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Autonomous Driveline System for Electric Vehicle

Electric and Autonomous Electric Vehicle

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Preface

This is a comprehensive book on the development of Autonomous Driveline for Electric and Autonomous Vehicle focuses on technological details, mathematical relationships, and basic design principles in line with the development of green transportation systems. This book's good blend of theoretical review and technical design makes it an excellent platform for educating today's engineers, post graduate students, and industries personnel. It has a total of five parts with twenty one (21) chapters that focus on the development of electric and autonomous vehicle driveline.

Part I gives a brief review on adoption electric vehicle, inline with the development of sustainable environment. Part I also presents a case study on prototyping a retrofitted electric transport, which would enhance the core knowledge of the users to develop of alltrain electric off-road vehicle prototype.

Part II introduces an artificial intelligent control energy system which is built with organic solar supercapacitor (OSSC) as a structural frame of electric vehicles to meet the electrical load demand with solar renewable energy trapping. A solar supercapacitor prototype is developed by utilizing Carbon Fiber Reinforced Polymer, nano Zinc Oxide (ZnO), and Copper Oxide (CuO) fillers as the positive and negative electrodes and a dielectric layer sandwiched between the electrodes. The adaptive neuro-fuzzy intelligent system (ANFIS) controller has been used to control the power storage of the OSSC, power flow to meet the EV's auxiliary load demand, and battery charging. The test results of OSSC show potential of energy conversion efficiency (η_{ec}) 13.33%, open-circuit voltage (V_{oc}) 599 mV, current density (J_{sc}) 222.22 A/m^2, capacitance (C) 11.17 μF/cm^2, energy density (E_d) 120 Wh/kg, and power density (P_d) 29 kW/kg. Therefore, the OSSC can save about 3.4 kWh battery in 11.00 to 17.00 hours which would be able to make the EV about 15% energy efficient and contribute to emission control.

Part III presents an intelligent battery thermal management system for the EV. It presents a comprehensive review for the solutions of the limitation of the battery cooling thermal management system (BC-ThMS) for the electric or autonomous electric vehicle, intelligent cooling system design technique, and control. The performance study both in air cooling, liquid cooling, and phase change refrigerant based cooling system individually to study battery sustainability in any operational mode on maintaining the battery recommended temperature of 40°C or below. An experimental study on an evaporative battery thermal management system has been conducted and found that it is potential to maintain the battery temperature 40 °C or below. An intelligent system has been embedded with the EC-BThMS to make the system optimize in controlling the battery temperature in the range of 30–40 °C and warning send to the EV user if there is any chance to reach out the battery temperature beyond 40 °C. It may span the battery life, provide security and safety of the battery and saving the energy specially decreasing the frequency of battery charging.

Part IV presents an autonomous two-speed transmission. It presents the technique on the development of a fuzzy-logic-controlled servo-electromagnetic autonomous two-speed transmission (SEMA-2ST) model. The electromagnetic actuator is modeled in terms of electromagnetic capacity, number of coil turns, supply current, and electromagnetic force needed to shift gears. Experimental results of AEM-2SGB show on first-gear shift time 110 ms at 300 Nm motor torque and a second-gear shift time of 116 ms at 110 km/h vehicle speed, with a maximum current supply of 16 A using a 24 V lithium ion battery. The SEAM-2SGB reduces weight by 37–66%, transmission losses by 40%–90%, and battery life by 5%.

Part V presents an intelligent electromagnetic continuously variable transmission. It describes the development technique of Autonomous Electromagnetic Continuously Variable Transmission (EMACVT) for EV. It could be considered as the solution of EV future transmission. An analytical model of the EMACVT is developed by deep analysis on the kinematics of the CVT clamping forces and electromagnetic forces of the EMA. A fuzzy intelligent system has been introduced in the EMACVT to control the dynamic behavior of the CVT with controlling the current flow to the EMA actuation. There is a failsafe mode built into the CVT to prevent damage in case some of the sensors malfunction. During failsafe mode, the system shifted to manual mode for fixing the gear ratio equivalent to first gear and to save the CVT from damage by the central manual switching system. It is observed in experiment that time taken to accelerate car with 40–60 km/h with taking time in the range of 1.8–3.1 sec. The EMA develops the electromagnetic force in the range of 108–301 Nm for the supply current in the range of 6–9.33 amp.

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