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Emilia Silvaş, Theo Hofman, Maarten Steinbuch

Eindhoven University of Technology, Department of Mechanical Engineering,
Section Control Systems Technology, P.O. Box 513, NL 5600 MB Eindhoven
phone +31-(0)40-2473174, e-mail: e.silvas@tue.nl

The change in the vehicle market in the last decades has posed increased challenges from the design perspective. Newly developed vehicles should cope with more strict emission regulations, have a decreased fuel consumption and in the same time have advanced performance and be costly convenient. The trend of electrification of components and hybridization of power trains can be observed in multiple transportation sectors, all being driven by market objectives (as fuel economy, pollution or limited resources). In the attempt to develop "greener" cars, research is being conducted for new technologies, power-train architectures and control design. To find the optimal design of a hybrid vehicle is a complex optimization problem. As motivated in more detail in [1], the choice of the optimization algorithm and the definition of the problem will strongly influence the resulting power train.

In this presentation, an overview of the global challenges in optimal hybrid vehicle design is presented. Furthermore, examples are given on how these challenges have been addressed so far, what hybrid topologies are commonly used and how are these separated by transportation sectors. By widening the analysis to multiple transportation sectors, it can be concluded that these research questions (in general, the search of optimal design parameters) are acknowledged, yet not addressed or developed properly in an integrated way. Beside the main components that are used for vehicles propulsion, also important energy consumptions are given by the auxiliaries present in the system. These, as for example, the power steering pump, or the air conditioning compressor, can be electrified and controlled for fuel economy. Some examples will be shown where significant improvement can be gained by looking at these auxiliaries.

The possibility to tackle multiple variables during optimization, as the power train topology or component sizes, has already proven to be beneficial in contrast with individual optimization of the design layers (control, sizes, topology and technology). Following this reasoning we are aiming to build a tool/method that can in an integrated way, address multiple layers. First steps in how can this be done are discussed in this presentation. The results presented here show the importance of optimization in design, and more, the difficulty brought by the big dimensions of the search space. Future work of this research involves the analysis and development of an integrated optimal design for commercial vehicles.

Reference

[1] Silvaş, E., Hofman, T. & Steinbuch, M. (2012). Review of optimal design strategies for hybrid electric vehicles. *IFAC Workshop on Engine and Powertrain Control, Simulation and Modeling, 23-25 October 2012, Rueil-Malmaison, France.*