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Analysis of the Prospects for Controlling Small Aircraft Using Cooperative Airspace Surveillance Systems

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***Abstract*—The paper analyzes the prospects for controlling small aircraft using cooperative airspace surveillance systems. The use of cooperative surveillance systems ADS-B, MLAT and their analogues for the possibility of airspace control for small aircraft is also investigated. The use of cooperative surveillance systems ADS-B, MLAT and their analogues for small aircraft for the possibility of airspace control will be useful in many sectors of society.**

Keywords—Small Aircraft, UAV, Analysis, Management, Control, ADS-B, MLAT, ADS-B Mini, Cooperative Surveillance, Airspace.

I. Introduction

The creation of methods for identifying and controlling small aircraft using cooperative surveillance systems is very necessary to ensure the control of small aircraft (SAC) or their groups. Since this has a direct impact on the security and defense capabilities of the country. The number of SAC in the airspace has increased many times. And the relevance of using SAC for strategic purposes continues to grow.

The management of SAC attracts the attention of countries around the world. And since they are only developing, there is no clear and unified solution. Currently, there are problems in identifying small aircraft on the basis of "friends and foes" [1-4] within the operational space (movement, delivery, etc.) [5-9]. It is also not clear how to act when a group of SAC s is moved and how it should interact with each other and the control system. Thus, the search for methods and ways to implement SAC identification systems, management of SAC s or their groups by a centralized or distributed system operating in the operational area is relevant.

The purpose of the work: to investigate the use of cooperative surveillance systems ADS-B, MLAT and their analogues in terms of the possibility of airspace control for small aircraft. Since there is no clear idea and systems for performing such tasks in Ukraine and in the world, this confirms the relevance of the research.

II. Main Part

To ensure the control of small aircraft or their groups, ready-made solutions such as ADS-B, MLAT [10-14], or cellular communication systems can be used. Currently, there are some ready-made solutions on the market, such as ADS-B Mini implemented in the USA [3-5], and active research work is being carried out in their implementation and testing. But the systems are still at the stage of prototypes. The use of unregistered small aircraft in the airspace can cause harm to both individuals and the state. Therefore, control makes it possible to avoid risks and losses [15-19].

According to the results of the study, the following areas for solving the problem were analyzed:

- methods of controlling the movement and identification of small aircraft and their groups in airspace;
- ADS-B and MLAT systems [20-22] - as a ready-made architecture, into which both a single aircraft and a swarm can be integrated as a single object;
- algorithms for controlling small aircraft in conditions of control by their cooperative systems.

Simulation modeling methods have demonstrated that the use of artificial intelligence methods and algorithms in combination with cooperative airspace surveillance systems for SAC control and for integrating a swarm of SAC s as a single object is effective.

The issue of using cooperative surveillance systems ADS-B, MLAT and their analogues to enable airspace control for small aircraft and their groups has been investigated.

The combination of ADS-B, swarm algorithms, and artificial intelligence (AI) can be used in a variety of industries, including autonomous systems, aviation, and more. Here are some potential applications for this combination:

1. Improved air traffic control, collision avoidance:

ADS-B provides real-time aircraft location data that can be used in conjunction with artificial intelligence and swarm algorithms to improve air traffic control. This can lead to more efficient routing, reduced congestion, and increased aviation safety. Using swarm algorithms and AI, aircraft can collaborate in real-time to avoid collisions and navigate complex airspace more effectively. This could be particularly useful for SAC swarms and autonomous aerial vehicles.

2. Autonomous aerial vehicles:

could enable the development of autonomous aerial vehicles that can operate safely and efficiently in urban environments, supporting applications such as package delivery, surveillance, and transportation.

3. Wildlife conservation:

help analyze the state of wildlife to protect endangered species, track migration processes, and prevent human-wildlife conflicts.

4. Disaster response and search and rescue:

in natural disaster scenarios such as earthquakes or wildfires, this combination can be used to coordinate aerial search and rescue missions, optimizing the deployment of SACs or aircraft to search for people or assess damage.

5. Environmental monitoring:

collecting data on environmental conditions such as air quality, weather and pollution levels, processing data to provide real-time environmental monitoring and early warning systems.

6. Precision farming:

monitoring plant health, optimizing irrigation and applying fertilizer exactly where it is needed.

7. Scientific research and exploration:

researchers can use this combination for a variety of scientific studies, such as tracking migratory bird patterns, monitoring marine life, or studying the effects of climate change, etc..

III. Conclusions

The cooperative MLA control system is attracting the attention of many countries, as its use will solve such problems as airspace management and control, reducing damage from air disasters, and the effective use of MLA for civil and military tasks.

In addition, the country that determines the rules for the movement and interaction of MLA groups in the operational zone will receive a strategic initiative, both on the battlefield and in the world, among other states. Therefore, this topic of research is relevant both for Ukraine and for the world.

The use of cooperative surveillance systems ADS-B, MLAT and their analogues for small aircraft to enable airspace control will be useful: for a joint civil-military airspace control system; for private and public organizations for the use of MLA; agriculture; cargo delivery companies, etc.

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