

HYBRID ELECTRIC VEHICLE FMI-BASED DESIGN OPTIMIZATION

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ABSTRACT

Powertrain electrification is a key factor in exploring innovative vehicle concepts that help reduce fuel consumption and exhaust emissions. Engineering teams in Germany successfully worked with Optimus to perform advanced optimizations involving virtual test driving of a hybrid electric vehicle (HEV) on the Nürburgring and an urban drive in and around Stuttgart.

Optimus can modify the design parameters of the MapleSim HEV powertrain model in order to capture the physical behavior of the model. This can be summarized in a Response Surface Model and exported as a Functional Mock-up (FMU). An adaptive Design of Experiment will be used to capture the best FMU possible. This method will alternate between the computation of new data points and the creation of a metamodel until the desired accuracy of the FMU is reached.

The FMU can be imported in CarMaker® to run related full-vehicle simulations in an automated way, requiring minimal user intervention. This approach enables automotive OEMs to efficiently investigate and optimize hybrid powertrain concepts in favor of greener vehicles offering higher range autonomy. This will allow to simulate different driving behavior in different environments.

Optimization of the parameters of the MapleSim HEV powertrain model can be done using more realistic testing scenarios and the outcome of different driving habits can be taken into account. A multi-objective algorithm will be used to capture all the best compromises between time elapsed during a specific route and the total energy needed. The results are shown in the form of a Pareto front which represent all the optimal compromises. The optimization algorithm used is a genetic algorithm that mimics the behaviors of nature, such as bird flocs. Both aggressive driving and passive driving will be analyzed including their effect on the total energy consumption.

The difference in total energy expenditure between the baseline and the optimized model are significant and show the advantages of Process Integration and Design Optimization such as Optimus alongside simulation tools.