PhD in Aerospace Engineering

Research Title: Artificial Intelligence Applications for Drones Navigation in GPS-Denied Environments

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**Context of the research activity**

The purpose of the project is the investigation of navigation issues connected with urban environments, where the degraded acquisition of GNSS signals and the presence of obstacles may compromise the efficient and safe operations of autonomous systems, aerial and ground vehicles as an example. A robust approach to the problem is mandatory, enabling the vehicle navigation system to handle seamlessly the transition among different conditions (outdoor, GNSS-degraded and GNSS-denied) while guaranteeing a safe motion path with respect to the surrounding environment. The project will implement innovative localization and navigation solutions based on Cloud-based Artificial Intelligence algorithms. The Cloud framework will be employed for multi-source big data off-board storage and computation. Artificial intelligence algorithms will be used to build, update, analyse and process the set of information required for the safe and accurate vehicle localization and navigation. Information will include, among others, GNSS and 4G/LTE/5G signals and their quality, vehicle on-board sensors data and obstacles occupation maps. A bidirectional datalink will allow the vehicle to access and provide in real time the required information. Solutions will be validated with robotic real world experiments.

**Objectives**

The scope of the project is to address the challenges pursuing the following high-level objectives:

- Definition and implementation of a Cloud architecture for navigation and motion planning information storage and processing relying on Artificial Intelligence algorithms
- Research on seamless positioning technologies in order to grant localization continuity by integration between GPS and Galileo GNSS services and communication systems of the new generation, 5G in particular
- Research on sensor fusion techniques to increase position accuracy and precision in GNSS degraded or denied environments, with a focus on Visual Inertial Odometry and SLAM
- Research in the field of motion planning for obstacle detection, recognition and avoidance for autonomous navigation in urban
outdoor and indoor environment, with a particular attention to Unmanned Aerial Vehicles (UAVs)

- Research in the field of autopilot firmware development and implementation to grant continuity of the services in non-standard GNSS environments
- UAV flight tests in dedicated areas (i.e. involving the test range DoraLab in Turin city area) are planned to evaluate and validate the overall system approach.

### Skills and competencies for the development of the activity

A solid background in aerospace engineering, mechatronics and applied mathematics is required as a prerequisite for the present research activity. Minimum programming skills are also mandatory.