

## ONLINE ENGINEERING FOR FUTURE FACTORY

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**Abstract:** The current study introduces possibilities of online engineering for higher education institutions and SME-s. The objective of the study was the development of integrated interdisciplinary e-tools concentrated on Mechatronics, Robotics and Manufacturing Automation, supported by online mobile sets that can save resources. New solutions of integrated engineering areas and information technologies are introduced in this paper.

**Key words:** online engineering, distance lab, mechatronics, robotics

### 1. INTRODUCTION

Today's engineering faces with complex system design and rapid time to market demands. The European engineering industry on the same time is faced with Asian competitors who have become from subcontractors to designers and developers (Christophe et al., 2009). According to these trends it is important to bring new concepts and solutions to engineering process for the industry and education. In continuous education the main problem is the lack of time of practicing engineers to participate in lectures or labs, and the common problem is how to exploit newest web-based technology for practical studies in engineering field. The industrial manufacturing and development on the same time needs more effective solutions and cooperation especially amongst the small and medium size companies (SME). Resource sharing and online process control allows reduction of the expenses and exploits the advanced technology for industrial engineering. For education the online engineering gives more flexible access to practical labs without time and place limits, but without losing the quality of the study.

The current paper describes the developments of online engineering solutions for education and industry at Tallinn University of Technology.

### 2. STATE OF ART

There have been several research projects targeted on the development of a tool that permits the supervision and control of any industrial process through internet. The exemplary developed set at Universidad Miguel Hernández consisted of a PC with access to Internet, a text editor, a navigator web and the plugin of Java, downloadable freely from the web page of Sun. However, to demonstrate the validity of the obtained results, they have been applied to a scaled industrial process in the laboratory ((Payá, et.al, 2003).

The system architecture elaborated at University of Missouri allowed remote users to access and control a PLC-based table-top manufacturing system via the Internet. A Web site was developed that facilitates interactivity and supports PLC programming and control. This study showed that software tools available in the market can be integrated to develop a fairly complex, yet effective, learning environment

for distance education (Saygin & Kahraman, 2004). Remote lab at Maribor University is based on MATLAB/Simulink and LabVIEW and a custom-made hardware i.e. DSP based controller. Remote users, connected to the server through the internet, however must have a LabVIEW Run-time Engine installed on the personal computer, in order to perform remote experiments (Rojko, et. al., 2009).

The TUT Department of Electrical Drives and Power Electronics has launched design project of remotely controlled electrical drives laboratories where students can make experiments on real objects. The PLC (Programmable Logic Controller) based control of remote laboratory experiments provides some advantages in the electrical drives remote laboratory (Moller, et.al, 2008).

The abovementioned distance labs have been successful as educational tools, but restricted in practicality. The industry however needs large variety of control systems and online services. Therefore a general concept solution for arranging different online solutions under a virtual resource-sharing umbrella is needed.

### 3. CONCEPT OF ONLINE ENGINEERING

The overall concept developed by the consortium of European universities and enterprises by the support of Autostudy project (<http://autostudy.eu>) combines the Distance Engineering Platform which enables to create the lab or factory access with device interfaces. Devices can be actively controlled and monitored over the Internet. The system is applied for the industrial future factory and educational laboratory on the same basis. System concept and architecture does not make any difference either the accessed location is university lab or factory or the device in this location is item on the lab or smart cell in the factory. The distinction is made by the logical data and specific device interface. An educational interface is shown in Fig. 1.

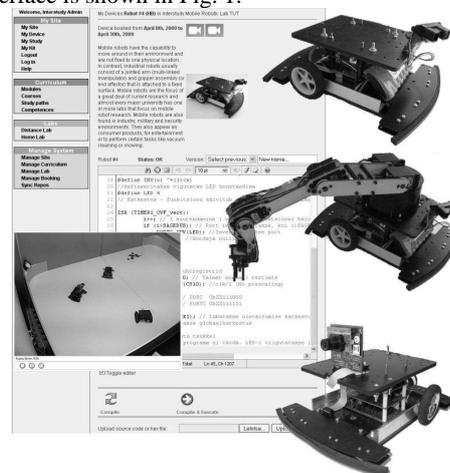


Fig. 1. Distance Lab robot programming interface and robots.

In distinction to the systems mentioned above, the consortium has developed full learning concept where the hardware i.e. Distance Lab and Home Lab, are integrated with methodology, curricula and theoretical material as well as web based community support centre for teachers and the learners.

### 3.1 Distance Lab for students and professionals

The Distance Lab solution for the education and professional use is fully developed and comprises the microcontroller based system access. The implemented lab consist numbers of mobile robots which can be programmed over the internet. The mobile robot specific interface enables to compile and execute the controller software written in C or C++ language and transfer it to the acting robot wirelessly. When new program is compiled and sent out by program server, robot interrupts its current routine and acquires new algorithm. User can monitor the real actions over the two real-time cameras. The programming interface is show on Fig. 1.

### 3.2 Distance manufacturing control and monitoring for industry

The industrial e-lab model described here consists of PLC controllable Profibus module, connected to Fieldbus (see Fig. 2). HMI (Human-Machine Interface panel) serves also as a web server, the image can be easily adopted to HTML page, e.g. the one used for distance lab. Two IP cameras are set to monitor the device – one for process, another for PLC and buses. Clients are allowed to access in pre-registered order (see interface Fig. 2) and thus the industrial processes can be easily shared for maintenance, or for lending out manufacturing resources.

### 3.3 Mobile Lab solution

All together the Home Lab Kit (Fig. 3) is a mobile ready to use a small test stand, which can be connected to PC and operated in home or working place. The aim of lab toolkit is to provide a practical and effective hands-on training. Learner can combine various solutions on different levels of complexity and functionality, based on modules in the kit. The Home Lab Kit main feature is mobility - toolboxes are small and compact and all modules with necessary tools are seated into box. Toolkit has a USB connection to PC (for example student home computer). Simple and easy to install software is used to connect main controller to computer. This is particularly important because the student can start his/her experiment in school then continues in home or even in his/her workplace.

Together with Distance Lab application and web support environment the Home Lab forms integrated learning concept helping to make engineering studies more effective with practical hands-on experience (Sell & Otto, 2008).

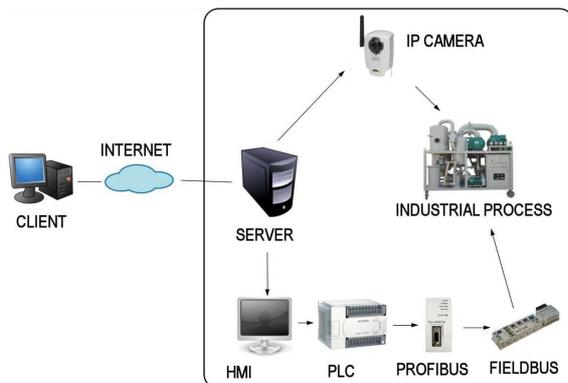


Fig. 2. Distance Lab PLC control through HMI Web server.



Fig. 3. Home Lab solution for hands-on training out of industrial lab/workplace.

## 4. CONCLUSION

The described solutions are used for teaching and research purposes at TUT, and the number of online labs of different subjects is increasing. This enables users to be trained outside regular lab facilities and to use the time resources more effectively. The proposed concept also enables to share different online monitoring and control solutions between user groups thus multiplying number of potential users. The main target for further research is to enlarge the network while optimising the lending of the resources. Also network security questions are important when designing large industrial networks.

## 5. ACKNOWLEDGMENT

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