PHD Position - Energy management of hybrid ships

Ref : ISHY Interreg 2 seas project

Keywords: Hybrid ship, optimal control, energy management algorithms

Advisor/Co-advisor: Pr. Sébastien Delprat UPHF (LAMIH) and prof. Rudy Negenborn (TU Delft)

Description

Context

The LAMIH UMR CNRS 8201 is located on the University Polytechnics Hauts-de-France in Valenciennes (France). It has a strong experience in powertrain hybridization and an historical experience with automotive industry. The developed knowledge is related to the energy management of hybrid powertrain using optimal control approaches. In simulation, an optimal solution is derived using for instance Pontryagin's Minimum Principle. The challenges are related to the nature of control signals (discrete signals such as on/off signals, integer signals such as gear selection) and the considered constraints, especially state constraints. State-of-the-art approaches lead to the formulation of a Boundary Value Problem where the state constraints are taken into account using interior or exterior penalty function and iterative continuation procedures. As a result, for a given powertrain and mission, the minimum fuel consumption achievable is obtained.

One of the advantage of using Pontryagin's Minimum Principle to solve the energy management problem is the possibility to derive efficient real time algorithms. During real-time operations, the future power request to be produced by the powertrain is unknown (or partially known if some additional information about the mission is available). As a result, real-time optimal operation cannot be achieved. The challenge is then to use mathematical analysis of the optimal control algorithm and/or numerical solutions to formulate the most efficient algorithm possible. In general, these algorithms need to be adapted to specific application characteristics.

Proposed work

The powertrains in the maritime industry are much more complex than those encountered in other applications (e.g., the automotive domain). Within the EU funded project ISHY, several actual pilot ships will be built with the aim of reducing CO_2 emissions. Amongst others an inland barge, a crew transfer vessels (CTV), and a large recreational vessel will be designed and realized. The ships will use many components: gensets, fuel cells combined with batteries and one or more electric propulsion components. These powertrains have many inputs and operating modes. Each ship will have its own specifics; especially the missions and operational profiles encountered by each ship are quite different from each other. As a result, the real-time management algorithms need to be adapted for each ship.

The proposed work is not only about the theoretical development of optimal and real-time energy management algorithms, but also about their application for real ships. Within the project, it is foreseen that concepts based on the real-time algorithms will be implemented by industrial partners. This PhD project will therefore cover the whole development process from theoretical work down to application.

International cooperation

Within this PhD project you will have the opportunity to gain international experience. Pr. R.R. Negenborn from the TU Delft (The Netherlands) will be involved as external co-supervisor. His area of expertise is in (automatic) control for maritime & transport applications. A close collaboration with many industrial and academic partners (from Belgium, The Netherlands and England) from the ISHY project is expected. Stays by the other partners are planned (e.g. the TU Delft University, the Hybrid Marine Company, etc.).

Application

Candidate profile

You should have a Master (or equivalent degree such as a French engineering diploma) in control engineering or mechatronic/electrical/mechanical engineering with some knowledge in control technology. You should be experienced with Matlab/Simulink programming.

You should be interested in academic work with some industrial applications and an international cooperation experience.

French is not needed but written and spoken English is mandatory.

Additional information

Net Salary : approx. 1730 €

Application dead line: June 2019 PhD start : Late July.

Applications

Candidate should send a CV + motivation letter. Skills in control engineering as well as any previous Matlab/Simulink experience should be explicitly stated and described.

Applications should be sent by email: sebastien.delprat@uphf.fr