Reconstruction methods for sound visualization based on acousto-optic tomography

The visualization of acoustic fields using acousto-optic tomography has recently proved to yield satisfactory results in the audible frequency range. The current implementation of this visualization technique uses a laser Doppler vibrometer (LDV) to measure the acousto-optic effect, that is, the interaction between sound and light, over an aperture where the acoustic field is to be investigated. By identifying the relationship between the apparent velocity of the LDV and the Radon transform of the acoustic field, it is possible to reconstruct the sound pressure distribution of the scanned area using tomographic techniques. The filtered back projection (FBP) method is the most popular reconstruction algorithm used for tomography in many fields of science. The present study takes the performance of the FBP method in sound visualization as a reference and investigates the use of alternative methods commonly used in inverse problems, e.g., the singular value decomposition and the conjugate gradient methods. A generic formulation for describing the acousto-optic measurement as an inverse problem is thus derived, and the performance of the numerical methods is assessed by means of simulations and experimental results.