2SC5390 – Design of a "last mile" urban delivery system using autonomous and connected vehicles

Instructors: Morgan Roger
Department: DOMINANTE - SYSTÈMES COMMUNICANTS ET OBJETS CONNECTÉS
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description
The challenges of autonomous and connected vehicles do not only concern the automotive sector. The integration teaching offered here allows you to understand on the one hand the approach of designing a complex and critical system, and on the other hand the plurality of problems of the autonomous and connected vehicle, through an industrial scenario in an adapted context.

The chosen scenario is that of a so-called “last mile” delivery. The cost and delivery time of a parcel by carrier is strongly impacted by the last mile, especially in urban areas. Due to traffic jams and parking, delivery trucks could advantageously be picked up at the entrance to major cities by lighter means of transport adapted to the urban environment. Using bikes is too expensive; the carriers consider in the short term a fully automated delivery on the last mile. The solution consists in managing a fleet of autonomous and connected robots carrying out deliveries, based on arrival times, delivery addresses and characteristics of the robots.

You work in a team in charge of designing such a delivery system. In this context, you follow a model-oriented system engineering process to specify the functionality of the system. You adopt a modeling methodology to develop the necessary algorithms (control / command, sensor fusion, data fusion, decision making and telecommunications) to meet the specifications. A reduced-scale test platform allows you to assess the quality of the delivery system obtained and improve the algorithms.

Quarter number
ST5

Prerequisites (in terms of CS courses)
1st-year SPI module "Electronic systems"
1st-year SPI module "Network security"
Specific teaching module "Architecture and technologies for smart and connected vehicules"

Syllabus

The following technical aspects are implemented in this integration teaching:

- functional needs analysis, system specifications
- system modeling
- state machines
- control law
- telecommunications
- communications protocol
- image processing
- sensor fusion
- embedded and real-time processing
- mixed hardware-software computation

Class components (lecture, labs, etc.)

The objective is to complete a technical proof of concept on a reduced-scale platform made up of robots rolling on an adapted support schematically representing the urban environment. Teams of 5 or 6 students are formed beforehand so as to present a broad spectrum of skills. After an initial functional analysis of the system based on brainstorming, the teams decide on their internal organization in order to deal with the various aspects in parallel and with consistency: hardware, modeling, embedded intelligence, connectivity. Each team is given a robot and can access the test rooms to validate the behavior of the system in a physical environment and refine its functionality. The last day of the week is devoted to the preparation of the evaluation and to the evaluation itself.

Grading

The grading is done through regular progress reports with the supervision team during the week (once per half-day), as well as with a final evaluation at the end of the week, comprising an oral presentation describing the design choices and the innovations of the system, and a demonstration of its performances on the test platform, in front of a panel of teachers and industrial experts.

Resources

Human resources: a team of teachers specializing in the various engineering fields concerned (electronics, telecommunications, modeling, signal processing) present 100% of the time; automotive (Renault) and modeling

(Mathworks) industrial experts visiting during the week and present for the evaluation.
Logistical resources: working rooms for student teams, large rooms for test and evaluation platforms, a teachers' HQ.
Material resources: rolling robots (including 4 driving wheels, an Arduino board, a Raspberry Pi nanocomputer, a camera and several other on-board sensors, batteries).
Software resources: Matlab / Simulink, Linux, Python, C ++, OpenCV, ...

Description of the skills acquired at the end of the course

The following skills will be evaluated during this learning activity: C2, C4 and C7. The skills assessment will be based on the regular progress reports with the supervision team (once per half-day), on the demonstrated performances of the system, and on the final oral presentation.