CHAPTER 7

CONCLUSION AND SCOPE FOR FURTHER WORK

7.1 SUMMARY OF THE WORK DONE

Direct torque control (DTC) scheme, for the control of induction motor drives, is the most sought after scheme of control due to its characteristic features such as quick torque response and robustness against motor parameter variations. Direct Torque Control is supposed to be one of the best control strategies for driving any induction motor. However, the reduction and minimization of torque ripple is still a challenge.

The work carried out in this thesis is aimed at the reduction in torque ripple present in induction motor drives when DTC scheme of control is applied. The effectiveness of the proposed analysis of torque ripple in induction motor drive using soft computing technique is demonstrated through simulation studies.

The highlights of the present investigation include the following

a) The most suitable multilevel inverter for DTC applied to induction motor which gives minimum torque ripple is identified.

b) A model for Three Level Diode Clamped Inverter with Space Vector Modulation Technique (TLDCISVM) with
Direct Torque Control (DTC) for torque ripple reduction is developed.

c) Hardware set up for TLDCI SVM based DTC scheme as applied to induction motor for torque ripple reduction is developed.

d) Fuzzy Logic controller, for TLDCI SVM based DTC scheme for reducing the torque pulsations present in induction motors, is developed.

7.2 CONCLUSIONS

One of the significant advantages of multilevel configuration is the harmonic reduction in the output waveform without increasing the switching frequency or decreasing the inverter power output. The elementary concept of a multilevel converter to achieve increased power is to use a series of power semiconductor switches with several low voltage dc sources to perform the power conversion by synthesizing staircase output voltage waveforms. The cascaded inverter needs several dc voltage sources to synthesize output voltage wave form. Diode clamped inverter is another type of multilevel inverter which is commonly used. By increasing the number of voltage levels, the quality of the output voltage is improved and the voltage waveform becomes closer to sinusoidal waveform. In the present study, a detailed analysis of an induction drive in open loop mode with three, five and seven level inverters is carried out using PSIM software. From the simulation studies, it is very clear that as the level increases, THD decreases. However, as the cost and complexity increase as the level of inverter increases, further simulation study in closed loop mode and the hardware implementation for validating the simulation are carried out with a DTC scheme with a three level inverter.
Closed loop study is carried out on two machines with ratings 3kW and 0.75kW. For the closed loop study on the induction motor drive, hysteresis controller is replaced by PI controller and space Vector Modulation technique is adapted along with PWM technique for a three level inverter with MI of 0.8. A load torque of 15Nm and 10 Nm are applied to the 3kW motor at 0.25 seconds and 0.45 seconds respectively and the developed electromagnetic torque is analyzed. It is clear from analysis that the torque response settles down to the steady state values in less than 0.015 seconds. The ripple present in the torque response at 10 Nm is 10.07% when running at 1500rpm. The rise time of the developed electromagnetic torque is 0.005 seconds. The speed response also takes less than 0.015 seconds to settle down to steady state. Similarly, the torque ripple with the 0.75kW at 5Nm load is 21.78%. An experimental set up is developed for 0.75kW machine for validating the simulation results. The measured torque ripple at 5Nm from the experimental set up is 21.42%, thus validating the simulation study.

Further, the study is repeated, for both the machines, by replacing the PI controller with a fuzzy controller. The settling time of the electromagnetic torque response of the induction motor drive with Fuzzy controller is almost the same as that of the drive with a conventional PI controller. However, for the 0.75kW motor, the torque ripple is reduced to 14.33%. Similarly, for the 3kW motor, the torque ripple is reduced considerably when the Fuzzy controller is used.

7.3 SCOPE FOR FUTURE WORK

The results and issues identified during the course of this work give rise to a number of possible directions for the future work. Some of them are briefly summarized below:
a) In the proposed work, torque ripple reduction study is carried out only with cascaded H bridge inverter and diode clamped inverters fed drive. The study can be extended to torque ripple minimization of the drive fed by multilevel inverter of flying capacitor type.

b) Multilevel inverters up to seven levels are only used in the present study as the cost and complexity increases as the level increases. The study can be extended to drives with multilevel inverters of levels more than seven to identify their viability for drives used for DTC applications.

c) In the torque ripple reduction approach, Fuzzy Logic Controller is used. Instead, the study can be carried out using Artificial Neural Network and Genetic Algorithm.