3D image reconstruction for underwater objects based on ramp response

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Abstract

Underwater exploration is becoming more and more important for many applications involving physical, biological, geological, and industrial issues. 3D images of the target's shape can give the most direct and useful information for identifying the target. The study of underwater acoustical imaging techniques and acoustical image processing is very important for underwater exploration.

This paper aims at reconstructing 3D image for underwater objects using ramp response signatures. It can be proven that ramp response is proportional to the physical cross-sectional area of the target (as a function of time or distance as the wave propagates over the target). Thus, the target's geometry can be generated from the ramp response. A technique named as "approximate limiting surface technique" is applied to generate the target's 3D image using profile function data at three nonmutually orthogonal viewing angles. It is found that, in general, image quality is somewhat corrected. The modification should be made by an iterative procedure which will adjust the parameters of each surface and will yield a result until the profile function of this generated image at all view angles are consistent with the input ones. In this paper, an automatic iterative mechanism is built to get a suitable aspect ratio each viewing angle which can make results more accurate. The targets presented in this paper include cube, ellipsoid and simplified submarine. The results of 3D images simulation are presented to demonstrate the process of the 3D image generation and indicate that the qualities of the final image are quite acceptable. The further research work is to eliminate the effect of the poles which dominate the late time portion of the response and are excitation invariant.

Keywords: 3D image reconstruction; ramp response; approximate limiting surface; acoustical scattering.