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A LSTM-GAN Algorithm for Synthetic Data Generation of Time Series Data for Condition Monitoring

Timo König [a] ✉, Akash Mangaluru Ramananda [a], Fabian Wagner [a], Markus Kley [a]

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Abstract

Condition monitoring plays a crucial role in real-time evaluation of system states, but requires a large amount of measurement data to develop an accurate model. In reality a sufficient amount of data is often not available. Therefore, the proposed approach focuses on data augmentation using a Wasserstein Generative Adversarial Network (WGAN) to augment time series condition data. To enable the generation of synthetic data in the time domain, a Long Short-Term Memory (LSTM) network architecture is used in conjunction with a WGAN. The practical implementation of WGAN with a LSTM architecture is verified with two different datasets, a vibration and an acoustic dataset. Therefore, vibration data of rolling bearings in various system states recorded on a rolling bearing test rig and acoustic data of a welding process are used for synthetic data generation in separately trained networks. This work also focuses on a detailed evaluation of synthetic data in relation to the real data using various methods, such as distribution function analysis, a parameter analysis, and a visual comparison in the time as well as frequency domain. A classification model is also used to classify the real and a combined (real and synthetic) dataset to verify the benefits. The classification of the acoustic data shows an improvement in test accuracy with the combined dataset to 100% compared to the existing real measurement data of 65%. The following paper highlights the potential of the mentioned algorithm for data augmentation as an optimal solution for the described use cases. Synthetic data generation in the time domain is also critically discussed and the difficulties involved are emphasized.

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Keywords

Condition Monitoring; Data Augmentation; Generative Adversarial Network; Long Short-Term Memory

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