Advances in Precision Navigation of low-cost Underwater vehicles

Giancarlo Troni
Post-doctoral Fellow
University of Michigan, NAME Dept.
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ABSTRACT  Ocean exploration is advancing dramatically due to advances in underwater vehicles. However, the multi-million dollar cost of current high-end vehicles typically employed for oceanographic missions limit their widespread use. New low-cost vehicles present a viable alternative for oceanographic exploration but, due to the limited accuracy of their low-cost navigation systems, they are presently limited to missions requiring only low-precision navigation. The goal of this talk is to present new methodologies for improving precision navigation for low-cost underwater vehicles.

Two common problems in the field are addressed in this talk. First this talk reports novel methodologies for estimating the sensor bias of magnetometers. Three methods based on batch linear least squares, real time Kalman filter, and real time adaptive identification are reported. These methods impose less restrictive conditions for the movements of the instrument required for calibration than previously reported methods, do not require knowledge of the direction of the field or the attitude of the instrument, and also ensure convergence for the estimated parameters.

The second problem is the development and experimental evaluation of new methods for in-situ calibration of the alignment rotation matrix between Doppler sonar attitude sensors. Two new methods are developed employing inertial data, depth data, and Doppler sonar data to perform alignment calibration. An advantage of the presented approach over previous methods is that it does not require expensive sensors external to the vehicle, so the overall calibration effort is reduced.

Improved calibration and attitude estimation methods are shown experimentally to improve the precision navigation position estimation when using low-cost sensors. These results may be useful in the development of lower-cost navigation systems for small and low-cost underwater vehicles for oceanographic missions.