Interaction of Artificial Intelligence in the Attack and Defense Industries Using Next-Generation Military Technologies

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Abstract: - The Attack and Defense Industry is essential to the nation's security by providing the most significant degree of confidence and satisfying military requirements safely. This research examines the significance of artificial intelligence, machine learning, and electronic information in the growth of the Defense Industry. With the emergence and development of artificial intelligence in the Defense Industry, what kind of products are produced, what studies are done, and the benefits/disadvantages in the defense industry are examined. The defense industry and all other sectors are affected by artificial intelligence, machine learning, robotics, big data, data science, deep learning, simulation, fuzzy logic, 5G, and electronics, which will be the next-generation military technologies. In this study, Hybrid Warfare, which has become more familiar with the developing artificial intelligence technologies in the Defense Industry, is also emphasized. Making sense of large-scale data processing using Artificial Intelligence technology may yield substantial military advantages, unique intelligence capabilities, and considerable improvements in various businesses. It is critical to keep up with the continual growth of artificial intelligence to maintain an effective defense.

Key-Words: - Artificial Intelligence, Big Data, Defense, Defense Industry, Defense Field, Deep Learning, Data Science, Electronics, Fuzzy Logic, Hybrid Warfare, Machine Learning, Robotics, 5G, Internet of Things.

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1 Introduction

Artificial Intelligence (AI), which came to the fore with its development and grew and developed by renewing itself day by day, thus providing benefits in every field, has also achieved great success in the defense industry. Expanding the production of Defense Industry products and reaching the top level in this field is one of the main strategies of many countries [1]. Due to these new technologies developed by merging Machine Learning, Robotics, and Artificial Intelligence, this issue will undoubtedly arise in our minds. Are hybrid Wars Coming?

Of course, this problem was born with the construction of autonomous vehicles, unmanned aerial vehicles (UAVs), armed unmanned land vehicles, and unmanned warplanes. Although it seems incredible at first, it has made an excellent contribution to the formation of Artificial Intelligence technologies, which will contribute to high-level development by combining several algorithms into its structure. Artificial intelligence is a collection of technologies designed to simulate human thought in robots, and it necessitates multidisciplinary research. Today, artificial intelligence techniques play a crucial role in collecting, processing, and interpreting data, enabling solutions and technologies that are not presently feasible. It is

typically impossible to analyze data acquired using the available technology without artificial intelligence tools.

On the other hand, machine learning is a subfield of artificial intelligence that does supervised-unsupervised aided learning rather than code-intensive solutions. We can extract valid inferences from rich, complicated data using machine learning. While talking about the production of war technologies produced in the Defense Industry, we said it was created with a lot of data. The way to process this data most accurately is Artificial Intelligence, Machine Learning, and Deep Learning. With these three, it is impossible not to see the popularity of data science in the world. Deep Learning is commonly regarded as a subfield of machine learning. It comprises strategies for generating artificial intelligence through data-driven learning. By evaluating the instantaneous decisions of a real pilot in a flight simulator in a virtual environment and the environment's information, an artificial intelligence pilot can develop rule sets without writing a program and make realistic flight decisions in an environment containing highly complex data [2]. Hybrid wars are formed with many changes between the war technologies used in the past and now used. In the real sense, the biggest key to this much development in defense is Artificial Intelligence.

2 What Is Hybrid War In The Defense Industry?

With the development of communication and war technologies in the Defense Industry, wars, in general, have changed. Because everyone wants to develop and become stronger, it is difficult to predict what we encounter on the battlefield [3]. Confidence is as necessary as motivation during warfare. Knowing that there is only a little bit of security is comforting, and it also leads to healthier thinking and strategic behaviour on the battlefield.

Hybrid Warfare is a war concept that replaces conventional wars with the diversification of international relations discipline and security strategies and new defense and attack vectors created by developing technology. Conventional wars, consisting of land, air, and sea layers, have been replaced by hybrid wars that include the electromagnetic spectrum, space, cyber, and information layers, and these three layers [4]. Hybrid Warfare can be seen in Figure 1.

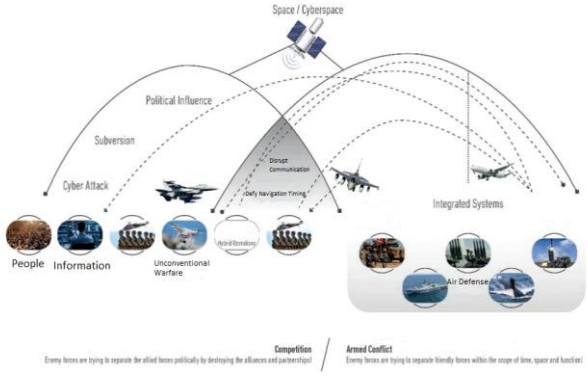

Fig. 1 Hybrid Warfare [4].

In hybrid wars, the aim is to achieve the goals of breaking the alliances, partnerships, and determination of the opponents without the need for armed conflict. For this, methods such as diplomatic and economic actions, information wars, and, if necessary, conventional forces as a deterrent threat are preferred. Instability is created within countries and alliances; the goal is achieved by creating political separation that slows the pace of friendly solutions, decisions, and reactions and ultimately results in strategic uncertainty [3].

During the hybrid wars, the struggling states started to prepare for the most efficient of these plans by making various strategic plans (tactical, operational) to protect themselves from the other side and gain superiority and power. The most significant advantage of hybrid warfare is artificial intelligence technology, which can offer many options and ensure the integrity of advanced abilities, allowing the opponent to gain superiority by confusing their minds.

As a result, Hybrid Warfare is becoming more familiar with the developing artificial intelligence technologies in the Defense Industry, and the scope of this war is developing with these technologies. To develop Artificial Intelligence technologies, we must collect data

and use this data appropriately so that we can take firm steps toward the target. Especially in the technologies made in this field, even the slightest mistake that is overlooked can adversely affect all studies. In the studies carried out in Artificial Intelligence, which everyone knows the importance of, it is necessary to reveal the feature that distinguishes us from the others. For example, we should be able to make decisions in seconds rather than minutes and detect and neutralize the enemies 99.9% of the time. By first testing the studies in this field in simulation and then taking them to the area, we can notice the deficiencies early and take the necessary precautions.

3 Use of Simulation in the Defense Industry

Simulation tools enhance production-related tasks by encouraging a sustainable production environment. Self-configuration is a feature of the digital tools used to create the production system. Therefore, it shows the roadmap of a practical study [5]. Simulators used in the Defense Industry provide information about the work to be done or the work that has been done, allowing it to be integrated into the strategies planned or created to be scheduled in the light of this information. The simulator's data allows for the development of (tactical, operational, and strategic) planning. Simulation Technologies are essential in the Defense Industry. Because in this environment, which gives almost accurate data, many projects and new technology products emerge. In Figure 2, we can see Havelsan's Simulation Technology.

Fig. 2 Simulation Technologies [6].

4 Big Data

Big data is in the middle of the constantly renewing science and business world. The resulting data is generated from simulators, videos, audio, images, posts, social network interactions, science data, sensors and mobile phones, and all other connected devices and technologies [7].

- Important Issues

Big Data demands a revolutionary leap from traditional data analysis, as seen in Figure 3 [7]. Big Data is defined by its three primary components: variety, velocity, and volume.

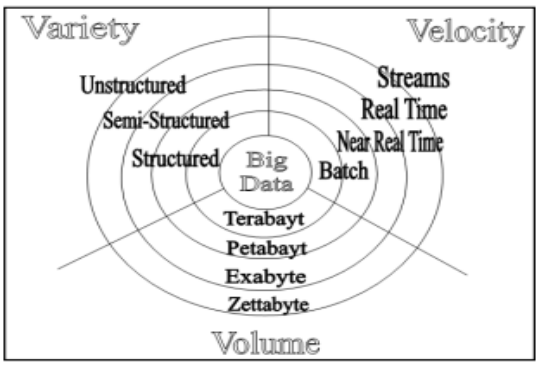

Fig. 3 The three vs. of big data [7].

Diversity brings big data into an oversized format. There are three types of big data from many sources. These are structured, semi-structured, and unstructured. Structured data adds a pre-labeled and quickly sorted data warehouse, but unstructured data is random and not easy to analyze. Semi-structured data contains tags to separate data items [8].

Currently, the volume or quantity of data exceeds terabytes and petabytes. Massive data growth and expansion surpass standard storage and processing techniques [7]. Therefore, the volume of data is everywhere in our lives and is produced very quickly.

Speed is an important factor throughout the entire process. This is the rate at which data is generated. Today, big data is generated rapidly due to the digital and social media landscapes

(sent, network interactions, images, videos). Thousands of GB of data are created every day in real-time in the digital world [9].

This component data flow must be verified to produce AI-based technologies in the Defense Industry. Data must be secured, as it is difficult to obtain and verify big data. After completing all these processes, that is, processing the data will provide an excellent advantage for the technologies to be produced. This will allow the production of powerful technologies in the Defense Industry.

5 DATA SCIENCE

The most general definition of data science can be expressed as the science and art of getting information from data. Using data science, we can acquire data, extract information from this data, and use this information for research that will shape the future. Most of the new studies carried out compare the data extracted from the past with the current data and show us which steps we prefer for our future. Data science includes organizing and analyzing, visualizing, and reporting data.

In conclusion, Data Science provides decision-makers with awareness by studying the present situation and increasing decisions' correctness by predicting current and future research [10].

5.1 DATA ANALYSIS

It is possible to access data that cannot be reached with human power through the ways provided by machine learning and deep learning. To understand the quality of the information obtained, it is possible to understand by analyzing the detailed examination, checking the method steps, and exploring the size, speed, and change of the data. For an optimum solution, machine learning algorithms chosen by sticking to the existing problem should be used by the distributed data.

5.2 DATA VISUALIZATION

The data we find can sometimes be complicated, so it becomes a little difficult for us to understand. If we visualize this data, it will allow us to understand and solve it better, and it will have a more permanent place in the mind. In addition, the greater the speed and size of the data, the closer the data will be to us. The connections in the data will not be easy to see, and they will be difficult for us to understand. Visualization of data is essential in this respect.

6 STUDIES OF ARTIFICIAL INTELLIGENCE IN THE DEFENSE INDUSTRY

As the use of Artificial Intelligence increases, the number of studies increases. In this regard, the Defense Industry has carried out and continues to make ground-breaking studies that will make a name for itself. Most of the technologies produced are still in the design, testing, or evaluation phase [11]. Of course, the aim is to be advantageous on the battlefield.

These technologies are expected to produce tactical reconnaissance and surveillance, air strikes with bombs or missiles, forward surveillance for indirect fire, special operations, and psychological operations, border control and protection, mine search and destruction, anti-smuggling, chemical, biological, and radiological scanning, ship identification in maritime and containment, combat search and rescue, air radio link and relay mission, and weather data collection [12]. Therefore, the defense industry is focused on artificial intelligence.

Some of the technologies produced;

I) Baykar Bayraktar Akinci

It is an armed unmanned aerial vehicle with high altitude long endurance (HALE) class, developed by Baykar Defense, a Turkey-based defense industry company. They entered the Turkish Armed Forces inventory for the first time on 29 August 2021.

Akinci has a maximum take-off weight of 5500+ kg with its two turboprop engines. 1350+ kilograms of this consists of a payload. It is also called the Assault Unmanned Aerial Vehicle (TİHA) because it can conduct air-air combat. Akinci is equipped with electronic support and countermeasure systems, dual satellite communication systems, air-to-air radar, collision avoidance radar, and a domestically produced radar with a synthetic range [13].

Fig. 4 Bayraktar Akinci [13].

II) HAVELSAN Barkan

Security threats in the world have increased, especially for land armies. Autonomous unmanned land vehicles integrate modern technology into military units by sensing the environment, both by remote management and using sensor systems, and performing the basic tasks such as reconnaissance, surveillance, and ammunition transport unmanned within the requirements of digital battlefields.

HAVELSAN has designed and produced HAVELSAN BARKAN to meet the needs of modern military fields. BARKAN is an essential assistant of field personnel in many areas, especially in increasing the operation's success, preventing losses, and reducing operation costs. In addition, BARKAN has been developed for tasks such as carrying or towing cargo, providing close protection, and armed reconnaissance [14].

Fig. 5 BARKAN [14].

7 5G Technology in the Defense Industry

New products will continue to emerge as the work of Artificial Intelligence grows day by day, and thus, the diversity of technologies produced in the Defense Industry will increase.

Factors such as the increase in the number of smart devices globally, technological developments, and demands for an increase in capacity and coverage quality affect the development of new technologies in the communication sector. Due to the increasing number of devices connected to the internet, machine learning, the internet of things, and increasing speed and capacity demand, studies have been started for the emergence of 5G. With 5G technology, it is aimed to meet this diversity of needs and demands better and simultaneously [15].

5th Generation communication technology, which enables the creation and use of products not only in the field of communication but also in many fields, and that allows new working areas and ways of doing business; It will play a vital role in the sustainable development goal by accelerating the development of innovative applications such as artificial intelligence, machine learning, big data and the internet of things. Therefore, 5G enters our lives, and its importance is seen [16, 17].

7.1 Internet of Things (IoT) by Mission

For IoT in the Defense Industry, Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance have focused on applications for fire control systems so far. The prevalent belief is that sensors serve primarily as data collection and sharing tools, hence enhancing Command and Control. The IoT enables commanders to make choices based on real-time analytics produced by merging data from unmanned sensors and field reports [18].

I) Surveillance and Reconnaissance: Many sensors are used to gain an advantage in defense. Radar, video, infrared or passive RF detection data, surveillance satellites, aerial platforms, unmanned aerial vehicles, ground stations, and soldiers in the field acquire data from these sensors. The data is delivered to an integration platform that analyzes and distributes information up and down the command chain [18].

II) Logistics: Multiple low-level defensive sensors are deployed in this region. RFID tags have, for example, been used to track shipments and manage supplies between central logistics hubs [18].

III) Soldier Health: Soldiers can be notified of unusual situations such as dehydration, sleep deprivation, high heart rate, or low blood sugar. If required, the medical response team at the main hospital can be notified [18].

IV) Surveillance: Combining advanced image analysis and pattern recognition software with security cameras and sensors facilitates remote facility monitoring for security risks. The employment of many sensors incorporated into airplanes, unmanned aerial vehicles, satellites, and ships is an example of marine and coastal surveillance [18].

If we summarize the innovations that 5G will bring to the field of defense as follows;
Units in the field will be able to get support by connecting to the war network, Critical mission controls will be carried out more efficiently, Quick decisions can be taken, and action will be taken in electronic warfare and missile attacks. Countries will be able to monitor their armed forces instantly.

Fig. 6 5G Technology [19].

8 Using Fuzzy Logic During Warfare

Artificial Intelligence technologies are becoming popular in the military as the battlefield has become complicated. Still, in the light of the studies, it has been seen that Artificial Intelligence-based technologies are not enough in the military field, and fuzzy logic has been applied.

During the war, it is one of the areas to be considered because the air is where the enemies attack the most. Therefore, air defense factors should be determined to best support all kinds of plans before the operation. The air defense priority degrees of the units to be given air defense support should be chosen.

During the war, the soldiers have to decide to make the right move in a short time. However, the decisions made are not always 100% certain. There are times or circumstances in which the person making the decision must choose other options. In this case, the circuit is Fuzzy Logic [20]. Fuzzy logic is an effective method for recognizing and resolving genuine uncertain and uncertain problems. Fuzzy logic is a multivariate theory that employs mean values such as "middle," "high," and "low" rather than traditional variables such as "yes," - "no," "true," - "false" [21].

8.1 Fuzzy Logic Process

To create a better solution in Fuzzy Logic, comparisons are made so that it is decided which is "Good," "Better," or "Bad" by making pairwise comparisons.

As an example, we will examine the BAHP method because this method handles uncertainty with a human way of thinking and effectively solves multi-criteria decision-making problems. This method should be applied in a war environment. The steps are given below [21].

Step 1: The fuzzy size value for the object;

$S_i = \Sigma_{j=1}^{m} M_{gi}^{i} \mathrm{x} \left[\Sigma_{i=1}^{n} \Sigma_{j=1}^{m} M_{gi}^{i} \right]^{-1}$

S_i = Synthesis value of purpose

M_{gi}^{i} = Extended value for all purposes

$\Sigma_{j=1}^{m} M_{gi}^{i} = \left(\Sigma_{j=1}^{n} 1_j , \Sigma_{j=1}^{n} m_j , \Sigma_{i=1}^{n} u_j \right)$

$\left[\Sigma_{i=1}^{n} \Sigma_{j=1}^{m} M_{gi}^{i} \right]^{-1} = \left(\frac{1}{\Sigma_{i=1}^{n} u}, \frac{1}{\Sigma_{i=1}^{n} m}, \frac{1}{\Sigma_{i=1}^{n} 1_j} \right)$

Step 2: After the fuzzy values are calculated, these values are compared, and the likelihood values V of the options and criteria are obtained.

$V\left(M_2 \geq M_1\right) =$

$$\begin{cases} 1, & \text{if } m_2 \geq m_1 \\ 0, & \text{if } 1_1 \geq u_2 \\ \dfrac{1^1 - u_2}{\left(m_2 - u_2\right) - \left(m_1 - 1_1\right)} & \text{in other case} \end{cases}$$

Step 3: The probability degree of a convex fuzzy number more significant than k fuzzy numbers $M_i \ (i = 1,2,\ldots,k)$ is defined as follows;

$V\left(M \geq M_1, M_2, \ldots, M_k\right) = \left[\left(M \geq M_1\right) and \left(M \geq M_k\right)\right]$

$= min\, V\left(M \geq M_i\right),\ i = 1,2,3,\ \ldots,\ k$

Step 4: Normalized weight vector W is obtained by normalization, where W is not a fuzzy number. The normalization process is obtained by dividing each value by the sum.

$W = \left(d\left(A_1\right), d\left(A_2\right), d\left(A_3\right), \ldots, d\left(A_n\right)\right)^T$

9 Advantages of Artificial Intelligence in the Defense Industry

The products produced by the defense industry are not only crucial in war activities but also contribute to the development of our country. Artificial Intelligence, Augmented Reality, Machine Learning, Deep Learning, and Robotics are a combination of all these, thanks to the new generation of war technologies, which increase the situational awareness of the soldiers in the war environment by providing fast access to information on the battlefield, providing access to information at the desired speed without the need for any monitor or panel. The advantages of the technologies produced by the Defense Industry: are border surveillance, intervention with hand-made explosives, mine detection and neutralization, use in search and rescue operations, fast and durable and analysis, many features that will benefit our soldiers. As Artificial Intelligence in defense technologies increases, it should be expected to gain superiority in the military field.

10 Disadvantages of Artificial Intelligence in the Defense Industry

Many new war technologies have been produced under the work of Artificial Intelligence. Although these technologies are loved by everyone and brighten the eyes, they also have unseen wrong sides. Since it is not easy to detect the errors that occur during the production of these produced technologies, they may be overlooked. Most technologies and applications are still in the design, testing, or evaluation phase. Of course, simulators have a significant role in finding these errors.

Autonomous systems benefit us in all circumstances as they make and implement their own decisions, but it is still a matter of debate whether they should decide on their own. Should he choose for himself in each case, or should human consent be sought when necessary?

For this reason, it should be determined in which critical situation the defense technologies produced based on artificial intelligence require human approval.

11 Conclusion

As a result, if the data used to produce new technologies in the defense field are processed through appropriate algorithms, the technologies built, developed, and used with artificial intelligence will play an essential role in the development of our country in the defense sector by providing strategic, tactical and operational benefits in the military field. In addition, these technologies will give target-oriented benefits by making appropriate directions during the war. Since every technology produced within this new situation created by artificial intelligence will make a name for itself, it will be an indispensable part of the defense industry by directly affecting the present and the future. These technologies, which provide monitoring, surveillance, and data collection among the unique features required in all studies, significantly affect defense. Still, they are equipped with sufficient equipment to neutralize the other side and to predict every step. To benefit more from the importance and power of Artificial Intelligence, it is essential not to fall behind in this field. Even by looking at the already produced technologies, we see how strong the defense field of our future will be.

References:

[1] Yeşilyurt, F., & Yeşilyurt, M. E. (2019). Türkiye'de Savunma Sanayi. Pamukkale Journal of Eurasian Socioeconomic Studies, 6(2), 1-42.

[2] Data Science, Data Visualization, Artificial Intelligence, Machine Learning and Deep Learning. (2020). Access Date:28/04/2022. [Online].Available: https://www.savunmasanayiidergilik.com/tr/HaberDergilik/Veri-bilimi-veri-gorsellestirme-yapay-zek%C3%A2-makina-ogrenmesi-ve-derin-ogrenme

[3] Yusuf, Ö. (2018). Savaşın Değişen Karakteri: Teori ve Uygulamada Hibrit Savaş. Güvenlik Bilimleri Dergisi, 7(1), 29-56.

[4] Artificial Intelligence. (2020). Access Date:28/04/2022. [Online].Available: https://www.havelsan.com.tr/content/files/uploads/55/HAVELSAN_7_SAYI_WEB.pdf

[5] Erboz, G. (2017). How to define industry 4.0: main pillars of industry 4.0. Managerial trends in the development of enterprises in globalization era, 761-767.

[6] Simulation. (2022). Access Date:28/04/2022. [Online]. Available: https://www.havelsan.com.tr/sektorler/egitimve-simulasyon

[7] Sagiroglu, S., & Sinanc, D. (2013, May). Big data: A review. In 2013 international conference on collaboration technologies and systems (CTS) (pp. 42-47). IEEE.

[8] Eaton, C., Deroos, D., Deutsch, T., Lapis G., & Zikopoulos, P. C. (2012). Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, Mc Graw-Hill Companies, 978-0-07-179053-6.

[9] Singh, J., & Singla, V. (2015). Big data: tools and technologies in big data. International Journal of Computer Applications, 112(15).

[10] Provost, F., & Fawcett, T. (2013). Data science and its relationship to big data and data-driven decision making. Big data, 1(1), 51-59.

[11] Artificial Intelligence. (2020). Access Date:29/04/2022. [Online]. Available: https://www.ey.com/tr_tr/government-public-sector/yapay-zeka-savunmasektorunde-hizmet-veren%20kurumlarin-daha-cevik-veguclu-olmasi

[12] Çiçek, T. (2014). İnsansız Hava Araçları ve Hava Gücü Teorisi.

[13] Akıncı (2022). Access Date:29/04/2022. [Online]. Available: https://tr.wikipedia.org/wiki/Baykar_Bayraktar_Ak%C4%B1nc%C4%B1

[14] Barkan. (2022). Access Date:29/04/2022. [Online]. Available: https://www.havelsan.com.tr/sektorler/egitim-ve-simulasyon/robotik-ve-otonom-sistemler/havelsan-barkan

[15] 5G Yayilim Planlari. (2022). Access Date:07/05/2022. [Online]. Available: https://www.aselsan.com.tr/tr/inovasyon/haber-detay/dunyada-ve-turkiyede-5g-yayilim-planlari-ve-pazar-analizi-7733

[16] 5G Nedir. (2022). Access Date:07/05/2022. [Online]. Available: https://www.aselsan.com.tr/tr/inovasyon/haber-detay/5g-nedir-6346

[17] Rao, S. K., & Prasad, R. (2018). Impact of 5G technologies on industry 4.0. Wireless personal communications, 100(1), 145-159.

[18] Fraga-Lamas, P., Fernández-Caramés, T. M., Suárez-Albela, M., Castedo, L., & González-López, M. (2016). A review on internet of things for defense and public safety. Sensors, 16(10), 1644.

[19] Askeri ve Kamu Alanında 5G. (2022). Access Date:07/05/2022. [Online]. Available: https://www.aselsan.com.tr/tr/inovasyon/haber-detay/askeri-ve-kamu-alaninda-5g-4837

[20] Kabak, M. (2011). Birlik hava savunma önceliklerinin tespitine bulanık bir yaklaşım. Savunma Bilimleri Dergisi, 10(2), 1-17.

[21] Aydin, Y., & Tamer, E. (2018). Hava savunma sanayii alt yüklenici seçiminde bulanık mantık altında çok kriterli karar verme ve hedef programlama yöntemlerinin kullanılması. Journal of Aviation, 2(1), 10-30.