Acoustic source localisation in underwater environment using interval analysis

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Abstract

The study of underwater acoustic wave propagation is used in many fields. It particularly provides solutions to localization and underwater navigation problems [1, 2]. In these cases, simulation can be a powerful tool for a better understanding of acoustic propagation. These simulations are based on models that rely on simplifying assumptions allowing the numerical resolution [3]. However, these assumptions are sometimes too restrictive and can cause inaccuracies, especially in the simulation of complex scenes.

Simulation can also be used to solve more specific problems in underwater environments. For instance, acoustic source localization using receivers in an underwater scene is still a challenging problem and has both civil and military applications. Classical methods are based on the use of acoustic receiver arrays placed in the environment. Assuming a normal modes model for the propagation, collected data are then processed, for example, by SVD based approach [4] or matched field processing [5], which provides probabilistic results.

The proposed approach to solve this problem is to use set theory. The method is to use simulated acoustic amplitude to solve the source localization problem. Using interval analysis, all possible source positions compatible with the recorded hydrophone signal can be enclosed [6]. In addition, possible sets for source position compatible with each receiver can be intersected to increase the certainty of the source location. Besides requiring a good knowledge of the scene, this method requires simulating the acoustic propagation as well as possible to correctly solve this localization problem.

A comparative study is carried out on different models that allow the simulation of acoustic propagation, and a suitable model is chosen for the study. Simulated results are used to localize the acoustic source by using interval analysis that provides guaranteed results. The robustness of the proposed method against noise and measurement errors is assessed and discussed.

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Keywords— Acoustic Propagation, Interval Analysis, Localization, Simulation

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