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THE DETECTION OF MINEFIELD IN SPECTRAL MAPPING WITH USING OF UAV

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ABSTRACT
Negligence in the use of human labor in demining dangerous areas can result in great human casualties. If we consider that we live in a modern information society, we can say that before the reconstruction and rehabilitation work in these areas, there is a need to apply information and communication technologies in the field of mine clearance to minimize human labor, hazards and losses. The scientific work presents the development of UAVs used for geo-detection of explosive surface mines by computer vision. The proposed integrated unmanned aerial vehicles will enable the acquisition of danger zones by spectral mapping and aim to clear explosives 100% and as soon as possible. In order to save time, it is important to identify the areas beyond the mine operations as well as detecting the mined areas. The proposed equipment will allow obtaining a map of the boundaries of dangerous areas. This will allow mines to be detected in larger areas and with minimal risks in the shortest possible time.

KEYWORDS
UAV, computer vision, dynamic objects, remote control, automatic control system.

Introduction. Explosive landmines are one of the most dangerous issues for people and the environment in conflict zones. It is very important to clear the ground of explosive mines before reconstruction and rehabilitation works in dangerous areas. For minimal risks, we need for a device that can work autonomously to detect and neutralize mines. The aim of this work is to integrate a set of technologies that allow to detect explosive mines without harming the environment and people.

Recently, a number of countries have developed new mine clearance projects. The most popular of these is the Ursula project, which is based on the use of mobile wheeled robots, mainly in flat areas. However, a number of risky situations can arise when the system fails during the detection process using ground vehicles and robots. The use of UAVs in overcoming these shortcomings provides both navigation and security for explosive mine detection operations. This is because UAVs can operate autonomously in less time and without errors. It can also be used as a remote sensing platform to gather the necessary information about the areas it accompanies. That is, it performs the acquisition of information related to an event or object on the earth's surface without physical contact with the object. Necessary information about the area observed using UAVs can be obtained using visual methods based on target localization, image mosaicing and tracking methods, which in turn will allow to obtain more detailed information about the area.
References Materials and Methods. Ground penetration (GPR) radar systems are a geophysical method that can generate images of the earth's crust using radar pulses. Impulses that penetrate the ground emit electromagnetic waves under the layers of the earth's surface, and using the principle of reflectometry can detect buried objects and objects and are able to distinguish between layers of soil. Reflectometry is based on the use of reflection of waves on surfaces or in the lower layers of the earth's crust to detect or characterize objects. Unlike metal detectors, GPR technology further increases the range of detection depth and minimizes the alarm. It is used to study cables and pipes in the lower layers of the surface. This method uses electromagnetic waves in the microwave band (UHF / VHF frequencies) of the radio spectrum and detects signals reflected from the ground with the help of a receiving antenna. GPRs can be used in a variety of environments, including soil, rock, ice, freshwater, sidewalks, and a variety of structures.

Integration of radar systems into UAVs. The research envisages the design, application and integration of a GPR radar system capable of penetrating the ground with the SDR radio communication system into an unmanned aerial vehicle, which we consider as a dynamic object [1-3]. However, it should also be borne in mind that in order for GPR signals to reach the ground properly, UAVs must fly very close to the ground. At the same time, the drone must fly properly, taking into account wind disturbances.
Software-defined radio (SDR) systems, while not a new technology, allow for the practical development of the rapidly evolving capabilities of digital electronics, many of the processes that were once theoretically possible. SDRs are software-based radio communication systems [1].

Unlike surface detection devices, unmanned aerial vehicles (UAVs) are more suitable for mine detection because there is no risk of landmines being used. As shown in Figure 4, the USRP system was used to further develop the SDR configurations and implement the GPR device. USRPs are used to manage USPR devices, send and receive data at the same time. It uses GNU Radio, a free and open source Python programming graphical user interface for everyone for SDR, to make SDR development even easier. Using GNU Radio SDR functions, it allows you to easily perform the most fundamental GPR operations, such as signal generation, filtering and conversion, through software [3].

Results and discussions. High efficiency can be achieved from the integration of drones with SDR communication system GPR radar systems. Therefore, unmanned aerial vehicles must fly close to the ground, and a spectral map is generated to determine the location of mines by transmitting pulse signals to the ground. Then image processing operations can be performed on images obtained with various software such as MATLAB, Python. For this, the task is carried out by the following algorithm:

a) creating an initial graphical user interface (GUI);
b) trajectory and flight control plan creation;
c) Experimental 3D trajectory in UAV.
d) Determination of GPS coordinates of detected mines;
e) a broad view of the area.

The block scheme of the algorithm is presented in Figure 5.
Fig. 5. Algorithm for detection

Fig. 6. Spectral mapping with GPR system drones
Conclusions. The article describes the mapping of an area using computer vision and at the same time the development of unmanned aerial vehicles used for geo-detection of explosive land mines, as well as the creation of the possibility of obtaining a spectral map of hazardous areas using unmanned aerial vehicles.

The model proposes the integration of pulse radar systems with unmanned aerial vehicles and the implementation of a spectral mapping process to neutralize open-pit mines.

The model was simulated with the MATLAB software package.

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