Efficient tracking of a moving source

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1 INTRODUCTION

Matched-Field Processing (MFP) has been used to process underwater acoustic data for many years and has recently been proposed for use in radar. In MFP the measured data is matched against predictions to produce an "ambiguity" surface which contains the matches for all possible source positions in a search region. Consequently the value of the ambiguity surface at any point reflects the likelihood that the source is at that position in the search region. This paper describes an efficient algorithm for tracking an acoustic or electromagnetic source in scenarios in which the source position is ambiguous during any single look. The source is assumed to be moving at constant speed in a two or three dimensional region and its track is a concatenation of linear and circular subtracks. Such an algorithm enables low signal-to-noise (SNR) ratio targets to be detected or localized by the tracker when the source is not detectable or can not be localized on a single snapshot.

2 THEORY

The algorithm finds the statistically significant subtracks formed by joining the highest peaks on pairs of ambiguity surfaces. Such an algorithm is much more efficient than exhaustive ones which find tracks through all possible source positions [1]. For the scenario in this study, 20 km $\times$ 20 km $\times$ 100 m, 10^{34} tracks would be examined with an exhaustive algorithm. It has been shown for an efficient algorithm that detectable source tracks will be examined with high probability [2]. Weighting the matches at each position in proportion to the expected signal level enables detection of sources with track SNRs as low as 10 dB [1].

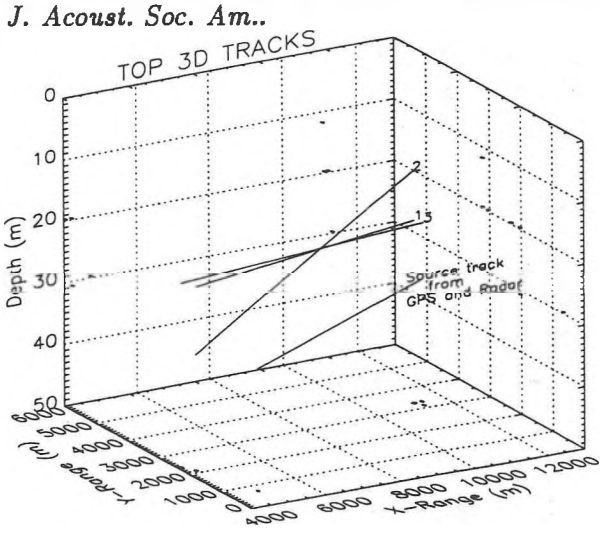
3 EXAMPLE

During PACIFIC SHELF 93 narrowband acoustic data at 45 Hz was collected on a 16 element vertical line array off Vancouver Island in range-dependent shallow-water a few hundred meters deep. This data was employed to form ambiguity surfaces in a range and depth wedge on 30 bearings covering the ocean volume through which the source passed. A 3-dimensional tracker that examines linear tracks, including diving tracks, was applied to the 3D ambiguity volumes formed from the 30 range-depth surfaces at each time interval. As seen in the figure the highest tracks, in the range-depth wedge 0-16 km $\times$ 34° $\times$ 100 m, approximated the source track from GPS and radar which has a 200 m range and 10 m depth uncertainty. This agreement was obtained despite a very limited knowledge of the geoacoustic properties of the environment and bathymetry.

References

[1] M.J. Wilmut, J.M. Ozard, and P. Brouwer, "Evaluation of two efficient target tracking algorithms for matched-field processing with horizontal arrays," *J. of Com. Acoust.* **3**, 311-326 (1995).

[2] M.J. Wilmut and J.M. Ozard, "Detection performance of two efficient source tracking algorithms for matched-field processing," submitted to *J. Acoust. Soc. Am.*.



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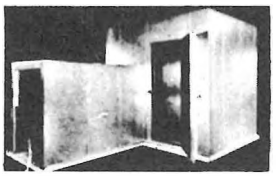

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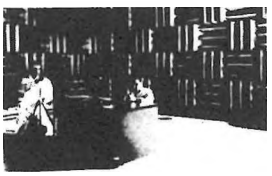

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