Estimating the attitude by IMU/vision measurements in navigation: an automatic control approach

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

Advisors: Hassen Fourati and Christophe Prieur
Email : Hassen.Fourati@gipsa-lab.fr and Christophe.Prieur@gipsa-lab.fr

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 satellite positioning, radar, robotics, pedestrian navigation, UAV, to name just a few. Being able to track a vectorial quantity/direction with a real-time algorithm is still not a completely solved problem and only approximate solutions are available today.

In the context where the recording sensors are inside a moving vehicle or inside of a building, many external perturbations add up and performing a thorough estimation of the time-varying state of the body and of the magnetic heading is an even more complicated challenge. Among the possibly recorded data, the magnetic field is exposed to many non-stationary noise sources and a smart denoising scheme needs to be developed to fully exploit the signal.

Developing algorithms which are able to accurately track, in a noisy environment, the true magnetic north is thus a challenging problem with many potential applications. When the measurements (magnetic and inertial) are made inside a building, external sources of noise are the one that alter the most the recorded signals. In addition, as the recorded quantities are vectorial by nature (magnetic field and motion), the extension of classical observer design approach (Kalman and Luenberger) is not trivial. One needs to take into account the non-linear nature of the system evolution to tackle the problem, together with a high robustness to model error and/or variability. Extended Kalman filter (EKF) is a known approximate solution that allows to deal with non-linearity [1, 4, 5]. Some authors have also incorporated the nonlinear nature of the measurement by using specific observer designs [6, 7, 8].

The proposed work will consist in exploring different approaches to estimate the attitude and position of the body by using magnetic, inertial and vision measures [2, 3]. Vision and depth measures are given by algorithms written in C/C+, whereas the other measures are physical sampled signals. Each type of measure has its own bias, drift, and possible perturbation, but we aim in designing new estimation algorithms. A possible track will consist in developing a thorough model of all the measured signals (continuous time and discrete time) in the context of developing a new observer, integrating all measures in one step, and not using separate objectives and separate observers, with a post-processing of observer outputs [9].

This work will be conducted in collaboration between an academic lab (Gipsa-Lab) and the SYSNAV company. First experimental tests can be achieved in Gipsa-Lab with the vicon system as a ground truth. Later, real datasets acquisition will be made using SYSNAV facilities and will be used to benchmark the developed algorithms. Depending of the achieved tasks, this PhD thesis may be followed by a work contract in the industrial partner or in an academic organization.

- **Profile:** The candidat should have a solid background and a MSc in control theory (observers, non-linear dynamics), and computer skills in Matlab and C/C+ are welcome.
- **Location:** GIPSA-Lab, Grenoble University East Campus, Grenoble, France.
- **Dates:** Beginning: As soon as an application has been selected. Duration: three years.
- **How to apply:** Applications should be declared as soon as possible, and not later than September 2018. The position may be closed as soon as a competent candidate has applied. Please include a detailed resume, the CV and a list of (at least) two references to one of the advisors.

References

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[2] D. Caruso, M. Sanfourche, G. Le Besnerais and D. Vissire, Infrastructureless indoor navigation with an hybrid magneto-inertial and depth sensor system, 7th Conf. on Indoor Positioning and Indoor Navigation (IPIN'16), Madrid, Spain, 2016.

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[6] L. Fusini, T. I. Fossen, T. A. Johansen, Nonlinear Observers for GNSS- and Camera-Aided Inertial Navigation of a Fixed-Wing UAV. IEEE Transactions of Control Systems Technology. to appear, 2017.

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[8] 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.

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