Increasing the Flight Safety of Coastal Rescue Drones and Helicopters with Protective Devices from Bird Strikes

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Abstract: *The use of modern drones, or unmanned aerial vehicles (UAVs), is rapidly increasing in both civilian and military fields. Drones are used for topographic surveying, infrastructure monitoring, emergency rescue operations, and many other important tasks. The successful operation of these mechanisms largely depends on increased flight safety.*
One of the serious risks when flying at low altitudes, in cities, in rural areas, especially along coastlines or near forests, is bird strikes. Bird strikes between drones and birds are a growing threat that not only cause damage to the drone itself, but can also result in bird fragments being thrown by the propeller onto a person or structure, creating potential for harm.heir aerodynamic stability, engine power, flight route sel. Therefore, the safe operation of drones requires not only a high technological level and management, but also the implementation of environmentally friendly and intelligent protection systems. Prevention of collisions with birds is one of the priority tasks, which is becoming more and more relevant today, given the widespread use of drones.ection, and many other factors.

Keywords: *Drone, protection systems, birds, helicopter.*

The problem

According to statistics, the demand for search and rescue helicopters and drones has increased significantly in the world. In the recent past, many different types of search and rescue operations have been carried out in our country. Unfortunately, some of them have not been successful, because the crew members encountered problems while trying to save people's lives, which made the operation high-risk. These risks are significantly due to the increased probability of birds getting into the engines of the aircraft. There is significant bird activity in the coastal zone of the sea (seagulls, birds, ducks, etc.) [8].

Fig. 1 Bird strike on aircraft propeller

Introduction

As ICAO (International Civil Aviation Organization) and EASA (European Union Aviation Safety Agency) point out, priority should be given to the safe flight of aircraft, especially to reduce risks such as collisions with birds [1].

The implementation of a bird collision protection system for drones may become mandatory for certain classes of drones, especially those used for the following purposes:

- Surveillance on passenger routes
- In public places.
- For multicopters, emergency medical services (MED-UAV)
- Monitoring the area around airports for safety purposes.
- Monitoring infrastructure (bridges, dams, power lines) during inspections, especially near cities and settlements.
- For fire-fighting drones operating in forest areas and natural protected areas where bird diversity is high.
- For agrodromes, from which large agricultural areas are worked and the risk of collision with birds is frequent.
- For monitoring transport corridors (for example, supervision of railways or motorways).
- In rescue operations in mountainous and natural landscapes, where bird migration routes pass.
- During television and film filming, when drones are used from high altitudes and fly over populated areas.

Technical means of protection against foreign bodies

Various types of engine protection devices are found in information sources. Given the relevance of the issue, technical information and achievements that are currently implemented and presented on the Internet were searched.

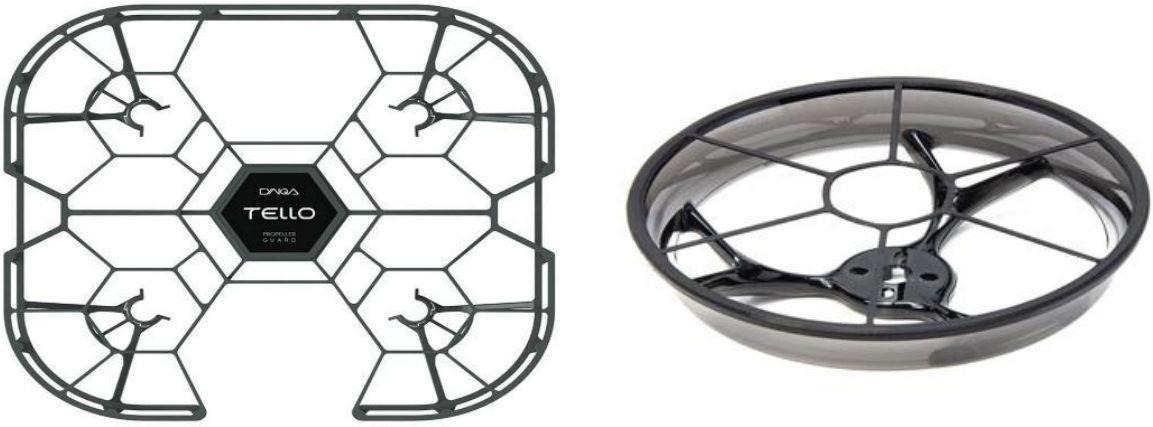


Fig. 2 Various technical means of protecting drones and their engines from birds

A drone and air taxi with impeller-type ducted engines, on which various types of protective devices can be installed:

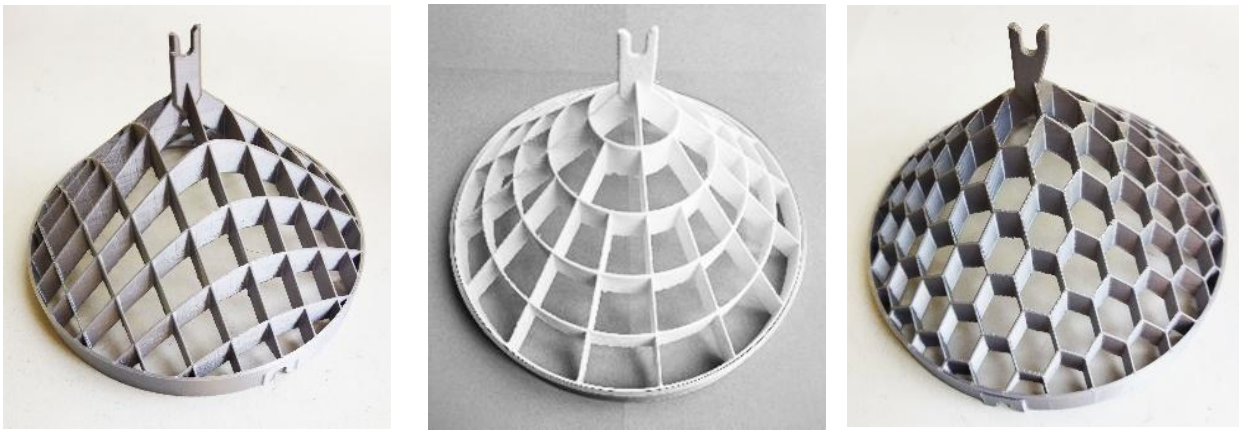
Fig. 3 Drones equipped with impeller-type ducted engines

When creating protective devices, a list of technical requirements was drawn up in advance, which the structures developed by the project must meet:

- Stability in the event of a collision
- Lightweight and strong materials
- Aerodynamic resistance
- Multi-segment cellular structure
- Modularity and quick replacement
- High level of protection in the event of a collision with birds
- Technological simplicity and cheapness of manufacture

In order to identify cones of protective honeycomb construction with the best technical characteristics, three types of constructions were developed that fully meet the listed technical requirements for protective devices.

Cone-type protective honeycomb constructions:



A B C

Fig. 4 Protective cone honeycomb structures: A-with hexagonal cells, B-with square cells, C-with arcuate cells

Materials used for the manufacture of protective equipment

PA-6 CARBON FIBER REINFORCED NYLON, a nylon-type plastic containing short carbon fibers.

Carbon Fiber Reinforced Polycarbonate (CFRP) and polyethylene terephthalate (PET) carbon fiber reinforced filament are also distinguished by similar acceptable properties. It is one of the most common polymers, which is widely used in many different industries. Of the above materials, carbon-infused nylon is considered the strongest material.

Aerodynamic tests

For the purpose of aerodynamic tests, 3D models of the protective cellular structure were made of plastic material according to the preliminary design drawings. The models have the same height, base diameter (200 mm), box area (370 mm2) and wall thickness (2 mm).

The structures were mounted on an aerodynamic tube, on a special sting-balance device, which is distinguished by high sensitivity and measurement accuracy.

In order to install the protective system on the aerodynamic tube and evaluate their aerodynamic resistance, it was necessary to design and manufacture a special mounting bracket.

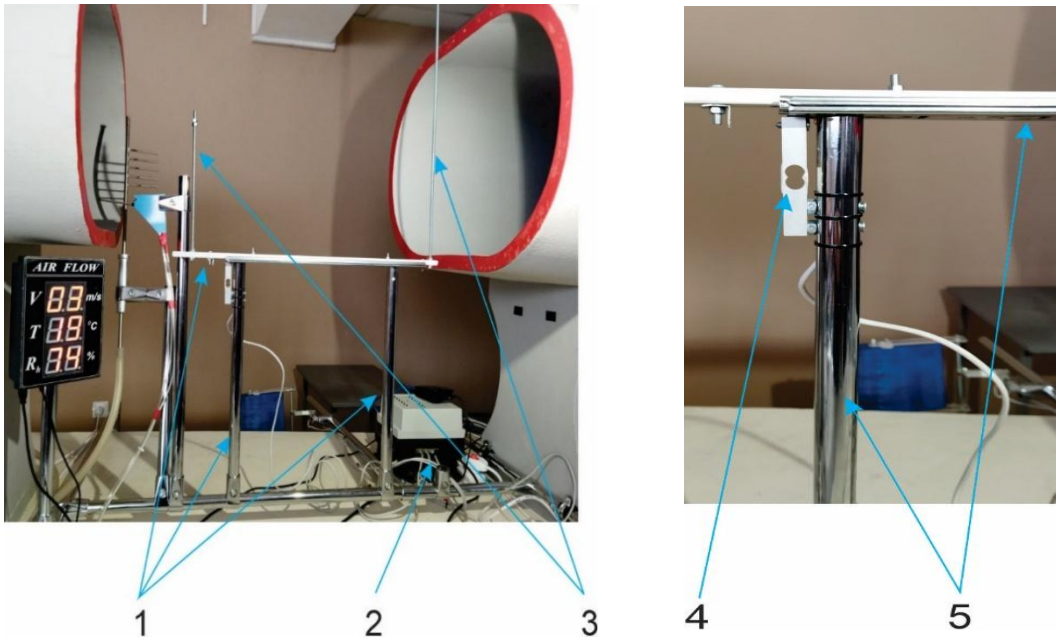


Fig. 5 Sting Balance assembled mounting and clamping device for testing a protective honeycomb-cone and mesh on a wind tunnel: 1, 5-clamping bracket; 2-controller; 3-angled rod; 4-force sensor.

The cones of the protective shell structure were tested in a wind tunnel at an air flow velocity of V=20 m/s and their aerodynamic drag forces were determined. The tests showed that the square-type tray-type protective device has the lowest drag force and it was determined that it showed the best results in the results of comparative experiments.

Conclusion

Bird strikes are one of the most common and serious threats to unmanned aerial vehicles (UAVs). In response to this problem, this study investigated the effectiveness of conical cellular protective structures around the engine as an innovative way to reduce damage from bird strikes.

The "Sting-Balance" system used in the study allowed for precise force and moment testing, which allowed us to understand the detailed assessment of aerodynamic parameters. The data obtained indicate that the addition of a protective structure increases energy consumption by an average of 10-12%, although this cost is much smaller than the damage that a collision with a bird may cause.

It can be said that the conical protection system with a cellular structure is a technologically sound and proven solution for protecting drone engines. In addition, it can be implemented on both civilian and military, rescue or scientific drones, where flight safety is important.

Acknowledgements

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სანაპირო ზოლში მომუშავე სამაშველო შვეულმფრენების და დრონების ფრენის უსაფრთხოების გაზრდა ძრავებში ფრინველების მოხვედრისგან დამცავი მოწყობილობების გამოყენებით

ზურაბ კოპალეიშვილი
საქართველოს საავიაციო უნივერსიტეტი
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რეზიუმე: *თანამედროვე დრონების, ანუ უპილოტო საფრენი აპარატების (UAV – Unmanned Aerial Vehicle), გამოყენება სწრაფად იზრდება როგორც სამოქალაქო, ისე სამხედრო სფეროებში. დრონების მეშვეობით ხორციელდება ტოპოგრაფიული გადაღება, ინფრასტრუქტურის მონიტორინგი, გადაუდებელი სამაშველო ოპერაციები და სხვა მრავალი მნიშვნელოვანი ამოცანა. ამ მექანიზმების წარმატებული ოპერირება დიდწილად დამოკიდებულია ფრენის გაზრდილ უსაფრთხოებაზე, მათ აეროდინამიკურ სტაბილურობაზე, ძრავების სიმძლავრეზე, საფრენი მარშრუტის შერჩევაზე და სხვა მრავალ ფაქტორზე.*

ერთ-ერთი სერიოზული რისკ-ფაქტორი დაბალ სიმაღლეზე ფრენისას, ქალაქში, ქალაქგარეთ, განსაკუთრებით სანაპირო ზოლებში ან ტყის მასივებთან არის ფრინველებთან შეჯახება. დრონებისა და ფრინველების შეჯახება (Bird Strike) წარმოადგენს მზარდ საფრთხეს, რომელიც არა მხოლოდ თვითონ დრონის დაზიანებას იწვევს, არამედ შესაძლოა გამოიწვიოს პროპელერის მიერ ფრინველის ფრაგმენტების მოხვედრა ადამიანზე ან სტრუქტურაზე, რაც ქმნის მოსალოდნელ პოტენციურ ზიანის რისკს.

ამრიგად, დრონების უსაფრთხო ექსპლუატაცია მოითხოვს არამხოლოდ ტექნოლოგიურად მაღალ დონეს და მენეჯმენტს, არამედ გარემოსთან ადაპტირებული და ინტელექტუალური დაცვის სისტემების დანერგვას. ფრინველებთან შეჯახების პრევენცია კი ერთ-ერთი პრიორიტეტული ამოცანაა, რაც დღეისათვის, დრონების ფართო გამოყენების პირობებში, უფრო და უფრო აქტუალური ხდება.

საკვანძო სიტყვები: *დრონი, დამცავი მოწყობილობა, ფრინველები, შვეულმფრენი*