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AUTONOMOUS WEAPONS SYSTEMS: ADVANTAGES AND RISKS OF THEIR APPLICATION IN MODERN WARS AND MILITARY CONFLICTS

The article examines the process of introducing and using the latest weapons systems equipped with artificial intelligence algorithms in the military sphere. It analyzes the advantages and risks that come with applying these systems in modern wars and military conflicts.

The relentless development of modern technologies is evident. The war raging in Ukraine has significantly accelerated this process and brought humanity to the threshold of an era of multi-purpose use of equipment with artificial intelligence algorithms. One of the names for this armament is "autonomous weapons systems".

The use of autonomous weapons systems in modern wars and military conflicts demonstrates the efforts of opposing sides to effectively influence the tactical and strategic aspects of waging wars (combat operations).

International military experts agree that the rapid development of digital technologies and their application in modern weapons systems will significantly affect the future security situation and stability in the world. Specifically, this refers to artificial intelligence systems.

Keywords: *autonomous weapons systems, unmanned aerial vehicles, war, military operations, combat operations, military conflict, drone, security and defense forces of Ukraine, service and combat (combat) tasks, digital technologies, artificial intelligence.*

Statement of the problem. The ability of Ukraine's security and defense forces to effectively execute service and combat (combat) operations in the face of armed aggression by the russian federation (rf) largely depends on the availability of a sufficient arsenal of modern weapons. Military experts emphasize that the current security posture in Ukraine is directly tied to the timely and efficient application of scientific and technological advances in state-of-the-art armament systems.

In recent years, in addition to conventional means of warfare, countries with significant economic, scientific, and technical, and intellectual capacity have been actively engaged in the development of advanced weaponry integrated with artificial intelligence. These systems are commonly referred to as "autonomous weapons systems" (AWS).

The main advantages of deploying autonomous weapons systems within the armed forces lie in their broad operational capabilities. These technologies enable seamless real-time coordination between military command elements and machine-operated systems, facilitated through a service member-operator interface, thereby ensuring the highly efficient execution of assigned combat tasks while minimizing risk to personnel.

At the same time, the rapid pace of technological advancement is prompting both sides in military conflicts to intensify efforts in upgrading their weapons arsenals. That includes autonomous platforms, ultimately fueling a new arms race.

Some military analysts warn, however, that the proliferation of autonomous weapons systems poses serious risks and security concerns for society at large. They also cast doubt on the overall safety and long-term implications of their use.

Analysis of recent research and publications. Artificial intelligence (AI) is a relatively young field of research that emerged in the 20th century, driven by rapid advancements in cybernetics and electronic computing.

It is evident now how once-speculative concepts from science fiction are materializing through cutting-edge technologies – powered by extraordinary computational speed, vast data repositories, and sophisticated network systems.

Today, AI has evolved into an interdisciplinary area of scientific inquiry focused on the creation of intelligent machines capable of performing tasks traditionally requiring human cognition. These include simulating intellectual behavior, modeling reasoning processes, learning mechanisms, and even creative thought.

Artificial intelligence may be described as a conceptual framework referring to a human-engineered system that replicates specific functions of human thinking. It is the capacity of intelligent systems to perform tasks of a creative or decision-making nature – tasks once considered the exclusive domain of human beings [1].

The multidimensional nature of this field has given rise to a range of definitions for artificial intelligence.

AI is generally understood as a program capable of learning, acquiring knowledge, and gaining experience independently throughout its operation. Afterwards, it should have the ability to effectively apply that accumulated experience to improve its performance in fulfilling the specific task for which it was designed [2].

AI presumes the ability of a machine or system to perform actions typically associated with human reasoning.

AI is also a branch of computer science concerned with developing software systems that exhibit intelligent behavior.

Moreover, AI can be viewed as the engineering science of creating intelligent agents. That is, those systems are planned to make autonomous decisions in pursuit of defined objectives.

Thus, the fundamental goal of machine mentality development lies in building mechanisms or systems that can think and act in a manner comparable to human beings – an aspiration that has preoccupied scholars and philosophers for centuries [3].

As we can observe, AI is evolving rapidly, reshaping the modern world and extending its influence across various spheres of public life. In the military domain, it is utilized across several key areas:

– support to command and control structures: assisting decision-makers in locating, acquiring, processing, and analyzing intelligence data about enemy forces; assessing the operational environment; and generating timely and well-founded recommendations regarding the deployment of military units for assigned combat missions;

– integration with unmanned systems: AI is embedded into unmanned technical platforms (aerial, ground, surface, and underwater), in other words, complexes, used for reconnaissance, combat operations, and logistics, these applications significantly reduce risks to personnel during mission execution;

– fire control systems: enabling real-time battlefield assessment, identification of enemy manpower, equipment, and installations, and autonomous decision-making regarding target engagement (destruction);

– electronic warfare (EW) and electronic intelligence (ELINT): assisting in detecting, analyzing, disrupting, and countering adversary electronic systems and operations;

– cyber threat defense: employing AI in real-time protection and response within cybersecurity systems to monitor network activity and prevent early detected hostile cyber intrusions [4].

The ongoing war in Ukraine has accelerated the pace of technological advancement and broadened the range of AI applications in the defense sector. Particularly, the integration of artificial intelligence with weapons systems capable of executing service and combat (combat) tasks autonomously has sped up.

These armament systems may include unmanned aerial vehicles (UAVs), robotic platforms, and other machine-operated platforms capable of independently conducting various missions (from intelligence gathering to offensive strikes against enemy).

Clearly, the growing use of AWS integrated with AI in the present-day situation is attracting significant international attention and strategic interest.

The purpose of the article is to analyze both the advantages and potential risks associated with the deployment and use of autonomous weapons systems equipped with artificial intelligence, as well as their impact on the state of international security and global stability.

Summary of the main material. The concept of creating mechanisms resembling human beings dates back to antiquity. It has evolved from myths and legends about anthropomorphic machines to today's autonomous robots endowed with artificial intelligence.

The earliest studies related to AI in its modern interpretation began almost simultaneously with the emergence of the first electronic computing devices.

By the late 1950s, a number of researchers in the field of AI began working on the development of intelligent machines capable of emulating human brain function.

At the dawn of the 21th century, artificial intelligence became a cornerstone technology driving progress across various domains of modern society.

Major achievements in the outcomes of the civilian use of AI provided a substantial impetus for introducing this technology into the military sphere. It has significantly influenced the evolution of conventional approaches to resolving disputes through armed force.

In today's world, success in warfare and the resolution of armed conflicts increasingly hinge on possessing advanced weapons systems integrated with the capabilities of machine mentality. The most widely adopted term for such systems is "autonomous weapons systems".

At present, there is no universally accepted legal definition or wording for AWS in international law.

However, during the international expert meeting held in Geneva on May 13–16, 2014, dedicated to Lethal Autonomous Robotic Systems (LARS), the participants described AWS as systems capable of independently, meaning without human control or intervention, carrying out such functions as scouting, detecting, identifying, and engaging the targets.

This is precisely what distinguishes autonomously controlled weaponry from unmanned aerial vehicles (UAVs), which still require human operators to select targets, activate and guide onboard weapons, and authorize strikes (neutralize objects). Nonetheless, UAVs are considered AWS prototypes – evolving robotic machines [5].

According to data from the International Committee for Robot Arms Control (ICRAC), as of March 2016, nearly 40 countries (including the United States, the United Kingdom, France, Israel, South Korea, China, russia, and some others) were engaged in the development of so-called "killer robots", or Lethal Autonomous Robots (LARs). At that time, around 30 countries were involved in the design and production of approximately 150 different types of UAVs, 80 of which had been adopted by the armed forces of 55 nations [6].

The integration of autonomous weapons systems (AWS) has become a critical element in the conduct of military engagements (combat operations). That is because these systems combine informational data streams, programmed decision-making algorithms, high-performance computing capabilities, and cutting-edge armaments and equipment. This subject requires heightened attention from military experts, as openly disclosing advancements in emerging technologies may compromise operational security of military operations (combat actions), particularly if such information becomes accessible to hostile forces [7].

Among the notable examples of high-performing AWS currently in use are the following.

The X-47B naval forces carrier-based pilotless battleplane was developed by Northrop Grumman (USA). It is designed for use in maritime operations in coordination with aircraft carriers. Capabilities include "stealth" technology, execution of both reconnaissance and strike missions, and full autonomy in mission execution – such as independent takeoff and landing on carriers and mid-air refueling [8].

The Kargu loitering munition (Turkey). This drone utilizes machine learning algorithms embedded in the Kargu platform to process visual data in real time. It can autonomously identify, classify, and engage enemy targets using a "human-in-the-loop" system. In "swarm attack" mode, up to 20 units can coordinatively operate to simultaneously strike multiple targets [9].

Ground-based autonomous combat robot SWORD (Special Weapons Observation Reconnaissance Direct-action System, USA) is designed for operations in urban environments. Weighing up to 45 kg, the platform can be equipped with various weapons systems, including an M16 rifle, a 7.62 mm M240 machine gun, and either a six-barrel 40 mm or a four-barrel 66 mm M202F1 grenade launcher. Additionally, the appliance is outfitted with advanced sensors for target detection. SWORD can carry out reconnaissance and combat missions in autonomous mode, including navigation, target identification, information gathering, and transmission – for up to 8.5 hours (or up to 7 days in standby mode). The operator maintains remote control over the robot's movements, target selection, and the decision to fire, within a radius of up to 1 km. The system has reportedly been deployed in Afghanistan and Iraq [10].

Some countries claim they intend to deploy AWS exclusively for self-defense purposes. Below are notable examples of autonomous weapons systems used for defensive missions:

The Aegis Ballistic Air and Missile Defense (AMD) System (USA) is an integrated weapons system installed on advanced U.S. Navy warships (cruisers, destroyers). It is designed to offer multi-layered protection against a broad range of threats: aircraft, cruise and ballistic missiles, as well as surface and sub-surface targets. Aegis demonstrates a high degree of automation in the detection, tracking, targeting (up to 100 targets), and elimination of identified threats. Once an interception protocol is initiated, the system can manage interceptors of various types (anti-aircraft, missile defense, anti-submarine, and strike-class) with minimal human intervention. Aegis serves as an example of a complex system already capable of making split-second decisions in high-risk scenarios such as missile defense operations [11].

The SGR-A1 facility (South Korea) is a stationary automated armory mode (turret) designed for border defense. Its armament includes a Daewoo K3 (5.56 x 45 mm) light machine gun and a lightweight 40 mm multiple grenade launcher (MGL). The SGR-A1 achieves self-containment through an integrated system capable of detecting, tracking, recognizing human speech, and issuing verbal warnings to potential border violators. In emergency scenarios, the turret can independently engage targets using lethal force. The number of SGR-A1 systems deployed to replace human personnel along the Korean Demilitarized Zone (DMZ) remains classified [12].

The Iron Dome mobile all-weather air and missile defense system (Israel) functions as a multi-layered platform, with its core components comprising a radar unit, a fire control center, and mobile interceptor missile launchers. Its subsystems analyze the trajectories of incoming projectiles, assess the threat level to strategic sites, and command launchers to neutralize hostile targets. The EL/M-2084 radar is capable of detecting threats at a range of up to 70 km, while each launcher can deploy up to 20 Tamir interceptors, which destroy incoming targets at speeds of up to Mach 2. The system's accuracy in intercepting missiles is made possible by complex algorithms and artificial intelligence, which are embedded into the fire control software. That enables the simultaneous processing of multiple threats and ensures efficient protection of infrastructure and military positions [13].

The NBS MANTIS (Modular Automatic and Network-capable Targeting and Interception System, Germany) is a stationary (semi-stationary) short-range anti-aircraft artillery system. It forms an essential component of the Bundeswehr's air defense network, used to protect both military and strategic facilities against low-altitude threats such as rockets, mortar shells, artillery projectiles, and both manned and unmanned aerial vehicles. The system is equipped with 35 mm automatic cannons that can engage targets at a distance of up to 5 km. Once manually activated, MANTIS operates in a fully autonomous mode: detects, tracks, and neutralizes incoming targets. Its reaction time from detection to fire initiation is less than 4.5 seconds [14].

In recent years, China has also accelerated the development of military-purpose robotic systems. It is anticipated that in the near future, not only personnel but also robots will serve in the People's Liberation Army of China (PLA). Reportedly, as early as 2014, China's state-owned engineering corporation NORINCO established a dedicated research center for the design and development of land-based military robots. However, the outcomes of these projects remain classified.

The russian federation is also placing significant emphasis on the development, testing, and production of new combat systems that incorporate AI elements. Notably, the russian armed forces have begun the formation of combat robotic units as part of a classified initiative known as the "Soldier of the Future" project [15]. In parallel, the enemy continues to enhance its unmanned systems capabilities. Since May 2025, new strike kamikaze drones have been field-tested on the battlefield, boasting an effective strike range of up to 80 kilometers. These UAVs, guided by AI algorithms, can operate in "swarms", performing evasive maneuvers to avoid detection and interception. A key feature of this machine is its autonomous target identification module (Jetson), paired with a laser rangefinder, a high-resolution optical sensor, and a high-speed onboard storage unit exceeding 100 GB. All these features allow the drone to be independent and resilient to EW measures, making it a highly dangerous and capable platform [15].

On April 4, 2025, the German defense firm Stark unveiled technical specifications for its new self-sustained loitering munition drone, known as "Virtus". This UAV is engineered for dealing with armored vehicles, personnel, and EW facilities. "Virtus" features vertical takeoff and landing capability and is equipped to autonomously detect, identify, and strike enemy targets at distances of up to 100 kilometers. Its most notable trait is its ability to function without reliance on GPS or continuous communication with an operator, using only embedded navigation and target recognition algorithms. Control of "Virtus" is managed by the "Minerva" system, which enables a single operator to command either a lone drone or a coordinated "swarm".

Army professionals underscore that the "Virtus" platform, which integrates AI mode, is built entirely from European components and benefits from automated manufacturing, aligning it with NATO standards and the doctrine of strategic autonomy. Systems like "Virtus" signify machine mentality integration, operating independently of centralized control and remaining effective even in contested electromagnetic environments. As such, the drone represents a new chapter in the evolution of self-sustained weapons systems in Europe [16].

With the onset of the full-scale russian-Ukrainian war, Ukraine's partner countries extended their military-technical assistance, which included certain types of weaponry featuring autonomous capabilities.

The FGM-148 Javelin anti-tank guided missile (ATGM) system (USA), developed by Raytheon and Lockheed Martin, is a man-portable facility. It is designed to engage armored vehicles, fortified positions, and slow-moving aerial targets such as helicopters and unmanned aerial vehicles (UAVs). As the first mass-produced third-generation ATGM, it operates on the "fire-and-forget" principle. The missile uses its infrared homing seeker to autonomously adjust its trajectory after launch. Depending on the operator's selection, it can strike targets head-on or from above, first ascending before descending onto the target. This system is widely regarded as one of the most effective anti-armor solutions globally [17].

The StarStreak or Starstreak HVM (High Velocity Missile) was developed in the United Kingdom. It is a man-portable short-range air-defense missile system (MANPADS) designed to counter aerial threats, including missiles, aircraft, helicopters, and UAVs. Once launched, the rocket accelerates to speeds exceeding Mach 3, after which three high-velocity submunitions ("darts") separate from the main missile body. These darts are guided semi-automatically to the target with high precision via the SACLOS laser beam-riding principle [18].

The Bayraktar TB2 killer-drones (Turkey) are operational-tactical medium-altitude long-endurance UAVs, developed for strike missions. Equipped with a triple-redundant avionics system and an automated takeoff and landing suite, it can perform missions in automatic and semi-automatic modes [19]. At the beginning of russia's invasion in February 2022, Ukraine had approximately 20 Bayraktar TB2s. These machines demonstrated high effectiveness in eliminating enemy personnel, military equipment, and command centers on both land and sea. Perhaps the most notable operation occurred on April 13, 2022, a day that has become emblematic in modern military history. While executing a combat mission over the Black Sea, the Bayraktar TB2 diverted the attention of the russian fleet's flagship cruiser "Moskva", thereby facilitating its destruction by two domestically produced Neptune missiles [20].

The Switchblade 300 and 600 assassin drones (USA) are tactical single-use loitering munitions designed to engage both enemy personnel and armored targets. The Switchblade 300, weighing 2.7 kg, is intended for striking enemy troops and lightly armored vehicles, while the Switchblade 600, weighing 23 kg, is capable of destroying or disabling heavier armored assets. Their manual transportation allows for launch from ground, naval, or aerial platforms. The system is controlled via a touchscreen tablet, offering both manual and autonomous operating modes. Navigation is supported by encrypted onboard communication channels and a GPS module with selective availability, designed to resist GPS spoofing and equipped with a programmable failsafe shutdown function [21].

Due to the critical shortage of partner-supplied military-technical assistance to Ukraine in resisting russian aggression, domestic developers have actively engaged in the creation of local AWS. Some of these systems are already operational, while others are undergoing field testing under combat conditions. The following are selected examples of Ukrainian-made systems.

The RZ-500 strike UAV-helicopter, nicknamed the "tank killer", is engineered to conduct reconnaissance missions at low and ultra-low altitudes and deliver precision-guided missile strikes against enemy armored vehicles. Its technical specifications include runway-independent takeoff, a cruising speed of 150–160 km/h, a ceiling of up to 4 km, and an operational range of up to 450 km, carrying a payload of up to 200 kg. The opto-targeting station, developed by Ukrainian enterprises, is equipped with television, thermal imaging, and laser guidance channels. These allow for target detection at 10–12 km, identification at 8 km, and engagement at distances of up to 7.5 km. Functionally, the RZ-500 operates as a robotic combat platform, with the operator's role limited primarily to confirming target acquisition and taking manual control in emergency situations. The full target engagement cycle is executed through a highly automated software regime, ensuring rapid and precise action [22].

The ST-35 "Hrim" (Thunder) kamikaze drone is a loitering munition designed for the high-precision destruction of strategically important military targets and enemy installations. It uses various types of warheads – fragmentation-explosive, thermobaric, incendiary, and shaped charge variants. Technical

specifications: operational range up to 30 km, warhead weight – 3.5 kg, guidance system – automatic, flight duration – up to 60 minutes, target hit probability – up to 95 %, operational altitude – 800–1200 m, cruise speed – 120–140 km/h, with vertical takeoff via multi-copter mechanism. The operator is involved only up to the stage of target detection and confirmation; afterward, the drone operates in autonomous mode, processing the video feed and automatically adjusting its trajectory until impact [23].

The "Wolly" combat system is a modern remotely controlled weapon module designed for integration with various ground-based robotic platforms. It is equipped with an artificial intelligence system that enables continuous independent detection, recognition, classification, and tracking of targets (both personnel and equipment). The system conducts ballistic calculations and delivers high-accuracy fire against unarmored enemy assets. Technical specifications: weight – 30 kg (excluding ammunition), armament – 7.62 mm or 12.7 mm PKT machine gun with automatic ammo feed, thermal imaging capability, engagement range – up to 1,000 m, autonomy – up to 130 hours (5 days) on a single charge, communication range – up to 100 m. Currently, the module has been codified and procured for the needs of the Armed Forces of Ukraine (AFU) and is actively employed on the frontline under real combat conditions, both independently and in conjunction with different robotized ground platforms. "Wolly" was developed based on combat experience and the practical needs of the troops, representing a significant step forward in the development of Ukrainian military robotics [24].

The RSVK-M "Myslyvets" (Hunter) is a robotic platform developed by the Kyiv-based design bureau "Robotics". It features a unique AI system that ensures autonomous navigation, high-precision targeting and firing, a robust and simple design, and extensive modernization potential. Technical characteristics: operational range – up to 2 km, independent movement with return via a pre-set route, maximum speed – up to 15 km/h, with battery life sufficient for 3-6 hours of operation. The combat robot is equipped with IP digital and thermal cameras, a rangefinder, and a navigation module. The platform supports the integration of various combat modules, including machine guns, grenade launchers, anti-tank guided missiles (ATGMs), electronic warfare (EW), and CBRN (chemical, biological, radiological, and nuclear defense) equipment [25].

The Droid TW is a tracked ground robotic platform equipped with integrated AI systems, enabling autonomous operation and enemy personnel detection. It is designed for surveillance, reconnaissance, and strike missions, as well as providing fire support to friendly units under complex battlefield conditions. Technical specifications: operated via tablet control, communication is maintained through the Starlink system; armed with either a 12.7 mm or 7.62 mm PKT machine gun; target detection range – up to 1,500 m, engagement range – up to 1,000 m, operational range – up to 14 km, and mission autonomy – up to 72 hours. In December 2024, following successful testing under combat conditions, the system was codified for delivery to the Armed Forces of Ukraine [26].

The "Bars" (missile-drone) is a hybrid system positioned between a conventional cruise missile and an aero plane-type UAV, categorized as middle strike weaponry. Developed outside state enterprise frameworks, information about "Bars" was classified for a considerable period, with the first public reference appearing on April 11, 2025. The system is outfitted with AI modules, cameras, sensors, and navigation units, allowing it to operate autonomously at extended ranges, evade air defenses, and precisely strike enemy targets such as SAM systems, air defense batteries, command posts, and logistical hubs. While exact specifications have not been disclosed, available data indicates that the missile can be launched from both ground-based platforms and aircraft, features a compact turbojet engine enabling speeds up to 700 km/h, and has an effective range of 700-800 km – sufficient to strike deep targets, including within the russian capital. The warhead is estimated at approximately 50 kg, and the system is capable of dynamic rerouting, unpredictable in-flight maneuvers, and reacquisition of targets after deviation. Following combat trials, Ukrainian servicemen emphasized that "Bars" is not merely a technological asset but a symbol of Ukrainian "vengeance from the skies" [27].

Therefore, it is evident that Ukrainian defense manufacturers are actively engaged in the development, research, and field testing of cutting-edge, high-tech weaponry and military equipment. These innovations significantly enhance national defense capabilities, performing combat tasks autonomously in the ongoing struggle against the russian invaders.

For some time now, intensive discussions have been underway in international circles regarding the use of automated weapon systems in contemporary warfare and armed conflicts. According to many military analysts, the employment of such systems provides a strategic, tactical, and economic advantage over the adversary, owing to a range of critical technical-operational and economic characteristics, including:

– reduction of combat losses: the deployment of AWS in active hostilities helps minimize casualties among personnel as well as preserve costly military equipment and armaments;

– speed and precision: equipped with advanced sensors and AI algorithms, autonomously controlled weaponry is capable of detecting, identifying, tracking, and engaging targets with high accuracy, while maintaining constant operational readiness to sustain its mission;

– expanded operational zones: AWS is particularly effective in environments hazardous or inaccessible to humans (e.g., CBRN-contaminated areas, minefields), and under conditions of restricted maneuverability;

– efficient resource utilization: their high fire-mission effectiveness allows for reduced ammunition expenditure and less human involvement, easing the burden on personnel and streamlining logistical support;

– minimization of collateral damage: with their precise target recognition systems, AWS helps to lower the risk of unintended harm to civilians, infrastructure, and sensitive or critical facilities;

– situational awareness and analytics: these systems autonomously gather, process, and interpret large volumes of data from diverse intelligence sources, enabling informed decision-making in fluid combat scenarios;

– network-centric operations: AWS can be integrated into unified networks of command, intelligence, weapons, communications, and defense systems to enhance coordination, information exchange, and operational coherence during missions;

– adaptability and self-learning: through machine learning, offline controlled weaponry can quickly adapt to changing battlefield conditions, improve operational algorithms, and accumulate combat experience autonomously;

– cyber resilience: built-in security systems ensure AWS remains functional in the event of external interference or communication loss with command authorities;

– information and psychological operations: AWS can also be effectively used for gathering, processing, distorting, and delivering deceptive data to the adversary, thereby enabling psychological pressure and projecting technological superiority.

The above non-exhaustive list of advantages reflects a profound understanding that the integration of autonomous weapon systems has initiated a paradigm shift in the conduct of modern warfare.

However, it is also recognized that the use of AWS comes with both benefits and limitations, particularly raising ethical and moral concerns over the delegation of authority to machines in making independent decisions involving the use of lethal force against human beings [28].

While the deployment of autonomously controlled weaponry may indeed reduce human casualties, the presence of automated lethal systems on the battlefield has generated justifiable concerns about potential algorithmic errors or technical malfunctions, which may lead to unintended consequences and pose a risk to civilian populations.

The implementation of AWS raises serious ethical, security, and legal challenges for the international community, which has identified several key risks associated with the use of such so-called "killer robots".

1. Lack (limitation) of human oversight:

– violation of international humanitarian law principles: AWS may independently decide to use lethal force without human intervention, contradicting the core tenets of humanitarian law ;

– technical errors and failures: the presence of software flaws, system malfunctions, or unforeseen operational scenarios may lead to uncontrolled and unpredictable weapon deployment.

2. Ethical concerns:

– dehumanization of warfare: entrusting machines, which lack emotions and ethical judgment, with termination decisions diminishes the value of human life;

– accountability dilemma: the issue of determining the responsible person (developer, operator, commanding officer, or the system itself) and the level of charge for the consequences of AWS actions, particularly in cases of error or misuse.

3. Risks to international security:

– a new arms race: the rapid development of AWS may provoke states to engage in a technological race for superiority in advanced weapons systems;

– uncontrolled proliferation of AWS: there is a tangible risk that such weaponry could fall into the hands of terrorist organizations or illegal armed groups, significantly heightening global security threats;

– escalation of armed conflicts: some analysts suggest that deploying AWS without proper human oversight may lead to an uncontrolled escalation of hostilities and potentially catastrophic consequences;

– "algorithmic warfare": the speed at which AI can process information and make decisions is becoming a decisive factor in contemporary conflicts, transforming the nature of warfare and emerging as a critical determinant of victory [29].

4. Technical risks:

– cyber vulnerabilities: AWS may be hacked, reprogrammed, or exploited by unauthorized actors, posing a threat to friendly forces and civilian populations.

– unpredictable behavior: the lack of assured predictability in autonomously controlled weaponry responses under complex and dynamic operational conditions.

5. Legal challenges:

– absence of international regulation: there is currently no unified set of global standards or legal frameworks governing the safe deployment of AWS or establishing mechanisms for oversight and accountability;

– ambiguous legal status: from a legal standpoint, it remains unclear whether autonomously controlled weaponry can be formally classified as weapons in the traditional sense [30].

As for the risks associated with the AWS utilization in AI algorithms, notably, Geoffrey Hinton – a Nobel laureate often referred to as the "Godfather of AI" – has expressed deep concern over the unregulated military application of artificial intelligence by global corporations and governments [31].

Conclusions

An analysis of the results stemming from the use of autonomous weapons systems in contemporary armed conflicts clearly demonstrates that these cutting-edge technologies, which have rapidly entered the "battlefield", have significantly transformed the paradigm of modern warfare.

The ability of AWS to operate independently with high precision, responsiveness, and reliability under complex combat conditions provides a range of potential advantages: reducing personnel and equipment losses, optimizing logistical support, and executing combat (or service-combat) tasks with enhanced effectiveness.

At the same time, the growing deployment of AWS presents a number of serious challenges. The most critical among them are: the potential loss of human oversight over the use of military force; the ethical dilemma surrounding the delegation of life-and-death decisions to "machines"; and the potential risk that state actors may violate international humanitarian law.

A separate concern arises from the increasing threat posed by non-state actors (terrorist organizations, cybercriminal groups, illegal armed formations, or private military companies) who operate outside legal boundaries, making the use of AWS in their hands particularly dangerous and potentially uncontrollable.

Given the rapid pace of technological advancements in the field of AWS and weighing both the advantages and risks of their deployment, the international community must urgently begin developing unified standards and legal frameworks. These should regulate safety requirements, impose ethical restrictions, and establish mechanisms for oversight, accountability, impact assessment, and enforcement in the use of such systems. This approach will help shape a legal environment for the deployment of advanced military technologies while ensuring their safe and controlled use in the interests of global peace and stability, rather than accelerating the world toward destruction.

In the authors' view, future research on autonomous weapons systems should be oriented toward the following key areas:

1) legal and ethical dimensions: the development of international legal norms governing the use of AWS; defining acceptable levels of independence in combat systems; and analyzing the ethical, social, and psychological implications of their widespread deployment;

2) technical safety and command structure: studies on the reliability of AWS, their vulnerability to cyberattacks, and the determination of optimal levels of human control over autonomous platforms in combat environments;

3) military-strategic implications: examination of the influence of AWS on the transformation of military strategy, operational art, and tactics, as well as the future role of artificial intelligence in warfare and armed conflicts;

4) geopolitical and national approaches: comparative analysis of national policies on the development of AWS, including associated opportunities and challenges, and an evaluation of Ukraine's potential in advancing indigenous autonomous combat technologies.

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АВТОНОМНІ СИСТЕМИ ОЗБРОЄННЯ: ПЕРЕВАГИ Й РИЗИКИ ЇХ ЗАСТОСУВАННЯ У СУЧАСНИХ ВІЙНАХ І ВІЙСЬКОВИХ КОНФЛІКТАХ

Розглянуто процес упровадження і використання у військовій сфері новітніх систем озброєння, обладнаних алгоритмами штучного інтелекту. Проаналізовано переваги й ризики їх застосування у сучасних війнах та військових конфліктах.

Спостерігається невпинний розвиток сучасних технологій, а війна, яка точиться в Україні, значно прискорила цей процес і поставила людство на порозі ери багатоцільового застосування озброєння, обладнаного алгоритмами штучного інтелекту. Однією з назв такого озброєння є «автономні системи озброєння».

Використання автономних систем озброєння у сучасних війнах і воєнних конфліктах демонструє намагання протиборчих сторін ефективно впливати на тактичні і стратегічні аспекти ведення війн (бойових дій). Безумовно, їх застосування змінює підходи до збирання розвідувальної інформації, оцінювання оперативної обстановки, планування та виконання службово-бойових (бойових) завдань. Достатня кількість цих систем дасть змогу суттєво знизити ризики для життя військовослужбовців і цивільного населення, зберегти військову та спеціальну техніку й підвищити ефективність ведення військових операцій (бойових дій).

Міжнародні військові фахівці сходяться на думці, що на сучасному етапі автономні системи озброєння цілком не замінять озброєних військовослужбовців, проте здатні суттєво вплинути на динаміку, способи й методи ведення війн (бойових дій).

Військові експерти також зауважують, що стрімкий розвиток цифрових технологій, зокрема технологій штучного інтелекту, та застосування їх у сучасних системах озброєння матиме значний вплив на подальшу безпекову ситуацію та стабільність у світі.

Ключові слова: *автономні системи озброєння, безпілотні літальні апарати, війна, військові операції, бойові дії, воєнний конфлікт, дрон, сили безпеки та оборони України, службово-бойові (бойові) завдання, цифрові технології, штучний інтелект.*

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