Title: Software and Hardware Platform for Hardware-in-the-loop Testing of Hybrid/Electrical Systems
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Hybrid/Electric vehicles have gained significant attention from the automotive industry due to their ability to capture vehicle's kinetic energy while braking to improve fuel efficiency and lower emissions. This is done by employing a regenerative braking function as well as an energy storage system such as an electric battery, super capacitor, flywheel, and air or hydraulic accumulator. An essential part of the study of a complex system such as hybrid/electric vehicles, is building accurate and reliable model of the various components that make up the overall system. An increasingly popular approach to modeling systems with multiple components is the hardware-in-the-loop (HiL) approach where – depending on the focus of the study – some of the components of the overall system model is replaced with actual parts or prototypes which interact with the computer models through sensors and actuators.

These types of simulations provide the researchers with insight into the dynamics of each component and the overall system. In particular, for the automotive hybrid/electric systems, the controller environment in which these type of simulations take place enables the researchers to study and evaluate various power management schemes with high level of accuracy and repeatability.

This project aims to develop a HiL software platform as well as a modular test setup for the simulation and evaluation of hybrid/electric systems. The software will include a comprehensive library of components found in the typical hybrid/electric systems such as IC Engines, Electrical Motors, Generators, Clutches, Brakes, Flywheel (representing vehicle inertia), Differentials, Transmissions, Batteries, Supercapacitors, Air and hydraulic accumulators Air and hydraulic motors and pumps, Inverters, DC-DC converters, Auxiliary devices and equipment, Solar Cells, and Vehicle dynamic model.

The user will be able to choose from the built-in components from a library and connect them graphically to establish a hybrid vehicle/system. To achieve the goals of this project and realize the proposed software platform architecture and the generalized test platform for evaluations of hybrid vehicles, research will be primarily conducted in the following areas, which however are strongly interrelated with each other:

- Hybrid/electric components modeling
- Development of a numerical/analytical component library using MapleSim
- Development of HiL infrastructure
- Development of parameter identification routines
- Experimental work to evaluate models and development of test platform
- Development of a user-friendly software interface

The development of this software and test platform will considerably benefit from recent advances in hybridization methods, powertrain, battery technologies, power/energy management strategies, identification and optimization techniques, virtual prototyping, HiL, vehicle system control, system integration and packaging, and vehicle testing.