Remote Laboratory Environment for Embedded System Experiments

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Abstract—Today’s engineering education needs practical hands-on experimentation as it has long been time already. However the learning process is now moved into the Internet in many aspects and learners expect to get most of the content and activity available over the Internet. Practical experiments is not trivial to carry out over the Internet, but using novel ICT technologies and integrated solution, most of the experiments can be done over the Internet. This interactive demo describes and presents the remote practical experiment system in embedded system domain.

Keywords—remote lab; robotics; embedded system; e-learning

I. INTRODUCTION

A remote lab (or online lab) enables actors (such as students or employees) to carry out experiments over the Internet, which are normally performed in presence studies at educational laboratories. Compared to a normal laboratory there is need of additional equipment for preparing traditional labs for online access. Remote labs can be divided into distance labs and virtual labs. The main difference between them is that in virtual lab, an experimental environment is simulated instead of mediating the real environment. This approach had some advantages but also disadvantages. If the virtual lab is a software service, once set-up, the lab can be used by a lot of student’s simultaneously, only affected by computational power of the host computer. It is also more robust than real equipment as student may not destroy the hardware while adjust some settings or failures in programming. The system can be easily duplicated without paying additional costs. Biggest disadvantage of virtual lab, compared with real one is that a virtual lab may never react in all cases equal to real hardware. It is impossible to include all environmental parameters into the virtualization, thus a virtual lab will react sometimes different from a real one. The best solution is a combination of virtual and remote labs to get benefits from both of them. A general approach, followed of the solution described in this paper is to use the virtual devices for basic education to teach basic system thinking and to get familiar with the hardware. In later steps the learners are switching to real hardware. Closer overview is presented in doctoral thesis [1] and paper [2].

The interactive demonstration, presented in this paper is about remote laboratories in the field of embedded systems. During the several EU projects, outcomes presented in several publications [3-5], a base platform is developed to host and mediate different types of remote laboratories around the world. The latest development is under the frame of EU Life Long Learning program project NetLab [6] which established three new lab centers in Estonia, Finland and Germany.

II. STRUCTURE OF THE E-ENVIRONMENT

The e-environment of remote labs is a part of Robotic Teaching and Learning Concept presented in the thesis [1]. The concept offers wide range of tools and methodology to effectively and interactively teach embedded systems and mechatronics as well as exploit latest web technologies.

The whole environment consists of several logical servers which can physically locate in one server or distributed over the many different locations. The current set-up consists of one portal server and every lab location has its own programming server. In addition, all labs and also all devices can have its own real-time audio-video feedback system.

The lab is consisting of number of similar equipment with wired or short range wireless communication module. The site is fitted with web camera and server which communicates with the robots. Server has a master communication unit which can be contact with any robot on the field and reprogram it at any time when needed. The site server is connected with the portal server passing and validating the communication between the robot and user input.

Remote Lab Centre (RLC) is a specific location-based lab which can be accessed over the Internet. A Remote Lab Center focuses on specific equipment or a series of experiments by giving online access, enabling control and monitoring of the process. Remote Lab Centres are located in different organizations like universities, vocational schools, SME-s and offer through a resource sharing concept, different remote labs, such as; mobile robot lab, microcontroller test bench, automotive lab and smart house lab. In principle, RLC can be either equipped with real hardware named as a DistanceLab or offer virtualized hardware simulator – VirtualLab.

III. DEMONSTRATION OF LABS

Remote Lab Centres are currently up and running as prototypes in following locations:
- Tallinn and Võru, Estonia
- Helsinki, Finland
- Bochum, Germany

During the interactive demonstration following online labs will be demonstrated in live:
1. Robotic HomeLab kit test bench in Robolabor (Fig. 1.)
2. Mobile Robot lab in VKHK, Võru (Fig. 2.)
Both online labs are located in Estonia, but different organizations and different cities. Labs are actively used by vocational schools and gymnasium teachers to practice their knowledge in embedded system programming.

IV. DISTANCELAB PORTAL

The remote lab environment portal offers a complete remote lab management and programming environment for remote labs - either distance labs or virtual labs. The functionality connected with remote lab is as following:

- user and group management,
- location, lab and device management,
- source code validation and version management,
- wireless device communication,
- device booking and booking rights.

Having a broad view in mind, the system supports three levels of grouping:

- Location – this is organizational level where different type of devices and labs can exist,
- Lab – the virtual room where physically or virtually different devices can be located,
- Device – a set of same type of devices in one location.

Devices have additionally grouped into several sub-groups according their type, e.g. mobile robots, manipulators, PLC-s, etc. Video feedback system can be connected to one lab (usually two cameras) or to every device. The number and focus of video cameras is related to the nature of the lab. In case of moving objects like mobile robots, usually lab has general cameras focusing on the arena where robots can drive around. In case of attached device like Robotic HomeLab test bench or manipulator, every device has its own camera. In this case camera can precisely focus to the device.

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REFERENCES