Digital Media and Remote Experimentation in TVET

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Abstract

In this work the special training modules in digital media and remote experimentation in automation techniques developed by the Competence Center Automation Dusseldorf (CCAD), Germany for TVET are offered and described. 4 training modules provide practical-oriented, industrial learning with the help of digital media. Target groups for trainings are teachers and trainers from vocational colleges, from universities of applied sciences and technology, from research universities as well as engineers from the industry. The aim of CCAD is to offer the TVET modules for Indonesian universities, post-graduates and young specialists in order to spread the German educational experiences to Asia.

1 Introduction

In recent years TVET is rapidly developing not only in Europe but also in the countries of Asia. By giving the opportunity for student and staff mobility to participate in TVET it is possible to upgrade their knowledge by offering modern and up-to-date courses especially in fields of automation, software engineering, computer science, production and manufacturing processes, and design techniques [Azad, A.K.M., 2011]. The Competence Center Automation Dusseldorf (CCAD) bundles the resources of the Department of Electrical Engineering in the field of automation engineering. The department also has a special R&D center for remote engineering, tele-learning and E-Learning [Langmann, R., 2011]. For TVET purposes CCAD has developed 4 special training modules (e-Trainer, Automation Live, PROFINET basics and PROFINET expert). Target groups for trainings are teachers and trainers from vocational colleges, from universities of applied sciences and technology, from research universities as well as engineers from the industry. Participants should already have completed a course of education in electrical engineering and possess basic knowledge of automation technology.

2 Training modules in Automation techniques

In the offered training modules digital media and remote experimentations provided by CCAD are used. The modules were developed by CCAD, Germany and can be used for TVET [Langmann, R., Jacques, H. 2012]. CCAD bundles the resources of the Department of Electrical Engineering in automation engineering.

There are four labs which bachelor and master students, specializing in automation technology, have to complete successfully:

- Lab 1: Manufacturing & Automation
- Lab 2: Instrumentation & Control
- Lab 3: EduNet* PLC
- Lab 4: Training & Research Factory Fab21
Besides these labs there is a R&D center for remote engineering and e-learning, the Düsseldorf Telelaboratory DT.

2.1 Module e-Trainer

The first module, e-Trainer, examines methods and principles related to the use of digital media to provide training of complex technical systems. Following a practical introduction to the issue at hand, the course concentrates on the use and handling of those types of digital media which are available to the student to acquire practical skills by conducting technical experiments. These include particular interactive virtual learning environments as well as remote experiments on real technical plants.

![3D models of automated stations from the Fab21](image)

Figure 1: 3D models of automated stations from the Fab21

The course addresses the following technical aspects:

- Bringing plants into service, testing and diagnosis with interactive and dynamic 3D models;
- Training with hardware-in-the-loop (HiL) and software-in-the-loop (SiL) simulation of automation plants;
- Web-based remote experimentation on real technical plants as complement to traditional lab experience.

Practical training is conducted on-site at Fab21 training & research factory [Internet: http://fab21.ccad.eu/] and remotely in the Dusseldorf Telelaboratory [Internet: http://dt.ccad.eu/].

Participants should already have completed a course of education in electrical engineering, possess basic knowledge of automation technology, and be familiar with the use of a PC as a learning tool.

2.2 Module AUTOMATION live

The second module AUTOMATION live complements basic qualifications in industrial automation engineering with teaching on their application in a realistic, industry-standard training factory. The CCADs FAB21 training & research factory for hybrid production processes provides state-of-the-art automation technologies to produce, bottle, package and store a liquid.

Under expert tutelage, course participants are given the opportunity to apply their knowledge to practical operational situations and to perform maintenance on a complex
automation facility. The following activities are carried out with the relevant knowledge being provided:

- Operation and maintenance of plants with various SCADA and DNC systems (WinCC, WebFactory);
- Bringing individual stations with PLC control systems into service;
- Configuration and diagnosis of industrial communication systems;
- Diagnosis and maintenance of positioning units and sensors.

Figure 2: Hybrid production processes in the Fab21

The Fab21 is a training&research factory for hybrid production processes. This factory focuses the most learning subjects in automation engineering to one real industrial system for education and training. Fab21 is situated in a 120 m² room together with 12 PC learning places for trainees.

Participants should already have completed a course of education in electrical engineering and possess basic knowledge of automation technology.

2.3 Module PROFINET basics

PROFINET basics module provides basic training on the deployment, operation, maintenance and diagnosis of the real-time Ethernet system PROFINET using a special PROFINET mobile box. PROFINET expert module complements the previous module with a hands-on PROFINET training course in the Fab21 training&research factory.

Given are a theoretical overview of the PROFINET communication system and of the practical configuration and parameterisation of a PROFINET I/O system comprised of components from different manufacturers.

The practical aspect of the training is provided using a mobile PROFINET lab box, which was developed as part of a EU project as an educational platform for industrial communications technology.

The course addresses the following technical aspects:

- PROFINET basics;
- PROFINET engineering;
- Practical exercises on process models from various industries.

Traditional teaching documentation is replaced for the purposes of this course with modern digital media. By way of example, these include web-based training (WBT), the PROFINET Remote Lab [Internet: www.profinet-lab.de] and smartphone apps providing test questions.
Participants should already have completed a course of education in electrical engineering and possess basic knowledge of automation technology and communication technology.

2.4 Module PROFINET expert

Module PROFINET expert complements the PROFINET basics course with a hands-on PROFINET training course in the Fab21. Course participants use the knowledge they have acquired for the commissioning, configuration, operation, maintenance and diagnosis of faults in industry-standard production automation plants. The course equipment consists of five Fab21 sub-stations with which bottle caps are processed and applied to the bottles produced and filled in.

The course addresses the following technical aspects:
- Configuration and parametrisation of PROFINET I/O controllers;
- PROFINET I/O device integration;
- PROFINET/Ethernet communication for distributed PLCs;
- Operation and maintenance of a PROFINET system;
- Diagnosis and troubleshooting of a PROFINET system.

A PLC unit from Phoenix Contact is used in the Fab21 Zone 3 stations. The training module can optionally be carried out on Fab21 Zone 1 (process automation) using a Siemens PROFINET controller.
Participants should possess basic knowledge of automation and communication technology, and should also have theoretical and practical knowledge of the PROFINET system. It is recommended that the iQ-net module PROFINET basics be completed prior to participating in this module.

3 Conclusion

We found that according to the market demands in Europe and especially in Asia and due to the spread of European enterprises in automation to the Asian market it is know extremely important to train the praxis-oriented specialists of the high educational level ready to implement their knowledge at the enterprises.

Decreasing costs and increasing demands of industrial automation has led to the concept of offering training modules in digital media and remote experimentation [Lyalina Y., Langmann R., 2011]. This modules will enable the training and education of automation engineers, maintenance engineers, process workers and students using non classic teaching methods such as learning by doing, remote and mobile teaching; providing the possibility to program all sets of training equipment via network and to control them via network based control screens, thus building up the remote visualization of real operations carried out in the lab. The objective of is to meet the challenges of the knowledge-based society, to enhance the competitiveness of companies and to improve the employability of employees and future graduates. The methodologies used to develop these training modules have an innovative character. These include all kinds of E-Learning, hands-on training (learning by doing) strongly focused on real work situations and not on theoretical examples or exercises. In other words, many of the materials use Project Based Learning and Problem Based Learning and the courses are supported by E-learning methodologies, such as remote labs, M-Learning and web-based exercises. In some of the teaching-learning contexts previously mentioned, these will be ‘new’ approaches.

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REFERENCES