantages but also are the cause of a lot of challenges when considering the construction of remote experiments. The advantages for students are clear: the 24/7 availability to experiment and repeatable experiments can motivate students to achieve a deeper learning on the topics. The challenges for the construction of the lab are to make it user-friendly, efficient in achieving the learning outcomes and motivating and attractive to students. Another major challenge is potential distant evaluation and feedback for the students on mistakes or good and bad practices they used [3]. Finally maintenance of the remote experiment is also challenging.

We examine here 2 case studies: the ISRT-lab (Informational Systems on Reliability Tasks-lab) at Zaporizhzhya National Technical University for project oriented e-learning, and the CALM (Computer Aided Learning Module) e-learning system for material sciences at KU Leuven as an example of practical-oriented e-learning.

The software for Remote Laboratory for CALM was a Master Thesis works and the Web-interface was a bachelor thesis work.

The ISRT software development consists of 3 year ba student project work and theoretical part of PhD student investigation.

A. *Informational Systems on Reliability Tasks-lab result*

In order to improve teaching in diagnostic methods for embedded systems, at ZNTU a remote lab for examining reliability problems in real time was constructed [4] based on the Raspberry Pi platform which was named ISRT (Informational Systems on Reliability Tasks). The Raspberry Pi is a single-board computer which is often used in cyber-physical systems and IoT applications. Possible operating systems for the Raspberry Pi are Debian Linux in Raspbian Jessie distribution or Ubuntu Linux. Raspberry Pi has several Input/Outputs for low level control and, as it offers the possibility of installing Linux on it, so a web server and databases can be installed. The ISRT comes with a set of predefined tasks for the students to learn on different aspects of using the Raspberry in relation to IoT-technology. Tasks include transformation of data, connecting and using different sensors for physical parameters (temperature, light intensity, luminosity, distance), image recognition, detecting time-delays in the execution of programs, access to remote working systems with different protocols like Wi-Fi, Bluetooth Low Energy and GSM. The goal of the predefined tasks is that students later on will work on an own-defined project in which they combine and use the knowledge to make a physical remote sensing device for some physical status (e.g. ecological measurements, climate control measurements).

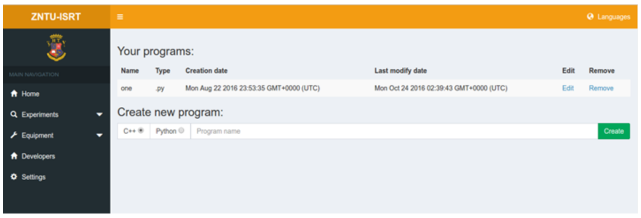

Figure 1 ISRT programming interface

In the case of the ISRT no formal testing of knowledge of the students was done. The ISRT is used for training purposes and as a step-by-step buildup of competences for the own project. With each preparatory task online feedback and a step-by-step lead through the task is foreseen. If students fail to answer the questions/perform the tasks, they cannot continue through the task list. Testing of the outcomes is not formally done, but evaluated in the students' own project afterwards.

B. *Computer Aided Learning Module*

The CALM (Computer Aided Learning Module) is a e-learning module for the study of material sciences for bachelor students. CALM contains sections on theoretical knowledge, a virtual lab and remote lab and the lab-instructions for the physical hands-on labs which are used for the study of material sciences.

The e-learning platform and remote labs was built in a collaboration between universities. The hardware of the remote lab was built during 2 student projects and software development involved a mixed team of staff of KU Leuven and ZNTU, and of 2 master students in ZNTU. This project approach of collaborative building on of the platform opened new perspectives in extended cooperation.

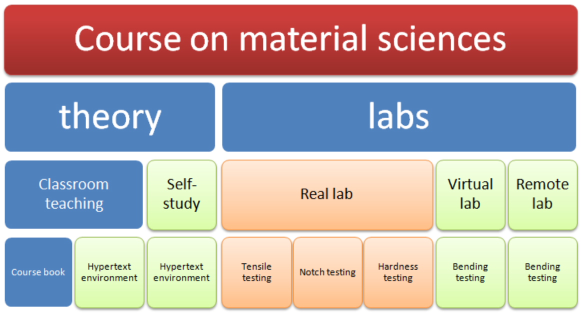

Figure 2 Structure of the courses on material science, integrated in the CALM

The aim is to use the CALM in classroom teaching, in self-study for the students and in the labs. The remote and virtual lab on the study of the difference between material and shape stiffness of a structure is available 24/7 to allow students to experiment on and check the theoretical formulas. The remote lab is a 2-point bending test.

The lab is used as one of the four compulsory lab sessions in the material sciences courses for bachelor 2 students in engineering technology. Data gathered in the remote lab is combined with the test-data from the other labs to report on material properties of the tested specimen.

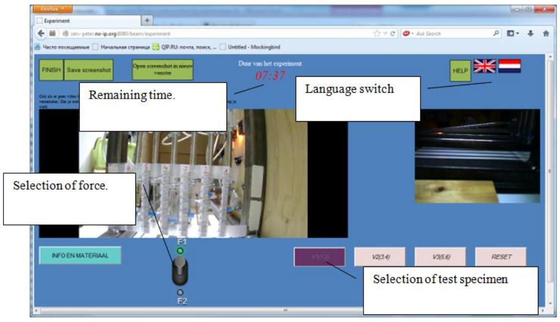

Figure 3 remote lab, screenshot with view of 2 cameras.

The CALM is used as a showcase and technology demonstration in the MMATENG project, as an example for new teaching methods in material sciences.

For an efficient pedagogical usage of remote labs and e-learning there is the problem measuring the results on learning outcomes and comprehension measurement.

In the CALM, formal testing is used. The knowledge gathered in the remote and virtual lab is tested in a real exam. In the original experiment it was proofed that there was no difference in outcomes between students who used the remote experiment and students who did the bending test in a hands-on lab. This proofed that the remote lab can successfully substitute a real hands on lab.

III. SMART-CAMPUS PROJECT

Within the framework of DESIRE Project a start-up, called Smart-Beacons, is created, which consists of the realization of two applications on one platform Smart Campus and Smart City.

All tasks were distributed between ZNTU-TMMA (Thomas More University College) teams. It involved 3 students from ZNTU, 1 Chinese exchange student at TMMA, and supporting staff for server administration at TMMA.

As collaboration platform BitBucket was used.

The general idea of a Smart Campus for universities is that the campus talks to you. Individual information for students, teachers and visitors is delivered, depending on their profile and time of day through the use of beacons.

The Smart Campus Application consists of three main parts: a mobile application for different operational systems iOS, Android; a custom-made Content Management System (CMS) for updating advertisement information, and an administration system, which consists of different components aimed to adjust hardware characteristics.

The Smart Campus Mobile Application provides users a variety of functions, allowing working both in on-line mode as in off-line mode, enrolling is favorite groups and blocking others and detecting buzz from the beacons[3].

The work consists of 3 bachelor work for Android & iOS Mobile Applications and CMS Development.

And further it transformed into 3 master thesis works – investigation and development of web-oriented mapping tools, mobile in-door route definition and smart interfaces. The same data coming from the central CMS-server was used by a Chinese exchange student from the Jiangnan University, but displayed in another fashion. The goal is to have a very user-friendly, easy-to-use and attractive system. As the owners and content-providers of the beacons are real external customers, the quality of the delivered work, should answer to the highest demands of modern-day cloud-based systems sharpening the relevant skills of the students involved.

IV. EMBEDDED FACTORY

With the increasing demand for autonomous IoT applications, which get sensor data from remote location and store this data in the cloud on sensor systems, a whole new boost is given to the already fast growing market of embedded systems. It is clear that a fast evolving set of skills need to be taught to students, who need to have a decent knowledge of the complete design process from idea to realization. Most of the time, the work which can be done at an Higher Educational Institute, limits itself to making a prototype or proof-of-concept, due to the decreasing size of electronic components and the increased complexity for assembly, as a consequence. There is however a lot of specific technologic knowledge between a prototype and actual automated production and going to market. To cope with the initial high investment cost and to enable the students to do project-oriented learning, a public-private cooperation is set-up at TMMA, during the DESIRE project, in the form of the Embedded Factory. This is a small factory to automatically produce small series of embedded systems, capable of placing up to the smallest electronic components and automatically soldering the systems in a small reflow oven. Quality of the assembly can be tested by visual and X-ray systems, CE certification can be done at a spin-of company on site. Due to the intense cooperation with local enterprises, the factory can be made available both for students and private businesses.

Figure 5 Embedded factory at campus De Nayer

V. CONCLUSIONS

Implementing internet of things and industrial internet of things require special knowledge, multidisciplinary knowledge, team work, soft skills. The boundaries between different fields of studies become more blurred. Implementation of remotely controlled experiments into study allows teachers not only to give students possibility to have access to the unique equipment 24/7. Involvement of master students for the development implements project based teaching approach and increase multidisciplinary knowledge.

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