MODERN TRENDS IN THE USE OF UNMANNED AERIAL VEHICLES IN MILITARY ENGINEERING RECONNAISSANCE

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Abstract. This article analyzes modern trends in the use of unmanned aerial vehicles (UAVs) in military engineering reconnaissance. Currently, drones are used as an important tool for improving the efficiency of engineering reconnaissance, remote monitoring of dangerous areas, detecting mines and explosive devices, and assessing obstacles and engineering structures. The article highlights the capabilities of modern unmanned platforms equipped with artificial intelligence, geoinformation systems, and high-precision sensors. The importance of real-time data transmission, 3D mapping, thermal imaging, and autonomous flight technologies in military engineering reconnaissance is also considered. The results of the study show that unmanned aerial vehicles can reduce the risks associated with the human factor in reconnaissance processes, quickly collect data, and improve the quality of decision-making. Further improvement of these technologies in the future can significantly increase the efficiency of military engineering operations.

Keywords: military engineering intelligence, unmanned aerial vehicles, drones, artificial intelligence, geoinformation systems.

INTRODUCTION

In the 21st century, the rapid development of information and communication technologies is also bringing about fundamental changes in the military sphere. The experience of modern armed conflicts and military operations shows that the rapid and accurate receipt of intelligence information is one of the main factors ensuring the success of military operations. In particular, military engineering intelligence is of great importance in determining the directions of movement of troops, studying obstacles and mined areas, assessing the condition of engineering structures, and collecting reliable information about the combat situation. Therefore, the issue of introducing modern technologies in this area has become one of the priority tasks for the armed forces of the world's leading countries.

In recent years, unmanned aerial vehicles (UAVs) or drones have been widely used as one of the most promising means of military intelligence. Their main advantages include high mobility, operationality, remote control, and the ability to operate in areas that pose a threat to human life. UUAs allow for the observation of large areas in a short time, the acquisition of high-resolution photo and video images, the detection of enemy engineering obstacles and minefields. This significantly increases the effectiveness of engineering reconnaissance and ensures the safety of personnel[8].

Modern unmanned systems used in military engineering reconnaissance are equipped with various optical-electronic cameras, thermal surveillance devices, laser rangefinders and geolocation systems. These technologies allow for real-time data transmission, the creation of digital maps of the territory and rapid analysis of reconnaissance results. In addition, as a result of the introduction of artificial intelligence elements, drones are becoming capable of performing tasks such as automatic detection, classification and risk assessment of objects.

Today, the use of drones in many armies of the world is expanding not only in reconnaissance, but also in engineering support, rescue operations, logistics and monitoring tasks. This is helping to raise military engineering activities to a new level. Especially in difficult geographical conditions or in areas with high combat risk, unmanned technologies allow reducing risks associated with the human factor and speeding up the decision-making process.

The purpose of this article is to analyze modern trends in the use of unmanned aerial vehicles in military engineering reconnaissance, to highlight their practical capabilities and advantages, and to assess the prospects for the development of these technologies.

LITERATURE REVIEW AND RESEARCH METHODOLOGY

The issue of using unmanned aerial vehicles (UAVs) in military engineering reconnaissance has been studied by many foreign and domestic researchers in recent years. Scientific research in this area is mainly focused on the reconnaissance capabilities of drones, their effectiveness in detecting engineering obstacles, and their integration with artificial intelligence technologies.

P. W. Singer and A. Friedman, in their work "Cybersecurity and Cyberwar: What Everyone Needs to Know" (Oxford University Press, 2014), emphasize the increasing importance of unmanned systems in modern military operations. The authors analyzed the role of drones in real-time information collection and combat decision-making[3].

P. W. Singer's Wired for War: The Robotics Revolution and Conflict in the 21st Century (Penguin Press, 2009) extensively discusses the impact of robotic military systems, including unmanned aerial vehicles, on the development of modern warfare. The study provides scientific evidence for the advantages of drones in reconnaissance operations[5].

The book Unmanned Aircraft Systems: UAVS Design, Development and Deployment by Austin (2010) provides a detailed analysis of the technical characteristics, control systems, and military applications of unmanned aerial vehicles. This resource is important in studying the stages of development of UAV technologies.

NATO's Joint Intelligence, Surveillance and Reconnaissance (JISR) documents also address the role of unmanned platforms in intelligence gathering and processing. These documents demonstrate the practical aspects of using modern surveillance tools in military engineering reconnaissance.

The US Department of Defense's 2023 "Unmanned Systems Integrated Roadmap" report analyzes the prospects for integrating unmanned systems with artificial intelligence, geoinformation systems, and autonomous control technologies. The report specifically notes the effectiveness of drones in detecting mined areas and conducting engineering reconnaissance[4].

The analyzed literature shows that unmanned aerial vehicles are recognized as an important tool for increasing the efficiency of military engineering reconnaissance, reducing the risk to human resources, and expanding the possibilities of obtaining operational information.

This study used a number of scientific methods to study modern trends in the use of unmanned aerial vehicles in military engineering reconnaissance.

The theoretical basis of the study was an analysis of scientific literature, reports of international organizations, and regulatory and legal documents in the military field. Comparative analysis and a systematic approach were used in the study of the literature.

Also, the experience of using drones in the armed forces of different countries was studied, and their advantages and disadvantages were identified based on the comparative method. The analysis used observation, generalization, and statistical data interpretation methods.

During the study, the functional capabilities of unmanned aerial vehicles in engineering reconnaissance, including remote monitoring, 3D mapping, thermal surveillance, and autonomous control systems, were separately evaluated. Based on the results obtained, scientific conclusions were developed on improving the use of drones in military engineering reconnaissance.

ANALYSIS AND RESULTS

The experience of modern military conflicts shows that unmanned aerial vehicles are becoming an integral part of military engineering intelligence. The analysis of scientific literature, international experience and existing technological solutions studied during the study showed that the use of drones significantly increases the speed, accuracy and safety of engineering intelligence. While traditional intelligence methods require personnel to enter dangerous areas to collect information, unmanned systems allow these tasks to be performed remotely. As a result, the risks associated with the human factor are reduced and the process of obtaining intelligence information is accelerated.

Modern drones used in engineering intelligence are equipped with high-resolution optical cameras, infrared sensors and geolocation systems. These technologies can be used to determine the condition of mined areas, engineering obstacles, destroyed roads and bridges in a short time. In particular, thermal surveillance systems allow for effective information collection even at night or in conditions of limited visibility. This is of great importance in planning the movement of military units.

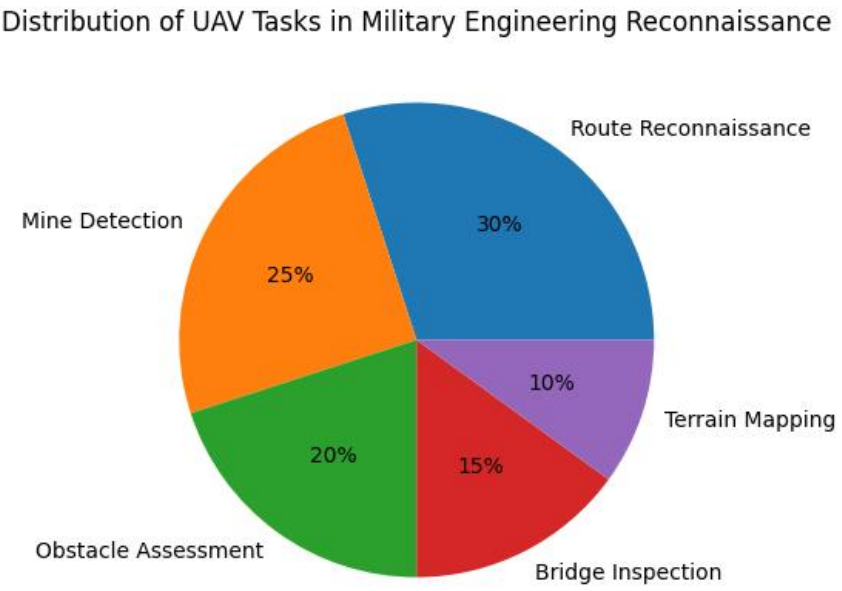
The capabilities of 3D mapping and digitization of territories of unmanned aerial vehicles have shown that they serve to raise engineering intelligence to a qualitatively new level. Based on the data collected by drones, a three-dimensional model of the territory is created, and through this model existing hazards, natural and artificial obstacles are identified. This approach increases the efficiency of advance planning of troop movements and operational decision-making[7].

Also, the integration of artificial intelligence technologies into drones is starting a new stage of development of engineering intelligence. As a result of the analysis, it became clear that algorithms based on artificial intelligence allow for automatic processing of images, recognition of objects and assessment of the level of danger. This reduces the operator's workload and increases the speed of data processing. As a result, intelligence information is delivered to command posts in a short time and quick decisions are made.

Based on the conducted analysis, the following results were achieved: firstly, unmanned aerial vehicles significantly increase the speed of engineering reconnaissance; secondly, they increase the level of security by reducing the presence of personnel in dangerous areas; thirdly, they ensure the reliability of information using high-precision surveillance tools; fourthly, they allow for the automation of reconnaissance processes as a result of integration with artificial intelligence and digital technologies.

Figure 1.

Pie Chart of UAV Application Areas



The prospects for the use of unmanned aerial vehicles in military engineering reconnaissance have shown that they are very promising. In the future, the further development of autonomous control systems, artificial intelligence and modern sensor technologies will increase the effectiveness of these tools and contribute to the successful implementation of military engineering operations.

CONCLUSION

The use of unmanned aerial vehicles in military engineering reconnaissance is one of the important directions of modern military operations. As a result of the conducted research and analysis, it was found that drones play an important role in increasing the efficiency of engineering

reconnaissance, quickly collecting and processing data, and ensuring the safety of personnel. In particular, the ability to remotely monitor the condition of mined areas, engineering obstacles, roads and bridges contributes to the safe and effective organization of the activities of military units.

The results of the study showed that equipping modern drones with high-precision optical systems, thermal sensors, geolocation tools, and artificial intelligence technologies significantly improves the quality of reconnaissance processes. These capabilities make it possible to obtain detailed information about the territories, identify dangerous objects, and provide the information necessary for making operational decisions in a short time.

The use of unmanned aerial vehicles also allows reducing risks associated with the human factor, rationally using material resources, and ensuring the continuity of reconnaissance operations. This will increase the combat readiness and mobility of military engineering units.

In the future, the introduction of autonomous control systems based on artificial intelligence, automatic data analysis technologies and new-generation sensors will further expand the capabilities of unmanned aerial vehicles. As a result, the accuracy, speed and efficiency of military engineering reconnaissance will rise to a new level.

In general, unmanned aerial vehicles are a strategically important tool of military engineering reconnaissance, and their scope and technological capabilities are expected to expand further in the future. Therefore, the development and implementation of scientific research in this area remains one of the urgent tasks.

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