Investigation of model based beamforming and Bayesian inversion signal processing methods for seismic localization of underground sources - DTU Orbit (16/05/2019)

Investigation of model based beamforming and Bayesian inversion signal processing methods for seismic localization of underground sources

Techniques have been studied for the localization of an underground source with seismic interrogation signals. Much of the work has involved defining either a P-wave acoustic model or a dispersive surface wave model to the received signal and applying the time-delay processing technique and frequency-wavenumber processing to determine the location of the underground tunnel. Considering the case of determining the location of an underground tunnel, this paper proposed two physical models, the acoustic approximation ray tracing model and the finite difference time domain three-dimensional (3D) elastic wave model to represent the received seismic signal. Two localization algorithms, beamforming and Bayesian inversion, are developed for each physical model. The beam-forming algorithms implemented are the modified time-and-delay beamformer and the F-K beamformer. Inversion is posed as an optimization problem to estimate the unknown position variable using the described physical forward models. The proposed four methodologies are demonstrated and compared using seismic signals recorded by geophones set up on ground surface generated by a surface seismic excitation. The examples show that for field data, inversion for localization is most advantageous when the forward model completely describe all the elastic wave components as is the case of the FDTD 3D elastic model.

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