Chapter 21
Modeling and Control of Hybrid Electric Vehicle

Flah Aymen

 https://orcid.org/0000-0002-3463-6096
National School of Engineering of Gabes, Tunisia

Habib Kraiem

College of Engineering, Northern Border University, Saudi Arabia

Lassaad Sbita

 https://orcid.org/0000-0002-6589-3976
National School of Engineering of Gabes, Tunisia

ABSTRACT

The transportation systems have become more electrified, and the major countries of the world program using electric scooters, electric bicycles, electric trains, electric buses, and electric vehicles for their transport. The traditional energy resource stocks are still decreasing rapidly, which makes the world afraid about the future of the transport sector. Therefore, several international restrictions and laws have limited using this kind of energy in relation to the transport sector by encouraging public transport and making a high taxes for the highly energy-consuming cars. The robustness and the efficiency of transportation systems designs are related especially to the internal electric motor and to the battery capacity used. From the other side, the energy management problem presents a serious factor that must be optimized in order to guarantee the overall efficiency and rentability. This chapter explores the modeling and control of hybrid electric vehicles.

1. INTRODUCTION

The world is evolving, and the physical systems are becoming increasingly smarter and somewhat successful towards the present. Every day of order to promote human life, new technology or a new approach or procedure were learnt to make it more comfortable. The area of transportation has also benefited from

the introduction of the vehicles due to the evolution steps (Bajracharya, 2016). Its development started in 1769 with the steam-driven automobile, in 1808 with the car powered by an internal combustion engine using hydrogen, and in 1870 with the combustion engine powered by petrol. Most of it was in the 19th century. ANYOS Jedlik was invented during the same period, and precisely in 1828, the tiny model car focused on the electric motor (Rajashekara, 1994), (Salima, Atarsia Loubna, & Toufouti Riad, 2018). Ten years later, the inventor Vermont Thomas, built on a DC machine, unveiled the electric car, and then the new ones appeared. After such dates, the electrified models have performed, and the standard versions have restricted areas of speeds ranging from 4 to 6 km/h. Because of the issue of limited rates and the battery recharge problems, such versions were not successful. Therefore the gasoline-based internal combustion engine was found to be more convenient even with the pollution problem. It is actually due to many factors these as the lowest fuel price, the high touched speeds, and the high torque is given. Recently, the growth of the ICE figure based on cars has raised the pollution issue, and the major environmental governments and organizations have been asked to limit the use of these model cars by using other ecological solutions. Hence, the electric vehicle was returned, and special laws were introduced by the major governments, such as tax minimization and other incentives, promoting the use of its form of the transport system (Kharola & Patil, 2017). This is officially started after 2008, and the then mass-produced electric car was in development (Bajracharya, 2016). First, with this policy, the U.S. government began, then China and the European countries followed. Recent facts have shown that more than 25 percent of the world's current vehicle is wholly or partially based on electric propulsion and this number is still growing (Duff & Ricketts, 2015). This propulsion device has been developed and updated throughout different times in history. These propulsion systems, in relation to the primary power source used, were planned. Many of them are linked to the energy from combustion and others were based on renewable energy sources. Others were combined to solve the problems in the other models, more than energy sources. The combustion-based propulsion systems have various issues related to the high gas emission level and the low-speed zones when high torque is required. The engine used also needs regular maintenance and this enables the use of this type of machine. The propulsion systems based on clean energy as electrical energy or hydrogen energy were defined from the other side by numerous advantages related in particular to the absence of any type of gas emission. Such propulsion systems have been covered by the mentioned difficulties, which characterized the previous system based on combustion energy. However, these two types are distinguished by two particular problems; the first is related to the high noises in the exhaust pipes, the reliability of the engine and the health of the user with the hydrogen version. For the electric variant, these problems do not occur and the underlying problem is related to the autonomy of the system and the lack of a useful transportable energy source adaptable for a similar application. In Table (1), by mentioning the problems and advantages, reveals and classifies the propulsion systems concerning the type of energy sources.

Basing on the table (1), it is clear that the propulsion system which uses the electric energy, have various advantageous and this is why the electrical vehicle number is still increasing. Many new names appear in the international vehicle market and produce vehicles basing on electric energy. The electric vehicle term was used for any kind of car using electric energy as the main power source. However, some versions were combined with two types of energy sources as the fuel energy and electrical energy. This type of vehicle was entitled to the hybrid electric vehicle (HEV) and it is exposed in more than architecture. Those architectures regrouped, an or more than an electric motor, an internal combustion engine, two kinds of energy blocs, electronic equipment and an electronic control unit. In what way

Related Content

A Web-Enabled, Mobile Intelligent Information Technology Architecture for On-Demand and Mass Customized Markets
M. Ghiassiand C. Spera (2011). *Interdisciplinary Advances in Adaptive and Intelligent Assistant Systems: Concepts, Techniques, Applications, and Use (pp. 83-123).*
www.irma-international.org/chapter/web-enabled-mobile-intelligent-information/46286

Methods for Developing Flexible Strategic Information Systems: Is the Answer Already Out There?
Alan Eardley, Hanifa Shahand June Lazander-Reed (2003). *Adaptive Evolutionary Information Systems (pp. 306-328).*
www.irma-international.org/chapter/methods-developing-flexible-strategic-information/4225

Effects of Discount Scenarios on Chaotic Behavior of Inventory Level Under Price-Dependent Demand
Iman Nosoohiand Jamshid Parvizian (2013). *International Journal of System Dynamics Applications (pp. 58-72).*
www.irma-international.org/article/effects-of-discount-scenarios-on-chaotic-behavior-of-inventory-level-under-price-dependent-demand/95237

Statistical Discriminability Estimation for Pattern Classification Based on Neural Incremental Attribute Learning
Ting Wang, Sheng-Uei Guan, Sadasivan Puthusserypadyand Prudence W. H. Wong (2014). *International Journal of Applied Evolutionary Computation (pp. 37-57).*
www.irma-international.org/article/statistical-discriminability-estimation-for-pattern-classification-based-on-neural-incremental-attribute-learning/114216

Dynamic Reconfiguration of Middleware for Ubiquitous Computing
Antonio Corradi, Enrico Lodoloand Stefano Monti (2012). *Technological Innovations in Adaptive and Dependable Systems: Advancing Models and Concepts (pp. 38-52).*
www.irma-international.org/chapter/dynamic-reconfiguration-middleware-ubiquitous-computing/63573