Abstract

The Direct Torque Control (DTC) algorithm has the features of precise and quick torque response and reduction of the complexity of Field Oriented Control (FOC) algorithms. In DTC, the generation of inverter switching state is made to restrict the stator flux and electromagnetic torque errors within the respective flux and torque hysteresis bands so as to obtain the fastest torque response and highest efficiency at every instant. Despite its simplicity, it suffers from few drawbacks such as high ripple in torque, flux and stator currents, variation in switching frequency of the inverter.

To reduce the steady state ripples and to achieve the constant switching frequency operation for the inverter, space vector pulsewidth modulation (SVPWM) algorithm is proposed for DTC based induction motor drives. Then, by extending the concept of 2-level inverter SVPWM algorithm, a simplified SVPWM algorithm for a three-level inverter fed DTC drive has been proposed in this thesis. To validate the proposed SVPWM algorithms for 2- and 3-level inverter fed DTC drives, numerical simulation studies have been carried out and results confirm the effectiveness of the proposed algorithms.

Though the classical space vector based PWM algorithms gives superior waveform quality, these algorithms require angle and sector
calculations, which increases the complexity of the algorithm. To reduce the complexity involved, a simple generalized PWM algorithm for a n-level inverter fed DTC drives has been proposed in this thesis. The proposed generalized PWM algorithm is developed by using the instantaneous phase voltages only. By allocating the effective time properly in each sampling time interval, the pulses are generated in the entire linear modulation region. To validate the proposed generalized PWM algorithm, several numerical simulation studies have been carried out by using MATLAB. However, in this thesis, the simulation results have been presented for 2, 3, 5, 7 and 9-level inverter fed DTC drives only. From the simulation results, it can be observed that as the number of levels increases the harmonic distortion in line currents and voltages can be decreased.

In order to meet the high and medium power applications, nowadays, the open-end winding induction motors are becoming popular. To control the two 2-level inverters which fed on either sides of the open-end windings, simplified decoupled and nearest sub-hexagonal centre (NSHC) PWM algorithms have been proposed in this thesis. The proposed PWM algorithms have been developed by using the instantaneous phase voltages only. These algorithms operate the two inverters with 180 degrees phase shift between each other. To validate the proposed algorithms, numerical simulation has been carried out using the MATLAB. From the results, it can be observed that both algorithms give reduced harmonic distortion when compared with the 2-level inverter fed DTC drives. Moreover, the proposed NSHC algorithm
gives reduced harmonic distortion when compared with the decoupled PWM algorithm. Also, the NSHC algorithm gives reduced electromagnetic interference (common mode voltage variations) when compared with the existing PWM algorithms in the literature.