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# BIOTECHNOLOGICAL APPROACHES IN CONSTRUCTION OF DRONES FOR MEDICAL PURPOSES

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***Aim.*** Construction of an unmanned controlled complex (drone) with a container for medical care in extreme conditions with the use of biotechnological approaches.

***Methods.*** The methods of analysis and object-oriented programming; use of the Python language; construction of the structure of the container for medical care; development of program supply for object recognition and operations with a container for medical purposes.

***Results.*** The structure of a drone as a carrier of a container for medical care was scrutinized as well as the versions of drones' modules for medical purposes. Simultaneously, the various structures of such drones and containers for medical purposes were studied; the possibilities of biotechnological methods use were examined. A new version of the container for transportation by drone was constructed. Appropriate samples of the software for performing individual tasks of medical care in extreme conditions for various types of drone vehicles started to develop.

***Conclusions.*** The drone with a container for medical care in extreme conditions with the use of biotechnological methods, as well as techniques of object recognition, was developed successfully.

***Keywords:*** similarity, homological series, drones, medical applicatios.

During this project fulfillment, numerous sources of scientific and technical literature [1–4], as well as patent sources, were studied, and the subject area was analyzed carefully. Prototypes and analogs of the developed drone were examined — different versions of the drones for providing various types of medical care in extreme conditions.

The *purpose* of the work done was to develop the structure of a container for medical purposes and to clarify the possibility of its transportation by a drone to a defined person (with object individual features recognition) [5] or to an object specified by the computer program [6].

*Research methods.* In the processes of these works, the listed methods were used: the methods of analysis and object-oriented programming; use of the Python language; systematization and generalization of information; specification of the functions and parameters of the UAV with a container; construction of the structure of the container for medical care; development of program supply for objects recognition and operations with a container for medical purposes. The subject of this research is an unmanned controlled complex (drone) with a container for medical care in extreme conditions.

**Principles of similarity and homology. Homologous series in chemistry, biology — and homologous series of technical elements.** Principles of similarity homology very often are put on the base of the novel invented techniques, devices, systems, and their components. The phenomenon of homologous series in organic chemistry is well known. For example, in the case of acyclic

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hydrocarbons, and according to the definition, a homologous series is an infinite series of organic compounds that have a similar structure and, therefore, similar chemical properties and differ from each other by any number of CH2– groups (homologous difference). Principles of homologous series of chemical compounds help to invent new compounds with predicted characteristics and structures (sometimes with predicted biochemical properties). The Phenomena of homologous series of organisms are well known from the evolution theory. Homologous series of biologically similar organs have also been described, for example, limbs of various terrestrial mammals, or eyes of different biological organisms. But contemporary theoretics in engineering also formulated the principles of a homologous series of technical elements. The last approach permits to invent successfully new systems, devices, and components. Fig. 1 demonstrates the similarity between the insect faceted eye and two types of image detectors in engineering, the principles of which can also be applied in the drones' production; such receptors (biosensors) receive visual information, and the technical "brain" processes it. Perhaps the most convincing implementation of the principles of homology in technology is the development and manufacture of multi-copters according to various construction schemes, which are: a) tri copter, b) quadcopter, c) hexacopter, d) octocopter.

Awareness of such principles helps greatly to invent and develop new analogues in engineering. It also permits to organization of better production of the series of devices or their elements in industry, in conditions of plant factories.

The initial element of such a series is the faceted eye of an insect, an ant (A), according to the principle of which physical models of technical devices for reproducing images of two types have been developed, with hexagonal cells (B) and with square cells (C, D) [7]. It is shown how 2 types of figures are visualized on the screens of such devices: a dot (B, C) and an elongated figure (C).

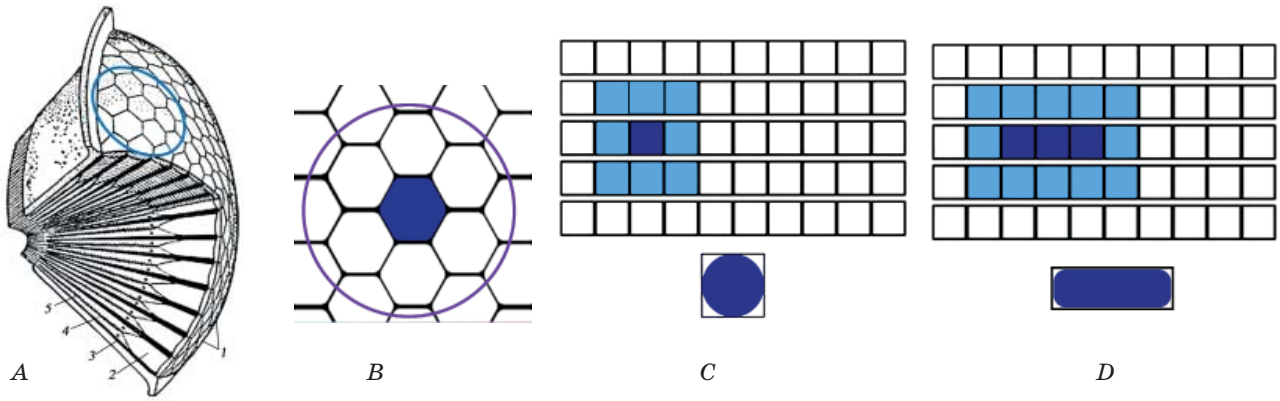


*Figure*. **Several elements of devices form a homologous series of technical devices; all of them reproduce images**

**Construction of a drone carrier of containers for medical care.** Development of the drone with such functions, with the possibility of container for medical purposes transportation to a defined person with individual features recognition, was the purpose of the fulfilled project. To achieve this purpose, the following tasks have to be solved:

1. Investigation of the prototypes based on patents' publications and literature reviews with the aim to observe the history of drone series development, their classification, and the areas of drone applications.
2. To observe the development of medical aviation in Ukraine and determine the features of drones' application for medical care.
3. To examine the structure of drones with containers for providing medical care in extreme conditions.
4. To specify the options for UAV modules for providing various types of medical care and/or detecting harmful chemicals in the environment.
5. To develop the structure of a container for medical purposes and to find out the software capabilities of its transportation by a drone to a specific object or person.

**The main directions of drone application in civil life.** Civilian drones can be used in the areas listed below:

– delivery of goods;

– emergency services (fire safety control, assistance in rescuing people in inaccessible places (mountains, forests, oceans);

– transportation of medicines (quadrocopters deliver blood, transplants, and vaccines to patients);
– aw enforcement agencies (patrol areas, analysis of road traffic incidents, crowd monitoring at mass events, bomb inspection, tracking criminals);
– organization of help in cases of disasters (assessment of damage from accidents at industrial enterprises, assessment of the consequences of railway accidents with dangerous goods, terrorist acts, determining the degree of contamination of large areas with chemical or nuclear waste, providing assistance to victims);
– agricultural activities (crops monitoring), forestry and fisheries (forest protection and control of fishing productions);
– environmental monitoring (monitoring of areas with oil spills, fires, etc.);
– geodesy (mapping);
– monitoring of oil and gas facilities;
– companies of buildings construction (inspection of construction sites, aerial inspection of the finished object, and etc.);
– cinematographic filming;
– journalism (reporting from the scene of hostilities, large-scale events, sporting competitions).

During the project fulfillment, the subject area was analyzed, and the tasks set at the beginning of the work were fully completed. These tasks were as follows.

1. Based on a review of the literature, it was found that the era of unmanned aerial devices and complexes controlled by radio began in the 1930s. The enormous practical potential of UAVs has led to their rapid development, constant modernization, and distribution. Today, according to UVS International (the leading international association of unmanned systems), UAVs are manufactured in 52 countries around the world. Scientists propose various criteria for classifying UAVs, namely: classification by purpose (military and civilian); by type of flight (rigid wing, flexible wing, rotary wing, flapping wing, and aerostatic type); by control principle (unmanned non-controlled, uncrewed automatic, uncrewed remotely piloted aircraft); by risk level (low, medium, high); by weight, speed, and flight range, etc.

2. Analysis of the development of Ukrainian medical aviation in the context of the use of drones in this area showed that UAVs are a progressive and innovative component of modern medical aviation, which every day occupies an increasingly important place in its development. The relevance of the development and modernization of existing UAVs for medical care in extreme conditions was also demonstrated. The improvement and development of uncrewed aerial vehicles for medical care is an essential direction of modern engineering activity.

3. A UAV as a container carrier for providing medical care in extreme conditions should have the following components: a strong but light, balanced, and aerodynamic frame; an engine with sufficiently large propellers; a speed controller to control the on/off of electric motors and the speed of rotation of the blades; a flight controller to collect data from sensors and commands from the user; a power source to provide energy to all multicopter systems.

4. A medical UAV can be equipped with modules for diagnosing a person's condition and providing them with appropriate medical care. The uncrewed aerial vehicle can be used repeatedly, and modular systems can be equipped as needed. Various modules for medical drones can be conditionally divided into two groups: *diagnostic* and *resuscitation*.

The *resuscitation group* of equipment may include a breathing bag for artificial lung ventilation, a mechanically driven aspirator, and a portable automatic external defibrillator.

The *diagnostic group* can be divided into two subgroups: direct diagnostics using appropriate devices and transportation of biomaterials for their further processing. Directly diagnostic subgroup includes a three-channel electrocardiograph; a portable diagnostic monitor with functions for measuring blood pressure, determining oxygen saturation, and measuring temperature; a portable clinical blood analyzer;

The subgroup for transporting biomaterials for their further processing requires the presence of special containers. An analysis of the feasibility of equipping one or more UAVs shows that it is impossible to put all diagnostic and assistance functions into one module of the device.

When providing medical care to a person in extreme conditions, especially in situations of possible chemical contamination due to accidents in industrial regions, it is important to determine the level of chemical pollution in the environment. As a result, the development of detector devices that record chemical pollution of the environment is relevant. For the development of chemosensitive surfaces of detectors, experience in studying the physicochemical nature of ion selectivity and specificity of artificially created and natural membranes is essential.

5. When determining the conditions for transporting biological samples and vaccines, it was found that the container must have certain characteristics: heat resistance, tightness, reliability of fastening test tubes with samples, the possibility of disinfecting the inside of the container, the presence of a bactericidal air filter, aerodynamics of the shape. All these conditions were taken into account during the development of the container, constructed in process of present project fulfillment.

In order to ensure the delivery of the container to a specific object or person in automatic or semi-automatic mode, the appropriate software was found to automate this process. This software is based on a facial recognition technology called a convolutional neural network (CNN).

**Results of the project fulfillment. The main parts and components of the constructed drone.** The main parts and components of the constructed drone will be represented during the report: the structure of the UAV, the structure and functions of the constructed container, software for its control and receiver recognition, etc.

Prototypes of constructed drones with medical containers were studied. On the basis of the analog, described in one patent, the special device — a medical container was proposed; the structure of the container itself and the software for the drone for performing specific tasks of medical assistance in extreme conditions. So, a container for a medical UAV for transporting medicines in extreme conditions was developed.

To find a programmatically defined object or person, face recognition was used using a web camera [5]. The system acts as a face detector and object detector. Initially, the camera, using the software written by the author [6], determines the appearance of a person or object and captures its image. Next, two possible schemes of operation of the face or object recognition module are implemented: identification or verification. The corresponding software has been developed and will be explained during the report [6]. As a prototype for the device for object recognition was [7], the main theoretical principles were described in [8, 9].

*Results of the project fulfillment*. 1. The drone with a container for medical care in extreme conditions with the use of biotechnological techniques, as well as techniques of object recognition, was developed successfully.

2. During the project fulfillment, the history of inventions and construction of various unmanned devices and complexes were examined, as well as drones' classification criteria, and areas of their application. The legislative framework of drones' construction and their applications in various civil spheres of activities and functions of drones were studied, too.

3. The structure of a drone as a carrier of a container for medical care was scrutinized as well as the versions of drones' modules for medical purposes. Simultaneously, the various structures of such medical containers were studied.

4. Appropriate samples of the software for performing individual tasks of medical care in extreme conditions for various types of UAVs were started to develop.

5. Recommendations for the use of results: UAVs with medical containers can be recommended for implementation in the spheres of activity of the Ministry of Health of Ukraine, the Ministry of Emergency Situations of Ukraine, and the Ministry of Defense of Ukraine.

*Conclusions*. The drone with a container for medical care in extreme conditions with the use of biotechnological methods, as well as techniques of object recognition, was developed successfully.

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*Authors Contributions*

B. Moskalenko — construction of the container for medical purposes for the drone, functions for image recognition, and writing of some fragments of materials; N. Fomenko — development of the systems for the connections and distant control; A. Lizunova — computer simulation, algorithms construction; O. Klyuchko — general supervision, works planning, and writing of the article. All authors contributed to the manuscript's revision and read and approved the submitted version.

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The authors declare no conflict of interest.

## REFERENCES


1. Gumenyuk, K.V., Horoshko, V.R. (2020). A look from the past to the future: unmanned flying drones as an element of the evacuation of the wounded in the medical service of the Armed Forces of Ukraine. *Emergency Medicine,* 16(5). (in Ukrainian) URL: http://webcache.googleusercontent.com/search?q=cache:-ov9uMZc9jUJ:emergency.zaslavsky.com.ua/article/download/212220/214318/483250+&cd=5&hl=uk&ct=clnk&gl=ua
2. Prototype of Commission Regulation on Unmanned Aircraft Operations — EASA. URL: https://www.easa.europa.eu/sites/default/files/dfu/Explanatory% 20Note% 20for% 20the% 20UAS% 20Prototype% 20regulation% 20final.pdf (Last accessed: 01.06.2021).
3. Rules of a good drone — Axon. (In Ukrainian). URL: https://axon.partners/uk/uncategorized/the-rules-of-good-drone/ (Last accessed: 01.06.2021).
4. Civil and military drones — European Parliament URL: https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/642230/EPRS_BRI(2019)642230_EN.pdf (Last accessed: 01.06.2021).
5. Facial Recognition — techopedia. URL: https://www.techopedia.com/definition/32071/facial-recognition (Last accessed: 01.06.2021).
6. Drone Programming Course — CVZONE. URL: https://www.computervision.zone/courses/drone-programming/ (01.06 2021).
7. Shutko, V. N., Klyuchko, O. M., Navrotskiy, D. O., Mikolushko, A. M. (2014). Possibility of images recognition in navigation by artificial system. *2014 IEEE 3rd International Conference on Methods and Systems of Navigation and Motion Control, MSNMC*. Proceedings Article, 165–169.
8. Aralova, N. I., Klyuchko, O. M., Mashkin, V. I., Mashkina, I. V. (2017). Software for the reliability investigation of operator professional activity for "Human-Machine" systems. *Electronics and Control Systems*, 51(1), 105–113.
9. Klyuchko, O. M., Klyuchko, Z. F. (2018). Electronic information systems for monitoring of populations and migrations of insects. *Biotechnologia Acta*, 11(5), 5–25. https://doi.org/10.15407/biotech11.05.005