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Optimal source tracking in an unknown ocean environment

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This paper develops and compares two approaches to localizing and tracking a low-level acoustic source when ocean environmental properties are unknown. Both approaches are based on a Bayesian formulation in which source and environmental parameters are considered random variables constrained by noisy acoustic data and by prior information on parameter values (e.g., physical limits for water-column and seabed properties) and on inter-parameter relationships (e.g., limits on horizontal and vertical source speed). One approach is based on determining the source track and environmental parameters that maximize the posterior probability density (PPD) using adaptive hybrid optimization. A key to solving this challenging problem efficiently is that the Viterbi algorithm is applied to compute the highest-probability source track for each environmental realization considered in the optimization-this provides the optimal track while requiring the optimization is applied only to environmental parameters. The second approach involves integrating the PPD over unknown environmental parameters to represent source-track information as a series of joint marginal probability surfaces over range and depth. The Viterbi algorithm is applied to extract the optimal track from these surfaces. For realistic environmental models (e.g., more than a dozen unknown parameters), the integration is carried out using efficient Markov-chain Monte Carlo methods.