Unmanned Aerial Vehicle

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History

- UAVs are military aircraft guided autonomously or by remote control
- They can carry sensors, target designators, offensive ordnance, or electronic transmitters
- They offer greater range and endurance than equivalent manned systems
- UAVs descended from target drones and remotely piloted vehicles used after WWII
- Modern UAVs debuted as an important weapon system in the early 1980s
- MQ-1 Predator is an important American tactical UAV
- The MQ-9 Reaper is a larger, turboprop-powered derivative of the Predator
- Both have been used in conflicts in Iraq and Afghanistan
- NASA's Reduced Gravity Program uses a weightless or zero-G environment of space flight for testing and training of human and hardware reactions
- Larger UAVs like the RQ-4 Global Hawk are used for strategic reconnaissance
- Extremely small UAVs are used to extend the vision of ground combat units beyond their front lines

Application

- AERIAL PHOTOGRAPHY

Drones are increasingly used in cinematography, real estate, sports photography, and journalism, providing an affordable and efficient way to capture footage from the air.

- GEOGRAPHIC MAPPING

Drones are utilized by both professionals and amateurs to acquire high-resolution data and imagery from remote areas such as coastlines, mountaintops, and islands. They are also valuable for creating 3D maps and aiding in crowd-sourced mapping applications.

- WEATHER FORECAST

Drones are being developed to monitor unpredictable weather. With specialized sensors, they can gather data in hazardous areas like hurricanes and tornadoes. Scientists and forecasters can gain new insights and prevent accidents.

- LAW ENFORCEMENT

Drones aid in law enforcement by surveilling crowds and ensuring public safety. They monitor criminal activities and illegal transportation, such as drug smuggling and human trafficking along coastlines. Border patrols use drones to investigate fires and detect illicit activities.

MAIN COMPONENT

1. Frame design
2. Propulsion
3. Navigation
4. Data collection
5. Data transmission
6. Power management

FRAME DESIGN

- FIXED WING

Fixed-wing UAVs use lift generated by their wings during forward motion. They can be self-propelled with an engine or a glider launched by a winch or towed. Ailerons, elevator and rudder control the drone's movements. They can be powered by batteries, combustion engines, solar power, or wireless power delivery.

- ROTARY WING

Rotary-wing UAVs use rotors to generate lift, which act as small airfoils spinning at high speeds. The rotors create a pressure difference that generates lift by forcing air downwards. The direction of travel is changed by altering the angle of the frame and/or rotors. They use the same principle as fixed-wing UAVs in generating lift.

- MULTI-ROTOR

Multi-rotor drones are affordable and easy to use for aerial photography and surveillance. They have multiple motors, such as tricopters, quadcopters, hexacopters, and octocopters. Quadcopters are the most popular type of multi-rotor drone. They provide greater control over position and framing.

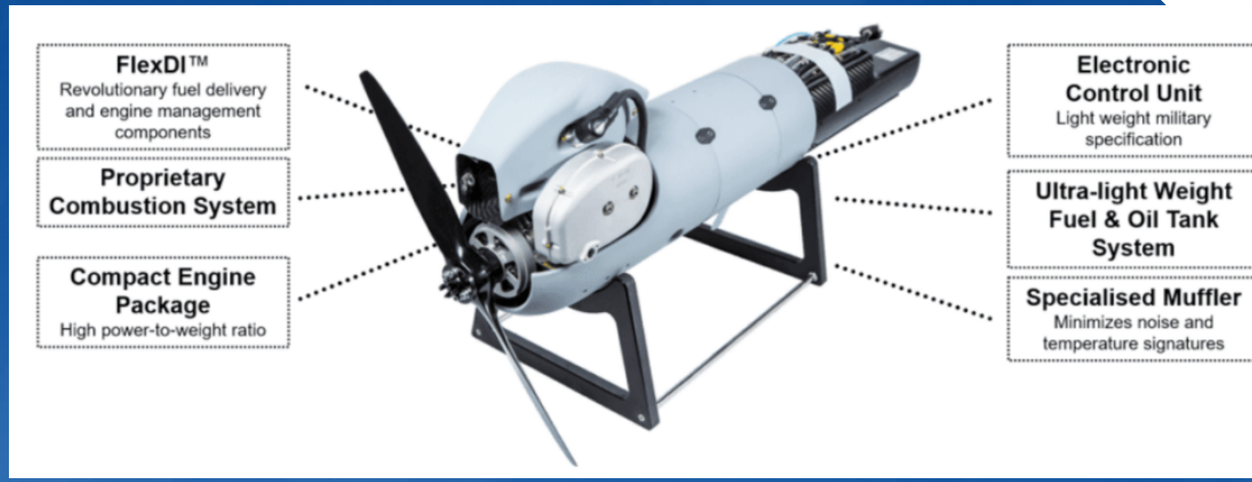
- TILTROTOR

Tiltrotor is a special aircraft with three flight modes: airplane, tilt, and helicopter mode. It combines the benefits of fixed-wing aircraft and helicopters. Changing the tilt angle of the nacelle enables the transition between different flight modes.

PROPULSION

- FUEL POWERED

These UAVs are powered by traditional fuels such as gasoline, diesel, or jet fuel. They have high endurance and can fly for several hours or even days without refueling. However, they can be noisy and emit pollutants.



- HYBRID FUEL

Hybrid propulsion systems combine two or more energy sources to provide power, and are used in a wide range of unmanned systems, including UAVs (unmanned aerial vehicles), UGVs (unmanned ground vehicles), USVs (unmanned surface vessels), and UUVs (unmanned underwater vehicles).

- PURE ELECTRIC

The electric propulsion system is the central part of UAVs, which generates thrust to control and hover the UAVs in the air. The propulsion system includes an electric motor, electronic speed controller, power sources, and an energy management system for efficient operation

NAVIGATION

- GPS

GPS is a crucial component of UAV navigation systems, providing location, speed, and heading data. Autonomous UAVs rely on GPS and IMU data for precise control. UAVs with GPS can also provide vertical and horizontal protection levels. For earth observation measurements, UAV GPS can accurately geographically reference collected data, including precise time stamps. GPS is essential for UAV safety in avoiding accidents with other vehicles.

- IMU

In UAVs, IMUs are used to provide real-time data on the vehicle's motion and orientation, which is crucial for navigation, stabilization, and control. The IMU typically consists of accelerometers, gyroscopes, and sometimes magnetometers. By combining the data from these sensors, the IMU can determine the UAV's position, velocity, and orientation. IMUs are essential for autonomous flight, especially in GPS-denied or weak GPS signal environments. Advanced IMU technologies, such as MEMS-based IMUs and integrated GPS/INS systems, are improving the accuracy and reliability of UAV navigation systems.

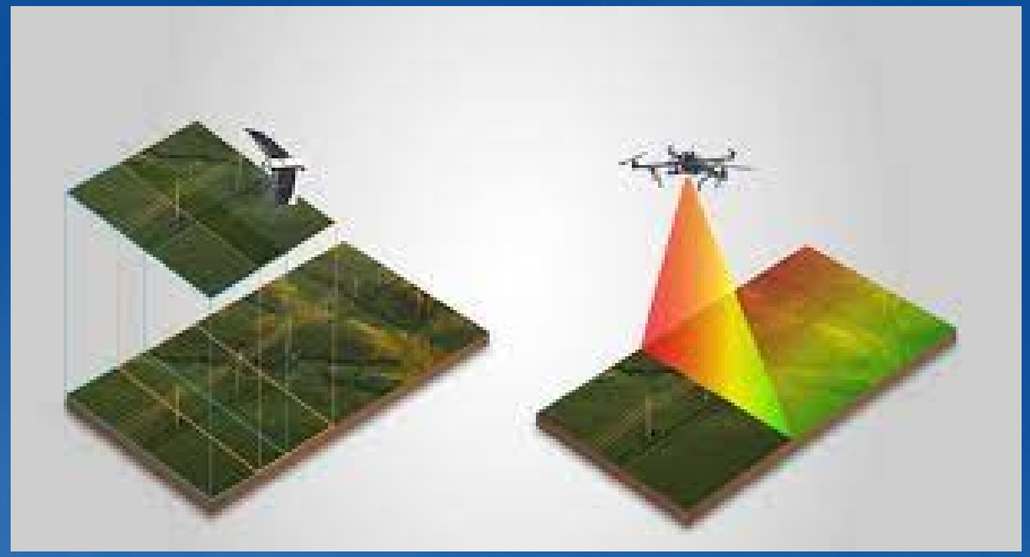
- FLIGHT CONTROLLER

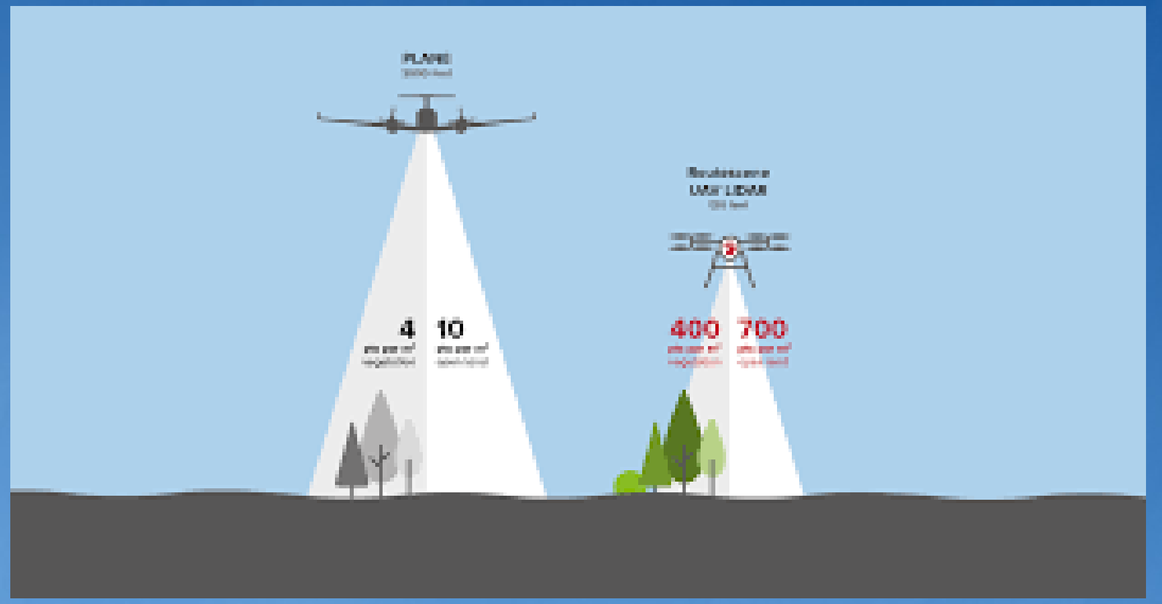
A flight controller is a key component in UAVs that processes data from sensors, such as the IMU and GPS, and sends commands to the motors to control the vehicle's movement. It uses algorithms and control strategies to stabilize the UAV, adjust its altitude and heading, and control its movements. Flight controllers can also incorporate features such as fail-safes, auto-leveling, and GPS waypoint navigation for autonomous flight. Advanced flight controllers can also support features such as obstacle avoidance and object tracking for more advanced applications.

DATA COLLECTION

- Lidar

LiDAR is a remote sensing technology that uses lasers to measure the distance to objects without making physical contact. By emitting light waves and measuring their return time, it accurately measures distances in 3D. The data collected is called a point cloud and is used to create a 3D representation of the object or environment. LiDAR can be used for applications such as topographical mapping, indoor mapping for cultural heritage projects, and construction and architecture. It allows for object extraction and classification in addition to distance measurements.





- Camera

Kappa offers special Full-HD camera modules with high-resolution optics for payload integration (gimbal). These cameras, with various FoVs, deliver razor-sharp images even at distances of km for HALE/MALE.

With our many years of experience developing and manufacturing cameras for aviation requirements, we offer you the highest level of safety for your application. Kappa is your expert for UAV / UAS cameras.

- Thermal sensor

Thermal, or infrared, sensors enable drone operators to see invisible temperature data. Deployed on drones, thermographic sensors make it possible to collect radiometric data over wide areas and hard-to-reach places. Recent advances, such as built-in visual imaging, heat analytics, and infrared intelligence, have made thermal analysis accessible and cost-effective for a wide range of applications

- Scanning building electrical equipment, such as breaker panels, fuses, bolted connections, and switchgear
- Identifying overheating equipment in electrical plants, substations, and towers
- Pinpointing the source of water leaks and energy inefficiencies in building roofs and facades

DATA TRANSMISSION

- RADIO CONTROL TRANSMITTER

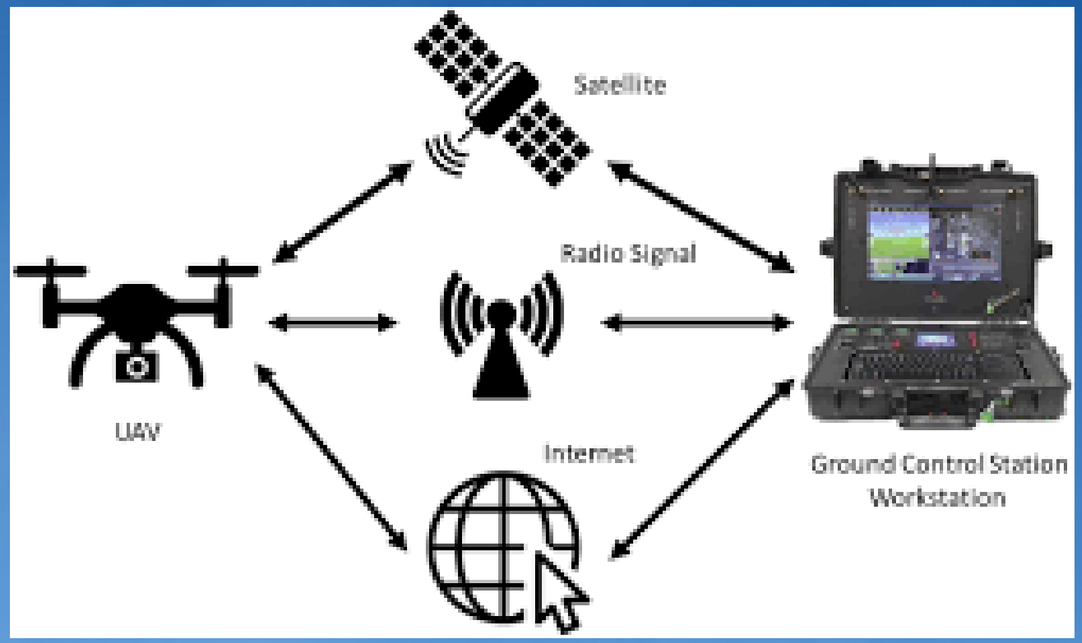
A radio control system is made up of two elements, the transmitter you hold in your hands and the receiver you put inside your drone. Dramatically simplifying things here, your drone transmitter will read your stick inputs and send them through the air to your receiver in near real time. Once the receiver has this information it passes it on to your drones flight controller which makes the drone move accordingly.

- WIFI

Most commercial drones as a set (drone, camera, battery, and remote control) are controlled in combination with a mobile phone. Thus, the Wi-Fi standard is used to control the drone and to transmit the video signal from the drone to the pilot. Realistic ranges of radio transmission by mobile phone are 220 – 330 yards (200 – 300 m). Some remote controllers can also reach ranges of up to 1 mile (~ 2 km). This depends on the geographical conditions (mountains, forest, or open field) and on the occupancy of the frequency band. When your drone reaches the limit of the communication range, first, the video signal is usually disturbed. Keep in mind the local legal regulations regarding the removal of the drone.

SATELLITES COMMUNICATION

- The system allows remote UAVs to access large pools of bandwidth while achieving low latency, and high network efficiencies. It can enable whole new opportunities to better leverage available advanced satellites' bandwidth.
- The System is with built-in beam switching technology, very low latency, multiple uplink carriers, and perfectly synchronized forward and return links. SpaceBridge solution enables UAVs to use High Throughput Satellite (HTS) systems – and gain access to drastically increased bandwidth potential. Narrow satellite beams on HTS satellites also reduce the potential footprint visible to enemy jamming.
- Synchronized Forward and Return Frequency Assignment provide resilience against jamming, and reduce the probability of intercept for large tactical UAVs.
- Fast data switching, and very short data frames also enable the Drone Swarm Concept of Operations



POWER MANAGEMENT

- BATTERIES

There are four drone battery types; namely,

- Lithium-Polymer
- Nickel Cadmium
- Lithium High Voltage
- Brand-Specific

The quality and value of your drone are best defined by the quality of its battery. If the battery lasts only a few minutes before it goes flat, then even the cost of the drone will be low. Such drones only allow you to fly them for not more than 10 minutes. It's not so with drones whose batteries last for about 30 minutes before they go flat.

- POWER DISTRIBUTION BOARD

A Power Distribution Board (PDB) distributes power from the battery to the drone ESC and other peripherals. While modern flight controllers (FC) have integrated PDBs, they can be limited by space and may not filter voltage spikes well. PDBs are preferred by some because they reduce stress on the FC and are better filtered from electrical noise. Adding a 4 in 1 ESC can be cheaper, but replacing one ESC is cheaper than replacing a 4 in 1 ESC. Ultimately, the choice between using a PDB or integrated FC/PDB depends on personal preference and the specific needs of the drone build.