

SECTION

6

UAV APPLICATIONS



Unmanned Aerial Vehicles (UAVs)

UAV Applications

INTRODUCTION

Welcome to this section. The section focuses on the applications of Unmanned Aerial Vehicles (UAVs). UAVs have become increasingly prevalent in both civil and military applications. Hence, we will discuss the various uses of UAVs within both the civil and military space, and the benefits they have for humanity and the potential threats they pose to personal and infrastructural safety in general. Please note that the list of applications discussed here is not exhaustive, as new uses for UAVs are constantly emerging.

At the end of this section, you will be able to:

1. Describe civilian applications of Unmanned Aerial Vehicles
2. Examine the uses of the military applications of Unmanned Aerial Vehicles

Key ideas

- Relay uses a small amount of electricity to control a bigger electrical device
- Jammer blocks or interferes with wireless signals
- Remote sensing is gathering information about an object, area, or phenomenon without making physical contact.

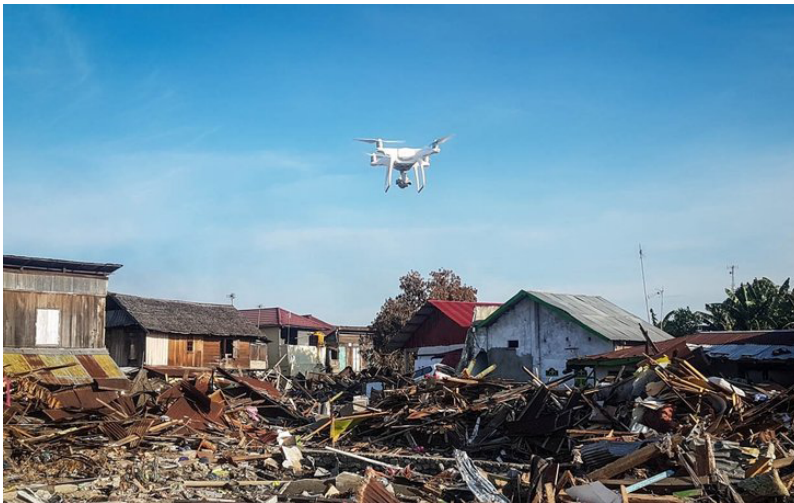
CIVILIAN APPLICATION OF UAVS

There are a lot of applications of drones in the civilian space. Let us consider some of the applications;

Disaster Management

Drones can be used in places that are too dangerous for people during man-made or natural disasters like terrorist attacks, tsunamis, or floods. In such situations, things like electricity, phone networks, water, and transport systems may be disrupted. Drones help by quickly gathering information, responding fast, and moving through the wreckage. With sensors, radars, and high-quality cameras, drones can assist rescue teams by spotting damage, starting recovery efforts, and delivering supplies such as medical kits and first-aid with manned helicopters. Sometimes, many drones can work

together in an emergency without needing human control. They can help find people and animals that need to be rescued.



<https://mobygeek.com/features/iit-madras-are-working-on-drones-for-surveillance-and-disaster-relief-9486>

Figure 6.1: Disaster management drone

Remote Sensing

UAVs are used to capture detailed images of hard-to-reach places like mountains, coastlines, and islands. They act as a bridge between data collected from the air, ground, and space. Due to their relatively small size, drones can quickly gather high-quality aerial data. They are used for many purposes, such as diagnosing diseases, checking water quality, monitoring famine, estimating gas and oil production, protecting natural resources, studying geological disasters, mapping landscapes, modelling water systems, and managing crops. Drones are also useful in archaeology and map-making, where they help create 3D maps and provide crowd-sourced information. This technology gives up-to-date information at a low cost, helping land planners avoid using outdated maps.

Search and Rescue (SAR)

Drones are used to locate lost hikers during trips or protect people in remote forests or deserts. They can help track victims in challenging terrain or bad weather conditions. In emergencies, drones can deliver important medical supplies before doctors arrive. They can carry food, vaccines, medical kits, and life jackets to communities affected by disasters or in remote areas. Drones can also deliver clothing, water, and other necessities to stranded people in difficult places before rescue teams arrive. This is helpful in situations like avalanches, forest fires, and dangerous gas leaks.

Infrastructure and Construction Inspection

Drones have made it easier, faster, and more efficient to monitor and survey construction projects. By tracking the progress of a building project from beginning to end, drones help ensure that the work is of high quality. They can provide reports to stakeholders with photos, videos, and 3D maps. Drones are becoming very popular for inspecting mobile communication towers, monitoring gas pipelines, checking power lines, and overseeing construction sites.



<https://mobygeek.com/features/iit-madras-are-working-on-drones-for-surveillance-and-disaster-relief-9486>

Figure 6.2: Drone for inspection of infrastructure

Precision Agriculture

Drones are used in farming to collect data with ground sensors to check water quality, soil composition, humidity, and more. They are also set up to spray pesticides, detect diseases, schedule irrigation, find weeds, and monitor crops. Drones save time and money, helping to improve farm productivity, performance, and income. With special cameras and sensors, drones can analyse crop health by checking leaf area, pollutants, chlorophyll content, and temperatures.



Figure 6.3: Drones used for farming

Real-Time Monitoring of Road Traffic

The use of drones in monitoring road traffic has greatly improved road safety. Drones are now a valuable tool for gathering data on highway traffic conditions. Compared with traditional systems like surveillance cameras and sensors, drones are more affordable and can cover larger areas. Local police can use drones to investigate road accidents or conduct security operations against illegal activities, such as car theft. Drones can also help identify vehicles, track suspects, pursue hijackers or robbers, and catch traffic violators. Additionally, they help monitor driving behaviour, prevent traffic congestion, and inspect road conditions for repairs.



Figure 6.4: Drone monitoring traffic

Automated Forest Restoration

UAVs (drones) are becoming an important tool for controlled forest restoration. They can be used for various tasks such as inspecting sites, planning restoration efforts, delivering seedlings, maintaining the area (like germination and weeding), and conducting biodiversity surveys after restoration. With the help of GPS and image sensors, drones can perform tasks like pre-restoration inspections and monitor biodiversity recovery. They can track temperature changes, forest functions, and ecological makeup, helping monitor replanting efforts. High-resolution cameras on drones gather important data on natural forests, supporting restoration projects. Drones are great for collecting data quickly and easily, and their cameras can help study and map forest landscapes. Optical sensors on UAVs are also used to measure forest features like vegetation cover, tree diameter, and height. Additionally, drones are valuable for remote sensing, an effective method for monitoring forests.



Figure 6.5: Tree planting drone

Space Exploration

A new trend in space exploration is the use of UAVs (drones). These unmanned vehicles have the potential to carry out space missions, such as studying the surface and atmosphere of the moon. Although there are several methods for exploring planets,

like rovers, landers, orbiters, flying balloons, spacecraft, probes, and telescopes, they have limitations in resolution, information, and flexibility. This has led to a growing interest in using UAVs because of their varied advantages. UAVs can cover larger areas than current orbiters and rovers, making them a valuable tool for space exploration.

Activity 6.1

1. Watch the videos below and discuss with your friend the civilian application of UAVs

[Top 10 applications of drones \(youtube.com\)](#)



[What Are Drones Used For? 31 Uses For Flying Drones and UAV. \(youtube.com\)](#)



2. Write down at least three applications of UAVs in the civilian space.

Activity 6.2

1. Your teacher will arrange for an in-person presentation by an expert on the uses of UAVs in civilian space.

Note: Ask the expert questions to improve your understanding, and support a whole class discussion which will be conducted after the session.

2. Summarise and write down at least three uses of UAVs

The focus of the summary should be on these areas;

- a. Health
 - b. Education
 - c. Business
 - d. Agriculture
 - e. Research
3. Discuss with your friend factors that could hinder UAV operations in these areas
 4. Based on your understanding so far, formulate examples of new applications of UAVs in logistics, education, and health

MILITARY APPLICATION OF UAVS

The military uses UAVs (drones) for various operations. Let's look at some key applications and reasons for their use, which you can discuss in pairs or in groups:

Search and Rescue

Drones are playing a bigger role in military search and rescue missions. They are used to find and rescue people in dangerous or hard-to-reach places and can also deliver supplies to soldiers in the field.



Figure 6.6: UAV SAR

Logistics and Supply

Drones can be used to deliver goods and supplies. They help carry equipment and people to places that are hard to reach. Drones are also useful for sending supplies to soldiers in the field, which reduces the need for vehicles on the ground.



Figure 6.7: UAV logistics supply

Anti-drone Operations

As drones are being used more in the military, stopping enemy drones has become important. Special drones and anti-drone guns can find and take down enemy drones, helping to prevent intelligence gathering and air attacks.



[The smart anti-drone grenade and bazzooka that will save us from Skynet \(wearethemighty.com\)](http://wearethemighty.com)

Figure 6.8: Anti drone gun in action

Training and Simulation

Drones are also used for training and practice. They can act like enemy targets, allowing soldiers to practice their strategies and skills in a safe way.



Figure 6.9: Ghanaian military simulating with a UAV

Unmanned Cargo and Transport UAVs

Unmanned cargo and transport drones are made to help with tasks like delivering supplies, moving people, and medical evacuations. Although they are still being developed, these drones could change the way the military moves goods and people by making transportation faster and more efficient.



Figure 6.10: Unmanned cargo transport

Communication Relay and Jamming

Tactical drones can help set up communication networks on the battlefield by sending signals between soldiers and command centres. They can also be used to block enemy communications by jamming radio signals, making it harder for the enemy to plan and carry out their operations.

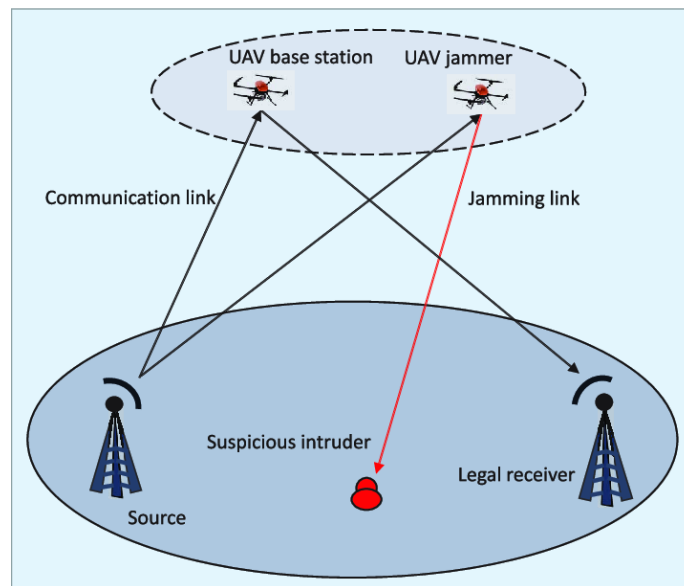


Figure 6.11: Picture of communication jamming

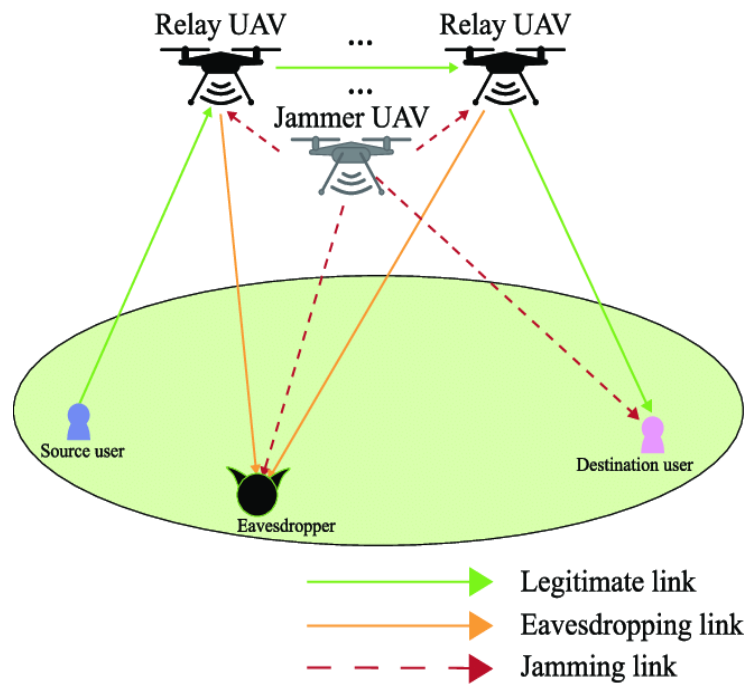


Figure 6.12: UAV multi-loop relay

Electronic Warfare

Electronic warfare 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 and vulnerable to attack.



Figure 6.13: A UAV in warfare

Activity 6.3

1. Watch the videos below and discuss the military application of UAVs with peers

[Skydio Scout + TAK Protects Police & Military On The Move \(youtube.com\)](#)



[Drones for Search & Rescue - Episode 2 \(youtube.com\)](#)



[7 POWERFUL Anti-Drone Weapons \(youtube.com\)](#)



2. Write a short essay about the military use of UAVs

Activity 6.4

1. Your teacher may invite a military person to speak to the class about the application of UAVs. Alternatively, listen to a recorded video presentation made by military personnel on their application of UAVs.
2. Summarise the military application of UAVs based on what you have learnt.
3. With your classmates, discuss potential problems with the use of military UAVs that must be overcome to ensure safety of use.
4. In small groups, consider new ways UAVs may be used for military purposes.

Review Questions

1.

You are a drone operator tasked with using UAVs in two different scenarios: one for civilian purposes and one for military purposes.

Civilian Application: You are asked to use a UAV to support a humanitarian mission after a natural disaster. What are some specific tasks the UAV could perform to assist in the recovery efforts?

Military Application: You are asked to use a UAV in a reconnaissance mission during a military operation. What are some key advantages of using a UAV for this task compared with traditional manned aircraft?

2.

Your team is tasked with launching a UAV operation in a busy urban area to monitor traffic congestion and assist emergency services. However, there are several challenges you must consider.

- a. Identify and explain at least two factors that could hinder UAV operations in an urban environment.
- b. How would you overcome or minimise each of these challenges to ensure a successful operation?

3. UAVs have already made an impact in many fields such as logistics, education, health, and agriculture.

Formulate at least one new application of UAVs in these areas

4. Identify and explain at least two potential problems with the use of military UAVs that must be overcome to ensure the safety of use.

5. Formulate at least one new way UAVs can be used by the military

Answers to Review Questions

1.

Civilian Application

Disaster Response: UAVs can be used to quickly survey disaster-affected areas, providing real-time images to rescue teams to identify the most damaged zones and help locate survivors.

Agriculture: UAVs are used for precision farming, helping farmers monitor crop health, apply pesticides or fertilisers, and track irrigation needs by capturing detailed aerial imagery.

Logistics and Delivery: Companies are exploring UAVs for last-mile delivery, especially in remote areas. Drones can deliver essential supplies like medicine or food to places that are difficult to reach by conventional transportation.

Military Application

Surveillance and Reconnaissance: UAVs can provide real-time intelligence by capturing high-resolution imagery of enemy movements or territories, without putting human lives at risk.

Target Acquisition: UAVs can be equipped with sensors to detect enemy positions and provide data to ground or air forces to accurately target hostile elements, increasing mission efficiency.

Stealth and Efficiency: Unlike manned aircraft, UAVs can fly for extended periods, often undetected, and can perform missions in dangerous environments where human pilots would be at significant risk.

2. a.

- i. Signal interference
- ii. Limited battery life
- iii. Crowded Airspace and Obstacles
- iv. Regulatory Restrictions
- v. Weather Conditions

b.

- i. Use drones with advanced anti-interference technology, and switch to more reliable frequencies to avoid signal overlap.
- ii. Use drones with longer battery life, or have spare batteries on hand for quick replacements. Plan operations efficiently to maximise flight time.
- iii. Use drones equipped with obstacle detection and avoidance systems. Pre-plan flight routes using detailed 3D maps of the area.

- iv. Obtain all necessary permits and follow local regulations. Conduct thorough risk assessments before the flight and ensure compliance with authorities.
- v. Monitor weather forecasts closely before operations. Use weather-resistant UAVs designed for various conditions or postpone flights during adverse weather.

3.

Agriculture

Soil Health Monitoring: UAVs could be equipped with sensors to analyse soil composition and moisture levels across large fields, giving farmers real-time data on soil health and suggesting precise areas for treatment, fertiliser application, or irrigation.

Logistics

Supply Chain Monitoring: UAVs could track the movement of goods in outdoor storage yards, ports, or manufacturing plants, helping to monitor logistics bottlenecks in real time. They could even assist in inspecting shipping containers or trucks for damage or security threats.

Health

Rapid Organ Transport: UAVs could transport organs for transplants, reducing the time needed to deliver organs between hospitals and increasing the chances of successful transplants by cutting down on delivery delays due to traffic or other logistics challenges.

Education

STEM Learning and Practical Drone Training: UAVs can be integrated into science and engineering classes where students learn coding, engineering, and robotics. Students could use UAVs for hands-on experiments such as conducting aerial surveys, environmental studies, or even building and programming their own drones.

4.

- a. **Signal Interference or Hacking:** Enemy forces could interfere with or hijack the control of a UAV, posing risks to both military personnel and civilians.
- b. **Collateral Damage:** Poor targeting accuracy or system failures may lead to unintended casualties or damage to civilian infrastructure.
- c. **Ethical Concerns:** The remote nature of UAVs could make it easier to launch attacks without fully considering the consequences, raising ethical questions.
- d. **Mechanical Failure:** Drones can suffer from technical issues like battery failure or engine malfunctions, potentially leading to mission failure or crashes.

5.

- a. **Emergency Medical Support:** UAVs could deliver first aid kits or medical supplies to soldiers on the battlefield quickly, potentially even carrying small autonomous medical robots.

- b.** Drone Swarms for Defense: Multiple drones could be deployed simultaneously to create a defensive shield or confuse enemy radar systems, offering protection for ground troops.

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