

Chapter 18

Hybrid Particle Swarm and Gravitational Search Optimization Techniques for Charging Plug-In Hybrid Electric Vehicles

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ABSTRACT

Electrification of Transportation has undergone major modifications since the last decade. Success of combining smart grid technology and renewable energy exclusively depends upon the large-scale participation of Plug-in Hybrid Electric Vehicles (PHEVs) towards reach the desired pollution-free transportation industry. One of the key Performance pointers of hybrid electric vehicle is the State-of-Charge (SoC) which needs to be enhanced for the advancement of charging station using computational intelligence methods. In this Chapter, authors applied Hybrid Particle swarm and gravitational search Optimization (PSOGSA) technique for intelligently allocating energy to the PHEVs considering constraints such as energy price, remaining battery capacity, and remaining charging time. Computational experiment results attained for maximizing the highly non-linear fitness function estimates the performance measure of both the techniques in terms of best fitness value and computation time.

INTRODUCTION

Recent researches on green technologies for transportation sector are gaining popularity among the research communities from different areas. In this wake, Plug-in hybrid electric vehicles (PHEVs) have great future because of their charge storage system and charging facilities from traditional grid system. Several researchers have proved that a great amount of reductions in greenhouse gas emissions and the

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increasing dependence on oil could be accomplished by electrification of transport sector (Caramanis & Foster 2009). Future transportation sector will depend much on the advancement of this emerging field of vehicle optimization. Indeed, the adoption of hybrid electric vehicles (HEVs) has brought significant market success over the past decade. Vehicles can be classified into three groups: internal combustion engine vehicles (ICEV), hybrid electric vehicles (HEV) and all- electric vehicles (AEV) (Tie & Tan, 2013). Plug-in hybrid electric vehicles (PHEVs) which is very recently introduced promise to boost up the overall fuel efficiency by holding a higher capacity battery system, which can be directly charged from conventional power grid system, that helps the vehicles to operate continuously in “all-electric-range” (AER). All-electric vehicles or AEVs is a kind of transport which use electric power as only sources to run the system. Plug-in hybrid electric vehicles with a connection to the smart grid can own all of these strategies. Hence, the widely extended adoption of PHEVs might play a significant role in the alternative energy integration into traditional grid systems (Lund & Kempton, 2008). There is a need of efficient mechanisms and algorithms for smart grid technologies in order to solve highly diverse problems like energy management, cost reduction, efficient charging station etc. with different objectives and system constraints (Hota, Juvvanapudi, & Bajpai, 2014).

According to Electric Power Research Institute (EPRI), about 62% of the whole United States (US) fleet will comprise of PHEVs within the year 2050 (Soares et al., 2013). Moreover, there is an increasing demand to implement this technology on the electric grid system. Large numbers of PHEVs have the capability to make threats to the stability of the power system. For example, in order to avoid disturbance when several thousand PHEVs are introduced into the system over a small period of time, the load on the power grid will need to be managed very carefully. One of the main targets is to facilitate the proper communication between the power grid and the PHEV. For the maximization of customer contentment and minimization of burdens on the grid, a complicated control appliance will need to be addressed in order to govern multiple battery loads from a numbers of PHEVs properly (Su & Chow, 2012a). The total demand pattern will also have an important impact on the electricity production due to differences in the needs of the PHEVs parked in the deck at certain time (Su & Chow, 2011). Proper management can ensure strain minimization of the grid and enhance the transmission and generation of electric power supply. The control of PHEV charging depending on the locations can be classified into two groups; household charging and public charging. The proposed optimization focuses on the public charging station for plug-in vehicles because most of PHEV charging is expected to take place in public charging location (Su & Chow, 2012). Wide penetration of PHEVs in the market depends on a well-organized charging infrastructure. The power demand from this new load will put extra stress on the traditional power grid (Morrow, Karner, & Francfort, 2008). As a result, a good number of PHEV charging stations with suitable facilities are essential to be built for recharging electric fleet, for this some strategies have been proposed by the researchers (Mayfield, Jul. 2012). Charging stations are needed to be built at workplaces, markets/shopping malls and home. Boyle (2007) proposed the necessity of building new smart charging station with effective communication among utilities along with sub-station control infrastructure in view of grid stability and proper energy utilization. Furthermore, sizeable energy storage, cost minimization; Quality of Services (QoS) and intelligent charging station for optimal power are underway (Hess et al., 2012). In this wake, numerous techniques and methods were proposed for deployment of PHEV charging stations (Z. Li, Sahinoglu, Tao, & Teo, 2010).

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