Using Artificial Intelligence for the Improvement of Weapon Efficiency

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Abstract. In the defense industry, which is one of the determinants of the political and economic power of the countries, there is a constant need for change, innovation, and modernization in parallel with the technological developments in the world. Therefore, in the field of defense technologies, Military and non-governmental organizations are working to develop high-performance armor systems that will increase mobility by reducing weight and against developing weapon systems. In this paper will be discussed, how artificial intelligence (AI) can be used for the improvement of weapon efficiency.

Keywords: Artificial neural network · Weapon · Efficiency · Defense · Autonomous

1 Introduction

A weapon is any device that can be used with intent to inflict damage or harm. Arms can be used to increase the efficacy and efficiency of activities and not only in the military, e.g., such as hunting, fishing, crime, law enforcement, self-defense, and warfare. Ensuring appropriate human control over weapons, such that they are used effectively and as intended, has been a critical task. Projectiles can miss their targets. Even hand-held edged weapons that are large and unwieldy run the risk of accidents in the hands of an untrained user. Many weapons require skill and experience to be used safely and effectively. As humankind has developed increasingly powerful weapons over time, concern has grown as well about ensuring that weapons are used appropriately. Nuclear weapons, for example, require stringent safeguards to prevent unauthorized use. The two main reasons for having a weapon are for self-defense, as a human being wishing to live a long, fruitful life or a policeman or soldier or security guard to keep someone from taking the right of life from you, and for providing food for yourself and family as a hunter. This can be a simple expression, but the main answer is the tendency of countries to produce weapons and to have power in the world as a gun industry [1]. Autonomous weapon systems might not be categorized based on the system's complexity, but rather on the type of function being executed without

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human intervention (e.g., target selection and engagement) [2]. There is a specific meaning based on tactical, technical parameters in weapon efficiency. Májek and Kacer, [3] define operationally essential elements as the weight of the operation charge, weapon range, projectile maneuvering ability, and system mobility. The United States Navy implemented a program in 1960 to work with dolphins and sea lions to help with defense, mine detection, and design of new submarines and new underwater weapons. "Bottlenose dolphins are better than any machine as far as detecting mines," says Paul Nachtigall, head of the marine mammal research program at the University of Hawaii. These animals can detect mines much faster than a machine might be able to [4, 5]. Every country has to protect its security against threats that may be directed by other countries. These threats can be made using economic, social, political, ideological, or military means. Most of these tools must be supported by a military force to create a severe threat [6]. This feature of the threat assessment requires both the countries with potential risks and their armed forces to be assessed in terms of qualitative and quantitative factors such as firepower, mobility, materials, tools, equipment, and human quality. The determination of the firepower potential and the efficiency of firearms used in the determination of firepower potential constitute a crucial part of this evaluation. In general, the methods developed for the detection of weapon activities are based on the approach of combining the selection and weighting of several weapon characteristics in a formulation for this purpose. Weapon Effectiveness Index and A Technique for Assessing Comparative Force Modernization (TASCFORM) methods are examples of this approach [7]. Weapon activity values showing the degree of effect of weapons to unity firepower and following combat results can be used in different stages of evaluations such as weapon comparison, power comparison, force potential determination, forward force planning. These evaluations refer to the various dimensions of the studies to determine combat power [1]. The Concept of Weapon Activity is based on Combat Force Analysis, Weapon Activity Index, Comparative Force Modernization Assessment Technique, and Operational Lethality Index. The Weapon Activity Index method emerged at the end of a study initiated by the US Army in the 1970s to compare the combat effectiveness of various units. This method is based on the approach of evaluating weapons activities by taking expert opinions with the help of the Delphi method. The part of the technique related to the evaluation of the weapon systems is based on the comparison of performance criteria of a selected base system such as ammunition weight, range, speed, maneuverability, mobility, target detection, target tracking of the weapon and weapon systems with the performance criteria of the selected mode [1, 8].

An autonomous weapon system is a weapon system that can select (search for, detect, identify, track or choose) and attack (use force against, neutralize, damage or destroy) targets without human intervention [9].

Artificial neural networks were developed for use as a potential 'information barrier' technology in the verification of arms control treaty accountable items [10].

2 Literature Review

Weapon activity values showing the degree of effect of weapons to unity firepower and following combat results can be used in different stages of evaluations such as weapon comparison, power comparison, force potential determination, forward force planning. These evaluations refer to the various dimensions of the studies to determine combat power. To better understand the use of weapons efficiency and weapon activity, combat power analysis, and studies in this area should be mentioned. The history of analytical studies to assess the outcome of the battle and to assess the success of the troops in a possible action is not very old. A game is known as the "war game (Kriegspiel)," which started to be played in Germany in the 19th century, can be seen as the first of such studies. The most significant contribution to the studies in this area was made by Lanchester Equations in 1916 [11]. The Weapon Activity Index method emerged at the end of a study initiated by the US Army in the 1970s to compare the combat effectiveness of various units. This method is based on the approach of evaluating weapons activities by taking expert opinions with the help of the Delphi method. The Comparative Force Modernization Assessment Method was developed in 1978 by the Analytic Sciences Corporation (TASC) upon the request of the US Department of Defense to develop a method for quantitative determination of force modernization degree. The technique aims to reveal the force potential of military systems based on the measurable characteristics of the military systems. The method of Operation Lethal Index was developed by Colonel Trevor Nevitt DUPUY, retired from the US army. The method is based on several formulas and principles for use in the calculation of weapon and union activity values by utilizing data from past battles. A weapon system is comprised of four actions, searching for a target, detecting that target, deciding to engage the target, and engaging the target. Developed by Colonel John Boyd, the OODA (**O**bserve, **O**rient, **D**ecide, **A**ct) loop is a model for competitive decision making, comprised of those four actions that define a weapon system: observe, orient, decide, and act. In human operated weapons systems, a human operator completes all of these actions. In a weapon system with autonomy, the human operator relinquishes control over some part of the loop.

2.1 Artificial Intelligence

Artificial Intelligence (AI) is the general name for the modeling of systems that behave similarly to the behavior and behavior of all human beings in nature. Artificial Intelligence can be considered as an interdisciplinary concept. These disciplines are biology, psychology, sociology, computer, mathematics, medicine, and their sub-branches [12–14]. According to the general view, Artificial Intelligence is a system that acts like a human. However, considering that other living things are taken as models, it can be defined as the modeling of behaviors in nature in general. This behavior is six different ways when people are treated like human beings. These; control of a system (robot control, traffic control, etc.), decision making (warfare strategies, diagnosis in medicine, law, expert systems), estimation (finance, traffic, fishing stock review, image process), learning and optimization (the most reasonable solution, shortest path, optimum process). The purpose of artificial intelligence; to provide intelligent systems to help people make decisions and achieve their goals. Along with the development of technology, artificial intelligence appears in the sub-areas of problem-solving, expert systems, robotics, vision, machine learning, and neural networks (Fig. 1).

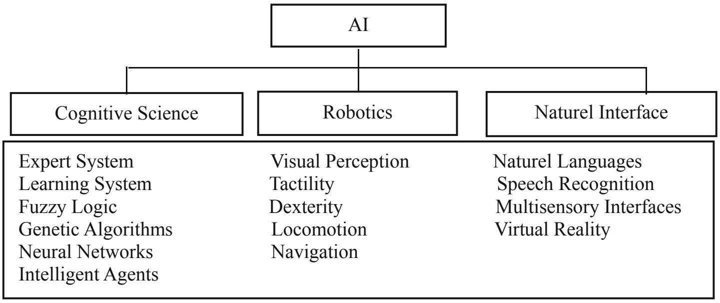

Fig. 1. Overview of artificial intelligence [15]

Considering the potentials of artificial intelligence, Phulera et al. [16] stated that smarter artificial intelligence could replace human jobs, freeing people for other works by automating manufacturing and transportation. Self-writing, self-modifying, and learning software's can help relief programmers of the difficult tasks of specifying functions of the different programs. Artificial intelligence will be used as cheap labor; then there must be an increment in profits for the corporation. Artificial intelligence can make deployment more comfortable and less resource intensive. Compared to traditional programming techniques, expert-system approaches provide the added flexibility (and hence easier modifiability) with the ability to model rules as data rather than as a code. In situations where an organization's IT department is overwhelmed by a software development backlog, rule-engines, by facilitating turnaround, provide a means that can allow organizations to adapt more readily to changing needs.

Furthermore, Phulera et al. mentioned that rapid advances in AI could lead to massive structural unemployment, unpredictable and unseen impacts of new features. An expert system or rule-based approach is not optimal for all problems, and considerable knowledge is required to apply in any of the methods. The ease of rule creation and rule modification can be double-edged. A system can be sabotaged by a non-knowledgeable user who can easily add worthless rules or rules that conflict with existing ones. Reasons for the failure of many systems include the absence of (or neglect to employ diligently) facilities for system audit, detection of possible conflict, and rule lifecycle management (e.g., version control, or through testing before deployment). The problems to be addressed here are as much technological as organizational.

2.2 Autonomous Technology

A weapon system that, once activated, can select and engage targets without further intervention by a human operator [17]. Examples include some 'loitering' munitions that, once launched, search for and attack their intended targets (e.g., radar installations) over a specified area and without any further human intervention, or weapon systems that autonomously use electronic 'jamming' to disrupt communications [18]. State of the art in computing machinery is unlikely to meet all of these requirements within the foreseeable future. Although computers are better at some tasks than humans, humans are better at some tasks than computers (Table 1). Military control and humanitarian impacts are best served by playing to the strengths of both.

Table 1. The differing skills of computers and humans

Computers	Humans
Calculating numbers	Deliberative reasoning
Searching large data sets	Perceiving patterns
Responding quickly to control tasks	Meta-cognition (thinking about thinking)
Simultaneous repetitive routine tasks	Reasoning inductively
Carrying out multiple complex tasks	Applying diverse experience to novel tasks
Sorting data	Exercising meaningful judgment

Computers are also susceptible to some potential problems that make them unpredictable: human error, human-machine interaction failures, malfunctions, communications degradation, software coding errors, enemy cyber-attacks, infiltration into the industrial supply chain, jamming, spoofing, decoys, and other enemy countermeasures or actions. Again, a human in the control loop can determine that a system is displaying aberrant behavior and take appropriate action. There are also other uses of technology that can be seen as being against human dignity. Heyns [19] looks beyond warfare and raises concerns about where we allow machines to make decisions. It was stated that allowing machines to make non-lethal decisions that affect humans is also against human dignity, writing. The notion of 'meaningful human control' should be developed as a guiding principle not only for the use of autonomous weapons but for artificial intelligence in general; not merely focussing on isolated applications of such technologies but the role of technology as such in our future. Allowing technology not only to supplement but indeed to replace human decision-making will undermine the very reason why life is valuable in the first place [19]. Human intelligence generally follows a sequence known as the perception–cognition–action information processing loop, in that individuals perceive something in the world around them, think about what to do, and then, once they have weighed up the options, decide to act. AI is programmed to do something similar, in that a computer senses the world around it, and then processes the incoming information through optimization and verification algorithms, with a choice of action made in a fashion similar to that of humans. Figure 2 illustrates how an autonomous system embedded with AI 'thinks' and makes decisions in this way [20]. While there are many parallels between human intelligence and AI, there are stark differences too. Every autonomous system that interacts in a dynamic environment must construct a world model and continually update that model (Fig. 1). This means that the world must be perceived (or sensed through cameras, microphones and/or tactile sensors) and then reconstructed in such a way that the computer 'brain' has an effective and updated model of the world it is in before it can make decisions. The fidelity of the world model and the timeliness of its updates are the keys to an effective autonomous system.

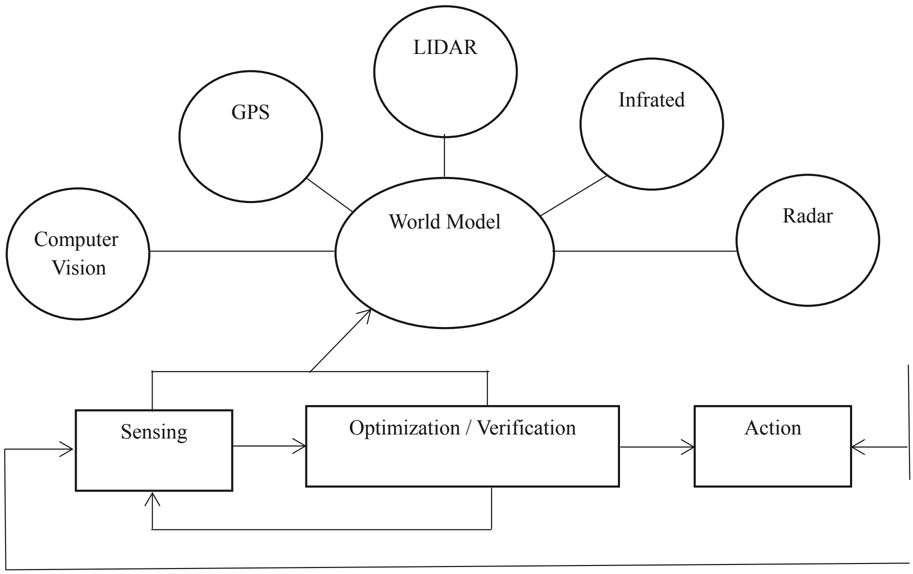

Fig. 2. How AI of an autonomous system Works [20]

3 Lethal Autonomous Weapons Systems

Lethal autonomous weapons systems (LAWS) are weapons systems that apply deadly force independently, with freedom from human control. AI has many subfields, including machine learning, data mining, speech recognition, and image processing. Policymakers frequently refer to any of the subfields of AI as AI. By grouping these various terms under the umbrella of AI, the term is commonly misused by technical experts, policymakers, and the general public [21]. The general idea is that a LAWS, once activated, would, with the help of sensors and computationally intense algorithms, identify, search, select, and attack targets without further human intervention. Whether the human being can still overpower or veto an autonomous weapon's 'decision' for it to be called a LAWS, is also debated. However, military operational necessity precisely seems to require weapons systems that can function once human communication links break down. Furthermore, state of the art research on AI is currently creating software which can 'learn' entirely on its own and even 'learn' to 'learn' on its own. Hence, (precursor) technologies for creating fully 'human-out-of-the-loop' weapons systems already exist [22].

4 Main Challenges for Using AI

Following the assumption of the calculability of the world, usually called digitization and robotization. It is easily overlooked that a human, and thus its actions, is anything but predictable. This is one of the most significant challenges of human-machine interaction, whether cooperative (i.e., the machine provides information to its operator in combat) or uncooperative (i.e., the machine remains intransparent to the opposing side). The artificial Intelligence weapon system, especially learning systems, require a large amount of sensor and training data to function correctly. This creates both quantitative and qualitative challenges. First of all, it is generally questionable whether more sensor technology and thus more data, actually enables more consistent and predictable machine behavior or better human decisions [23]. As Artificial Intelligence, machine learning and deep learning evolves further and moves from concept to commercialization, the rapid acceleration in computing power, memory, big data, and high-speed communication is not only creating innovation, investment and application frenzy. When countries individually and collectively accelerate their efforts to gain a competitive advantage in science and technology, the further weaponization of AI is inevitable [24].

A new report written by a former Pentagon official who helped establish United States policy on autonomous weapons argues that such weapons could be uncontrollable in real-world environments where they are subject to design failure as well as hacking, spoofing, and manipulation by adversaries. And A new report says eight new F-22 fighter jets like these experienced total computer failure when crossing the international date line [25].

The more powerful technology becomes, the more it magnifies design errors and human failures. As society contemplates deploying AI in self-driving cars, in surgical robots, in police activities, in managing critical infrastructure, and in weapon systems, it is creating situations in which errors committed by human users or errors in the software could have catastrophic consequences [26].

5 Restriction (Application Dimension)

Autonomous systems can reduce or eliminate the need for human involvement in some tasks. They are not close to reaching the goal of human-like artificial general intelligence. They are, however, continually becoming more powerful because of developments in machine learning and natural language processing and advances in materials science, networking, energy-storage, and hardware capabilities.

Every expression of daily life, either civil or professional or familial or personal, will be diminished by the iron grip of Artificial Intelligence on the fundamental realities of interpersonal communications. Despite concerns, artificial intelligence technology continues at a dizzying pace. Governments also introduce artificial intelligence strategies. The fact that Russian President Putin has made an ambitious statement that he will control the world that controls the artificial intelligence technology reveals this.

Johnson and Axinn [27] also state that 'To give a programmed machine the ability to 'decide' to kill a human is to abandon the concept of human dignity' since to do so is to treat a rational being as an object. They insist that a machine cannot be moral, but can only follow the values of its programmers. Concluding that arguments based on human dignity are not the best way to argue against AWS is not at all the same as saying that such weapons are acceptable. As explained earlier, there are strong reasons to oppose their use and to argue for a ban. Eventually, the machines will gradually push the humans out of the loop. First, they stand in supervisory roles and finally they'll end up as "killswitch operators" that monitor these autonomous weapons. Machines can be much faster than humans. The act of killing an enemy is based on reflexes, and if soldiers realize that these types of tools can outperform them, they'll eventually come to trust and rely on them. As these systems advance, the ones that rely less on human supervision will dominate. Instead, humans will be given other roles, such as analyzing the behavior of these systems and concentrating on other strategic areas.

There is also rising pressure and incentives to improve these kinds of systems too. All countries are equally pressured to gain superiority, and as such, the inevitability of fully automated, always on orders should be seriously considered in all aspects of AI integration. The best way to avoid catastrophe is by supporting regulation and prohibition of LAWS like chemical and biological weapons, for weaponized AI.

6 Results and Limitations

The decision-making process will be shortened by artificial intelligence-based command control systems, real-time enemy activities can be monitored, and the possible patterns of the enemy can be followed dynamically. In this direction, the decision makers will be able to revise their plans momentarily and will be able to change the speech structures and force structures of the military elements. Weapon systems can be kept under observation by artificial intelligence algorithms against cyber-attacks, and algorithms which can simulate cyber-attacks can detect weak points of system, and immediate corrective intervention can be found.

Considering all the issues discussed above, it can be concluded that the use of artificial intelligence in the military field is necessary. The most crucial factor in deciding is whether the use of artificial intelligence should be performed autonomously or only as a support system. Once a certain maturity has been reached, it will not be reflected in the fact that military operations should be fully autonomous systems. At this point, the target can be applied for alternatives such as target priority determination, target engagement, and even target change according to the current situation, starting from the detection, follow-up, and identification.

Improving collaboration across borders and stakeholder groups; developing policies to assure that development of artificial intelligence will be directed at augmenting humans and the common good; and shifting the priorities of economic, political and education systems to empower individuals to stay ahead in the race with the robots are worrisome potential future [28].

7 Conclusions and Further Steps

Depending on today's weapon requirements, it is required a very complex decision making within a very short time. Additionally, various situations might not be defined in advance. From this point of view, a support for alternative control and evaluation isa very important task for weapon efficency. On the other hand, depending on the situation there can be available big data for decision making, which can not be use directly for manking decisions. Therefore, there is an absolut need for AI support.

While many modern weapons have units for target searching, tracking and seeking without human input, the full-fledged use of autonomous artificial intelligence systems in warfare has prompted concerns among AI and robotics researchers. Alternatively, there are available many negative ideas as well. One special approach is the autonomy of machines.

In summary, as with previous technological advances, AI technology increases the risk that failures in human organizations and actions will be magnified by the technology with devastating consequences. To avoid such catastrophic failures, the combined human and AI organization must achieve high reliability. Work on high-reliability organizations suggests important directions for both technological development and policymaking. It is critical that we fund and pursue these research directions immediately and that we only deploy AI technology in organizations that maintain high reliability.

The next step for this study is a analysis about different countries using AI in the area of weapon efficency.

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