ABSTRACT

Power converters play a significant role in operating the motor drives. Generally, a motor drive system consists of an input source, power converter, motor, controller and a mechanical load. The input source can be a DC or AC at various voltage levels. The power converter could be a dc/dc converter interfacing the dc source (or battery source) or the conventional inverter, or an ac/dc converter interfacing the power supply and the motor. But the performance of the drive system is dependent on converter topologies, switching schemes and advanced controllers which are used to drive the system. Therefore to achieve high-performance in drives, the investigation of appropriate switching schemes and motor control schemes are essential. Hence this thesis work has two main objectives. The first objective is to develop various PWM strategies and to determine its effect on the output voltage and current for Induction Motor (IM) drive applications. A modified Discontinuous PWM technique (DPWM) is proposed for Z Source Inverter (ZSI) to operate the induction motor drive at a higher modulation index. Switching sequences involved appropriate placement of the active, zero and shoot through vectors to switch the ZSI. The technique developed is such that the dc link voltage is boosted with a better harmonic profile. Furthermore, a near state PWM is proposed for quasi ZSI which incorporates only active and ST vectors. The main contributions in both PWM strategies are to increase the voltage gain, improved dc bus utilization and reduction in line current harmonics of the induction motor drive.

Secondly, execution of motor control techniques to improve the dynamic and steady state characteristic of BLDC and SRM drive is carried out. Several controllers for dc and ac motor drives have been studied and
reported in the literature, mainly the linear and non-linear controller. Each one has its own advantages and disadvantages with regard to accuracy, response time and robustness. An improved speed controller namely Fractional Order Integral Sliding Mode Control (FOISMC) is proposed for BLDC system to achieve faster response and robustness. Finite time settling and a faster reaching velocity are the special features of this method. However the implementation of SMC leads to undesirable oscillations with finite frequency and amplitude known as Chattering. To overcome this, a composite control method incorporating Fuzzy with FOISMC method is developed to vary the gain continuously depending upon the speed requirement.

Subsequently, the Z Source dc/dc converter is proposed as a front-end converter to operate the BLDC motor drive which incorporates hybrid power sources for the drive. Existing topologies have two separate stages of converter for combining battery and fuel cell. Z Source dc/dc converter, in one single structure has the capability to satisfy the load demands with two power sources during load variations. Predictive Current Controller in the converter and the motor improves the dc link current response to attain a faster motor torque response.

Finally, this thesis also proposes a front-end dc/dc converter to improve the driving performance of SRM drive. In motoring mode, Z Source dc/dc converter is operated to establish a well-regulated and boosted dc link voltage of the SRM drive to improve the dynamic response. In idle mode, the converter is rearranged to perform as a battery charger connected to the utility. Existence of Z network in the converter reduces the inrush and harmonic current. This improves the power factor without any additional circuit in charging the battery from the utility. All of the above studies involve theoretical analysis, computer simulations and experimental demonstrations.