MODERNIZING LABORATORIES FOR AUTOMOTIVE INDUSTRY RELATED CURRICULA

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Abstract

By recognizing the needs of both global and local labor market related to the automotive industry, the Faculty of Electrical Engineering, Computer Science and Information Technology (FERIT) Osijek, Croatia and the Faculty of Technical Sciences (FTN) Novi Sad, Serbia, have launched new study programs oriented towards education of engineers specialized for automotive software and hardware. It is therefore necessary to enable students to work with the latest equipment, which in the case of automotive industry is quite expensive. Thus FERIT and FTN have applied for a joint project of cross-border cooperation between Croatia and Serbia, named "Modernizing Laboratories for Innovative Technologies" (DRIVE), which is approved and currently is in implementation, starting in July 2017. Using the funds of the DRIVE project, until now faculties have acquired the valuable equipment, which serves them for teaching students through modern courses in the automotive field. This paper describes the procured equipment and the content of few key courses of new study programs that students of these faculties make ready for the fastest growing part of the labor market, both locally and globally across Europe.

1. INTRODUCTION

Trends in automotive industry has been changing significantly in the last decade. Autonomous vehicles are becoming a reality, while the level of vehicles autonomy has been rising on a daily basis. Today vehicles make autonomous decisions and perform some functions without the driver intervention. In order for vehicles to be able for making autonomous decisions, it is necessary to embed them artificial intelligence. Therefore, in the last few years, there has been a significant increase in the number of companies specialized for automotive software (SW) and hardware (HW) in Europe, which need engineers with adequate knowledge and skills [1], [2], [3].

By recognizing the needs of both global and local labor market related to the automotive industry, two faculties, the Faculty of Electrical Engineering, Computer Science and Information Technology (FERIT) Osijek, Croatia and the Faculty of Technical Sciences (FTN) Novi Sad, Serbia, have launched new study programs oriented towards education of engineers specialized for automotive SW and HW. Consequently, it was necessary to procure the modern laboratory equipment for teaching students. Thus, since July 2017 FERIT and FTN have been performing a joint project named "Modernizing Laboratories for Innovative Technologies" (DRIVE), and using the funds of DRIVE project they have acquired the valuable equipment.

This paper describes new graduate study program at FERIT, called Automotive Computing and Communications (ACaC), completely aligned with the needs of the relevant labor market sector (Section 2), describes the modern equipment procured for the purpose of student education for this sector (Section 3) and presents the content of few key courses of new study program, that students of these faculties make ready for the fastest growing part of the labor market, both locally and globally across Europe (Section 4). Concluding remarks of the paper are given in Section 5.

2. NEW AUTOMOTIVE COMPUTING AND COMMUNICATIONS STUDY PROGRAM AT FERIT

During 2015/2016 FERIT performed an extensive discussion with its relevant industry partners from the field of automotive SW and HW (six partners were included: RT-RK Institute Osijek, Rimac Automobili, Yazaki, GlobalLogic, Xylon, AVL-AST). Based on requirements stated from industry partners, in 2017 FERIT launched the graduate university study program in ACaC [4]. Furthermore, it is important to note that the mentioned study program is the first of such kind in Croatia and that it is in line with the study programs of European universities that have been conducting automotive engineering studies for several years, such as Automotive Software Engineering - Technische Universitat Munchen [5], Automotive Engineering - Universitat Politècnica de Catalunya [6], Automotive Electronics - Technical University of Ostrava [7].

FERIT ACaC study program provides students the opportunity to specialize in the field of designing, implementing and testing software and computer systems in the automotive industry. Besides basic knowledge in the field of advanced programming and embedded computing systems, this graduate study provides students specific knowledge related to:

- general software development processes for automotive industry;
- communication networks and protocols in automotive systems;
- security of vehicle information systems;
- artificial intelligence and deep learning in automotive software systems;
- methodologies for testing and verification of software systems in automotive industry;
- power supply and vehicle systems;
- application of energy electronics in the vehicle;
- etc.

In that way, upon completion of the mentioned study program, students will be able (among other things) to:

- develop and test algorithms for effective message transmission in wireless ad-hoc vehicle networks;
- design automotive software support: from risk analysis to a functionally safe concept;
- develop one's own software solution to the given problem for the target architecture and correct the faults that occurred in its creation;
- explain and apply automotive software diagnostics methods;
- apply advanced image and video processing algorithms in real time;
- choose and apply appropriate deep learning methods and models to solving specific problems in intelligent transport systems;
- etc.

More details on Automotive Computing and Communications study program as well as about expected students capabilities upon its completion can be found at [4].

3. EQUIPMENT PROCURED FOR NEW STUDY PROGRAM

In order for the faculties to be able to educate students through the new study programs in the high quality way for the mentioned labor market, it is necessary to enable students to work with the latest equipment, which in the case of automotive industry is quite expensive. By identifying this need and being aware of the fact that they have limited own funds, FERIT and FTN have applied for a joint project of cross-border cooperation between Croatia and Serbia [8] (named DRIVE [9]), which is in implementation, starting in July 2017. Using the funds of the DRIVE project, until now faculties acquired the equipment worth 715.980,00 Euro (FERIT part is 273.092,00 Euro), which serves them for teaching students through modern courses in the field of automotive industry. The specific procured equipment for forming of two automotive-related laboratories at FERIT is shown in Fig. 1.

(a)

(b)

Fig. 1. Laboratory equipment procured by using DRIVE project funds (a) equipment that supports automotive application development in AUTOSAR for automotive ECUs (b) ADAS development boards with appropriate periphery

The laboratories are equipped with the latest equipment for development and verification of automotive software systems:

- equipment that supports automotive application development in Automotive Open System Architecture (AUTOSAR) for automotive electronic control units (ECU) and supporting software;
- Advanced Driver-Assisted System (ADAS) development boards and supporting software.

It is important to note that 16 sets of each equipment is procured, making the possibility for a particular student to perform its exercises alone.

4. KEY NEW COURSES FOR ACaC STUDY PROGRAM

In order to create a modern study program which is in line with labor market requirements (acquired through discussion with FERIT's industry partners), it was necessary to develop a number of new courses that are closely related to automotive software and hardware. The complete graduate study program consists of 18 courses (4 semesters) and the entire list of courses per semester can be found at [4]. The main contents that will be presented to students as well as the general learning outcomes of the entire program are mentioned briefly in Section 2. In this section, more details about four new key courses that use the equipment procured by using funds from DRIVE project (presented in Fig. 1), and are also defined as outputs of DRIVE project, are given.

4.1. Software Architecture in Safety-Critical Control Systems

Through this course, students will be introduced in the basics of AUTOSAR: concepts, architecture, methodology, building elements (RTE-Runtime Environment, BSW-Basic Program Support, SWC-Programming Support Components, VFB-Virtual Functional Bus), migration modes. Furthermore, AUTOSAR-practical parts will be considered: operating systems, software components, communication, handling input/output, handling states, system services and memory, diagnostics (using the equipment from Fig. 1(a)). After that, basics of safe automotive software development, with an emphasis on ISO 26262 and basic requirements (safety management, concept development, system development) will be presented. The general goal of this course is to provide students with insights into the concepts and architecture of safety-critical control systems software and train students in developing and managing software for automotive safety-critical systems.

4.2. Methods and Techniques for Automotive Software Testing

The goal of this course is to introduce and explain the concepts and objectives of software testing and diagnostics. Furthermore, special cases of automotive programme testing and automotive ECU testing methods will be discussed. Besides that, students will be introduced to online/offline equipment calibration. All of these goals will be achieved through lectures and laboratory exercises dealing with special cases of automotive software testing (types, environments, modules, flows, etc.), and methods for testing automotive ECU - SIL&HIL, modelling (XML+HTML, for ODX), simulation/emulation. Laboratory exercises would be performed by using CANape + XCP + Data mining, CANoe + CANalayser + CAPL for FLEXRAY/CAN, and additional specific software (using the equipment from Fig. 1 (a)).

4.3. Digital Image and Video Processing for Autonomous Vehicles

Through this course, after introduction regarding digital image processing (image acquiring, representation, color spaces), students will be introduced to image processing and manipulations techniques (filtering, denoising, edge detection,…). Furthermore, image segmentation methods will be discussed (like line/circle detection), followed by object detection methods. Motion analysis and object tracking techniques will be presented. All of mentioned techniques will be then applied in pedestrian and car detection systems (Fig. 2).

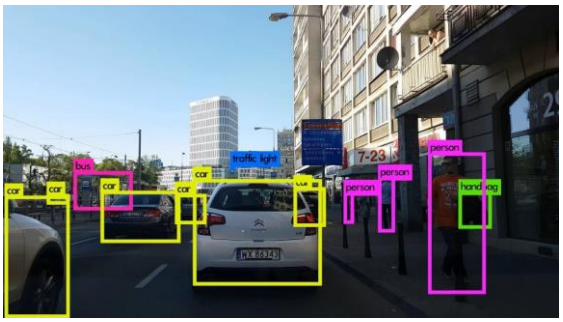

Fig. 2. Example of pedestrian and car detection system based on processing of image from car camera system

Additionally, students will be familiar with 3D scene reconstruction (camera models and calibration, stereovision and structure from motion will be discussed). At the end, student will be

introduced to ADAS board HW and SW, and by performing laboratory exercises by using the equipment from Fig. 1 (b), student will be able to develop and build own use case. Different ADAS algorithms implementation on ADAS board will be discussed (lane detection, pedestrian detection, driver monitoring, camera mirror replacement,…).

The final goal of this course is to enable students to apply and develop advanced algorithms for processing of digital images and video signals, with an emphasis on real-time algorithms for usage in autonomous vehicles.

4.4. Machine Learning in Systems of Autonomous and Networked Vehicles

After introduction to machine learning, unsupervised, supervised learning (linear regression, neural networks, support vector machines, decision trees, random forests) and reinforcement learning will be discussed. Different regression and classification methods will be presented. The basics of deep learning followed by architectures and deep learning algorithms will be discussed. Furthermore, different types of deep neural networks, convolution neural networks, will be presented. Different applications of machine and deep learning in intelligent transport systems: fusion of sensor inputs, segmentation, detection and classification of objects (signs, lines, pedestrians, etc) in the image, motion planning, learning with and without the driver, local autonomous vehicle control, centralised and distributed control of networked vehicles, will be analysed.

Upon successful completion of the course, students will be able to develop their own software solution using appropriate libraries that contain implemented methods and machine learning algorithms and to choose and apply appropriate methods and deep learning models to solving specific problems in intelligent transport systems.

5. CONCLUSION

Based on automotive related labor market requirements, FERIT Osijek launched new graduate study program in Automotive Computing and Communications. By performing the European Union co-founded DRIVE project, FERIT procured the valuable modern and state-of-the art laboratory equipment, which will be used for teaching students through modern courses in the field of automotive industry. Details about few most important courses and usage of equipment mentioned above are presented in this paper.

Good news currently are coming from the labor market, from FERIT's industry partners where students perform their practice: all students (16 of them) of the first generation of this study program have a secured job in Osijek. This is a confirmation that the study program is fully aligned with the needs of the labor market. FERIT will monitor the needs of the labor market and in the future it is likely to increase the number of enrollment places at the ACaC study.

6. REFERENCES

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