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Оригинални научни рад

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EFFECTS OF THE USE OF ROBOTIZED COMBAT SYSTEMS DURING THE CONFLICT IN UKRAINE FROM 24.02.2022.

Abstract: This study analyses the use of robotic combat systems during the Russian Federation's invasion of Ukraine (special military operations of the armed forces of the Russian Federation) in two periods. The first period refers to the beginning of the special military operation (24 February 2022) until the declaration of partial mobilization in the Russian Federation and the holding of referendums in four regions of Ukraine on joining the Russian Federation. The second period includes the conflict after the annexation of the Donetsk People's Republic, Luhansk People's Republic, Kherson, and Zaporizhzhia regions to the Russian Federation.

The study critically examines the concept of using unmanned aerial vehicles as well as the way of fighting against unmanned aerial vehicles in certain combat situations during a special military operation. This study hypothesises that the success of using robotic combat systems depends on the experience in combating unmanned aircraft, the reliability of the command and information system, electronic warfare systems, and anti-aircraft defence systems. The side that planned a layered approach in combating drones (good intelligence assessment, use of electronic warfare systems, anti-aircraft defence systems, and efficient and effective application of lessons learned) had more success in suppressing the use of drones.

Keywords: Ukraine, Russian Federation, special military operation,, robotic combat systems, unmanned aerial vehicles

INTRODUCTORY CONSIDERATIONS

A new generation of warfare is currently underway in Ukraine. The basic characteristic of this warfare at the operational-tactical level is the use of robotic combat systems in combat operations. The mass use of robotic combat systems, especially unmanned aerial vehicles, has come to the fore in the special military operations of the armed forces of the Russian Federation Ukraine (Russian Federation'sinvasion of Ukraine). The use of robotic combat systems in military operations increases the efficiency and effectiveness of destroying the enemy's combat equipment and reduces the number of innocent victims. The effective use of robotic combat systems destroys profitable objects of action and strengthens combat power. By analysing the special military operation of the Russian Federation in Ukraine, mainly from the aspect of the use of robotic combat systems, and

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comparing the use of unmanned aerial vehicles during previous conflicts, it is possible to find the causes of the successful or unsuccessful use of unmanned aerial vehicles during the conflict in Ukraine. By determining the causes of the successful or unsuccessful use of drones and observing the consequences of their use, it is possible to develop and prove the hypothesis stated in the abstract. After much speculation in the literature regarding unmanned aerial vehicles (robotic combat systems), this study provides some necessary specifics regarding the use of robotic combat systems during the conflict in Ukraine. Although the goal of this announcement is to clarify, based on an analysis of combat operations, the success-failure of the use of robotic combat systems during the conflict in Ukraine, it does not avoid the technical aspects of robotic combat systems.

While discussing the use of robotic combat systems, it is necessary to mention the basic theoretical provisions of robots. The term 'robot' has its roots (origin) in the Czech and Slovak languages, in the words 'ob' and'robota', which literally means work (activity). In Serbia, the word robot has two meanings: 1. electronically controlled automation, often performed according to human figure that performs various operations. 2. Obedient, blind executor of orders or program procedures (Речник српског језика, 2017: 1169). The word robot in the English speaking world refers to a machine (an electromechanical assembly) controlled by a computer and used to automatically perform tasks (https://dictionary.cambridge.org). The word robot was first mentioned in the scifi drama 'Rosums Universal Robots - R.U.R.' by the Czech writer Karel Čapek performed in 1920.

American science fiction, Russian-born writer and biochemist Isaac Asimov[1] was the first to introduce the laws of robotics.

1. A robot may not injure a human being, or through inaction, allow a human being to come to harm.

2. A robot must obey the orders given to it by human beings except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

For a machine (electromechanical assembly) to be called a robot, it must meet the following conditions: it must have the ability to receive, analyze, and understand information from the environment, move its parts, move itself, and perform certain actions with objects. The constituent parts of the robot enable it to functionand fulfil the purpose of its existence. The components of the robot are as follows:

- sensors that register and receive information from the environment in which the robot is located (robot senses).
- aprocessor or logic (electronic circuits that function with some logic) that processes information collected from sensors (the so-called brain of the robot),
- parts that perform some action according to the instructions of the processor (moving parts or limbs of the robot),
- source of energy (power supply) that revives the robot,
- the body of robot (multiple moving parts and sensors combined into one unit).
- the body of robot (multiple moving parts and sensors combined into one unit).

1 Рус. *Исаáк Юдович Озúмов*; Иетрович, University of Columbia PhD in Chemistry graduate, lived from January 2nd 1920 – April 6th 1992.

Sensors represent the part of a robot that interacts with its environment. The robot collects the necessary information from the environment using sensors. The installation of sensors depends on the purpose for which the robot is designed and on the needs and program on which it is working. The processor (logic, logic circuits, and programmer) or the brain of the robot manages and controls the functioning of the robot. Different models of processors and computers are used depending on the number of complex activities that the robot must perform. The movable parts of the robot enable movement (e.g. legs, wheels, propeller, wings, and tracks) and help perform certain activities or functions (arms, gun, grenade launcher, moving camera, laser target designator, periscope, or a specific work tool). The power source is the part of the robot that provides energy to work. Power supply batteries, solar panels, internal combustion engines, and nuclear generatorscan be connected to the robots.

We can argue that Nikola Tesla[2] was one of the pioneers of robotics. He filed Patent No. 613, 809; dated November 8, 1898, entitled 'Method of and apparatus for controlling mechanism of moving vessels of vehicles'. The patent shows the beginning of the development of a robotic remotely controlled system (ship). Remote control of the ship was achieved using two transmitters with different frequencies and two paired receivers individually with each transmitter. Navigation of the ship (in the form of starting the propeller and controlling the rudder) was possible only when the receivers of the ship simultaneously registered signals at both frequencies from individual transmitters located on the ship. It was the result of the logical operation 'I', which was then used for the first time and realised by relays, where the output was the starting of the propeller or rudder. The patent application states: 'What distinguishes this patent from all systems up to that point is that no wires are required, the only thing required is the natural media in the space'. This is much more practical and achieves similar results (as when the mechanism is connected to a wire) as long as the body is within the range of the waves, currents, and pulses being emitted. The invention enables the application of any means of propulsion, allows a moving body or ship, the greatest possible speed, to control the operation of its machinery, and to direct its motion either from a fixed point or from a body that moves and changes its direction at any speed. The control is maintained atlong distances without any physical connections between the ship and the apparatus that controls its movement, and thus without restrictions (https://teslauniverse.com/).

There are two groups of robots based on their purpose:

1. autonomous general-purpose robots and,
2. specialized robots (which perform one or a set of similar functions).

Autonomous general-purpose robots can independently perform various functions. They can move independently in pre-designated areas, perform some of their needs (e.g., charging) for proper functioning, use electronic doors and elevators, and perform other basic tasks. Special types of autonomous robots are used in space research, where the problem of real-time interaction with the environment must be solved. Therefore, complex and precise sensors, autonomous and automatic operations, and artificial intelligence

2 Nikola Tesla (Smiljan, July 10, 1856 - New York, January 7, 1943) was a famous Serbian and world inventor and scientist who worked in the fields of physics, electricalengineering, and radioengineering.

have been developed. The problem with these robots is related to the transmission of control signals and information from sensors over long distances. These robots are the for erunners of robotic combat systems that have almost all the advanced functions of space exploration robots but are armed and adapted for military combat use. Specialised robots are designed for specific skills. Examples include flying in swarms, taking field photos, hovering over an object, or providing guidance to a signal emission source.

By analysing the purpose of robotic combat systems, we can conclude that this special autonomous type of robot is 'dehumanized' because it does not respect Asim's basic laws of robotics because its purpose is to inflict the greatest possible losses in workforce, and destroy military equipment and infrastructure. However, some theoreticians state that robotic combat systems will be dehumanised when they are left with the opportunity to make their own decisions about combat actions based on objectives. If the human factor makes decisions regarding the combat effectiveness of robots, a certain level of humanity can be maintained. However, the practice of using robotic combat systems by the Russian Federation during the conflict in Syria (the Uran-9 and Vehar robotic combat platforms which were used), the use of unmanned aerial vehicles (the so-called kamikaze drones) of the Israeli-made Harop type during the conflict in Nagorno-Karabakh, and the use of unmanned aerial vehicles, the Russian-made Lancet, and Geranium-2 aircraft during the conflict in Ukraine indicate that the level of humanity has been lost. For example, Kamikaze drone type Geranium-2 (Shahid-136) and Harop refer to the electromagnetic signal source of the radar observation station or the signal source of the radar guidance and control station in which there is a human crew. The drone circles above a certain area, and when it registers a radar signal, it is simultaneously directed towards the source of the radar signal (the drone has made a decision), destroying the radar station and its crew members. The use of drone swarms in combat operations (to find and destroy enemy targets) with the aid of artificial intelligence is also possible without human decision (Johnson 2019). The effective use of unmanned aerial vehicles has a great influence on the effectiveness of combat operations, which is achieved by an adequate assessment of their purposes and capabilities (Terzic 2020).

The synchronised use of robotic combat systems in the air (unmanned aerial vehicles) and robotic combat systems on the ground with combat units in a tactical-level operation were first practically applied during the execution of an operation against terrorist forces in the Syrian province of Latakia in December 2015 (Terzić, Đekić et al. 2020). The success of the synchronised use of robotic combat systems by the Russian Federation in the operation against terrorists in the province of Latakia, among other things, had the factor of surprise and insufficient readiness of terrorists (ISIL terrorists did not posses the appropriate weapons, tactics, techniques, and procedures) to fight against robotic combat systems. In conflicts from the end of the 20th century until 2023, during the planning and execution of military operations, unmanned aerial vehicles were massively used, while land-based robotic combat platforms were rarely used.

The reasons for the rare use of land-based robotic platforms, although advertised at arms fairs, are as follows.

- During the testing of robotic combat systems, it is difficult to create or simulate a realistic combat environment, making it difficult to determine the degree of reliability of certain functions of the tested robotic system.

- Land-based robotic combat platforms do not have sufficient autonomy to operate in a complex combat environment because sensors and artificial intelligence are developing, and they should ensure: 1) the ability to work with partial or complete absence of initial information about the operational environment, 2) recognition of objects andanalysis of the situation, and 3) ability to overcom physical obstacles (obstacles in road communications, rivers, lakes, objects in urban areas, etc.) in a short period of time.

- The command and information system should enable an increase in the control range and functional connection of robotic combat platforms with combat and combat support units during the preparation and execution of military operations in the conditions of network-centric warfare.

- Energy sources (powering the terrestrial robotic platform) should enable operation under different climatic conditions, and the operation of the power source should not be an unmasking sign.

Despite the great diversity in the offers of robotic combat platforms and the insufficient amount of reliable data on the functioning of robotic combat platforms in military operations, there is a common interest in three basic questions:

1. Is a reliable command and information system necessary for the success of robotic combat platforms?

2. What is the intensity of the use of robotic combat platforms (unmanned aerial vehicles) during the Special Military Operation of the Russian Federation in Ukraine (Invasion of the Russian Federation in Ukraine)?

3. Is the effectiveness of robotic combat platforms affected by enemy electronic warfare and antiaircraft defence units?

In the next two sections, the special military operation of the Russian Federation in Ukraine (the Russian Federation's invasion of Ukraine) is analysed, the views and reasons for the successful or unsuccessful use of robotic combat platforms (unmanned aerial vehicles) are presented, and the impact of robotic combat systems as a very important component ina new generation of warfare is discussed. The first period includes an analysis of the conflict in the time frame of 24 February 2022. (the beginning of the Russian Federation's invasion of Ukraine) until the annexation of the four Ukrainian regions to the Russian Federation. The second period includes an analysis of the conflict from the annexation of the four Ukrainian regions until June 2023.

THE INITIAL PHASE OF THE CONFLICT BETWEEN UKRAINE AND THE RUSSIAN FEDERATION

Before the beginning of the Russian Federation's invasion of Ukraine (special military operation, as stated by the President of the Russian Federation, Vladimir Putin), Ukraine was a member of NATO's military-political program 'Partnership for Peace'. Ukraine, as a member of the 'Partnership for Peace' alliance, expressed an aspiration to become a member of the NATO alliance and thus represented a threat to the security of the Russian Federation. As a member of the Partnership for Peace Program, Ukraine began modernising its armed forces in 2014 to reach an appropriate level of interoperability and compatibility with the NATO forces. The armed forces of Ukraine switched to a new concept of organisation and training, established a digital system of command and

control, received new systems for reconnaissance and observation, systems for combat support, and so on. According to The Military Balance magazine for 2021, Ukraine had 209,000 members of the armed forces (Army: 145,000; Navy: 11,000; Air Force: 45,000; Special Forces: 8,000), 102,000 members of the Paramilitary Forces 900,000 members in reserve. (The Military Balance, 2021: Chapter Five) According to the magazine, the armed forces of Ukraine had 12 remotely piloted Bayraktar TB-2 aircraft (six UAVs in the Air Force and six UAVs in the Navy). It is possible to assume that the reconnaissance units were equipped with different types of drones intended for reconnaissance, selection of objects of action, and evaluation of the effects of actions at the tactical level.

Thus, based on the above information and the current situation in the Donetsk People's Republic and the Lugansk People's Republic, Russia considered its interests to be threatened, and on 21 February 2022 it recognised the Donetsk and Lugansk People's Republics and from 24 February 2022, it started thespecial military operation or invasion of Ukraine. The declared goal of the special military operation in Ukraine, announced by the President of the Russian Federation, Vladimir Putin, was to protect the people of the aforementioned republics and the demilitarisation and denazification of Ukraine, as well as to bring to justice those who committed numerous bloody crimes against the civilian population, including citizens, including the citizens of Russian Federation (http://en.kremlin.ru, 2022).

Aspecial military operation (Russian Federation's invasion of Ukraine) was launched infive strategic directions. It is possible to arrive at based on monitoring the situation on the Ukrainian battlefield, using the data from open sources of information present on the website https://liveuamap.com, as shown in Figure 1; it illustrates the course of combat operationsin on 25 February 2022.

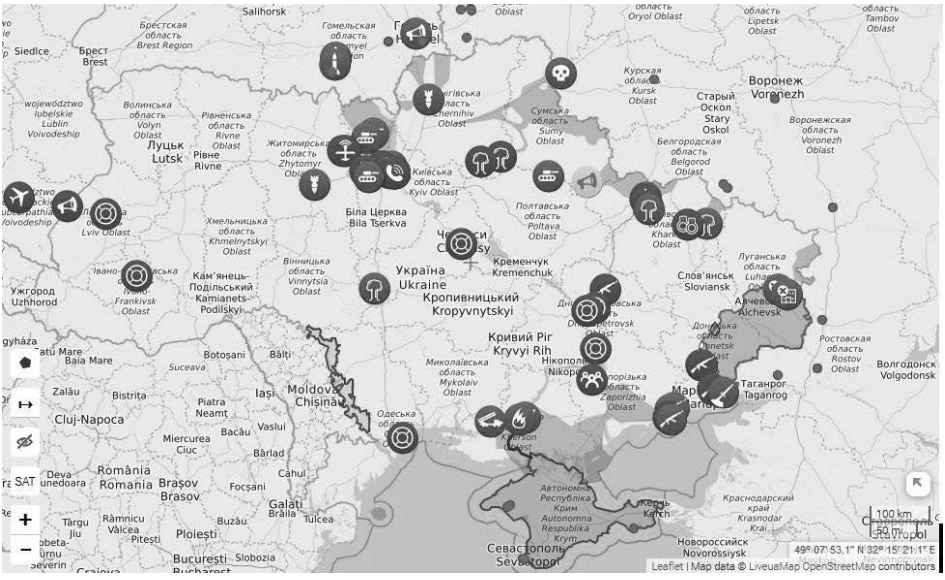

Figure 1: Combat operations on the territory of Ukraine on 25 February 2022.[3]

3 Image taken from the site https://liveuamap.com/en/time/25.02.2022.

The first strategic direction of action was led by the Homyel Region of the Republic of Belarus towards Kyiv. Another strategic direction of action was from the Kursk region of the Russian Federation towards Kyiv. The third strategic direction of action was from the Belgorod region towards Kharkiv. The fourth strategic direction of action was from the Rostov region towards Lugansk and Mariupol. The fifth strategic direction of action was from the Crimean Peninsula towards Zaporizhzhia and Kherson.

In the initial phase of the special military operation, a semi-circular base was established by attacking from five strategic directions, and favourable operational-tactical conditions were created for the continuation of the offensive operation by carrying out concentric frontal breakthroughs to the Dnieper River. By breaking through the Dnieper River, a certain phase line or the desired end state of the attackers would be reached. However, for a large territory (operation zone), unfavourable weather conditions, modern weapons, combat training and equipment, and different attitudes of the population towards the execution of the operation, are necessary to exploit the initial successes (favourable operational-tactical conditions), conquer and control the territory, adequately access the intelligence, and ensure resource (force sufficiency) and operational capabilities. In the initial period of the conflict between Ukraine and the Russian Federation, the Russian side carried out deep penetrations from five strategic directions by using robotic combat systems, indicating a number of specifics. Based on the analysis of the reports on the operational capabilities of the armed forces of Ukraine the Russian Federation, and the analysis of open-source data from the zone of operation, it is possible to draw a conclusion about the manner and efficiency of the use of remotely piloted aircraft and drones.[4]

EFFECTS OF THE USE OF ROBOTIC COMBAT SYSTEMS OF THE ARMED FORCES OF THE RUSSIAN FEDERATION IN THE INITIAL PHASE OF THE CONFLICT

According to the magazine The Military Balance (The Military Balance, 2021: Chapter Five), by the end of 2021, the remotely piloted aircraft Forpost (Searcher II) and unmanned aerial vehicles Pchela 1 and Pchela 2 were in operational use by the armed forces of the Russian Federation. The Russian Federation purchased the Forpost drones from Israel in 2015 in order to overcome the technological and operational gap of the Armed Forces of the Russian Federation in unmanned aerial vehicles (Julian 2022). In addition, in the units of the Ground Army of the Russian Federation (most often in artillery units) there were Orlan-10 unmanned aerial vehicles. Information can also be found on the Internet that in the first days of the special military operation, an unmanned aerial vehicle (kamikaze drone) 'Kub-BLA' was used. There no reliable data on the use of land-based robotic combat systems in the initial period of the conflict between the Russian Federation and Ukraine.

4 A remotely piloted aircraft is an unmanned aerial platform that requires a runway and piloting skills, and an unmanned aerial vehicle is an unmanned aerial platform for the use of which no runway and aircraft piloting skills are necessary - author's note.

The remotely piloted aircraft Forpost (Searcher II) is designed for battlefield reconnaissance, target data delivery, correction of fire missions, and evaluation of fire missions on the target. The maximum flight height was approximately 6000 m and the operational range wa up to 250 km. The armed forces of The Russian Federation developed this aircraft as a combat version by arming it with anti-tank missiles and KAB-20 with laser and satellite guidance. During the deep penetrations by the armed forces of the Russian Federation on strategic routes towards Kyiv, it is possible to assume that the remotely piloted aircraft Forpost was used for the strategic reconnaissance and bombing of important targets. An aggravating circumstance of use can be the system for control and data transmission, because, in practice, the distance between the control cabin and the unmanned aircraft is less than 250 km owing to the influence of the terrain and time on the propagation of electromagnetic waves. If located in Ukraine, the control cabin should be part of a unified communication system for a special military operation. Communication and data links are sensitive to electronic warfare. The operation of the power source (internal combustion engine) of a UAV (unmanned aerial vehicle) produces noise that can be detected, thereby compromising the UAV. The UAV costs approximately 6 M U.S. dollars which makes this remotely piloted aircraft a very important target for defenders. Ukraine's air defence and electronic warfare systems were fully operational. In mid March 2022, the Ministry of Defense of Russia published a video of the combat use of Forpost remotely piloted aircraft. The video showed actions being performed in the warehouse of the Ukrainian Army, most likely guided by a KAB-20 bomb. Following this action, newspaper reports revealed that a Forpost drone was destroyed in the Zhytomyr region (https://www.jewishpress.com, 2022).

The unmanned aerial vehicles, Pchela 1 and Pchela 2 are, according to some data, in operational use since 2022. The unmanned aerial vehicle is intended for the collection of intelligence data in the area of operation with the help of optoelectronic means to support ground army units. It is envisaged that the UAV Pchela will send the collected intelligence data to fire support systems ('Smerch', 'Grad') and attack helicopters via a datalink. For its launch, a launch pad located on a tracked vehicle is necessary. Landing is performed using a parachute with an inflatable shock-absorbing bag. It is powered by a two-stroke piston engine. Based on the experience from combat operations in Chechnya, the maximum distance of the UAV Pchela from the control station wa 55 km (within optical visibility), and the flight height wa in the range of 600–2200 m. The UAV Pchela was most likely used at the operational level to provide operational support to ground units during combat operations in all strategic directions. The disadvantages of using this drone are its low flight height and noisy engine operation; therefore, it is easy to spot and act on it using infantry weapons.

The UAV Orlan-10 is intended for reconnaissance and tracking of targets in the operational zone at the operational level. The maximum flight height wa approximately 5000 m, and the maximum flight distance wa approximately 120 km. The drone wa controlled by control station, and the data were sent via 3G and 4G networks. This can also be a disadvantage because if the data transmission and management links are disrupted,

then control is lost. Pictures and videos of the UAV Orlan-10, as well as the destruction of theUAV Orlan-10 control station, can be seen on the Internet. Figure 2 shows the UAV Orlan-10on the launch pad and the interior of the Orlan-10 UAV control cabin.

Figure 2: Orlan-10 launch layout and Orlan-10 control cabin

In the initial phase of a special military operation, the UAV (kamikaze drone) 'Kub-BLA' was used at the tactical and operational levels to attack armoured vehicles and anti-aircraft defence systems.'Kub-BLA' is launched from the control panel and carries approximately 3 kgof explosives, the flight speed is approximately 130 km, it can stay in the air for approximately 30 minutes, and there is no reliable information about the range. It does not have the option of being on duty in the air and returning after launch. The drone was assumed to have three modes of operation: 1. vertical action towards the observed target, 2. to land with a parachute and rest until someone touches it, and then explode 3. toactivate self-destruction. The disadvantage of using this aircraft is that it acts only on the target for which the coordinates have been entered and cannot be guided by a laser or radar signal. On the Internet, we can see pictures of destroyed 'Kub-BLA' in the zone of a special military operation, most likely as a result of the action of light air defence of the armed forces of Ukraine.

Analysing the initial phase of the Russian Federation's invasion of Ukraine (special military operation) based on the available data, it can be concluded that the intensity of the use of remotely piloted aircraft and drones was low on the Russian side. The reasons for the low intensity of UAV use, especially in the strategic direction towards Kyiv, should be sought in the electronic warfare and air defence capabilities of the armed forces of Ukraine. One of the reason for this may be the functioning of a unique command and information system in certain strategic directions.

EFFECTS OF THE USE OF ROBOTIC COMBAT SYSTEMS BY THE ARMED FORCES OF UKRAINE IN THE INITIAL PHASE OF THE CONFLICT

In the initial period of the conflict, the armed forces of Ukraine were equipped with Bayraktar TB-2 remotely piloted aircraft, and received, as part of the military aid, a certain number of UAVs that were used at the operational-tactical level, of which Switchblade 300 and Switchblade 600 were the most commonly mentioned (Bajak-Ahirova 2023).

The remotely piloted aircraft, Bayraktar TB-2, is a multipurpose system that can be used for information, observation, reconnaissance, air strikes on ground targets, correction of artillery fires, damage assessment, and laser marking of targets. In combat operations, the aircraft can carry a payload for the realisation of the ISR (Intelligence, surveillance and reconnaissance) function and laser target marking or carrying precision-guided bombs for the execution of an air strike against fixed targets on theground, targets moving at low speed on the ground, or targets sailing at sea, which have a high value or are time-sensitive. Figure 3 illustrates the components of the Bajraktar TB-2 UAS remotely piloted aerial system. The elements of Bayraktar TB2 UAS are as follows: 1 - Bayraktar TB2 AIR vehicle platform; 2 - generator; 3 - ground control station; 4 - ground data terminal; 5 - remote video terminal; and 6 - Forward base.

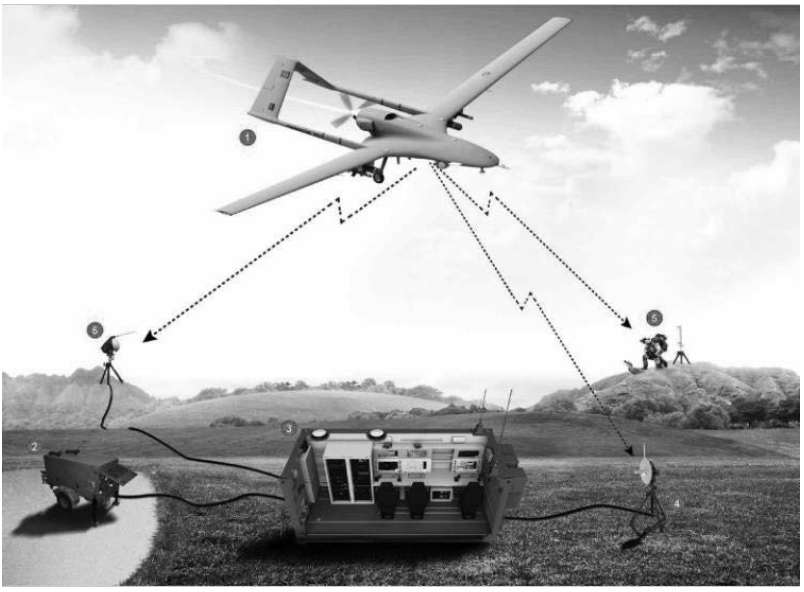

Figure 3: Bayraktar TB-2 UAS (Baykar_catalog_eng.pdf)

The effectiveness of using the UAV Bayraktar TB-2 in the initial period of the conflict wa influenced by the fact that the armed forces of the Russian Federation possessed data on the characteristics of the aircraft and the tactics of fighting against them. The armed forces of the Russian Federation obtained information about the aircraft and tactics of fighting against them during the conflicts in Syria, Nagorno-Karabakh, and the DNR (rus. Донецкая Народная Республика, ukr. Донецька народна республіка) and LNR (rus. Луганская Народная Республика, ukr. Луганська народна республіка). At that time, Pancir S1 antiaircraft and electronic warfare systems were used against the Bayraktar TB-2. In the initial period of the armed conflict, the armed forces of Ukraine used a remotely piloted Bayraktar TB-2 aircraft to collect intelligence and destroy valuable targets on land and sea. The UAV targeted marching columns in the pincer of deep penetrations, command posts, and the area around

the Snake Islands. In addition, the armed forces of Ukraine tried to use Bayraktar TB-2 for operations in the Kursk and Belgorod regions; however, the aircrafts were shot down by air defense. According to open sources, the loss of remotely piloted aircraft until September amounted to 10 aircrafts. After the stabilisation of the front line (from the period of the annexation of four Ukrainian areas to the Russian Federation - ed.) there is not enough information regarding the us of Ukrainian Bayraktar TB-2 for ground targets.

By analysing the earlier conflicts, it is possible to draw a parallel that indicates the successful use of Bayraktar TB-2 by Azerbaijan during the conflict in Nagorno-Karabakh and the failure to use Bayraktar TB-2 in Ukraine. The facts that indicated the successful performance of Bayraktar TB-2 during the conflict in Nagorno-Karabakh included poor intelligence assessment, poor intelligence preparation on the battlefield, insufficient operational-tactical camouflage, and insufficient combat capabilities on the part of Nagorno-Karabakh. The armed forces of Azerbaijan implemented a good tactics of the use Bayraktar TB-2 by first using modified AN-2 light transport aircraft (unmanned) to 'detect' the air defense system, then acting on the detected systems with kamikaze dronesof the Harop type, which were directed to the source of the radar signal or used laser-guided missiles from Bayraktar TB-2 (Terzić 2022). Bayraktar TB-2 remotely piloted aircraft performed reconnaissance and missile strikes on tank columns and recorded the effects of fire missions by transmitting these images in real time. The mass appearance of footage from the use of remotely piloted aircraft and kamikaze drones had a strategic effect and represented a key moment in the change in warfare.

The inadequate performance of UAV Bayraktar TB-2 used by the armed forces of Ukraine may be because the armed forces of the Russian Federation had enough time to study the tactics of use of the remotely piloted aircraft Bayraktar TB-2 and to prepare an adequate response in the form of an intelligence assessment for the possibility of using Bayraktar TB-2 for the destruction of high-value targets in the zone of special military operation, the application of deception, operational tactical camouflage, electronic warfare, and the use of hybrid systems (cannon-missile system Pancir S1) to act against UAV Bayraktar TB-2.

THE EFFECTS OF THE USE OF ROBOTIZED COMBAT SYSTEMS AFTER THE ANNEXATIONS OF THE DONETSK PEOPLE'S REPUBLIC, LUGHANSKA PEOPLE'S REPUBLIC, KHERSON AND ZAPORS REGIONS TO THE RUSSIAN FEDERATION

Referendum on the annexation of the Donets People's Republic, Luhansk People's Republic, Zaporizhzhia Oblast, and Kherson Oblast to the Russian Federation was held between the 23rd and 27th of September. Consequently, a decision was made to annex these territories to the Russian Federation. For the purposes of this article, this period is taken as the beginning of a new phase of the special military operation. Since this

period, the Russian Federation has considered the mentioned territories as its own, and for that reason, it can undertake additional activities that regulate the defence system (mobilisation in those areas, deployment of new combat systems, coordination of combat activities, etc.).

At this stage of the conflict between the armed forces of the Russian Federation and Ukraine, it is possible to draw conclusions from the perspective of robotic combat systems. Based on the available data, the land-based robotic platforms used were the robotic demining complex 'Prohod-1' and the robotic complex 'Marker' andthe navalbased robotic platforms included unmanned combat boats (https://nvo.ng.ru, 2022). Robotised demining complexes were used to smaller extent in rear areas and the 'Marker' robotic system was deployed in February 2023 for real-time testing capabilities for reconnaissance, logistics, and light combat actions. As for the use of naval-based systems, on 24 May 2023, three unmanned boats attacked the Russian reconnaissance ship 'Ivan Hurs', and with the analysis of the open source footage, it can be concluded that, as a defence measure unmanned boats were attacked only with light artillery without the use of an electronic warfare system (https://function.mil.ru, 2023). Land and naval robotic combat platforms have been used in individual cases, and thus far, with reduced intensity in ongoing special military operations. This leads to the following considerations: Are there enough resources and opportunities for the use of land-based robotic systems? The physical-geographic characteristics of the combat environment limit the movement of land-based robotic platforms, affecting the propagation of electromagnetic signals, reducing their overall efficiency and effectiveness, and increasing the impact of electronic warfare compared toother combat platforms.

In the second period of the conflict, Ukraine intensively used UAVs (drones) intensively at the tactical level. At the tactical level, the Ukrainian armed forces most often use commercial drones on which they place their cumulative grenades. These drones were used for reconnaissance, bombarding military positions in trenches, and directing machine guns, mortar, tanks, and artillery fires.

At the operational-strategic level, the UJ-22, Mugin-5, and SKIF drones were used with reduced intensity. Ukraine produced the UJ-22 UAV to meet the requirements of its armed forces. During the conflict, this aircraft performed double functions. The first function was to bomb targets; it is realised at a range of up to 100 km because according to technical characteristics, this is the maximum distance from the command and control station. The second function is most likely related to breakthroughs in Russia's anti-aircraft defence system. To perform the function of 'provoking' air defence, the aircraft works in unmanned mode by programming a flight route of up to 800 kilometres. On 30 May 2023, a group of UJ-22 attack drones attacked Moscow. The data indicate that approximately 20 UJ-22 attack drones took part in the attack, and that the Russian side managed to disable eight drones from carrying out their mission (electronic warfare systems disabled three UJ-22 attack drones and the cannon-missile system Pancir S-1 disabled five UJ-22 strike drones). Figure 4 summarises the appearance of the UJ-2 attack UAV, technical flight characteristics, conditions for combat use, and the purpose of the UJ-22 attack UAV.

Figure 4: Appearance and characteristics of the UJ-22 attack drone (https://aif.ru/, 2023)

Remotely piloted aircraft 'Mugin-5' belongs to the group of commercial drones for reconnaissance, but for the needs of the armed forces of Ukraine, it has been modified tocarry explosives weighing up to 25 kilograms. The maximum range of the aircraft is 800 km. It isused to critical infrastructure based on a given route. The Ukrainian drone 'SKIF' is an agricultural drone, but it was used during a special military operation for photographing the combat positions of units and equipment, providing data on the positions of soldiers, and the location of combat equipment. The maximum length of use of the 'SKIF'drone, according to the given route, for recording and evaluating the effects of actions is approximately 50 km.

In the second period of the conflict, the armed forces of the Russian Federation used UAVs at the tactical and operational levels with great intensity. In the zone of special military operations, the Russian side often used commercial drones (quadrocopters), 'Geran 2' (Shahid-136) and 'Lancet'drones.

'Geran 2' drones (Shahid-136) were often used in swarms to break through Ukraine's air defence system and to attack critical infrastructure facilities (https://www.slobodnaevropa.org, 2023). They carry a warhead, and thus, they are also called kamikaze drones. The flight distance is greater than 700 km, and the guidance system is inertial or satellite. The open sources of information have several recordings showing the successful mission of the UAV'Geran 2'.

UAVs (drones) 'Lancet'are often used for precise actions in zones of special military operations at tactical levels up to 40 km. In most cases, the drone was paired with another reconnaissance drone (most often the ZALA 421-16 drone), which provided data on the target and recorded the effects of the action. The targets were, most often, air defence systems, self-propelled howitzers, tanks, trucks, and naval ships. To effectively use these drones, reliable telecommunications and information systems are necessary. After several videos of the successful operation of the 'Lancet' drones, videos appeared showing certain metal gratings above the artillery systems for protection against the effects of kamikaze drones. Figure 5 shows the Lancet UAV and the comparative characteristics of the Lancet-1 and Lancet-3 UAVs.

Figure 5: Appearance and characteristics of the Lancet drone (https://tadviser.com, 2023)

Monitoring social networks and official reports, such as those of the armed forces of the Russian Federation, offer more videos of the use of drones in the second period of the conflict. The claim regarding the more intensive use of drones by the Russian Federation's armed forces is based on certain assumptions. In the initial period of the conflict, the Russian side, among other things, planned to achieve complete supremacy in the airspace by targeting air defence systems, command posts and electronic warfare systems of Ukraine. After the initial period of the conflict, especially after the annexation of the four Ukrainian regions to the Russian Federation, the Russian side was able to establish a unique telecommunication-information system and air defence system, and deploy electronic warfare systems in areas where it had full control of the combat situation. In the second period of the conflict, the consequences of the dissymmetric relationship in combat techniques on the side of the Russian Federation med forces came to the fore, as did the effects of the lessons learned by the Russian army.

For Example, combat operations in Bakhmut and surrounding areas should be considered. During the fight in Bakhmut, many videos appeared on the use of drones, especially from the Russian side. The fact that Bakhmut was in a semiencirclement and that many of the effects of combat power were concentrated in Bakhmut indicates the assumption that Russians could instal the Repellent-1 electronic warfare system in the vicinity of Bakhmut and later in Bakhmut. The electronic warfare system Repellent-1 is intended for the detection and jamming of various types of signals used for the guidance and control of UAV in the frequency range of 20 MHz to 6 GHz. This range includes the guidance and control frequencies of commercial and military drones, satellite signals, and GPS signals. Figure 6 illustrates the electronic jamming range of the Repellent-1 system when the station was located in Bakhmut.

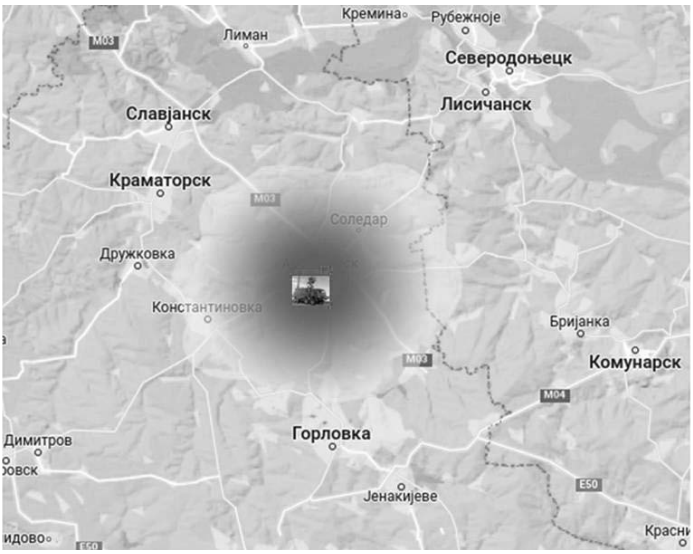

Figure 6: Illustration of the jamming signal range of Repellent-1 system in the vicinity of Bakhmut

The red and yellow colours in Figure 6 symbolise the strength and range of the jamming signal, respectively, in the frequency range of 20 MHz to 6 GHz when the output power is 1000 W. Red indicates a very strong interfering signal, and yellow indicates a slightly weaker jamming signal. Therefore, if a unified command and information system was established, an electronic jamming station was installed, and synchronisation was carried out between the use of its own drones and the Repellent-1 system, and a unified military unit, a possible electronic unit for understanding, the Russian side managed to deny the ability of Ukrainian drones tocomplete their mission in Bakhmut.

At the lower tactical level, from the soldier to the department, both sides in the conflict used anti-drone guns. There is no reliable data on the effectiveness of anti-drone guns. It can be assumed that, at a lower tactical level, if a drone is spotted in time and the anti-drone gun is properly directed towards the drone by radiating a jamming signal of a certain strength, it is possible to jam the drones.

The importance of the use of UAVs in the armed forces of Ukraine is supported by the announcement of the General Staff of the Ukrainian Army dated 27 January 2023, which was reported by both the Ukrainian and Russian media, in which it wa stated that the Ukrainian Army wa forming drone company of attack (https://mil.in.ua, 2023). The company was formed as part of the 'Drone Army' project. The company is assumed to be equipped with drones, weapons, Starlink for communication, and other supporting equipment. Mykhailo Fedorov, Ukraine's minister for digital transformation, claims that fully autonomous weapons (robotized drum systems) are "the logical and inevitable next step of war" (Fedorov 2023).

Realising the importance of the use of UAVs in combat operations and other areas of Russian society, the President of the Russian Federation held a video conference with the representatives of ministries, the economy, and businesses on the development

of UAVs, on 28 April 2023 (http://kremlin.ru, 2023). At that conference, Vladimir Putin explained the importance of developing UAVs for the entire country; therefore, it is important to analyse the problems that hinder the development of UAVs and propose concrete solutions. The task of the national project is to use the entire technological potential of a prospective industry to strengthen the security of the country, increase the efficiency of the domestic economy, and improve the quality of life of the people. Russian companies must master certain technologies, demonstrate many technical solutions in the field of UAVs, and ensure certain levels of technological sovereignty.

CONCLUSION

The use of land-based robotic combat systems in military operations is difficult; however, UAVs are increasingly being used. Humanity is increasingly neglected when using drones in military operations.

In the initial period of the special military operation (the Russian Federation's invasion of Ukraine), the Russian side used drones with reduced intensity, particularly at the operational-strategic level. The reasons for the reduced intensity of the use of UAVs include the effective functioning of the electronic warfare system and the anti-aircraft defence system of Ukraine and the difficult functioning of the command and information system in certain strategic directions of action. In the initial period of the conflict, Ukraine achieved little success in the use of unmanned aerial vehicles because it lost most of its resources tothe remotely piloted aircraft Bayraktar TB-2. Bayraktar TB-2 remotely piloted aircraft were used in earlier conflicts (in Syria and Nagorno-Karabakh), where the armed forces of the Russian Federation gained sufficient experience to destroy those aircraft.

During the second period of special military operations (the Russian Federation's invasion of Ukraine), individual cases of land and sea robotic combat systems were distinguished. Landbased robotic combat platforms have been used for demining certain areas and logistic operations. Unmanned kamikaze boats were used to attack the ships. These robotic combat platforms have achieved some success because they are not affected by electronic warfare systems. The intensity of the use of UAVs (commercial and military) at the operational-tactical level was high. The armed forces of the Russian Federation have extensively used drones to destroy Ukrainian artillery systems, armoured vehicles, and anti-aircraft defence systems. This was possible because the armed forces of the Russian Federation established a reliable command and information system in the four occupied areas, and installed anti-aircraft defence, electronic warfare, and drone control systems in the occupied areas. In addition, in the areas occupied by the Russian Federation, the intensity of Ukraine's electronic warfare was low.

Further directions of development in the field of robotic combat systems could include the development of artificial intelligence that will improve the efficiency and enable the synchronised action of robotic combat systems in a complex combat environment, it will help in the development of systems for electronic warfare, systems for anti-aircraft defense, and a layered approach for improving the tactics, techniques, and procedures of fighting against robotic combat systems.

In modern conflicts, if the desired end state is not reached by the application of 'soft power' and a decision is made to apply 'hard power' (the use of armed forces), then the implications of this form of warfare include, at least, three aspects:

- the technical aspect includes the development of multipurpose robotic combat systems and artificial intelligence for the efficient use of these systems in a complex combat environment, while maintaining a certain degree of humanity,
- the kinetic aspect includes the mass use of robotic combat systems (on an individual level, in pairs, in groups, and in swarms),
- operational-tactical aspects, such as the mass use of robotic combat systems, will affect the change (improvement) in the process of operational planning of military operations and the improvement of the method of carrying out combat actions, security, and protection of forces in operations.

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Мирослав Р. ТЕРЗИЋ

ЕФЕКТИ УПОТРЕБЕ РОБОТИЗОВАНИХ БОРБЕНИХ СИСТЕМА ТОКОМ СУКОБА У УКРАЈИНИ ОД 24.02.2022.

Резиме

Ова студија анализира употребу роботизованих борбених система током инвазије Руске Федерације на Украјину (специјалне војне операције оружаних снага Руске Федерације) у два периода. Први период се односи на почетак специјалне војне операције (24. фебруар 2022.) до проглашења делимичне мобилизације у Руској Федерацији и одржавања референдума у четири региона Украјине о придруживању Руској Федерацији. Други период укључује сукоб након припајања Доњецке Народне Републике, Луганске Народне Републике, Херсонске и Запорошке области Руској Федерацији.

Студија критички анализира концепт употребе беспилотних летелица као и начин борбе против беспилотних летелица у одређеним борбеним ситуацијама током специјалне војне операције Руске Федерације у Украјини. Ова студија поставља хипотезу да успех употребе роботизованих борбених система зависи од искуства у борби против беспилотних летелица, поузданости командно-информационог система, система електронског ратовања и система противваздушне одбране. Страна у сукобу на територији Украјине која је планирала слојевит приступ у борби против беспилотних летелица (добра процена обавештајних података, употреба система за електронско ратовање, системи противваздушне одбране, ефикасни и ефикасна примена научених лекција) имала је више успеха у сузбијању употребе беспилотних летелица.

Кључне речи: Украина, Руска Федерација, специјална војна операција, роботизовани борбени системи, беспилотне летелице.

Рад је предат 29. фебруара 2024. године, а након мишљења рецензената, одлуком одговорног уредника *Баштине*, одобрен за штампу.