NUMERICAL METHODS FOR THE RECOVERY OF THE SOURCE OF ACOUSTICAL NOISE

Tom DeLillo, Tomasz Hrycak and Nicolas Valdivia
Naval Research Laboratory, USA

Abstract

We consider the inverse problem in acoustics of computing the normal velocities in the boundary of a region from pressure measurements on an interior surface. In this paper we consider the case where the region is three-dimensional. Mathematically the acoustical pressure satisfies the Helmholtz equation inside the region and can be represented as an integral equation of the first kind. The traditional representation of the pressure will be given by the combination of a single layer and a double layer, while a recent approach will represent the pressure as a single layer potential. In both cases the problem is reduced to the solution of an integral equation, which will be discretized into a linear matrix system using the Matlab boundary element methods toolbox NAH 2.1. The resultant linear matrix system is ill-posed and needs to be solved using regularization methods. We will discuss the two representation methods and regularization techniques to this inverse problem and will compare the errors associated with several regularization schemes; Tikhonov, Truncated Singular Value Decomposition and Conjugate Gradients. We also study regularization parameter selection procedures; the Discrepancy Principle, Quasi-optimality Criterion, Hanker and Raus Method, DeLillo and Hrycak Method and Generalized Cross-Validation. We report numerical results for this inverse problem applied to two geometries: a sphere, a cylinder with a floor modeling the interior of an aircraft cabin. The exact test solution is given by a point source exterior to the surfaces with about 1% random noise added.