Bearing Fault Prediction Using Current Signature Analysis in Electric Water Pump

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Abstract: This paper present an initial attempt to develop a simple algorithm for a device to predict the bearing fault in electric water pump using current signature. Bearing faults cause variations in the physical air gap of the rotating machine. It can modulate the air gap flux density and may vary the magnitude of harmonics of stator current. The current signatures has been collected for various fault bearings. Magnitude features has been extracted from harmonics of electrical current. These features have been used to build prediction models using SVM classifier. Maximum accuracy of 64.7% was achieved.

Keywords— Bearings, Current signature analysis, Harmonics,

I. INTRODUCTION

Interest in this area is motivated from difficulties faced by the farmers in rural area like Kilinochchi due to faulted water pumps. Without knowing that there is a fault developing, farmers continue to use the pump until it breakdown. If the fault is detected earlier, then it may be rectified easily with lower cost. Sometimes faulted pumps consume more electricity, produce unwanted heat, noise and vibration during its operation before breaking down. Usually faults start at a small scale, expand gradually over a long time, sometimes significantly long time, and finally may lead to a major breakdown. It could be reduced if the faults are detected before the major failure and then it can minimize the cost of repairing. Bearing fault is one of the most common fault.

A bearing is a machine component that reduces friction between moving parts and makes relative motion only in the desired motion. Over 40% of all machine failures are due to bearing fault [1]. In the case of induction motors, which is the one used in water pumps, rolling element bearings are enormously used to provide rotor support.

Rolling-element bearings mainly consist of two rings, inner rings and outer rings, between which a set of balls or rollers rotate in raceways [6]. Under the normal operation of balanced load with good alignment, failure may begin with small cracks, which located below the surfaces of the raceway and rolling elements, then gradually spread to the surface creating distinguishable vibrations and noises [1]. So it is possible to predict this fault before it actually breaks down.

Vibrational signal analysis of water pump is one of the predictive method in fault prediction. Roger xu et al. [17] presents a diagnostic approach for bearing health monitoring and maintenance. The vibrational signals preprocessed, then it was sent to PCA (principal component analysis) to extract main principal features then these features sent to HMM (Hidden markov model) to create bearing's health/degradation index which was input to the algorithm which predict the remaining useful time of the bearing. Further Shaojiang Dong et al. [13] Suggested to use wavelet and Tsallis entropy to extract character features. To get more accurate model Shaojiang Dong et al [15] proposed to extract the features like kurtosis, skewness, peak-peak (P-P), RMS, and sample variance from time domain signal and they changed time domain signal samples to intrinsic mode function (IMF) by EMD, which energy can represent vibration characteristics of the bearings. Predicting vibration is highly depend on the environment where the pump is being used and how it is installed. It is suitable for the motors that are used in control environment such as laboratories and factories. But our concern is the water pump used by farmers in different terrains, in rural areas where farmers are not technically strong. So the prediction method should not depend on the physical environment. For this reason current signature analysis is considered as a better alternative.

Current signature analysis is a non-intrusive method which does not demand any sensors installed inside the pump or rotating drive. Interference from the environment is less. The device can be used in any terrains and require less maintenance.

When a fault happens on the bearing that may cause variation in the air gap eccentricity and it produces abnormalities in the air gap flux density. In the case of a dynamic eccentricity which varies with rotor position, the oscillation in the air gap length causes fluctuations in the air gap flux density. In return it affects the harmonics of the stator current [1]. Current signature can be captured by a sensor and from harmonic analysis fault can be predicted. It could be a better and economic method to predict the fault.

In 1994 R.R schoen et al [16] suggested a system that uses artificial neural network to learn the frequency domain characteristics of the current signature under good motor operating condition. This spectrum had many harmonics, but using selective filter they isolated only the required harmonics, and by using neural net algorithm they predicted the fault. The instantaneous power was used as a feature for the motor current signature analysis in [20]. It was shown that the amount of information carried by the instantaneous power, which is the product of instantaneous supply current and

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