

ABSTRACT

This research attempts to develop a methodology for augmenting ecodesign, comprising its attributes; fuel consumption and greenhouse gas (GHG) emission for a plugin hybrid electric vehicle (PHEV), having the configuration of a passenger car. An unconventional consideration of gradeability, covering rolling terrain is also factored in the proposed model. For ecodesigning, a data-driven methodology is developed here by combining powertrain components optimization and power management strategy. The fuel economy and GHG emission depend on both the external and internal factors, constituents of ecodesign. The external factors are vehicle speed profile or driving cycle and road gradient. The internal factors relate to powertrain components sizing or optimization as well as power management strategy that influence vehicle energy consumption, affecting fuel economy and emission. Gradeability covering rolling terrain and a standardised driving cycle are considered as external factors for powertrain components sizing and power management strategy modeling for realizing ecodesign. Powertrain components sizing is accomplished based on a design space exploration approach, utilizing surrogate assisted evolutionary algorithms. For PMS, robustness is incorporated here based on explicit model predictive control algorithm. The search space contraction, for this purpose, as necessary, is achieved by using Non-dominated sorting genetic algorithm, to generate multiple pareto heads as possible alternative control solutions. To select the set of best pareto heads for optimal control signal, the dynamic programming (DP) technique is employed. The results show that based on the proposed ecodesigning approach, an improvement, exceeding 5 % in fuel economy is seen when compared with a DP based solution and the same turns out to be nearly 10% when compared with a fuzzy based solution. This establishes the superiority of the proposed model. The results also exhibit reduction in emission range between 5% and 9% if compared with DP based result and such values range between 10% and 18%, when compared with a Fuzzy based solution. The proposed methodology for ecodesigning also aids in light-weighting of the vehicle, which is around 4%. Above results indicate improvements in target design parameters and hence, the proposed methodology can be beneficially adopted for ecodesigning.

Keywords: Design planning, Fuel Economy, Greenhouse gas emission, Explicit Model predictive control, Plugin hybrid electric vehicle, Power management strategy, Surrogate assisted design optimization