# UNMANNED AERIAL VEHICLES

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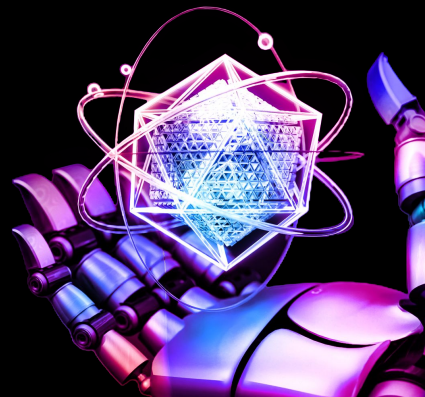
(1916067)

# TABLE OF CONTENTS

# 01

## INTRODUCTION

Unmanned Aerial Vehicles (UAVs), commonly referred to as drones, are aircraft that lack an on-board crew or passengers. These advanced systems can be either fully automated, operating autonomously, or remotely piloted by human operators.



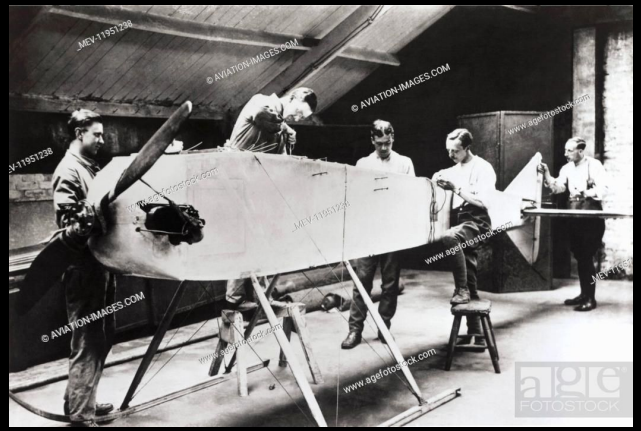
# INTRODUCTION

UAVs possess the remarkable capability to sustain prolonged flights while maintaining precise control over their speed and altitude. Their versatile applications span across numerous domains within the aviation industry.

# 02 History

**AERIAL TARGET (1917)**

- The Aerial Target, a British radio-controlled aircraft from the First World War.
- Its remote control components, which were designed by Dr Archibald Low, are part of IWM's collection (see AIR 567 to AIR 571).
- It became the first drone to fly under control when it was tested in March 1917.
- The pilot on this occasion was the future world speed record holder Henry Segrave.



# 02 History

**THE QUEEN BEE (1935)**

- In 1935 the British produced a number of radio-controlled aircraft to be used as targets for training purposes.
- Prime Minister Winston Churchill and Captain David Margesson, launch of a De Havilland Queen Bee seaplane L5984 from its ramp.
- The Queen Bee pilotless target drone was a radio-controlled version of the Tiger Moth trainer.

# 02 History

**DRONE PROTOTYPE (1946)**

- A remote-controlled drone prototype based on a B-17 Flying Fortress airframe takes off from Hilo Naval Air Station in Hawaii 6 August 1946, to fly to Muroc Army Air Field, California,
- Remotely controlled by United States Army Air Forces (USAAF).
- This 2,600-mile journey involved two of these prototypes, taking almost 15 hours and setting a new endurance record for remote controlled aircraft

# 02 History

**DRONE TRIAL (1961)**

- The first Canberra U Mk 10 jet plane which was to be used as a pilotless drone aircraft in the Seaslug.
- Guided missile trials from HMS Girdle Ness, the Royal Navy's guided weapons trial ship based at Malta, in 1961.

# 02 History

**RECONNAISSANCE DRONE (1991)**

- A pilotless drone aircraft designed for reconnaissance and artillery spotting used by British forces in the Gulf War, 1991.


**WATCHKEEPER DRONE (2021)**

- A British Watchkeeper UAV (Unmanned Aerial Vehicle) at Camp Bastion, the principal British base in Helmand Province, Afghanistan during Operation Herrick XVI (H16), August 2012.
- This UAV was operated by 32 Regiment, Royal Artillery for intelligence, surveillance, target acquisition and reconnaissance (ISTAR).

# 03 Applications

## 01 Aerial Photography and Videography

UAVs equipped with high-resolution cameras are used for capturing stunning aerial photographs and videos for various purposes, including cinematography, real estate marketing, and landscape surveys.

## 02 Agricultural Monitoring

UAVs equipped with multispectral or thermal cameras provide valuable insights for farmers by monitoring crop health, detecting irrigation issues, and optimizing pesticide or fertilizer usage.

# 03 Applications

## 03 Disaster Management

UAVs play a crucial role in disaster management by providing real-time aerial imagery of affected areas, helping in search and rescue missions, assessing damage, and facilitating efficient response planning.

## 04 Infrastructure Inspection

UAVs are employed to inspect infrastructure such as bridges, pipelines, power lines, and buildings, allowing for detailed visual assessments, identifying structural issues, and reducing the need for manual inspections.

# 03 Applications

## 05 Environmental Monitoring

UAVs are used to monitor and survey ecosystems, wildlife habitats, and environmental changes. They assist in tracking deforestation, studying marine life, monitoring air quality, and conducting environmental impact assessments.

## 06 Delivery and Logistics:

With the rise of e-commerce, UAVs are being explored for delivery purposes. They can transport small packages or medical supplies efficiently and quickly in areas with limited infrastructure or during emergencies.

# 03 Applications

## 07 Mapping and Surveying

UAVs equipped with LiDAR or photogrammetry systems are utilized to create accurate 3D maps, terrain models, and survey large areas for urban planning, construction projects, or land management.

## 08 Traffic Monitoring

UAVs equipped with cameras and sensors help monitor traffic flow, identify congestion points, and gather data for optimizing transportation infrastructure and improving road safety.

# 04
# Main components

# MAIN COMPONENTS

## ROBOT DESIGN

## DATA COLLECTION

## LOCOMOTION SYSTEM

## DATA TRANSMISSION

## NAVIGATION SYSTEM

## POWER MANAGEMENT

# 01 ROBOT DESIGN

## MULTI-ROTOR UAV

A multi-rotor UAV is a type of unmanned aerial vehicle that utilizes multiple rotors, typically two or more, to generate lift and control its flight. These rotors are typically arranged in a symmetric configuration, such as a quadcopter with four rotors or a hexacopter with six rotors. Each rotor is driven by an individual motor, and the UAV's flight control system adjusts the speed and direction of rotation of these rotors to control its movement in the air. Multi-rotor UAVs are known for their agility, stability, and ability to hover in place, making them suitable for applications such as aerial photography, surveillance, and inspections.

# 01 ROBOT DESIGN

## SINGLE-ROTOR UAV

A single rotor UAV, also known as a helicopter or rotary-wing UAV, features a single large rotor mounted on top of the aircraft, which provides both lift and propulsion. The rotor is driven by an engine or motor and is equipped with a variable pitch mechanism that allows the UAV to change the angle of attack of its rotor blades. By adjusting the rotor's collective pitch and cyclic pitch, the UAV can control its altitude, forward/backward movement, sideways movement, and rotation. Single rotor UAVs are capable of vertical takeoff and landing, and they can hover, maneuver in tight spaces, and fly at higher speeds compared to multi-rotor UAVs. These characteristics make th suitable for applications such as military operations, search and rescue missions, and long-range surveillance.


# 01 ROBOT DESIGN

## FIXED -WINGS UAV

A fixed-wing UAV is an unmanned aerial vehicle that features fixed wings, similar to traditional airplanes. These wings generate lift as the UAV moves through the air. Unlike multi-rotor UAVs, fixed-wing UAVs require a runway or launching mechanism for takeoff and landing. Once in the air, they rely on forward motion and aerodynamic principles to maintain lift and control their flight. Fixed-wing UAVs are known for their efficient and long-endurance capabilities, making them suitable for applications such as aerial mapping, surveying and large-area surveillance.

# 01 ROBOT DESIGN

## FIXED -WING HYBRID UAV

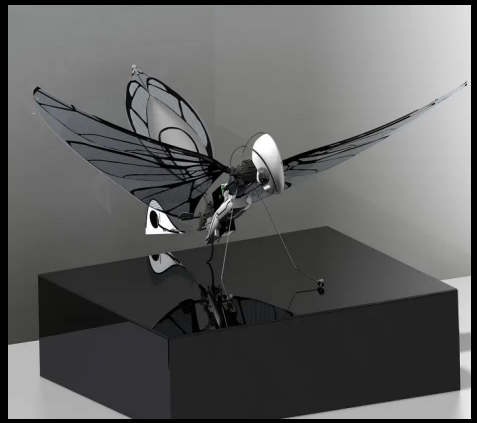
A fixed-wing hybrid UAV combines the features of both fixed-wing and multi-rotor UAVs. It typically includes fixed wings for efficient forward flight and additional rotors or motors that can provide vertical takeoff and landing capabilities. This hybrid design allows the UAV to transition between vertical takeoff and landing like a multi-rotor UAV and efficient forward flight like a fixed-wing UAV. Fixed-wing hybrid UAVs offer the advantage of longer flight endurance and higher speeds compared to multi-rotor UAVs while still providing the flexibility of vertical takeoff and landing when needed. These UAVs are often used in applications such as aerial surveillance, cargo delivery, and search and rescue operations.

# 02 LOCOMOTION SYSTEM

## FIXED-WINGS

Fixed-wing UAVs rely on aerodynamic lift generated by their wings during forward motion. They utilize propulsion systems to create a steady airflow over the wings, allowing them to oppose their weight and sustain flight.

# 02 LOCOMOTION SYSTEM



## FLAPPING-WINGS

Flapping-wing UAVs imitate the flight of birds or insects. This emerging locomotion system involves the flapping motion of wings to generate lift and thrust. It is primarily used for experimental and research purposes in the field of biomimicry.

# 02 LOCOMOTION SYSTEM

## ROTARY-WINGS

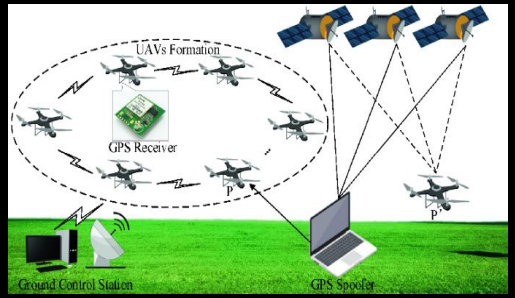
Rotary-wing UAVs employ rotating blades or rotors to generate lift and propulsion. Examples include quadcopters, hexacopters, and octocopters. These UAVs are favored for their ability to hover in place, maneuver in confined spaces, and perform tasks such as aerial photography and inspections.

# 02 LOCOMOTION SYSTEM

## HYBRID

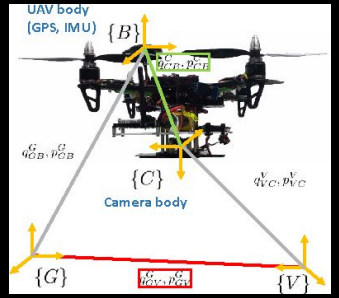
Hybrid UAVs combine different locomotion systems to achieve enhanced capabilities. They may utilize a fixed-wing configuration for efficient long-range flight and then transition to rotary-wing for vertical takeoff and landing. This hybrid approach offers flexibility and efficiency in various applications.

# 03 Navigation & Control System



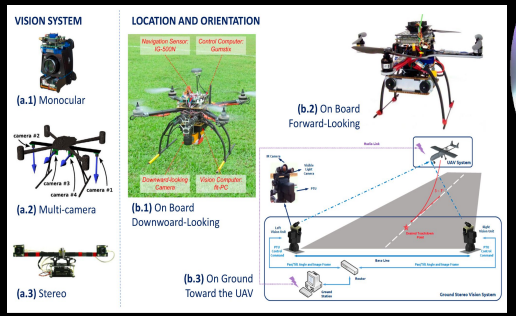

## GPS (Global Positioning System)

A GPS receiver determines the UAV's precise location and velocity by receiving signals from satellites.




## Inertial Measurement Unit (IMU)

An IMU combines accelerometers and gyroscopes to measure the UAV's acceleration and rotation rates, allowing for estimation of its orientation and position.



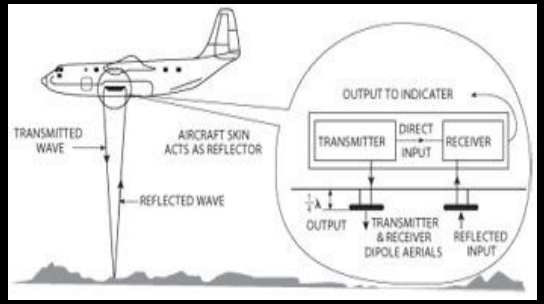

## Computer Vision

Computer vision algorithms enable the UAV to detect and track ground features, such as landmarks or roads, aiding navigation in GPS-challenged environments.

# 03 Navigation & Control System

## Magno meter

A magnetometer measures the Earth's magnetic field strength and direction, providing information on the UAV's magnetic orientation relative to north.




## Barometric altimeter

The barometric altimeter sensor measures the atmospheric pressure to estimate the UAV's altitude above sea level.

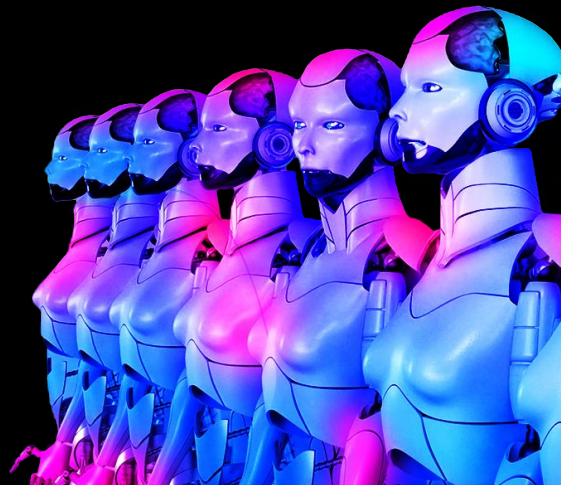
## Flight control software

The UAV's flight control software integrates sensor data and algorithms to manage its movement, adjusting trajectory and controlling various flight parameters

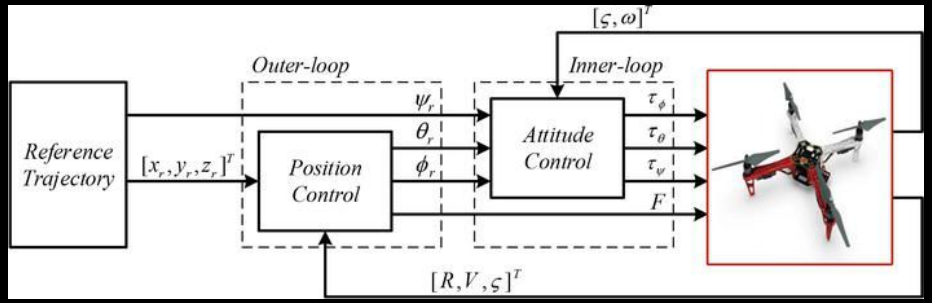
# CONTROL THEORY

Function:
For course keeping control system for automatic heading and balancing of the UAV

Type of internal Controller
1. Classical Control Methods Based on PID Control
2. Linear-Quadratic-Gaussian Control (LQG)
3. Model Predictive Control (MPC)
4. Adaptive Control Based On Back stepping Control Design
5. Intelligent Control (Genetic Algorithms , Neural Networks)
6. Robust Control
7. Sliding Mode Control



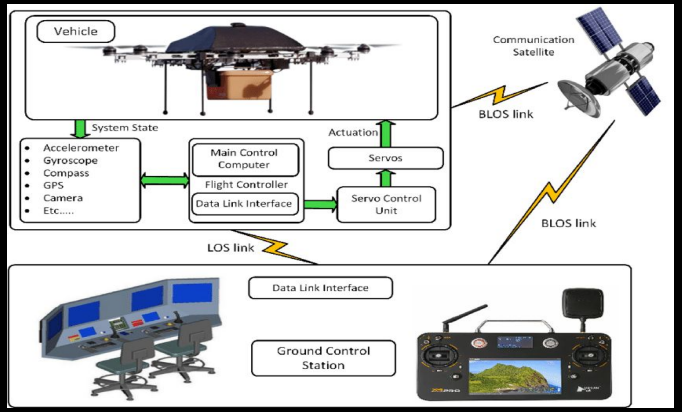
# CONTROL SYSTEM

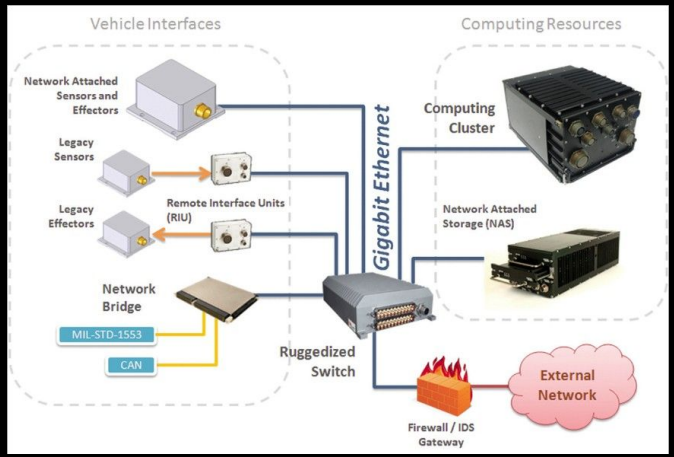



UAVs and drones necessitate flight control software and hardware components to enable remote control, either through direct pilot intervention or autonomous operation facilitated by an onboard computer. These critical elements provide the necessary infrastructure for commanding and managing the aircraft's flight dynamics.

# SYSTEM ARCHITECTURE

The structure of a remote-controlled drone involves a well-orchestrated combination of onboard sensors and a sophisticated control computer, effectively taking the place of human operators in autonomous drone operations. These integral components work in tandem to enable precise control and decision-making, ensuring safe and efficient flight performance.



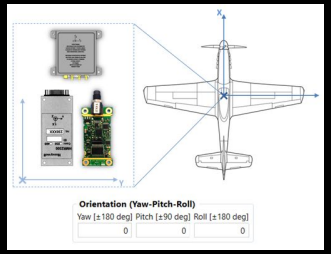
# 04 DATA COLLECTION


RGB CAMERAS


MULTISPECTRAL CAMERAS

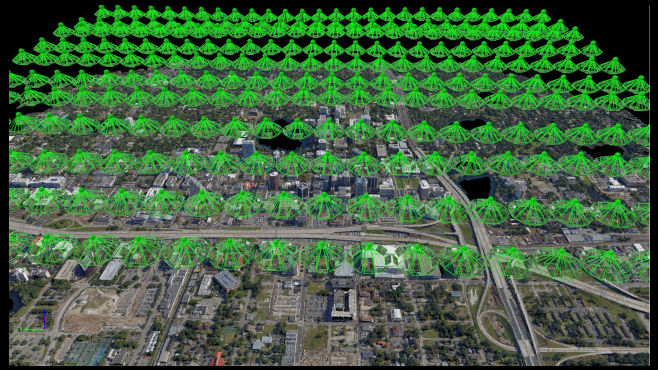

GLOBAL POSITIONING SYSTEM (GPS)


INERTIAL MEASUREMENT UNIT (IMU)




MAGNOMETER

# DATA COLLECTION SOFTWARE



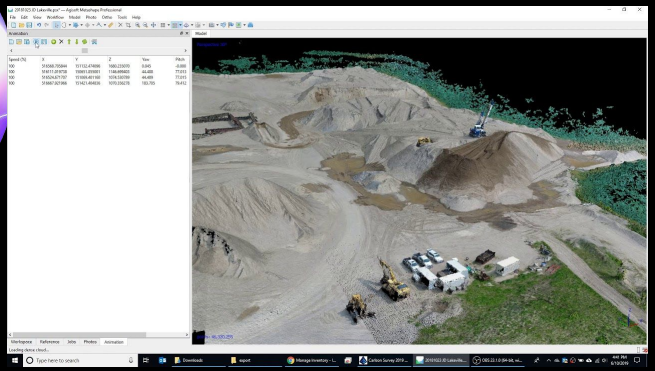
## PIX4D

Pix4D is a photogrammetry software that processes aerial images captured by UAVs to generate accurate 2D maps, 3D models, and point clouds for various applications like surveying, mapping, and construction.

## DRONE DEPLOY

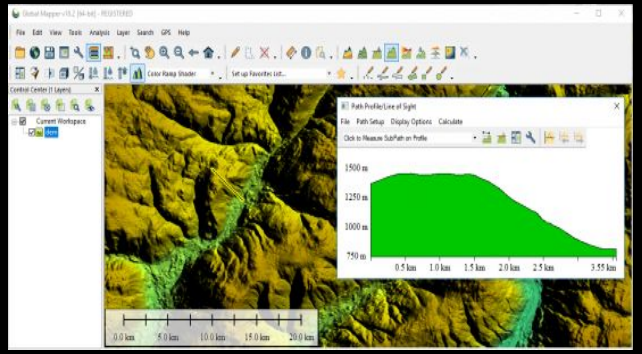
DroneDeploy is a cloud-based software platform that enables UAV users to plan, capture, and process aerial imagery, providing tools for mapping, analysis, and sharing of geospatial data for industries such as agriculture, construction, and inspection.

# DATA COLLECTION SOFTWARE



## AGISOFT METASHAPE

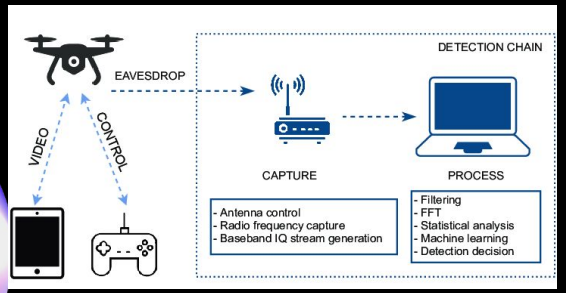
Agisoft is a software suite used for photogrammetry and image processing, allowing UAV users to create high-resolution orthomosaics, 3D models, and digital surface models from aerial imagery for applications in fields like archaeology, forestry, and cultural heritage documentation.




## GLOBAL MAPPER

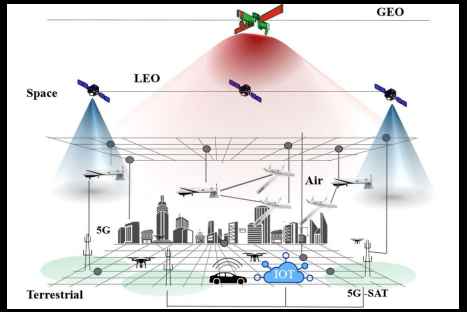
Global Mapper is a GIS software that supports UAV data analysis, offering tools for importing, visualizing, and analyzing geospatial data, including UAV-collected imagery, terrain data, and point clouds, aiding in tasks such as land surveying, urban planning, and environmental analysis.

# 05 DATA TRANSMISSION



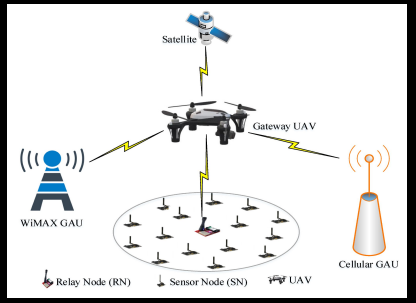

## RADIO FREQUENCY

RF communication is commonly used for short-range data transmission in UAVs, allowing for direct communication between the UAV and a ground control station using radio waves.




## SATELLITE

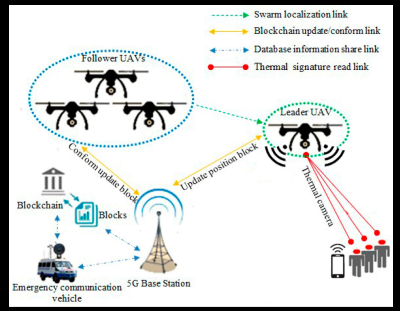
Satellite communication systems enable long-range data transmission for UAVs by utilizing satellites orbiting in space, providing global coverage and allowing UAVs to transmit and receive data over vast distances.




## CELLULAR NETWORKS

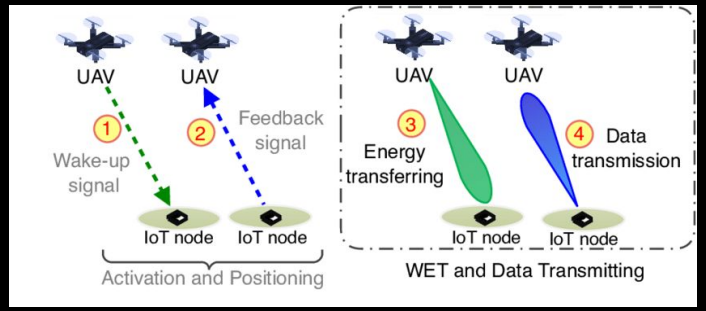
UAVs can utilize cellular networks to establish communication links, leveraging existing infrastructure to transmit data over larger areas, enabling beyond-line-of-sight operations and real-time data streaming.

# 05 DATA TRANSMISSION




## WIFI

WiFi technology is employed for local wireless communication between UAVs and ground control systems, allowing for high-speed data transfer and control within a limited range.




## BLUETOOTH

Bluetooth communication is utilized for short-range wireless data transmission between UAVs and nearby devices, such as smartphones or tablets, enabling convenient control, configuration, and data transfer in close proximity.

# 06 POWER MANAGEMENT

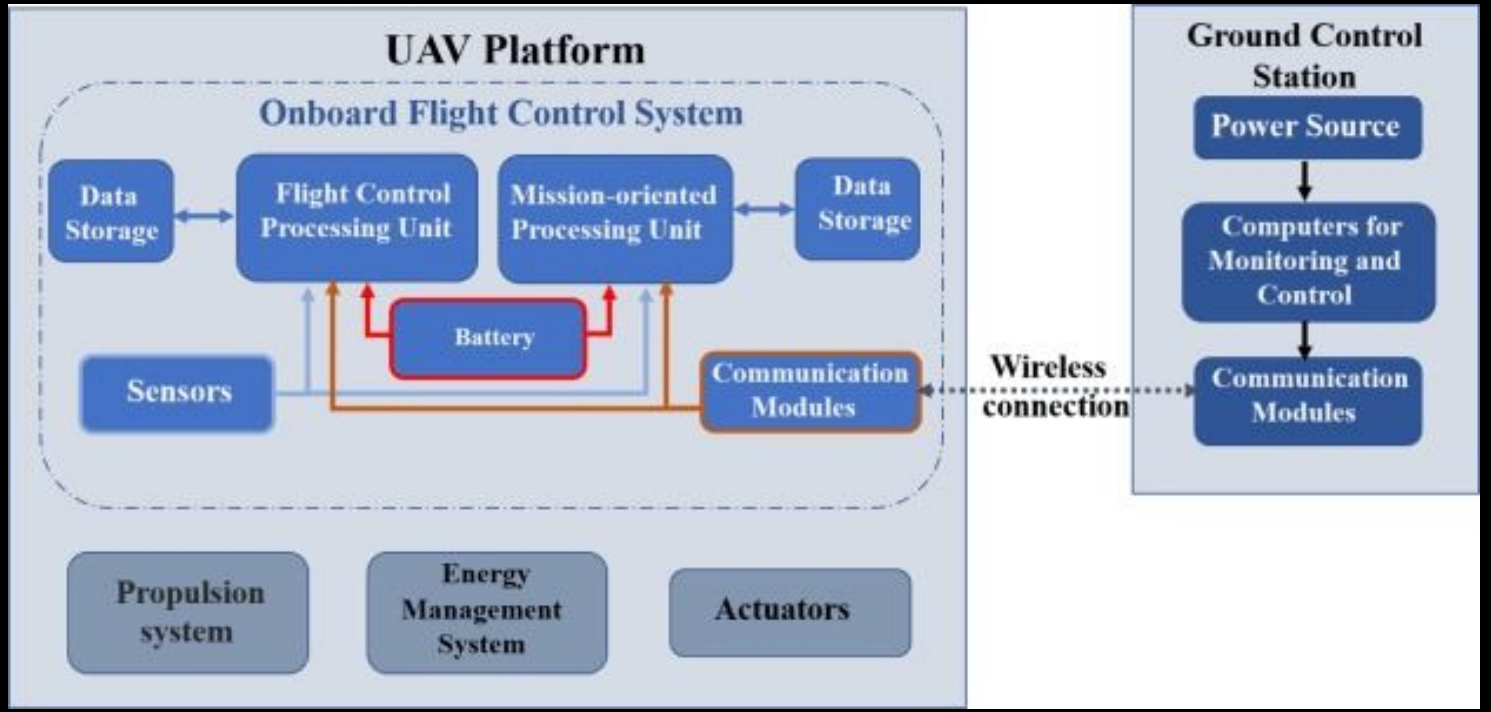
## BATTERY POWER

## FUEL CELLS

## GASOLINE /DIESEL ENGINES

## SOLAR POWER

# 06 POWER MANAGEMENT



# 06 POWER MANAGEMENT