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Editorial for special collection on the estimation and control of MAV navigation in GPS-denied cluttered environments

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New types of missions are being addressed by micro air vehicles (MAVs) in GPS-denied environments, which can be either indoor buildings or plants or outdoor facilities such as electrical substations or forests. These places can be highly uncertain with no previous mapping available and with little prior information, as well as highly cluttered and possibly containing dynamical objects.

Progress in technology and automation has made it possible to embed cameras (monocular, stereo or more) or laser scanners as main sensors on MAVs, which can be associated in a sensor fusion scheme with an inertial measurement unit and – depending on payload mass allowed – small-scale sonar or depth sensors.

However, safe navigation for autonomous surveillance or inspection missions in this type of challenging environment still requires the development of new sensor-based estimation and control algorithms that can be embedded on multi-rotor or flapping-wing MAVs with limited on-board computational capabilities.

This special issue covers several aspects of the research effort on this topic, ranging from localization issue using a limited number of sensors to control or learning-based approaches for achieving specific tasks.

Vina and Morin[1] present a methodology to obtain complete 3D local pose estimates in electric tower inspection tasks (where GPS localization is disturbed) with MAVs, using an on-board sensor setup consisting of a 2D LiDAR, a barometer sensor and an inertial measurement unit (IMU).

Chojnacki and Indelman[2] present a vision-based method using a light bundle adjustment procedure for simultaneous robot motion estimation and dynamic target tracking, while operating in GPS-denied unknown or uncertain environments.

Yu et al.[3] propose an end-to-end landmark detection system based on a deep convolutional neural network and an associated embedded implementation on a graphics implementation processing unit to perform vision-based autonomous landing.

In van Hecke et al.,[4] a self-supervised learning strategy is proposed for the safe navigation among obstacles of a flying robot using very light embedded vision sensors. The proposed learning mechanism relies on distance estimates provided by stereo vision and then learns how to perform this estimation using only monocular information.

Tripicchio et al.[5] address the problem of semi-automatic navigation in confined environments using laser-based localization, with application to the inspection of an industrial combustion chamber with poor lighting conditions, in the presence of magnetic and communication disturbances, iron dust and repetitive patterns on the structure walls.

Sarras et al.[6] treat the problem of simultaneous collaborative localization and control for a fleet of MAVs tracking a common target using only range and velocity measurements. The proposed solution combines local filters for each agent and cooperative filters to estimate all positions, which are then used in a dynamic consensus control law to track the target without any

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external reference which makes it applicable in GPS-denied environments.

In summary, these papers report a number of contributions on sensor integration, signal processing and control algorithms associated to validations based on simulations and experimental data, which should pave the way to future developments and widespread use of MAV technology in future applicative scenarios involving indoor and cluttered environments.

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