Abstract of Ph.D. Thesis

"Control of Switched Reluctance Motor Drive for Light Electric Vehicles with Solar Photovoltaic Integration"

Mr. Arjun Kumar (2019EEZ8342), Research Scholar

This thesis deals with the development of advanced control strategies, regenerative braking schemes, and renewable energy integration, as rooftop for SRM drives in LEV applications. A three-phase, 12/8, 48 V, 28 A, 2700 rpm SRM is used as a candidate machine. Various converter topologies, modified boost, Zeta, Cuk, and SEPIC, are developed for solar photovoltaic (PV) integration, and maximum power point tracking (MPPT) algorithms such as incremental conductance and variable step-size perturb & observe are implemented to maximize energy harvesting efficiency. Advanced control techniques, including modified direct instantaneous torque control (DITC), model predictive control (MPC), and torque sharing functions (TSF), are proposed to achieve torque ripple reduction, smooth motoring operation, and efficient regenerative braking. Furthermore, sensorless rotor position estimation techniques based on flux polynomials, pulse injection, and inductance calibration are investigated to eliminate mechanical sensors, thereby improving system reliability and reducing cost. Simulation and experimental validations are carried out using MATLAB/Simulink and a real-time dSPACE DS-1103 controller platform. The results are verified that proposed methods have effectively minimized torque ripple, enhanced efficiency under rated conditions, and have provided reliable regenerative energy recovery during stop-and-go driving scenarios. An integration of solar PV array has further extended the vehicle operating range, while optimized battery sizing demonstrated that overall storage requirements are reduced without compromising performance. The findings of this thesis confirm that SRM drives, when supported with advanced control strategies and renewable energy integration, represent a technically viable, economically competitive, and environmentally sustainable propulsion solution for light electric vehicles. The developed methodologies and experimental validations lay a strong foundation for future commercialization of SRM-based electric mobility platforms.