Abstract

Mechanical failures in rotating machinery (e.g. wind turbines, generators, motor-derives etc.) may result in catastrophic failures. Different mechanical faults induce characteristic vibrations in the equipment structure. Online vibration monitoring helps mitigate catastrophic failures through early detection and identification of underlying mechanical faults. However, extracting characteristic vibration features that improve fault classification performance and are robust to various noises in the vibration signals is a challenging task. Various statistical and signal processing-based vibration-features have been proposed in the literature. These vibration-features were devised on the basis of prior knowledge about characteristics of vibration signals from different fault types. Recently, automatic feature extraction through unsupervised learning in deep neural architectures has resulted in state of art performance on image and speech recognition tasks. So, Instead of feature-engineering, we, here, hypothesized that feature learning on raw vibration signal possibly will extract vibration-features that can improve fault identification performance of subsequent classifier. To the purpose, we explored Convolutional Neural Network for unsupervised feature learning on vibration signals and
Denoising Auto-Encoder for extracting vibration features that are robust and invariant to the noises in vibration signals. We proposed a Hybrid deep-model consisting of a Multi-channel Convolutional Neural Network followed by a stack of Denoising Auto-Encoders (MCNN-SDAE) with a single classification layer at the top. We compared the fault identification and classification performance of the proposed model with other models employing traditional statistical and signal processing based vibration-features. We validated the performance of all models on a benchmark vibration data collected from an experimental test-rig specifically designed to study vibration characteristics of bearing related faults.

References

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Index Terms

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Keywords

Vibration-features learning, equipment condition monitoring, bearing fault identification, machine learning, online monitoring.