Abstract of Ph.D. Thesis
"Control of Synchronous Reluctance Motor Drive for Electric Vehicle with Solar PV and Grid Support"
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This research work presents a comprehensive development of a speed sensorless SyR motor drive for EV applications, incorporating multi-source energy support, including rooftop solar photovoltaic (PV) systems and grid-assisted charging, to enhance overall system autonomy, efficiency, and adaptability. The research commences with essential control of a SyR motor drive, which encompasses the selection of components and configuration of SyR motor drive for EV. Subsequent research investigates progressive system configurations in which a solar PV array is integrated at the DC link through an optimized boost and buck-boost DC-DC converter and managed using maximum power point tracking (MPPT) techniques. A variety of sensorless estimation techniques, such as open-loop flux observers, adaptive observers, and enhanced quadrature phase-locked loop (EQPLL) mechanisms, are implemented to estimate rotor position and speed across a wide speed range with high accuracy. Further developed configurations include bidirectional DC-DC converter-fed SyR drives that enable power exchange between battery and PV systems through half-bridge, SEPIC and interleaved parallel converter topologies. To achieve precise control and improved dynamic performance, modified adaptive complex coefficient filter (MACCF), modified disturbance observer (MDO), and closed-loop flux observer (CLFO)-based flux estimation strategies are employed, which ensure accurate rotor position and speed estimation. The system architecture is extended to include a single-phase grid interface to support battery charging during idle vehicle states, demonstrating the system's versatility under different operating conditions. Comprehensive simulations in the MATLAB/Simulink platform and hardware prototype validation confirm the efficacy of proposed system for motoring, regenerative braking, and charging scenarios with efficient sensorless control of SyR motor drive.