PhD position @ ISAE-SUPAERO

Performance study on multi-sensor collaborative navigation of unmanned vehicles in constrained environments

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Summary:

This thesis is in the general context of collaborative autonomous systems such as UAVs (Unmanned Aerial Vehicles) or UGVs (Unmanned Ground Vehicles), operating in challenging environments.

Global Navigation Satellite Systems (GNSS), such as GPS, have become widely used for localization purposes. They provide geo-positioning with global coverage for civil and military use and allow portable receivers to determine their position on the earth with an accuracy ranging from a few tens of meters to a few meters depending on the environment (countryside, semi-urban, urban). The performance of a GNSS receiver is widely known to be very good in open sky conditions (at least four satellites in full view) but may strongly decrease in difficult situations, such as natural/ urban canyons, wooded areas, inside buildings, at high latitudes, or in the presence of electromagnetic interference. Such environments can adversely affect availability, time to first fix (TTFF), accuracy, and integrity.

Nowadays, multi-standard devices are more and more interconnected, and so-called collaborative approaches may probably become an alternative, or a complement, to satellite positioning systems in constrained environments. Indeed, collaborative positioning (CP), in contrast with traditional self-positioning, allows the localization of a set of mobile devices by exploiting not only local information on the devices themselves but also external information received from neighbor devices. However, precise vehicle positioning in collaborative approaches can be a critical matter when dealing with applications such as autonomous navigation of a fleet of vehicles, or collision avoidance, and a need to assess the performance of the CP algorithm is essential. Although, performance analysis of collaborative positioning algorithms is a challenging task since there are many impact factors (i.e. number of devices, their distribution and relative distance measurement accuracy, etc.).

This thesis project focuses on multi-sensor collaborative approaches, allowing a joint improvement of the PVT (Position, Speed and Time) of several vehicles (UAVs or UGVs) in a constrained environment.

More specifically, the study will focus on evaluating the performance of collaborative algorithms based on the factors impacting the systems.

Collaborative approaches will be based on GNSS and IMU (Inertial Measurement Unit) hybridization, coupled to ultra-wideband (UWB) signals and/or a vision system (monocular / stereo cameras).