



Principal component analysis approach for detecting faults in rotary machines based on vibrational and electrical fused data

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ABSTRACT

Rotating machines are frequently used in industrial applications. However, due to their severity, mechanical failures such as rotor imbalance, shaft imbalance, pulley imbalance, structural breakage, and bearing imbalance can lead to unplanned shutdowns. While vibration analysis-based condition monitoring techniques can detect and diagnose many early errors, certain mechanical faults have associated vibration characteristics that make it difficult to identify and distinguish these faults. To address this issue, this paper proposes a method based on data fusion for vibrational and electrical signatures to achieve new fused signatures for healthy and different faulty cases. The weighted decision fusion method generates the fused decision by weighting and combining the output of multiple sensors. Conventional vibration evaluation parameters diagnose unbalance, pulley misalignment, belt damage, and combined faults. However, these parameters have more dimensions and correlated features for some faulty cases, such as unbalance and misalignment. Therefore, the Principal Component Analysis (PCA) was applied to reduce the dimensionality of evaluating parameters and preserve almost all data variation. The PCA produces uncorrelated Principal Components (PCs) for each case. A backpropagation neural network (BPNN) was constructed to construct an integrated fault diagnosis framework. The first and second PC was inserted as input parameters in the training set of BPNN. It was observed that BPNN achieves 2.1762×10^{-10} Mean Squared Error (MSE) demonstrates superior data fusion solutions and PCA in the condition monitoring of rotating machines. Overall, this study proposes an effective method for diagnosing mechanical faults in rotating machines, which can improve reliability and reduce downtime in industrial applications.

1. Introduction

Rotary machines driven by the electromechanical system, such as the induction motor, are widely used in industrial applications due to their cost-effectiveness, simplicity, and ease of maintenance. The traditional maintenance management approach involves time-based preventive maintenance, which involves rebuilding or repairing machines based on pre-determined schedules derived from failure statistics. However, these statistics vary widely depending on operating and plant-specific variables, resulting in ineffective

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