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An Innovative Unmanned System for Advanced Environmental Monitoring: Design and Development

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The paper summarizes the design and development of a new technology and tools for real-time coordination and control of unmanned vehicles for advanced environmental monitoring.
A new Unmanned System has been developed at Institute for Coastal Marine Environmental – National Research Council (Italy), in the framework of two National Operational Programs (PON): Technological Platform for Geophysical and Environmental Marine Survey-PITAM and Integrated Systems and Technologies for Geophysical and Environmental Monitoring in coastal-marine areas-STIGEAC.
In particular, the system includes one Unmanned Aerial Vehicle (UAV) and two Unmanned Marine Vehicles (UMV).
Major innovations concern the implementation of a new architecture to control each drone and/or to allow the cooperation between heterogeneous vehicles, the integration of distributed sensing techniques and real-time image processing capabilities. Part of the research in these projects involves, therefore, an architecture, where the ground operator can communicate with the Unmanned Vehicles at various levels of abstraction using pointing devices and video viewing.
In detail, a Ground Control Station (GCS) has been design and developed to allow the government in security of the drones within a distance up to twenty kilometers for air explorations and within ten nautical miles for marine activities. The Ground Control Station has the following features:
1. hardware / software system for the definition of the mission profiles;
3. autonomous and semi-autonomous control system by remote control (joystick or other) for the UAV and UMVs;
4. integrated control system with comprehensive visualization capabilities, monitoring and archiving of real-time data acquired from scientific payload;
5. open structure to future additions of systems, sensors and / or additional vehicles.
In detail, the UAV architecture is a dual-rotor, with an endurance ranging from 55 to 200 minutes, depending on payload weight (maximum 26 kg) and wind conditions, and a capability to survey an area of up to 5x5 square kilometers.
The UAV payload consists of three different types of sensors: a laser scanner, a thermal-camera and an integrated camera reflex with gimbal. The laser scanner has 10 mm survey-grade accuracy and a field of view up to 330°. The thermal-camera has a resolution 640x480 pixels and a thermal sensitivity <20 mK (at 30 °C), while the reflex is a 22.3 Megapixel full-frame sensor.
In addition to the common applications, such as generating mapping, charting, and geodesy products, the system allows performing real-time survey and monitoring of different natural risk under dangerous condition. The system is, also, address to environmental risk monitoring and prevention, industrial activity and emergency interventions related to environmental crises (i.e. oil spills).