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POSSIBILITIES OF USING UNMANNED AERIAL VEHICLES FOR BIOLOGICAL PROTECTION OF AIRPORTS IN EUROPE

Summary. This paper offers a comparison of selected European countries´ approaches to the civil and commercial use of Unmanned Aerial Vehicles (UAV) with the approach and rules set by the Civil Aviation Authority (CAA) in the Czech Republic. The authors specially focused on the differences in the approaches of individual authorities, which regulate the use of unmanned vehicles in the countries concerned in order to emphasise the inconsistency of rules within the European Economic Area. In the other part of the paper, the authors outline the possibilities of using unmanned aerial vehicles (drones), particularly dealing with increasing safety in air transport as a complement to biological protection of airports, and propose their original idea of the system.

Keywords: unmanned aerial vehicles, UAV operation regulation, civil aviation authority, unmanned aircraft system.

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1. INTRODUCTION

At present, with technological advances in aviation is likewise the growth of new technology systems with demands on security. An example of such new technology may be the unmanned aerial vehicles (UAV) that have become very popular in the civil sector. It is the mass character of their use itself, both civil and commercial, that puts greater demands on safety and the regulation of their use. The two largest organisations that implement the global rules and regulatory frameworks in the field of unmanned aerial navigation – EASA (in Europe) and the FAA (in North America) have a heterogeneous approach to regulatory principles. Both, however, quite considerably ignore a number of technological loopholes. While the FAA favours direct and uncompromising modes of implementation, the EASA takes a step-by-step approach in order to involve all major UAV stakeholders in the definition of legislative frameworks [1,2].

The United States is a few steps ahead of Europe in the global implementation of unifying rules, and the situation is not expected to change in nearest the future. The US's lead is given by the level at which the two organisation operate. While the FAA is an entity that unites the smaller administrative units (states) in the US under its agenda, the EASA unifies the sovereign EU countries, each having its regulatory framework, either established or with their deployment underway. It is desirable for all EASA member states to adopt uniform legislation between 2018 and 2019, when the EU's active bodies should approve the regulatory framework. In the United States, the introduction of unified legislation became a reality in 2016 and today, it serves not only as an important source of information, experience and recommendations for EASA but also as an important aspect for the compatibility of these two agencies, whose common interest is in mutual cooperation.

2. BASIC RULES FOR UAV OPERATION IN THE CZECH REPUBLIC

The operation of unmanned aircraft in the Czech Republic is directly anchored by legislation (in particular by L2 - the ICAO Annex 2, and Amendment X), and pilots must follow precisely defined parts of the airspace when controlling the aircraft. The airspace structure is international, crossing borders and enabling flights in a protected area [3].

Under standard conditions, the aircraft may move in the airspace of Class G, the level of which begins at an altitude of up to 300 m above ground level (AGL) outside the control zone of airports with controlled traffic (CTR). VFR and IFR flights are not part of the flight permit. Special modifications of operation are provided by the Amendment X in the airport traffic zone, where the airports with air traffic control need to be distinguished from airports without air traffic control. In the aerodrome traffic zone (ATZ) of a non-controlled airport, flight may only be operated on the grounds that it meets previously set conditions by its operator and based on communication with the airport flight information service (AFIS). Above the airspace of class G, flights in ATZ may only be operated on the condition that AFIS is present at the aerodrome or air traffic information is provided in the aerodrome area. Up to 100 m above the ground at a controlled zone of the aerodrome, the flight may only be operated with the exceptional permit of the appropriate air traffic control unit and at a horizontal distance greater than 5,500 m from the reference point of the controlled aerodrome, except for the case of authorisation by the Civil Aviation Authority (CAA), or during aeronautical shows and public appearances [3].

In the airspace of class G, an unmanned aeroplane can move without restriction. However, pilots have to abide by the principle of increased caution from a height of 150 m, where normal air traffic can occur. The minimum height at which the UAV can be conducted is not specified. The basic principle for all operations of these aircraft is the provision determining the exclusion of flights from the common airspace. The protection of people and property on the ground is also primary for this area. The CAA recommends that twice the flight height should be maintained as a safe distance. Flights are possible in densely populated areas, but only under specific conditions and with the permission of the CAA. An aircraft may not be operated in a forbidden, hazardous and other, user-activated restricted and reserved areas [4].

Special areas of the restricted ban on movement of unmanned aircraft are protection zones. Unless otherwise provided by the CAA, flights of unmanned aircraft may not be carried out in the following areas: the protection zones established by the relevant legislation alongside aboveground transport constructions, aboveground utility constructions, aboveground communications networks, inside specially protected areas, around water resources, and buildings important for state defence [4]. Among other things, a drone operator may use the aircraft only within the visual line of sight (VLOS); the start and take-off must always be carried out with the consent of the owner of the land; in the air, the drones must not be closer than 50 m to people, vehicles, etc.

2.1. German approach

The Federal Ministry of Transport and Digital Infrastructure in Germany proposed new rules effective on 9 November 2015. Individual Länder may allow flights beyond the VLOS depending on safety and traffic conditions. There is no national regulatory authority in the area of unmanned aerial vehicles in Germany, and the issue of permits and regulatory frameworks is, therefore, the responsibility of individual Länder. Some of the states even have more than one active body within their region. There are currently 22 competent authorities in Germany (in a total of 16 Länder). Every flight operated for commercial purposes has to be approved by the appropriate aviation authority. Operators must pass an appropriate exam to test their piloting capabilities and knowledge of aviation laws. In practice, the aviation authority is in charge of issuing individual licenses. The following principles apply to the Remotely Piloted Aircraft System (RPAS) with a payload of less than 25 kg [5, 6]:

- the use within the perimeter of an airport or restricted airspace only on the basis of permits; flights within the perimeter of 1.5 km from the airport or landing area are also subject to a special permit
- flights in controlled air traffic must have permissions from the Air Traffic Control (ATC)
- take-offs and landings must always be permitted by the landowner or airport operator
- permission is mandatory in the Radio mandatory zone (RMZ)
- all flights are forbidden in the area of protection zones (public, military, industrial, motorways, and railways), as well as flights over people, sites of crashes or disasters; flying over sites of security forces actions is not allowed as well
- safe distances have to be maintained around people, vehicles, high voltage lines, and other obstacles. However, unlike the Czech Republic, the exact distances have neither been determined nor recommended by the German authorities
- the UAV operator must be able to take control of the vehicle in manual mode at any time

- accidents and incidents must be reported immediately to the appropriate aviation authority

If unmanned aeroplanes are heavier than 25 kg, their operators must apply for a special permit. A usual flight request must include a copy of a valid insurance, date, time, and start of the flight. As a recommendation, it also states that it is desirable to inform the local police department.

2.2. French approach

France, in comparison to the Czech Republic as well as the whole EU, is much more benevolent concerning UAV operation regulations. French laws likewise distinguish drones flying for recreational and commercial purposes. Flying in France similarly requires a prior one-time permit. In connection with this issue, the regulations adopted by the Transport Ministry on 17 November 2015—on the concept of UAV and the rules for the use of UAV—are crucial. The legislation divides RPAS into seven categories, primarily depending on weight. Regardless of the purpose of the flight, VLOS traffic is only allowed for aircraft with a maximum payload of less than 25 kg and a maximum flight height of 150 m above unpopulated areas; flights above populated areas are permitted for aircraft weighing less than 4 kg. Beyond VLOS, traffic irrespective of the distance is permitted for drones weighing less than 2 kg flying below 150 m, and in the range of 1 km for drones up to 25 kg flying below 50 m of flight level. Current regulations state, inter alia, that:

- drones must be in the pilot′s VLOS
- aircraft is not allowed to move above 150 m
- night operation of drones is prohibited
- recreational use of drones over inhabited areas is not allowed
- commercial flights can only be operated by an operator based in France that owns a PPL pilot license (at least its theoretical part) for aeroplanes, helicopters or gliders
- in the event of unauthorised use of UAS, the user may be liable to a maximum of one year's imprisonment and a fine of up to 75,000 Euros.

France divides flights by region and local conditions into 4 different areas (flight scenario areas):

1. outside a built-up area, flight in visibility to a maximum distance of 200 m and a maximum flight level of up to 150 m
2. outside a built-up area, flight in visibility to a maximum distance of 1000 m and a maximum flight level of 150 m for aeroplanes up to 2 kg, or 50 m for aeroplanes above 2 kg
3. in the city, flight in visibility to a maximum flight distance of 100 m at a maximum flight level of 150 m; in the case of aircraft weight exceeding 2 kg, the aeroplane must be equipped with a parachute safety system and the safety perimeter should be set within a range of 30-50 m
4. in a built-up area without visual contact, the maximum permitted flight level is 150 m and unlimited distance at a maximum aircraft weight of 2 kg.

2.3. Italian approach

The Italian ENAC regulates the aviation law legislation dealing with the UAS quite often. The basic principles of flying with drones in Italy include the following:

- a ban on flying with drones above 70 m
- when flying with UAV, the maximum flight distance is set to 130 m of visibility
- a ban on the transport of any potentially dangerous material by UAV
- the UAV operation over built-up areas, beaches, national parks, cities and gatherings, railways, motorways and industrial areas is not permitted
- the UAV must always be kept by the pilot at least 8 km away from an airport
- piloting a drone is possible only in the daytime
- the maximum permitted weight of a drone is 25 kg
- every aircraft must be insured
- when operating drones, a safety distance of 50 m from persons or property must be maintained

2.4. British approach

As far as the United Kingdom is concerned, the UAS legislation and operation is in charge of the Civil Aviation Authority (CAA) as in the Czech Republic. The CAA divided drones into 3 basic categories by weight. The first category includes UAV up to 20 kg, the second one includes drones in the weight range of 20-150 kg and the third contains drones weighing 150 kg or more. For most flights of drones, there is no need for special permissions except for aviation works. These are similar to the aviation works considered by the Czech Republic legislation. These works concern civil flights. The following rules on flying in the UK have to be followed [5]:

- the maximum flight level of the aircraft must be 120 m
- the maximum (horizontal) distance between the pilot and the controlled aeroplane must not exceed 500 m (unless there is an exception by the CAA)
- operation with FPV system only is not possible, there has to be at least one other person—a direct observer of the aeroplanes who always maintains visual contact with the aeroplane
- if the UAV weighs less than 3.5 kg, the maximum flight level is 305 m
- take-offs and landings must be at least 30 m from the nearest person, including the pilot and other people involved in the operation of the aircraft
- in case of a large gathering which is anchored in the law as a gathering of more than 1,000 people the aircraft must not exceed a safety distance of 150 m
- in the air, drones must not be closer than 50 meters to people, vehicles or buildings

2.5. Spanish approach

Similarly, to the United Kingdom, the Spanish Civil Aviation Authority (DGAC) divides UAV into three basic categories. The first category includes drones with a maximum take-off weight of up to 25 kg. UAV with a maximum take-off weight between 25 and 150 kg are classified as the second weight category, but they must also be registered in the aircraft register (Registro de matrícula de aeronavegabilidad). To aircraft with a maximum take-off weight higher than 150 kg operated in the civilian sector, the same standards apply as to

a normally piloted aircraft. An aircraft of each of these three categories is subject to registration and must have a visible registration plate on it. As in the Czech Republic, two types of use are considered. The first type is recreational use, to which licensing requirements do not apply. The second one is professional use, which has been regulated in Spain since 2014 and is intended only for professional pilots who meet the following conditions:

- age over 18 years
- at least one of the following certificates: a pilot license or the theoretical knowledge certificate issued by an organisation that is authorised by the EASA, or an issuing organisation approved by the Spanish administration
- medical examination
- operational manual
- insurance

The use of drones for recreational purposes is also regulated by Spanish legislation under the following conditions:

- only during the day and in clear weather (no rain, fog, strong wind)
- outside towns, villages, built-up areas, and gatherings
- only in uncontrolled airspace
- only in good visual conditions, up to a horizontal distance of 500 m from the pilot, while maintaining a maximum flight level of 120 m

3. UAS AND BIOLOGICAL PROTECTION OF AIRPORTS

The following passage was adapted from the authors' research project entitled "Biological Protection of Airports Using Unmanned Aircraft System (UAS)". The term "biological protection of airport" comprises of activities related to frightening birds and animals off the airport area, especially the area of the runway and the approach area in order to prevent collisions of birds or flocks of birds with aeroplanes. This is one of the most important components of airport subjects.

The organisation and control of biological protection must ensure the timely and quality use of all forces and means possible to estalblish air traffic, that is, biological protection employees with the help of all practical means must reduce the risk of a bird crash with a moving aircraft. However, it is not possible to eliminate the movement of birds from around the airport. Collisions of birds with aircraft are relatively common. Usually, most of these collisions take place directly at the airport when airplanes take off or land, and at lower flight levels. Every day, tens to hundreds of such collisions are dealt with in international aviation and this is is the reason these collisions rank among the major risks in air transport. According to available data, 20% of all aeroplane collisions with birds cause damage to the aircraft; from the viewpoint of biological protection, the protection of passengers and the aircraft crew is very important, although the high cost of repairing damaged parts of aircraft must be considered as well. Up to 75% of devastating collisions damage aircraft engines and parts of aircraft wings [7-9].

Work of the biological protection employees, however, is complicated by the fact that, for their extensive grassy areas, the airport spaces become optimal living habitats for small animals and birds. Airports are usually located as close to major cities as they are close to agricultural areas. Due to the modern phenomena that disrupt natural ecosystems, such as growing agriculture, chemistry, building roads, land-drying, etc., these animals are forced to

move their sanctuaries elsewhere. Moreover, the airport space combined with the adjacent agricultural areas offers them ideal conditions for living. Although, the airport is a very noisy place, birds like most creatures, are endowed with the ability to adapt to changing conditions. Currently, different types of active or passive methods are used to drive birds and animals off airport take-off and landing areas. Very often, a combination of several methods is necessary because of the constant adaptation of birds to the set conditions [10].

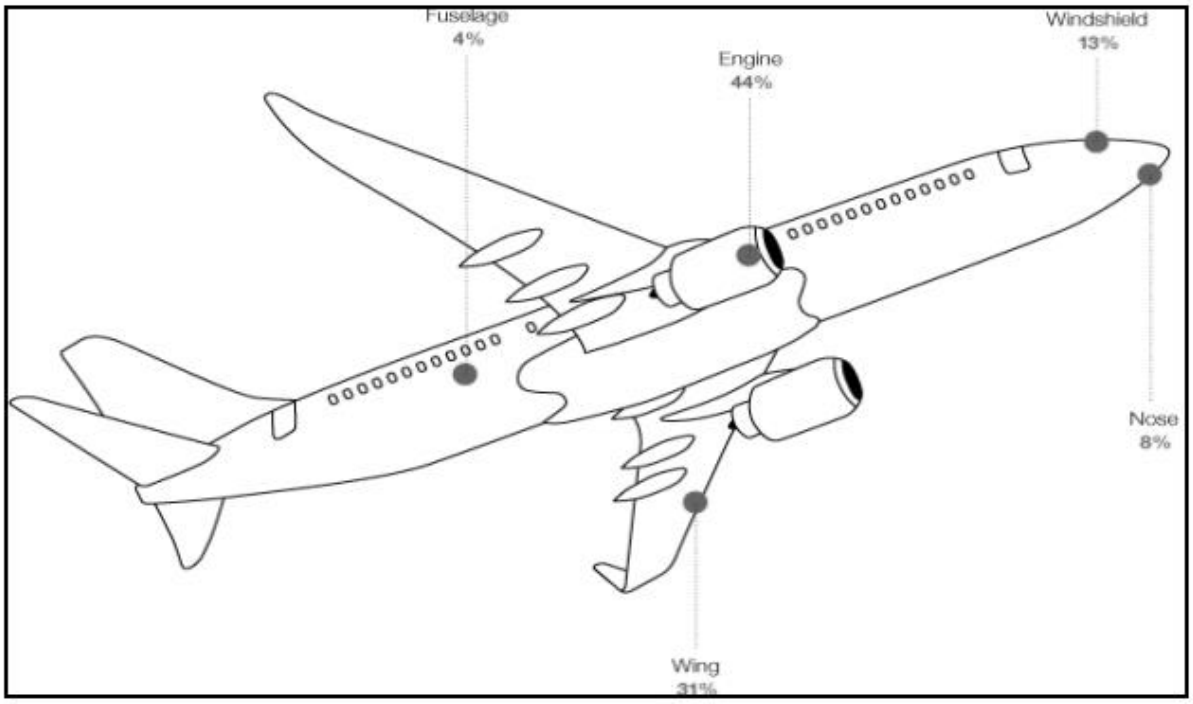

Fig. 1. Percentage representation of bird collisions with individual parts of an aeroplane according to international data [7]

Thus, active and passive methods are combined in a bid to frighten birds and animals off the area around the airport. Examples of the active methods include the use of live predators and dogs for frightening birds, the use of bio-acoustic equipment and even pyrotechnic methods. On the other hand, passive methods may be represented by the selection of crops that can be grown in the vicinity of airports, so that the crop species do not attract flocks of birds. Other examples include a variety of preventative training of aviation personnel, maintenance and removal of green vegetation around the runway, and the like.

4. DRAFT OF UNMANNED AIRCRAFT SYSTEM SUPPORTING THE BIOLOGICAL PROTECTION METHODS USED AT AIRPORTS

The proposal for a new concept of the method for driving birds off the surrounding area of airports allows for a combination of some already proven technologies. A carrier, that is, a UAV, constitutes the basis, given the fact that it is easy to use and programmable to become semi-autonomous. UAV can be organised into swarms or squadrons that work together due to a created controlling program. Owing to the software that ensures semi-autonomous decision-making, the vehicle can be called a drone. The drone becomes a carrier for other types of devices: a bio-acoustic device for frightening off birds and animals is considered in particular,

as well as a camera that can be connected to a monitoring device via a transmitter to enable monitoring of the airport area [9].

The cooperative drone system should have both a monitoring function (due to airport security or for data collection purposes) and a safety function, implemented by a bio-acoustic device installed on the drones representing the tool for frightening birds off the airport [10]. There should also be a scanning and detection function (bird detection plays an important role here), which can be performed by a detection device placed directly on the drone board or by a land-based device linked to the system (ornithological surveys and data collection, or bird detection).

The innovative idea in this system is a specially developed software that could enable drones to be controlled and capable of partial decision making in different situations. For example, one element of the system records a flock of birds in the approach zone of the airport; it evaluates this situation as serious and passes the information to other drones in the system, which will then cooperate with one another to frighten birds off the respective part of the airport. The software development would also require creation of flight levels within the airport CTR and the operation of the system only in a limited area, or flights of drones along defined routes using the Global Satellite Positioning System.

Another type of technology is the GNSS, which is an essential technology enabling accurate targeting of each drone in the system, while allowing drones to be controlled by means of precise information about their location, minimal interference in control and maintenance by the dispatcher (the drone itself disconnects and connects to the docking station) and targeting coordinates for other activities (data collection for ornithologists, airport security component, etc.). The choice of this kind of satellite positioning device falls on the GNSS, particularly because of its topicality in real time, signal continuity and the widest possible coverage. In terms of the services offered by Galileo, unwanted persons (SOL or PRS) should use encrypted data transmission to avoid system misuse [11].

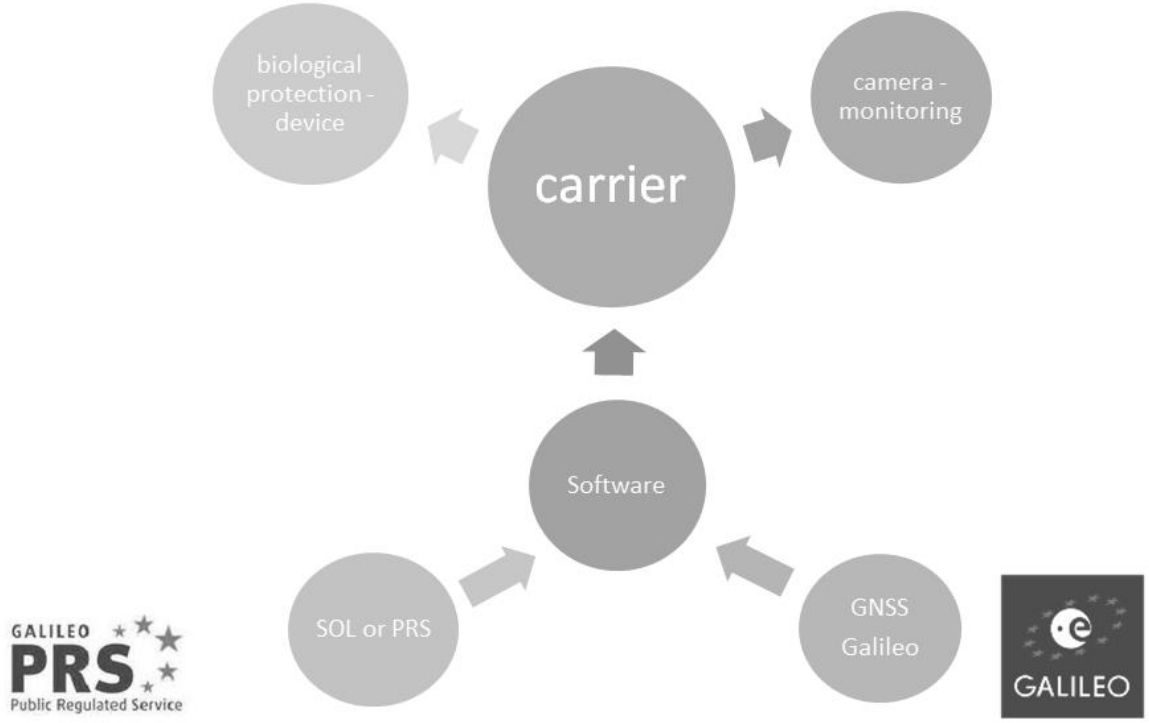

Fig. 2. Diagram of the system including the different technologies

Following the proposal for a new active method of biological protection for airports, it is recommended that this method be combined with already established active and passive methods and other procedures in the field of ornithological observation, that is, monitoring of migratory movements, nesting of birds, bird food, etc. The creation of a nesting site at a safe distance from the airport, where the birds would be directed with the help of drones, is also considered as an effective method [12-13].

5. CONCLUSION

The analysis of selected European countries regarding their regulation of unmanned flights has shown that a relatively progressive and coherent group of states, such as the EU member states, is not uniform in this respect. The reason for the high number and scope of measures is due primarily to the short-term rapid development of these technologies or even the development of aviation in the civil sector. Only a small number of countries expected to be main co-authors of the new, global and uniform legislation were able to promptly react to such development.

These concerns countries that were selected for analysis in this paper. Countries such as Germany, France, or the United Kingdom are the world's leading legislators, which goes hand in hand with their level of technological advancement and UAS development. Their major contribution can be seen in their improvement in professionalism and accessibility that is currently at such a level, which according to the official EASA schedules, the united Europe will achieve in five years time. The main initiators of the gradual expansion of discussions and measures at individual aviation offices are manufacturers of these technologies with high volume of production and a global group of potential customers. They put pressure on specific state apparatuses, owing to the fact that they can on demand launch machines in tune with legislative requirements with huge turnover profits.

This contribution also includes a demonstration of the potential use of unmanned systems in the transport sector, namely to increase safety in air transport. The project entitled "Biological Protection of Airports Using Unmanned Aircraft System (UAS)" is a research project by the authors of the paper. Unmanned aeroplanes can, however, be used and are used in other areas of the economy and commercial sphere. For example, they serve for photographic documentation during construction, in photogrammetry, or even as a means of inventorying in logistics warehouses.

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