Opinion

Optimal E-Powertrain Solutions for Future Electric Vehicles

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Owing to increasing emission specification, decreasing price of energy storage systems and power electronic devices, in addition to fast-developing technology, Electric Vehicles (EVs) will become a significant share of automotive market in the near future [1]. Therefore, there is a huge competition among car manufacturers to produce EVs. The final price and driving range are known as vital factors to win the competition. For this purpose, e-powertrain of EVs should be efficiently designed and managed to maximize the driving range [2,3] while the total costs (including implementation, operation, maintenance and replacements) be minimized [4]. A complex multi-objective dynamic Mixed-Integer Nonlinear Programming (MINLP) optimization problem [5–11] needs to be solved to achieve this goal. The major reason of the complexity lies in the hybridization of EVs with different types of power sources [12–17] e.g., Battery Storage Systems (BSSs), Supercapacitors (SCs), Fuel cells (FCs), Photovoltaic (PV) modules, and flywheels (FWs) (Figure 1). BSSs are used

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for their high energy density, while FWs and SCs are utilized mostly due to their high power density supplying transient active–reactive power demand. FCs and PV modules work to generate power without exposing pressure to energy grid. As shown in Figure 1, these are sources connected to the Electric Machine (EM) through different DC/DC and DC/AC converters enabling the EM to consume/generate active–reactive power. The efficiency of all these components varies based on their size and load profiles. Therefore, the optimization problem aims to minimize the operation costs (probabilistic) during the lifetime of EV (e.g., 15-year prediction horizon) and the initial costs (deterministic) by finding both the size and the number of all components while satisfying operation and design constraints.

References


3. Conlon BM, Holmes AG, Tate ED (2011) Range maximization of a hybrid vehicle operating in an electric vehicle operating state. In Google Patents.


