10th World Congress on Structural and Multidisciplinary Optimization
May 19 -24, 2013, Orlando, Florida, USA

Potential of Predictive Control Strategies to Reduce Lifetime Cost of Plug-in Hybrid Powertrains

Orkun Karabasoglu[1], Burak Yuksel[2], Guo Li[3], Jeremy J. Michalek[4],

[1] Carnegie Mellon University, Pittsburgh, PA, USA, karabasoglu@cmu.edu
[2] Istanbul Technical University, Istanbul, Turkey, burakyuksel@itu.edu.tr
[3] Carnegie Mellon University, Pittsburgh, PA, USA, guol@andrew.cmu.edu
[4] Carnegie Mellon University, Pittsburgh, PA, USA, jmichalek@cmu.edu

1. Abstract

We determine the potential of predictive control strategies to minimize component sizing, powertrain mass, lifetime cost and emissions of plug-in hybrid electric vehicles compared to heuristic or thermostat control strategies. We account for the design and control interactions by performing parametric studies over the vehicle design space. We create a backward-looking quasi-static physics model of a parallel PHEV. To find the upper bound of the benefits of the predictive controllers, the proposed method applies dynamic programming in an inner loop to converge to the results of a predictive energy management strategy with the perfect information about the trip. Then the design space is explored by discretization for the battery, engine, and motor sizing and corresponding lifetime cost and life cycle GHGs are computed. The same procedure is applied using a thermostat control in the inner loop as the energy management strategy and results are compared. The implications of predictive control strategies on component sizing, mass reduction and lifetime cost are discussed.

2. Keywords: Plug-in hybrid electric vehicles, co-design, predictive control, lifetime cost, energy management