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Enhanced Gearbox Fault Diagnosis with Fusion LSTM-CNN Network

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We introduce a novel approach to enhance gearbox fault diagnosis by integrating Long Short-Term Memory (LSTM) networks and Convolutional Neural Networks (CNNs) for vibrational data analysis. Our method aims to improve fault detection accuracy, particularly in identifying subtle anomalies like broken teeth. Our methodology starts with Continuous Wavelet Transform (CWT) applied to the vibrational data to reveal crucial frequency-domain features. Concurrently, a CNN, using the Inception architecture, extracts spatial features. Simultaneously, LSTM networks capture temporal patterns. The unique feature representations from both the CNN and LSTM branches are fused, creating a holistic feature set incorporating spatial, material, and frequency-domain information. This integrated feature set is then classified using a fully connected neural network. Our method's effectiveness is rigorously validated through comprehensive experiments on a diverse dataset. The results demonstrate exceptional accuracy in identifying gearbox faults, even in the early stages. This research advances predictive maintenance, offering a precise and comprehensive approach to gearbox fault diagnosis. The model's ability to detect faults promptly empowers industrial operators to reduce downtime and operational costs. In conclusion, the fusion of LSTM and CNN architectures for vibrational data analysis holds promise for gearbox fault diagnosis, benefiting industries reliant on machinery reliability and operational efficiency.