Abstract

Matched field processing (MFP) has been extensively explored for use in detecting and localizing underwater sources. By matching the received data to replica vectors, which account for multipath effects, three-dimensional source localization is possible. A significant problem for MFP is that the beamformer output often displays high ambiguities in range and depth, with a single source leading to multiple spatial peaks. This is particularly true for arrays with limited vertical aperture because of their limited ability to resolve multipath. Many of the ambiguous regions may be essentially in the main lobe of the cell of interest, making adaptive suppression of them difficult.

In this paper we explore methods for analyzing and exploiting the structure of the ambiguity surfaces. Statistical clustering methods allow regions of similar response in the ambiguity surface to be identified, using the generalized cosine between replicas as a measure of distance. The cluster analysis gives a map of ambiguous regions in the MFP search space. We present several ways of exploiting this map. First, we demonstrate that computational gains are possible by treating each cluster as a separate "beam" that is represented by a single replica vector. Because the ability to resolve sources is a function of SNR, the appropriate cluster size will depend on SNR as well. This can be built into the adaptive beamforming by allowing beamforming at multiple resolutions. Second, we show how the cluster map can be used in post-processing. By "peak-picking" in cluster space, rather than in spatial dimensions, we are able to identify and discard spatial ambiguities that result from the presence of a strong source.