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ORIGINAL SCIENTIFIC PAPER

Establishment of a System for the Transport of Goods by Unmanned Aircraft

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Abstract: Delivery of goods by air using unmanned aerial vehicles is one of the many potential applications of unmanned aerial vehicles.

The problem in the operationalization of this type of use of unmanned aircraft is, on the one hand, the limitation in the legal regulations and, on the other hand, the lack of a unified system of control, management and servicing of unmanned aircraft.

The paper describes a model of a unique, integrated system of control, management and servicing of unmanned aircraft that can be logistically supported by an extensive network of small airports in the Republic of Serbia.

The economic profitability of this way of delivering goods is correlated with the real needs of the market with the efficiency and effectiveness of delivery on the principle of "today for today".

Keywords: unmanned aerial vehicle, airport, control, management and service system.

INTRODUCTION

The imperative of the time in which we live is the fast, safe and efficient delivery of goods, this is especially relevant during the pandemic caused by the virus "COVID-19" where people's lives depend on the timely delivery of medicines.

The problem that the aviation authorities of almost all countries of the world are facing today is the safe integration of unmanned aircraft into regular air traffic.

The integration of unmanned aerial vehicles into scheduled air traffic and their potential market success depends on a complex set of technical, economic, political and legal factors. Unlike previous years of aviation, drones do not fly in "empty" airspace [1].

One of the possible methods of safe integration of unmanned aircraft into air traffic is the technical solution that applies it - an air tunnel designed to protect the boundaries of the air corridor intended for the flight of unmanned aircraft [2].

In addition to the above, the flight safety of drones can be improved by applying the system to the drone itself, which is known in the literature as the "Flight Awareness System". This system is designed to semi-automatically (under human supervision) avoid hazards and accidents due to internal or external causal factors [3].

Deliveries of goods to drones and their further distribution using commercial airports are not adequate due to the size of commercial aircraft and the airport infrastructure itself, which would be very difficult to adapt to the needs and requirements for servicing drones and significantly condition time constraints for other air traffic.

The development of a network of small sports airports that would be in the function of a single system of control, management and servicing of unmanned aircraft would enable more efficient, economical and effective integration of unmanned aircraft into air traffic.

In a single integrated system of control, management and servicing of unmanned aircraft, in addition to human and material resources, processes that enable the safe integration of unmanned aircraft into a single air traffic system play a significant role.

In the further work, the process performance in a unique integrated system of control, management and servicing of unmanned aircraft will be discussed.

METHOD

In order to better understand the performance of the process, we will briefly look at the very definition of the process. There are several definitions of the term "process", some of which are:

The process can be defined as "a set of interconnected activities, which convert inputs into outputs" [4].

A process is a set of interconnected or interacting activities that converts input elements into output [5].

An activity or group of activities that use resources

and have a management that enables the transformation of input elements into output elements can be considered a process [6].

Each process has a performance that allows the establishment of an efficient system, and is reflected through the categories of performance [7].

Quality in the delivery of products / services is ensured by certification of human and material resources, one of the possibilities for transporting goods is the use of unmanned aircraft "Black Swan" which can transport payloads up to 350 kg and can fly 2500 km in one flight [8].

Speed in the delivery of goods on the principle of "today for today" is achieved by establishing a single information system that would have the function of collecting and processing requests and distribution of goods with continuous control of mission execution.

Reliability is achieved by linking all elements of the system into a single information system.

The flexibility of the system is reflected in the possibility of flight derailment due to the meteorological situation or other extraordinary circumstances.

The price / cost in relation to other types of air transport is significantly reduced due to the flight in the free flight layer.

For the successful implementation of a unified system of control, management and servicing of unmanned aircraft, it is necessary to develop an information system whose purpose would be to use it in the airport operations center and to facilitate access to information relevant to traffic. This information system considers five main processes:

1. Airport certification process;
2. Airport monitoring process;
3. Information forwarding process;
4. The process of legal and financial operations and
5. The process of flight monitoring and dispatch / acceptance of goods.

In the further work, the system will be decomposed by describing the hierarchy of data flow diagrams. A diagram at the highest level of the hierarchy is called a context diagram, and it actually represents the entire information system [9].

The context diagram contains:

One process (information system for control, management and servicing of drones)

Five external facilities (airports, civil aviation directorate, Ministry of Civil Engineering, Transport and Infrastructure, air traffic control service and drone operators)

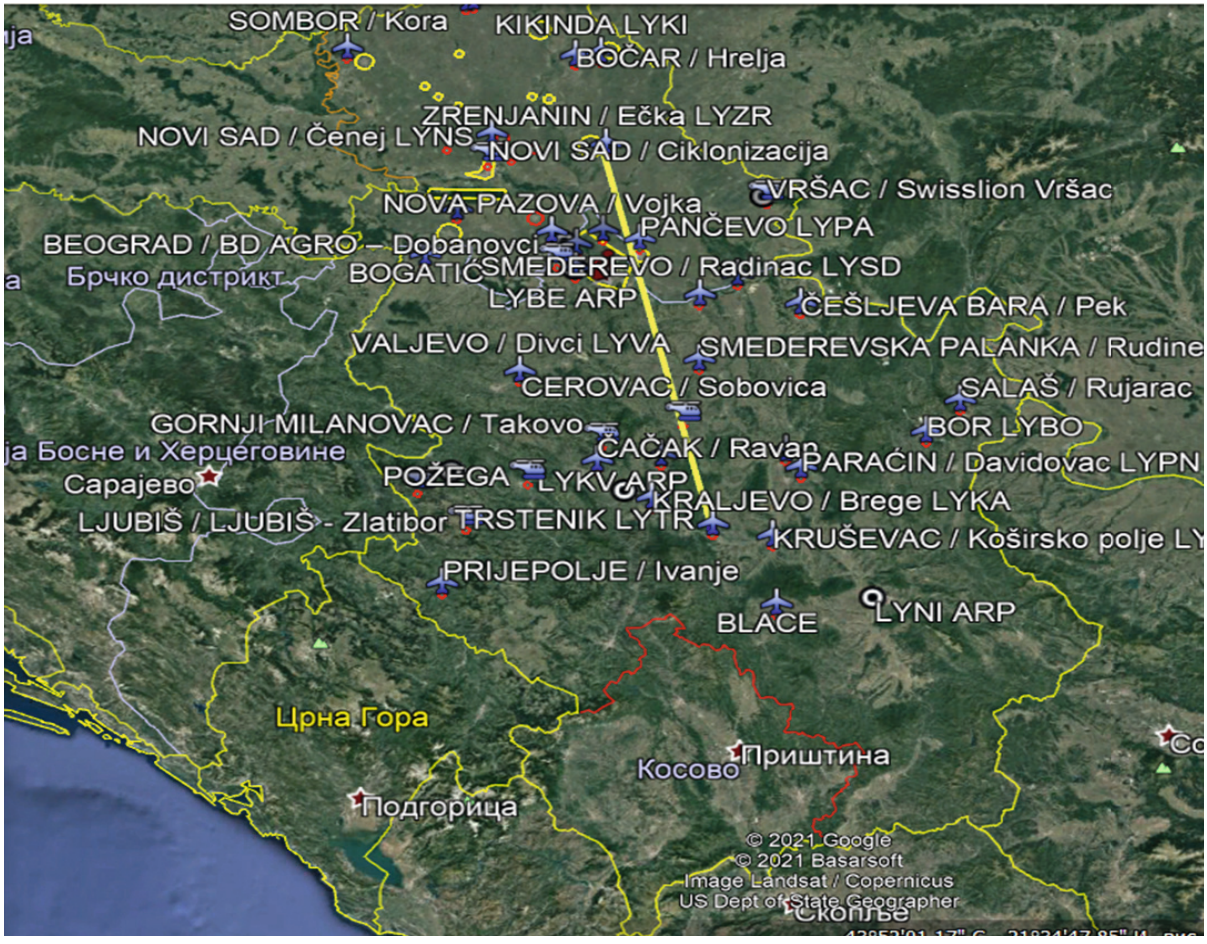

Figure 1. Overview of airport networks in the Republic of Serbia

Data flows (between these five external objects and processes)

The first level diagram contains:

Five processes (1. request for information on traffic conditions at the airport, 2. request for information on the condition of the airport, 3. request of drone operators for the use of the airport, 4. legal business and 5. legal business)

Five external facilities (airports, civil aviation directorate, Ministry of Civil Engineering, Transport and Infrastructure, air traffic control service and airline)

Data flows (between external objects and processes)

In the further work, the network of airports in the Republic of Serbia and the possibility of transporting goods by unmanned aircraft from the airport "Ečka" near Zrenjanin to the airport "Odžaci" near Trstenik will be presented.

ANALYSIS OF TRANSPORT OF GOODS

Figure 1 shows the airport network in the Republic of Serbia. The distance from the airport "Ečka" near Zrenjanin to the airport "Odžaci" near Trstenik by air is 196 km, taking into account the characteristics of the unmanned aircraft "Black Swan" flight time would be about 30 minutes, and the maximum weight of the goods would be 350 kg.

If the goods were transported by land, the duration of transportation would be about 2 hours and 30 minutes. The operating costs of transporting goods by land would be around 250€, while the operating costs of transporting goods by air would be around 150€.

CONCLUSION

The performed analysis indicates that the use of unmanned aircraft in a single, integrated system of control, management and servicing of unmanned aircraft can achieve higher profits, faster delivery of goods and at the same time ensure safe flight with minimal risk to other air traffic.

This paper should provide the basis for the development of regulations in the field of drone flight management, on the one hand and on the other hand to provide the basis for the development of a system of safe, efficient and efficient transport of goods by air.

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