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Chatter detection in the turning process using acoustic wavelet scattergram...

Chatter detection in the turning process using acoustic wavelet scattergrams and transfer learning

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Abstract

Chatter is an unwanted vibration in machining processes that degrades surface quality, reduces productivity, and shortens tool life. Reliable chatter detection is essential, particularly under varying machining conditions where traditional vibration-based approaches are often intrusive, complex, and require expert interpretations. This study introduces a novel time-frequency representation of acoustic signals using wavelet scattergrams for chatter detection in the turning process. These wavelet scattergrams generated through a wavelet scattering network (WSN) are used as an input to fine-tune a deep neural network (DNN) using a transfer learning framework. To ensure robust evaluation, experiments were conducted with five different overhang workpiece configurations, where the acoustic signals from the first four configurations were used for training and validation, and a completely new workpiece configuration was used to test the model performance. Among the evaluated models, ResNet50V2 achieved the highest classification accuracy of 99.2% while maintaining a low detection latency of about 62 ms, outperforming MobileNet and DenseNet121. The results demonstrate that the proposed method can reliably detect chatter using a non-intrusive microphone sensor and limited experimental data while maintaining robustness across varying machining conditions, making it suitable for accurate chatter detection in industrial applications.

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