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FORMATION AND DEVELOPMENT OF THE CONCEPT OF USING UNMANNED AERIAL VEHICLES AND THEIR INNOVATIVE APPLICATION IN MODERN WARS AND MILITARY CONFLICTS

The article analyses the genesis, formation and further development of the use of unmanned aerial vehicles for military purposes. Prospects for the use of unmanned aerial vehicles in modern wars and military conflicts are considered. Their impact on the formation of the theatre of future military operations and enhancement of the potential combat capabilities of formations, units and subunits of the security and defence forces of Ukraine is investigated.

The russian-Ukrainian war is often called the first drone war. The use of drones in modern wars and military conflicts demonstrates their growing role and impact on the tactical and strategic aspects of warfare. They are changing the rules of the game on the battlefield, performing tasks ranging from reconnaissance missions to targeted strikes, which help reduce risks to the lives of military personnel, preserve military and special equipment, and increase the efficiency of combat operations.

Military experts argue that although these unmanned aerial vehicles do not fully compensate for the urgent need for shells and military equipment, they can create a new dynamic on the battlefield.

Keywords: *unmanned aerial vehicle, military aggression, state security, security and defence forces of Ukraine, drone, situation monitoring, reconnaissance operation, war, military conflict.*

Statement of the problem. The effectiveness of the service and combat activities of the security and defence forces, in particular the National Guard of Ukraine, in the context of repelling a full-scale aggression of the enemy forces, which are superior in military potential, largely depends on the quality of their use of the achievements of technical sciences. Therefore, there is an urgent need to constantly introduce the latest methods and means of armed struggle, which involve the use of modern achievements of digital, technological, scientific and technical progress.

In recent years, unmanned aerial vehicles (UAVs) have taken a special place among robotic weapons and innovative technologies in the air. The advantages of using UAVs lie primarily in their broad functionality, which allows for the real-time integration of an automatic piloting system with the simultaneous receipt and transmission of intelligence information to the relevant military command and control bodies.

Today, the use of UAVs in combat operations makes it possible to effectively carry out reconnaissance and combat (service-combat) tasks at relatively low financial costs. It is worth noting that as the capabilities of domestic UAVs develop, so do the capabilities of the enemy, and countering it requires constant technical improvement and tactical development of UAVs. Researching and analysing the practice of using UAVs not only in Ukraine but also in other countries helps to identify trends and factors that influence them.

Analysis of recent research and publications. The topic of unmanned aerial vehicles is of great interest to the scientific community today. Domestic and foreign researchers have repeatedly referred to the history of the creation, development, current state and combat use of UAVs in various local wars and armed conflicts. For example, S. Korsunov, A. Volkov, M. Oboronov, S. Oriekhov, V. Hurtovenko, S. Fedchenko in their scientific works investigated the evolution of the role of unmanned aircraft in modern armed conflicts [1].

The results of a systematic analysis of the technical aspects of UAVs during the anti-terrorist operation in eastern Ukraine are presented in a scientific paper by R. Koltsov, P. Vaniiev and D. Indutnyi [2].

Military researchers of the National Defence University of Ukraine O. Korshetz and V. Horbenko, based on the experience of local wars and armed conflicts, conducted a comparative analysis of the methods of use and technical capabilities of UAVs, and considered the issue of countering enemy UAVs [3].

Scientists O. Oleksenko, O. Avramenko, A. Fedorov, V. Snitsarenko and O. Chernavina have conducted a thorough retrospective analysis of the use of UAVs by the russian federation during the first and second russian-Chechen wars (1994–1996 and 1999–2003), the Abkhazian-Georgian conflict (2008), and studied the use of unmanned aerial vehicles by the russian armed forces in 2022–2023 during the large-scale invasion of Ukraine [4].

However, these works do not sufficiently cover the use of UAVs during the ATO and JFO in eastern Ukraine, as well as during the full-scale invasion of our country by russia.

In addition, foreign researchers have made a significant contribution to the study of the massive use of UAVs and the impact of drone swarming technology on future conflicts [5–10]. Usually, their studies focus on certain aspects of the use of UAV swarms in combat, but without generalising the advantages and disadvantages of their massive use.

Changes in views on the use of UAVs are discussed in more detail in the scientific work of S. P. Mosov [11]. The author analyses the development of military unmanned aerial vehicles in different countries, determines the prospects for the development of aerospace intelligence for future armed conflicts and explores their group and mass use in combat.

An analysis of scientific publications shows the relevance of studying the methods and ways of using UAVs in modern wars and armed conflicts. However, the use of unmanned aerial vehicles by the Armed Forces of Ukraine during the Joint Forces Operation (JFO) and after russia's full-scale invasion of Ukraine has not yet been sufficiently studied, as it was during this period that significant changes occurred in the military command's approaches to the use of unmanned aerial vehicles.

The purpose of the article is to analyse the genesis, formation and further development of the practice of using unmanned aerial vehicles for military purposes, as well as the prospects for the use of unmanned aerial vehicles in modern wars and military conflicts, their impact on the formation of the theatre of future military operations and the enhancement of the potential combat capabilities of formations, units and subunits of the security and defence forces of Ukraine.

Summary of the main material. The history of the use of drones is older than the current russian-Ukrainian war, as well as the Second and even the First World Wars. The basic concept of unmanned aerial vehicles was considered by the military more than 170 years ago. The date of the beginning of the creation of these vehicles is generally considered to be 22 August 1849, when Austria, which at that time controlled most of Italy, laid siege to Venice. During the siege, Austrian General F. von Uhatsius proposed an innovative idea: to release balloons with explosives towards the city. The Austrians released about 200 unmanned balloons carrying high-explosive bombs weighing almost 13 kg. They are known in history as the "Austrian balloons". Despite the fact that the effect of the bombing was minimal, this episode went down in history as the first use of an unmanned aerial vehicle in combat [12].

On 8 November 1898, the American scientist Nikola Tesla received a USA patent no. 613809 for a remote control, demonstrating a radio-controlled toy electric boat at the Madison Square Garden Electrical Exhibition in New York in September of the same year, which impressed the audience. This invention of Nikola Tesla paved the way for modern robotics. The inventor was annoyed that the Spanish-American War had ended a few months earlier and he did not have time to build a larger boat, fill it with dynamite and send it to the enemy ship [13].

Subsequently, the First World War broke out, and the participating countries began new experiments with weapons that could be controlled remotely to inflict maximum destructive damage on the enemy and minimise their losses.

In 1917, at the request of the US Army, the Dayton-Wright Company, led by inventor C. Kettering, developed a prototype of an unmanned aircraft, the Kettering Bug, also known as the Kettering Air Torpedo. The Bug was a low-cost biplane with a 40-horsepower Ford engine that was loaded with explosives and used as a flying bomb that could hit enemy targets at a distance of up to 120 km.

The Bug was guided to the target using a combination of pneumatic and electrical systems and a gyroscope. Before launching the biplane, the engineers calculated the number of engine revolutions required to reach the target based on the wind speed and direction. Upon reaching the specified number of revolutions, the engine was switched off, the wings detached, and the fuselage fell on the target and detonated.

The first flight of this aircraft took place in 1918. Although the revolutionary Bug technology was successful, it was not used as the First World War ended, and the development remained in research. Nevertheless, the Bug became a precursor to modern cruise missiles [14].

In the period between the First and Second World Wars, the world's leading powers were actively developing unmanned aerial vehicles capable of carrying explosives over long distances and striking enemy targets.

In 1920, the UK made the first successful flight of the Bristol F.2B remote-controlled fighter in the UK, and in 1921–1922, the Royal Aircraft Establishment (RAE) created the RAE Target, an unmanned radio-controlled target aircraft, a prototype of a surface-to-surface missile. Inspired by these experiments, the British Navy ordered RAE to develop a long-range unmanned "flying torpedo". According to Navy experts, such projectiles could be effectively used by light ships to shell both coastal installations and strike deep into enemy defences without the risk of losing their aircraft carriers and heavy artillery ships [15].

In the late 1920s, RAE designed the first cruise missile, called the RAE Larynx, a long-range gun with Lynx engine, a surface-to-surface missile that was an unmanned piston-engine aircraft. The RAE Larynx had the shape of a small monoplane aircraft, could be launched from a combat aircraft, was run by autopilot and was intended to fire at shore targets from ships. However, despite successful tests, this project was closed due to the lag between the aircraft's parameters and the level of aviation development.

The first significant success was the creation of a number of radio-controlled unmanned aerial vehicles by the United Kingdom and the United States in the 1930s [14].

For example, in 1931, based on the Fairey III biplane, the UK developed the Fairey Queen light radio-controlled aircraft, and in 1935, based on the De Havill and Tiger Moth biplane, another light aircraft, the DH.82B Queen Bee, was created [14].

The British did not stop there and developed another successful version of the Queen Bee drone, a radio-controlled aircraft used as a flying target for air defence training. It is believed that the name "Queen Bee" is the origin of the term "drone". In 1936, this word was first used by the head of a research group of the US Navy as a name for a radio-controlled UAV. Queen Bee showed the significant potential of unmanned systems as a prototype of future drones [16].

World War II was a catalyst for the development of unmanned vehicles. The participating states – Germany, Britain, and the United States – continued to work on the development of radio-controlled aircraft for reconnaissance and strikes on enemy targets at a rapid pace.

One of the first practically used UAVs was the German V-1, known as the Fau-1 (German: vergeltungswaffe – retaliatory weapon). The main work on this project was carried out by German engineers R. Lus and F. Gosslau, and the company Feseler took over its implementation.

The V-1 made its first successful flight in 1942 and entered service with the German Army at the end of World War II. It was equipped with a pulsating jet engine and had impressive tactical and technical characteristics at the time: it could reach speeds of up to 640 km/h, a flight range of 250 km (later increased to 400 km), was capable of carrying a warhead weighing 750–1000 kg, and was equipped with an autopilot system that maintained the aircraft's course and altitude.

Between June 1944 and March 1945, the German Army used about 30.000 V-1s for massive bombings of British cities, launching them from catapult launchers or Heinkel-111 bombers.

The V-1 was one of the world's first mass-produced long-range strategic unmanned aerial vehicles, which gave impetus to the further development of UAVs and stimulated the search for means of defence against them.

The results of using the V-1 during the Second World War influenced the concept of using cruise missiles and unmanned aerial vehicles in many countries around the world [17].

During the Cold War, UAVs became an important tool for intelligence operations. For example, in the 1950s, the United States began using Fire bee drones for reconnaissance flights over the Soviet Union. It was equipped with state-of-the-art photographic, infrared, and electronic reconnaissance equipment. Later, some of these aircraft were equipped with a television camera that transmitted information in real time. The Fire bee could be launched both from a carrier aircraft (the first was the Invader) and from the ground using the JATO aircraft accelerator [3].

In the 1960s, during the Cuban Missile Crisis, the US government decided to create reconnaissance UAVs, which resulted in the world-famous Lightning Bug reconnaissance drone. In the period 1965–1973, during the Vietnam War, Lightning, supporting South Vietnamese troops, collected information on the location and movement of North Vietnamese pro-communist troops.

With the rapid development of technology, these UAVs began to additionally perform electronic warfare tasks, which reduced the risks to pilots from the threat of anti-aircraft missiles and increased the effectiveness of military operations. The successes achieved in the use of Lightning Bug allowed them to be produced in various modifications until the beginning of the 21st century [18].

In the 1990s, the US Air Force created the RQ-4 Global Hawk strategic reconnaissance UAV, which is still considered the pinnacle of such vehicles.

The Global Hawk made its first flight on 28 February 1998 from the US Air Force base in California, and after modifications was transferred to the US Navy in 2004 and began performing combat missions in March 2006 [19].

In June 2011. The Global Hawk was certified by the US Secretary of Defence as "critical to national security". At the same time, the US Secretary of State stated that the Global Hawk is essential to national security and that there are no alternatives that would provide acceptable capabilities at a lower cost.

The Global Hawk is impressive in its tactical and technical characteristics: a range of approximately 5.500 km, a 24-hour stay in the destination area, a 36-hour airborne time, a maximum speed of 637 km/h, an upper limit of 6.811 m, and a range of up to 25.015 km.

In addition, the Global Hawk is the world's largest production UAV in terms of size and weight: its length is 13.3 m, wingspan is approximately 35 m, and take-off weight is close to 15 tonnes.

The Global Hawk is equipped with the HISAR (Hughes Integrated Surveillance & Reconnaissance) integrated surveillance and reconnaissance system. The synthetic aperture radar is manufactured by Raytheon (Hughes) and is designed to operate in all weather conditions. It is capable of detecting ground-based moving objects and transmitting information about such objects (coordinates and speed) via text messages. The daytime electronic optical digital camera is manufactured by Hughes and provides high-resolution images.

The images received from the radar and EO/IR sensors are processed on board the UAV and transmitted to the ground station in the form of separate frames. The ground station assembles images from the frames and prepares them for further use.

The Global Hawk is equipped with a satellite-corrected inertial navigation system, which allows most of the flight to be performed automatically. Intelligence data and control commands are transmitted via satellite. This UAV has a broadband integrated communication system called AICS (Airborne Integrated Communication System). If the UAV is used in the line-of-sight area, direct data transmission to the respective ground station is possible.

Thus, the Global Hawk uses all modern high-tech solutions, so it is not surprising that it became the first UAV to receive permission from the FAA (US Federal Aviation Administration) to independently dispatch for a flight mission and fly using civilian air corridors in the United States without additional notifications [20].

In the 1990s, the number of states that began to actively develop their own UAVs increased.

For example, the Israeli defence concern Israel Aircraft Industries, known for its innovations in the military sphere, created the IAI Scout tactical reconnaissance UAV. The first IAI Scout was unveiled at the 1979 Paris Air Show. It was equipped with a Tamam television camera with high-quality optics and a secure remote system for real-time video transmission. Thanks to the innovative technologies incorporated in the IAI Scout, it was adopted by the Israeli Air Force and Army, Singapore Air Force, South African Air Force and Swiss Army and was successfully used in the 1982 Operation Peace in Galilee against Syria and Lebanon.

The first ever case of a jet fighter being shot down by a drone is associated with the IAI Scout UAV, which took place on 14 May 1981. During a routine reconnaissance flight, the IAI Scout was attacked by a Syrian MiG-21. Trying to intercept the drone, the pilot lost control and the MiG-21 crashed into the ground. The UAV returned safely to its base, where the aviation technicians wrote a "kill mark" on the aircraft, a sign of victory in an air battle.

The use of the Scout UAS for reconnaissance, targeting, and adjusting artillery fire has significantly increased the accuracy of Israeli strikes against the enemy and reduced civilian casualties [21].

At the turn of the twentieth and twenty-first centuries, with the development of communication and navigation systems, in particular the Global Positioning System (GPS), UAVs reached a new level of application and became an integral part of military operations.

Due to the rapid development of microprocessor technology, control, navigation, information transmission, and artificial intelligence, UAVs are able to fly automatically from take-off to landing and perform situational awareness tasks, provide reconnaissance, search, selection, and destruction of enemy targets.

Thus, the US Global Hawk has participated in dozens of operations over Afghanistan, Iraq, Syria, Libya, Nigeria, the Persian and Aden Gulfs, and in many other regions of the world, including Ukraine and the Black Sea. In addition to combat and national security operations, these UAVs have been effectively used to monitor natural disaster areas: forest fires in the United States, the earthquake in Haiti, the tsunami in Japan, typhoons in the Philippines, etc.

In 2011, during the Libyan Civil War, NATO drones, in particular the MQ-1 Predator, demonstrated their effectiveness in gathering intelligence and conducting precision strikes on military targets of the dictatorial regime of M. Gaddafi, providing support to rebel ground forces.

It is known that in the period 2010–2020, the United States conducted more than 14 thousand such attacks, including in military conflicts in Iraq and Afghanistan. For example, Predator [22] and Reaper drones have become a symbol of modern conflicts, providing an operational advantage due to the ability to operate over long distances without risking the lives of pilots, and providing fire support to advanced units and remote outposts [23].

Until recently, the United States did not believe that UAVs would soon be effective in the fight against armies with powerful air defences. The Second Karabakh War changed their minds, where modern drones easily bypassed air defences and effectively performed their tasks.

Already in 2020, Azerbaijan successfully used Turkish Bayraktar TB2 strike drones, destroying enemy military equipment and facilities with great accuracy, which played a decisive role in ending the military conflict.

The Bayraktar TB2 proved equally effective during military conflicts in northern Syria, Libya and since the start of the anti-terrorist operation in eastern Ukraine.

In general, many examples demonstrate the growing role of drones in modern wars and military conflicts, and Ukraine is no exception.

For example, the US Air Force's RQ-4 Global Hawk conducted reconnaissance flights over the territory of Ukraine, namely:

– October 15, 2016 – after taking off from the NATO Sigonella airbase in Sicily, a UAV flew over the occupied Crimea via Mykolaiv-Kherson-Melitopol, filming the entire frontline in Donbas;

– December 2016 – the UAV made two more flights to Ukraine, one of which lasted almost 10 hours on 16 December and took place near the combat zone in eastern Ukraine;

– July 20, 2017 – the UAV conducted a reconnaissance and observation flight lasting more than 17 hours along the demarcation line, the southern coast of occupied Crimea and the coast near Sochi;

– October 23, 2017 – the UAV crossed the border from Romania near Chernivtsi and continued to fly over the territory of Ukraine near Khmelnitsky after switching off its transponder;

– December 4, 2017 – the UAV made a reconnaissance flight for several hours along the contact line in Donbas, the coast of occupied Crimea and to russia's Novorossiysk with its naval base.

Since February 24, 2022, the date of russia's full-scale invasion of Ukraine, RQ-4 Global Hawk drones have been regularly conducting reconnaissance flights over Ukraine and the Black Sea to monitor the operational situation and observe the movement of russian troops.

The flights of reconnaissance drones are known due to the activation of aircraft transponders, a device in an aircraft that automatically transmits information in response to a request from the ground [24].

The experience of the russian-Ukrainian war has shown that the use of drones for reconnaissance and combat missions has become a tragic routine.

Drones are an integral part of combat operations – the army's "eyes" and weapons. The demand for drones has grown rapidly, and they are needed here, now, and in sufficient quantities. Hundreds of Ukrainian large and small businesses have responded to the needs of the military and started developing their own drones.

Deutsche Welle (a German state radio and television station broadcasting abroad), citing G. Tshakai, an adviser to the Minister of Digital Transformation and one of the architects of the Army of Drones project, writes that at the beginning of the full-scale invasion, there were only seven UAV manufacturers in Ukraine, and now there are 150. At the same time, the production of drones is mainly carried out by private companies, which reduces bureaucracy. By the way, 40 different types of drones have already been put into operation by the security and defence forces of Ukraine [25].

In addition to UAVs, completely new drones are used for aerial reconnaissance, which carry out:

– situation monitoring;

– repeated and single-use strikes (FPV kamikaze drones);

– fire support, as they are capable of carrying combat modules (machine guns, automatic grenade launchers and man-portable air defence systems) that destroy enemy manpower and equipment;

– distant mining of the territory (area), water area (lake, sea, river, etc.) and enemy movement routes;

– delivery of explosives to enemy objects (targets) in order to disable or destroy them;

– performing logistics tasks – delivering the necessary cargo to the frontline units (ammunition, food, medicine, etc.);

– interception of enemy UAVs of short and medium range;

– destruction or disabling of enemy aircraft, in particular aircraft and helicopters during their flight;

– evacuation of the wounded from the battlefield, etc.

Thus, drones have transformed the modern battlefield in the air, on land and at sea, increased the number and quality of non-contact combat operations and, as a result, reduced the level of human losses and the loss of expensive military and special equipment during combat missions.

The key aspects that determine the need to use drones in modern wars and military conflicts are as follows:

– autonomy and remote control: the use of drones reduces the risk of casualties among personnel, reduces the need for human presence on the front line, and increases overall security in combat areas;

– expanding the scope of information gathering capabilities by inspecting large areas and territories occupied by the enemy where combat missions are planned to be performed;

– speed, manoeuvrability and multitasking: enables rapid movement in combat areas, simultaneous performance of several tasks and the ability to focus on important combat missions;

– invisibility and stealth: the ability to camouflage in the environment, the availability of electronic warfare countermeasures and stealth technologies enables drones to remain undetected and unattacked by enemy weapons;

– efficiency and accuracy: drones are equipped with modern sensor and camera systems that provide high recognition and identification of objects, allow collecting detailed information, including high-resolution video images, provide operational and objective data, as well as determine the exact coordinates of objects, conduct high-precision mapping of the territory and predict the enemy's actions;

– the ability to work around the clock in real time and in non-critical weather conditions: drones can operate continuously where it is impossible or dangerous to involve personnel;

– synergy with other technologies: drones can be integrated with other advanced technologies, including artificial intelligence, to objectively monitor, process and analyse large amounts of data;

– cost-effectiveness: the use of drones is sometimes hundreds of times more cost-effective than the use of expensive military equipment operated by human crews.

This is an incomplete list of all the advantages of using drones compared to outdated or traditional methods of warfare and armed conflict.

Conclusions

Drones are currently a high-tech system of modern weapons that is changing approaches to warfare and military conflicts and providing new opportunities for armies around the world.

The vast majority of military experts consider drones to be the best safeguard against the state's involvement in a protracted and positional war. The number one priority is to master the entire arsenal of relatively cheap, modern and highly effective unmanned aerial vehicles and other technological means. Already, these tools allow commanders to monitor the situation on the battlefield in real time, day and night, and in any non-critical weather conditions. The intelligence obtained in this way helps commanders to make prompt decisions on the use of forces and means of formations (units and subdivisions) to destroy enemy manpower and equipment, and to launch precision strikes on enemy targets at the front lines and in the depths. This means a complete rethinking of warfare and operations on the battlefield and the rejection of outdated, in particular soviet, stereotypical thinking.

Taking into account the combat experience gained by the security and defence forces of Ukraine, we can confidently state the effectiveness and prospects of using drones equipped with high-tech systems to provide a decisive rebuff to armed aggression and liberate the territories of Ukraine temporarily occupied by russia and restore its territorial integrity.

Prospects for further research may include studying the potential combat capabilities of unmanned aerial vehicles in modern military conflicts.

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СТАНОВЛЕННЯ І РОЗВИТОК ПРАКТИКИ ВИКОРИСТАННЯ БЕЗПІЛОТНИХ ЛІТАЛЬНИХ АПАРАТІВ ТА ЇХ ІННОВАЦІЙНЕ ЗАСТОСУВАННЯ У СУЧАСНИХ ВІЙНАХ І ВОЄННИХ КОНФЛІКТАХ

Проаналізовано генезис зародження, становлення і подальшого розвитку концепції застосування безпілотних літальних апаратів у військових цілях. Розглянуто перспективи застосування безпілотних літальних апаратів у сучасних війнах і воєнних конфліктах. Досліджено їхній вплив на формування театру майбутніх воєнних дій і підвищення потенційних бойових можливостей з'єднань, частин та підрозділів сил безпеки й оборони України.

Розвиток воєнних технологій завжди був однією з головних рушійних сил прогресу людства. Із часів стародавніх і до сучасних війн і конфліктів новітні розробки та інновації визначали хід битв і забезпечували перевагу тим, хто мав доступ до передових технологій.

Однією з найбільш значущих інновацій останніх десятиліть стало застосування безпілотних літальних апаратів, які з кожним роком набувають дедалі більшого значення у веденні бойових дій (військових операцій).

Російсько-українську війну часто називають першою війною дронів. Використання дронів у сучасних війнах і воєнних конфліктах демонструє зростання їхньої ролі та впливу на тактичні і стратегічні аспекти ведення бойових дій. Вони змінюють правила гри на полі бою, виконуючи завдання від розвідувальних місій і до здійснення точкових ударів, що дає змогу знизити ризики для життя військовослужбовців, зберегти військову та спеціальну техніку, а також підвищити ефективність ведення бойових дій (військових операцій).

На думку військових експертів, ці безпілотники хоча цілком не компенсують гострої потреби у снарядах і військовій техніці, проте здатні створити нову динаміку на полі бою. Так, рої дронів за підтримки штучного інтелекту можуть взаємодіяти між собою, вибирати пріоритетні цілі (об'єкти) противника і знищувати їх, а для керування ними достатньо лише одного оператора.

Ключові слова: *безпілотний літальний апарат, військова агресія, державна безпека, сили безпеки та сили оборони України, дрон, моніторинг обстановки, розвідувальна операція, війна, воєнний конфлікт.*

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