Data Compression in Ultrasonic Network Communication via Sparse Signal Processing

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Abstract : This document presents the approach of using compressed sensing in signal encoding and information transferring within a guided wave sensor network, comprised of specially designed frequency steerable acoustic transducers (FSATs). Wave propagation in a damaged plate was simulated using commercial FEM-based software COMSOL. Guided waves were excited by means of FSATs, characterized by the special shape of its electrodes, and modeled using PIC255 piezoelectric material. The special shape of the FSAT, allows for focusing wave energy in a certain direction, accordingly to the frequency components of its actuation signal, which makes available a larger monitored area. The process begins when a FSAT detects and records reflection from damage in the structure, this signal is then encoded and prepared for transmission, using a combined approach, based on Compressed Sensing Matching Pursuit and Quadrature Amplitude Modulation (QAM). After codification of the signal is in binary chars the information is transmitted between the nodes in the network. The message reaches the last node, where it is finally decoded and processed, to be used for damage detection and localization purposes. The main aim of the investigation is to determine the location of detected damage using reconstructed signals. The study demonstrates that the special steerable capabilities of FSATs, not only facilitate the detection of damage but also permit transmitting the damage information to a chosen area in a specific direction of the investigated structure.

Keywords : data compression, ultrasonic communication, guided waves, FEM analysis

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