An Optimal Two-Tier Fuzzified Control Scheme for Energy Efficiency Management of Parallel Hybrid Vehicles

Hao Ran Chi , Kim Fung Tsang , Chung Kit Wu , Faan Hei Hung , Gong-sheng Huang

PII: S2452-414X(16)30059-0
DOI: 10.1016/j.jii.2016.08.003
Reference: JII 18

To appear in: *Journal of Industrial Information Integration*

Please cite this article as: Hao Ran Chi , Kim Fung Tsang , Chung Kit Wu , Faan Hei Hung , Gong-sheng Huang , An Optimal Two-Tier Fuzzified Control Scheme for Energy Efficiency Management of Parallel Hybrid Vehicles, *Journal of Industrial Information Integration* (2016), doi: 10.1016/j.jii.2016.08.003

An Optimal Two-Tier Fuzzified Control Scheme for Energy Efficiency Management of Parallel Hybrid Vehicles

Hao Ran Chi[1,*], Kim Fung Tsang[2], Chung Kit Wu[3], Faan Hei Hung[4], Gong-sheng Huang[5]

* Corresponding author

[1]Department of Electronic Engineering, City University of Hong Kong, Hong Kong, China, haoranchi2-c@my.cityu.edu.hk

[2]Department of Electronic Engineering, City University of Hong Kong, Hong Kong, China, ee330015@cityu.edu.hk

[3]Department of Electronic Engineering, City University of Hong Kong, Hong Kong, China, chungkwu4-c@my.cityu.edu.hk

[4]Department of Electronic Engineering, City University of Hong Kong, Hong Kong, China, fhhung4-c@my.cityu.edu.hk

[5]Division of Building Science and Technology, City University of Hong Kong, Hong Kong, China, gongsheng.huang@cityu.edu.hk

Abstract: Hybrid vehicle technology has been widely adopted because of its improvement of fuel economy as well as reducing emissions. In this paper, a new scheme, namely GAFUCS, is developed for the energy management of parallel hybrid vehicles. In order to enhance the performance in uncertainty and dynamic environment, as well as to improve the performance under different driving conditions, the operation is accomplished in two tiers, namely Tier-1 and Tier-2. With the sufficient principle design of Tier-2, GAFUCS fuses Fuzzy Logic (FL) and Genetic Algorithm (GA) by performing a real time operation. Hence GAFUCS is a more robust, efficient and accurate scheme than [16] originally invented by authors. It is shown that the new scheme produces less pollutants and carbon dioxide by reducing the consumption of petroleum. Based on various realistic driving conditions, the SOC and the fuel capacity, three hundred (300) have been investigated. Evaluation reveals that GAFUCS achieves an average improvement of 35.5%. It is evaluated that GAFUCS achieves an improvement of 16.6% compared to FGAS. GAFUCS thus is a new control scheme and is proven to be the most efficient scheme for energy efficiency management and emissions reduction for PHEVs.

Keywords: Parallel Hybrid Electric Vehicle (PHEV); State of Charge of the battery (SOC); Fuel Capacity; Energy Management; Fuel Efficiency; Genetic Algorithm (GA); 2-Tier Fuzzy Logic (FL).

1. Introduction

With the rapid decrease of fuel source, the price of fuel will be more and more expensive as a general trend. Much cleaner alternative energy source is desperately required to minimize potential pollutants generated by burning fuel for next generation of vehicles [1]. Electric vehicles (EVs) are a potential candidate for reducing the fuel consumption [2-3]. Hybrid vehicles (HEVs) are becoming popular because it yields a high fuel-efficiency. In particular, the parallel hybrid vehicle (PHEV) is a kind of HEV that performs better than other HEV since it presents a stronger safety than EVs by virtue of the fact that the internal combustion engine (ICE) is connected to the wheels in parallel to the Electric Motor (EM) in PHEV. In addition, these two energy sources may provide power at the same time [4]. More importantly, PHEV is a very good candidate for fuel saving. As a result, the PHEV has become a popular type of green vehicle attributed to its salient feature of enhanced fuel efficiency and gas emissions reduction. There is a drawback for PHEV at this point. Since fuel remains the main source to provide power in PHEV, under the circumstance of fast speed