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TRAFFIC CONTROL AT THE AIRPORT BASED ON ACOUSTIC SCANNING

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***Abstract**: The round-the-clock vehicles operation at the airports, including in low visibility conditions with fog, snowfall, etc., requires the development of new methods for monitoring their traffic, including those that do not require direct visual contact between the dispatcher and the vehicles. In this study, a method for monitoring airport traffic based on acoustic scanning of the territory has been developed. The method allows you to control traffic remotely, including in conditions of 'zero' visibility. Controlled vehicles include ground vehicles that ensure airport operation, including tractors, tankers, buses for delivering passengers and the crew to the aircraft, snow plows, cars, etc. The method provides equipping the airport territory where vehicle traffic is possible with a network of acoustic sensors configured to detect noise generated by vehicle traffic, which allows you to receive traffic data on the airport territory. The structure of the airport traffic control system based on acoustic scanning and the algorithm of its operation is developed in the study for practical implementation of the method. To configure the acoustic sensors, which are the main element of the system, the noise generated by various types of airport vehicles was measured. The proposed method and the system implementing it can be used to prevent emergencies, as well as to ensure aviation security at airports.*

***Keywords:** airport, traffic, acoustic scanning.*

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1. INTRODUCTION

A modern airport as a complex system imposes strict requirements to the operational reliability of its constituent elements. Malfunctioning of one of the elements can lead to a shutdown of the entire airport, and in some cases to an aviation accident.

The main structural elements of a modern airport include ground vehicles that ensure its functioning [1-3].

In the process of the ground vehicles operation at the airport, they constantly interact with the aircraft serviced by the airport. Such interaction includes refueling, baggage transportation, delivery and boarding of passengers and crew on board of the aircraft, etc. At the same time, emergency situations connected with a collision of ground vehicles and aircraft (Fig. 1) often arise, the consequence of which is both damage to the vehicles and injury and in some cases death of people [4-7].

Fig. 1: Accident at Hong Kong airport (https://www.telegraph.co.uk/travel/news/watch-van-crash-into-plane-as-it-prepares-for-take-off/)

Such accidents explain the need for continuous monitoring of the ground vehicles traffic on the airport territory.

Analyzing the modes of airport ground vehicles operation, we see that their operation can occur both in normal mode and in the mode of extreme weather conditions, such as fog, snowfall, heavy rain, etc.

In such conditions, the dispatcher cannot control the vehicle traffic visually, monitoring is only performed using technical systems [8-11]. Accident statistics [1, 2] confirms that there is a need to develop additional methods for monitoring vehicle traffic, while their joint work with existing systems [7-13] will reduce the risk of emergencies at modern airports.

2. THE METHOD OF THE AIRPORT TRAFFIC CONTROL BASED ON ACOUSTIC SCANNING

To increase the controllability of the process of ground vehicle traffic, including in difficult weather conditions, the author has developed a method for monitoring the airport ground vehicle traffic based on acoustic scanning.

The method is implemented as follows. Acoustic sensors tuned to the noise range generated by vehicle traffic are installed throughout the entire territory of the airport where ground vehicles move. When a vehicle passes near the sensors, the sensors record the noise coming from it, then the signal from the sensors goes to the dispatcher's computer, which allows you to reflect the vehicle traffic situation on the airport territory.

The structure of the system that practically implements the developed method of airport traffic control based on acoustic scanning is shown in Fig. 2.

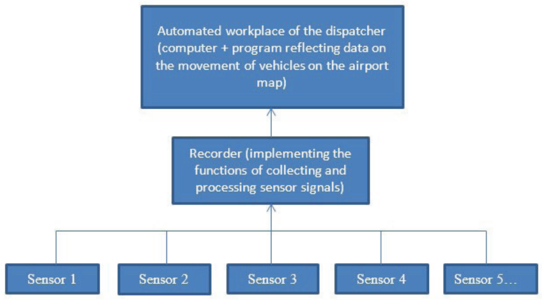

Fig. 2: Structure of the airport ground vehicle traffic control system based on acoustic scanning

When choosing the settings of the acoustic sensors included into the system, it is necessary to take into account the noise level generated by both ground vehicles and aircraft operating in the immediate vicinity of them.

In the aircraft service area, the noise level of aircraft engines is 90-120 dB, when the engines are operating in take-off mode, the total sound pressure levels can reach 160-165 dB, 160-168 dB during flow disruptions and 140-145 dB in the boundary layer [13].

To determine the noise range generated by moving airport ground vehicles, the level of the acoustic radiation intensity adjusted according to the 'A' scale of LA was measured by portable noise meters (in accordance with the regulation methodology – 'Regulation No. 51' of the UNECE [15]) (Fig. 3).

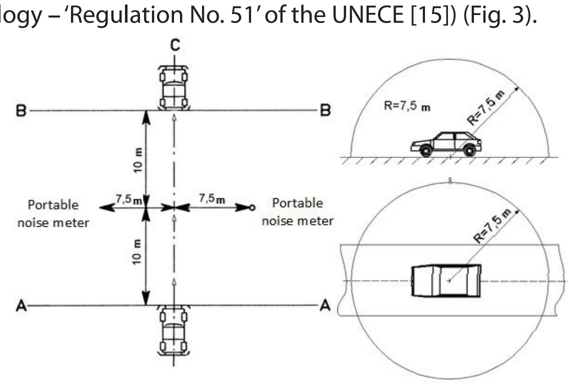

Fig. 3: Scheme for determining the vehicle noise
** When preparing the figure, the elements of the scheme for measuring the noise from the source were used [15]*

At the same time, the following conditions for determining LA were set: tests for evaluating LA are carried out on a measuring section of the road A-B with a length of 20 m; the vehicle in front of the measuring section (up to the A-A line) moves uniformly at a speed of ~50 km/h at an engine speed of n ~~ 3/4nnom; the measurement is made when the vehicle passes the middle of the measuring section with noise meters [14, 15] installed at a distance of 7.5 m from its axis; two measurements are made on each side of the vehicle. The maximum sound level, expressed in decibels (dB), is measured at the moment when the vehicle passes between lines A-A and B-B. The obtained value is the measurement result [15].

The obtained measurement results are shown in Tab. 1.
Tab. 1: Noise generated by airport ground vehicles

Analyzing the transport noise level of the monitored objects (Table 1), we can conclude that the settings of acoustic sensors

Vehicle	Generated noise level (dB)
Buses for the transportation of passengers	58
Aviation Security Service vehicles	45
Pushback tractors	78
Stair vehicles for passenger boarding	60
Fuel trucks	83
Vehicles for the transportation of luggage and cargo to the airplane	72
Catering service vehicles	48
Vehicles with warming-up and AC units	77
Fire tenders	80
Medical vehicles	58
Tank trucks for treating the airplane with anti-icing fluid	78
Mobile power supply units	73

should be in the range of 35-85 dB.

3. THE ALGORITHM OF THE AIRPORT TRAFFIC CONTROL SYSTEM OPERATION BASED ON ACOUSTIC SCANNING

Based on the goals of the acoustic scanning system, we can formulate an algorithm for its operation (Fig. 3).

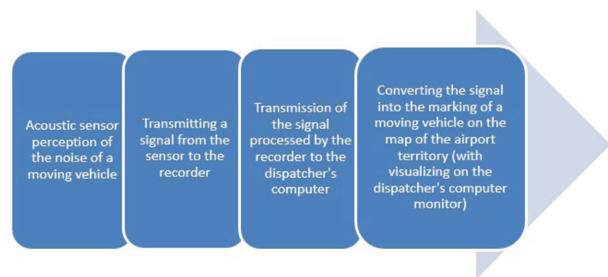

Fig. 4: The algorithm of the airport traffic control system operation based on acoustic scanning

4. CONCLUSION

In this study, a method for monitoring the airport ground vehicles traffic based on acoustic scanning and a system implementing it has been developed. The proposed development is aimed at reducing the number of emergencies that occur during the interaction of air and ground vehicles at the airport. It is established that the acoustic sensors included into the system must have a setting in the range of 35-85 dB. This setting will allow you to record the ground vehicles traffic and will not be triggered by the noise of aircraft engines. Equipping the airport territory with a network of sensors with appropriate settings will allow the dispatcher to receive information about the ground vehicles traffic even in conditions of 'zero' visibility. Taking into account the fact that traditional systems that allow monitoring airport traffic are quite complex technical systems, as a result of which there are frequent failures in their operation, the use of the proposed traffic control system will increase the reliability of such a complex system as a modern airport and reduce the risk of accidents involving air and ground vehicles.

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