ABSTRACT

The performance of the induction motor drives largely depends on the power electronic circuitry and the type of control used in designing the controller to control the speed. The heart of the AC drive, i.e., the induction motor (plant), which is to be controlled, is generally characterized by highly non-linear, complex and time-varying dynamics and many of its states are not available for measurement purposes. Hence, it can be considered as a challenging engineering problem in the industrial sector for any specific application, say the control of speed. Numerous control techniques for the speed control of IMs have been developed by various researchers across the world so far.

The development of the advanced control techniques has partially solved some of the induction motor's speed control problems but they remain sensitive to drive parameter variations and the performance may deteriorate if conventional controllers are used. Moreover, these methods require mathematical models for control problems and suffer from drawbacks such as large settling times, ringing oscillations, etc. In this context, the fuzzy logic or neural network (or both)based controllers are considered as potential candidates for such speed control applications and thus does not require the mathematical model of the system for control purposes.

A novel technique for the design and simulation of conventional PI controller and also hybrid controllers using the concept of Mamdani-FLC, Takagi-Sugeno FLC and the adaptive neuro-fuzzy strategies for controlling the commands for generating gating signal. The inverter terminal voltage controlled by these gating signals, in turn control the speed of IM drive, which is proposed in this work. Also, the concept of robustness in the speed control of IM has been explored in this research work by developing hybrid controllers yielding excellent results and improving the dynamic stability. Accordingly, it also deals with the use of space vector pulse width modulation (SVPWM) with a voltage source inverter fed to an IM to control its speed by using 4 different strategies, viz., PI, Mamdani, Takagi–Sugeno and ANFIS. Simulink-based models of the IM are developed in Matlab 7 with the different types of controllers put in closed loop with the plant and their performances are evaluated for speed control after running the simulations.

To start with, the modeling and simulation of a Proportional-Integral based controller in order to control the speed of the IM using SVPWM concept is proposed. Secondly, the design of a Mamdani-based fuzzy logic control scheme for controlling the speed using the SVPWM technique is explored. Thirdly, a systematic approach of achieving the speed control of an IM using Takagi–Sugeno-based FLC has been investigated. Finally, this research work proposes a novel development of

an adaptive neuro-fuzzy control scheme to select a proper rule base using the back-propagation algorithm to control the speed of IM.

One important concept presented in this work is the development of efficient control algorithms by writing a set of optimal fuzzy rules. The effectiveness of the control strategies developed for controlling the speed of the IM is well justified through the simulation results, thus improving the system performance, cost-effectiveness, efficiency, dynamism, reliability and robustness of the designed controllers compared to the control methods developed so far. Also, the performance and robustness of the proposed controllers are being evaluated under various conditions of the drive system (clockwise and anticlockwise rotation with variable speed). Further, the proposed control method is being compared with the work done by various researchers till date, thus showing the efficacy of the proposed methods in this research work.