CHALLENGES OF APPLICATION OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

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ABSTRACT

Originality: In the simplified film imagination, artificial intelligence is most often depicted through humanized robots that in the distant future occupy the planet and destroy the human race. However, in the background of this terrifying scenario is an advanced technology that is already widely applied for countless useful purposes and whose level of development will largely shape life as we know it today.

Theoretical reference: The beginnings of artificial intelligence appear with the development of cybernetics and automation, and its development was initially focused on machines and robots, primarily in space technology.

Research implications: The emergence and mass application of digitalization led to a strong expansion of artificial intelligence and extended its field of action to practically all areas of human life.

Keywords: artificial intelligence applications, humanized robots, cybernetics and automation, digitalization and AI expansion.

Received: 21/06/2023
Accepted: 13/09/2023
DOI: https://doi.org/10.55908/sdgs.v11i7.1325

DESAFIOS DA APLICAÇÃO DA INTELIGÊNCIA ARTIFICIAL EM ASSUNTOS MILITARES

RESUMO

Originalidade: Na imaginação cinematográfica simplificada, a inteligência artificial é mais frequentemente retratada através de robôs humanizados que num futuro distante ocupam o planeta e destroem a raça humana. No entanto, no pano de fundo deste cenário aterrorizante está uma tecnologia avançada que já é amplamente aplicada para inúmeros fins úteis e cujo nível de desenvolvimento moldará em grande parte a vida tal como a conhecemos hoje.
**Referencial teórico:** Os primórdios da inteligência artificial surgem com o desenvolvimento da cibernética e da automação, e seu desenvolvimento foi inicialmente focado em máquinas e robôs, principalmente na tecnologia espacial.

**Implicações da investigação:** O surgimento e a aplicação massiva da digitalização levaram a uma forte expansão da inteligência artificial e alargaram o seu campo de ação a praticamente todas as áreas da vida humana.

**Palavras-chave:** aplicações de inteligência artificial, robôs humanizados, cibernética e automação, digitalização e expansão da IA.

**1 INTRODUCTION**

Artificial intelligence enables machines to learn from experience, adapt to circumstances, perform tasks and make decisions. It automates iterative learning and discovers new correlations with the help of data, improves the performance of existing technologies, adapts to progressive learning algorithms, finds structure and regularities in large amounts of data, analyzes it using artificial neural networks, achieves incredible estimation accuracy, extracts the most accurate data, predicts with incredible accuracy.

Among the functional applications of artificial intelligence today, computer vision is the most common - image recognition (Computer Vision), then natural language processing (Natural Language Processing), and then speech processing, robotics and various methods of computer monitoring and control. The main fields of application of artificial intelligence today are transport, energy, telecommunications, medicine, agriculture and public services. As for key breakthroughs in the field of innovation, most patents in this area come from business (consumer electronics - Internet of Things⁴, telecommunications, software, electrical industry and car manufacturing); from Japan, the United States of America and China.

Studies show that artificial intelligence could double annual global economic growth rates in the next 15 years. It is predicted that by 2030, about 70% of companies will implement at least one type of technology with artificial intelligence, which will affect the growth of the global gross domestic product by 1.2% per year. (https://www.srbija.gov.rs/text/437277)

The above data undoubtedly indicate that artificial intelligence is one of the key drivers of the fourth industrial revolution, primarily due to its multidisciplinarity, i.e.

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⁴ The Internet of Things is the interconnection of physical objects, vehicles, buildings, and other things with embedded electronics, software, sensors, and connectivity that allow the objects to exchange data with the manufacturer, operator, and/or other connected devices.
connections with other scientific and technological areas in the development of innovative solutions. As such, artificial intelligence has the characteristics of a general-purpose technology, such as the steam engine, railways or electricity, because its application permeates all areas of economy and society and brings about revolutionary changes in many of them.

As always, epochal changes in the world economy bring with them a parallel revolution in the nature of warfare. Artificial intelligence has already found a number of effective applications in the military environment, and that process is still ongoing and undoubtedly accelerating. This paper specifically touches on the influence of artificial intelligence in today's military technology, as well as the possibilities and challenges of its further application in military affairs.

The world is rapidly changing and moving from agricultural to industrial and finally to a new civilization of knowledge. We should not expect that this transition will take place peacefully - "...introducing a new civilization to the planet and expecting peace and quiet is the height of strategic naivety". (Tofler, 1998, 22)

More than ever, military science needs to modernize and follow the development of new technologies. "If war was once too important to be left to the generals, today it is too important to be left to the ignorant - whether they wear a uniform or not." (Toffler, 1998, 11).

1.1 THE TERM OF ARTIFICIAL INTELLIGENCE

The evolution of life on Earth, in addition to the complexity of the structure and multiple diversity in physical appearance, also included the development of psychological phenomena - processes, traits and conditions. Thus, living beings on Earth today are at different levels of development of psychological traits - primitive beings feel and perceive, more developed ones learn and remember, while human beings, as the most perfect, are associated with the abilities of thinking, intelligence, emotions, motivation, as well as acquiring attitudes, beliefs and values.

1.2 DEFINING THE TERM INTELLIGENCE

In the 13.8 billion years of the existence of the Cosmos, the most spectacular event is certainly the emergence of life as a specific combination of matter and energy that has the ability to replicate and thus maintain its existence in space and time. In continuous
interaction with the inanimate environment around it, life evolved and improved, from primitive single-celled organisms that arose about 4 billion years ago to the species homo sapiens that appeared about 200 thousand years ago, (Harari, 2019:19) and then in a dizzying development up to today has acquired the ability to change not only the world around it, but also the entire universe.

Defining intelligence, as a higher cognitive function, has so far not been precisely performed in the science of the human psyche.

Colloquially, the concept of intelligence is associated with the ability to quickly solve a given problem, mental endowment, clarity, higher-level reason. As such, intelligence is a trait that can be measured in modern times through appropriate tests, the result of which is IQ (intelligence quotient).

Essentially, intelligence represents a more complex mental trait made up of several different abilities: the ability to quickly and easily learn and effectively master assigned problems, learning from experience, adapting to new situations and understanding them, as well as the ability to quickly and effectively apply previously acquired knowledge in new circumstances. As such, intelligence is a psychological property that is strictly individual, and therefore must be viewed through multiple layers of each individual personality.

American psychologist Howard Gardner in his work "Frames of Thought" presents a theory according to which each individual has his own weaknesses and strengths, on the basis of which the dimensions of multiple intelligence are formed. In other words, a certain intelligence quotient does not necessarily mean that a person is not intelligent enough, but that his intelligence may lie in some other abilities, which standard tests do not sufficiently take into account. Also, intelligence by itself is not sufficient for the successful functioning of a human being in the world around him, but must be combined with other cognitive, conative and emotional psychological functions such as will, motivation, learning, etc.

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5 Stephen Hawking refers to intelligence as "the ability to adapt to changes", while Bertold Brecht associates intelligence with the ability to learn from one's own mistakes. According to Vujaklija, "intelligence (lat. intelligentia) is the innate ability to properly understand things and phenomena about life and the world, reason, mind, the ability to understand and understand" (https://samoobrazovanje.rs/sta-je-inteligencija)

6 According to Gardner's theory, there are nine dimensions of human intelligence: verbal-linguistic, logical-mathematical, visual-spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalistic and spiritual intelligence. (https://samoobrazovanje.rs/sta-je-inteligencija)
In the broadest sense, intelligence can be described as "the ability to achieve complex goals" (Tegmark, 2020, 72) and can be viewed in three levels, depending on the complexity of the set goals for which it is used.

The first, lowest level involves noticing and understanding yourself and the world around you, as well as using the acquired experience to achieve your own goals, such as survival or personal well-being, that is, well-being.

The second field of intelligence is at a significantly higher level and represents the observation and description of deeper regularities and relationships in the natural, social and spiritual world, primarily with the aim of constantly increasing the quality of life.

The third and most abstract level is the field of metaphysics - the search for meaning and the creation of ideas about the beyond and the divine, "knowledge for the sake of knowledge" and not only for the achievement of practical goals. While the first level of intelligence is the innate ability to understand things correctly, learn quickly and easily, and solve assigned problems (to a certain extent, these qualities can be attributed to animals, even plants), the second and third levels are related to the ability to think abstractly and create new values in interaction with complex natural and social phenomena in the environment (fields of science, art, religion and philosophy).

1.3 DEFINING THE TERM ARTIFICIAL INTELLIGENCE

Although artificial intelligence is not a new term, with the acceleration of its development in the 21st century, scientists are continuously revising its definition. For the purposes of this work, the widely accepted definition in the expert bodies of the European Union can be used:

"Artificial intelligence (AI - Artificial Intelligence) refers to systems that exhibit reasonable, intelligent behavior based on the analysis of their environment and make decisions - with a certain degree of autonomy - to achieve specific goals." (https://www.srbija.gov.rs/tekst/437277)

Artificial intelligence is a way of reasoning and acting on derived conclusions, with full reliance on logic, while this is not performed by a human or any living organism, but by machines in the broadest sense of the word. Machines here should not only be understood in the traditional sense of the word - physical inanimate things that perform certain functions, but also virtual, non-physical entities - software applications that do not have a visible physical appearance, and which do not even have to be located in one place,
but rather be active at a large number of virtual addresses and at the same time performing operations at billions of spatial points around the globe.

This phenomenon of the omnipresence of artificial intelligence in the space-time continuum refutes the classic notion of identity, and thus in certain features it surpasses the creator and the phenomenon it imitates - natural intelligence. Therefore, it is not surprising to claim that the development of artificial intelligence actually started the third phase of the evolution of life on Earth - the so-called. Life 3.0\(^7\), (Tegmark, 2020,46) which will ensure the conquest of the cosmos by the human species.

In artificial intelligence, what is artificial is that an inanimate being performs intelligent actions, that is, it imitates the natural intelligence that is characteristic of humans and the rest of the living world. In artificial intelligence, what is intelligent is that it applies the logical rules and principles set by the human mind, and then the ability of machines to learn. What artificial intelligence cannot achieve is self-awareness – the existence of an awareness of one's own identity and what distinguishes one person from others. Today's artificial intelligence constitutes a system of rules and procedures that, when implemented, produce results similar to the product of human thinking and reasoning, but there is no way for a single individual of artificial intelligence to position itself and recognize itself as an individual with self-awareness, values, morals, feelings and which, based on that, sets goals for itself and takes care of their realization.

1.4 DEVELOPMENT OF ARTIFICIAL INTELLIGENCE

Alan Turing, a British mathematician and cryptographer from the beginning of the 20th century, is considered the father of artificial intelligence. Turing became famous for creating a computer that deciphered messages from the German Enigma device and thus managed to shorten the Second World War by at least two years and significantly contribute to the victory of the Allies. However, equally important is his pioneering work in the field of machine learning, as well as in the design of algorithms that are still used in computer work today. In 1950, Turing published an article in which the concepts of computer and intelligence were connected for the first time and touched upon the ethical norms of computer use, which will be discussed later.

The term artificial intelligence was first mentioned in 1956 at a scientific meeting in the USA, organized by the American computer scientist John McCarthy. The further

\(^7\) Max Tegmark, "Life 3.0 - how to be a man in the VI age", Laguna, Belgrade, 2020, p.46
development of artificial intelligence was marked by ups and downs, so that at the beginning of the 21st century there would be a breakthrough in this area again, primarily due to increased computer processing capabilities and easier access to increasingly large amounts of data.

The accelerated development of computers was triggered by the race to create realistic computer games and the need for specialized graphic microprocessors with the possibility of increasingly large-scale parallelized numerical calculations. The speed of processor cores in the past half century grew according to the so-called According to Moore's law, (Kaku, 2011, 32), that is, it was doubled every 18-24 months.

Realizing that this pace of development will soon reach the physical limits of the material used in the production of integrated circuits, scientists around the world are turning to new solutions in computer manufacturing, the most significant of which is certainly the emergence of the so-called quantum computer. (In June 2016, China made super-computer Sunway Taihu Light which is considered to have reached the data processing capacity of a human brain. (Tegmark, 2020, 171) Furthermore, by digitizing images, videos, voice and text, as well as by networking computers, an environment has been created that enables practical unlimited data access.

The combination of unlimited access to data and high speed of data processing enabled the development of machine learning within artificial intelligence, as the possibility of predicting future behavior based on large data sets of previous events. Traditionally, a programmer would write software to solve a problem that would process the input data and offer the appropriate answer at the output. In a system based on machine learning, the computer analyzes the input data by classifying it into a pattern, searches the database for all expected answers to the given pattern, and then designs an algorithm that will provide the most successful solution to the given problem.

Depending on the success of solving an individual problem from a certain pattern, the computer will apply the mentioned algorithm or even slightly improve it in subsequent iterations when encountering a similar problem. That is why it is said that such a computer system "learns", which ranks it among intelligent entities, that is, it gives it the

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8 Michio Kaku, "Physics of the Future", Laguna, Belgrade, 2011, p.32
9 In contrast to the binary logic of standard computers, which use two stable states in electronics (0 or 1), quantum computers apply the logic of multiple quantum states and effects in working with data, which enables multiple parallel, i.e. super-fast, information processing.
10 The human brain has about 100 billion neurons, each of which is connected to about 1000 others via special hubs - synapses, which makes about 100 trillion connections, that is, possible memory units. (Max Tegmark, "Life 3.0 - how to be a man in the VI age", Laguna, Belgrade, 2020, p.171)
characteristic of artificial intelligence. The neural network in the human brain remembers and learns in a similar way, so an analogy with natural intelligence can be drawn, that is, the mentioned concept of machine learning is also called an **artificial neural network**.

Seeing the possibilities of "deep" machine learning ("deep learning"), IT conglomerates such as Google, Microsoft, Facebook, Tesla and others invested the most in the development of artificial intelligence. Having super fast computers and an inexhaustible database of digitized data on all possible forms of the world that surrounds us, these companies have become rich by creating application software such as various types of simultaneous translators, navigation programs, personal digital assistants, programs for recognizing objects in the image, sentiment analysis, advertising on social networks, etc.

The basic difference between human and artificial intelligence is that human intelligence encompasses a wide range of applications, while artificial intelligence is developed for a specific narrow range of applications in a specific social area. However, the number of domains in which artificial intelligence is applied and surpasses human intelligence is increasing, so it is only a matter of time when a comprehensive, so-called **human-level general artificial intelligence**. The purpose of such a machine will be to distract the human brain from routine tasks that take a lot of time, which can be solved in this way almost instantly and with much greater accuracy than if they were performed by a human.

However, if this kind of intelligence is assigned the task of replicating and evolving, it would inevitably lead to the so-called the **explosion of intelligence** and the creation of some kind of digital self-aware personality, *i.e.* **singularity**, which would represent one of the most ambitious goals in science ever.

### 2 APPLICATION OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

A number of diverse applications of artificial intelligence in the military environment in the broadest sense can be classified into two large groups, depending on whether intelligence, *i.e.* software, or physical performance, *i.e.* hardware, prevails in its use. Surely this rough division cannot be strict, because any software is impossible to realize without the existence of a computer - hardware, just as any robot - automaton - drone could not function without some kind of control program - software.
However, what sets artificial intelligence apart in the world of machines is the autonomy in the execution of John Boyd's OODA loop (Observe-Orient-Decide-Act)\textsuperscript{11}, (Shar, 2020, 40), i.e. independence on the battlefield, which refers to the collection of data about the environment through own sensors, the orientation of one's own position in relation to all important elements of the environment, making a decision on the execution of an action and the action itself - action. The basic conceptual differences in the application of artificial intelligence in military affairs relate to the place of the human in the decision-making loop, that is, whether the human is "in the loop" (HITL concept - Human-In-The-Loop) or "on the loop" (HOTL concept - Human-On-The-Loop). In the event that a human is ultimately the one who decides to "pull the trigger", it is a matter of supervised autonomy, and if that right is left to the machines, they have complete autonomy.

2.1 HARDWARE APPLICATION OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

In the application of artificial intelligence in military affairs related to the concept of HITL ("man in the loop"), the active protection of complex combat systems has gone the furthest. These are partially autonomous subsystems embedded in a larger weapon system (ship - plane - tank) that are intended to directly protect them from physical threats in the immediate environment. Active protection systems have sensors through which they search the immediate environment of the entity they are protecting, identify the threat in the environment and direct their own weapons at it, which removes the threat.

Supervision of these systems is achieved through the man who controls the entire platform (weapons officer - pilot - tank commander), who can interrupt the sequence at any moment in accordance with the immediate situation on the battlefield; however, unless a human intervenes, the mentioned systems work completely autonomously. Typical representatives of this type of weaponry are the American ship defense systems AEGIS and PHALANX, the German MANTIS system for the active protection of stationary objects, the family of American anti-radar missiles HARM, as well as the TROPHY (Israeli) and ARENA (Russian) autonomous armored vehicle protection systems.

\textsuperscript{11} Paul Schar, "Army without soldiers - autonomous weapons and the future of warfare", Laguna, Belgrade, 2020, p.40
Fully autonomous weapons systems, without a human in the decision-making loop, that are in operational use are rare for now, but they do exist. The Israeli unmanned aerial vehicle "kamikaze" HAROP, made in a stealth version, is sent to the operation zone where it flies for hours undetected. After turning on the enemy's radar device, the aircraft autonomously aims, falls on the target and destroys it with an integrated warhead.

Following a similar logic, the American anti-ship missile AGM 158C LRASM (Long-Range-Anti-Ship-Missile), the successor of the TOMAHAWK missile in the TASM variant, is launched from a long distance into the zone where the enemy's group of ships is assumed to exist. Upon arrival in the expected zone, the missile uses its own radar to search the area, detect targets, decide on the action that will have the best effect, aim, and then destroy the target.

Also, the controversial South Korean SAMSUNG SGR A1 machine gun, which is used in continuous protection of the border with North Korea, should be included in this group of weapons. This system consists of a 5.56mm machine gun and a 40mm underbarrel grenade launcher, a laser range finder and a high-definition infrared day-night camera; in the assigned zone of action towards which it is directed, it fully autonomously detects the presence of people, takes aim and automatically opens fire, thereby preventing unauthorized crossing of the border.

In addition to the aforementioned weapons, there are a number of robots in the phase of final testing or the very beginning of use that are currently remotely controlled, but with further development they will acquire an increasing number of functions that they can perform completely autonomously. In the development of ground forces, the Russian Federation is leading the way, having developed a whole series of platforms and tested them in real combat conditions in Syria and Ukraine\(^\text{12}\); Israeli robotic armed vehicle GUARDIUM with a high level of autonomy also has combat experience.

On the other hand, the USA, through the agency DARPA (Defence-Advanced-Research-Projects-Agency), is working on the development of advanced naval platforms, among which the anti-submarine unmanned ship SEA HUNTER stands out; the aforementioned development is also followed by Israel with its Protector light...
autonomous combat boat project. The furthest, however, has come with the development of the autonomy of drones, i.e. remotely piloted aircraft. The X-47B demonstrator of the DARPA agency has already performed an independent landing on an aircraft carrier (2013) and independent refueling in the air (2015), and the TARANIS drones (UK), Mikoyan SKAT have also achieved a high level of autonomy. (Russian Federation), HONGDU GJ-11 SHARP SWORD (China), GHATAK (India) and nEUROn (consortium of European countries). Also, artificial intelligence is constantly being improved in the field of small quadricopter-based drones, suitable for mass use in the form of swarms, but also anti-drone air defense systems based on the a2/ad (anti-access / area-denial) concept.

2.2 SOFTWARE APPLICATION OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

In the middle of 2020, a group of intellectuals from Silicon Valley (mostly former employees of the IT companies Google, Facebook and Apple) participated in the production of the documentary film The Social Dilemma and presented a series of astonishing data in it. The film explores the rapid expansion of social networks and the damage they cause to society, focusing on the exploitation and manipulation of users for financial gain by a narrow circle of wealthy capitalists (so-called surveillance capitalism).

The film presents examples of how social media negatively affect the mental health of children and adolescents, but also how they affect the formation of public opinion and even the making of important political decisions. Behind all these cases is artificial intelligence, that is, powerful algorithms that continuously collect and process physical and mental data about each user, from daily habits and routines to deeply hidden mental functions - subconsciousness, motivation, emotions, attitudes, etc.

By applying deep machine learning in the processing of such collected data, algorithms predict the future behavior of each individual, as well as social groups, and even entire nations. For now, these software are (officially) used for targeted advertisement placement, i.e. in the economic sphere, but it is simply impossible to rule out the possibility that this way of manipulating the human psyche is not used in the

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13 a2/ad (anti-access / area-denial) represents the concept of active anti-aircraft defense of stationary objects based on the principle of forming a no-access zone around a certain area within which the automatic destruction of all flying objects is ensured with high precision
14 The Social Dilemma, an American documentary film directed by Jeff Orlovsky
military-security sector in some variant of hybrid warfare. In Clausewitz's triangle government - army - people, this way of applying artificial intelligence can be directed both at public opinion - the people (the example of the "Arab Spring"\textsuperscript{15}) and at politics - the government (the example of the "Russiagate" affair\textsuperscript{16}), which makes it extremely dangerous.

The next way of applying artificial intelligence in military affairs is the so-called autonomous cyber weapon. The execution of information operations was intensified by the accelerated development of computers in the world, which introduced the war into another dimension - cyberspace. Although cyber warfare is not new for a long time, and although multiple mutual attacks on information systems are carried out daily by various state and non-state actors, the novelty is precisely the use of artificial intelligence for these purposes\textsuperscript{17}.

The reason for the use of artificial intelligence in cyber warfare is primarily the speed of the information system's reaction to a cyber attack, which in modern conditions must be instantaneous. Modeled after similar software that provides timely warning of disruptions in the operations of the world's major stock exchanges, defensive software packages continuously search cyberspace for any signs of cyberattacks, malicious software, and other forms of threats to their own information systems, and then automatically take measures to repel the attack, as well as to send an adequate counter-cyber attack to the attacker through the same channel. With the logic of machine learning,

\textsuperscript{15} "Arab Spring" is the name for a series of revolutions in the countries of the Arab world that took place continuously from the winter of 2010 to the fall of 2013. Through peaceful demonstrations, but also through dramatic social unrest, the population of the countries of North Africa and the Middle East rebelled against the ruling theocratic and authoritarian structures, the restriction of basic human rights and freedoms, and the poor economic situation. The results of these social events are devastating - only a part of the countries went through a peaceful and quick transition, while in others either extreme Islamists came to power (Egypt), or they were introduced into devastating wars in which they were totally devastated (Libya, Syria, Yemen). A characteristic of all mentioned revolutions is that they were organized and led through social networks that were not controlled by the establishment (Twitter, Facebook).

\textsuperscript{16} The "Russiagate" affair refers to the alleged involvement of the Russian government in the election campaign and election process in the USA in 2016. In January 2017, US intelligence agencies accused then-President Donald Trump of coming to power by hacking the emails of high-ranking officials of the Democratic Party and abusing social networks, in which, according to the accusations, the administration in the Kremlin also took part.

\textsuperscript{17} The forerunner of autonomous cyber weapons is certainly Stuxnet - a specially created malicious program that infected Siemens devices that control oil pipelines, electrical, nuclear and other industrial facilities in Iran in 2010, infecting at least 30,000 computers across the country. It is believed that the virus was introduced into the system via a USB flash drive inadvertently by a worker or intentionally by an operative of the Israeli intelligence service MOSAD, and that it then spread through local networks by self-replication and further transmission by portable memory. One of the affected industrial facilities was Natanz, a nuclear facility for the enrichment of uranium whose efficiency was reduced by 30% in this way, thereby indirectly slowing down the Iranian nuclear program.
this defense system is constantly updated and improved, so that it is ready not only to respond to every new cyber attack, but also to retaliate in kind.

Apart from the defending side, artificial intelligence is also successfully applied by the other side, the one launching the cyber attack. Namely, all previous malicious software that was inserted into a closed information system (most often via portable media or by the technique of "fishing" for harmless e-mail messages) had the characteristic of replicating and spreading rapidly until the successful application of an antivirus program that would bring under control.

The application of artificial intelligence in this area offers more prospects for success in such a way that malicious software, after being injected into the system, analyzes the environment and then applies the most effective attack technique, after which it again approaches the analysis based on which it changes and adapts (mutates) in order to survived longer in an environment that rejects it by nature, i.e. it circulates completely autonomously in the OODA loop, trying to be faster than the opponent.

This "invisible war" of software takes place in real time, in cyberspace, without the human crews using the information systems most of the time being aware of it.

2.3 NEW CONCEPTS OF THE USE OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

The next step in the evolution of artificial intelligence is cooperative autonomy, i.e. the so-called "swarming". It is about the coordinated use of several small autonomous units (most often mini-drones) at a short distance from each other in one community (swarm), where each separate unit behaves cooperatively, whereby the swarm itself acquires a certain level of self-organization and becomes a weapon system of high combat capabilities. The prerequisite for achieving cooperative autonomy was the development of the so-called "fast and lightweight autonomy" (Fast Lightweight Autonomy), i.e. equipping lightweight drones with devices (high-definition cameras, sonars, laser rangefinders) for recognizing and avoiding obstacles in their own flight path at high speeds (up to 20 m/s), thus avoiding mutual collisions in a swarm.

The problem of coordinated swarm action, i.e. the direction of all individual drones towards the same goal, is solved by the already mentioned machine learning.

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Designers are examining several ways of coordinating the swarm - centralized coordination (one drone issues tasks to all other drones in the swarm), hierarchical coordination (a multi-level hierarchy is established in the swarm with a clearly established chain of command) or consensus coordination (all elements of the swarm communicate with each other and jointly reach solutions).

However, a swarm of individual artificial intelligences, with their machine learning capabilities, organize themselves after some time into a structure that best matches the solution to the given task. This results in a new quality, the so-called "collective intelligence", through which the swarm is no longer a simple sum of individual entities, but becomes one, "a collective organism, with one distributed brain that makes decisions, and whose elements adapt to each other like swarms in nature". In joint combat, a swarm of drones is far more effective than the same number of drones fighting individually. The possibilities of combat use of swarms are unfathomable, especially if you take into account the ability to independently find the most effective tactics in battle, unencumbered by the limitations of the human brain.

Another modern concept of the use of artificial intelligence that is currently being developed is CODE (Collaborative-Operations In Denied-Environment), in translation: collaborative operations in a hostile environment, popularly called "the pack". Unlike a swarm, whose elements in battle are in a condensed formation, members of the pack act in separate directions and at a greater distance, under the supervision of one person - the leader of the pack. During the action, each member of the pack independently evaluates the environment and submits proposals to the leader of the pack for engaging the team from his point of view. The leader of the pack decides on the further course of action based on all the collected information and issues tasks to all members. However, in the event of a break in communication with the pack leader, each member continues to act independently in the spirit of the mission of the entire pack and in accordance with the pre-established rules of engagement. In this way, the initiative in the mission is retained and it ensures quick and efficient adaptation to changes in the environment.

This concept is adapted to extremely unfavorable environmental conditions that imply frequent interruptions or disruptions in communication between members of the pack. Also, it assumes higher intelligence and greater autonomy of individual members of the pack (similar to the idea of mission command 2.0) in the execution of the action.

ibid
3 CHALLENGES IN THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN MILITARY AFFAIRS

3.1 MAN IN A DECISION LOOP - YES OR NO?

War, as the most complex social phenomenon, is itself full of ethical dilemmas. The deployment of fully autonomous weapons represents a fundamental paradigm shift in warfare, in which inanimate lethal entities that are not subject to any human control are introduced to the battlefield. Therefore, it is not surprising that there are numerous discussions on this topic, primarily in the field of ethics.

As already mentioned, the biggest challenges in the application of artificial intelligence in military affairs relate to whether machines should be allowed to independently make a decision on the execution of an action or whether they should still ask for approval from a human.

Proponents of the robotization of the military argue that the use of artificial intelligence in war will reduce human casualties on all sides. First of all, in this way the exposure of one's own forces to the deadly force of the enemy is eliminated, because machines take over that role on the battlefield. Also, the number of total and especially civilian casualties on the enemy's side is reduced, bearing in mind the high reliability and precision of the new generation of weapons.

By using a cold-blooded, calculated artificial intelligence that does not tire during combat operations, the overall uncertainty, friction and "fog of war" caused by the imperfection of the human psyche is reduced, plans are implemented more accurately, and operations last less time.

The high-stress conditions in which a person finds himself during war, especially if the enemy is forcibly dehumanized, bring out the worst forms of behavior and moral boundaries are easily crossed for the commission of war crimes - torture, rape, murder of prisoners, etc. In the application of autonomous weapons, emotions would be removed from the decision-making loop, and killing would be reduced to what was necessary. A machine can be programmed to never violate the law of war, it would not be able to get angry, scared, get a desire for revenge. Proponents of this position go one step further - if it is determined that artificial intelligence can be more ethical than human, humanity has a moral imperative to use it and thus suppress barbarism in war. They even defend the lack of empathy in the so-called machines. According to the Sherman principle, yes, with their application, humanity is lost in decision-making, the possibility of pity,
forgiveness and gift of human life to a defeated enemy, but it is war, and every war is brutal; the more brutal the war, the sooner it will end.

Opponents of the application of artificial intelligence in military affairs most often cite the example of Stanislav Petrov, a Russian officer who, in the midst of the Cold War, stopped a sequence of nuclear retaliation based on an intuitive assessment that it was a mistake of the automation system that recommended it. They argue that machines will never be able to make the right decision in situations that require knowledge of the wider context, and especially a clear view of the ethical consequences of an action. Also, a fully autonomous weapon in war would be faced with unpredictable conditions, and especially with the active combat of the enemy in which he will use all means, including deception. The question that arises is whether the machines will be programmed to respond to all new situations or how long it will take them to adapt to them through machine learning.

It seems that reliability will be on the side of man for a long time.

Furthermore, proponents of this theory believe that war casualties will not decrease, but that the robotization of military forces will turn war into mechanical slaughter. The human species has a strong biological drive that resists killing, despite increasingly precise weapons and all measures taken by the command - pressure of authority, dispersion of responsibility, physical and psychological distance, dehumanization of the enemy - at most a fifth of soldiers in war actually aim at the enemy when they pull the trigger.

Automation itself distances people from responsibility for killing and creates a moral buffer that contributes to overcoming resistance to simple killing. Furthermore, the behavior of robots in a swarm or pack differs from the psychology of a "human crowd". Although it is easier for a group of people to decide on collective war crimes because of their natural flexibility and diffused responsibility, in every such group there is at least one voice of reason that opposes their execution. On the other hand, no one would object to a bad decision by artificial intelligence, but it would automatically be spread throughout the entire group of autonomous weapons. Also, the absence of a human eye at the end of the scope eliminates empathy, humanity, the ability to forgive and save a life instead of taking it in cold blood the way a machine would. All this speaks in support of the thesis that the total number of victims in a war in which robots are used would be increased, not decreased.
Opponents of the complete autonomy of machines in war in defense of their views also use the argument of human dignity and believe that it is a fundamental violation of human rights to give a machine the right to kill ("if I have to die, at least let a human be the one who decided to kill me"). This attitude, however, goes to the very essence of war, which is terrible in itself and brings inevitable human casualties. Roughly speaking, from the victim's point of view, it makes absolutely no difference whether the trigger was pulled by a human or a machine.

Nevertheless, the most important ethical question related to the application of artificial intelligence in war is the question of the catharsis that war brings to an individual, but also to society as a whole. A man in war makes decisions that go to the core of personal and collective attitudes, beliefs and values - decisions about life and death. In those situations, war brings out both the best and the worst in a person, and every decision carries with it moral weight and responsibility, inevitable purification or severe trauma. War changes not only individuals, but also entire states and societies, for better or for worse. The use of machines, however, eliminates the moral dimension of war. "If there was no one to feel that pain, what would war turn into?" If there were no one to hear the cries and moans of the wounded, what would protect us from the worst horrors of war? What would protect us from ourselves?" (Shar, 2020, 372)

3.2 RUNAWAY WEAPON

Another challenge related to the application of artificial intelligence in military affairs is briefly called "runaway weapons". This challenge lies in the fear of scientists around the world that fully autonomous weapons systems will at some point begin to behave contrary to the expectations of the people who sent them into action, which is especially dangerous considering that there is no way to stop such behavior in a certain time. or to avoid damage caused by such behavior. Advanced autonomous systems often take into account multiple variables and can deal with a large number of unpredictable situations that the environment throws at them.

However, due to their complexity, they are bound to make a mistake at some point, and when that happens in a high-risk situation, the consequences can be catastrophic. Especially dangerous are situations when the mentioned errors are caused by the enemy,

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by hacking or simple deception; and especially the possibility of the enemy taking full control over the operation of autonomous machines.

Letting autonomous systems operate independently means accepting the risk that it may not perform its task properly. Activating the autonomous system is an act of trust. However, this trust must not be blind, but must be built through a large number of tests and evaluations, before independent action. Even so, considering that there are a huge number of possible interactions between the machine and the environment, a situation will occur that the scientists did not foresee during the testing. So far, artificial intelligence has not been able to overcome this problem on its own - with enhanced or deep machine learning, so the only way to solve this problem is either to retain full human control over the operation of the machine or to be willing to accept the aforementioned risk.

In the part of the paper that deals with autonomous cyber weapons, an invisible war is being waged in cyberspace between two artificial intelligences, one of which attacks and the other defends and retaliates, while both are constantly learning and improving their own abilities. The spiral of machine learning in which artificial intelligence rapidly improves itself at one point leads to an "intelligence explosion", that is, the case where its capabilities begin to far exceed the requirements of the human creator.

Viewed theoretically, this development ultimately leads to the mentioned general artificial intelligence of the human level, about which there are divided opinions. While one group of scientists believes that this invention would represent humanity's most ambitious scientific goal and would show enormous potential for its improvement, another believes that general artificial intelligence will inevitably lead to the extinction of the human race.

The fear of the rise of smart machines, apart from being widely exploited in the film industry, has also burdened other intellectuals dealing with the subject of artificial intelligence from the very beginning. Back in 1950, Alan Turing invented a test for computers with the aim of checking their intelligence, that is, answering the question of
whether a computer thinks like a human\textsuperscript{21}. Also known are the Three Laws of Robotics\textsuperscript{22} by science fiction writer Isaac Asimov, which govern robots in his works.

The actual development of artificial intelligence for now is not directed towards the creation of a single, broad, general intelligence, but more towards overcoming human capabilities in certain narrow areas. However, most experts predict that general artificial intelligence could be possible by 2040, and most likely by the end of the century\textsuperscript{23}; and no one can predict with reliable certainty what will happen after that.

3.3 THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE - THE GENERATOR OF THE GLOBAL ARMS RACE

Artificial intelligence, as stated, appears as one of the most promising technologies of the present and it is inevitable that it will be used in a wide range of military affairs in the future. The need to implement the OODA loop on the battlefield faster than the enemy, places before the designers of autonomous weapons demands for faster computers, more robust software, ingenious procedures of deep machine learning, possibilities of joining in swarms and packs, etc.

It is assumed that in most applications - whether due to ethical requirements or fear of runaway weapons - humans in war will retain full control over the decision-making of machines. However, pressure from the battlefield could lead military circles to demand greater deployment of fully autonomous weapons. This especially applies to situations where there is a need for robots to continue fighting when their communication with the humans controlling them is interrupted or disrupted. Also, the development of fully autonomous weapons could be encouraged by the simple fact that possible adversaries in a future conflict are doing the same, as was the case with the development of nuclear weapons or space exploration in the Cold War.

It is precisely the possibility of a new global arms race - and it cannot be confidently asserted that it is not already underway - that represents a new challenge in

\textsuperscript{21} In the Turing test, a human judge sends messages alternately to a human and a computer, not knowing who is who. If a computer succeeds in fooling a human judge into thinking it is human, that computer is considered intelligent. So far, no machine has been able to pass this test, although there are already chatbots in cyberspace that manage to trick some people into believing they are human beings.

\textsuperscript{22} A robot must not injure a human being, nor, through its inaction, allow a human being to be injured. A robot must obey the orders of a human being unless those orders conflict with the first law. A robot must protect its existence as long as such protection does not conflict with the first or second law.

the application of artificial intelligence in military affairs. Bearing in mind that the legal and ethical aspects of the use of this type of weaponry are not regulated at the global level (international agreements), and especially due to the fact that it is not possible to see all possible consequences of its engagement in war conditions, recognized experts in the IT field and numerous non-governmental organizations joined together and issued a joint appeal for the ban of offensive autonomous weapons24.

However, despite the efforts of intellectuals, another scenario is more certain, according to which the development of artificial intelligence will contribute to the further polarization of individual societies and the world as a whole25. wealth, so the world will be sharply divided, and that "not into two, but into three different and opposed civilizations: the first is still symbolized by the hoe; second assembly line; and the third computer"26, (Alvin and Heidi Toffler, 1998, 23) and the countries of the so-called The third wave, having all the possibilities of artificial intelligence, will take over a complete monopoly in the world in the sphere of information, finance, health, education and military affairs.

3.4 THE EFFECTIVENESS OF THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN MODERN WARS

In the previous part of the paper, it was already noted that artificial intelligence in the form of fully autonomous weapons has the potential to replace nuclear weapons in the new global arms race, which can contribute to endangering peace and destabilizing the world. On the other hand, its possession in itself can be a strong deterrent and therefore, paradoxically, contribute to the creation of bipolar or multipolar balance and stability in the world. It is interesting that even in the Cold War, a form of artificial intelligence played the role of a deterrent factor in a bizarre but extremely effective way (the so-called "dead hand")27.

24 In 2014, the Institute for the Future of Life (FLI - Future of Life Institute) was founded in the USA with the aim of improving safety in the use of artificial intelligence. The result of the work of this organization is an open letter entitled "Priorities of the search for robust and useful artificial intelligence" signed by over 8000 recognized experts and activists in this field (Max Tegmark, "Life 3.0 - how to be human in the age of artificial intelligence", Laguna, Belgrade, 2020, p.53).
25 Srbobran Branković, “Artificial Intelligence and Society”, Serbian Political Thought 2/2017
26 Alvin and Heidi Toffler, "War and anti-war", Paidea, Belgrade, 1998, p.23
27 The dead hand is the name for the Soviet computer program that would be activated in the event that the entire leadership of the USSR from the chain of decision-making on the use of nuclear weapons was killed in the first nuclear attack by the enemy. Following automatic procedures to verify this scenario, the Dead Hand would autonomously issue the order to execute nuclear retaliation.
If the application of artificial intelligence in symmetric conflicts would show a certain effectiveness in the form of a deterrent, there is a doubt as to how the same would be shown in asymmetric conflicts with the application of the principle of maneuver warfare. Wartime conditions assume a changing hostile environment in which the enemy is constantly trying to find weaknesses in our functioning and use them to his advantage.

Awareness of the unpredictability of the environment, a culture of persistence and resistance, self-initiative and the principle of mission command are the basis of education and training of the modern armies of the world. Soldiers in war must adapt on the fly and devise new solutions in response to enemy actions. It is an area where humans excel but machines perform poorly. Machine learning, as already mentioned, implies that the artificial intelligence has all the possible moves of the enemy in its memory, but it cannot predict its innovative, maneuvering solution, and therefore cannot offer an appropriate response. The predictability of artificial intelligence, which is otherwise considered desirable, represents a significant vulnerability in asymmetric conflicts.

It seems that artificial intelligence can be most effective in hybrid conflicts, and especially in information and cyber warfare, as described in the previous part of the paper.

3.5 COSTS OF DEVELOPMENT AND EXPLOITATION OF ARTIFICIAL INTELLIGENCE

Finally, the no less significant challenge of the financial costs of the development and application of artificial intelligence in military affairs should be mentioned. As in other cases, there are arguments "for" and arguments "against" the use of autonomous weapons.

Some authors claim that it was the need to reduce financial expenses that led military experts to deal with giving greater autonomy to combat systems. Namely, for the effective use of an American Predator or Reaper drone, seven to ten "pilots" are needed who will provide 24-hour surveillance of an area, as well as additional personnel who will manage the drone's numerous sensors, as well as a multitude of intelligence analysts who will analyze the data collected by those sensors. Cost reduction is only possible through the reduction of engaged personnel, and it can only be achieved by automating certain functions or by giving complete autonomy to an artificial system.

Designers of unmanned land and naval platforms are thinking in the same direction. The use of swarms of lightly armed drones equipped with facial recognition...
algorithms greatly reduces the cost of conventional anti-personnel or anti-armor combat. The savings achieved by the use of robots in the removal of mines and explosive devices from the battlefield are also significant.

As for the Navy's resources, it is enough to mention the prediction that rearment of the US Navy with unmanned anti-submarine ships of the SEA HUNTER class will reduce operational costs by an incredible 35 times compared to the existing use of conventional vessels for this purpose.

On the other hand, there are examples that show that the application of artificial intelligence increases the costs of developing combat systems and their exploitation. It is primarily about the integration of artificial intelligence into complex flying platforms such as the aforementioned sixth generation aircraft demonstrators. In these cases, the possibility of accidents and loss of these overpriced aircraft caused by small errors of autonomous control systems is particularly criticized.

Also, some devices of this type require significant support expenses - the need for uninterrupted power supply and provision of significant telecommunication capacities in all terrain and weather conditions, expensive spare parts, etc., which significantly increases the total financial costs of the operation.

4 CONCLUSIONS

The rapid development of artificial intelligence caused by innovations in the field of information technologies is the main generator of the development of the world economy at the beginning of the XXI century. In the past three years, the European Union has increased its investment in research and innovation in this area by 70% to €1.5 billion, which is still insufficient compared to the countries of North America and Asia, which allocate 12 and 6.5 billion respectively for the same expenditure. billion €.

The Republic of Serbia follows modern development trends - for five years in a row, the export of IT services has grown by over 20% per year, it is the only country in the region that adopted the Strategy for the Development of Artificial Intelligence, and in the next two years it will finance 12 research projects with €2.4 million. projects in this area.

Based on the available literature, a partial idea of the current level of development of artificial intelligence in the world can be obtained. Computers have reached the human

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28 https://www.danas.rs/zivot/razvoj-vestacke-inteligencije-u-srbiji-kroz-12-istrazivackih-projekata/
brain in the number of possible neural connections, surpassed it in calculation and prediction capabilities, and are approaching the human capacity for memory and learning. Although significant advances have been made recently in the fields of artificial neural networks and deep learning, machines are nowhere near the higher levels of human intelligence - intuition, self-awareness and consciousness. However, if the current pace of development of this technology continues, new significant discoveries that will significantly change the world as we know it are possible already in the middle of this century.

The use of artificial intelligence in military affairs is so far limited to supervised autonomous weapons in the form of active protection systems and a few devices that can be said to possess the ability to be fully autonomous after deployment to a human-approved area of operation. It is also assumed that artificial intelligence is already widely used in cyber warfare and unarmed forms of hybrid warfare. However, there are already numerous demonstrators and robots in the testing phase that are developing the ability to operate completely autonomously. Research in the field of collective artificial intelligence is particularly significant - the concepts of "swarm" and "pack".

This paper examines some of the challenges that arise in the application of artificial intelligence in military affairs. As noted, there is resistance in civilian and military circles around the world to the development and use of fully autonomous weapons in warfare, which concerns primarily the moral frameworks within which humanity currently operates.

Justified or not, there are fears that humans will not be able to control all aspects of the use of AI weapons in war, which could lead to unforeseeable consequences. It is also feared that the development of artificial intelligence will lead to a new global arms race in which the world's most powerful powers will gain an unattainable advantage over the rest of the world. However, there are also opinions that, in non-linear asymmetric conflicts and with the application of the principles of maneuver warfare, human intelligence will successfully fight against artificial intelligence.

The answers offered to the mentioned challenges are diverse - from the adoption of an international legally binding agreement on the general principles of the use of artificial intelligence in the military environment, through the obligation to keep humans in the decision-making loop of machines, to proposals for a complete ban on autonomous weapons.
"It is often believed that senior military figures spend their time constantly preparing to fight the last of the previous wars over and over again"\textsuperscript{29}. Contrary to this claim, the importance of this work is precisely reflected in the need to learn about new paradigms in the creation of a strategic and operational environment and to start finding answers to the question of how to prepare our own military forces for the new patterns of warfare that the future brings us.

\textsuperscript{29} Alvin and Heidi Toffler, "War and Anti-War", Paidea, Belgrade, 1998, p.7
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