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IMAGING EXTENDED REFLECTORS IN TWO-DIMENSIONAL WAVEGUIDES

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In this work we consider the problem of detecting and imaging *extended* reflectors submerged in the sea using acoustic waves. The sea is modeled as an acoustic waveguide consisting of a single water layer confined above by the sea surface and below by the seafloor, both assumed to be horizontal, i.e., our waveguide is an infinite strip of constant depth. Note that the term 'extended' indicates that the reflectors are comparable in size to the acoustic wavelength.

We examine the following imaging problem: The extended reflector is illuminated by an active vertical array composed of N transducers that act as sources and receivers. On the array we measure the data in the form of the so-called *array response matrix*. In the frequency domain this is an $N \times N$ complex matrix whose entries are the Fourier transforms of the time traces of the echoes recorded at all receivers when each source emits a signal. To image the reflector, we define a search domain (a bounded subset of our waveguide) and use appropriate imaging functionals, such as *Kirchhoff migration*, which have the property that their values, when they are computed and graphically displayed in the search domain, exhibit peaks that indicate the presence of the reflector. Moreover, we are interested in creating images that focus selectively onto specific parts of the reflector.

To this direction one may employ a selective imaging technique called the subspace projection method [1], which makes use of the singular value decomposition (SVD) of the array response matrix. The concept of selective imaging of extended scatterers has been motivated by the concept of *selective focusing*, cf. the so-called DORT method [2], which concerns the case where there are multiple point (or small) scatterers in the medium and, essentially, allows one to distinguish specific scatterers by creating images that focus separately on each one of them.

In [3] we proposed and analyzed a novel method for selective imaging of extended reflectors in waveguides. Our method is based on Kirchhoff migration and the singular value decomposition of a weighted modal projection of the usual array response matrix. The proposed method was tested on several extended reflector geometries, and was theoretically analyzed for a simplified model of a vertical one-dimensional reflector. In particular, it was shown that the number of 'significant' (non-zero) singular values of the array response matrix is equal to the size of the reflector divided by the array resolution. The assumptions we made in [3] is that the waveguide is homogeneous (with constant sound-speed) and that the array spans the whole depth of the waveguide. Here, we extend the applicability of the method in the case of a waveguide with a sound speed profile that varies with depth. Some preliminary results for the case of partial array aperture are also discussed.

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