US Army TARDEC
Fuels and Lubricants Research Facility

Hybrid Electric Vehicle Simulink Toolbox: User's Guide, Technical Notes, and PATHS Validation

by Ashok Nedungadi

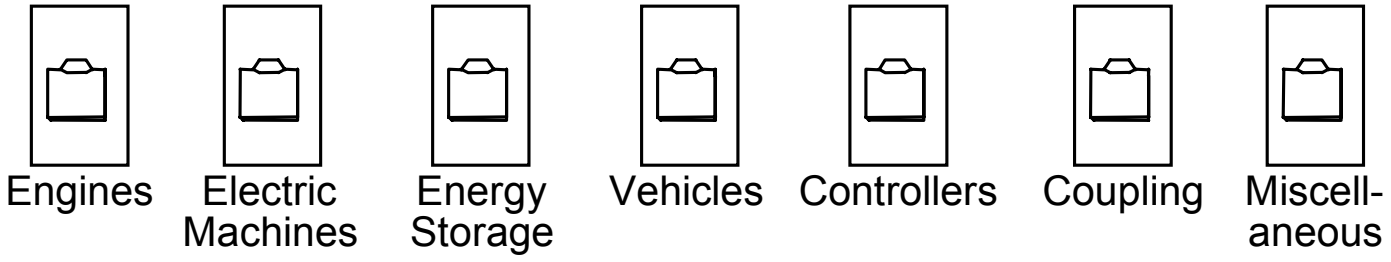
Interim Report TFLRF No. 333, DTIC No. AD A366478

Problems and Objectives: The HEV toolbox was initially conceived as a "standard" set of modules for use in evaluating the performance of concept HEV architecture. This effort resulted in the development of a general-purpose HEV modeling and simulation toolbox, named PATHS (Performance Assessment Toolbox for Hybrid Systems). PATHS is based on principles of physics models, developed in Matlab® and Simulink®, is modularized into several libraries and uses the forward-looking approach. It can be used to obtain detailed performance characteristics of the modeled HEV or its sub-components, as well as perform parametric trade-off studies. Particularly useful is the ability to size components and evaluate their effects on vehicle performance in computer simulation prior to prototyping or fabricating hardware.

Importance of Project: The following are possible applications of the toolbox: evaluation of new drivetrain options / architectures; test and debug hybrid vehicle control strategies; sub-componentssizing and specifications; evaluation of hardware modifications on HEV performance; impact of software modifications on HEV performance and other sub-components; build a computer model of a HEV before hardware prototyping.

Technical Approach: The following is the current list of libraries within PATHS: engine library, electric machine library, energy storage library, vehicle library, controllers library, couplings library, and a miscellaneous library. The multiple components within a library have the same input-output structure so that they can be interchanged in an HEV model. The user can also add to the library as long as the input-output structure of the particular library is maintained. PATHS is fully customizable as long as the user adheres to the input-output structure of each library and is aware of the existing naming convention of the variables. Validation of PATHS was performed by first developing a computer model of a 22-foot series hybrid shuttle bus, followed by comparing its output to data collected from the same bus on a chassis dynamometer. The hybrid shuttle bus was placed on a heavy-duty chassis dynamometer and driven by a human operator, while data was collected from the drive motors, Auxiliary Power Unit (APU), batteries, and vehicle speed sensors.

Accomplishments: This data was compared with model predictions, executing the same driving profile as that of the hybrid bus. Both steady state and transient comparisons were made between the bus and the model. Fuel consumption predicted by the APU model was within 1% over 6 EPA cycles of measured data. The battery state of charge predicted by the lead-acid battery model was within 5% over 6 EPA cycles of measured data. The motor model predictions (transient / steady state) are within 10% of measured data for low speeds and lower throttle positions. Larger deviations between the measured and model predicted data at larger speeds and higher throttle positions. The dynamic vehicle model validated to within 2% of measured data..



Hybrid Electric Vehicle Simulink Toolbox (Commercial)