Informatik og Matematisk Modellering

M.Sc. Project

Project Title: Modelling and Characterisation of a Ring Laser Gyro Inertial Measurement Unit

Based: IMM, Technical University of Denmark (DTU)

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Background & Rationale

An *inertial navigation system* (INS) is at the core of most modern high performance vehicle navigation systems (aeroplanes, missiles, autonomous robots, submarines, …). Self-contained inertial navigation is performed using measurements from an *Inertial Measurement Unit* (IMU). An IMU is composed of 3 *accelerometers* and 3 *gyros*. Gyro measurements are used to maintain knowledge of orientation. Accelerometer measurements, when carefully compensated for gravity and Coriolis force, can be integrated into velocity and position. A high performance INS can autonomously determine its absolute orientation relative to the Earth via sensing of Earth gravity and its rotation.

Accuracy is of critical importance to many applications of inertial technology. Sensors of the type used in high end commercial IMU's (50-80k€ in 2007) are accurate to approx. 0.03 deg/hour (gyros) and 100μG (accelerometers). It can be shown that 0.03 deg/hour gyro drift is equivalent to a drift in position of 3km/hour and a heading (North) error of 0.1 deg.

Project description

The project aims to apply *modern system identification techniques* to enhance Inertial Measurement Unit (IMU) accuracy and navigation system performance. Deterministic sensor errors are modelled and calibrated. Statistical models of residual non-deterministic IMU errors are established for use in multi-sensor fusion, e.g. GPS/INS.

Experimental data sets are obtained from a high end commercial inertial navigation system made available for the project. A mathematical model of IMU errors is developed - based on a mix of models from literature and analysis of experimental data. A procedure for experimental determination and compensation of deterministic errors is implemented:

- Sensor axis misalignment (mounting), bias, scale factor, ...

Algorithms and procedures that allow IMU calibration with minimum use of specialized test equipment are sought. Results are incorporated into industrial IMU manufacturing and navigation system operational procedures.

Competency Requirements:

- *Statistics and mathematics, preferably knowledge of time series analysis and Kalman filtering*
- *Matlab practical experience, other programming skills are a plus.*

Duration and location: 6-9 months, IMM-DTU, Sonardyne UK (near London).