

Thesis subject: Control of Systems of Systems: Case of several autonomous vehicles in interaction

PhD Advisors:

- Reine Talj, CNRS Researcher
Heudiasyc laboratory, UMR CNRS-UTC 7253
+33 (0)3 44 23 46 31, Reine.Talj@hds.utc.fr
- Ali Charara, Professor
Heudiasyc laboratory, UMR CNRS-UTC 7253
+33 (0)3 44 23 46 78, Ali.Charara@hds.utc.fr

Context of the thesis:

The thesis is part of the project activities of the Laboratory of Excellence (LABEX) at the Université de Technologie de Compiègne (UTC) in France on the Control of Technological Systems of Systems (MS2T) (www.utc.fr/labexms2t).

This thesis concerns the control of Systems of Systems, particularly in the case of autonomous vehicles in interaction. Hence, this thesis is perfectly integrated in the main objectives of the Labex MS2T project; moreover, it is in the heart of the Equipex Robotex project.

PhD thesis description:

Systems of Systems (SoS) exist everywhere, and are more and more developed with technological advances. More particularly, the control of SoS is a very important domain to manage cooperation and communication between interacting systems, with the aim of realizing a common goal for the set of interacting systems, so as to emerge a new behavior.

By definition, SoS are high dimensional heterogeneous systems, integrated together, and independently operable. They are networked together to realize a common goal. This goal could be cost, performance, robustness, etc.

Several examples of SoS exist, as airports, renewable energy systems, multi-modal transport services, and other. They exist in different application domains, as military domain, health domain, etc.

Control of SoS has been largely inspired from the control of large-scale systems. Among the main control approaches that have been applied for SoS, one can mention hierarchical control, decentralized control, distributed control, networked control, cooperative and consensus-based control.

In this context, and in narrow relation with the “autonomous vehicle” ambitious project of the laboratory Heudiasyc (in relation with the Equipex Robotex project), we propose to study in this thesis the case of several autonomous vehicles in interaction, and to control this system of systems such that each vehicle realizes its objective when avoiding obstacles and other neighboring vehicles. This problematic is in the heart of the Labex MS2T project axes.

The proposed tasks of the thesis can be divided into two main parts:

- The first part consists of:
 - a deep bibliographical study on SoS control, allowing a better understanding of the advantages, disadvantages and characteristics of each of the existing approaches,
 - the proposition and development of a new control law for SoSs.

- The second part, based on the first one, consists on studying the case of several interacting autonomous vehicles where each vehicle should accomplish its goal when avoiding collisions with other neighboring vehicles, and executing its desired trajectory. The objective of this part is:
 - to apply and adapt the proposed control law on the case of autonomous vehicles,
 - and to validate it experimentally on the robotized vehicles of the Equipex Robotex project, in Heudiasyc laboratory. Some particular driving situations will be defined and considered to test the developed approach.

Candidate's profile:

Knowledge in Automatics, Control/command and Robotics are required. Furthermore, the candidate should be able to program in C++ and Matlab/Simulink.

A good level in English is also required.

Documents required to apply:

Send to (Reine.talj@hds.utc.fr)

- Curriculum vitae
- Motivation letter
- At least two references and/or recommendation letters
- A statement of research experience and interests

Location:

Laboratory Heudiasyc UMR CNRS 7253
Université de Technologie de Compiègne (UTC)
CS 60319
57 avenue de Landshut
60203 Compiègne cedex –France
<https://www.hds.utc.fr/>

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J. Hespanha et al., "A survey of recent results in Networked Control Systems", Proceedings of the IEEE, Vol. 95, N°1, January 2007.