Towards attitude, velocity and position estimation with gyro-free inertial and magnetic sensors array

Open PhD position at GIPSA-Lab, Grenoble, France.

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Attitude and position estimation as well as tracking is a crucial problem that occurs in a wide range of applications. It has attracted continuous attention in the last decades in many applications such as robotics, pedestrian navigation, UAV, to name just a few. The attitude is represented sometimes by Euler angles, rotation matrix or quaternion. The position represents the linear displacement in 3D (x, y, z). In indoor applications, only proprioceptive measurements can be used and then GPS data is missing.

Traditionally a standard inertial measurement unit (IMU) comprised of 3-axis linear acceleration measurement by accelerometers installed at center of mass and 3-axis angular velocity measurement by rate gyros readily provides complete attitude motion-related measurements spanning the 3-dimensional space [1, 2]. Sometimes a 3-axis magnetometer is added to complete the attitude with heading (yaw angle). The gyroscope-free inertial measurement unit (GF-IMU) is one of the more popular IMU methods to derive linear acceleration, angular acceleration, and angular velocity [3, 4]. Compared to the traditional IMU, the GF-IMU utilizing only accelerometers includes several features such as low-cost, easy calibration, being less affected by temperature variations, and a simple mechatronic setup. Some recent works propose to use a set (6, 9, etc.) of 3-axis accelerometers, complemented sometimes by one 3-axis magnetometer. Kalman filters and observers are proposed to be used to combine these measurements. The proposed work in this thesis consists in revisiting these configurations/estimation approaches and combining with recent magnetic navigation approaches [5, 6, 7, 8, 9]. The goal is to estimate attitude and velocity in a first step and later focus on the observability of position state.

This work will be conducted in collaboration between an academic lab (Gipsa-Lab) and the SYSNAV company, under the supervision of Hassen Fourati and Christophe Prieur for the preparation of the PhD of the University Grenoble Alpes.

- **Profile:** The candidat should have a solid background in control theory (observers, nonlinear dynamics), and computer skills in Matlab and C/C+ are welcome.
- **Location:** GIPSA-Lab, Grenoble University East Campus, Grenoble, France.
- **Dates:** Beginning: October 2019. Duration: 3 years.
- **How to apply:** Applications should be declared as soon as possible. The position may be closed as soon as a competent candidate has applied. Please include the CV, marks and a list of (at least) two references to one of the advisors.

References

[1] H. Fourati, N. Manamanni, L. Afilal, and Y. Handrich, Complementary Observer for Body Segments Motion Capturing by Inertial and Magnetic Sensors. IEEE/ASME Transactions on Mechatronics, vol. 19, no. 1, pp. 149-157, Feb. 2014.

[2] P. Martin, E. Salaün, Design and implementation of a low-cost observer-based attitude and heading reference system. Control Engineering Practice, vol. 18, no. 7, pp. 712-722, 2010.

[3] H. Naseri, M.R. Homaeinezhad, Improving measurement quality of a MEMS-based gyro-free inertial navigation system. Sensors and Actuators A: Physical, no. 207, pp. 10-19, 2014.

[4] C.F. Kao, T.L. Chen, Design and analysis of an orientation estimation system using coplanar gyro-free inertial measurement unit and magnetic sensors. Sensors and Actuators A: Physical, no. 144, pp. 251-262, 2008.

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[6] D. Caruso, A. Eudes, M. Sanfourche, D. Vissiere and G. le Besnerais, An inverse square root filter for robust indoor/outdoor magneto-visual-inertial odometry, 8th Conf. on Indoor Positioning and Indoor Navigation (IPIN'17), Sapporo, Japan, 2017.

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