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Product Function Correntropy and Its Application in Rolling bearing Fault Identification

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Abstract: Rolling bearing as one of the key mechanical components plays a significant role in the field of industrial. To improve the ability of rolling bearing fault diagnosis under multi-rotating situation, this paper proposes a novel rolling bearing fault characteristic product function correntropy (PFC), and employs Least Square Support Vector Machine (LSSVM) to implement intelligent fault identification of rolling bearings under multi-stationary working situations. Firstly, rolling bearing vibration acceleration signal is decomposed by Local Mean Decomposition (LMD) to extract product functions (PF). Secondly, PFC needs to be obtained. PFC is the solution of the correntropy mathematical model of primary signal and PF component that is modified by Correlation Coefficient Entropy (CCE) as amplitude modulation operator. Finally, drawing support from LSSVM, the fault identification is achieved. Through the bearing identification experiments in different rotating situations, it is verified that PFC generates higher diagnosis accuracy than traditional fault features. Meanwhile, it is proved that PFC has more robustness than traditional fault features under cross-mixed roller bearing rolling status. Above all, the higher efficiency and availability of LMD-PFC-LSSVM are confirmed from the experiment consequence. It can be concluded that LMD-PFC-LSSVM is a reliable technology for rolling bearing fault diagnosis online under complicated rolling conditions and possesses the broad application prospect.

Key words: local mean decomposition, product function correntropy, least squares support vector machine, rolling bearing, fault identifications

1. Introduction

Rolling bearings always rotate constantly in harsh industrial environment such as high temperature, variable rotational speed and big loads so that they have high breakdown frequency [1]. It is difficult to diagnose the rolling bearing faults for that the fault burst of roller is strong and the ambient noise and unsettled rolling condition exist generally. The health condition of rolling bearing brings hidden danger for mechanical and electrical system, which is especially essential in key systems of high speed train, aircraft engine, hydraulic turbine and many crucial industrial fields. Consequently, it is of great significance to improve the health identification ability of rolling bearings for facilities operating in safety. Fault diagnosis includes two aspects: feature extraction and pattern identification [2]. To improve the fault diagnosis ability, it is more convincing to dig a fault divisible feature than develop the pattern identification approach.

Before calculation of fault features, it needs techniques to extract incipient fault information in bearings. The welcomed extracting techniques currently mainly refer to the measurement of vibration by suitable transducers, sound pressure level (SPL) measurement using acoustic emission equipment and motor current signature

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