ACOUSTICS2008/3250
Landmine detection using nonlinear vibrations excited by time reversal techniques

Brad Libbey[a], Alexander Sutin[b,c] and Armen Sarvazyan[c]
[a]U.S. Army RDECOM CERDEC NVESDS, 10221 Burbeck Rd, Fort Belvoir, VA 22060, USA
[b]Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ 07030, USA
[c]Artann Laboratories, 1753 Linvale-Harbourton, Lambertville, NJ 08350, USA

Time reversal focuses seismic waves and excites nonlinear surface vibrations that are large in the presence of a landmine. These soil vibrations provide an accurate localization cue when contrasted with measurements made without a mine. Traditionally nonlinear effects were investigated by measuring the interaction of harmonic waves and nonlinear resonance frequency shifts. These methods provide high signal to noise ratios, but required tuning of excitation frequencies resulting in test times unsuitable for field applications. Time reversal is capable of providing broad band excitation at amplitudes large enough to drive the nonlinear mechanisms at measurable levels while reducing the overall measurement time. Spatial and temporal focusing data will be presented for three different time reversal systems compromising speakers and vibrators for seismic excitation and a Doppler laser vibrometer and geophones for signal recording. The high amplitude signals generated by these systems adequately drive the nonlinear responses. Special processing techniques, phase inversion and varied amplitude, have been developed to extract the nonlinear responses from the broadband response by cancelling the linear part. The remaining nonlinear response shows greater mine/no mine contrast than the linear data. Practical implementations of the developed methods will be discussed.