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Low energy ultrasonic single beacon localization for testing of scaled model vehicle

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Abstract. Tracking the location (position) of a surface or underwater marine vehicle is important as part of guidance and navigation. While the Global Positioning System (GPS) works well in an open sea environment but its use is limited whenever testing scaled-down models of such vehicles in the laboratory environment. This paper presents the design, development and implementation of a low energy ultrasonic augmented single beacon-based localization technique suitable for such requirements. The strategy consists of applying Extended Kalman Filter (EKF) to achieve location tracking from basic dynamic distance measurements of the moving model from a fixed beacon, while on-board motion sensor measures heading angle and velocity. Iterative application of the Extended Kalman Filter yields x and y co-ordinate positions of the moving model. Tests performed on a free-running ship model in a wave basin facility of dimension 30 m by 30 m by 3 m water depth validate the proposed model. The test results show quick convergence with an error of few centimeters in the estimated position of the ship model. The proposed technique has application in the real field scenario by replacing the ultrasonic sensor with industrial grade long range acoustic modem. As compared with the existing systems such as LBL, SBL, USBL and others localization techniques, the proposed technique can save deployment cost and also cut the cost on number of acoustic modems involved.

Keywords: Low Energy Ultrasonic based Beacon (LEUB), Extended Kalman Filter (EKF), Autonomous Surface Vehicle/ Underwater Vehicle (ASV/UV)

1. Introduction

The general class of oceanographic exploratory research vehicles includes the Autonomous Underwater Vehicles (AUVs), Autonomous Surface Vehicles (ASVs) and Remotely Operable Vehicles (ROVs). These are widely used in scientific, military and commercial applications which include oceanographic surveying and mapping, exploration and production of oil and gas, hull inspection and mine detection (Nicholson and Healey 2008). These vehicles require reliable navigation system for trajectory tracking, geo-referencing of data acquired during their mission and for recovery of the vehicle after the mission (Leonard *et al.* 1998). There are three main types of navigation systems for the general class of marine vehicles operating at or below the surface,

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