

# **Metamaterial-aided correlation-based signal processing for damage localisation**

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## **ABSTRACT**

A spider-inspired sensor was developed with embedded metamaterial in the form of phononic crystals. The metamaterial aims to filter out frequencies around the main harmonic of excited guided waves so that the piezoelectric sensors located on the spider's body listen to higher harmonics induced by damage. The correlation of the measured response and a set of measured reference data acquired at various grid points along the specimen surface allows the determination of the source of nonlinearity (damage localisation). The experiments were conducted on an aluminium alloy plate. For simplification of the experiment, the nonlinearity was simulated by the piezoelectric excitation. Reference data were collected simultaneously by piezoelectric sensors located at the spider and plate to respond to excitation on a square grid of points. Additional testing signals were collected in response to excitations at various points on the plate. Correlation coefficients were calculated between reference data and test signals as damage indicators. Damage localisation efficacy by using the proposed spider-inspired sensor was compared with the case when the band-pass filter is used for signals registered at piezoelectric sensors directly attached to the plate. It has been shown that the use of the proposed spider-inspired sensor can achieve a better signal-to-noise ratio.