Title: Defect Sizing in Guided Wave Imaging Using a Convolutional Neural Network

Abstracts

In Guided Wave (GW) Structural Health Monitoring (SHM), a sparse array of ultrasonic sensors, usually piezoelectric transducers, are permanently integrated on the inspected structure to periodically investigate its health. Among the set of post-processing techniques to analyze such measurements, Guided Wave Imaging (GWI) is a promising approach as it allows immediate defect detection and localization. With a large number of sensors and tomographic algorithms, GWI can provide quantitative information on the defect size. However, with a limited number of sensors, inversion of the defect size from the imaging algorithm is a non-linear problem depending on many parameters, including the defect size and position, the frequency of inspection and the positions of the sensors.

In this work, a deep learning strategy is implemented to invert the size of defects based on GWI with a sparse array of transducers. A database of guided wave images is first built with the simulation software CiVA for various defect positions and sizes. The database is then used to train a Convolutional Neural Network (CNN) to learn an inversion model. A CNN is a type of neural network relying on successive convolution-like operations applied to images, and is usually used in classification problems. The constructed model is then used to invert the size of defects on experimental images.

This methodology is applied on an aluminum panel with a circular through-hole of various positions and diameters, due to the simplicity of creating such experimental samples. Successful inversion of experimental defects is conducted with the numerically trained model. The defect size is inverted with an accuracy of the order of the millimeter for defect in the range of 5 to 15 mm with an inspection frequency at 40 kHz.

Keywords

SHM | Guided wave imaging | Inversion | Neural networks |