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Sub-band attention CNN with feature evaluation for chatter detection

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ABSTRACT

In chatter detection, feature evaluation is an important task to identify mechanical systems and achieve higher classification accuracy. The importance of frequency bands is useful under various operating conditions. In this study, we propose a new methodology to identify the importance of frequency bands based on sub-band attention CNN. The sub-band attention CNN is a structure that combines the sub-band CNN and the attention layer. Unlike conventional CNNs that treat all frequency components with the same filter, the sub-band CNN processes different filters for each band. The attention layer is used to evaluate the importance of each band. The time-varying variance in frequency domain is used to extract chatter characteristics that vary greatly with time and it is used as an input for chatter detection. The useful frequency bands for chatter detection are obtained from the sub-band attention CNN. The importance of the frequency band is analyzed with the frequency response of the mechanical system.

1. INTRODUCTION

With the fourth industrial revolution, machine automation is rapidly spreading. In addition, the importance of fault detection technology for efficient operation is also increasing [1, 2]. Feature evaluation is a necessary operation to remove unimportant features. In chatter detection, a sub-band attention convolutional neural network (sub-band attention CNN) is used for feature evaluation. The variance is used to calculate the amplitude variation of the oscillations. Chatter detection and feature evaluation are performed using the variance as input data.

2. EXPERIMENTAL SETUP

Vibration signals were measured during the milling process using two accelerometers attached to the head stock. The vibration signal was acquired by a data acquisition board with a sampling rate

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of 65536 Hz. A milling tool was used to machine steel workpieces. The cutting parameters, spindle rotation speed and radial depth were varied.

3. RESULTS AND DISCUSSION

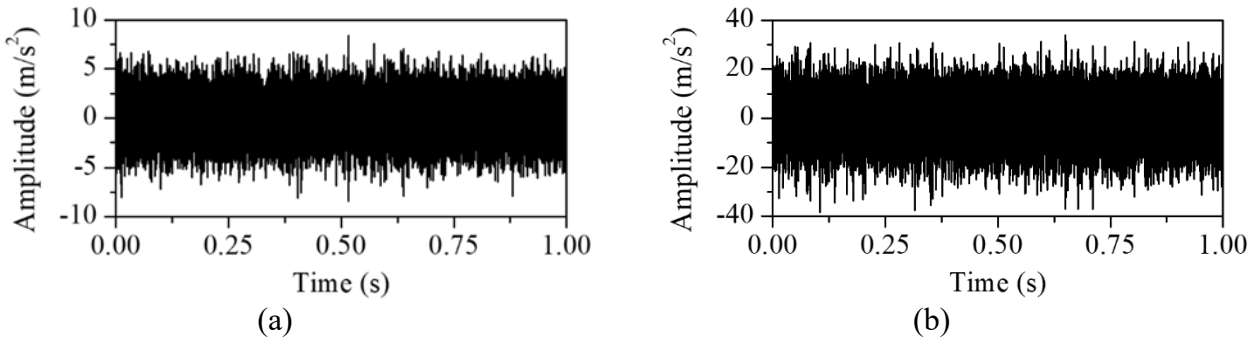

Figure 1: Vibration cutting signals for (a) stable and (b) chatter states.

Figure 1 shows the vibration cutting signals for stable and chatter states. The time-varying variance was calculated using the amplitude of the vibration cutting signal in the frequency domain. Using the time-varying variance, a sub-band attention CNN was trained for chatter detection. The main frequency bands were calculated from the attention layer. Chatter detection was performed with several classifiers using the main frequency band. By using the main frequency band, better performance was obtained than using all the features.

4. CONCLUSIONS

A sub-band attention CNN was used for feature evaluation of frequency bands in chatter detection. Frequency bands with distinct chatter characteristics were identified as important. Chatter detection was successfully performed using important frequency bands.

5. REFERENCES

1. Langarica, S., Rüffelmacher, C., & Núñez, F. An industrial internet application for real-time fault diagnosis in industrial motors. *IEEE Transactions on Automation Science and Engineering*, **17(1)**, 284-295 (2019).
2. Yu, W., Dillon, T., Mostafa, F., Rahayu, W., & Liu, Y. A global manufacturing big data ecosystem for fault detection in predictive maintenance. *IEEE Transactions on Industrial Informatics*, **16(1)**, 183-192 (2019).