# ABSTRACT

Three-phase induction motors are the most widely used electrical motors in industrial applications due to their high reliability, simple construction, relatively low cost and modest maintenance requirements. However, for high dynamic performance industrial applications, their control remains a challenging problem because they exhibit significant non-linearities and many of the parameters, mainly the rotor resistance and hence the rotor time constant, vary with the operating conditions. Field oriented control (FOC) of induction motor drives is becoming a major candidate in high performance motion control applications. Decoupling effect of torque and flux dynamics leads to independent control of the torque and flux as in the case of a separately excited dc motor. Though attractive, FOC methods suffer from disadvantages of sensitiveness to motor parameter variations such as the rotor time constant and incorrect flux measurement.

Variable speed issues of electrical drives are traditionally handled by proportional-integral (PI) and proportional-integral-derivative (PID) controllers. PI controller even though is simple, has difficulty in dealing with dynamic speed tracking, parameter variations and load disturbances since the controller's gain values are fixed. The performance of the speed control

system also depends on the accuracy of the slip calculation. Unfortunately, the slip calculation depends on the rotor time constant, which varies continuously according to the operating conditions. Thus, the control parameters of PI controller are not adaptive.

In the past two decades, artificial intelligence techniques such as fuzzy logic and neural network control have been applied for the speed control of electrical drives. Fuzzy control provides a systematic way to incorporate human experience and implement nonlinear algorithms, characterized by a series of linguistic statements, into the controller. In general, if the system is ill defined or too complex to have a mathematical model, the fuzzy controller provides an effective way to design the control system. Neural network, on the other hand, has the capability to adapt itself to changes in the control environment using the system input and output. It does not require complicated control theories and exact model of the system.

Recently, wavelet transform has been used in the modeling, control and analysis of electrical motor drives for high performance applications. Wavelet transform has the ability to decompose wide band signals into time and frequency localized sub bands. Therefore, an effort is made to combine the advantages of wavelet transform and fuzzy logic for the speed control of induction motor drives. The broad objective of this thesis is to design and implement a wavelet fuzzy based speed controller for high performance applications of induction motor drives.

In the proposed wavelet fuzzy based self-tuning controller, the discrete wavelet transform is used to decompose the speed error into localized sub band frequencies. These wavelet transformed coefficients are scaled by their respective gains and added together to generate the control signal for the induction motor drive. The minimum description length data criterion is used for selecting the optimum wavelet function and the entropy based criterion is used for estimating the optimum level of decomposition of the speed error. In order to get better results, a fuzzy based self-tuning algorithm is proposed for obtaining the scaling gains.

For implementing the controller, a 1.47 kW three-phase induction motor with indirect field oriented control (IFOC) is used in the drive system. The complete drive system including the proposed controller is simulated and implemented successfully in real time using digital signal processor (DSP) based hardware environment. Simulations and experiments are performed under various operating conditions and load disturbances. The simulation and experimental results are compared and they are found to tally with each other.

Further, experiments are conducted on the drive system using conventional PI controller to prove the superiority of the proposed controller. Comparing the results, the proposed controller is found to be better than the conventional PI controller in terms of smaller overshoot, quick settling, less steady state error and smooth control.