Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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BSc (Bangladesh University of Engineering and Technology, 2010)

"Multi-Objective Optimization of Plug-in Electrified Vehicle (PEV) Powertrain Families Considering Variable Drive Cycles and User Types over the Vehicle Lifecycle"

Department of Mechanical Engineering

Monday, September 14, 2015
1:00 P.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Curran Crawford, Department of Mechanical Engineering, University of Victoria (Supervisor)
Dr. Zuomin Dong, Department of Mechanical Engineering, UVic (Member)

External Examiner:
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Dr. Barton Cunningham, School of Public Administration, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

Plug-in electrified vehicle (PEV) technology has the potential to reduce operational costs, greenhouse gas (GHG) emissions, and gasoline consumption in the transportation market. However, the net benefits of using a PEV depend critically on several aspects, such as individual travel patterns, vehicle powertrain design and battery technology. To examine these effects, a multi-disciplinary optimization model was developed integrating vehicle physics simulations through a Matlab/Simulink model, battery durability, and Canadian driving survey data. Moreover, all the drivetrains are controlled implicitly by the ADVISOR powertrain simulation and analysis tool. The simulated model identifies Pareto optimal vehicle powertrain configurations using a multi-objective Pareto front pursuing genetic algorithm by varying combinations of powertrain components and allocation of vehicles to consumers for the least operational cost, powertrain cost and gasoline consumption under various driving assumptions. A sensitivity analysis over the foremost cost parameters is included in determining the robustness of the optimized solution of the simulated model in the presence of uncertainty. Here, a comparative study is also established between conventional and hybrid electric vehicles (HEVs) to PEVs with equivalent optimized solutions, size and performance (similar to Toyota Prius) under both the urban and highway driving environments. In addition, breakeven point analysis is carried out that indicates PEV lifecycle cost must fall within a few percent of CVs or HEVs to become both the environmentally friendly and cost-effective transportation solutions. Finally, PEV families (a platform with multiple powertrain architectures) are optimized taking into account consumer diversity over various classes of light-duty vehicle to investigate consumer-appropriate architectures and manufacturer opportunities for vehicle fleet development utilizing simplified techno-financial analysis.