Chapter 8
Chapter 8

Hybrid Controller

8.1 Introduction

This chapter deals with the development of a hybrid controller incorporating ANFIS and PI controllers to further reduce the overshoot/undershoot and to eliminate the steady state error following sudden changes in load-torque disturbances. It is seen in the previous chapters that the performance of the system with a PID controller shows slow response and large overshoot, even though there is a little steady state error and the ANFIS controller exhibits fast settling, negligible overshoot, but some steady state error is present. To overcome these drawbacks, the possibility of a hybrid controller is tried to enhance the performance of the system by adding up the plus points of both of them. The steady state error in speed of the motor drive with ANFIS controller is completely eliminated by the hybrid controller, in addition to quick settling of speed.

8.2 Hybrid (ANFIS-PI) Controller

The conventional controllers like PID controllers used for closed loop operation are inadequate for providing robust control and transient stability over a wide range of operating conditions. The limitations of conventional controllers are slow response, large settling time and undesirable overshoot. Present day applications require intelligent controllers free from the above drawbacks. The
controller gains of PID controllers are usually fixed. These are adjusted in ANFIS controller after learning from the training data. In this chapter, a hybrid ANFIS-PI controller, which is a combination of ANFIS and PI controllers is developed to overcome the drawbacks like larger overshoot, slow response, etc. of the conventional controller and the steady state error that persist in the performance with ANFIS controller. This is achieved through the implementation of a PI controller in parallel with ANFIS controller. It is found that the PI controller has the potential to minimize the steady state error, whereas the ANFIS controller provides fast settling with negligible overshoot [94].

8.3 Simulation with Hybrid Controller

A PI controller is put in parallel with the ANFIS controller in the closed loop model of the drive system explained in Chapter 7. The SIMULINK block diagram for hybrid ANFIS-PI controller is shown in figure 8.1. This model is simulated with a number of load torque disturbances and noises. Data for training the ANFIS controller is obtained from the simulation of the closed loop system with conventional controller. Different loading patterns namely random load pattern, a pattern of three load changes, load with small oscillations (chirp signals) and load with small step deviations at regular intervals applied to the motor drive system are shown in figures 8.2 (a), 8.3 (a), 8.4 (a) and 8.5 (a). The transient responses of the PMBLDC motor drive system corresponding to the above load patterns with PID, ANFIS and Hybrid controllers are shown in figures, 8.2 (b), 8.3 (b), 8.4 (b) and 8.5 (b).
Fig. 8.1 SIMULINK Block diagram with Hybrid (ANFIS-PI) Controller
Fig. 8.2 (a) Random load pattern applied to motor drive system

Fig. 8.2 (b) Comparison of speed responses with PID, ANFIS and Hybrid controllers for random load pattern
Fig. 8.3 (a) A pattern of three load changes

Fig. 8.3 (b) Comparison of speed responses with PID, ANFIS and Hybrid controllers for the pattern of three load changes
Fig. 8.4 (a) Load pattern with small oscillations in load

Fig. 8.4 (b) Comparison of speed responses with PID, ANFIS and Hybrid controllers for the pattern of small oscillations in load
8.4 Conclusion

In order to overcome the drawback of load transient responses with PID and ANFIS controllers, a hybrid ANFIS-PID controller is introduced by introducing a PI controller in parallel with the ANFIS controller following sudden changes in load torque disturbances. The speed response of the three controllers are compared and it is found that the hybrid ANFIS-PID controller is having a superior performance.

Fig. 8.5 (a) Load pattern with small step deviations superimposed over load

Fig. 8.5 (b) Comparison of speed responses with PID, ANFIS and Hybrid controllers for small step deviations superimposed over load

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8.4 Conclusion

In order to overcome the drawbacks in the transient responses with PID and ANFIS controllers, a hybrid ANFIS-PI controller is developed by introducing a PI controller in parallel with the ANFIS controller following sudden changes in load torque disturbances. The PI controller has the potential to eliminate the steady state error prevailing with the ANFIS controller. The performances of all the three controllers are compared and it is found that the Hybrid ANFIS-PI controller is having a superior performance.