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# Проблеми техногенно-екологічної безпеки в сфері цивільного захисту

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# АКТУАЛЬНІ ПИТАННЯ ОЦІНКИ ПАРАМЕТРІВ ЕКОБЕЗПЕЧНОГО СТАНУ КОМПОНЕНТІВ НАВКОЛИШНЬОГО ПРИРОДНОГО СЕРЕДОВИЩА

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## METHOD FOR OBTAINING MONITORING DATA USING UNMANNED AERIAL VEHICLES

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The multifactorial nature of the parameters that affect the state of the atmosphere does not allow us to fully solve the problem of forecasting the spread of emissions of pollutants in the atmosphere using the methods and methods of mathematical modeling that exist today. Based on these positions, the development of modern methods of operational (in emergency conditions) control of the state of the atmosphere is an urgent problem in the field of civil protection.

Unmanned aerial vehicles (UAVs) are elements of the technical structure of the atmospheric air monitoring system; accordingly, the following tropospheric monitoring algorithm was developed:

1. Receiving data from system elements:

A) Automatic air pollution monitoring stations based on networks of 3G / 4G base stations of mobile operators

B) Weather stations – meteorological parameters (or in case of unfavorable weather forecast – 6 hours before a possible change in weather conditions)

C) Operationally – the coordination center of operational and rescue services (fires, accidents, explosions and other types of emergencies)

2. Determination of zones of possible dangerous pollution in the surface layer of atmospheric air using the method of organizing atmospheric air monitoring [1-3] .

3. If, based on the pollutant dispersion calculations, no zones are detected in which the values of surface concentrations of pollutants exceed the value of 0.7 MPC, then the system goes into standby mode for the next data package.

4. In the event of a possible exceedance of 0.7 MPC, the UAV tracking route for measurements in the local area of potentially dangerous pollution should be calculated. The headquarters makes a decision about the necessity of a UAV departure (taking into account the weather conditions and the nature of the dispersion of pollutants during the next few hours).

5. The time allotted to the UAV for measurements depends on the interval during which the meteorological parameters deviate little from the values at which the decision was made to take off for measurements. To determine the minimum time interval of UAV operation, processing of meteorological data on wind direction and speed was carried out. According to the processing results, a lower estimate of the recession time was obtained, in which the correlation between the current and initial values of meteorological parameters is significant (at least 2 hours). The flight time of the UAV to the point of control and measurement is usually no more than 30 minutes.

The coordinates of the points inside the zone of possible pollution, in which it is necessary to conduct measurements, are formed before the departure of the UAV, and in the process of conducting measurements, they can be transmitted additionally from the operator's workplace.

6. The measurement results are immediately transferred to the monitoring headquarters for processing.

To implement steps 3-5 of the described scheme, it is necessary to solve the following tasks:

1) determine the points at which measurements of surface concentrations of pollutants in the zone of possible dangerous pollution should be carried out;

2) calculate the UAV tracking route to the place of local pollution;

3) synchronize measurement results taking into account different measurement times due to the time spent on the UAV tracking route between points;

4) if as a result of the measurements it is found that the maximum allowable concentrations of pollutants are exceeded – identify the sources of pollutants, the emissions of which led to the violation of the established standards (only those that can influence the concentration values with the current direction and wind speed will be selected in the list of sources). The solution to this problem is described in [4].

UAV equipment should include guidance systems, on-board radar complex, sensors and video cameras. During the flight, as a rule, the UAV is controlled automatically or semi-automatically using the on-board navigation and control complex, which includes: a satellite navigation receiver; a system of inertial sensors; air signal system, which provides measurement of altitude and air speed; different types of antennas designed to perform tasks [5] .

The on-board navigation and control system provides: flight according to the given route (the route assignment is made with the coordinates and height of the turning points of the route); changing the route task or returning to the starting point by command from the ground control point; flying over the indicated point; stabilization of UAV orientation angles; maintenance of set altitudes and flight speed (road or air); collection and transmission of telemetric information and flight parameters and operation of target equipment; software control of target equipment devices.

On-board communication system: functions in the permitted range of radio frequencies; provides data transfer from the plane to the ground and from the ground to the plane. The data transmitted to the board includes: UAV control commands; target hardware management commands. Data transmitted from the ship to the ground: telemetry parameters; streaming video and photo images, dosimetric and gas analysis data [6].

Today, monitoring of atmospheric air from UAVs is performed using metal oxide sensors (MOS), which have the following qualitative advantages: Low cost compared to chromatographs (from $1 to $150 depending on accuracy and manufacturer); Reusability unlike indicator tubes; Small mass (lower than that of the chromatograph and compressor); Analysis in real time.

MOS sensors, unlike large chromatographs and indicator tubes, do not have the same accuracy, but their accuracy can be improved by calibrating them with standard gas mixtures. Installation of several sensors will also increase the accuracy and reliability of the measuring device [7].

For gas analysis, a special gas analyzer manufactured by Albatros LLC (Fig. 1) can be used, which in the basic configuration determines temperature, humidity, finely dispersed solid particles (PM1.0, PM2.5, PM10) and also determines from 10 to 80 types of gases (depending on the model). Transmits all data and gas distribution thermogram to the ground control station in real time.

A special dosimeter with video cameras Z-16 GAMMA-VR, manufactured by ZALA AERO , can be used for radiation control (Fig. 2). This dosimeter detects X-ray and gamma radiation and automatically displays the data superimposed on the video stream in real time.

Today, when conducting local monitoring of the state of the atmosphere using a UAV, the operator's task is to conduct the maximum number of measurements for a limited autonomous flight time, and the determination of the required number and coordinates of the measurement points is carried out by the operator or another authorized person based on his own experience and analysis of monitoring conditions.

Currently, domestic unmanned technologies are not being developed in Ukraine at the industrial level, but many companies offer retrofitting and modernization of UAVs, act as distributors and integrators of professional equipment and software products for UAVs of leading global companies: XAG, ZALA AERO, EcoFlow, Pix4D , Kandao, Albatross, Chasing, Flyability, MicaSense, DroneDeploy, Parrot, AgroCares, DronePort, Sniffer4D, Dobot and many other manufacturers. For example, the distributor DroneUA presented AirSense technology – a complex system for dynamic determination of gas concentration integrated with on-board drone controllers.

**Figure 1 – Modular gas analyzer manufactured by Albatros LLC**

**Figure 2 – Dosimeter with video cameras Z-16 GAMMA-VR**

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