ABSTRACT

Rotating machines are essential components in most of the manufacturing and production industries. They are exposed to a variety of environmental conditions. These operating conditions coupled with natural ageing cause incipient faults in the machines. The most common incipient faults are winding insulation failure and bearing wear. With proper monitoring scheme, if these faults were detected at their early stages, the maintenance cost and down time can be reduced. Many of the conventional fault detection methods require the need of an expert to evaluate the machine condition. The development of soft computing techniques in the area of computer science motivated the researchers to use these techniques for intelligent problem solving, which exhibits the characteristics of human intelligence.

The soft computing tools like neural networks and fuzzy system have been used in many engineering applications such as fault identification and control of dynamic systems. It is well known that a feed forward neural network is capable of approximating any continuous functions closely. The use of fuzzy logic in control applications has tremendously increased over the last decades. With the commercial availability of fuzzy logic control development tools and the better understanding of analysis methods, more and more industrial companies have successfully used this technology for their specific applications. The main advantages of fuzzy controllers are simplicity, low cost and possibility to design without knowing the exact
mathematical model of the process or system. Therefore, this thesis is focused on the applications of neural networks and fuzzy system for fault detection in single phase induction motor, three phase induction motor and synchronous generator.

The neural network and fuzzy system based fault detection schemes are proposed for single phase induction motor operating at constant load and supply voltage. The incipient faults such as insulation failure and bearing wear are considered to illustrate fuzzy fault detector. The mathematical relationship between the motor faults and motor parameters is derived. The laboratory motor is used to obtain the experimental data. The faults are simulated in the laboratory motor and stator current, speed and temperature are measured. The measured data are used as a training data to tune fault detector. The fuzzy fault detector is tested in simulation environment with different types of membership functions, defuzzification schemes and hybrid combination of membership functions. The effectiveness of fuzzy fault detector is analysed in terms of percentage error between the experimental value and estimated value. The performance of neural network based fault detection scheme is compared with fuzzy fault detection scheme.

Three different fuzzy logic based fault detection schemes are proposed to monitor the stator winding turn faults in three phase induction motor. The first scheme is based on monitoring the line currents. Second scheme is based on monitoring negative sequence component of line currents compensating the effect of asymmetries in the machine and unbalanced supply voltage. Third scheme is based on monitoring sequence component
impedance, which is immune to supply voltage unbalance. The performances of these schemes are compared. The neural network fault detection scheme is also proposed based on monitoring the sequence component impedance of the machine. To improve the performance of conventional back propagation algorithm, the immediate weight update scheme is proposed for fault detection. The performance of these two algorithms for fault detection is compared. To verify simulation results experimentally, a prototype model is developed to implement the impedance based fault detection scheme online.

The neural network and fuzzy system based inter turn fault detection schemes are proposed for synchronous generator. The negative sequence components of line voltages and line currents are used as fault indicators. The laboratory synchronous generator is used as a test machine to obtain the training data. The negative sequence components of voltage and current are obtained from the line voltages and line currents and used as inputs for the proposed fault detectors. The performance of the fault detection schemes is compared.