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Artificial Intelligence in Military

M. N. O. Sadiku[1], S. R. Nelatury[2], S.M. Musa[1]

[1]College of Engineering, Prairie View A&M University, Prairie View, TX 77446
[2]School of Engineering, Pennsylvania State University, Erie, PA 16563-1701
Email: sadiku@ieee.org; srn3@psu.edu; smmusa@pvamu.edu

Abstract Artificial intelligence (AI) has done remarkable things such as defeating human experts at various games. AI is a technology that the military and defense world cannot ignore because the military cannot afford to miss out on the opportunities it brings. AI is one of the disruptive technologies that promise to change the face of warfare for years to come. It has become a critical part of modern warfare. It could cause drastic changes in hybrid warfare, which is a major concern for NATO. The paper examines various applications of artificial intelligence in the military and defense.

Keywords military, artificial intelligence, artificial intelligence in military, military AI

Introduction

Since the dawn of civilizations, humans have made effort to control their environments using machines. These machines have aided to make one's life comfortable, effective, and efficient. Computer is one of the most important machines which have not only raised hopes in this regard but has also contributed significantly in every sphere of human endeavor. A computer is yet to understand all situations and simultaneously adapt to an evolving situations [1].

Technological development has become a rat race. New technologies that promise significant strategic advantages can upset balances or disrupt previously stable global governance arrangements. Artificial intelligence (AI) is one such critical technology. AI is an integral part of bringing technological advancements to the next level [2].

Advances in artificial intelligence (AI), machine learning, and robotics are enabling new military capabilities that will have a disruptive impact on military strategies. The effects of these capabilities will be felt across the spectrum of military requirements – from intelligence, surveillance, marketing departments, and reconnaissance to offense/defense balances and even on to nuclear weapons systems themselves [3]. Artificial intelligence and other emerging technologies will change the way war is fought. AI has been described as the "third revolution" in warfare, after gunpowder and nuclear weapons. It has also been considered as the 4th Industrial Revolution, which includes the Internet of things (IoT), nanotechnology, biotechnology, and robotics. Whether it involves AI or not, war will always be violent, politically motivated, and composed of the same three elemental functions that new recruits learn in basic training: move, shoot, and communicate [4].

Overview on Artificial Intelligence

The term "artificial intelligence" (AI) was first used at a Dartmouth College conference in 1956. AI is now one of the most important global issues of the 21st century. AI is the branch of computer science that deals with designing intelligent computer systems that mimic human intelligence, e.g. visual perception, speech recognition, decision-making, and language translation. The ability of machines to process natural language, to learn, to plan makes it possible for new tasks to be performed by intelligent systems. The main purpose of AI is

to mimic the cognitive function of human beings and perform activities that would typically be performed by a human being. Without being taught by humans, machines use their own experience to solve a problem.

AI is stand-alone independent electronic entity that functions much like human expert. Today, AI is integrated into our daily lives in several forms, such as personal assistants, automated mass transportation, aviation, computer gaming, facial recognition at passport control, voice recognition on virtual assistants, driverless cars, companion robots, etc. AI is not a single technology but a range of computational models and algorithms.

Some forms of AI that are most commonly used in electrical and computer engineering include the following [5,6]:

- ***Expert systems:*** They solve problems with an inference engine that draws from a knowledge base equipped with information about a specialized domain, mainly in the form of if-then rules. Expert systems are the earliest and most extensive, the most active and most fruitful area.
- ***Fuzzy logic:*** This makes it possible to create rules for how machines respond to inputs that account for a continuum of possible conditions, rather than straightforward binary.
- ***Neural networks:*** These are specific types of machine learning systems that consist of artificial synapses designed to imitate the structure and function of brains. They are similar to the human brain. They are made up of artificial neurons, take in multiple inputs, and produce a single output. The network observes and learns as the synapses transmit data to one another, processing information as it passes through multiple layers.
- ***Machine learning:*** This includes a broad range of algorithms and statistical models that make it possible for systems to find patterns, draw inferences, and learn to perform tasks without specific instructions. Machine learning is a process that involves the application of AI to automatically perform a specific task without explicitly programming it. ML techniques may result in data insights that increase production efficiency. Today, artificial intelligence is narrow and mainly based on machine learning.
- ***Deep learning*:** This is a form of machine learning based on artificial neural networks. Deep learning architectures are able to process hierarchies of increasingly abstract features, making them especially useful for purposes like speech and image recognition and natural language processing. Deep learning networks can deal with complex non-linear problems.
- *Natural Language Processors*: For AI to be useful to us humans, it needs to be able to communicate with us in our language. Computer programs can translate or interpret language as it is spoken by normal people.
- *Robots*: These are computer-based programmable machines that have physical manipulators and sensors. Sensors can monitor temperature, humidity, pressure, time, record data, and make critical decisions in some cases. Robots have moved from science fiction to your local hospital. In jobs with repetitive and monotonous functions they might even completely replace humans. Robotics and autonomous systems are regarded as the fourth industrial revolution.

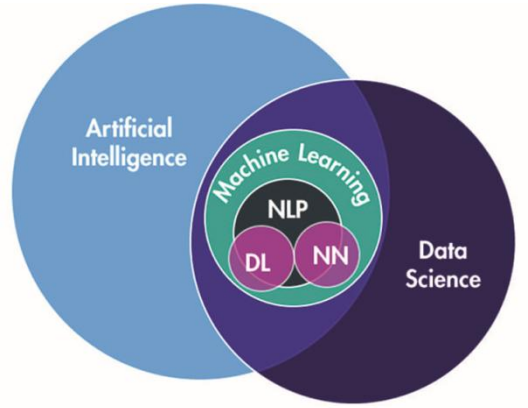

Figure 1: Artificial intelligence encapsulates several concepts including natural language processing (NLP), deep learning (DL), and neural networks (NN) [7]

These AI tools are illustrated in Figure 1 [7]. Each AI tool has its own advantages. Using a combination of these models, rather than a single model, is recommended. AI systems are designed to make decisions using real-time data. They have the ability to learn and adapt as they make decisions.

Military AI

Artificial intelligence (AI) is a comprehensive technology that involves psychology, cognitive science, thinking science, information science, system science, and biological science. Artificial intelligence invades all major civilian and military systems and gadgets. The United States government has attempted to proliferate AI technology innovations for the Department of Defense (DOD). If the enemy develops better AI for their military, then the US needs to compete as well. Some believe that the US, Russia, and China are competing to develop and harness artificial intelligence technologies. At the moment, the United States is the leading AI power, while China is emerging as an aspirant challenger. China is a strategic competitor with robust economic and technological capabilities. The DOD has created the Joint Artificial Intelligence Center in the hopes of winning the next great-power AI competition.

The following key findings summarize a report military applications of artificial intelligence [8]:

- A steady increase in the integration of AI in military systems is likely
- The United States faces significant international competition in military AI
- The development of military AI presents a range of risks that need to be addressed
- The U.S. public generally supports continued investment in military AI

Figure 2 shows a typical use of Artificial intelligence in the military [9]. There are some problems with applying AI tools in the military and defense. These include [10]:

- Integrity of operation is of paramount importance.
- Operation must often be in real time (millisecond responsiveness)
- It must be flexible in the face of changing circumstances
- It must be applicable in a domain in which even its most senior "practitioners" are in fact

Applications of Military AI

Artificial intelligence has the capability to help a decision-maker make better, more informed decisions. Militaries and defense organizations can use AI for autonomous weapons, autonomous vehicles, surveillance, cybersecurity, military intelligence, homeland security, logistics and transportation, military intelligence, and war planning. These applications are discussed as follows [11,12]:

- *Autonomous Weapons:* Defense forces around the world are embedding AI into weapons and other systems used on land, naval, airborne, and space platforms. AI-based systems have enabled the development of efficient warfare systems, which are less reliant on human input. AI is also expected to empower autonomous and high-speed weapons to carry out attacks. US ground troops patrol while robots carry their equipment and drones serve as spotters. Figure 3 shows killer robots in wartime [13]. Military robots are better suited than humans for dull, dirty, repetitive, or dangerous tasks or missions. We should keep in mind that the public debate over the military use of AI mainly revolves around autonomous weapons systems.
- *Autonomous Vehicles:* AI is enabling autonomous systems to conduct missions, automating tasks, and making better, quicker decisions than humans. An autonomous vehicle can operate with less regard for other drivers if its mission means saving the lives of one or more operators. It can drive itself using machine vision, creating a convoy. Boeing has offered autonomous drones, and aircraft to militaries today and is currently designing autonomous submarines. Lockheed Martin has offered many AI-based solutions to the US military.
- *Weapons Targeting:* Targeting systems need to be accurate and quick to lock on targets. A human is capable of identifying an enemy vehicle, deciding a weapon system to employ against it, and then engaging the target. Today, autonomous weapon platforms use computer vision to identify and track targets. AI can be used for weapon targeting. This requires training the AI on what exactly a strategic target is worth focusing its firepower on and alerting the operator if necessary.

- *Surveillance:* Militaries around the world gather massive surveillance data a day from various sources, such as phone cameras, video surveillance, UAVs, and satellites. AI could be of help in the important task of processing the data for strategic information. The US DOD currently employ machine learning and computer vision software for surveillance operations.
- *Homeland Security:* One core capability of artificial intelligence is predictive analytics, which is basically identifying patterns within a data set and then predict that trend will occur again. Predictive analytics models are currently being used in homeland security. Predictive analytics software can be used to give a prediction of possible suspects of a crime based on various environmental factors and past criminal record data.
- *Cybersecurity:* Military systems are vulnerable to cyber attacks, to avoid the high level of risk associated with cyber attacks, leaked government intelligence, and data breaches in military and defense networks, cybersecurity seems to be a high priority for the military. Artificial intelligence has the capability to play a large role in preventative measures for the military. Some AI vendors use machine learning to offer security products that can identify and predict threats before they can affect the networks.
- *Logistics & Transportation:* Logistics (which is essentially the ability to supply forces with food, fuel, and replacements) has traditionally been the limiting factor in war. Military logistics is one area where AI could make a great impact. The effective transportation of goods, ammunition, armaments, and troops is an essential component of successful military operations. AI is expected to play a crucial role in military logistics and transport. Integrating AI with military transportation can help lower transportation costs and reduce human operational efforts. Military operators performing logistic support runs account for a minimum of 50% of the casualties while at war. AI is capable of allowing more efficient, data-backed logistics and maintenance of military equipment.
- *Battlefield Healthcare:* AI can be integrated with Robotic Surgical Systems (RSS) and Robotic Ground Platforms (RGPs) to provide remote surgical support in war zones. Under difficult conditions, systems equipped with AI can mine soldiers' medical records and assist in complex diagnosis.
- *Military Intelligence:* Military intelligence is a military branch that uses information collection and analysis approaches to provide guidance and direction to assist commanders in their decisions. As an academic field, military intelligence is multidisciplinary area that combines language, political theory, economics, sociology, and psychology [14]. AI may be particularly useful for intelligence because of the proliferation of sensors and the availability of large data sets. The speed and precision of AI-enabled intelligence analysis can provide US forces an operational advantage against adversaries that do not possess similar capabilities.
- *Central Intelligence Agency* (CIA): AI capabilities in the CIA include discovering threats and thwarting planned attacks, neutralizing cyber attacks that come in through email, surveying areas via satellite, identifying and predicting social unrest in a region. The CIA finds modern innovations in AI useful for security and intelligence purposes [15].
- *War planning:* This is an area that desperately needs AI technologies. War plans are usually based on both assumptions and facts. As assumptions and facts change, the plan too changes. The plan may be based on units whose availability or mission changes. Using AI technologies, the plan could be automatically modified so that it is more than just shelfware [16].

These applications are simply a taste of what is ultimately possible. Other potential applications of AI in the military include shooting down drones, aiming tank guns, coordinating resupply, planning artillery barrages, blending sensor feeds, stitching different sensor feeds together into a coherent picture, analyzing how terrain blocks units' fields of fire, war games, combat automation in so-called manned-unmanned operations, and warning commanders where there are blind spots in their defenses.

Benefits

The military benefits a lot from AI technology. AI has many application areas where it will enhance productivity, reduce user workload, and operate more quickly than humans. The modern uses of AI in military

are not limited to the battlefields. AI can help reducing the risk of life loss in wars. Autonomous machines can be more efficient than regular soldiers. They are less in cost about ten times than the cost of human soldiers. AI has the new capability to operate autonomous weapons at the miniaturized level. It increases the performance of warfare systems while minimizing the need for maintenance. It can automatically monitor weapons systems, mobile devices, and aircraft, which are vulnerable to cyber attacks. AI can be used for training systems [17]. Some AI applications will change many aspects of the global economy, security, communications, and transportation by altering how humans work, communicate, think, and decide. It improves self-control, self-regulation, and self-actuation of combat systems due to its inherent computing, and decision-making capabilities. AI supports and protects US service members, safeguards US citizens, defends US allies, and improves the affordability, effectiveness, and speed of US military operations. The US military sees many benefits in pairing humans with intelligent technologies.

The following six benefits of artificial intelligence in the military are changing the world of defense and national security:

- better threat identification
- reduced staff requirements
- improved recruiting
- more preparedness
- enhanced cybersecurity
- smoother transportation

Challenges

Some consider the term "artificial intelligence" as an oxymoron since it is regarded as the capability of a machine to imitate intelligent human behavior. The bar for what is considered "intelligent" keeps rising higher. Most AI systems today are designed to perform a single task and they do not adapt well to new environments and new tasks, as humans. Research shows that under adversarial conditions, AI systems can easily be fooled, resulting in wrong decisions. Many critics warn that AI may someday evolve beyond submission to their human controllers.

Risks associated with military AI will require human operators to maintain positive control in its employment. There have been proposals to ban or regulate the employment of autonomous weapons in a military operations. Efforts should be made to keep fast-paced advances in machine learning from sparking a worldwide AI arms race that poses a new existential risk to humanity. If autonomous machines supported by one country target and kill humans, other countries can follow suit, resulting in destabilizing global arms races. Moral objections to AI by some US citizens may slow new development by the DOD.

Future of Military AI

Modern warfare is based on unprecedented connectivity of military systems. Artificial intelligence will certainly play a major role in future military applications. In the future, AI systems that can be trained, learn, and think independently will likely dominate the field of AI. Many nations are developing AI for their policy guidance and strategic planning. They are increasingly deploying AI technology into weapons and other defense systems that are used on airborne, land, naval, and space platforms. More than thirty nations and international organizations have strategies and initiatives for AI.

Militaries around the globe are seeking ways to gain a strategic edge over their adversaries by integrating AI technology into their arsenals. Various organizations such as NATO help spread knowledge, create awareness, stimulate research and development on AI technology. All NETO member states need to be involved in preparing for the transition to an AI-powered, highly interconnected world. Perhaps the best areas to invest in military AI are those that operate in uncontested domains.

Robotics and AI could take on a central role in the military. Advances on AI will determine their future strategic effectiveness in military matters, as well as their performance, competitiveness, and ability to deter adversaries. As AI technology improves, a constellation of military devices could be made largely autonomous. Unmanned

underwater vehicles (UUVs) could be widely deployed in times of crisis. Some sort of robotic swarm might be used to create an interconnected network of unmanned aquatic systems.

Conclusion

Artificial intelligence is a rapidly growing branch of computer science which requires computer programming. It is a rapidly developing capability and AI models are improving daily. The use of AI in everyday life increases. AI will change how wars are planned and fought. It also has many military application areas where it will enhance productivity, reduce user workload, and operate more quickly than humans. It has the capability to gather and quickly synthesize information from many sources to produce highly accurate estimates of locations for submarines, or land-based mobile launchers. AI technologies should be used to supplement rather than replace human ingenuity, creativity, and judgement. Current military doctrine assigns command and control responsibilities to humans, not to machines. Artificial intelligence will have immense impact on national and international security.

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About The Authors

Matthew N.O. Sadiku is a professor emeritus in the Department of Electrical and Computer Engineering at Prairie View A&M University, Prairie View, Texas. He is the author of several books and papers. His areas of research interest include computational electromagnetics and computer networks. He is a fellow of IEEE.

Sudarshan R. Nelatury is an associate professor at Penn State University, The Behrend College, Erie, Pennsylvania. His teaching and research interests lie in electromagnetics and signal processing.

Sarhan M. Musa is a professor in the Department of Electrical and Computer Engineering at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow. His areas of research interest include computational electromagnetics and computer networks.