Instructions of the project

Goal

The goal of the project is to perform a uncertainty analysis quantification of the automatic balancing system of a spherical bearing platform used for for attitude determination and control system testing.

Short description of the test rig and the balancing algorithm

An Attitude Determination and Control System (ADCS) is the system of a satellite responsible for estimating and changing the satellite orientation by dedicated sensors and actuators. ADCS is commonly tested on the Earth through a test rig composed of a platform holding the ADCS that can freely float upon a spherical air bearing (see Figure 1). In order to simulate torque-free motions experienced by the satellite in the space, the platform must be perfectly balanced. It means that the torque due to gravity effects must be minimized by making the center of mass of the system to be coincident with the center of rotation of the bearing. The balancing process is very difficult to be performed manually. Thus, an automatic system is advocated for peforming this task. The provided Matlab model simulates the dynamics of the floating system and the response of an automatic balancing system proposed in the literature (Young1998). In particular, the model output gives the estimate of the center of mass of the system. A complete modeling of the system balancing would also involve the process of moving the center of mass by moving counterweights.

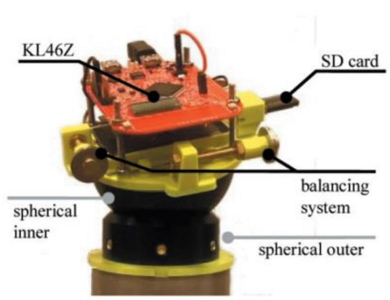

Figure 1: Test article mounted on the floating platform equipped with a 2-axis manual balancing system

Uncertainty analyses

The automatic balancing algorithm estimates the position of the center of mass basing on IMU measurements (accelerometer and gyro). Since the measurements are affected by sensor noise, then the resultant estimate will be in turn affected by uncertainty. Quantify the amount of uncertainty using the following two methods:

- Monte Carlo
- First Order Second Moment (FOSM)

Assume an offset of the center of mass with respect to center of rotation and levels of noise of the sensors as follows:

<u>Case 1 (high noise)</u>

`RG_SYS` = [0.002, -0.002, -0.005] [m]
`noiseGyro` = 2 [rad/s]
`noiseIMU` = 1 [m/s^2]

<u>Case 2 (moderate noise)</u>

`RG_SYS` = [0.002, -0.002, -0.005] [m]
`noiseGyro` = 0.5 [rad/s]
`noiseIMU` = 0.05 [m/s^2]

<u>Case 2 (low noise)</u>

`RG_SYS` = [0.002, -0.002, -0.005] [m]
`noiseGyro` = 0.01 [rad/s]
`noiseIMU` = 0.01 [m/s^2]