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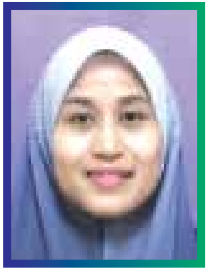

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Title : APPLICATION OF SYSTEM IDENTIFICATION METHOD COUPLED WITH EVOLUTIONARY ALGORITHMS FOR THE OPTIMIZATION OF POWER CONSUMPTION IN A PEM FUEL CELL PROPULSION SYSTEM

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Fuel cell vehicles have the potential to address the problems surrounding the ICE vehicle, without forcing any significant restrictions on vehicle performance, driving range or refueling time. The fuel cells will however need to work at different operating points because of the dynamic load characteristic where current is drawn instantaneously from the load source connected to the fuel cell stack during transient conditions. Research on fuel cell vehicle design is therefore imperative in order to improve vehicle performance in term of energy usage and durability, increase efficiency and reduce the fuel costs. This thesis makes a number of key contributions to the advancement of fuel cell vehicle design within two main research areas; powertrain system design based on quality energy, and optimization system based on biology based algorithms. With regards to powertrain design, this research first evaluates the quantitative and qualitative energy efficiency and fuel consumption of the hydrogen fuel cell propulsion system under various system design configuration conditions. Exergy analysis was performed for each type of plant. Three alternative configurations of a vehicle system were considered namely, without DC/DC converter, with DC/DC converter on the supercapacitors side and with DC/DC converter on the PEM fuel cell side. In the process of evaluating the best system configuration, Multi-Criteria Decision Making technique (MCDM) through the Analytical Hierarchy Process (AHP), was used for evaluation, comparison and applicability assessment. The ability to construct accurate mathematical models of real systems is an important part of the control parameters in prototype PEM fuel cell systems for vehicles. Secondly, in this research, an empirical dynamic model of the PEM fuel cell system in vehicles was analyzed and validated using the system identification method. This thesis involved the development of an empirical mathematical model for offline identification based on the commercial PEM fuel cell stack from Horizon to predict the dynamic behavior in the fuel cell system. The system identification is used to locate approximate models of PEM fuel cell stack in vehicles based on observed input-output data pairs. The PEM fuel cell can be modeled as a Multi-Input Single-Output (MISO) system, where the inputs are hydrogen pressure, air speed and vehicle speed, and the output is power. The parametric identification of the fuel cell stack using Least Squares (LS) with Auto-Regressive Exogenous input (ARX) model structure was considered. Finally, to optimize the PEM fuel cell system parameters, two different optimization techniques, namely the Particle Swarm Optimization (PSO) and Differential Evolution (DE) techniques were incorporated into the system. The main objective of this investigation is to optimize the PEM fuel cell system parameters using two different types of intelligent optimization techniques for different constant speed in vehicles. The optimum parameters identified were tested through experimental work to evaluate the performance of the system. The outcome was decided that the system with DC/DC converter on the PEM fuel cell side is the best configuration with power as the main weighted (0.6). The findings of the study also demonstrate that the DE optimization technique is the best method with lower Integrated Absolute Error (IAE) value and fast convergence compared with PSO method for the vehicle system for excellent performance.