A High Performance IMU Based Navigation System for a Small Size ROV

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Abstract: The latest technological developments on electronics, mechanics, optics, and other areas have made possible the availability of low cost and high performance sensors for navigation. This opens doors to the development of high accuracy navigation systems to be used on low cost small size underwater vehicles.

In this context this paper describes the development and implementation of the navigation system for the remotely operated vehicle (ROV) of the IES Project. The goal of this project is the construction of a prototype of a low cost open system for underwater structures inspection, based on a small size ROV.

The purpose of the navigation system of the vehicle is to compute in real time the best estimates of its position, attitude and linear and angular velocities. These estimates are used by the ROV control system to close the feedback loops, and also by the operator to drive the vehicle. To compute those estimates, the navigation system receives information from a high performance IMU (Honeywell HG1700 – AG12), a Doppler Velocity Logger (Sontek Argonaut DVL), a pressure sensor (KPSI 735-430), a magnetic compass (Precision Navigation – TCM2), and also from an acoustic positioning system.

The IMU supplies measurements of linear accelerations and angular velocities at high data rates. The DVL outputs the velocity of the vehicle with respect to the ground at a lower data rate. The outputs of these systems are integrated to produce dead-reckoning estimates of position and attitude. The uncertainty of the dead-reckoning estimates increases with time due to the integration process.

The pressure sensor is used to measure the vehicle depth and the magnetic compass outputs its heading. The acoustic positioning system relies on a network of transponders deployed in the operation area and produces range measurements form the vehicle to these transponders based on time of flight of exchanged signals. These ranges are more or less likely to be corrupted due to changes in propagation properties of the media. Nonetheless, these measurements do not drift in time and can therefore be used to correct the dead-reckoning estimates, bounding their uncertainty.

A Kalman filter based process is used to fuse all the data. This process produces the best real time estimates of position, attitude and velocities, taking advantage of the complementary characteristics of the data. In fact, we have on one hand high rate measurements with long term drift and on the other low rate data without drift but possibly affected by noise. The data fusion algorithm can detect spurious erroneous data and prevent their inclusion in the estimation process.

The paper will present the data fusion algorithm and discuss the major factors that affect the performance of the navigation system. The process of alignment and calibration of the sensors will be presented too. Although the system is still in development, preliminary results illustrating the approach are presented and discussed. These results will demonstrate the accuracy of the estimates produced by the navigation system.

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