Direct and Inverse Acoustic Scattering Problems in a Class of Three-dimensional Waveguide
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This thesis primarily considers direct and inverse time-harmonic acoustic scattering problems. In a direct scattering problem, we are looking for the scattered field resulting from a given scatterer whose location, geometry and acoustic properties are known. In contrast to this, in an inverse scattering problem, we try to recover the geometry of the scatterer given its acoustic properties and the far-field data.

In chapter 2, acoustic scattering in a three-dimensional homogeneous shallow ocean with totally reflecting seabed is considered. The scatterer is assumed to be sound-soft, i.e. the homogeneous Dirichlet boundary condition is imposed on its surface. We solve the direct scattering problem by a higher-order perturbation method. The corresponding inverse problem is solved by the Intersecting Canonical Body Approximation method (ICBA).

In chapter 3, we consider a homogeneous ocean with sloping rigid seabed. The Green's function is constructed by using the method of images. The direct scattering problem is solved by a boundary integral method and the inverse scattering problem by the dual indicator method. The uniqueness and existence of solutions of this inverse problem is also discussed in this chapter.

A shallow ocean with a fluid-like seabed is considered in chapter 4. This chapter consists of a uniqueness theorem of the direct scattering problem in this two-layered waveguide and construction of the Green's function via a multiple-scattering method.

Chapter 5 considers acoustic wave propagation in a composite of two different poro-elastic materials with very rough interface. The effect of the rough interface on acoustic wave propagation is studied by using homogenization to replace the layer which contains the rough interface by a flat layer within which a system of homogenized equations hold. The homogenized equations and the cell problems are derived in this chapter.