Evaluation of a new source localization method in a simulated dispersive plate

Abstract:
The problem of estimating the location of an impact force in a dispersive medium is complicated given the dispersion-related distortion of the generated traveling wave. The problem cannot be solved, with reasonable accuracy, using conventional time difference of arrival (TDOA) techniques. A building floor is an example of a dispersive medium that is being loaded by occupant footsteps. If more accurate localization algorithms are obtained, then they can be used to localize and track occupants in a building using floor vibration sensors measuring the footstep-induced traveling waves. This paper presents the evaluation of a new localization approach, in a simulated aluminum plate (dispersive waveguide), using a network of sensors measuring the plate's vibration. Average signal power is calculated for all the sensors over a fixed time period, and then used to generate a location estimate. Two different location estimation solutions are presented and compared; a constrained least squares solution (CLS), and a non-linear root finding solution generated using the Levenberg-Marquardt (LM) algorithm. A finite element (FE) thin plate model is used as a testbed to evaluate the performance of the developed localization algorithm by estimating the location of virtual hammer impacts acting on the plate. The results encourage further future development.