CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

In order to minimize the torque ripples in PMSM, many methods are proposed in literature, the methods can be classified into two types, namely, proper motor design and active control schemes respectively. There are instances where proper motor design is insufficient to achieve the required level of torque ripple reduction. For such instances, active torque control schemes play a vital role in minimizing the torque ripples.

The main objective of the research is to present a family of active torque control schemes to minimize the torque ripples in PMSM driven by FOC that caters to the various requirements of the user and application. Performance of these active control algorithms were analysed based on certain parameters like transient response, steady state response and TRF to prove their effectiveness.

The active torque control algorithms proposed in chapter 3 are namely, ILC in combination with HPWM and ILC in combination with SVPWM respectively to reduce torque ripples in FOC of PMSM operating at constant torque. These two techniques are simulated for drive performance under different load conditions using the SIMULINK under MATLAB and the results obtained are presented and compared. The performance of these proposed techniques is evaluated in terms of torque ripple factor. The results
of the simulation show that the ILC in combination with SVPWM based FOC of PMSM has lesser torque ripples in comparison with ILC with HPWM based FOC of PMSM, and all the existing methods.

A novel ANN with SVPWM based FOC technique of PMSM operating at constant torque has been proposed in chapter 4. The proposed ANN controller consists of Feed-Forward network Structure, composed of one input layer, one output layer and three hidden layers. The structure of the three hidden layer having three neurons give satisfactory results. The performance of this proposed technique is evaluated in terms of transient and steady state torque response along with torque ripple factor. The results of the simulation of ANN controller with SVPWM based FOC of PMSM shows that the proposed ANN Controller is superior to the existing PI controller.

Further more, two novel instantaneous FOC techniques operating at constant torque, namely, Fuzzy Logic Controller (FLC) with HPWM and FLC with SVPWM respectively are proposed in the chapter 5 to reduce torque ripples in PMSM. The performance of these proposed techniques is evaluated in terms of transient and steady state torque response along with torque ripple factor. The result of the simulation shows that the proposed FLC with SVPWM based FOC of PMSM has least torque ripple factor of 1.75% than all the proposed methods.

The experimental verification is done for FLC with SVPWM based FOC of PMSM in FPGA controller – SPARTAN 3A DSP. The results of the simulation are validated with experimental results in PMSM prototype.

A conclusion that can be drawn from the results is that the proposed methods, ILC with SVPWM based FOC of PMSM, ANN with SVPWM based FOC of PMSM and FLC with SVPWM based FOC of PMSM shows
superior torque response and are very effective in minimizing the torque ripples than all the existing active torque control systems.

6.2 FUTURE SCOPE

In future, to improve the FOC of PMSM drive in both performance and economy, few of the following can be researched.

i. Hybrid (FLC - ILC) for minimizing the torque pulsations in FOC of PMSM. Here, the FLC works at transient state and ILC is activated during steady state to suppress the torque ripples in PMSM.

ii. Hybrid (PI-ILC) for minimizing the torque pulsations in FOC of PMSM. Here, the PI controller works at transient state and ILC is activated during steady state to suppress the torque ripples in PMSM.

iii. Hybrid (PI-ANN) for minimizing the torque pulsations in FOC of PMSM. Here, the PI controller works at transient state and ANN is activated during steady state to suppress the torque ripples in PMSM.

iv. Hybrid (ANN-FLC) for minimizing the torque pulsations in FOC of PMSM. Here, the FLC controller works at transient state and ANN is activated during steady state to suppress the torque ripples in PMSM.

v. Detailed modelling and simulation of the commutation torque ripple minimization can be taken up for steady state and transient analysis of torque.
vi. Detailed modelling and simulation of the Sensorless (without rotor position sensor) FOC control of permanent magnet synchronous motor can be taken up for steady state and transient analysis of torque.

vii. Detailed modelling and simulation of the optimum torque per ampere control can be taken up for steady state and transient analysis of torque.

viii. Detailed modelling and simulation of the constant mutual air gap flux linkages control can be taken up for steady state and transient analysis of torque.

ix. Detailed modelling and simulation of the Unity power factor control can be taken up for steady state and transient analysis of torque.

tax. Temperature can affect the flux density of the magnet so also the field-weakening performances. Thus, saturation effect of d-q axis inductances and temperature dependence of the magnet should be included in future research to complete the prediction of the losses (iron losses, stray losses, etc...).