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THE USE OF ARTIFICIAL INTELLIGENCE AND AUTONOMOUS WEAPON SYSTEMS IN MILITARY OPERATIONS

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Abstract: *In the modern era, artificial intelligence and autonomous weapon systems represent an important step in the evolution of military conflicts. The ability of these technologies to make fast and accurate decisions in real time brings significant benefits to the military, improving the efficiency of actions and protecting the lives of soldiers.*
Artificial intelligence can analyze vast amounts of data and information in a much shorter time than humans, thus providing critical information for decision-making in order to surprise the adversary and achieve strategic objectives. Artificial intelligence is becoming an indispensable tool for modern armed forces because it allows actions to be carried out with maximum efficiency that would involve a high consumption of human resources, time and would involve numerous risks for human operators, from data analysis to identifying enemy targets and anticipating adversary movements or even engaging adversary forces under certain conditions. At the same time, autonomous weapon systems, equipped with AI technologies, have the ability to act independently, reducing the dependence on human intervention and speeding up the response time in critical situations. These systems can detect and neutralize threats faster and more efficiently than humans could. However, the use of artificial intelligence in military conflicts raises numerous ethical and moral challenges. Concerns about the loss of control over the technology and the possibility that it could be mistakenly used against civilians or against protected targets have generated intense debate in the international community.

Keywords: disruptive technologies, artificial intelligence, autonomous weapons systems, adaptation

1. Introduction

The international security environment is in a continuous evolution, with numerous transformations being registered in all fields. In order to achieve and maintain supremacy, states must have a comprehensive approach and focus on economic development, maintaining solid diplomatic relations, creating alliances and partnerships that allow their evolution, but also on developing the military instrument of power which allows deterring potential adversaries and protecting national values and interests.

The military field is an extremely dynamic field, and "the battlefield is constantly evolving, both in terms of the accelerating pace and in terms of the spectrum of means and systems used" [1]. The pace of actions increases surprisingly quickly, and people have to make decisions and implement them in a very short time to be able to maintain superiority in relation to the opponent. In order to increase the efficiency of fighters and increase their ability to accomplish missions, it is necessary for new technologies to be used in increasingly unconventional ways, and human skills to

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be supplemented by the technological factor, which can increase force and precision, lethality, but also the ability to analyze and interpret data.

In the context of accelerated technological evolution and the unprecedented development of the cyber dimension, it is necessary to integrate new technologies in the military field, so that military actions are as effective as possible, and the operational performance of the forces increases, simultaneously with the reduction of risks for military personnel and the population civil. New technologies designed to change the way military operations are conducted can be considered disruptive technologies due to the major impact they can have on the battlefield. These technologies can determine the way military conflicts are conducted, due to the fact that they allow increasing the pace of military actions and reduce the importance of the spatial dimension of the confrontation area by providing the possibility of real-time monitoring of it and hitting targets at appreciable distances, which force the commanders to take unprecedented force protection and military action assurance measures. In modern military actions, whether we are talking about operations to fight terrorism and irregular groups, as in the case of the conflict between Israel and Hamas, or whether we are talking about classic conventional war, such as the one that is taking place between Russia and Ukraine, we observe that modern technologies are used on large-scale, which have the potential to change the way operations are carried out and which allow the overcoming of some asymmetries and the development of new ones. In modern conflicts, we see the increasing use of revolutionary, disruptive technologies such as hypersonic missiles, artificial intelligence, autonomous weapons and other high-performance systems that contribute to situational awareness, monitoring the battlespace, identifying threats, countering threats, protecting forces and infrastructures and achieving the desired effects. Even if at the moment these weapons systems do not have the ability to completely change the face of the war and decisively tilt the balance in favor of those who use them, in the future it is possible to witness an increase in the importance of these systems, especially in what concerns the use of artificial intelligence and autonomous weapons systems, which will be able to revolutionize the way armed conflicts are conducted.

2. Methodology

The research paper aims to present the importance of artificial intelligence in the current security context and analyze the impact of autonomous weapons systems on the way military operations are conducted.

To achieve the objective, we analyzed relevant information from the specialized literature and from other open sources with the aim of highlighting a series of particularities of artificial intelligence used in the military field and to understand what are the advantages and disadvantages of using this disruptive technology in the military field. Starting from the importance of artificial intelligence in the military field, we also aim to analyze the impact that autonomous weapons systems can have in the conduct of military actions**.**

3. The Military Importance of Emerging and Disruptive Technologies

Modern military technologies have the potential to provide a significant advantage over the adversary, who will not have at their disposal effective means of countermeasures both in terms of their destruction and in terms of protecting the territory, forces and combat equipment. These modern technologies force military organizations to adapt to these new realities both in the way they think and in the way they organize and act. The use of disruptive technologies accentuates the asymmetric and hybrid character of military confrontation by creating a fault in the way

of thinking and acting. The use of disruptive technologies belongs to the category of hybrid methods of waging war and creates the conditions for achieving strategic surprise and reducing the opponent's desire to fight, affecting the morale of fighters, political and military decision-makers and the population, and powerful states have shown interest in developing technologies and capabilities that can serve as force multipliers and be employed as asymmetric responses against high-tech adversaries [2].

Due to the fact that humanity is currently facing numerous security challenges and even existential threats to regional and global security and stability, with the emergence of new threats and new sources of tension, NATO and EU states have begun to grant increased attention to the issue of new technologies with disruptive potential and emerging character. From the analysis of the relevant documents, it follows that 6 disruptive technologies have been identified at the EU level that must be treated with due attention [3]: quantum technologies, artificial intelligence, autonomous robots and weapon systems, big data, hypersonic weapons systems and space technologies and advanced materials, while the US adds to this list directed energy weapons and biotechnology. In the same vein, taking into account the multiple challenges it faces, NATO must adapt its approach to military actions in order to maintain its regional and global military superiority and to be able to meet its security objectives and to ensure the defense of member states against conventional and hybrid threats, which manifest themselves in both physical and cyber environments. In a similar approach to the EU, NATO focuses on nine areas of interest in terms of disruptive technologies [4]: artificial intelligence, autonomous weapons, military quantum technologies, biotechnologies and human force amplifiers, hypersonic systems, space technologies, new/breakthrough materials, energy and propulsion, next-generation communication networks. From the analysis of the vision of NATO and the EU on emerging and disruptive technologies, it can be found that both organizations, although they have different objectives and a different way of achieving these objectives, have a similar approach, and the areas of interest in terms of emerging and disruptive technologies are almost identical. Among the directions of action or areas of interest, artificial intelligence and autonomous weapons systems stand out, which can have a significant impact on the way military actions are carried out, both through the opportunities they offer and through the challenges to which member states are subjected, who see themselves in a position to adapt to new realities, to face new types of threats. Although artificial intelligence is still in its early stages, we can assume that it will evolve from the base level - narrow AI stage that has already been passed, which can do simple things like voice recognition, providing assistance, weather forecasts, etc., at the stage of strong AI-1, a situation where it can learn autonomously, can make connections between information, sources and fields and can ensure decision-making under pressure and then at the stage of Strong AI-2, the level of artificial superintelligence, where the system will be fully autonomous and will be even stronger, more flexible, more adaptable than humans [5].

The 21st century has brought many changes in the security environment and has highlighted the fact that regional and global security is being tested by events taking place in different areas of the world. The ongoing conflicts, but also the growing tensions in Europe, Southeast Asia, the Middle East, Africa, allow us to note that the evolution of society in the economic, cultural, technological and informational fields has not eliminated the danger represented by the resolution of conflicts by using force. The ongoing wars in Ukraine and the Gaza Strip are very conclusive

examples of what armed confrontations will look like in the near future. From the analysis of the events we can see that the modern war has two basic components: a conventional component, which involves the use of classic weapons and tactics, which were also used in the past, but also an unconventional, hybrid component, which involves the use of any tactics or systems of weapons that can provide a strategic advantage to those who use them. We could observe the use of precision weapons, drones, hypersonic missiles, electronic warfare systems and other categories of high-tech weaponry, simultaneously with the intensive use of artillery, positional warfare, deception, etc. No category of weaponry, no matter how well-performing, still don't have the potential to become a silver bullet, a magic solution for winning the conflict quickly, as we were tempted to believe about drones at the beginning of the war in Ukraine, which have were used "to plan, prepare, and execute attacks on opposite forces and on "soft targets" in the civilian sector" [6]. The future of war is represented by a combination of conventional means with disruptive and emergent ones in order to gain strategic advantage, surprise and exhaust the adversary so that his desire to resist is reduced. Modern technology controlled by artificial intelligence can act as a combat power amplifier for now, but it cannot yet play the role of a game changer in military operations. In order for artificial intelligence to become a game changer, it needs to be much more efficient, to prove its usefulness and reliability, and to be implemented in as many autonomous weapon systems as possible, replacing the human operator and decision-maker in the entire decision-making and operation cycle, which is not yet desirable.

4. The Use of Artificial Intelligence in Armed Conflicts

In the modern era, artificial intelligence has become a vital component in the military domain, bringing significant transformations in the way military actions are planned and conducted, in the conduct of military operations and in the drafting of strategies. Artificial intelligence has been gradually improving and becoming a more efficient way worldwide with the help of data, computer processing power, and machine learning developments, especially during the last two decades [7]. The use of artificial intelligence in the military field will bring many advantages to the party that uses it and, if used rationally, can create the conditions for weakening the adversary, by outrunning decision-making and operational processes and by creating major effects that are difficult to counter in its ranks. Artificial intelligence (AI) has the potential to amplify human qualities and increase the efficiency of fighters, but also to ensure informational and decision-making superiority through superior possibilities of information accumulation and processing. One of the most obvious advantages of AI in the military field is its ability to process and analyze an enormous amount of data in an incredibly short time. From image and sound recognition to data analysis, AI can quickly extract critical information for decision-making, help identify patterns, trends and potential threats, providing military commanders with crucial information for decision-making. This data analysis and synthesis capability gives military commanders a deeper understanding of the situation on the ground and allows them to react in real time to changes on the battlefield. In addition to the ability to analyze and process enormous amounts of information without direct human intervention, another fundamental characteristic of artificial intelligence is the ability to learn and evolve, something that systems equipped with classical software are not able to do [8]. It follows from this that systems equipped with artificial intelligence have the ability to improve themselves, to learn from experience, and this opens the way to autonomy.

Another important aspect of AI in the military field is automation and autonomy in decision-making and operational processes. Autonomous systems, equipped with AI technologies, can make decisions and act without direct human intervention or with limited human intervention, which can speed up reaction time and reduce human error in critical situations. For example, autonomous drones can identify and neutralize threats in real time, protecting military lives and minimizing operational risks. These systems can be programmed to attack specific targets or provide support and cover for ground forces.

Artificial intelligence can also be used for:

- Reconnaissance and surveillance: AI-based reconnaissance systems can analyze images and data from drones or other intelligence sources to identify and monitor enemy activities. These systems can detect and identify vehicles, military equipment, infrastructure and other elements relevant to the planning of military operations.
- Operational planning: AI-based planning algorithms can be used to optimize operational plans, including resource distribution and movement paths. These systems can consider multiple variables and constraints to generate efficient and adaptive plans in real time.
- Simulations and training: AI can be used to develop realistic simulations and virtual training for military personnel. These simulations can recreate complex combat scenarios and help prepare soldiers for real battlefield situations.
- Logistics and resource management: AI can be used to optimize military logistics and resource management, including planning supply routes, inventory management and maintenance of military equipment.
- Autonomous weapon systems that are controlled by artificial intelligence and that can identify a threat, analyze and evaluate it, decide to engage it, without human control or intervention.
- Cybersecurity, by monitoring cyberspace, quickly identifying threats and taking countermeasures before human operators even become aware of the existence of risks or vulnerabilities.
- Ensuring emergency medical assistance by using robotic systems and monitoring the fighters' vital functions.

Overall, the use of artificial intelligence in warfare can improve efficiency, precision and adaptability in military operations, but requires a careful and responsible approach to avoid the associated risks and ethical dilemmas.

At the same time, the use of artificial intelligence in warfare brings with it numerous disadvantages and risks, which must be carefully considered by armed forces and policy makers, as they can have both short-term, tactical and long-term consequences , at operational or strategic level. First, artificial intelligence, although it has the ability to learn, is completely dependent on the quality, timeliness and correctness of the input data used, because in order to achieve maximum performance, artificial intelligence must learn, have access to models and relevant databases for improving analysis algorithms. In addition to this limitation, among the main disadvantages of using artificial intelligence in military actions we can mention:

- Over-reliance on technology: Being technology-based, the use of AI in warfare can lead to an over-reliance on associated systems and infrastructure. In the event of a technological failure or cyber attack, military forces could be vulnerable and powerless.
- Risk of errors and wrong decisions: AI systems are not immune to errors

and may make incorrect or inappropriate decisions in certain situations. This can result in loss of life or significant property damage, particularly in the case of autonomous weapon systems.

- Ethical and moral challenges: The use of AI in warfare raises numerous ethical and moral dilemmas. For example, the use of autonomous weapons raises questions about accountability and control over lethal decisions, and the use of AI for surveillance raises privacy and human rights concerns.
- Widening of the technology gap: The use of AI in warfare can lead to a widening of the technology gap between nations that have access to these technologies and those that do not. This can create inequalities and intensify geopolitical tensions.
- Reducing human role in decision-making: As AI technology becomes more sophisticated, there is a risk that humans will lose control and be marginalized in the military decision-making process. This can lead to loss of control and unpredictable risks in conflict management.
- Cyber resistance and sabotage: The use of AI in military systems can make these systems vulnerable to cyber attacks and sabotage. Hackers may attempt to manipulate data or take control of systems, which can compromise military operations and create chaos on the battlefield.

The importance of AI in the military is undeniable, offering significant advantages in terms of effectiveness and national security. AI is not only an augmenter of human capabilities but "can increasingly support and replace humans for military tasks as they are becoming faster and more accurate as well as able to consider more information and higher levels of complexity. This may lead to an increased speed of military operations and better military decision-making, ultimately offering armed forces with performant AI significant advantages" [9].

However, it is essential that we approach the evolution and use of this technology with care and responsibility to ensure that it is used ethically and for the benefit of humanity. The use of artificial intelligence in warfare brings with it numerous risks and challenges, and political and military decision-makers must be aware of them and approach the evolution and use of this technology in a military context with care and responsibility. It is essential that the use of AI is subject to strict ethical and legal standards to ensure that it is used responsibly and in accordance with international humanitarian law. "AI technologies are largely discussed as enablers and amplifiers of established, albeit continuously evolving, means and methods of warfare – reflecting an evolutionary rather than revolutionary approach to emerging technologies" [10], and their use in the military field has the potential to revolutionize military art, especially since the use of artificial intelligence paves the way for the development and use of autonomous weapons systems, which will automate many processes and activities and eliminate human intervention.

5. Considerations for Using Autonomous Weapon Systems in Modern Conflicts

Autonomous weapon systems are military systems that are capable of identifying, locating and attacking targets autonomously, without direct human intervention in the decision-making process. These systems use advanced technologies such as artificial intelligence, sensors, decision algorithms and control systems to conduct military operations without constant human supervision. The development of artificial intelligence and its use in the military field paves the way for the development of much more efficient weapon systems, which greatly reduce

reaction time and increase operating efficiency. These systems, controlled by artificial intelligence, can reduce the involvement of human operators to a minimum level and can even eliminate their presence, thus giving rise to weapons capable of deciding where, when and in what form to engage targets, based on analysis algorithms and selection of the appropriateness, necessity and legality of threat neutralization.

By autonomous weapon systems we mean weapon systems that select targets and use force without direct human intervention. However, according to specialized studies, there are several levels of autonomy, where human intervention is different and the way the weapon systems work is different, so we have [11]:

- Supervised autonomous weapon or "human on-the-loop" are the categories of weapons that can hit targets autonomously, but that allow at any time the intervention of human operators to modify or cancel a set mission,
- Semi-autonomous weapon or "human-in-the-loop" system, which once activated are only able to hit targets that have been selected/pre-approved by a human operator,
- Fully autonomous weapon or "human out-of-the-the-loop" system, which once programmed and activated can independently assess the situation, select and engage targets without any intervention from human operators.

Autonomous weapon systems can be relevant in military operations due to the advantages they confer, such as: speed and reaction time, which are much higher respectively lower than in the case of the involvement of human operators, accuracy, which is much higher and is not affected fatigue, stress or other human-specific factors, reducing the exposure of human operators to risk as they are no longer involved in ongoing combat processes and actions, adaptability and flexibility as autonomous weapon systems can be programmed and reprogrammed to do against a wide range of scenarios and combat situations, increased operational efficiency, due to reduced consumption of resources and time to accomplish certain objectives, the ability to operate in hostile or dangerous environments, including in radiation areas, underwater or in conditions extreme weather, where human intervention would be difficult or impossible.

Autonomous weapon systems, in addition to the indisputable advantages they offer, can also represent a risk factor, given that precisely the lack of human interaction and human control can give rise to complicated situations, in which decisions taken by autonomous systems can be at least immoral, if not illegal, due to programming errors or problems interpreting situations where human feelings, logic and intuition can make a difference. For autonomous weapon systems to be used in military operations and not be challenged, they must be built in such a way that there is a balance between the degree of independence of artificial intelligence and the need for human intervention and supervision in the event of the decision to use force. The minimum measures to be implemented to ensure the viability of the use of autonomous weapons systems must ensure that they: "function as anticipated in realistic operational environments against adaptive adversaries taking realistic and practicable countermeasures, complete engagements within a timeframe and geographic area, as well as other relevant environmental and operational constraints, consistent with commander and operator intentions. If unable to do so, the systems will terminate the engagement or obtain additional operator input before continuing the engagement, are sufficiently robust to minimize the probability and consequences of failures. Persons who authorize the use of, direct the use of, or operate autonomous and semi- autonomous weapon systems will do so with appropriate care and in

accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement" [12]. Autonomous weapon systems can represent solutions for complex situations, such as the lack or insufficient number of military personnel, the large area of the confrontation space that must be covered, the very short time in which a decision must be made and an action implemented, the level of associated risk and so on. Depending on these factors, the level of control and the possibility of intervention by the human operator can be established to direct or cancel an action when it is considered to be acting at the limit of legality or morality, or when the change in the operational situation acquires nuances that cannot be perceived by artificial intelligence and autonomous weapons systems.

6. Conclusion

The evolution of society also causes major changes in the military field, in the way military operations are planned and carried out, and more and more concerns are starting to appear related to the involvement of the human factor, the willingness of people to participate in military actions and the way of managing human losses in the conflict. As artificial intelligence becomes more and more present and more efficient, it will find its place in the military field because it offers significant opportunities to the states that dare and allow themselves to use it, that find solutions to overcome the barriers related to legality, the morality and effectiveness of its use. Artificial intelligence augments human capabilities and increases the level of performance of forces participating in military actions. More than that, artificial intelligence is the central element in the development of autonomous weapons systems that "are likely to become a mainstay of modern advanced militaries. These systems come in different forms, shapes, and sizes, and imbued with different levels of autonomy, and thus have different capabilities in the field" [13]. The use of autonomous weapons opens the way to new forms of military confrontation, but, at the same time, it raises numerous problems regarding the manner of their use, the ability of systems to discern the manner of use of force, the intensity of the use of force, legal responsibility regarding the consequences of actions carried out by autonomous systems controlled by artificial intelligence, etc. Once these obstacles are overcome, artificial intelligence and autonomous systems will be used more and more because they offer possibilities almost unimaginable for humans, they allow complex military actions to be carried out in any environment, in any conditions, without exposing military personnel to risks, achieving increased efficiency and with a much lower consumption of time and resources.

References List

[1] PEKAŘ O., ŠLOUF V., ŠOTNAR J., POTUŽÁK L, HAVLÍK T., *War game as a method of training – as a method of analysis*. In: Costa C. Proceedings of the 16th European Conference on Games Based Learning, ECGBL 2022. Lisabon: Dechema e.V., 2022, roč. 2022-October, č. 1., p -654, https://doi.org/10.34190/ecgbl.16.1.656.

[2] BENDETT S., BOULÈGUE M., CONNOLLY R., KONAEV M., PODVIG P., ZYSK K., *Advanced military technology in Russia. Capabilities and implications*, Research Paper, Russia and Eurasia Programme, September 2021, Chatham House, p. 66.

[3] Sebastian Clapp, *Emerging disruptive technologies in defence*, European Parliamentary Research Service, september 2022, available from https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/733647/EPRS_ATA(2022)733647_EN.pdf.

[4] *Emerging and disruptive technologies*, 22 iunie 2023, available from https://www.nato.int/cps/en/natohq/topics_184303.htm.
[5] BOJOR L., *The operational environment in the age of artificial intelligence. Possible scenarios*, Land Forces Academy Review Vol. XXIV, No 4(96), 2019, p. 266, doi: 10.2478/raft-2019-0032.
[6] KRÁTKÝ M., MINAŘÍK V., ŠUSTR M., IVAN J., *Electronic Warfare Methods Combatting UAVs.* Advances in Science, Technology and Engineering Systems Journal, 2020, **5**(6), p. 447, doi:10.25046/aj050653.
[7] ADIB R., ASHFAKUL K, AHAMED S., MEHEDY B., *Artificial Intelligence in the Military: An Overview of the Capabilities, Applications, and Challenges*, International Journal of Intelligent Systems. 2023. p. 1, doi: 10.1155/2023/8676366.
[8] BUTTON R. W., *Artificial Intelligence and the Military*, available from https://www.rand.org/pubs/commentary/2017/09/artificial-intelligence-and-the-military.html.
[9] VESTNER T., *Military Operations and Artificial Intelligence*, in Robin Geiß and Henning Lahmann (eds), Research Handbook on Warfare and Artificial Intelligence, p. 3, 8 july 2021, Geneva Centre for Security Policy, available from https://dam.gcsp.ch/files/doc/military-operations-and-artificial-intelligence.
[10] BENDETT S., BOULÈGUE M., CONNOLLY R., KONAEV M., PODVIG P., ZYSK K., *Advanced military technology in Russia. Capabilities and implications*, Research Paper, Russia and Eurasia Programme, September 2021, Chatham House, p. 66.
[11] DRESP-LANGLEY B, *The weaponization of artificial intelligence: What the public needs to be aware of.* Front. Artif. Intell. 6:1154184, 2023, p. 3, doi: 10.3389/frai.2023.1154184.
[12] Office of the Under Secretary of Defense for Policy, *DOD Directive 3000.09 Autonomy in Weapon Systems*, January 25, 2023, p. 4.
[13] UMBRELLO S., WOOD N.G. *Autonomous Weapons Systems and the Contextual Nature of Hors de Combat Status*, Information 2021, 12, 216. https://doi.org/10.3390/info12050216 .