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CASE REPORT

First Report of Using Portable Unmanned Aircraft Systems (Drones) for Search and Rescue

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Unmanned aircraft systems (UAS), colloquially called drones, are used commonly for military, government, and civilian purposes, including both commercial and consumer applications. During a search and rescue mission in Oregon, a UAS was used to confirm a fatality in a slot canyon; this eliminated the need for a dangerous rappel at night by rescue personnel. A second search mission in Oregon used several UAS to clear terrain. This allowed search of areas that were not accessible or were difficult to clear by ground personnel. UAS with cameras may be useful for searching, observing, and documenting missions. It is possible that UAS might be useful for delivering equipment in difficult areas and in communication.

Keywords: search and rescue, drone, unmanned aviation systems, SAR, UAS, UAV

Introduction

Unmanned aircraft systems (UAS) are widely used by military, government, and commercial entities and are becoming commonly used by consumers, also called hobbyists. In Europe, UAS are referred to as remotely piloted aircraft systems; in the United States, they are sometimes called unmanned aviation vehicles.[1] In lay terms, UAS are called "drones." UAS can be categorized into 4 primary uses: consumer, commercial, government, and military. They come in a vast array of sizes and payloads. They can be used for a variety of applications: as weapons or to carry weapons; for reconnaissance, surveillance, and search; for logistics such as delivering supplies and equipment; for research and data collection such as with agriculture, land survey, and weather; for communication; and for aerial photography. In the United States, consumer and commercial UAS are defined by the Federal Aviation Administration as those that are <1.0 lb (0.45 kg).[2] These have roughly a maximum of 500 m altitude and 2 km range from the base operator. Military and government UAS often have a 5 km altitude and 150 km range or more. Although large UAS have been used successfully in natural and urban disasters, small portable UAS are just starting to be used among search and rescue (SAR) personnel.

Case 1

A group of 5 men completed a 5-rappel, 1-day canyoneering descent of Dry Creek, a 1.6-km slot canyon in the Columbia Gorge National Scenic Area, Oregon. Earlier in the day, the men hiked off trail to the headwaters of the creek, at 600 m elevation. With a series of rappels, they descended the entire canyon. After rappelling the terminal waterfall sometime around 4:00 PM, they tried to pull the rope and it got stuck. To retrieve the rope, a 28-year-old man decided to free-solo rock climb (without the protection of a rope) the east wall of the amphitheater of columnar basalt that surrounds the 21-m-high waterfall. The man ascended the rock cliff up the amphitheater and continued about 15 m above the top of the waterfall because there was no easy entrance from the cliff into the slot canyon. From there, group members observed him slip, fall about 15 m, and disappear into the slot canyon at the top of the waterfall. No further vocal or visual contact was made by the victim.

Approximately 1 hour later, Cascade Locks Fire Department and the Crag Rats Mountain Rescue responders arrived. One team of firefighters tried to ascend the route taken by the victim and could not safely ascend the cliff without rock-climbing protection, which was not immediately available. A team of mountain rescuers

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ascended the west side of the canyon, a moss-covered scree field, to 378 m and then bushwhacked in steep terrain to the rim of the slot canyon, 90 m directly above the victim. A belay station was constructed, and a mountain rescue physician was lowered on a 60 m rope, but the canyon was too narrow to see the victim. It was near dark, and gaining access to a 90 m rope would take an hour.

Meanwhile, a personal UAS was brought by a local resident. A Phantom 3 4K quadcopter UAS made by DJI (Shenzhen, China) was used with an Apple iPad and Apple iPhone (Cupertino, CA) with the DJI Go app software. This model has a 12-megapixel resolution for still images and 4000-pixel resolution for video. It has a flight time of <23 minutes, a range of 5 km, and a weight of 1.2 kg.

The pilot flew the UAS from the bottom of the waterfall into mouth of the slot canyon, about 30 m away and 30 m high. The pilot acquired images that confirmed a fatality. The rappel team then safety aborted any further investigation and returned to SAR base at dark. The body was recovered the following day by mountain rescue crews.

Case 2

A 21-year-old woman was reported missing, and 2 days later her car was found at the Wahclella Falls Trailhead, a 1.6-km box canyon in the Columbia Gorge National Scenic Area in Oregon. Rescue crews from multiple counties and agencies searched for several days in steep terrain that was densely wooded and covered in thick brush. On 2 search days, portable UAS were used. The woman was found deceased 2 weeks later, after the search had been called off.

On search day 2, a SAR Bot made by Aerial Technology International (Portland, OR) was used. It has a flight time of up to 25 minutes and was used with a personal computer tablet. The resolution is 1080 pixels for color video, and it was equipped with VUE PRO 640 thermal imager (FLIR, Wilsonville OR). The UAS was carried up the box canyon and flown over Tanner Creek, which flows from the base of the waterfall. The SAR Bot took 4 flights to cover 2.7 km of Tanner Creek, capturing video of the creek bottom that was difficult to view from the creek banks. The UAS made a fifth flight along powerlines on Munra Point using a personal computer ground station. The UAS eliminated the need for ground rescuers in that area.

On search day 3, an Inspire 1 version 2.0 from DJI was used. It has a battery life of up to 18 minutes with a 12-megapixel camera and 4000-pixel video. It was used with an Apple iPad with the DJI Go App. It weighs 2.9 kg. The UAS was carried to Munra Point and used to search the cliff and surrounding scree field, which was difficult to view by ground rescuers. Rope teams rappelled to clear one section of the cliff that was not visible using the UAS.

Discussion

The successful use of portable UAS for small-scale SAR has not previously been described in the wilderness medicine literature. In case 1, the camera of the UAS was able to confirm a fatality, whereas a rescue team would have needed to wait for a longer rope, set up a belay station, and send a rescuer into a slot canyon at night. In case 2, UAS flights augmented ground searching and acquired images of areas that were difficult or impossible to search, particularly the stream bottom and the cliff.

In addition to search capabilities, UAS may have other uses for SAR. This includes recording missions for debriefing, teaching, and forensic documentation. It is likely that larger UAS could be used to deliver additional equipment to rescue crews or victims, as has been suggested in 2 articles that theorize that UAS could be used to deliver automated external defibrillators and vaccines to austere locations.[3,4] It is possible that UAS may be useful for radio relay in situations in which handheld ultrahigh frequency/very high frequency radios and cell phones have difficulty receiving signals and establishing 2-way communication with victims. UAS may also be useful in global positioning system applications, such as mapping or acquiring coordinates. One study suggested UAS may be useful for avalanche search.[5]

Some potential pitfalls exist. Portable UAS consume energy to power the motors, camera, and transmitters; thus, operating time is often limited by battery power to up to 30 minutes. UAS have limited use in tight canyons, thick trees, and foul weather. On search day 2 of case 2, spotters were used to help the pilot navigate in tight trees. Electromagnetic interference is possible between UAS, cellphones, handheld radios, and global positioning system units. In the cases described, ground rescuers near the UAS turned off their phones and radios to minimize this problem. In addition, interference with manned aircraft is a concern. In both cases, UAS pilots notified SAR incident command before commencing flight, and SAR command relayed flight notice to manned aircraft when used in case 2.

If considered, UAS should be viewed as another tool for SAR. Mission coordinators and pilots should be aware of their useful applications, limitations, safe flying practices, and rules and regulations. Rules and regulations are changing with this rapidly evolving technology.

In the United States, for example, UAS use falls under the jurisdiction of the Federal Aviation Administration and regulations exist regarding equipment registration, pilot certificates, and flying.[2] UAS use for SAR may, in some circumstances, fall under commercial use and thus may be subject to stricter regulations than those for consumer use.[6] Some agencies have additional regulations. The National Park Service, for example, has a provisional ban of UAS until a formal policy can be devised, with exemptions for SAR, scientific research, and firefighting. In the European Union, a proposed regulation would give European Aviation Safety Agency oversight of UAS in 2017, as UAS now are regulated by individual countries. Some national associations have policies in place and acknowledge that UAS technology and techniques, and thus guidelines, are evolving.[6,7]

Potential areas of future study include increased payloads, improved batteries, global positioning system applications, 2-way communication with a SAR victim, and possibly avalanche transceiver searches.

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