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The Role Of Artificial Intelligence (Ai) In The Military Sector

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Abstract: This article focuses on artificial intelligence (AI) and its role in the military sector, particularly analyzing its applications and potential uses. Special attention is given to the implementation of AI technologies in engineering fields, especially in military engineering and sapper units. The article also highlights specific opportunities that AI offers to such units and provides relevant information about these applications.

Key words: Artificial intelligence, combative, countries, drone, robot, technique, engineer, modern, weapons, mining, mine, distance, system and means.

During a meeting on strengthening national security and defense, the President of the Republic of Uzbekistan and Supreme Commander-in-Chief of the Armed Forces, **Shavkat Mirziyoyev**, emphasized the growing use of artificial intelligence, robotics, missiles, drones, and countermeasures in regional conflicts of varying scale and intensity. In light of this, he stressed the necessity of establishing new military units specializing in drone operations and anti-drone systems, cyber structures powered by artificial intelligence, robotic technologies, and air defense systems. The President also underlined the importance of enhancing the combat readiness and training standards of the Armed Forces of Uzbekistan and proposed the development of a unified automated command-and-control system based on artificial intelligence technologies [1].

Therefore, along with the armed forces of other countries, it is essential for us to utilize artificial intelligence in enhancing the potential of our national army. **Artificial intelligence (AI)** is a field of science and technology aimed at creating machines capable of imitating human intelligence (**Figure 1**).

Figure 1. Artificial Intelligence

Governments and companies in developed countries such as the United States and China were among the first to recognize the potential of artificial intelligence technologies and have invested heavily in their development (**Figure 2**).

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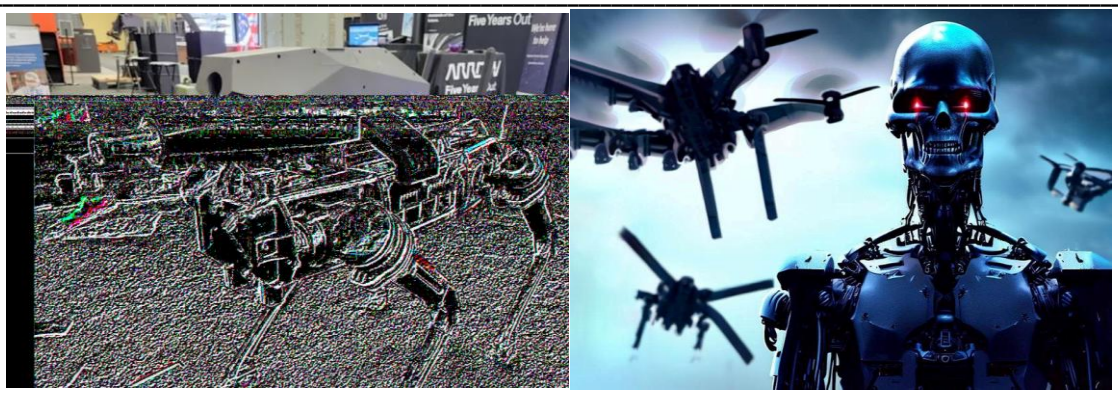

Figure 2. Stages of Artificial Intelligence Development

Without exaggeration, we can say that today we are living in what used to be portrayed as the distant future in science fiction films. A quick look around reveals that many of our daily tasks are now being carried out directly or indirectly by technological devices. Often, all it takes is the push of a button to get something done. This is because almost all modern electronic devices are equipped with some level of artificial intelligence (AI) technology [3].

Simply put, electronic devices based on AI have already taken over many routine human tasks. For example, this technology can recommend a song on your playlist or suggest the fastest and easiest route to your destination.

Of course, artificial intelligence has not only advantages but also its own set of drawbacks. In terms of benefits, this "miracle of progress" can enhance our intelligence and capabilities. Most importantly, it enables us to find the necessary information in a very short time and to perform various tasks more efficiently. Moreover, AI allows complex tasks to be completed quickly and easily, helping people save time and focus on what truly interests them.

Today, artificial intelligence is present almost everywhere. It plays a leading role in the internet, social networks, smart gadgets, and virtual personal assistants like Siri, Alisa, and Google Assistant, among many other everyday applications.

As AI continues to develop, every society must address the challenge of designing this technology in a way that is safe and beneficial for humanity. Ensuring the responsible and secure use of AI is a critical issue.

Such concerns are indeed valid. Currently, developed nations are increasingly turning to AI technologies to enhance the capabilities of their armed forces (**Figure 3**). Billions of dollars are being invested toward this goal. As a result, a new and terrifying form of modern military technology — driven by artificial intelligence — is being added to the arsenal of mankind, potentially matching the destructive capacity of weapons of mass destruction [4].

Figure 3. Developments in Artificial Intelligence

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Today, the integration of artificial intelligence (AI) into military sectors is creating a number of advantages:

1. **Automated Weapons and Drones:**
   AI is enabling the automation of military weapon systems. These systems are capable of performing tasks independently, such as collecting intelligence, eliminating critical targets, or conducting reconnaissance operations.
2. **Data Analysis:**
   AI can analyze large volumes of data rapidly and efficiently, which enhances the speed and accuracy of decision-making in military operations.

In addition to its growing use in military areas (including IT and programming systems), artificial intelligence also holds significant potential in the field of engineering. The practical application of AI in various engineering units improves efficiency, automates production processes, and helps monitor and analyze operational outcomes [5,6].

AI is also of great importance for **military engineering units**, especially **combat engineer (sapper) divisions** (**Figure 4**). In situations involving military and governmental facilities where there may be explosive devices or hazardous materials, AI can aid in detection, neutralization, and ensuring overall safety. The use of AI in engineering reconnaissance significantly facilitates the work of sappers, making operations more accurate and efficient.

Figure 4. AI-Powered Drones for Mine Detection and Neutralization

Below are some key capabilities of artificial intelligence that are particularly valuable for combat engineer (sapper) units:

1. **Robots and Drones.**

Detection of Explosive and Hazardous Devices:

AI-powered autonomous robots use multiple methods to detect explosive devices and conduct engineering reconnaissance. Most of these methods rely on advanced sensors and machine learning algorithms to identify threats with high accuracy.

– Sensors:

Metal Detectors: One of the most common methods. They detect the metal contained in potentially explosive objects. However, they cannot detect plastic mines and may be confused by other metallic objects present in the soil (such as bricks or pieces of iron). Nevertheless, they help ensure the safety of the sapper.

Radar (Ground Penetrating Radar – GPR): Sends radio waves into the ground and analyzes the reflected signals. Helps to determine the shape and location of potentially explosive objects. However, its quality may vary depending on the composition of the soil.

Infrared Sensors: Detect the temperature difference between potentially explosive objects and the surrounding soil. Effective for detecting mines heated by sunlight.

Chemical Sensors: Detect chemical substances released from potentially explosive objects (traces of explosives).

Machine Learning Algorithms:

Classification: Analyzes data received from sensors to determine whether an object is a "mine" or "not a mine."

Object Detection: Widely used to identify potentially explosive objects from images and video footage. For example, it analyzes visuals captured by drones.

Segmentation: Determines for each pixel in an image whether it represents a "mine" or "not a mine."

Deep Learning: Neural networks trained on large volumes of data. Highly effective in analyzing complex data received from sensors.

Autonomy:

- GPS and IMU (Inertial Measurement Unit): Used to determine the robot's position and movement.
- SLAM (Simultaneous Localization and Mapping): Enables the robot to build a map of its environment while simultaneously determining its own location.
- Path Planning: Finds the optimal route by taking into account the risk posed by explosive objects.
- Obstacle Avoidance: Detects surrounding obstacles and avoids them during movement.

Operating Procedure:

1. The robot collects environmental data using sensors (magnetic fields, radar signals, temperature, chemical substances, etc.).
2. This data is processed using machine learning algorithms.
3. The algorithms calculate the probability that the object is an "explosive hazard."
4. If the probability is high, the robot takes safety measures (e.g., marks the location, sends an alert, or attempts to neutralize the mine).

Potential Challenges:

- False Signals:
  Sensors may mistakenly identify non-explosive objects as mines.
- Soil Conditions:
  The composition of the soil can affect the performance of sensors.
- Power Supply:
  Robots may lack sufficient energy capacity to operate for extended periods.
- Safety:
  There is a risk that the robot itself could trigger a mine.

3. Simulations in the Detection and Identification of Explosive Devices

Artificial Intelligence and Machine Learning:

Machine learning and artificial intelligence algorithms help automate various techniques for detecting explosive devices. These technologies analyze roads, fields, and multiple factors simultaneously to determine areas with a high probability of containing mines.

Modeling and Simulation:

In mine detection and neutralization, artificial intelligence is used in modeling and simulation processes. Software systems simulate the types, locations, and potential responses of explosive devices, helping identify safe routes and appropriate actions.

Simulations play a vital role in the field of explosive detection and search. They replicate real-life conditions and allow the testing of different scenarios in a safe and cost-effective manner. This is especially useful for developing and evaluating new algorithms and technologies.

Advantages of Simulations:

Safety:

Since real minefields are extremely dangerous, simulations provide a safe environment for testing new methods and technologies.

Cost-Effectiveness:

Conducting experiments in real minefields can be extremely expensive. Simulations are more affordable and can be run more quickly.

Control:

Simulations allow for precise control over conditions. Parameters such as soil composition, mine types, and their placement can be easily modified.

Repeatability:

Simulations can be repeated multiple times, allowing for comparison and evaluation of results under consistent conditions.

Data for Machine Learning:

Simulations can generate large datasets for training machine learning algorithms, enhancing their accuracy and performance.

Types of Simulations:

Physical Simulations:

These simulations model real-world physical processes. For example, the propagation of ground-penetrating radar (GPR) signals, the operation of metal detectors, and so on.

Sensor Simulations:

These simulations model data collected from various sensors, such as metal detectors, GPR, infrared sensors, and chemical sensors.

Robot Simulations:

These simulations model the movement of robots, their sensor functions, and interactions with the surrounding environment.

Virtual Reality (VR) Simulations:

These simulations allow users to operate in a virtual minefield environment, providing realistic training and experience.

Applications of Simulations

Algorithm Development and Evaluation:

Testing mine detection algorithms in simulations and evaluating their effectiveness.

Sensor Optimization:

Adjusting the parameters of various sensors within simulations to improve their performance and accuracy.

Development of Robot Control Strategies:

Designing and evaluating robot navigation strategies for minefields using simulation environments.

Training:

Simulations can be used to train specialists in mine clearance operations.

Rapid Decision-Making and Safety

Rapid Decision-Making Based on Updated Information:

Sappers often need to make quick decisions during combat missions or under challenging conditions. Artificial intelligence and its algorithms assist in detecting dangerous situations in military or government facility areas, enabling faster and more accurate decision-making in critical moments.

Organizational and Logistical Support:

Weapons and Ammunition Support: Artificial intelligence also assists sappers in identifying critical engineering munitions and ammunition. For example, through automated systems, it helps quickly locate the necessary tools or engineering explosives that match specific operational needs.

Logistics and Safe Transportation: Artificial intelligence can be used in logistical processes to assist sappers in the removal and safe disposal of landmines. This is of vital importance. In addition, training simulations are also widely used. These simulations, supported by artificial intelligence and virtual reality (VR) technologies, significantly enhance the ability to detect and handle mines effectively.

Based on the above, the following conclusions can be made:

1. In today's rapidly changing world, artificial intelligence is contributing to increased efficiency, automation, and stability in military operations. It supports the integration of innovative technologies and helps ensure the safety of military personnel. However, the growth of this field also requires careful consideration of legal and ethical issues.
2. Likewise, in the field of engineering, AI creates numerous advantages and improves efficiency. It supports critical tasks such as mine detection, disposal, and ensuring safety. Furthermore, artificial intelligence plays a key role in automating sapper operations, enabling faster decision-making, and optimizing logistical processes. AI not only enhances the performance of engineering units but also plays a crucial role in minimizing human risk and ensuring personnel safety.

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