Towards an automatic UAS-based mapping tool for first responders

Defibrillator Missions in Alpine Regions

by **Eliezer Fajardo Figueroa**

Cardiovascular disorders are the main cause of fatalities in Alpine Regions during mountain activities [1]. Rescue teams are exploring the use of drones for delivering defibrillators to improve their response times towards these emergencies [2]. However, it is crucial to identify suitable locations to deploy drones and optimal flight paths that consider terrain variations [3]. This could be achieved through a cartographic approach, incorporating spatial analysis and geostatistical methods [4].

Objectives

This research aims to design a map-driven distributed emergency drone service network, enable to identify suitable locations and propose time-efficient strategies for delivering Automatic External Defibrillators (AED) in Alpine Regions. As a contribution to the development of a solution for first responders to plan automatic drone missions over challenging environments.

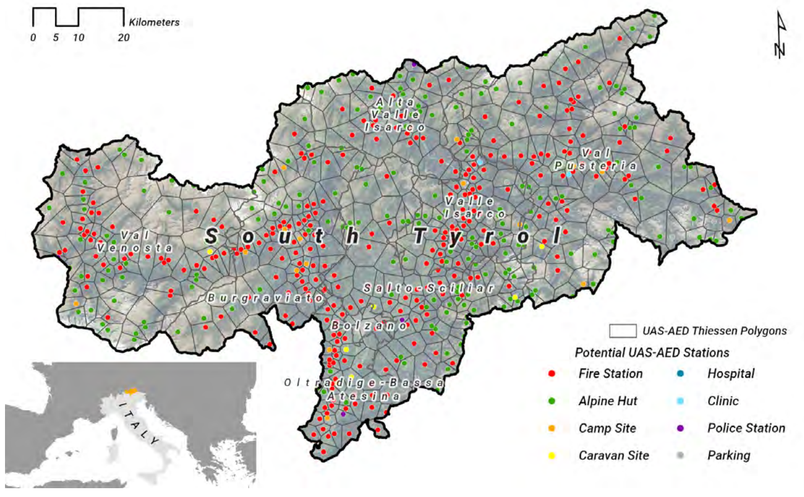
Background

Early defibrillation should be feasible in mountain areas [5]. This could be accomplished by using a network of drones to deliver defibrillators, located strategically in facilities like rescue stations or alpine huts [3]. Capable to identify the shortest path through a 3D environment, operating safely in the U-Space [6]. Being deployed through a map-based interface, enabling first responders to plan the missions effectively [7].

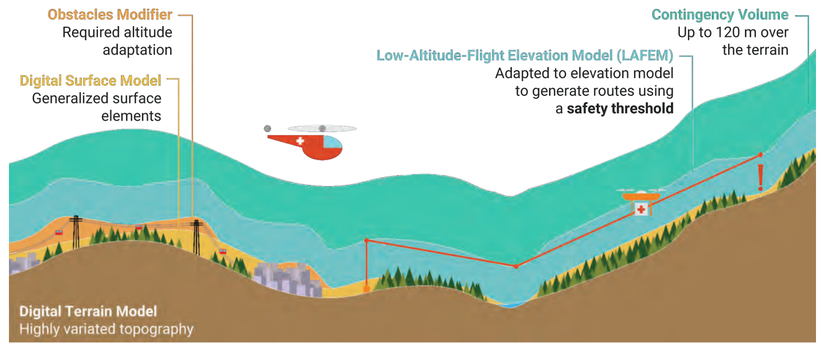
Methodology

The first phase focuses on designing a map-driven distributed emergency drone service network for the Province of South Tyrol, Italy [3]. Are identified suitable areas to place drone stations based on a weighted overlay [8]. Then potential locations (Fig. 1), are selected considering the spatial distribution of existing facilities.

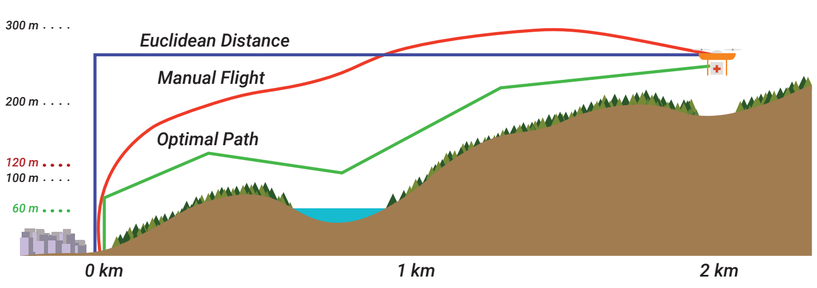
The second phase proposes a cartographic workflow to program flight missions in Alpine environments, based on a modified surface model (Fig.2), to create routes using least-cost paths [9]. The proposed workflow is compared against other routing approaches (Fig. 3), conducting flight tests simulating emergency scenarios [2].



Potential locations of the distributed drone emergency service network of South Tyrol in Italy. Composed mainly by fire rescue stations and alpine huts, to cover the entire province (Fig. 1)



Surface model modified using a safety threshold and spatial filters to route flight plans using least-cost path methods (Fig. 2)



Comparison of the proposed paths againts other routing approaches used in rescue opeations (Fig. 3)

Experimental Setup

Route Testing Simulation
Mountain Hiking in Lake Braies

Flight plan simulation using different simplification parameters over steep slopes

Winter Scenario Field Test
Recreational Ski in Corvara

Manual approach over a simulated emergency site in a ski slope (June, 2023)

Summer Scenario Field Test
Trail Running in Ritten

Flight test to deliver a defibrillator using paths adapted to the terrain (July, 2023)

Results

1. Suitable areas to place drones identified in South Tyrol extend in mountainous terrain.
2. 542 potential locations to place UAS-AED stations were selected.
3. Proposed cartographic workflow generate optimal flight paths adapted to terrain variations.
4. Proposed paths showed significant improvements against other routing approaches.
5 Testing and automation is required for implementation within rescue operations.

Conclusion

It is feasible to determine a network of potential locations for drones to deliver defibrillators in Alpine Regions using a cartographic approach. This network can rely on a map-driven workflow to find optimal paths across mountainous terrain to reach the emergency sites timely. Even though, this require further automation and testing to support first responders facing life-threatening emergencies.

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Chair Professor: Prof. Dr. Liqiu Meng, TUM

Supervisor: Dr.-Ing. Abraham Mejia-Aguilar, Eurac Research

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