Merging IMU/vision measurements and estimating the attitude for navigation tracking

Open internship 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 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, 5, 6]. Some authors have also incorporated the nonlinear nature of the measurement by using specific observer designs [7, 8, 9].

The proposed work will consist in merging physical data coming from IMU and visual sensors. The data are collected on a true experimental device with the industrial partner. Then different approaches to estimate the attitude and position of the body may be considered, following e.g. [2, 3, 4]. 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.

This work will be conducted in collaboration between an academic lab (Gipsa-Lab) and the SYSNAV company, in collaboration with Makia Zmitri, PhD student under the supervising of H. Fourati and C. Prieur. Depending of the achieved tasks, this internship may be followed by a PhD thesis on a close subject.

- **Profile:** The candidat should have a solid background in control theory (observers, nonlinear dynamics), and computer skills in Matlab and C/C+ are welcome. MSc students are welcome
- **Location:** GIPSA-Lab, Grenoble University East Campus, Grenoble, France.
- **Dates:** Beginning: January/February 2019. Duration: several months.
- **How to apply:** Applications should be declared as soon as possible, and not later than December 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

[1] D.O. Anderson and J.B. Moore, Optimal filtering, Dover Books on Electrical Engineering, Mineola, N.Y., Dover Publications, 2005.

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[4] C.-I. Chesneau, Navigation à l'estime magnéto-inertielle en champ inhomogène, et applications en intérieur, PhD thesis, Univ. Grenoble Alpes, 2018

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[6] C.-I. Chesneau, M. Hillion, and C. Prieur, Improving magneto-inertial attitude and position estimation by means of a magnetic heading observer, 8th Conf. on Indoor Positioning and Indoor Navigation (IPIN'17), Sapporo, Japan, 2017.

[7] 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.

[8] 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.

[9] 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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