LINKÖPING UNIVERSITY

Expert Conference: *Search and Rescue* UAVs

Bram Kieskamp, Hyndavi Kommineni, Patricia Baños Fernández and *Yorick Smit*
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1 INTRODUCTION

According to the Cambridge Dictionary, UAV is the *"abbreviation for unmanned aerial vehicle: an aircraft that is operated from a distance, without a person being present on it."*. [1]

In this report we specifically talk about *Search and Rescue UAVs*, these are UAVs used by emergency services and rescue teams perfected for searching for targets (persons or objects) in almost any type of environment providing live visuals and data. [2]

2 UAVS IN *SEARCH AND RESCUE MISSIONS*

Search and rescue UAVs play a vital role when it comes to finding survivors, detecting entry points for rescue teams and scanning areas from above. They send all this data to the pilots on the ground, which is then communicated to the rescue team. They are employed for decreasing the search time, avoiding unnecessary danger for humans and performing operations where the target would be unreachable for rescuers or other search and rescue equipment.

2.1 Typical Uses [3] , [4]

- Natural disasters: floods, tsunamis, hurricanes.
- Fire in buildings or nature.
- Gathering data from accidents from above in remote areas.
- Measuring data in order to prevent accidents in gas, nuclear and chemical industries or to scan these areas in case of accidents, where it is too dangerous for humans.
- Inspecting power lines, wind turbines and bridges.

2.2 State of the Art

During the past few months, a number of developments have been made to drones in order to assist *Emergency Response, Search and Rescue* professionals and to save the lives of thousands of migrants in the Mediterranean Sea. Also, UAVs have played an important part on the aid and relief programs created after earthquakes, for example, in Nepal and Ecuador. These tools have truly changed the mentality of professionals who need to make quick and decisive decisions in emergency situations. These effects can be seen in real-world situations.

When this kind of technology started, regular drones had cameras attached, giving rescuers an idea of what was happening in a disaster zone. However, the data was not as accurate and reliable as the drones deployed nowadays will give. Further development led to more exact data, which was obtained with the help of thermal imaging. The drones are now capable to withstand different temperatures and environmental conditions depending on the disaster they are facing.

A recent study for the development of *SAR* drones was conducted to detect vital signs of people in war zones and other disasters. These drones are being designed to remotely measure heart rates and breathing rates and also, to detect the movement of victims involved in major accidents. [5]

Two great examples of this type of UAVs are the following:

- Fire Fighting Drone: Latvian company *Aerones* created an UAV which, according to the company, can fly up to 984 feet [6]. This is higher than most firefighting trucks can reach with their ladders. The drone is fitted with a water hose connected to a fire truck. It is still under development but *Aerones* hopes the machine will be ready for real operations soon [7].
- DJI Matrice 201: *Matrice 200 Series* can be used for inspection of power lines, *SAR* operations, firefighting and also, for emergency responses. It is capable of flying even at sub-zero temperatures due to the higher reliability of its battery. It has a thermal and optical feed for detection and surveillance in real time [8] [9].

3 DESIGN AND MISSION OF A *SAR* UAV

The most important design parameter for a SAR mission is to optimize the search strategy in a way that

the probability of finding the target is maximized, in a minimised timeframe [10].

3.1 Preliminary mission parameters

Several points should be kept in mind regarding *"how we search"* for a certain Subject/Object (S/O or target), such as: [11]

- The **Probability of Area** is the chance of finding the S/O in a certain area.
- The **Probability of Detection** is the chance of locating the S/O in a certain area by using a definite technology.
- The **Sweep Width** is a number, which defines the mean capability of a sensor to find and identify a particular S/O while having a specific set of atmospheric conditions.
- The **Average Maximum Detection Range** is the mean span, above which the sensor cannot find the S/O.
- The **Critical Separation** is the spacing between sensors in a search area, where the S/O is in the middle of two UAVs without overlapping coverage of each sensor

3.2 Mission requirements [11] , [10]

- Inherent design characteristics of the vehicle such as range, speed, duration of battery, sensor imaging properties, resolution of cameras.
- Operational requirements such as landing and take-off parameters.
- Post-processing diagnostics.
- Searching pattern (optimising goal).

3.3 Systems used

There are many different SAR UAVs currently in use, designed for varying use cases. These can be divided into two groups:

- **Rotorcraft**: Being the most common among the different UAVs used for SAR purposes. Rotorcraft UAVs are highly versatile and are often equipped with some kind of camera for surveillance purposes. What makes them ideal for SAR operations is that they can land in almost any place, allowing them to carry a certain payload to any place needed.
- **Fixed wing UAVs:** Mostly used for military purposes, UAVs with fixed wings also have a good amount of use in SAR operations. Although they are not as flexible in use as their rotorcraft counterparts, these drones can generally obtain larger speeds and longer flight times. This makes them ideal for surveillance of larger areas.

4 ADVANTAGES AND DISADVANTAGES

The usage of SAR UAVs comes with an unique set advantages and disadvantages:

Advantages

- **Cost:** Due to the aircraft being unmanned, the operational cost are low. They are especially cheap in use for situations where helicopters are the alternative.
- **Response time:** As was discussed earlier, UAVs can often be deployed very swiftly, which is a great asset considering how critical time often is in SAR missions.
- **Risk:** UAVs can be used in areas where it is too dangerous for rescue teams.
- **Mobility**: When the terrain is hard to navigate, UAVs are the ideal solution. Due to their possible size, they can also be designed for indoor areas.

Disadvantages

- **Flexibility:** UAVs can only do what they are programmed and designed for. SAR operation requirements are varied, making it difficult for a drone to be able to function appropriately in every situation.
- **Operators:** A specialist has to operate the drone. Training them takes up valuable time and resources.
- **Obstruction:** UAVs could obstruct other aircraft during operations by taking up airspace.

5 Conclusions

It can be concluded that these machines can support emergency services in critical situations and rescue operations. They even surpass the capabilities of human professionals by the innovations in this area. However, they will only reach their optimal performance when the specific design takes all the parameters that affect a *SAR* process into account. Even if perks exist regarding this kind of technology, crucial characteristics for this matter get improved: time response, costs and danger decrease where the searcher's mobility increases.

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