2SC5310 – Architecture and technology of the autonomous vehicle

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Department: DÉPARTEMENT ÉLECTRONIQUE ET ÉLECTROMAGNÉTISME
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 60
On-site hours (HPE): 34,50

Description
The objective of this course is to familiarize students with the architectures and technologies used for the autonomous and connected vehicle (ACV) and their means of development.
To do this, it is necessary to define what is a mobility system in which the vehicle is embedded and then to understand the functional architecture of the ACV. As the functions of the ACV are essentially composed of electrical and electronic systems, the electrical and electronic hardware architecture is presented as well as its specificities and constraints due to the environment in which the automobile operates. Also at the hardware level, intelligent sensors and real-time embedded aspects of processing are studied. At the processing level, traditional or more advanced control laws, image processing and artificial intelligence are discussed. At the communication level, the "vehicle-to-vehicle/vehicle-to-infrastructure" (V2X) technologies, the associated protocols, the characteristics and constraints of the communication channels for the application are studied. Finally, at the level of vehicle validation, the development process as it is carried out by manufacturers is presented.

Quarter number
ST5

Prerequisites (in terms of CS courses)
To follow this thematic sequence, it is recommended to have taken one of the SPI courses in Electronic Systems (two occurrences in SG1 and two occurrences in SG3) and one of the SPI courses in Networks and Security (one occurrence in SG1 and two occurrences in SG3). The Modeling course given in ST2 is also a prerequisite.

Syllabus

I Mobility system and embedded electronics

· Definition of the mobility system (infrastructure/vehicle) and architecture of the autonomous and connected vehicle (perception, processing, communication, actuation, and propulsion and energy conversion)

· AD/ADAS development process

· The electrical and electronic architecture of the vehicle (power supply network, ECUs, communications bus)

· Hardware specificities in automotive electronics (physico-chemical environment, EMC, reliability, card manufacturing process, operating safety)

· Intelligent sensors (LIDAR, RADAR, cameras, smart sensors)

II On-board algorithms and processing

· Control laws for the autonomous vehicle (LQR, Kalman filtering, neural networks, fuzzy logic...)

· Artificial intelligence for autonomous vehicles

III Communication of the vehicle with its environment

· V2X Technologies

· Channel access, traffic, and performance

Note: this outline does not reflect precisely the chronology of the course

Class components (lecture, labs, etc.)

15 HPE of lectures + 18 HPE of practical work

Grading

The final exam for the specific course will be a 1.5 hour written exam and assess skills C1 and C6. Some practical work will also be evaluated and contribute to the evaluation of skill C6.

Resources

The courses will be taught by CentraleSupélec professors and by industrial experts from automotive manufacturer or automotive electronics companies.

Learning outcomes covered on the course

At the end of this course, the student will be able to understand the electrical and electronic architecture of an autonomous and connected vehicle and the communication technologies between the vehicle and its environment. The student will be able to model and simulate a vehicle communicating at the functional and physical level by detailing the constraints and limitations related to the environment and technologies.

Description of the skills acquired at the end of the course

C1 : Analyze, design and build complex systems with scientific, technological, human and economic components
C6 : Be operational, responsible and innovative in the digital world