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The use of drones in various rescue sectors – an analysis of examples in Poland and in the world

Wykorzystanie dronów w różnych sektorach ratownictwa – analiza przykładów w Polsce i na świecie

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Keywords

unmanned flying devices, drones, mass events

Słowa kluczowe

bezzałogowe systemy latające, drony, imprezy masowe

Conflict of interest

Konflikt interesów

None

Brak konfliktu interesów

Summary

Owing to a rapid development, the Polish drone market has become more popular in the last years. UAVs (Unmanned Aerial Vehicles) are used in various areas nowadays, including the medical sector. To a large extent, mass event security depends on prompt actions taken by paramedics and other public order services to react to any kind of threats. The process of monitoring and overseeing of mass events is especially difficult when the events involve vast areas of land and the organization of medical security is complex. Monitoring with the use of drones to secure participants of the events enables a more efficient cooperation of medical services and a faster reaction of the personnel in case of accidents. The implementation of drones in the system of medical security requires proper planning of cooperation between various types of services, dividing the area into sectors and identifying potential risks and other factors. The aim of the research is to illustrate the real potential of drones by means of analyzing cases of application of drones in the medical sector in the world. The presented benefits and possibilities related to the use of drones as elements of mass event medical security indicate that drones have a potential and support the human factor.

Streszczenie

Rynek dronów w Polsce w ostatnich latach dzięki szybkiemu rozwojowi zyskał na popularności. Bezzałogowe statki latające są obecnie wykorzystywane w różnych dziedzinach, także w sektorze medycznym. Bezpieczeństwo imprez masowych w dużej mierze zależy od szybkiej reakcji ratowników medycznych i innych służb porządku publicznego na wszelkie zagrożenia. Obserwacja i nadzór nad uczestnikami imprezy są szczególnie utrudnione, kiedy obszar wydarzenia obejmuje duży teren i organizacja zabezpieczenia medycznego jest skomplikowana. Monitoring bezpieczeństwa uczestników za pomocą dronów umożliwia sprawniejszą współpracę służb medycznych oraz szybszą reakcję personelu podczas wypadków. Wdrożenie dronów do systemu zabezpieczenia medycznego wymaga odpowiedniego zaplanowania współpracy służb, podziału obszaru na sektory, ustalenia prawdopodobnych zagrożeń oraz innych czynników. Praca ma na celu zilustrowanie realnych możliwości dronów poprzez analizę przypadków wykorzystania danych maszyn w sektorze medycznym na świecie, a przez to przedstawione korzyści oraz możliwości użycia dronów jako elementu zabezpieczenia medycznego wydarzeń masowych ilustrują ich potencjał oraz wsparcie dla czynnika ludzkiego.

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INTRODUCTION

Owing to a rapid development, the Polish drone market has become more popular in the last years. UAVs (Unmanned Aerial Vehicles) are used in various areas

nowadays, including the medical sector. To a large extent, mass event security depends on prompt actions taken by paramedics and other public order services to react to any kind of threats. The process of monitoring

and overseeing of mass events is especially difficult when the events involve vast areas of land and the organization of medical security is complex. Monitoring with the use of drones to secure participants of the events enables a more efficient cooperation of medical services and a faster reaction of the personnel in case of accidents. The implementation of the drones in the system of medical security requires proper planning of cooperation between various types of services, dividing the area into sectors and identifying potential risks and other factors.

The aim of this publication is to illustrate the realistic potential of drones by means of studying cases where drones were applied in the global medical sector. The presented benefits and the possible application of drones as elements of the mass event medical security system illustrate the potential of these devices and their supportive function to the human element.

LAND RESCUE

UAVs have already been applied in the medical sector in numerous countries. Studies on the new possibilities of application of UAVs are still in progress. More and more paramedics around the world have the chance to familiarize themselves with the advantages and the potential of drones in their work. One of the pioneers in UAV monitoring is the UNOSAT program (1). UNOSAT, which is related to UNITAR (United Nations Institute for Training and Research), is a program focused on modern technologies with the aim of performing an imagery- and satellite analysis for the United Nations. The goal is the support in transformations within key sectors, such as humanitarian aid, human security, strategic spatial planning, and strategic planning of development (1). The first drone mission started by the organization was launched in Haiti to estimate damage and to design the reconstruction of buildings (1).

The early research was followed by a test verifying the benefits of the application of UAVs in situations requiring a real-time monitoring of large gatherings (1). The test was performed in July 2012 during the Paleo Music Festival in Nyon (1). It is the largest open-air music festival in Switzerland with an area that is perfect for an effective real-time drone monitoring of stages (1). The test involved md4-200 drones produced by Microdrones (1). They were hovering no longer than 20 minutes and were transmitting high-resolution images to the operator in real time (1). Drone activities ensured prompt reaction to threats during public gatherings. The type of mass event selected for the test was based on the agreement between the UNOSAT and the World Health Organization (WHO) in order to ensure the best possible evaluation of the potential benefits of applying this type of monitoring (1). Due to their low flight altitude, UAVs are able to monitor the specific area in cloudy weather and adverse weather conditions. This factor makes them a cheap and effective alternative to satellites as a source of a high-resolution material for

analysis. Drones are more and more frequently applied as an evaluation tool in the case of natural disasters and as a means of support for the rescue services (1).

Currently, UAVs are also used in search actions. The advantages of drones are appreciated not only by special public services but also by private individuals. For instance, Eric Garcia disappeared in California on 7 December 2013 (2). The rescue action encountered many difficulties due to heavy snow. The services withdrew after a few days of searching because of no available clues. Jim Bowers, a private drone operator supported this case (2). For a week, he was using the DJI Phantom 2 Vision+ drone to cover a 40-mile area and places difficult to access. Owing to the UAV, the man's corpse was found after he had fallen down into a ravine as a result of a car accident (2). After that, Bowers established a group called SWARM (Search With Aerial RC Multi Rotor). The idea is that certified drone operators volunteer to assist the families of the missing people in searching their relatives (2). Two years after the group had been established, it involved 3000 registered operators all over the world (2). There is at least one SWARM member in each state in the USA (2). However, it is not always possible to legally use drones in search actions (2). Rescue services have their particular procedures and their own professional equipment to search (2).

In May 2014, the Canadian police found a man in an overturned car in an empty area by means of using the Draganflyer X4-ES drone with a thermo-vision camera (2). As a result, the victim was offered assistance and he later recovered. In July 2015, rescue services applied UAVs to deliver life jackets to individuals trapped on the rocks in the middle of the Little Androscoggin River, Maine (2).

However, the application of drones in search actions is not an easy task. It usually requires special software to detect all important details (2). DridPlanner is a frequently used software (2). Thermo-vision cameras also facilitate search activities. UAV recordings can also be replayed, which makes it possible for more people to review the image (2). The devices used by SWARM hover 60-100 feet off the ground within the period of 10-25 minutes (2). Many people claim that drone hobbyist should not deal with rescue service actions. Nevertheless, the successful actions illustrate the advantages of drones and the potential of the devices as far as their application in the medical sector is concerned. Dr. Robin Murphy, an engineer and director of the Center for Robot-Assisted Search and Rescue (CRASA) in Texas, created a program offering the application of drones in search actions and disasters (2). Such equipment was used after the earthquake in Capri, Italy, in 2009 (2).

MOUNTAIN RESCUE

In the US, the inclusion of UAVs in the fixed equipment of the rescue services becomes a common practice (3). 2015, the Austin Fire Department in Texas was

involved in a four-year program to study the benefits of drones in rescue actions and fires. Most of the organizations similar to SAR (Search and Rescue) already have drones available (2). Other types of services also have such devices in their equipment. To illustrate, the FlyTech company started a cooperation with Grupa Podhalanska GOPR (the Podhale Group Mountain Volunteer Search and Rescue) in 2014 (4). The company in question created a special system called Guardian for the purposes of mountain search and rescue (4). FlyTech devices can be successfully used to coordinate rescue actions, to perform search actions and to detect destinations from bird's-eye view (5). The company is located in Krakow, Poland, and specializes in the construction of devices equipped with sensors and steering systems to collect as much required data as possible for the purpose of analysis (4). The cooperation is based on common actions and training that lead to the construction of a specialized system which is expected to support rescue actions in the mountains. Guardian is based on GIS (Geographical Information System) software available at the command center of the Mountain Search and Rescue and is processed by the rescuers. The mobile command center is simultaneously the Air Traffic Control Ground Station for drones that participate in search actions (4). The cooperation agreement was signed after the meeting between the head of GOPR (the Mountain Volunteer Search and Rescue) and a FlyTech specialist (4). The main argument in favor of using the devices is that they can search fast and cover large areas of land that would normally take rescuers significantly more time from the ground. Owing to this advantage, Grupa Podhalanska GOPR has the possibility to significantly shorten the time of implementing rescue procedures in life-threatening events (4). It was already before the cooperation started that rescuers had to familiarize themselves with the potential of Unmanned Aerial Vehicles to know where the devices would be most useful.

The FlyTech drone available at Grupa Podhalanska GOPR is visually similar to other standard devices of its kind (4). The advantage of the FlyTech drone is that it is easy to operate as rescuers need a training on how to use the device before it is applied in a rescue action. The optical sensors of the device are adapted to be able to monitor the area mostly covered with forests. The only still outstanding issue lies in the procedures of applying UAVs in the services provided by GOPR. Rescuers must be prepared for the possible situation that the functioning of the sensors may be disturbed by changing weather conditions in the mountains, and by dense forests. The preliminary test was based on taking high-resolution images covering the area of 100 ha. The device managed to take the images within 40 minutes. It would take much more time and human resources to search the area if rescuers were expected to search without the support of drones. The company has got two drones that are applied in rescue actions. One of them is located in Rabka, Poland, and serves as

a training drone. The other device supports real search actions. Drones are usually used in actions where it is very difficult to localize the missing individual. UAVs are able to cover the area faster than helicopters, and are cheaper in use. The drones applied by Grupa Podhalanska GOPR are equipped with a thermo-vision camera, which enables them to find the particular person in the fog or at night. In order to operate effectively, the areas monitored by the rescuers have been divided into sectors. As a result, the rescuer who operates a drone from the ground is able to communicate with rescuers and other services, localize the missing element, and coordinate the action with the rescue center (4). FlyTech has also been testing drones dedicated to water rescue and land rescue (6). The research already started at the beginning of 2015 in the area of the Andrzej Frycz Modrzewski Krakow University (6).

The research conducted in Ottawa in March 2016 has been a huge step forward as far as the application of drones in medical emergency is concerned (7). There were tests of real-time monitoring of critical situations with the use of drones beyond visual line of sight (BVLOS) (7). Rescue services have also announced that the task of the new drone monitoring application was successfully completed (7). The application was expected to improve safety in using drones (7). The County of Renfrew Paramedic Service is one of the first medical emergency systems in Canada to use a commercial UAV as a means of prompt reactions to threats (7). The device became famous on the media after it was used in the case of a triple murder in Wilno, Ontario (7). Legal regulations are the greatest limitation of the Canadian security services as the regulations do not allow to use private drones beyond visual line of sight (7). It is especially problematic in areas covered with dense forests where the trees limit the operator's field of view, and the use of a BVLOS drone would be a preferred solution for the rescuers (7). A company called Kongsberg Geospatial has been dealing with the technology of military UAV platforms for ten years (7). Currently it is actively cooperating with the security services of the USA and Canada to develop a simple, portable and homogenous software for civil UAV operators (7). The software is expected to ensure the necessary spatial awareness on how to securely use drones beyond visual line of sight (7). The technology uses a compatible tablet to share data on the location of the particular drone and the position of other aerial vehicles, as well as the information on obstacles in the air and on the ground (7). During the training, operators were able to successfully use the software to communicate with emergency medical teams and determine the position of the casualties, who were usually hidden in the dense forest of the nature sanctuary near Cobden, Ontario (7). The results of the research may have a significant influence on search and rescue actions in the near future. Nowadays, drones operated by means of the above mentioned software are sent to accidents in distant areas (7). Michael Nolan,

a paramedics who is the County of Renfrew Paramedic Service chief believes that the pioneering efforts of his team might eventually contribute to the transformation of rescue procedures all over Canada (7). Final changes come after a regulation framework is created, which is required for certified drone pilots to be allowed to operate BVLOS flights (7). In Canada, drones are used as devices for basic monitoring of areas in various scenarios: to find lost hikers, to deliver life vests to sailors in trouble, and to verify hazardous materials in the case of highway accidents (7). The County of Renfrew Paramedic Service has also signed a contract with the company Indro Robotic and Remote Sensing to be provided with larger drones carrying medical equipment (e.g. defibrillator and necessary medication) to rescue actions in the future (8).

WATER RESCUE

Unmanned aerial vehicles have started to be applied in water rescue as well. One of the first tests related to the sector of water rescue were done on Algarrobo beaches in Chile in 2015 (9). The objective of the project was to deliver life vests to individuals in danger in the water (9). Drones named after the Greek hero, Perseus, were created by two companies: the American company Green Solution, and the British company X-Cam (9). This ambitious project was inspired with a similar project started earlier in Iran (9). Drones can fly up to 1200 meters and are equipped with a GPS for alternative navigation (10). There are also external loudspeakers to give instructions, and video cameras available with the devices, which enables the rescuers on the shore to monitor what is happening in real time, and to verify the location where the life vest is left by the drone (9). Using LED lights, UAVs can also illuminate the water area at night in order to find the victim (10). Furthermore, it is also easier for rescuers in water to detect casualties when the drone can be heard and seen flying over the victim (10). It takes 30 second for the drone to reach the injured (9). Statistically, water rescuers reach casualties after additional 3 minutes (9). The earlier Iranian device called PARS is additionally equipped with a thermo-vision camera that enables rescuers to localize a drowning victim at night (11). There is also an autopilot function, a GPS, a barometer and a compass in the device (11). Iranian drones are also equipped with a special water platform where batteries can be charged through solar panels, and where drones can stop over between actions (11). There is place for more than one device on such platforms (11). Based on the information provided by the manufacturer of PARS, the drone is able to fly at the speed of 7.5 m/s, and to hover for 10 minutes (11). Owing to this, the device always reaches the area range of 4.5 km (11). In a competition between the drone and a rescuer, the drone achieved better results and it was confirmed that the device can significantly improve time-reaction in rescue actions (11). In the case of casualties drowning in the distance of 75 meters from the shore, the

drone reaches the target within 22 second, whereas a human rescuer can do this within 91 seconds (11). The main reason why the Iranian RTS company constructed the drone was a high number of fatalities in the Caspian Sea every year (11). There were 45 thousand drowning casualties within eight years (11). The price of the Iranian UAV is about 30-40 thousand dollars, depending on the equipment version (11). The idea was also implemented in Switzerland, where there is EMILY (Emergency Integrated Lifesaving Lanyard): an unmanned vehicle that is used on a water surface and fulfills a function similar to the function of the Chilean and Iranian devices (11).

Similar ideas may be implemented in Poland. On 17 May 2015, WOPR (Water Volunteer Rescue Service) in Slupsk in cooperation with the UAV Training Center acknowledged by the Civil Aviation Authority organized a rescue drone presentation at the beach in Ustka, Poland (12). A similar action was organized in Gdynia, Poland, a few days later as a result of the cooperation of WOPR in Sopot and the Mikromakro Institute Foundation (13). The simulation started at a distance of 200 meters from the shore and presented the procedure of rescuing a missing surfer by means of a UAV (13). The rescue action was 15 minutes long, and it was coordinated by the president of WOPR in Sopot (13). The simulation presented the procedure of cooperation between the rescuers and the drone (13). When a case is reported, the person on duty depicts the directions on the map and, by doing this, navigates the device to its destination (13). The equipment that was put to the test did not require any effort of the operator as the device was intuitive (13). Any changes in flight direction can be made by means of a suitable software available at the command center (13). Similar training and presentations related to crisis management, and a robot parade called Droniada have been organized by the Mikromakro foundation every year since 2009 (14).

CONCLUSIONS

Public security services have recently perceived UAVs as a means of minimizing threats in the case of large gatherings. Drones are more and more frequently tested and implemented all over the world as elements of monitoring of mass events, and as a means of supporting medical security. The use of the devices requires proper training and must comply with the aviation regulations of the particular country. Unmanned flights are legal in Poland, which leads to the growth of the UAV market and to the increased potential of the devices. This publication is based on the analysis of the UAV sector and the potential of using drones during mass events. Consequently, the analysis illustrates the benefits of the cooperation between rescue services and modern technologies.

The main advantage of drones is that they can assist teams in a credible evaluation of the situation during events on a large scale. The number of specialized

publications on the use of UAV in the rescue sector is growing. Based on that, one can notice that there is a tendency of rapid development of modern technologies used during mass events. The most important issue for rescuers is the rescue time that can be shorter when the casualty can be localized faster. Minimizing the time spent on rescue actions is the task for drones.

The main potential of UAVs lies in their equipment. The camera of the particular drone is the most significant element as far as medical security in mass events is concerned. It is crucial that the camera resolution is sufficient to ensure images that enable rescuers to identify any threats in the crowd. The method of image transmission from the drone to the operator is also of great importance. The BVLOS (beyond visual line of sight) method appears to be the most effective one (6). This method enables operators to monitor a wide range of area in the case of large gatherings, and ensures a permanent control over areas difficult for paramedics to access. Moreover, a UAV can be equipped with various sensors that are beneficial when monitoring (15). Depending on the model, a UAV can have additional equipment to ensure fastening of further required equipment. Other crucial parameters are flight altitude and time of single flight (15). These parameters influence the quality of work of a drone used for monitoring purposes. As a result, better quality of work leads to an improved monitoring of the crowd and faster identification of life threats.

Every organizer of a mass event is obliged to ensure security during the event. The application of drones is especially worth considering in the case of vast open areas, where on-the-ground monitoring is not always sufficient because of the varied landscape. Drones do not replace any of the elements of medicals security of mass events but they support these elements, contributing to a higher effectiveness of medical security services. A wireless connection between the services together with the aerial monitoring create the possibility of constant exchange of information that leads to an effective cooperation. One can find restrictions and threats related to the use of drones. However, these devices can very frequently localize threats better than human individuals. It is even the visualization of the area before a mass event that is very beneficial (15). For instance, one can plan escape routes and identify dangerous spots in advance. Based on the experience of teams using drones for the purpose of monitoring, there are two significant aspects: an adequate software and a proper cooperation planning.

Over a half of the companies on the drone market is ready to cooperate with the emergency sector (15).

Therefore, the cooperation between the organizers of mass events and such companies opens the area of drone application for the purpose of monitoring as an element of medical security. It is also the European Union that takes into account projects related to the use of drones within the programs that financially support innovations (15). The costs of renting UAVs are sometimes extremely high, and, therefore, purchasing the device is more cost-efficient. In this way, the advantages of the machine exceed exploitation costs. The value of the particular models may vary significantly depending on the type class and the potential application of the device (15). Quality and reliability are the most important factors as far as medical security is concerned. This is because a proper cooperation within the medical sector frequently influences the chances of survival. When considering the purchase of a UAV, one should analyze carefully the parameters of the device, in order for them to be adequate to the scale of the mass event. The selection should be easier when based on the classification of drones described in this article.

Not everybody is allowed to operate a UAV, especially during mass events when the security of the participants is the most important aspect of the event. Based on the analysis of using drones abroad, the most beneficial method of monitoring appears to be the BVLOS method, where operators use drones beyond the visual line of sight (6). In order to be able to navigate a drone BVLOS, an operator has to join a special training to obtain a UAVO license (a certificate for UAV operators), and meet certain criteria (16). Depending on the type of qualifications, the license granted for a specific period of time, and can be prolonged by the Civil Aviation Authority (16). If the training is provided to a person who participates in the medical security of the mass event, it is possible to apply drones in a flexible and precise way. Furthermore, due to the fact that hiring an operator provided by an external company is very expensive, a trained member of the medical security team also ensures lower cost to be covered by the organizer of the event.

Every successful rescue action assisted by drones is a milestone in the development of the devices in the rescue sector, including Poland. The issue that is still outstanding is the training of an adequate personnel, as well as training on how to operate a drone and effectively cooperate. The time needed to localize casualties is the basic factor having an impact on survival. Therefore, UAVs should be applied in order to minimize this time. The value of human life exceeds any costs of implementing innovation.

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received/otrzymano: 22.05.2018
accepted/zaakceptowano: 12.06.2018