Automotive Systems

Proposal for a 2024 Blended Intensive Programme (BIP)
at Fachhochschule Dortmund – University of Applied Sciences and Arts in Dortmund, Germany

Introduction

Automobiles are complex systems that are composed of mechanical, electric/electronic, and software components. The activity of specification, design, integration, and testing of these components to build a safe, performant, and desirable car is a joint effort of a global network of car manufacturers and their suppliers and sub-suppliers. Automotive system engineering is about orchestrating all these parties and addresses a wide range of engineering and management skills.

All that being said, the complexity of automotive systems is ever-increasing as advanced driving assistance systems (ADAS), autonomous driving (AD), and connectivity capabilities boost the functionality of new vehicles by incorporating novel sensor systems as well as powerful software algorithms.

Due to these developments, the automotive industry is undergoing a deep transformation: established development processes are being questioned, software companies gain importance and the formerly potent car manufacturers fight for their supremacy in the market.

However, one thing persists: the industry's need for system engineers that have a comprehensive understanding of the system engineering process paired with knowledge in software engineering. The BIP *Automotive Systems* proposed here contributes to the formation of this type of engineer.

Learning content and methods

The BIP *Automotive Systems* is about automotive systems engineering with a focus on advanced driver assistance systems (ADAS) and autonomous driving (AD). Another focus lays on software engineering.

The backbone of the module are the so-called *V-Model* and *ASPICE*, two engineering process models/guidelines that are fundamental in automotive system engineering. Many aspects of these models are explained and numerous examples originating from ADAS/AD are presented.

Learning Content

- V-Model
- ASPICE
- Requirements management
- System Architecture
- Sensors for ADAS/AD
- Safety and Security
- Management and Support Processes
- Software Development
- ADAS/AD Algorithms
- Model-based Development in Matlab/Simulink
- Agile Methods
- Software Testing
- System Validation

Teaching in this module will utilize diverse methods:

Lectures and Seminars

In lectures and seminars, knowledge will be presented and discussed with students. At the conclusion of each segment, a set of questions will be provided to the students online and will be answered immediately so that the lecturer can give direct feedback as well as additional explanations.

Demonstration of a Test Vehicle

The demonstration of an Audi Q7 that is available at the Department of Information Technology and that carries different sensors used in ADAS/AD like radar, lidar and GPS e.g. complements the seminars.

Development using Matlab/Simulink

An ADAS function called *Autonomous Emergency Breaking (AEB)* is presented and will be demonstrated using a Matlab/Simulink simulation. The students themselves will develop, optimize, and test an AEB function in a Simulink simulation environment.

Other algorithms that are crucial to ADAS/AD will be demonstrated through Simulink simulations.

Practical Work on a Mobile Robot

An autonomous mobile robot that is available at the Department of Information Technology will be used as a prototype to develop and test the AEB function. Models-based code that is developed in Simulink will be deployed on the robot and tests will be conducted in an indoor laboratory.

Discussion of White Papers/Scientific Papers

Current technological trends that are explained in white papers and/or scientific papers will be provided to the students. The students will then briefly present the core ideas of each paper to trigger a discussion between the students and the lecturer.

Third-party Contributors

Depending on availability, guest speakers from other universities or industry partners will join and present their perspectives.

Also depending on availability, a field trip to an automotive supplier with an R&D site located in Dortmund is planned.

Assignment

During the virtual phase, an assignment will be given to the students. The students will be split into several groups and will be given a specific topic originating from the automotive world. The students will search for relevant literature and prepare a written report about their respective topic. At the end of the BIP, the groups will share their results with all other students and the lecturer through a final presentation and a discussion in a (virtual) colloquium.

Organizational Framework

The BIP spans over seven consecutive calendar weeks (CWs). It starts with a virtual phase, followed by a presence phase of one week (block week) and a virtual phase as shown in the table below:

CW	Mon	-	Fri	Phase	Content
CW 10	4-Mar	-	8-Mar	Virtual Phase	Literature Reading
CW 11	11-Mar	-	15-Mar	Presence Phase/Block Week	
CW 12	18-Mar	-	22-Mar	Virtual Phase	Function Development
CW 13	25-Mar	-	29-Mar		Function Validation
CW 14	1-Apr	-	5-Apr		Publication of Assignment Topic
CW 15	8-Apr	-	12-Apr		Working on Assignment
CW 16	15-Apr	-	19-Apr		Assignment Colloquium

The schedule for the block week is planned as follows:

	Monday March 11th	Tuesday March 12th	Wednesday March 13th	Thursday March 14th	Friday March 15th
09:00-10:30	**Seminar** Introduction	**Discussion** White Paper	**Company Presentation** Tbd	**Exercise** Model-based Development	**Exercise** SW Testing
10:45-12:15	**Seminar** Requirements Management	**Demonstration** Sensors for ADAS/AD	**Seminar** Automotive SW Development	**Laboratory** Function Integration	**Seminar** System Validation
12:15-13:30	Lunch Break	Lunch Break	Lunch Break	Lunch Break	Lunch Break
13:30-15:00	**Seminar** System Architecture	**Seminar** Safety and Security	**Seminar** ADAS/AD Algorithms	**Laboratory** Function Validation	**Seminar** ADAS/AD
15:30-17:00	**Seminar** Sensors for ADAS/AD	**Seminar** Management and Support Processes	**Exercise** Model-based Development	**Seminar** SW Testing	-

Student Competence Requirements

The target group are bachelor students in their last year as well as master students.

Matlab/Simulink will be used in some demonstrations and in hands-on exercises. Basic knowledge of Matlab and Simulink is appreciated, however a Simulink crash course will be given during the block week. Each student should have a laptop computer with Matlab/Simulink installed.

Contact

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