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Use of UAVs to provide ornithological safety

Providing ornithological safety is now possible in many ways, in this work we will consider the use of UAVs and their varieties, as well as the features of work. We will also consider the technique of scaring away birds using a neural network and automated algorithms.

Ornithological danger belongs to the category of dangerous environmental influences. It is caused by the sudden appearance of birds in the path of aircraft movement and can lead to special flight situations. Over the past several decades, birds have become a direct threat to aviation security, and a killer element with an uncontrollable source of flight safety problems. Birds are a direct source of incidents and accidents in the sky, which cause colossal losses for aviation and often lead to huge accidents with victims and hundreds of lives lost.

The International Civil Aviation Organization (ICAO) records more than 5,000 bird strikes annually alone. Aircraft repairs reach $ 1.2 billion annually, and the number of victims is steadily increasing. Because of this, aviation requires increasingly radical measures to prevent dangerous situations associated with ornithological activities of birds, especially in areas of airfields and airfields.

For such tasks, there are ornithological airport services. The work of such specialists is a whole range of events. This includes conducting an environmental and ornithological survey - in order to collect complete information on the seasonal, altitude, species distribution of birds during the year, the use of passive and active repellents, the use of traps, the recording of collision cases that occur in the area of the airfield, the analysis of this information, the investigation of cases that led to damage or some negative consequences for the flight of the aircraft. Their main task is to make the territory of airfields as less attractive to birds as possible, as well as monitoring the flight field, timely detection of the appearance of clusters of birds on the flight field and taking appropriate measures.

Most often, ornithological danger occurs during periods of seasonal and daily migrations, with post-breeding, forage and other congestion. The behavior of birds is determined by the action of a huge number of environmental factors: birds can attract affordable and abundant food, convenient water supply, nesting places, for safe rest, overnight stays. On the territory of the airport, measures are being taken to remove ground predators - they are also a source of danger for taking off and landing aircraft, thanks to which the birds feel more safe there. It is also worth considering that the airport is a regime enterprise with a small number of people who can attend it, and this is also very favorable for birds.

According to the International Civil Aviation Organization (ICAO), due to a collision with birds, the engine and wing of the aircraft are most often damaged, these parts account for more than 40% of all cases. Less often - windshield, radar antenna, fuselage, stabilizer, headlamp and landing gear. The most dangerous are the

ingress of birds into the engine (due to the threat of its destruction) and into the windshield (due to possible depressurization of the cockpit). Also, according to many years of analysis, it is possible to identify certain patterns characterizing the threat posed by birds. So, more than 70% of all collisions occur during the day, and the most dangerous are heights up to 100 m (52-80% of all collisions). At the same time, 47-57% of collisions occur at the stages of descent and landing, and 30-47% of collisions occur at the stages of take-off and climb.

In the fight against ornithological danger, many different methods are used, these are both the latest technical tools and traditional ones. Traditional means are considered to be the use of birds of prey and environmental change to make it as attractive to birds as possible. Such means are regular care of the territory of the airfield, minimization of landfills and their protection from birds using wires and nets, regular painting of grass in order to prevent the nesting of birds in it, control over its height, reducing the possibility of nesting birds at aerodrome facilities, Since tall grass attracts birds, the reduction and elimination of trees and shrubs, since this provides birds with food, shelter or overnight accommodation, getting rid of sources of standing water by draining lakes and swamps, minimization of crops and fields in the immediate vicinity of the airfield.

Accordingly, the newest tools include bioacoustic repellers, which are a mobile complex that generates an alarm signal and screams of birds of prey to feathered violators, to enhance the scare effect, they additionally use pyrotechnic devices, noise propane and portable laser guns, occasionally simulating gunshots, reflective balls, laser repellents, as well as networks and anti–priest strings, radio-controlled bird models, images, scarecrow, radiolocators. Also, more recently, UAVs have entered into widespread use, with various techniques for scaring away birds.

The purpose of introducing unmanned aerial vehicles into the airport bird service is to improve aviation security due to the use of modern bird scaring devices, as well as to improve the safety of the runway, which will significantly affect the financial profit of the airport and airlines in general, and the collection of ornithological information. Compared to other research methods, the advantages of using drones for collecting bird information are the relative savings in resources, as well as the collection of volumetric information with good resolution with minimal disturbance to birds. Since the study of a number of bird species is complicated by the difficult accessibility to nesting sites, with the help of drones there is an opportunity, both for nature conservation and for scientific purposes, to explore territories that cannot be visited by any other means.

In order to scare away birds, the so-called drone-bird is used, this is a remotely controlled drone that looks like a falcon or a bird of prey. It flaps its wings like a real feathered predator to stay in the air. This makes it believable and scares the birds even more. An example of such a drone is the Robird, which is currently in use at Edmonton Canada International Airport.

There are also drones that are used as a scarecrow and noise repeller. They make sounds that notify of danger to birds and imitate the calls of birds of prey. One such UAV is the ProHawk, developed by Bird-X. Equipped with GPS, the ProHawk

drone can be programmed for a specific flight path that it will follow during operation.

A new and most promising technique for scaring birds with the help of drones is a neural network that coordinates the actions of a UAV using an automated algorithm, allowing you to control the entire flock of birds at the same time, rather than individual individuals. It was developed by engineers at the Caltech Institute. This algorithm is based on the model of bird behavior, which in turn is based on the study of the critical distance from the stranger, when moving to which the birds interact with each other as a flock, as well as other features of the behavior of birds. The herding algorithm, referred to as the mwaypoint algorithm, is designed using a dynamic model of bird flocking based on Reynolds 'rules.

Human-controlled drones can be unreliable, if the operator becomes very aggressive and scares the birds, the flock can scatter and become even more uncontrollable. Therefore, this method seems very attractive from the security side, since the algorithm allows drones to scare birds away without human intervention, that is, it trains drones to autonomously drive flocks of birds away from the airport airspace. In the implemented project, cameras record how the flock is formed and determine its position. The computer system forms a further model of the flock's behavior, predicts its trajectory and issues commands to the drone, which automatically chooses how to fly so that the birds are guaranteed not to fall into the "protection" zone.

Since each bird is guided by the nearest bird in the flock during flight, drones need to monitor the latest wedge birds, which set the direction for the flight of the entire group. The exact location of the drone can cause the last individuals of the wedge to slightly change the direction of their movement - which affects the birds closest to them and birds deeper in the flock and other individuals, until it forces the entire group to perform a certain maneuver. At the same time, it is very important to consider the bird wedge as a single closed system, and control all participants in the bird pack synchronously. In this case, another need arises, namely, the need for additional drones that would track the birds that have strayed from the general flock and return them to the group. In order for the drone to automatically ward off the birds, a mathematical model of the flock was built, which describes how it sticks together and how it responds to danger that comes in at a certain angle. The old algorithms developed for the detachment of sheep herds were taken as a basis. They were expanded for three dimensions instead of two. Previous research on spacecraft and drone swarms has also been surprisingly helpful. It is planned that from space, information about new flocks discovered, will be received, and at least a dozen drones will need to be used to protect a large airport.

Thus, activities using UAVs to provide ornithological safety include:
• Ornithological survey of the area;
• Elimination of conditions conducive to the accumulation of birds at airfields, and the implementation of measures to scare them away;
• Conducting visual and radar system observations to ensure control over the ornithological situation;

• Collection and evaluation of data on the actual ornithological situation in the area of the airfield in order to determine the danger posed by birds for aircraft flights.

Various scarecrow, technical means and other variants of ground-based bird scarers are not very suitable for use in large areas, while drones, on the contrary, have a wide range of action and can scare away pest birds even on the fly. They are also less resource-intensive than other methods and are quite economically beneficial. Thus, the use of UAVs for ornithological safety purposes is quite effective and requires widespread implementation in airport structures around the world.

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