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Title: Autonomous Oceanographic Sampling Designs Using Excursion Sets for Multivariate Gaussian random fields

Abstract:

Improving and optimizing oceanographic sampling is a crucial task for marine science and maritime management. Faced with limited resources to understand processes in the water-column, the combination of statistics and autonomous robotics provides new opportunities for experimental designs. We develop methods for efficient spatial sampling to map salinity and temperature characteristics in the ocean. Specifically, we define a design criterion based on improved characterization of the uncertainty in the excursions of vector-valued Gaussian random fields, and derive tractable expressions for the expected Bernoulli variance reduction in such a framework. We demonstrate how this criterion can be used to prioritize sampling efforts at locations that are ambiguous, making exploration more effective. We use simulations to study the properties of methods and to compare them with state-of-the-art approaches, followed by results from field deployments with an autonomous underwater vehicle in a river plume. The results demonstrate the potential of combining statistical methods and robotic platforms to effectively inform and execute data-driven environmental sampling.