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Towards an automatic UAS-based mapping tool for first responders: Defibrillator Missions in Alpine Regions

Eliezer Fajardo Figueroa [a, *], Abraham Mejia-Aguilar [b], Michiel J. van Veelen[c]

[a] *Technical University of Munich, MSc Cartography. Munich, Germany - eliezer.fajardo@tum.de*
[b] *Eurac Research, Center for Sensing Solutions. Bozen, Italy - abraham.mejia@eurac.edu*
[c] *Eurac Research, Institute of Mountain Emergency Medicine. Bozen, Italy - michiel.vanveelen@eurac.edu*

* Corresponding author

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Abstract

Cardiovascular disorders are the main cause of emergencies with fatal outcomes related to mountain activities in Alpine Regions (averaging 23%) [1]. The limited timespan to assist effectively these urgencies, is driving rescue teams to adopt novel strategies, like delivering Automatic External Defibrillators (AED) using Unmanned Aircraft Systems (UAS), to aid in cases of Out-of-Hospital Cardiac Arrests (OHCA) in remote settings [2]. Recent studies have shown the efficiency of drones to carry supplies flying over long distances, making them a promising solution to improve the response time of Emergency Medical Services (EMS) [3], especially in rural areas [2]. However, critical factors need further optimization for widespread implementation in mountain environments [4]. In Alpine Regions, the successful implementation of this solution needs to identify suitable locations to deploy the drones within limited facilities and a routing workflow capable to find optimal pathways in a 3D environment [4]. The spatial component of these requirements, can be addressed through the use of cartographic and geostatistical methods based on suitability models [5], and least-cost paths [6]. Generating drone routes compatible with the on-going design of a secure airspace for UAS operations, as the U-Space [7], keeping a safe altitude across topographic variations while avoiding obstacles, to support the joint efforts of emergency teams [8].

According to the presented statements, this research aims to design a map-driven distributed emergency drone service network, enable to localize suitable areas and propose time-effective strategies for delivering Automatic External Defibrillators (AED) in Alpine Regions (Figure 1). As a contribution to the development of a solution for first responders to plan automatic Unmanned Aircraft System (UAS) missions in mountainous environments.

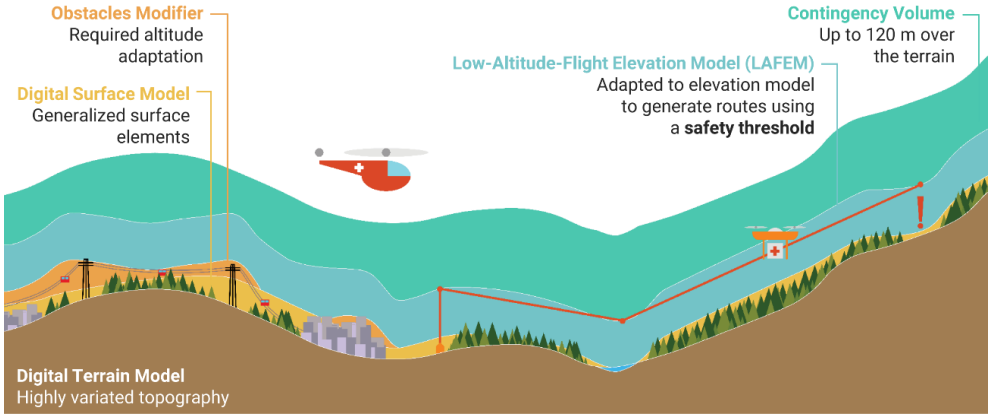

Figure 1: Optimal flight paths adapted to Alpine terrains

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The first phase of the study focuses on designing a map-driven distributed emergency drone service network tailored to deploy UAS-AED missions within the Province of South Tyrol, Italy [4]. This identifies suitable areas for positioning drone stations (Figure 2), based on the unique spatial characteristics of the region [9]. Potential locations to place the UAS stations are selected as the base of the proposed network, considering the spatial distribution of existing facilities in the studied area [4].

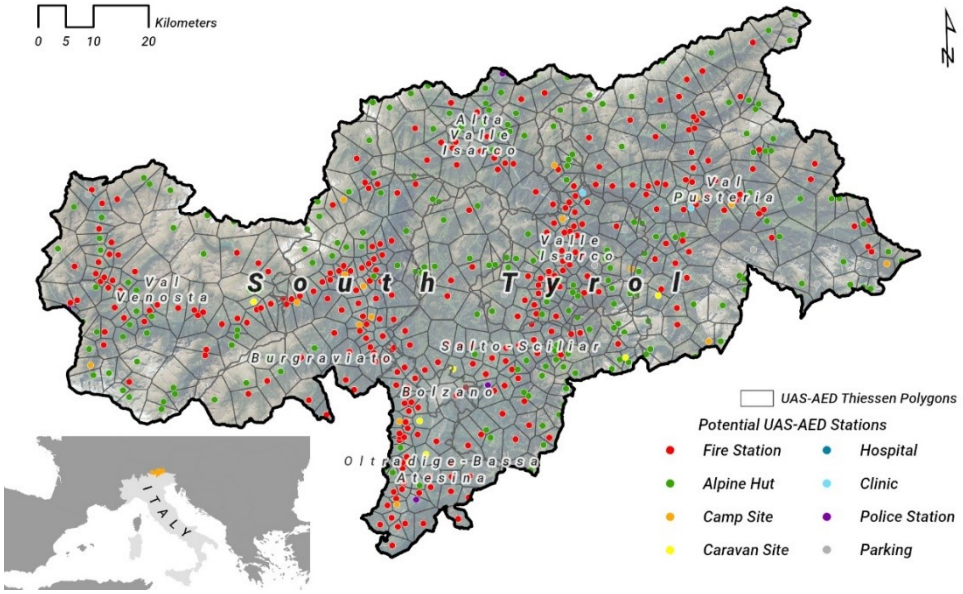

Figure 2: Potential Locations for UAS-AED Distributed Network of South Tyrol, Italy.

The second phase focuses on defining a cartographic workflow for programming automatic flight missions to facilitate the efficient delivery of defibrillators using drones in Alpine environments, taking South Tyrol as a model for its implementation and testing. After a comprehensive analysis of the spatial variables critical for navigating demanding mountain scenarios, the study introduces the Low-Altitude-Flight Elevation Model (LAFEM) as a modified surface model for creating flight routes using least-cost path methods [10].

Subsequently, a semi-automatic workflow, based on geographic information management and geoprocessing techniques, is developed to generate optimal flight paths for AED delivery using drones. To assess the effectiveness of the proposed workflow, field tests are conducted to compare its performance against other routing approaches considered by first responders in rescue missions [11] (Figure 3).

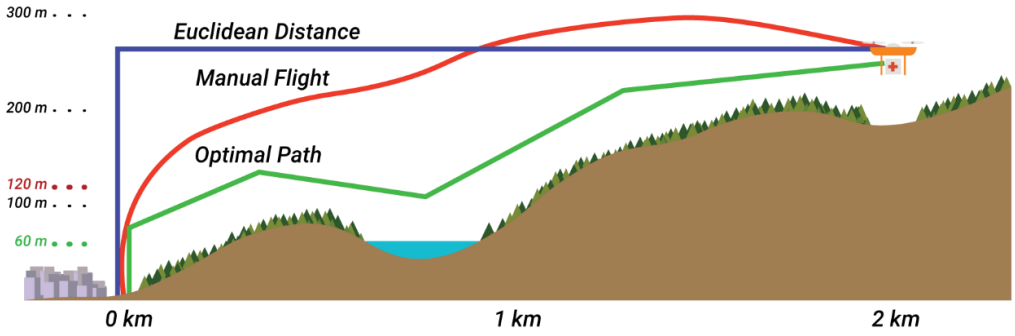

Figure 3: UAS-AED routing approaches comparison.

The outcomes of this project show the extent that would have an emergency drone service network in the studied region, and the promising improvements of considering a routing workflow to plan automatic UAS-AED missions in mountain environments based on cartographic methods.

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