Ensemble Augmentation for Deep Neural Networks Using 1-D Time Series Vibration Data

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ABSTRACT

Purpose

Deep Neural Networks (DNNs) typically require enormous labeled training samples to achieve optimum performance. Therefore, numerous forms of data augmentation techniques are employed to compensate for the lack of training samples.

Methods

In this paper, a data augmentation technique named ensemble augmentation is proposed to generate real-like samples. This augmentation method uses the power of white noise added in ensembles to the original samples to generate real-like samples. After averaging the signal with ensembles, a new signal is obtained that contains the characteristics of the original signal. The parameters for the ensemble augmentation are validated using a simulated signal. The proposed method is evaluated by 10 class-bearing vibration data using three Transfer Learning (TL) models, namely, Inception-V3, MobileNet-V2, and ResNet50. The outputs from the proposed method are compared with no augmentation and diferent augmentation techniques.

Results

The results showed that the classifers with the ensemble augmentation have higher validation and test accuracy than all the other augmentation techniques. The robustness assessment conducted with noisy test samples and test samples from diferent loads showed that the classifers could obtain much higher robustness when trained with samples from ensemble augmentation. Conclusion The proposed data augmentation technique can be applied to 1-D time series data to achieve robust classifers.

KEYWORDS: Data augmentation, Transfer learning, Condition monitoring, DCGAN, Vibration signal

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