Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw, Poland 00-773
Tel: +48 226 0 227 03
Email: editorial_office@rsglobal.pl

JOURNAL	World Science
p-ISSN	2413-1032
e-ISSN	2414-6404
PUBLISHER	RS Global Sp. z O.O., Poland

ARTICLE TITLE	THE DETECTION OF MINEFIELD IN SPECTRAL MAPPING WITH USING OF UAV
AUTHOR(S)	Sultanova A. B., Safarov T. A.
ARTICLE INFO	Sultanova A. B., Safarov T. A. (2022) The Detection of Minefield in Spectral Mapping with Using of UAV. World Science. 2(74). doi: 10.31435/rsglobal_ws/28022022/7765
DOI	https://doi.org/10.31435/rsglobal_ws/28022022/7765
RECEIVED	03 January 2022
ACCEPTED	07 February 2022
PUBLISHED	11 February 2022
LICENSE	This work is licensed under a **Creative Commons Attribution 4.0 International License.**

THE DETECTION OF MINEFIELD IN SPECTRAL MAPPING WITH USING OF UAV

Sultanova A. B., *Azerbaijan State Oil and Industry University, Institute of Control Systems of ANAS, Azerbaijan, ORCID ID: https://orcid.org/0000-0003-3230-6349,*
Safarov T. A., *Azerbaijan State Oil and Industry University, Azerbaijan, ORCID ID: https://orcid.org/0000-0002-6986-673X*

DOI: https://doi.org/10.31435/rsglobal_ws/28022022/7765

ARTICLE INFO

Received: 03 January 2022
Accepted: 07 February 2022
Published: 11 February 2022

KEYWORDS

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

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.

Citation: Sultanova A. B., Safarov T. A. (2022) The Detection of Minefield in Spectral Mapping with Using of UAV. *World Science.* 2(74). doi: 10.31435/rsglobal_ws/28022022/7765

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 mosaicization and tracking methods, which in turn will allow to obtain more detailed information about the area.

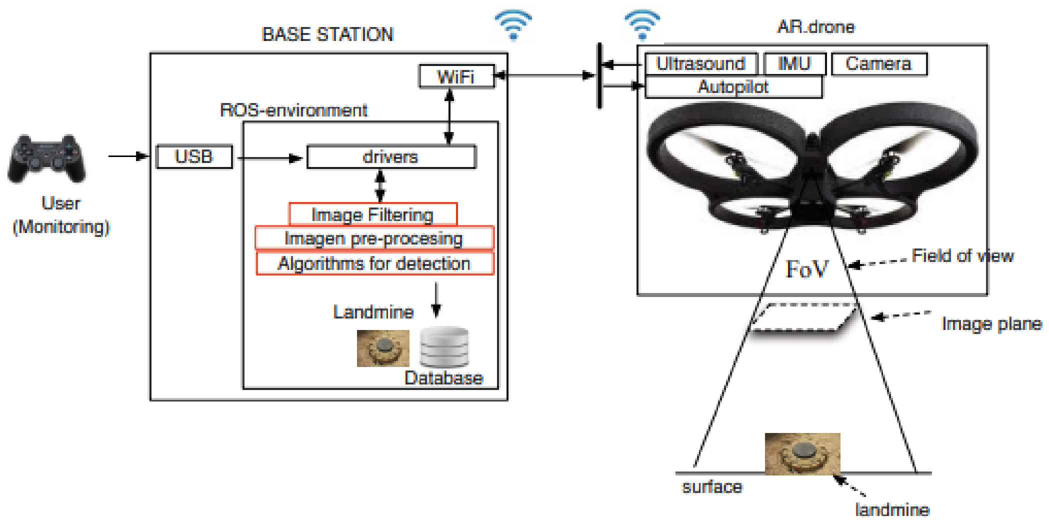

Fig. 1. Proposed architecture for mine detection

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.

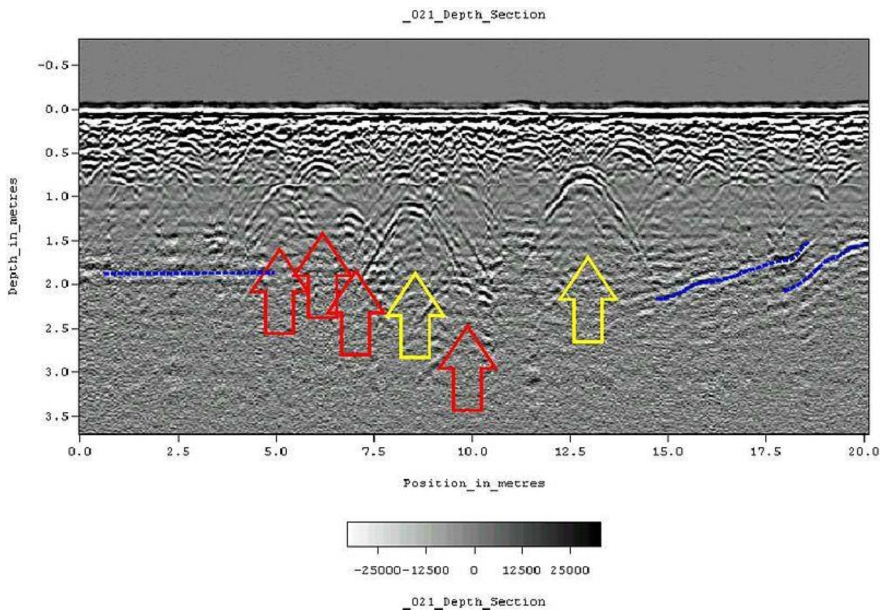

Fig. 2. Underground survey with GPR

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.

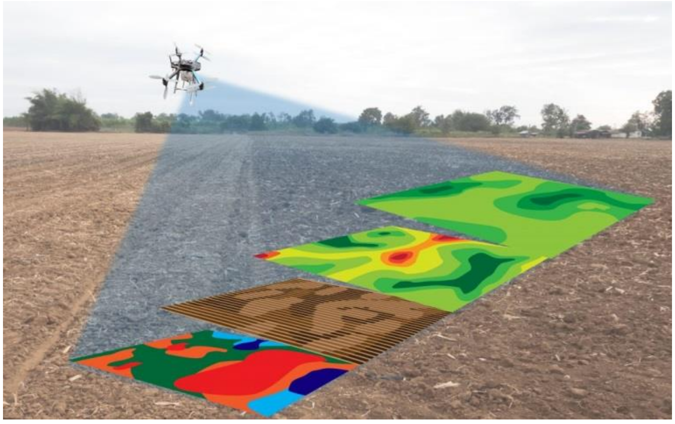

Fig. 3. Integration of GPR system with UAVs

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].

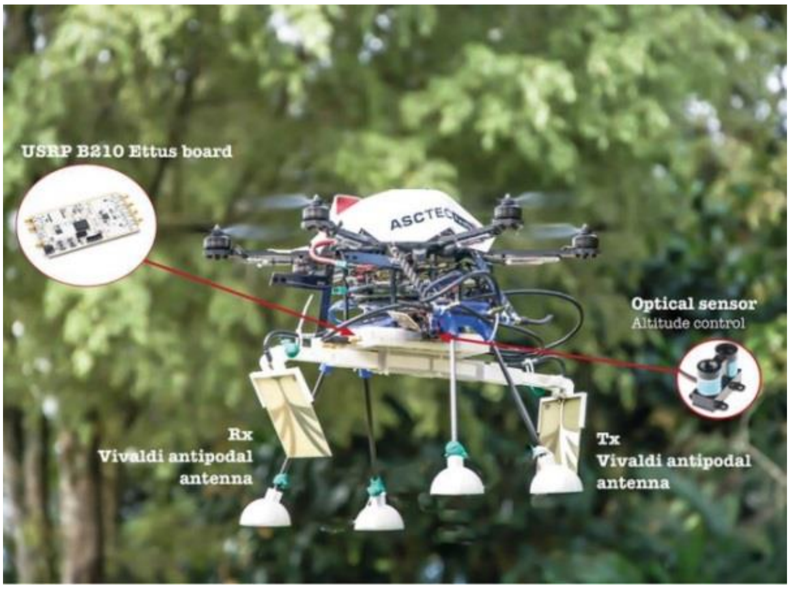

Fig. 4. Asctec Firefly unmanned aerial vehicle with penetrating radar

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.

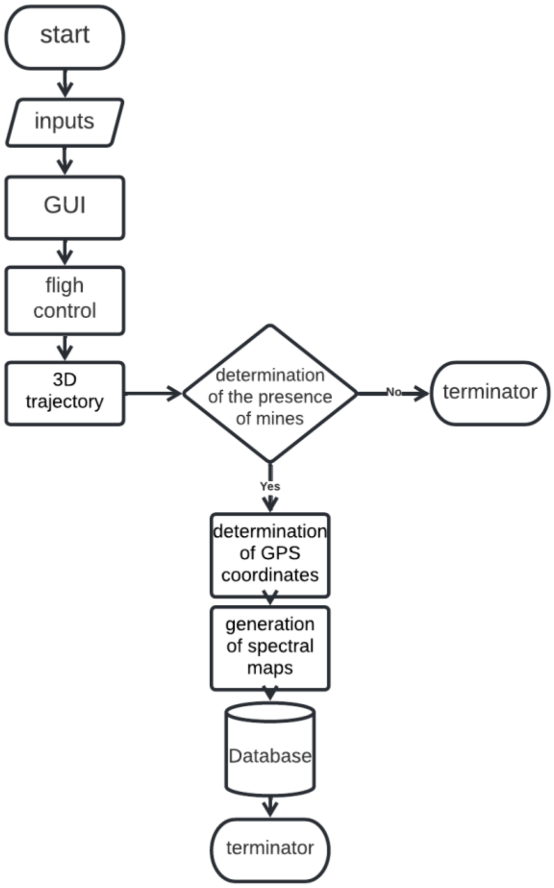

Fig. 5. Algorithm for detection

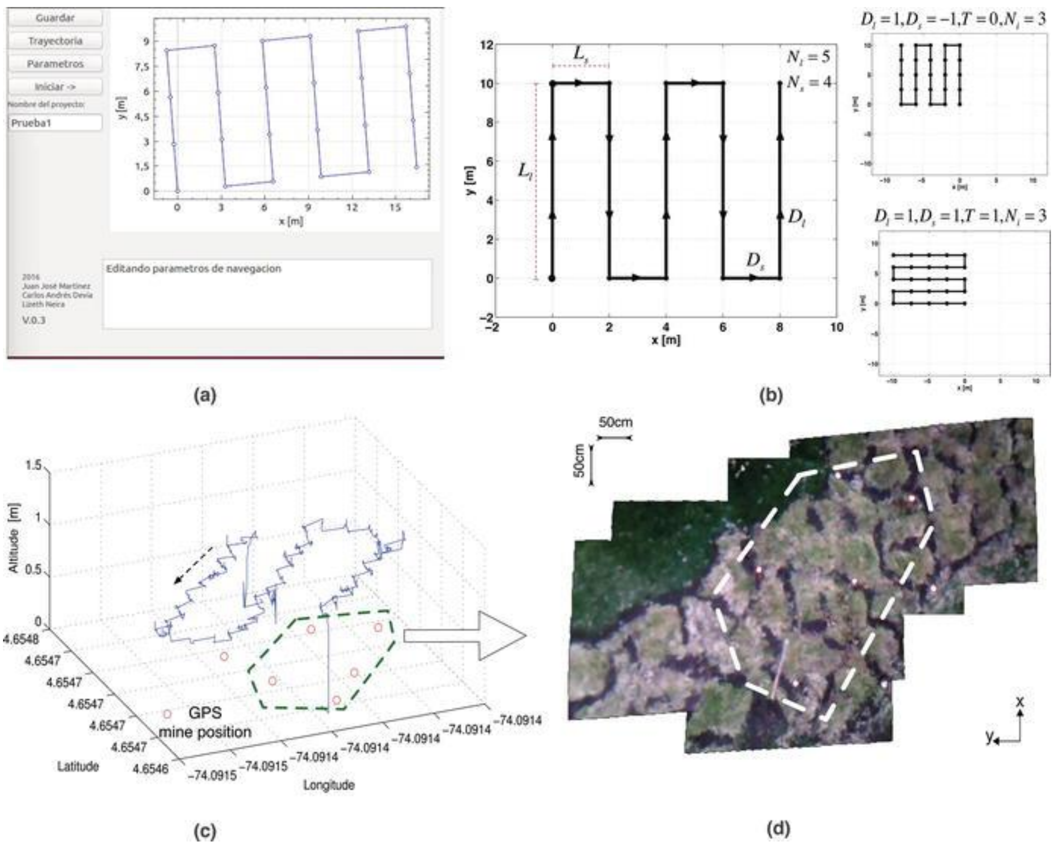

Fig. 6. Spectral mapping with GPR system drones

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.

REFERENCES

1. Nonami K, Huang Q, Komizo D, Fukao Y, Asai Y, Shiraishi Y, Fujimoto M, and Ikedo Y. Development and control of mine detection robot comet-ii and comet-iii. JSME International Journal Series C, 46(3):881–890, 2003.
2. Baudoin, Y. and Colon, E., Humanitarian Demining and Robotics State-of-the-art, Specifications, and On-going Research Activities, Proc. of the Third Int. Conf. on Climbing and Walking Robots (CLAWAR2000), October 2-4, 2000, Madrid, pp.869-877.
3. Nonami, K. et al., Development of Mine Detection Robot COMET-II and COMET-III, Proc. of the Sixth Int. Conf. on Motion and Vibration Control (MOVIC2002), August 19-23, 2002, Saitama, pp.449-454.
4. Uchida, H. and Nonami, K., Biological Walking of a Mine Detecting Six-Legged Robot Using Rhythm Generation and Fuzzy Control, Proc. of 5th Int. Conf. on Climbing and Walking Robots, (CLAWAR2002), 2002, Paris, pp.741-748.
5. Raibert, M.H. and Craig, J.J., Hybrid Position/Force Control of Manipulators, ASME Journal of Dynamic Systems, Measurement, and Control, Vol.103, No.2 (1981), pp.126-133.
6. Maathuis, B.H.P., van Genderen, J.L. A review of satellite andairborne sensors for remote sensing based detection of minefields and landmines. Int. J. Remote Sens. 2004, 25, 5201–5245.
7. Turner, D., Lucieer, A., Malenovský, Z., King, D., Robinson, S. Spatial Co-Registration of Ultra-High Resolution Visible, Multispectral and Thermal Images Acquired with a Micro-UAV over Antarctic Moss Beds. Remote Sens. 2014, 6, 4003–4024.