Automotive Mechatronics Chair (Faurecia / CentraleSupelec / Esigelec)

Multiphysics for embedded systems

The main objective of the chair is to provide Faurecia with methodologies and tools able to induce the emergence of ground-breaking devices based on innovative technologies for embedded mechatronics systems. For that purpose, the chair wants to contribute to the creation of a characterisation and modelling platform for smart materials and systems for automotive applications. The program of the chair is organised around three research axes addressing major scientific challenges for the design of advanced mechatronics systems. These axes are summarised hereafter.

Axis 1: Electromagnetism and EMC

This axis is dedicated to a better understanding of electromagnetic effects in order to allow the various electromagnetic devices inside and outside a vehicle to work together with or without interaction. The tasks assigned to the chair include:

- developing the necessary experimental and modelling platforms needed to understand, characterise and predict the distribution of electromagnetic fields emitted by or imposed to electromagnetic devices (applications: magnetic shielding, wireless charging, ...),
- understanding, characterising and predicting the electromagnetic behaviour of heterogeneous materials in order to understand the role of heterogeneities and possibly to use them in the design process (applications: composite floors, active paints, composite shielding, exterior-interior electromagnetic interaction),
- designing electronic systems robust to electromagnetic perturbations.

Axis 2: Mechatronics systems based on smart materials

This axis aims at revisiting the automotive functions in terms of actuation or sensing using the potentialities of active materials. The objective is notably to enable the development of breakthrough designs for mechatronics actuators and sensors.

- A main task will be devoted to devices based on the use of ferroic materials (giant magnetostrictive materials, piezoelectric materials, shape memory alloys). For that purpose, there is a need for a better understanding of coupling effects in smart materials. The chair will address the development of physics based models to describe the complex behaviour of smart ferroic materials. This work has to be associated with experimental tools dedicated to coupled behaviour in order to elaborate, identify and validate modelling approaches.
- Beside these investigations at the material scale, there is a need for advanced numerical design tools for mechatronics systems. A challenge is to encompass the wide range of temperature and frequencies covered by Faurecia mechatronics devices. In close cooperation with Faurecia's R&D teams, the goal is to build proofs of concept for mechatronics systems (applications: smart actuators, valves, sensing systems, sound devices, smart absorbers).

Axis 3: High performance electromechanical devices

This axis is dedicated to advanced actuation systems based on standard electro-mechanical conversion principles but subjected to harsh external loadings. The objective is to design high performance devices in terms of mass, compacity and efficiency by increasing the capability of these devices to hold increasing levels of external loadings.

- The principal task is to develop multiphysic design tools able to incorporate high temperature, high frequency, or high mechanical stress effects. The prediction of the efficiency of the system, as a function of the high intensity and multiphysic nature of the loadings is a key objective.
- The adaptation of the electronics to the complexity of external loadings is another task of this axis. Among the scientific challenges, integration of hysteresis effects in the definition of control systems, algorithmic strategies and robustness to external perturbations are given specific attention.

Projects

The chair activities are implemented through different projects dedicated to specific mechatronics functionalities. These projects combine Faurecia, Esigelec and CentraleSupelec expertise in the various fields of Mechatronics, combined if necessary with the input of external partners, so as to enable the practical development of industrial mechatronics systems.

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