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Drones in the Military

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ABSTRACT

Drones have rapidly evolved into an essential component of modern warfare. Today, drones primarily serve the military industry around the world. Military drones have become indispensable tools for special operations forces, providing real-time situational awareness, communication relay, and electronic warfare capabilities. They can be used to establish communication networks in the battlefield, relaying signals between ground forces and command centers. Military drone applications have revolutionized the way modern warfare is conducted. From surveillance to combat and logistics, drones have become an indispensable tool for military operations worldwide. This paper examines the applications, benefits, and challenges of drones in the military.

KEYWORDS: *drones, unmanned aircrafts, unmanned aerial vehicles (UAVs), military, military drones*

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INTRODUCTION

The United States has been at the forefront of military drone development and deployment. The number of nations using drones has increased to about 50 in recent years, including China and Iran. The primary purpose of the Department of Defense (DoD) domestic aviation operations are to support Homeland Defense (HD) and Defense Support of Civilian Authorities (DSCA) operations, and military training and exercises. The primary purpose of DoD domestic UAS operations is for DoD forces to gain realistic training experience, test equipment, and tactics in preparation for potential overseas warfighting missions. The vast majority of DoD UAS training is conducted in airspace delegated by the FAA for DoD use [1]. While drones have their many civilian uses in agriculture, education, business, manufacturing, surveillance, film making, etc. military drones are armed ones used in combat.

WHAT IS A DRONE?

The FAA defines drones, also known as unmanned aerial vehicles (UAVs), as any aircraft system without a flight crew onboard. Drones include flying, floating, and other devices, including unmanned aerial vehicles (UAVs), that can fly independently along set routes using an onboard computer or follow commands transmitted remotely by a pilot on the ground. A typical drone is shown in Figure 1 [2]. A drone is usually controlled remotely by a human pilot on the ground, as typically shown in Figure 2 [3].Drones can range in size from large military drones to smaller drones. Drones, previously used for military purposes, have started to be used for civilian purposes since the 2000s. Since then, drones have continued to be used in intelligence, aerial surveillance, search and rescue, reconnaissance, and offensive missions as part of the military Internet of things (IoT). Today, drones are used for different purposes such as aerial photography, surveillance, agriculture, entertainment, healthcare, transportation, law enforcement, etc.

Commercial drones have come a long way in the last decade.

Drones work much like other modes of air transportation, such as helicopters and airplanes. When the engine is turned on, it starts up, and the propellers rotate to enable flight. The motors spin the propellers and the propellers push against the air

molecules downward, which pulls the drone upwards. Once the drone is flying, it is able to move forward, back, left, and right by spinning each of the propellers at a different speed. Then, the pilot uses the remote control to direct its flight from the ground [4].

Drone laws exist to ensure a high level of safety in the skies, especially near sensitive areas like airports. They also aim to address privacy concerns that arise when camera drones fly in residential areas. These include the requirement to keep your drone within sight at all times when airborne. In the United States, drones weighing less than 250g are exempt from registration with civil aviation authorities. If your drone exceeds 250g in weight, you will also require a Flyer ID, which requires passing a test [5]. It is necessary to register as an operator, be trained as a pilot, and have civil liability insurance, in addition to complying with various flight regulations, and those of the places where their use is permitted.

Most drones have a limited payload, usually under 11 pounds. Drones are classified according to their size. Here are the different drone types:

- Nano Drone: 80-100 mm
- Micro Drone: 100-150 mm
- Small Drone: 150-250 mm
- Medium Drone: 250-400 mm
- Large Drone: 400+ mm

One of the emerging trends in drone use for factories is the utilization of LiDAR technology. LiDAR stands for Light Detection and Ranging. This technology provides accurate depth information essential for understanding the three-dimensional structure of the environment. LiDAR sensors emit laser beams to measure distances to objects, creating high-resolution 3D maps of the surrounding terrain and objects. The ability to capture detailed data through LiDAR technology has opened up opportunities for better predictive maintenance, reduction in inspection times, and overall cost savings [6].

MILITARY DRONES

The concept of unmanned aerial vehicles(UAVs) dates back to the early 20th century. But it was not until World War II that UAVs began to take shape as a vital military tool. In the late 20th century and early 21st century, military drones evolved rapidly. Today, military drones are used by numerous nations for intelligence, surveillance, and reconnaissance (ISR) missions. In 1959, as tensions between the US and the Soviet Union began to skyrocket, so did drone innovation. The first military conflict in which UAVs played a major role was the Gulf War, after which military drones became commonplace worldwide.

Military drones are remote-controlled aircraft of various sizes designed to perform tasks deemed too dull, dirty, or dangerous for human troops. The main selling point of a military drone is the lack of an on board human pilot. The drones have revolutionized the way modern warfare is conducted by providing a means of engaging targets with precision and reduced risk to military personnel. They are often used in dangerous areas where human soldiers might be at risk. These drones can conduct precision strikes on high-value targets. A typical military drone is shown in Figure 3 [7]. Military drones are remotely-piloted UAVs used for monitoring, mapping, target acquisition, intelligence, battle damage management, and surveillance. They are armed with missiles, bombs, or anti-tank weapons. These drones have been a valuable asset in the military for many years. Pentagon takes the issue of military drones used on American soil very seriously.

There are different types of military drones, including the following [8]:

- Combat drones (or fighter drones) are designed for offensive operations.
- Tactical drones are used in a range of specialized missions, such as communication relay, electronic warfare, and counter-drone operations.
- Transport drones are designed for logistical support, such as delivering supplies, medical evacuation, and personnel transport.
- Reconnaissance drones can be used to monitor enemy movements, troop deployments, and infrastructure.
- Surveillance drones have the ability to observe enemy activities without putting human lives at risk.
- Detecting and tracking drones can provide real-time information on drone locations, flight paths, and potential payloads.
- Swarming drones refer to coordinated deployment of multiple drones to carry out complex tasks or missions.
- Logistics drones are drones that are used for logistical purposes, such as transporting supplies and equipment to troops in the field.
- Target drones are drones that are used as targets for training exercises.
- Stealth drones are drones that are designed to be stealthy and difficult to detect.

Leading manufacturers in the global market of military drones include [9]:

1. General Atomics Aeronautical Systems, Inc.
2. Northrop Grumman Corporation
3. Israel Aerospace Industries Ltd
4. BAE Systems Plc

5. Lockheed Martin Corporation
6. Raytheon Company
7. Insitu Inc.
8. AeroVironment, Inc.
9. Turkish Aerospace Industries, Inc.
10. Elbit System Ltd
11. The Boeing Company
12. Thales Group
13. Saab Group

APPLICATIONS

Military drone applications have expanded dramatically, playing a critical role in intelligence gathering, combat operations, and logistical support. Drones are used by the military for a variety of purposes, including surveillance, target acquisition, reconnaissance, logistics, and targeted strikes. Common applications of drones in the military include the following:

- *Electronic Warfare:* Electronic warfare is the art of locating enemy forces by the signals that they send out and then isolating them by jamming their communications. This is a critical aspect of modern military operations, and tactical drones have emerged as valuable assets in this domain. They can be equipped with electronic warfare systems to detect, identify, and disrupt enemy radar and communication systems, rendering them ineffective. Drones can jam enemy communications and detect radar installations.
- *Enforcement and Countermeasures:* Law enforcement agencies are also investing in counter-drone technologies and capabilities to detect and neutralize unauthorized or malicious drone activities. These efforts include jamming and spoofing. Once a drone has been detected, jamming and spoofing techniques can be used to disrupt its communication and control systems. Jamming involves the transmission of radio frequency signals to interfere with the drone's remote control or GPS navigation, while spoofing involves sending false signals to deceive the drone's GPS receiver, causing it to deviate from its intended course or crash.
- *Surveillance:* Drones' surveillance capabilities allow for better situational awareness on the battlefield, helping to detect potential threats and plan effective military strategies. In urban warfare scenarios, where the environment is complex and unpredictable, drones can be invaluable assets, assisting ground troops in navigating and understanding the terrain from above.
- *Reconnaissance:* Drones can conduct surveillance missions by hovering over an area for an extended period. They can survey hostile territories and provide real-time information to command centers. This can help protect soldiers from danger and improve situational awareness. They can provide rapid assistance that significantly impacts the survival and recovery of injured individuals. They can help swiftly locate and assess injured soldiers in combat zones.
- *Logistics*: Drones are revolutionizing the delivery of medical supplies. They can carry essential medical equipment and medications to injured personnel in areas inaccessible by traditional means. They can deliver supplies to front-line units in hard-to-reach areas. They can also help evacuate injured personnel. A drone can hover around and land anywhere without using runways. Examples are retail companies, parcel services, and pharmacies using drone delivery to bring goods and medications to our doorstep. Manufacturers are also using drones to ship supplies directly to businesses. Figure 4 shows a delivery drone [10].
- *Communication:* Drones can act as airborne communication relays to connect units and command centers, especially in areas with compromised communication infrastructure**.** Drones also use radio to send data like videos and receive remote control.
- *Search and Rescue:* Drones can be used for combat search and rescue. For example, imagine a search and rescue mission in a dense forest, where a drone uses its AI edge computing capabilities to navigate through the complex environment. Some drones for rescue missions are portrayed in Figure 5 [11].
- *Autonomous Navigation:* Modern drones are equipped with cutting-edge AI and edge computing that enables them to navigate complex environments autonomously. This includes obstacle avoidance, terrain analysis, and even adaptive mission planning based on real-time data. It can identify and avoid obstacles like trees and cliffs, analyze the terrain to find the safest and most efficient routes, and adapt its flight plan in real-time based on changes in the environment.
- *Decision Making:* AI algorithms allow drones to make critical decisions rapidly. For instance, a drone can analyze threats, select targets, and even choose flight paths with minimal human input. In a military operation, a drone equipped with AI algorithms can rapidly analyze aerial footage to identify potential threats, such as enemy combatants or unsecured territories. It can then

autonomously select the safest flight path to avoid detection or confrontation.

- *Coordinated Operations:* Swarm technology involves multiple drones working together, coordinated through advanced AI. This approach allows for complex, large-scale operations where drones collaborate to achieve common objectives. Swarm drones can be used in various scenarios, from reconnaissance missions to creating real-time 3D maps of battlefields to overwhelming enemy defenses. Figure 6 displays a swarm of drones [2].
- *Military Exercises:* Drones are becoming increasingly important in modern military exercises. Military exercises are an important part of military training around the world. It is a way for soldiers to hone their skills, test their equipment and improve their tactics. In recent years, drone technology has played a key role in military exercises. Drones are a game-changer when it comes to military operations and can help soldiers in numerous ways. Drones are also being used in more specialized training exercises. They can be used to train in complex and dangerous environments that would be too dangerous or expensive to train in with live troops. The use of drones in military exercises is not without its challenges. One challenge is that drones can be easily hacked or jammed.

BENEFITS

Drones play a crucial role in war, medicine, and rescue missions. Their success in different operations makes them an invaluable asset. Drone strikes ensure the safety of the United States by deconstructing terrorist organizations anywhere in the world. They protect more US military personnel and kill fewer civilians than any other weapon used by the military. They are cheaper than manned aerial warfare or ground combat. The Pentagon has deployed drones to spy over US territory for non-military missions over the past decade. Other benefits of military drones include the following [12]:

- *Better Reconnaissance:* Drones provide real-time information on targets' positions, terrain, and enemy movements to commanders on the ground. Compared to high-altitude aircraft, drones can take closer footage without compromising the quality of both photos and video.
- *Reduced Cost:* Drones are cheaper than conventional aircraft in terms of both price and maintenance. Because drones are unmanned, they also reduce the risk of pilots being injured mid-flight. States and non-state groups that cannot afford to buy fighter jets can buy drones.
- *Increased Convenience:* Compared to conventional aircraft, drones are faster and easier to deploy. They are easier to operate and do not need training as extensive as most aircraft. Also, many drones do not need a runway, and other types can easily fit in a backpack.
- *Enhanced Safety:* Military drones have changed how military bases secure their perimeters and monitor for threats, improving surveillance and soldier safety. Drone operators can provide real-time information without putting themselves at risk. On top of this, that same information also informs commanders where to position their troops to ensure safety. Everything the FAA does is focused on ensuring the safety of the nation's aviation system.
- *Increased Flexibility:* Military forces always need to be ready for anything at a moment's notice. Drones are helpful in readiness. They can even be fully automated. They provide many benefits and advantages that make them extremely useful for different roles.
- *Precision Warfare:* Armed drones have become a game-changer in modern warfare. With the ability to carry various types of munitions, including missiles and guided bombs, they offer precise and lethal firepower. Precision warfare, made possible by drone technology, minimizes collateral damage and civilian casualties, making it a more ethically acceptable form of warfare compared to traditional indiscriminate bombardments.

CHALLENGES

Critics of the drone strikes argue that drone strikes wreak havoc on civilian communities and in turn create more terrorists than they set out to destroy. Drone operations are secretive, lack sufficient legal oversight, and prevent citizens from holding their leaders accountable. In spite of the growing use of drones, they remain a controversial and unpopular tactic. Other challenges of military drones include the following [12]:

- *Cost:* The Pentagon abhors cheapness; no production line exists for cheap drones or cheap artillery shells. The defense industry prices are prohibitively high. Official procurement figures are classified, but press reports indicate per unit costs for military drones vary from $6,000 to $58,000— twelve to one hundred times more expensive than Ukraine's home-assembled drones. (Ukraine is producing one million drones). The same cost disparity affects defense just as much as offense on land. Another challenge is that drones can be expensive to operate.

- *Drone Strikes:* Drone strikes violate the sovereignty of other countries and are extremely unpopular in the affected countries. They often raise complex legal and moral dilemmas. They are illegal under both international and United States humanitarian law, which states that lethal force is only permissible when the target poses an immediate threat to the country's survival. And it can be argued that not all drone targets fit this category. The death toll from American drone strikes was approximately 2,400 in total from 2009-2014 and has risen to more than 6,000 since 2015.
- *War:* Whichever side you are fighting on, war is horrific and lamentable. Less of them are in harm's way because of the use of drones. The proliferation of drone technology poses security risks, as non-state actors and adversarial nations can utilize drones for malicious purposes. Drones have been linked with civilian deaths in many conflict zones
- *Ethical Concern:* The use of military drones, particularly in armed strikes, has raised several legal and ethical concerns. The concerns refer to the use of combat drones in targeted killings, that is the intentional killing of specific individuals outside of an active battlefield, resulting in the unintentional deaths of innocent civilians.
- *Accountability*: Another significant concern is the lack of transparency and accountability surrounding drone operations. Due to the covert nature of drone warfare, it can be challenging to ascertain the precise circumstances and justifications for drone strikes. This lack of accountability has led to calls for greater oversight of drone operations to ensure that they are conducted in accordance with international law and ethical standards.
- *Regulations:* To prevent the misuse of drones and ensure public safety, governments worldwide have implemented legal restrictions and regulations governing the use of civilian drones. These regulations typically include requirements for registration, flight restrictions in specific areas (e.g. near airports, military installations, or populated areas), and limitations on drone size, weight, and capabilities.

CONCLUSION

The rise of drones has been nothing short of revolutionary in the military industry. Modern warfare and national defense using drones make for big business the world over. With the largest military budget in the world, the United States is a leader in the development and production of the drones.

As technology continues to evolve, so too will military drone applications. As the use of military drones becomes more prevalent, the development of counter-drone measures and defense systems has become increasingly important. An increase in terror threats, unconventional military threats, and geopolitical tensions worldwide have led to an increase in demand for unmanned aerial vehicles (UAVs) to target terrorist and insurgent groups across the globe. As the market for military drones continues to expand, driven by increasing government funding and technological innovations, drones are set to play an even more crucial role in shaping the landscape of global security and defense strategies.

The search for small disposable and accessible drones in military and defense is on the rise around the world. Every military specialist agrees that Unmanned Aerial Vehicles, or drones, are the future of warfare. Future drones will be even more autonomous, capable of performing complex tasks such as tactical strikes, surveillance missions, and supply deliveries without human intervention. More information about drones in the military can be found in the books in [13-20] and related journal: *Drones*.

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Figure 1 A typical drone [2].

Figure 2 A drone is usually controlled by operators on the ground [3].

Figure 3 A typical military drone [7].

Figure 4 A delivery drone [10].

Figure 5 Drones for rescue missions [11].

Figure 6 A swarm of drones [2].