Modernizing Laboratories for New Courses in Automotive Software Engineering

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Abstract - Rapid expansion of information-communication technology (ICT) sector, although promising, does not have a satisfactory support in education which can adapt fast to trends and demands of the automotive industry. In addition, one of the leading European employers – the automotive industry, has included in its focus the software and embedded systems. With growing need for engineers with adequate skills, university roles are shifted to take active part in creating healthy business environment, but the needed skills are not sufficiently acquired at universities in the region. The Faculty of Technical Sciences in Novi Sad and Faculty of Electrical Engineering, Computer Science and Information Technology in Osijek have started the common project DRIVE as part of the IPA Cross-Border Programme, with the goal of equipping the laboratories and developing the course materials in the field of automotive software engineering. Four laboratories have been set up to support the project goals and accompanied materials, such as books and tutorials, will be created. The materials will be used in new and updated courses at the upper years of undergraduate studies and graduate studies. This paper gives an overview of the procured equipment and plans for establishment of new courses in automotive software engineering.

Keywords - automotive, automotive software, cross-border cooperation, laboratories

I. INTRODUCTION

Rapid expansion of information and communication technology (ICT) sector, although promising, does not have a satisfactory business environment support that can adapt fast to trends and demands, for sustainable economic growth. In addition, one of the leading European employers – the automotive industry, has included in its focus the software and embedded systems. As a result, there is a growing need for engineers with adequate skills and ICT companies that can respond to the demand [1]-[2]. Simultaneously, the University roles are shifted to take active part in creating healthy business environment via technology transfer-oriented research, provision of services that utilize infrastructure, courses oriented to better employability of prospective students and trainings that support lifelong learning. Common problems in the targeted regions, such as workforce attrition caused by challenged economy, or low employability and income, can be solved faster and with higher efficiency if opportunities, such as for example the changes mentioned above, are timely recognized and seized.

In order to respond to the fast-growing needs of automotive industry and enhance the competitiveness of the region in education of future engineers specialized for automotive software and hardware, the new project idea was proposed. University of Novi Sad, Faculty of Technical Sciences (FTN), Serbia and Faculty of Electrical Engineering, Computer Science and Information Technology (FERIT) in Osijek, Croatia have joined in a cross-border cooperation project “Modernizing Laboratories for Innovative Technologies” (DRIVE) as part of the European Union’s INTERREG IPA program. The aim of this project is to equip the two partner institutions with latest laboratory equipment for development of automotive software and develop the curriculum with study materials for graduate-level education of computer engineers to specialize them for engineering in automotive industry. The project has started on 15 July 2017 and it will last for 29 months, until 14 December 2019.

The project DRIVE will allow faster integration and economic development of the region and make the region more competitive and closer in development to the developed European regions. This will in turn decrease the difference between European regions. Engineering of embedded computer systems applied to automotive systems is a new field within the automotive industry and the engineers working in this field have less than 20 years of experience. Nevertheless, it is one of the fastest-growing fields with a high impact on economy in terms of the Gross Domestic Product (GDP) [3]. The industry faces challenges like updating the infrastructure for product development and hard-to-find people with desired information technology (IT) skills. The development suffers if the infrastructure does not keep pace with the market demands. Still, the infrastructure cannot be developed without skilled people. Skills are best acquired through formal studies, which stresses the importance of quality education programs.

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In addition to increasing the competitiveness of the region, the project DRIVE aims to allow younger generations to study on state-of-the-art technologies and gain practical skills on modern laboratory equipment which will make them ready for work in the automotive industry. [4]-[5] One of the project outputs will be course materials, as well as a proposal for a complete curriculum suggested for education of the automotive software engineer profile. Published materials, such as books and laboratory manuals will be available to teachers, students and engineers. The project will organize workshops which will be attended by engineers who seek increase in knowledge and skills in automotive-related computer and software engineering topics.

The rest of the paper is organized as follows: section II gives an overview of the procured equipment and established laboratories; section III describes the curriculum for automotive software engineering and the courses being developed in the project and section IV provides the timeline of the project activities for the remainder of the project length, as well as conclusions.

II. PROCURED EQUIPMENT FOR LABORATORIES

One of the main goals of DRIVE project is to equip four laboratories on two locations, two in Novi Sad and two in Osijek, which will serve as laboratories for teaching laboratory activities in the courses within the automotive software engineering field. Laboratories will also serve to host workshops for engineers which the faculties FTN and FERIT will offer to institutions in the region.

At FTN the following two laboratories have been established:

- Laboratory for functionally safe automotive architecture and software design,
- Laboratory for hardware-in-the-loop testing, calibration and diagnostics.

At FERIT the following two laboratories have been established:

- Laboratory for design and testing of automotive-related software,
- Laboratory for image and video processing in automotive applications.

The laboratories are equipped with state-of-the-art equipment for development and verification of software for automotive systems, which consists of:

- equipment that supports automotive application development in Automotive Open System Architecture (AUTOSAR) for automotive electronic control units (ECU) and supporting software,
- advanced driver assistance system (ADAS) development boards and supporting software,
- equipment for automotive application testing based on hardware-in-the-loop (HiL) simulation.

Equipment that supports the fundamental automotive application development (Fig. 1) is based on Automotive Open System Architecture (AUTOSAR). It consists of a hardware platform of the Electronic Control Unit (ECU) which allows development and verification of applications by completely simulating the ECU in the vehicle and the communication interfaces to the peripherals in the automotive computer system. The equipment is supported by a software whose academic licenses were purchased together with the equipment. The software contains tools for application development for AUTOSAR architecture, as well as tools for design, development, configuration and verification of automotive software applications.

Equipment that supports advanced automotive application development (Fig. 2) serves for design and verification of applications for Advanced Driver-Assistance Systems (ADAS). It consists of development boards with large number of camera interfaces as the main purpose of these applications is to analyze the data coming from several cameras placed on different parts of a vehicle. Development boards contain digital signal processors (DSP) which allow required image processing in real time. Another possible application of these development boards is in the development of algorithms based on artificial intelligence and deep learning which is heavily used nowadays to increase the level of autonomy of a vehicle.
The development boards were placed in an automobile model with placings for cameras, not only to protect the board and make it ready for student use in a laboratory, but also to allow application testing with the cameras and not only with the image files as inputs. Example of an automobile model equipped with the development board and camera placings is given in Fig. 3.

Previous equipment focuses on application design and development for various purposes in automotive systems. For the verification of applications, a separate set of equipment was procured, i.e. equipment for automotive application testing. This equipment is based on Hardware-in-the-Loop (HiL) testing and consists of a server system with: a computer for ECU testing, network modules, signal generator module, measurement module, power module, digital stimulus module, sensor module, input-output module and interface cards for network interfaces which are abundant in modern automotive systems: Controller Area Network (CAN), Local Interconnect Network (LIN) and FlexRay. Every workstation is equipped with the platform containing the ECU system and the computer with installed software for design, development, testing and analysis of networks and buses connected to an ECU in a vehicle, as well as the software for calibration, real-time measurement, bus analysis and analog signal measurement tool integration. Fig. 4 and fig. 5 show a server system and an example network interface module for FlexRay interface.

After procuring this equipment and establishing the four laboratories, FTN and FERIT have become, to the best of our knowledge, the most equipped higher education institutions in the region, considering the field of automotive software engineering and one of the most equipped higher-education institutions in Europe. These laboratories will allow education of students using the equipment which will make them job-ready as soon as they finish the studies.

Figure 3. Development board with the automobile model ready for student use

Figure 4. Equipment for automotive application testing – server system

Figure 5. Equipment for automotive application testing – FlexRay interface network module

III. CURRICULUM FOR AUTOMOTIVE SOFTWARE ENGINEERING

After consulting the experts in automotive industry and researching the existing study programs in the information-communication technology (ICT) fields in automotive systems [6], the project partners have identified the study areas which are needed to educate an engineer specialized in software development for automotive systems.

Since the automobile is a complex system, traditional study programs in the domain of computer science and computer engineering do not give required level of specialized knowledge needed for software development in automotive industry as the processes in software development in this industry are very different from classical software development due to high level of reliability and safety which the software must satisfy.

To prepare the student for a career in automotive industry, the following is the list of topics identified as essential for study:
• software development processes for automotive industry;
• networking and protocols in automotive;
• engineering of safety-critical software systems;
• artificial intelligence and deep learning in automotive software systems;
• digital signal processing in automotive systems, with focus on image processing;
• multimedia systems in automotive systems, i.e. development of infotainment unit;
• methodologies for testing and verification of software systems in automotive industry;
• at least one course covering non-software fields important for understanding the automobile as the system: e.g. electronics, mechanical engineering, thermodynamics.

The suggested areas still require a lot of prerequisite knowledge which is obtained in classical courses in electrical and computer engineering, as well as computer science, which is why we propose this curriculum to be on the master level or in the last year of the bachelor studies.

Following is the list of courses in a suggested curriculum for automotive software engineering which is based on the identified topics:
• Introduction to the automotive engineering (bachelor level, year 4)
• Architectures and methods of the design of safety-critical software in automotive systems (bachelor level, year 4)
• Processes in the automotive software design (master level)
• Computer networks, buses and protocols in automotive systems (master level)
• Methods of testing the automotive control software (master level)
• Deep learning in the systems of autonomous and connected vehicles (master level)
• Multimedia systems in automotive (master level)
• Principles of digital image processing in automotive systems (master level).

Some of the courses are already ongoing at FTN, while the rest will be included in the new accreditation cycle. The previous list contains the suggested level and the year in which the course is planned in the new accreditation at FTN.

At FERIT, the new study program “Automotive computing and communications” has already been established and more information about it can be found on an institutional webpage [7].

IV. CONCLUSIONS

The DRIVE project, part of the Interreg IPA CBC Croatia-Serbia program, allowed equipping the four laboratories in two institutions which will lead to the increase of competitiveness of the region and increase of the quality of teaching in the field of automotive software development.

During the year 2019 the DRIVE project will enter its final phase. FTN and FERIT will organize the workshops which will be attended by 100 engineers invited from companies in the region. Course materials for all courses listed in section III will be finalized and their full application will begin in the academic year 2019/20. Courses and workshops will allow students, current and future engineers to be ready for high demands of automotive industry.

REFERENCES