Localization Of Lamb Waves: Technique Based On The Inverted Source Amplitude Comparison

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ABSTRACT

Signal localization is a complex problem having a wide range of application. We propose a new localization method on plates which is based on energy amplitude attenuation and inversed source amplitude comparison. This inversion is tested on synthetic data using lamb wave propagation direct model and on experimental dataset (recorded with 4 Brüel & Kjær Type 4374 miniature piezoelectric shock accelerometers, 1 - 26 kHz frequency range). We compare the performance of this technique to the classical source localization algorithms, arrival time localization, time reversal localization, localization based on energy amplitude.

Furthermore, we measure and compare the accuracy of these techniques as function of sampling rate, dynamic range, geometry and signal to noise ratio with a conclusion that this technique, which is very versatile, works better than conventional techniques over a range of sampling rates 10 kHz – 1 MHz. Thus, using this proposed energy based localization method, it is possible to have a decent resolution using a very cheap equipment set.

The experimental setup consist of a glass/plexiglass (Figure 1) plate having dimensions of 80cm x 40cm x 1 cm equipped with four accelerometers and an acquisition card. Generated signals over the glass plate due to a wooden hammer hit or a steel, glass or polyamide ball hit (with different sizes) are captured by sensors placed on the plate on different locations with the mentioned sensors.

The numerical simulations are done using a dispersive far field approximation of the plate waves. The signals are generated using a hertzian loading over the plate. By using the imaginary sources outside the plate boundaries, the effect of the reflections is also included.

This proposed method, can be modified for the application in 3d environments, to monitor industrial activities (e.g boreholes drilling/production activities) or natural brittle systems (e.g earthquakes, volcanoes, avalanches).
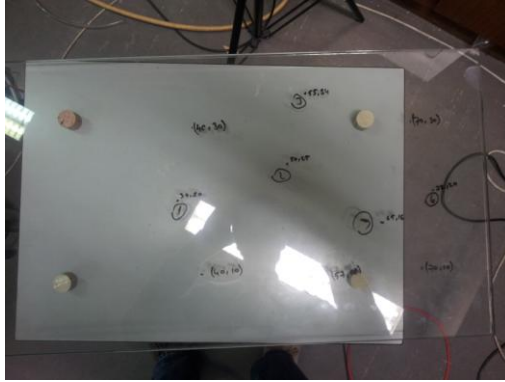
Fig. 1 Glass plate with marked source locations.