Abstract

This thesis represents the research work to detect low-amplitude stationary and non-stationary signals and its application to the diagnosis of weak faults in Squirrel Cage Induction Motors (SCIM). SCIM incipient faults include Broken Rotor Bar (BRB), eccentricity faults, bearing defects, and inter-turn short circuit fault. If the incipient faults are not detected at an early state, and proper maintenance is not carried out, then it may result in complete failure of the motor and loss of production.

In this research, SCIM faults are detected by identifying fault specific frequency components in the motor armature current and motor vibration signal spectrum. First, a Multiple Signal Classifier (MUSIC) based method has been developed to detect the SCIM faults under low loads using a single phase current signal at steady state. The size of the autocorrelation matrix for MUSIC has been estimated from the derived analytic relations between the matrix size and the required frequency resolution. Under some applications, the loading of the motor changes with time and during that transient period, the steady-state fault diagnosis methods may fail. Therefore, another method is developed to detect SCIM faults during the time-varying and fixed loading conditions. However, the loading of the motor needs to be higher compared to the steady-state based method to detect the faults. In some applications, the primary requirement is to develop a low-cost online system for continuous condition monitoring. Therefore, a fault detection algorithm with low computational complexity has been developed which uses only a single current sensor. The low complexity method can detect faults during the steady state of the motor operations but needs higher loading compared to the first proposed method. Sometimes it may be required to quickly assess the motor health without any dedicated sensor or processing unit. For such requirements, an Android application has been developed which will convert any Android mobile phone with inbuilt accelerometer into a SCIM fault diagnosis tool. The proposed four algorithms have been tested using data from a laboratory setup of 22kW SCIM loaded by a 24kW DC generator.

Keywords: Induction motor, fault diagnosis, Extended Kalman Filter, Frequency Estimation, MUSIC, Blackman-Tukey algorithm, broken rotor bar, inner raceway fault, outer raceway fault, rolling element fault, static eccentricity, dynamic eccentricity, mixed eccentricity, multi-coset sampling, Android programming.