Correlation of Imaging Sonar Shadows and Bathymetry for Underwater Robotic Localization
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The ability to localize an underwater remotely-operated vehicle (ROV) accurately with respect to seafloor terrain enables safer operation and improved navigation to sites of interest. Typical ROV positioning is accomplished through acoustic triangulation of the ROV from the surface vessel, e.g. using an ultra-short baseline (USBL) system. While this method of ROV positioning may be suitable for some mission profiles, it does not provide a terrain-relative position estimate of the ROV, and as such is insufficient for missions requiring accurate knowledge of ROV position relative to the seafloor.

This work demonstrates the use of sonar imagery as an automated pilot aid for localization of an underwater ROV with respect to a stored bathymetric terrain map. Specifically, a method is presented to correlate acoustic shadows in sonar imagery with expected visibility images generated from a bathymetry map, where acoustic shadows are significant drops in the sonar image intensity. An expected visibility image is generated for a given ROV position estimate with respect to a stored terrain map by extracting a bathymetry profile along the sonar scan plane and then evaluating a metric termed “differential height” to quantify visibility probability in the pixel space of the sonar image. Results from Monterey Bay Aquarium Research Institute (MBARI) ROV field trials using a Kongsberg mechanically-scanned imaging sonar are presented that demonstrate localization using the proposed method.