Acoustic array data processing for AI

An application for condition monitoring using machine learning

L.A.L. Janssen, I. Lopez Arteaga

Acoustic array processing method for fault detection based on 3D image artificial intelligence techniques

Introduction

The vast majority of work on artificial intelligence in the field of condition monitoring is based on sensors collocated in the machines. However, the possibility of using acoustic arrays as a non-intrusive contact-less sensor is emerging. This poster shows a novel a method to localize disturbances in dynamical systems using acoustic arrays by processing their data such that common artificial intelligence techniques can be used. The acoustic array data is compressed into spatial- and frequency-domain based 3D images. The proposed method has been demonstrated by localizing a disturbance mass on a vibrating brass plate using a 32 by 32 microphone array. The experiments show promising results for applications where space-frequency information is of essence.

Experiment

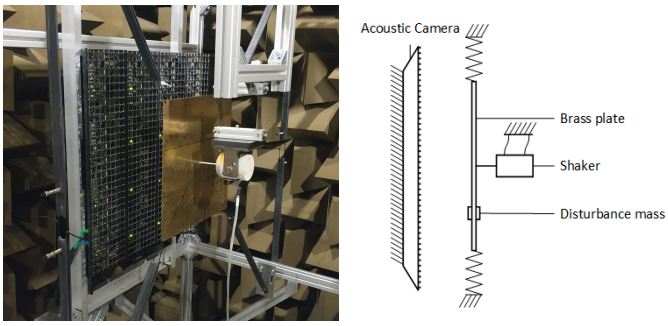

Fig. 1: Experimental setup

In order to validate the method, a data set is created of experimental data from a 32 by 32 microphone array that measures the acoustics of a vibrating brass plate with a disturbance mass located in different positions (Fig. 1). The data set is used to train an AI to predict the location this mass based on the measured acoustics.

Method

The microphone array data is compressed firstly by taking the Fourier transform per microphone. Consequently, spatial images for an equally distributed range over the relevant frequencies are acquired. This data is reshaped into a 3D input [freq · x · y] for a simple neural network in Keras [1] that is designed for robustness and testing methods (Fig. 2).

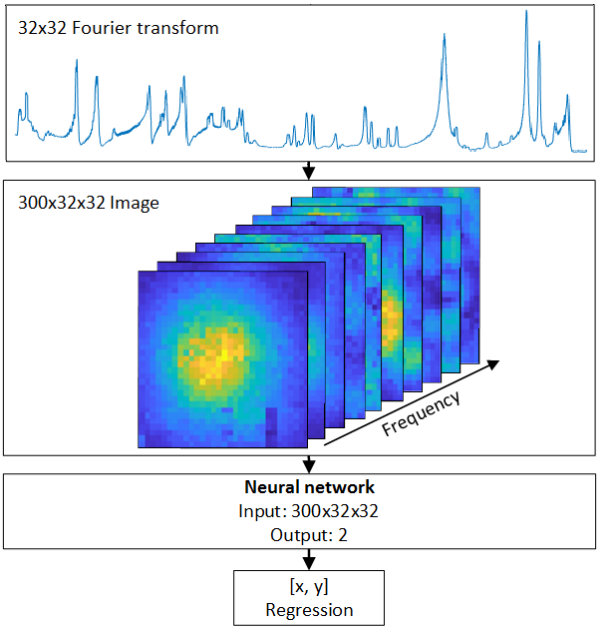

Fig. 2: Method: acoustic array to fault detection steps.

Results

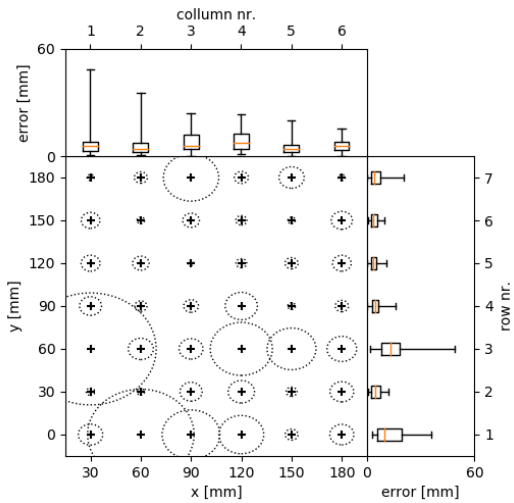

Fig. 3: Mean prediction accuracy per location and error distribution per row/column in mm.

The results (Fig. 3) show that, in most cases, the trained neural network is able to predict the location of the mass with low amounts of training data (4 training samples per mass position) with a test error $< 8mm$.

References

[1] F. Chollet, et al., Keras, `https://keras.io` (2015).

Department of Mechanical Engineering