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”FLEET#3 - Automated domain adaptation for bearings fault detection and classification”

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Effective fault classification of mechanical components based on vibration signals requires robust domain adaptation methods, particularly in scenarios where complete data on all fault types is unavailable. The challenge lies in monitoring the health of components with variable characteristics, such as speed, load, and torque, where the lack of information on their current state renders target domain labels unavailable. Maximum Mean Discrepancy (MMD) is a widely used loss function in domain adaptation; however, its popular Gaussian kernel necessitates prior knowledge of the target domain data, posing a limitation in domain adaptation problems. To address this challenge, this paper proposes a novel approach that aims to achieve two key goals: (1) accurate fault identification and (2) automatic tuning of the MMD Gaussian kernel to adapt to different domains. The proposed approach consists of two stages. Firstly, a static representation of the standard deviation is identified using the Pascal Triangle that allows the reconstruction of a Gaussian kernel accurately. In the second stage, a dynamic parameter is computed by considering the difference between the source and target features distribution, extracted from the desired layers of the considered model. The proposed approach is evaluated by the classification of bearings health state, using the Case Western Reserve University (CWRU) signals as the source dataset and Jiangnan University (JNU) signals as the target one. The model employed in this evaluation is a 2D Convolutional Neural Network (CNN) model designed to process 2D reshaped signals. The desired layers for adaptation were identified as the fully connected layers of the network. The results demonstrate that the proposed method outperforms traditional MMD with a manually tuned Gaussian kernel, as well as other domain adaptation methods such as Correlation Alignment (CORAL) and Wasserstein distance that do not require any parameter tuning, making it a valuable contribution to the field of intelligent fault classification based on vibration signals.

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