PhD in Aerospace Engineering

Research Title:
Planning and Control Strategies for Collaborative Aerial and Maritime Autonomous Vehicles

Funded by	MIUR – Fondo per il sostegno dei giovani

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Contact	A detailed overview of the Department of Mechanical and Aerospace Engineering (Politecnico di Torino) is presented in http://www.polito.it/.

Context of the research activity	Over the past years there has been a significant growth in the development of unmanned air vehicles (UAVs) and underwater autonomous vehicles (AUVs) driven in part by the need to gather additional data to support civil and military activities as well as from Earth and maritime scientists who are becoming increasingly aware of this potentially huge opportunity and cost benefit when applied to the collection of data. Depending on the type of data required and the desired mission and budget, there are several systems from which to select. The core of the proposed activity is the development of a comprehensive AUV/UAV modular simulator including vehicles' dynamics and conventional autonomous navigation functions according pre-assigned waypoints' sequences. The dynamics of the vehicles is based on a state-space representation of the platforms while the response of their propulsion system is reproduced by user-defined routines. This approach enables the extension of the model to different types of vehicles and architectures. Both the aerial (rotary or fixed wing aircraft) and the underwater vehicles operate in a demonstrative environment including models for physical obstacles/threats and a simplified network of distributed sensors (sparse). The vehicles are expected to host mobile sensors (payload) modeled in the simulation tool. A model for the data link of the ground segment (Ground Control Station supervising the mission of the aerial vehicle with uplink and downlink of navigation data) may be included for sake of completeness of the operative scenario. The navigation paths reproduced by the simulator should be generated according to selected planning strategies such as (i) geometric patterns (2) optimal grids (optimized for on-board mobile sensors) and (3) optimal algorithms (A*/Theta* solvers as an example) providing stable communication link between the vehicles and the distributed sensors, also enforcing separation from physical obstacles/threats. Static domains and navigation patterns are assumed. An extension to the simulation of collision avoidance functions may be also considered (including the elaboration of the data from on-board and distributed sensors).

Objectives	The main output of the proposed project is the development of a comprehensive simulation tool available for the assessment of cooperative surveillance missions involving both aerial and underwater vehicles, or more specifically the verification of (a) the line-of-sight between the vehicles and the stability of the communication link (b) the surface marked by on-board mobile sensors (c) the separation from static obstacles/threats (d) the functional interaction of the vehicles with the distributed sensors and ground segment (e) the energy budget for navigation (f) the performance metrics. The generation of navigation paths is another relevant output of the package.

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