

## Mountain Search and Rescue with Remotely Piloted Aircraft Systems

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Remotely Piloted Aircraft Systems (RPAS) also known as Unmanned Aerial Systems (UAS) are nowadays becoming more and more popular in several applications. Even though a complete regulation is not yet available all over the world, researches, tests and some real case applications are wide spreading. These technologies can bring many benefits also to the mountain operations especially in emergencies and harsh environmental conditions, such as Search and Rescue (SAR) and avalanche rescue missions.

In fact, during last decade, the number of people practicing winter sports in backcountry environment is increased and one of the greatest hazards for recreationists and professionals are avalanches. Often these accidents have severe consequences leading, mostly, to asphyxia-related death, which is confirmed by the hard drop of survival probability after ten minutes from the burying. Therefore, it is essential to minimize the time of burial. Modern avalanche beacon (ARTVA) interface guides the rescuer during the search phase reducing its time. Even if modern avalanche beacons are valid and reliable, the seeking range influences the rescue time. Furthermore, the environment and morphologic conditions of avalanches usually complicates the rescues.

The recursive methodology of this kind of searching offers the opportunity to use automatic device like drones (RPAS). These systems allow performing all the required tasks autonomously, with high accuracy and without exposing the rescuers to additional risks due to secondary avalanches. The availability of highly integrated electronics and subsystems specifically meant for the applications, better batteries, miniaturized payload and, in general, affordable prices, has led to the availability of small RPAS with very good performances that can give interesting application opportunities in unconventional environments.

The present work is one of the outcome from the experience made by the authors in RPAS fields and in Mechatronics devices for Mountain Safety and shows the design, construction and testing of a multipurpose RPAS to be used in mountain operations. The flying, multi-rotors based, platform and its embedded avionics is designed to meet environmental requirements such as temperature, altitude and wind, assuring the capability of carrying different payloads (separately or together) aimed to:

- Avalanche Beacon search with automatic signal recognition and path following algorithms for quick buried identification.
- Visual (visible and InfraRed) search and rescue for identifying missing persons on snow and woods even during night.
- Customizable payload deployment to drop emergency kits or specific explosive cartridge for controlled avalanche detachment.

The resulting small (less than 5kg) RPA is capable of full autonomous flight (including take-off and landing) on a pre-programmed, or easily configurable, custom mission. Furthermore, the embedded autopilot manages the sensors measurements (i.e. beacons or cameras) to update the flying mission. Specific features such as laser altimeter for terrain following have been developed and implemented. Remote control of the RPA from a ground station is available and a possible infrastructure, based on cloud/on-line architecture, for the real application is presented.