Oral Defense Announcement

University of Missouri – St. Louis Graduate School

An oral examination in defense of the dissertation for the degree
Doctor of Philosophy in Mathematical and Computational Science with an emphasis in Statistics

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M.A. in Statistics, May 2016, University of Missouri-Columbia
B.S. in Economics, July 2013, Liaoning University

Enhancing Rotating Machinery Fault Diagnosis: A Dual-Head Attention Mechanism in Deep Learning Neural Networks

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Time: 10:00 a.m. to 12:00 p.m.
Place: Remote

Abstract

Rotating machinery is crucial to production efficiency and safety in manufacturing industries for an extended time. Ensuring machinery reliability necessitates effective diagnostic systems, particularly for rotating bearings, the key components of such equipment. Fault diagnosis in rotating machinery is essential to prevent failures and minimize downtime, thereby playing an important role in industrial operations. The application of advanced neural network techniques in industry has risen recently. Among these, attention-based neural networks, especially the Transformer models, are originally noteworthy for their sequential data handling capability. This research delves into attention-based algorithms for rotating machinery fault diagnosis, signifying a substantial advancement in the field. The dissertation reviews traditional signal processing techniques and traces the evolution of machine learning and deep learning algorithms in rotating machinery fault diagnosis. It discusses various methods, including the short-time Fourier transform (STFT), k-nearest neighbor (k-NN), support vector machine (SVM), artificial neural network (ANN), deep convolutional neural network (CNN), autoencoder (AE), recurrent neural network (RNN), and focuses on attention-based neural networks, mainly the original Transformer and the vision Transformer models (ViT). This research's highlight and key aspect is the invention of the Dual-Head Ensemble Transformer (DHET) algorithm, which was engineered specifically for rotating bearing fault diagnosis. This model integrates ensemble learning's robustness with the sophistication of the Transformer and the CNN architectures. The DHET's design, methodology, and experimental outcomes are thoroughly investigated. Using the Case Western Reserve University (CWRU) datasets, the DHET's efficacy is meticulously compared to other advanced deep learning models in bearing fault diagnosis, including tests under varied working conditions provided by the CWRU dataset. The experiment also evaluated the DHET's performance in a noisy environment. The CWRU datasets provide a diverse range of fault scenarios, ensuring a comprehensive evaluation of the model's effectiveness. The experimental results demonstrate the DHET model's exceptional capability in precise fault detection, positioning it to outperform the existing techniques. This research extends beyond academia, promising impactful industrial benefits by enabling more reliable, efficient, and safer machinery operations.

Defense of Dissertation Committee

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