USE OF REMOTELY PILOTED AIRCRAFT SYSTEMS IN AIRPORT OPERATIONS

Petr LÍKAŘ, David HŮLEK, Andrej LALIŠ
Department of Air Transport, CTU in Prague, Faculty of Transportation Sciences, Prague, Czech Republic
**Corresponding author.* E-mail: likarpet@fd.cvut.cz

Summary. The article addresses a possible use of Remotely Piloted Aircraft Systems (RPAS) in airport operations. The following processes are of interest: the perimeter surveillance, biological protection, and surface inspection of movement areas. Firstly, we analyzed current state of selected processes at the Vaclav Havel Airport Prague. Secondly, the implementation of RPAS into the processes is evaluated along with defining tasks and ways of their integration.

Keywords: Unmanned Aircraft, Unmanned Aerial Vehicle, Airport Operations, Václav Havel Airport Prague, RPAS, UAV

1. INTRODUCTION

There is a lot of ongoing researches dealing with practical use of unmanned aircraft systems but only a few of them address the possibility of RPAS integration into airport operations. The airport is a very specific environment, but even there can be found some tasks that could be effectively performed using RPAS. This article addresses three processes: the perimeter surveillance, biological protection, and surface inspection of movement areas. Firstly, the current state of each of the processes was analyzed. Vaclav Havel Airport Prague was chosen as a model international airport which is appropriate in its size and performed operations. The determined current state subsequently serves as a basis for evaluation of the prospects of integrating UAVs into the processes. With regard to available technological equipment, the individual tasks and the implementation of RPAS are defined. Due to the excellent manoeuver requirements and the obligation to perform hovering, a multicopter was chosen as the most suitable type of machine.

2. PERIMETER SURVEILLANCE

Perimeter surveillance process is carried out by an Airport Security (OLE). It includes both regular mobile patrols along the fence and the airport space monitoring by surveillance system. The surveillance system consists of a color optical camera for daytime use and infrared camera to monitor the area at night and in poor visibility. Further, a ground surveillance radar is installed for detection of moving targets.

This process works very well in its present form. Nevertheless, it has been selected as the most interesting process for unmanned aircraft implementation by Prague Airport itself. One of the benefits could be especially increase of the regular patrols frequency and coverage of places out of reach of existing CCTV system.

Technological equipment for the object surveillance using RPAS is readily available. For the daytime operations an optical camera with high resolution, such as the GoPro Black 4 with compact dimensions (65x45x25 mm), low weight (88 g) and a high resolution image (up to 4K) would be sufficient [1].

Image from the camera would be transmitted in real time via a secure wireless network directly from the camera to the operator's screen. The standard resolutions would be lower, such as 1080p in order to avoid unnecessary network congestion. The operator, however, would have the opportunity to switch to a higher image resolution at any time.

At night and in poor visibility infrared cameras would be used. They allow not only to detect a person attempting to disrupt the perimeter but wildlife as well. An example of such a camera is FLIR Tau2 with resolution up to 640x512 px, dimensions of 44x44x30 mm and weight of 72 g [2]. RPAS are supposed to carry both types of cameras at the same time so that an operator could be always able to see both outputs and could choose the suitable one according to the situation.

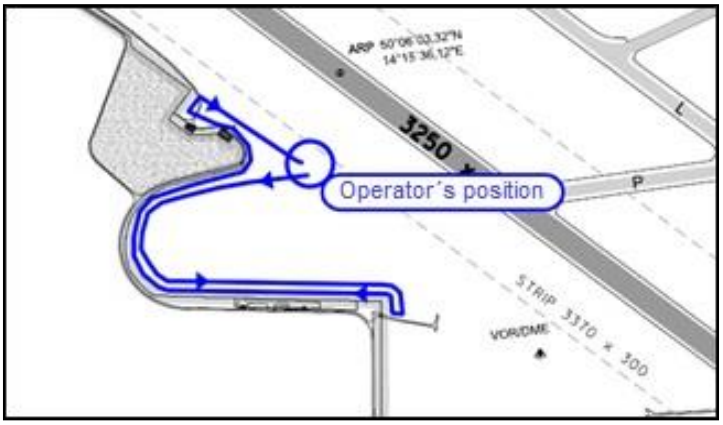

Figure 1 A possible RPAS flight route on perimeter surveillance

Furthermore, the unmanned aerial vehicle may be equipped with a system for snapshots evaluation, allowing the machine to automatically follow a moving target determined by the operator. In combination with a GPS receiver it would be possible to determine a current location of the intruder on the basis of the known RPAS position and guide an OLE patrol to the location to pacify the intruder.

Operation of RPAS carrying out patrols along the fence would take place outside the movement area, which would reduce the risk of conflict with airliners [3], [4]. Still, it would be necessary to coordinate the operation with the Air Traffic Management (ATM) [7]. Patrolling activities could be carried out in manual or automatic flight mode. While manual mode represents a safer method of operation in legislation terms and easier way to obtain all necessary permits, the automatic mode would allow to use full potential of unmanned technologies and to reduce the number of staff required.

During a manually controlled flight the unmanned aircraft operator must be present in the field and constantly maintain a direct visual contact with the machine. That poses a considerable limit to the action radius and so this method makes sense only in such parts of the airport where fencing creates corners. Figure 1 illustrates a possible arrangement for a patrol circuit in manual flight mode near the middle of RWY 12/30. The route is approximately 2350 meters long and it takes 5 minutes to be flown around by an unmanned aerial vehicle at a speed of 8 m/s. Pedestrian patrol would walk through the same section in 15 minutes in one direction only.

Automatic mode would allow the regular RPAS flights along the fence to be carried out without the need for operator´s intervention. The operator could be present in the control room, where he oversees the flight and evaluates images from onboard cameras. If necessary, he could interfere the preset flight route, or perform a controlled landing of the machine.

Given the total length of the perimeter over 27 km, it is not possible to go around the whole area on a single charge with the considered RPAS type. It is therefore necessary to divide the flights into several shorter routes which an unmanned aerial vehicle can manage even with a margin of electrical enegy for eventual target tracking. A possible architecture of the perimeter circuit division is shown in Figure 2. This case allows sufficient flight endurance of 45 minutes at a speed of about 8 m/s. The proposal allows for placement of four automatic charging stations RPAS would operate from. These stations may be for example the *Droneport* by *SkySense Inc.* [5].

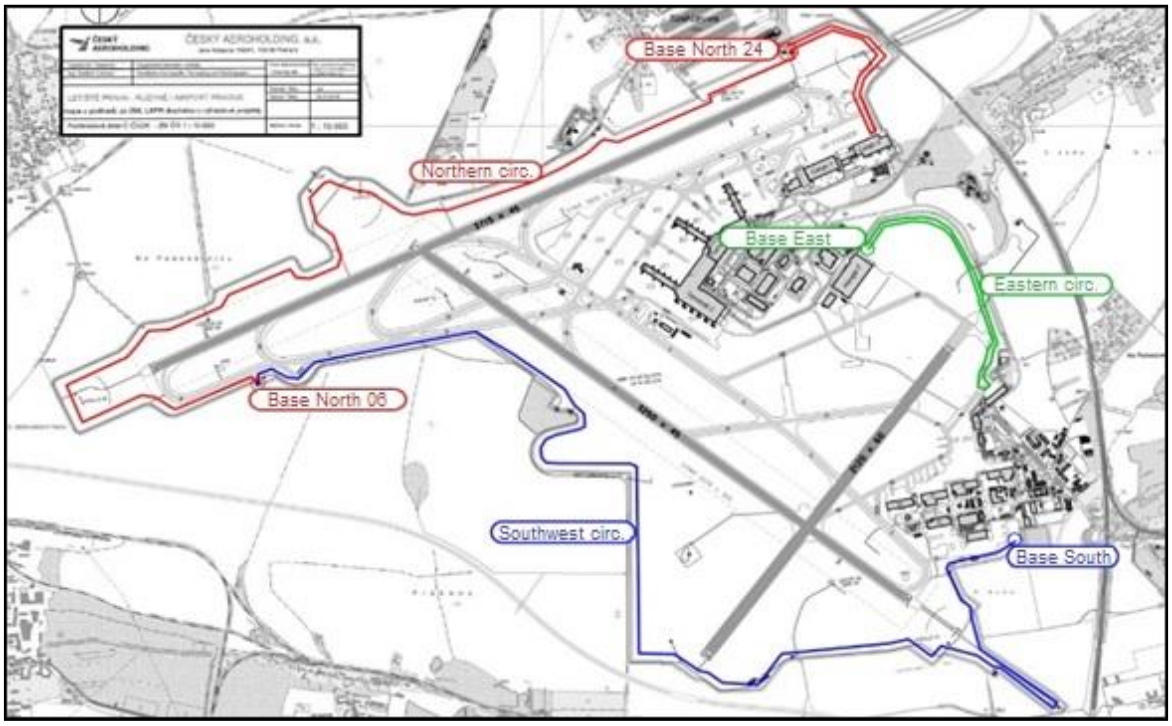

Figure 2 A draft of circuits for perimeter surveillance by RPAS in automatic mode

With regard to the legislation that requires maintaining a minimum safe horizontal distance from bystanders and objects, the standard height of flight is determined to be 10 m and flight distance from the fence to be 20 meters [6].

On each circuit one unmanned machine would be deployed and the flights would be coordinated in a way so that they do not meet at the base. Flight time is always within 20 minutes, which ensures the necessary power reserve in case of necessary intervention. Battery recharge to full state would not take more than 40 minutes. By appropriate planning of flights any part of the perimeter can be covered at least once per hour using only three machines. However, it is advisable to have at least one more machine in reserve to ensure operation during planned maintenance and unplanned repairs.

In addition to patrols along the perimeter unmanned aerial vehicles could perform other tasks, such as finding an intruder inside the area by using infrared cameras and tracking his position until the arrival of OLE mobile patrols. Another use may be in monitoring the restricted area, such as an aircraft stand and guarding a VIP flight. RPAS could also be useful in emergencies as they are able to provide a comprehensive picture of the overall situation [8].

3. BIOLOGICAL PROTECTION

For the aircraft protection from collisions with birds and wildlife is responsible the Biological Protection of the Airport department (BOL). Its staff continuously monitors the airport space from sunrise to sunset and in case of wildlife occurrence near the active runway they start scaring. Scaring is done in several ways. The most elegant one represents a bird of prey trained by falconers who is a natural predator for many birds and small animals' species. Also hunting guns are used not only for frightening, but also for hunting. Against large bird flocks shrapnel bullets are successfully used. Animals on the ground are subsequently searched by a hound. To achieve an effective biological protection it is necessary to combine all these activities effectively. One of the things that BOL employees are missing is a tool for monitoring the presence of birds and animals inside the perimeter and adjacent areas so they could choose the most appropriate way of scaring [9].

This can be achieved by a deployment of an unmanned aircraft equipped with a suitable type of on-board cameras. Because the intended use is during daylight, a color camera such as GoPro would be

sufficient. The image of the board would be transmitted to the operator´s screen who would thus gain an overview about the actual occurrence of wildlife in a given location. The operator could in this way observe occurrence of field crops on agricultural land close to the airport and estimate its attractiveness for birds.

In addition to the cameras RPAS could also carry an acoustic equipment for bird scaring. This facility would be technically identical to static acoustic frightening equipment that plays predator´s sounds or contrarily distress signals of small birds. The main advantage of such a use would be the possibility of placing the acoustic equipment close to a flock and in a direction so that the birds fly away from the airport. A team of researchers from VŠTE in Ceske Budejovice currently deals with such way of scaring [10].

Unmanned aerial vehicle used for the needs of biological protection of the airport would be always directly deployed in the target area, an operator would transport it to the target area by car. It would eliminate flights over the airport movement area and reduce the risk of a collision with airliners. RPAS operation would take place in manual mode and always in coordination with Air Traffic Control.

4. MOVEMENT AREAS SURFACE INSPECTION

The state of surface movement areas at Prague Airport is regularly checked by a controller from Area Operations Control Department (RPP). The aim of the inspections is to prevent the occurrence of loosened objects that could cause damage to an aircraft. They primarily monitor the condition of surface area, the condition of road signs and the presence of foreign objects debris (FOD). Types of performed controls as well as their frequencies are shown in Table 1.

Table 1 Types of controls and their frequencies [11]

Control type	Frequencies
Regular inspection	min. 5x a day
Detailed inspection	1x a day
Detailed regular inspection	1x in 3 weeks

The current form of movement area inspections consists of at least five routine and one detailed inspection per day. At an average of 350 movements per day, the runway is checked after every 60th aircraft, which in terms of operational safety is not a positive figure. For more, regular checks are performed by the dispatcher looking from the vehicle which moves across the surface often at high speed (over 100 kph), what gives space to miss the foreign object. There are two options how to improve this process: by increasing the frequency of checks, or by increasing the reliability of FOD detection.

The speed of the unmanned aircraft cannot be equated with ground vehicle. So the frequency of routine checks could not be increased. The RPAS can however carry such onboard equipment that ensures reliable detection of foreign objects on the surface. An example may be onboard radar transmitting millimeter waves. This technology is already used by *Tarsier* static radars that continuously monitor the surface of the runway at some airports [12]. Flyby of the RPAS above the runway, however, takes trice more time in comparison with a car, and thus this method may cause undesirable reduction of runway capacity.

So, unmanned aircrafts are not appropriate for routine inspections. However, their use would be found in detailed regular inspections, that are realized every 3 weeks and for the duration of this inspection the affected part of the area is closed to all traffic. Nowadays this inspection is performed by employees of *Area Operations Control Department* and *Technical management of properties*, who physically pass through the whole area to note detected defects. This process is very lengthy and acquired recordings must be elaborately evaluated.

RPAS would be able to fulfill this task using the onboard camera, which is much simpler and cheaper equipment than the aforementioned radar. This method of inspection is already offered by *airsight GmbH*. During a flight over the area the camera captures detailed images of the surface labeled by their GPS position. These images are then composed by a computer program to form a complete picture of the inspected area. Evaluation of images is performed by the inspector in calm environment of his office

while the overseen area is back in operation. Though the evaluation itself takes the same time as when using conventional method, the obtained output is clear and reproducible at any time. Moreover, it can serve as a basis for long-term monitoring of the area condition and for well-timed renovations planning [13].

That means of RPAS using is safe from the operational point of view, since the individual flights are realized only over the area that is closed to all traffic. In addition, the operator controls the unmanned aircraft manually and has it in direct line of sight throughout the whole flight. The risk of collision with other traffic is therefore minimal.

5. CONCLUSION

Current way in which each process is performed is in full compliance with the relevant standards, regulations and laws. However, every process can be enhanced, for example by an implementation of new technologies or procedures. One of the possible ways is the integration of remotely piloted aircrafts that can fulfill wide range of tasks. In the airport environment, their potential will be best utilized by their integration into airport security process, where they can automatically patrol along the perimeter. Though, systems that ensure an automatic flight safety are at stage of development, so only the manual mode operation is applicable. In that mode the RPAS could guard a circumscribed area inside the airport, or help in solving an emergency event. It could be used also for the movement area surface inspection, but, regarding its speed, only for the detailed inspections. In the process of biological protection, it can be used for monitoring the animals in airport fields rather than scaring birds. That activity can be done by a vehicle that is primarily assigned to another task, such as patrolling along the fence.

6. LITERATURE LIST

Journals:

[8] ENDRIZALOVÁ, E. and NĚMEC, V. The Costs of Airline Service [online]. MAD - Magazine of Aviation Development. 2014, 2(8), pp. 14-16. ISSN 1805-7578.

Conference Proceedings:

[3] ZACH, M. and PLENINGER, S. Probability of Successful Message Reception on "Low-cost" ADS-B Receiver. In: Aeronautika 15. Aeronautika 15. Lublin, 15.10.2015 - 16.10.2015. Lublin: Lublin University of Technology. 2015, pp. 113-117. ISBN 978-83-7947-149-2.

[4] PLENINGER, S. and LIPTÁK, T. Mapping of Cooperative Surveillance Systems Using SSR Transponder's Replies Analyze. In: New Trends in Civil Aviation 2016. New Trends in Civil Aviation 2016. Žilina, 22.09.2016. Žilina: Žilinská univerzita v Žilině Fakulta prevádzky a ekonomiky dopravy a spojov. 2016, pp. 69-72. ISBN 978-80-554-1252-8.

[7] LETÁK, F., FRYNTA, J., and ENDRIZALOVÁ, E. Optimization of Ground Navigation Aids of Regional Airports. In: Aeronautika 15. Aeronautika 15. Lublin, 15.10.2015 - 16.10.2015. Lublin: Lublin University of Technology. 2015, pp. 210-214. ISBN 978-83-7947-149-2.

Web sides:

[1] *GoPro Hero4 Black*. gopro.cz. Available at: http://gopro4.cz/gopro-hero-4-predstaveno

[2] *Tau 2 Uncooled Cores*. Flir: OEM cores & components. Available at: http://www.flir.com/cores/display/?id=54717

[5] *Introducing Skysense Drone Charging Stations*. Skysense, Inc. Available at: http://www.skysense.co/charging-stations

[6] *Jaká vzdálenost je z pohledu ÚCL považována za bezpečnou?(What distance is considered by CAA to be safe?)*. Úřad pro civilní letectví (Civil Aviation Authority). Available at: http://www.caa.cz/letadla-bez-pilota-na-palube/jaka-vzdalenost-je-z-pohledu-ucl-povazovana-za-bezpecnou

[10] *Odborník VŠTE: Letiště by mohly místo dravců hlídat drony (VSTE specialist: Airport could be watched by drones instead of predators)*. VŠTE. Available at: http://www.vstecb.cz/Odbornik-VSTE-Letiste-by-mohly-misto-dravcu-hlidat-drony-1439.htm

[12] *Tarsier*. QinetiQ Group. Available at: http://www.tarsier.qinetiq.com/solution/Pages/tarsier.aspx

[13] *UAV pavement inspections*. Airsight GmbH. Available at: http://www.airsight.de/en/consulting/uav-aerodrome-inspections.html

Other:

[9] Internal procedure. *Ochrana letadel před střety s ptáky a volně žijícími zvířaty (Aircraft protection from birdstrike and other wildlife collisions)*. Prague Airport. 2015. LP-PP-047D/2009

[11] Internal procedure. *Výkon služby Řízení provozu ploch (Airport operations duty performance)*. Prague Airport. 2014. LP-PP-011D/2009