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E-training in mechatronics using innovative remote laboratory

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Abstract

This paper describes a novel E-training developed for teaching mechatronics. The training has been developed as part of the Leonardo da Vinci lifelong learning programs and MeRLab project (Innovative Remote Laboratory in the E-training of Mechatronics). The primary target group are engineers or technicians who have already completed formal education in the field of mechanical, electrical engineering or other technical fields, but have no knowledge of mechatronics, although their job requires it. For the training, special E-learning platform has been built in the user friendly environment, which is based on combination of commercial eCampus platform and open-source Moodle platform. The complete materials with the animations, graphical presentations, tests and the utilities such as discussion forums are offered. In addition to E-learning materials, the remote laboratory experiments are also available. The training has been executed with a group of 70 participants from Slovenia and second group of 6 participants from Austria. 90% of participants have successfully finished this quite extensive training. Results of anonymous survey show that they have evaluated the training as excellent and think that the gained knowledge will be useful in their further career.

Keywords: Remote laboratories; Distance learning; E-training; Adult education; Mechatronics

1. Introduction

In the European countries, the number of jobs that require the knowledge of the skilled professionals in mechatronics is increasing. Mostly, there are not enough officially educated mechatronics professionals in the job market, since mechatronics educational programs have been introduced quite recently and not many have finished it yet. The consequence of the lack of trained mechatronics professionals is that electrical and mechanical engineers often occupy those jobs. Since, mostly, they do not possess the required expertise, this can lead to dissatisfaction of both the employees and employers. Additional education could solve this problem, however for the most employed professionals, it is hard to engage in any kind of formal education, which requires their physical presence at specific place and time without sacrificing their family time and social life. E-training in mechatronics can at least partially solve both problems.

However, introduction of the distance learning in the engineering education brings some additional educational challenges. Namely, for the engineering education, it is especially important to give the participants a possibility to gain some practical skills by working on the real devices. In distance learning, this can be achieved only by implementing remote laboratories where the user operates real devices trough the Web [1–5]. In the field of mechatronics and automatic

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Table 1
Remote experiments in the field of mechatronics and automatic control.

Experiment	Reference
DC motor	[6,25,19,5,22,23,26,11]
Inverted pendulum	[20,2,8,21,10]
Coupled tanks	[2,14,7,10]
Helicopter	[5,13,2,7]
Magnetic levitation	[5,2]

control, several different remote experiments and remote laboratories have been successfully realized [2–20]. Most common experiments are summarized in Table 1. The main common imperfection of available remote experiments is the lack of learning material. Namely, only distance courses, which include remote experiments with high quality study materials and sufficient online support of the teacher, can provide complete learning experience that can be compared to the conventional in-the-classroom education with laboratory exercises.

This paper presents adult distance training of mechatronics as unique, since it introduces adult E-training in mechatronics with number of remote experiments on real devices. The primary target group for the training are engineers or technicians who have already completed their formal education in the field of mechanical, electrical engineering or other technical fields, but have no knowledge of mechatronics, although their job might require. Therefore, the training is developed for engineers and technicians from the related fields (electrical engineers, engineers, construction workers, etc.) but it is also suitable for the teachers of the secondary schools who want to pass this knowledge to their pupils. It can be used for the education of regular students of mechatronics and automation in their first year as well. From the participants, only, the basic preliminary knowledge is required, which includes introductory course in mechanics or some practical experience, introductory course in linear algebra and physics, everything at the secondary school level.

Paper is organised as follows. Second section describes E-learning Web portal and the remote laboratory. Third session presents contents of the training and remote experiments. Section 4 presents organization of the training and adapted educational approach. In Section 5, results of the evaluation based on the survey results are given. Section 6 gives a summary and some plans for the future work.

2. E-learning Web portal and remote laboratory

E-learning portal, established for the training, is based on eCampus platform [1]. This system offers all functionalities that are required for execution of distance training such as assessed E-tests, forums, personal messages, analysis of the user activities and similar. According to the usability testing of eCampus [9], it is in some aspects even better then open source Moodle, which is the often used platform for E-learning. eCampus' main advantage, when compared to Moodle, is its superior visual design of E-learning content.

Second, practical part of the training is executed in the innovative remote laboratory, which is established at the Faculty of Electrical Engineering and Computer Science, University of Maribor [12]. The remote laboratory is built within Moodle environment [4] so that additional functionality, the booking system for remote experiments, could be included. Home page of remote laboratory [24] is shown in Fig. 1.

The connection between the eCampus E-learning portal and the Moodle based remote laboratory is automatic and seamless and requires no additional registration or actions from the user. Mostly, the users do not even notice the transition. Both systems are reliable and user friendly [9,16].

3. Contents of the training and remote experiments

3.1. Contents

The training includes four modules that upgrade each other and should therefore be studied in the predetermined order. Optionally, the participants with sufficient preliminary knowledge can only study separate module(s). Each of the modules introduces one major topic in mechatronics. Emphasis is on practical aspects of mechatronics, therefore problem-based examples and case studies are included.