Chapter 13

Detection of Stator and Rotor Faults in Asynchronous Motor Using Artificial Intelligence Method

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ABSTRACT

This chapter deals with the implementation of a PC-based monitoring and fault identification scheme for a three-phase induction motor using artificial neural networks (ANNs). To accomplish the task, a hardware system is designed and built to acquire three phase voltages and currents from a 3.3KW squirrel-cage, three-phase induction motor. A software program is written to read the voltages and currents, which are first used to train a feed-forward neural network structure. The trained network is placed in a Lab VIEW-based program formula node that monitors the voltages and currents online and displays the fault conditions and turns the motor. The complete system is successfully tested in real time by creating different faults on the motor.

INTRODUCTION

A three phase induction motor consists of stator and a rotor. The stator is fabricated from laminated sheet steel stampings having slots on the inner periphery. The rotor may squirrel cage or wound rotor. A squirrel cage or (simply) cage rotor has a number of conducting bars housed in slots on the outer surface of rotor core (Acosta, Verucchi, Gelso, 2004). These bars are short circuited at both ends by conducting end rings. The three-phase squirrel-cage induction motor is frequently used, owing to its ruggedness, robust construction, and low cost, it can however show defects. The flow of phase currents in the stator winding produces a rotating magnetic field. This magnetic field has a constant amplitude and rotate at

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synchronous speed assume that the rotor is initially stand still. The rotating stator field induces an EMF in the rotor conductors (Benbouzid 2000).

Since the rotor circuit is closed (either because of the end rings in cage rotor or because the slip rings are short circuited in a wound rotor), a current flows in the rotor circuits. This rotor creates a rotor field. The interaction of stator on rotor produces a torque which causes the rotation of rotor in the direction of stator rotating field. The three-phase induction motor is a workhorse of the manufacturing industry. They can come either from stator, rotor or a mechanical problem. Knowing that industrial constraints are even stronger, reliability and a safe operating system have to be considered. As a matter of fact, the stresses of induction motor generally bring about a breakdown with a range of few minutes to several days in industrial processes (Blodt, Chabert, Regnier, Faucher, 2006).

It is well known that many defects come from a rotor problem. A broken rotor bar is an example. The brazen connection between the end ring and the rotor bars, induced by several consecutive start up, is another one. Moreover, some defects can come from an eccentricity of the rotor which can be static or even dynamic. These ones are incipient, and they, slowly but surely, induce some perturbations like an increase of vibrations of the motor process, the appearance of torque ripples, and/or an increase of the temperature of the induction motor. These types of defects can lead to dismantling. A predictive maintenance cunningly allows one to avoid expensive repair due to damages.

Consequently, monitoring and fault severity have been focused on for some decades. The most popular approach is the monitoring of the induction motor, owing to the spectral analysis of the stator line current absorbed by the induction motor, this paper is devoted to the monitoring and fault detection of an induction motor drive using two current sensors. The diagnostic approach we propose in this paper is based on fuzzy fault detection, owing to human knowledge of the process. The main goal of this approach is to inform an operator of symptoms by means of indicator lights. It could be the presence (or not) of an incipient rotor defect or the presence of one rotor broken bar. This motor may encounter several fault conditions, which can damage the motor. These conditions include overload, unbalanced supply voltage, locked rotor, single phasing, under-voltage, and overvoltage. A 3.3 kW squirrel-cage, three-phase induction motor is used for this purpose (Casimir, Boutleux, Clerc, Yahoui, 2006; Calis, Cakir 2007).

**ANN STRUCTURE AND FAILURE MODES**

**Stator Winding Failure**

NNS is a simulator for artificial neural networks (ANN). This simulator is designed with a new graphical user interface. In this technique, Feed Forward Neural Network (FFNN) structure is used with back propagation algorithm is shown in figure 1. This ANN involves with one input layer and one output layer. In this technique, five neurons are used in the hidden layer. The Activation function used in hidden layer and output layer is Log Sigmoid function.

The ANN structure is trained through momentum coefficient ($\alpha$) and learning coefficient ($\eta$) with 0.1 to 0.9 values and the best results obtained for momentum coefficient ($\alpha$) and learning coefficient ($\eta$) is found to be 0.2. With the momentum coefficient ($\alpha$) and learning coefficient ($\eta$) of 0.2, the error graph and log file is obtained. In this proposed work, Neural Network Simulator is used to diagnosis the condition of stator and rotor of a three phase squirrel cage induction motor. For training first open the NNS program, then choose create / layer from the tool menu (Didier, Ternisien, Caspary, Razik, 2007).
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