# Unmanned Aerial Vehicle (UAV)

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# 1. Introduction

- **UAV stands for Unmanned Aerial Vehicle**, which is an aircraft that **does not require a pilot** on board to fly.
- **UAVs** come in a **variety of shapes and sizes**, ranging from small drones that can fit in your hand to larger aircraft that can carry heavy payloads.
- UAVs are typically controlled remotely by a pilot on the ground or can fly autonomously using pre-programmed flight plans and GPS navigation.
- UAVs have become increasingly popular in recent years due to advances in technology, including improved battery life, lightweight materials, and advanced sensors.
- UAVs are often equipped with cameras or other sensors that allow them to capture high-quality images and data from a variety of perspectives.
- UAVs can be used in areas that are difficult or dangerous for humans to access, such as disaster zones or war zones.

# 2. History of UAV

| Year | Event |
| --- | --- |
| 1849 | Austrians use unmanned balloons for bomb attacks |
| 1898 | Nikola Tesla demonstrates remote control of a boat |
| 1915 | First UAV developed by the US military, the Kettering Bug |
| 1935 | Reginald Denny develops a radio-controlled model airplane |
| 1944 | First combat use of UAVs by the Germans in WWII |
| 1959 | US Navy develops the first drone with the ability to take off and land on an aircraft carrier,the KDH-1 |
| 1960s | Development of reconnaissance drones for the US military |
| 1980s | Development of the Predator drone for surveillance and reconnaissance |
| 1990s | First armed drones, the Predator B and Global Hawk |
| 2000s | Increased use of armed drones in military operations |
| 2010s | Emergence of civilian drones for commercial and recreational use |

# History of UAV: NOW

| | |
|---|---|
| 2020s | Continued growth of civilian drone industry, increased use of military drones in conflicts around the world |

# History of UAV: NOW


# History of UAV: NOW


# 3. Applications of UAV

| Agriculture | Construction | Energy | Entertainment |
| --- | --- | --- | --- |
| • Crop monitoring<br>• Mapping<br>• Spraying | • Site inspection<br>• Surveying<br>• Mapping | • Inspection of power lines<br>• wind turbines<br>• oil rigs | • Aerial filming photography |

| Environmental | Insurance | Logistics | Public Safety |
| --- | --- | --- | --- |
| • Mapping and monitoring of wildlife, forests, and water resources | • Aerial inspections for insurance claims | • Delivery of packages and goods | • Search and rescue<br>• disaster response<br>• surveillance |

# 4. Main Components of UAV

- 01. Airframe
- 02. Propulsion system
- 03. Flight control & Navigation system
- 04. Data Collection
- 05. Data transmission
- 06. Power System Management

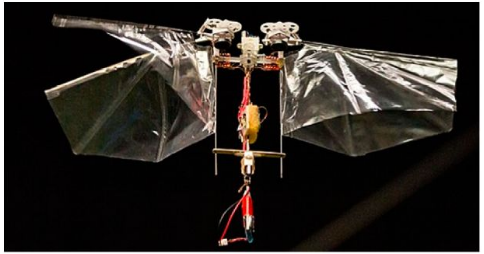
# 4.1 Airframe

(a) Fixed Wing


(b) Rotary Wing


(c) Unmanned Helicopter

(d) Blimp



(e) Flapping Wing

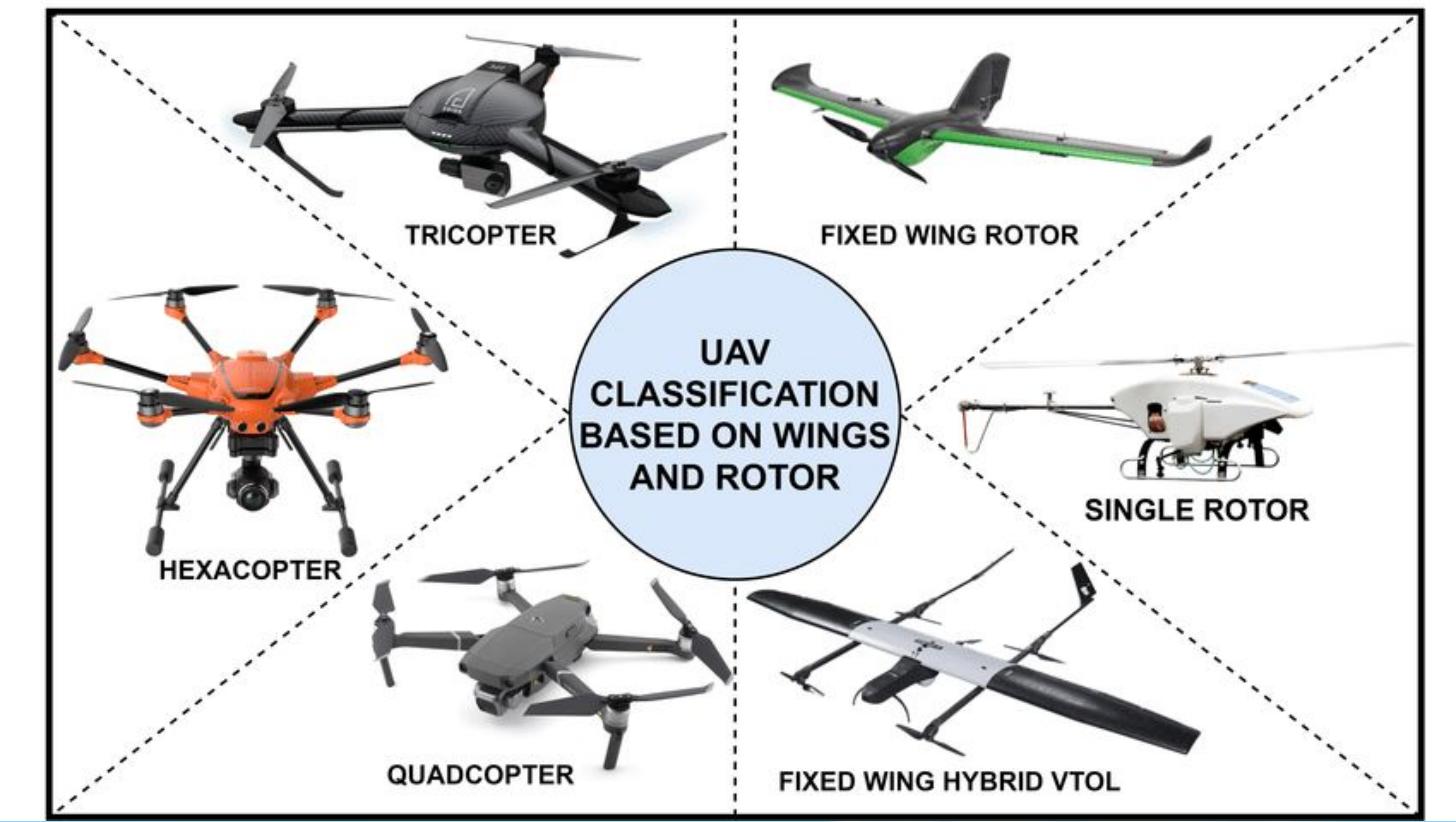
# 4.1 Airframe


ScanEagle
Hornet Maxi
V-BAT (Hybrid UAV)
IT180 (Coaxial UAV)
Small tactical UAVs
RQ-11B Raven
EBee (Flying Wing)
FlyingCam
Dragonfly (Multi-Rotor)
Miniature UAVs
Black Hornet
Hubsan quadcopter
Nano UAVs

# 4.1 Airframe

| Airframe Type | Advantages | Disadvantages |
| --- | --- | --- |
| Fixed-Wing | Long endurance, High speed, Efficient lift-to-drag ratio, Large payload capacity | Limited ability to hover or perform vertical takeoff and landing (VTOL), Requires a runway or catapult for launch |
| Rotary Wing (Helicopter) | Ability to hover and perform VTOL, Good maneuverability, Capable of operating in confined spaces | Lower speed and endurance compared to fixed-wing UAVs, Higher maintenance costs |
| Flapping Wing | High maneuverability, Quiet operation, Efficient lift-to-weight ratio | Limited endurance, Limited payload capacity |
| Blimp | Ability to stay aloft for extended periods, Quiet operation, Good for surveillance and observation | Limited speed and maneuverability, Vulnerable to wind and weather conditions |
| Hybrid | Ability to combine advantages of fixed-wing and rotary-wing UAVs, Capable of VTOL and long-endurance flights | More complex design, Higher maintenance costs |

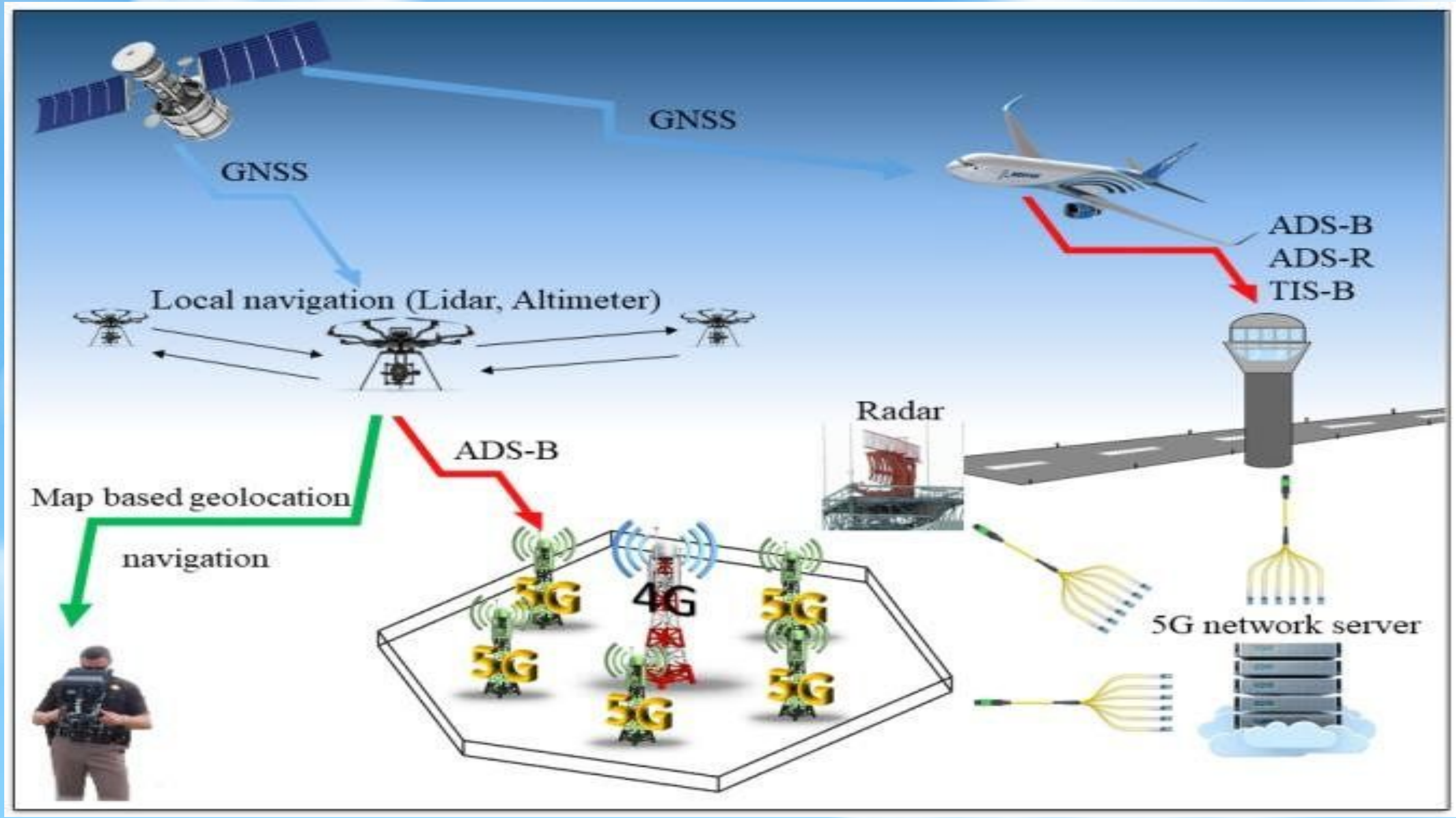
# 4.2 Propulsion system



# 4.2 Propulsion system

| Propulsion System | Advantages | Disadvantages |
|---|---|---|
| Electric Motor | Lightweight, efficient, quiet, low maintenance, can be powered by batteries or solar cells | Limited range and endurance, batteries add weight, recharging time |
| Gasoline Engine | High power, long range, widely available fuel | Heavy, loud, emits pollutants, requires regular maintenance |
| Jet Engine | High speed, high altitude capability, efficient at high speeds | Expensive, heavy, requires a large fuel supply, loud |
| Hybrid Electric | Combines benefits of electric motor and gasoline engine | Complex, expensive, heavy |
| Solar Power | Renewable, long endurance, low maintenance | Limited power output, requires sunlight, expensive |
| Hydrogen Fuel Cell | Quiet, low emissions, long endurance, can be refueled quickly | Expensive, requires hydrogen fuel infrastructure, heavy |

# 4.3 Flight control & Navigation system



# 4.3 Flight control & Navigation system

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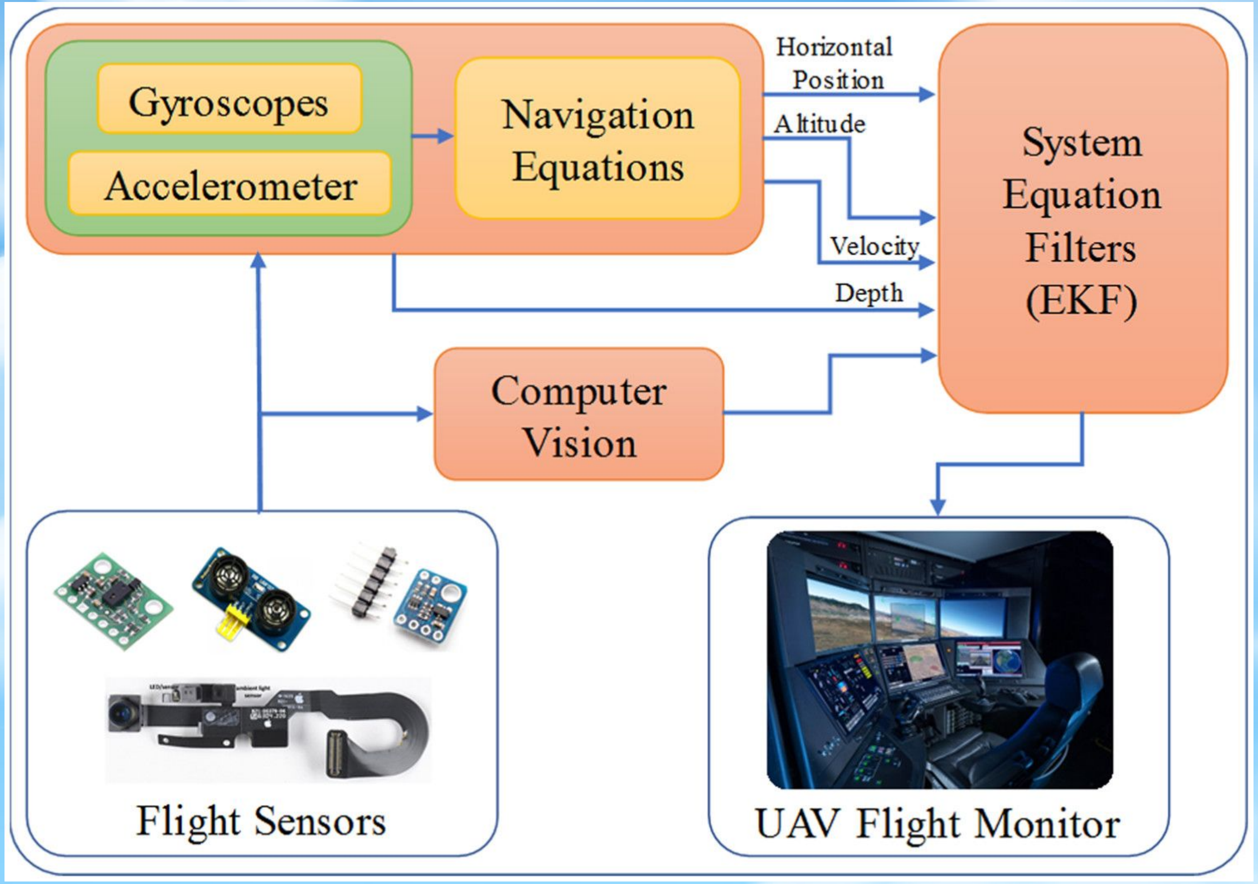
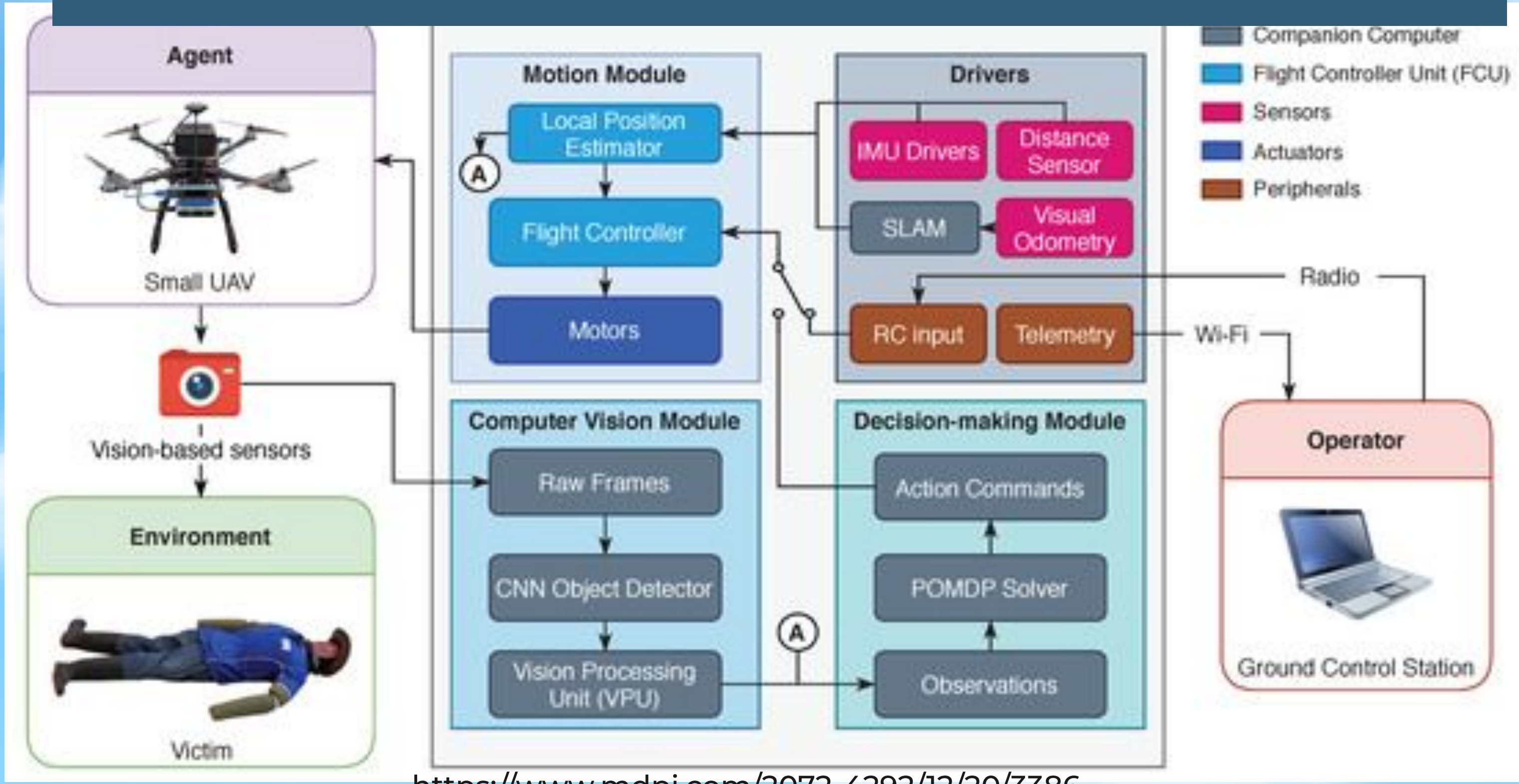


# 4.3 Flight control & Navigation system

UAV Framework for Autonomous Onboard Navigation and People/Object Detection in Cluttered Indoor Environments




https://www.mdpi.com/2072-4292/12/20/3386

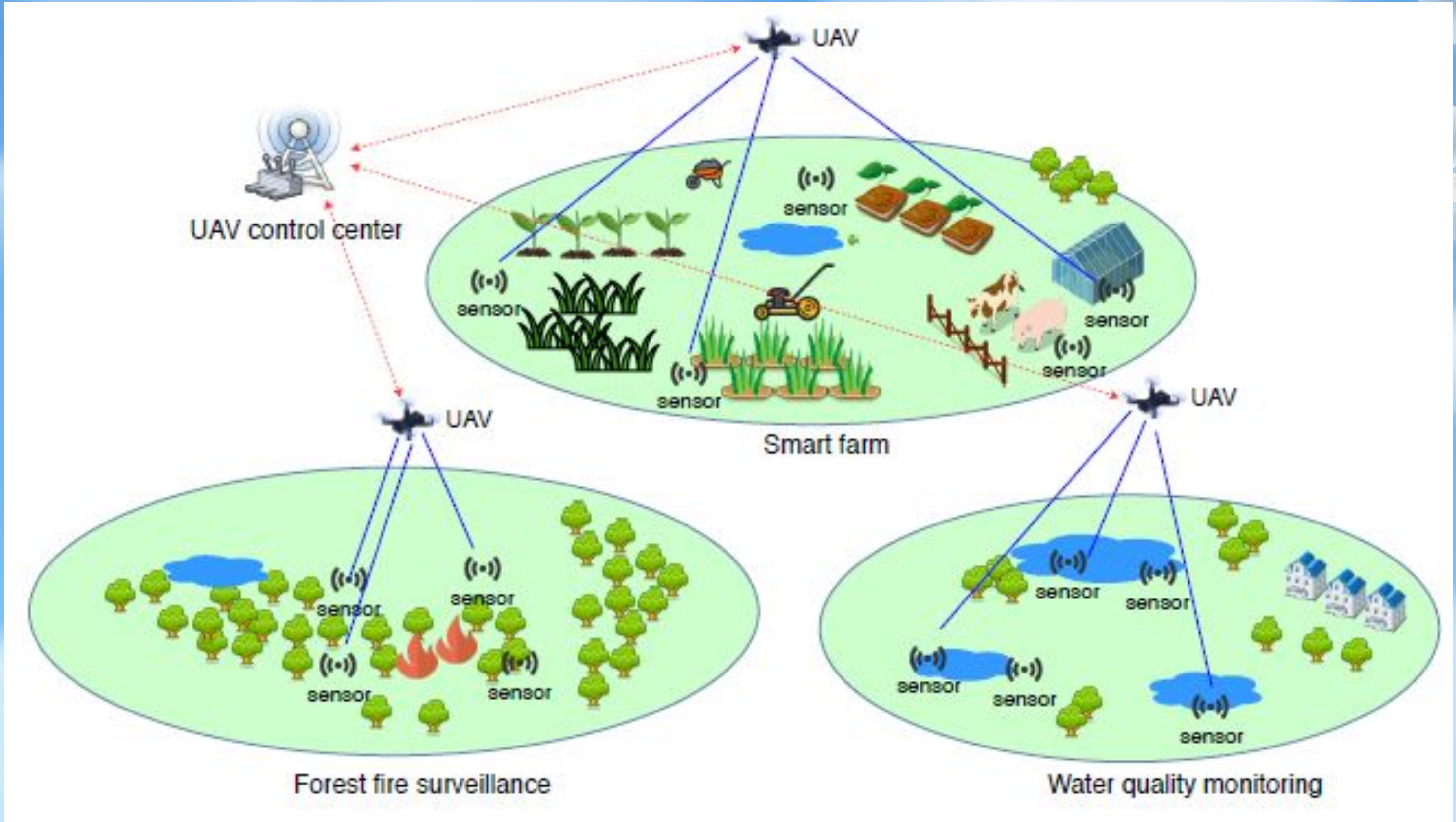
# 4.3 Flight control & Navigation system

| Navigation System Component | Function |
| --- | --- |
| Global Navigation Satellite System (GNSS) | Receives signals from GPS, GLONASS, Galileo, or other satellite constellations to determine the UAV's position, velocity, and time. |
| Inertial Measurement Unit (IMU) | Measures the UAV's acceleration, angular rate, and magnetic field to determine its orientation and velocity. |
| Barometer | Measures the atmospheric pressure to determine the UAV's altitude. |
| Magnetometer | Measures the Earth's magnetic field to determine the UAV's heading. |
| Ground Control Station (GCS) | Provides a user interface for the operator to control the UAV, view telemetry data, and plan missions. |
| Telemetry System | Transmits data between the UAV and GCS, including position, altitude, speed, battery level, and sensor readings. |
| Flight Controller | Calculates and executes the UAV's control commands based on inputs from the navigation system and operator commands. |
| Obstacle Avoidance System | Uses sensors (such as lidar or cameras) to detect and avoid obstacles in the UAV's path. |

# 4.4 Data Collection

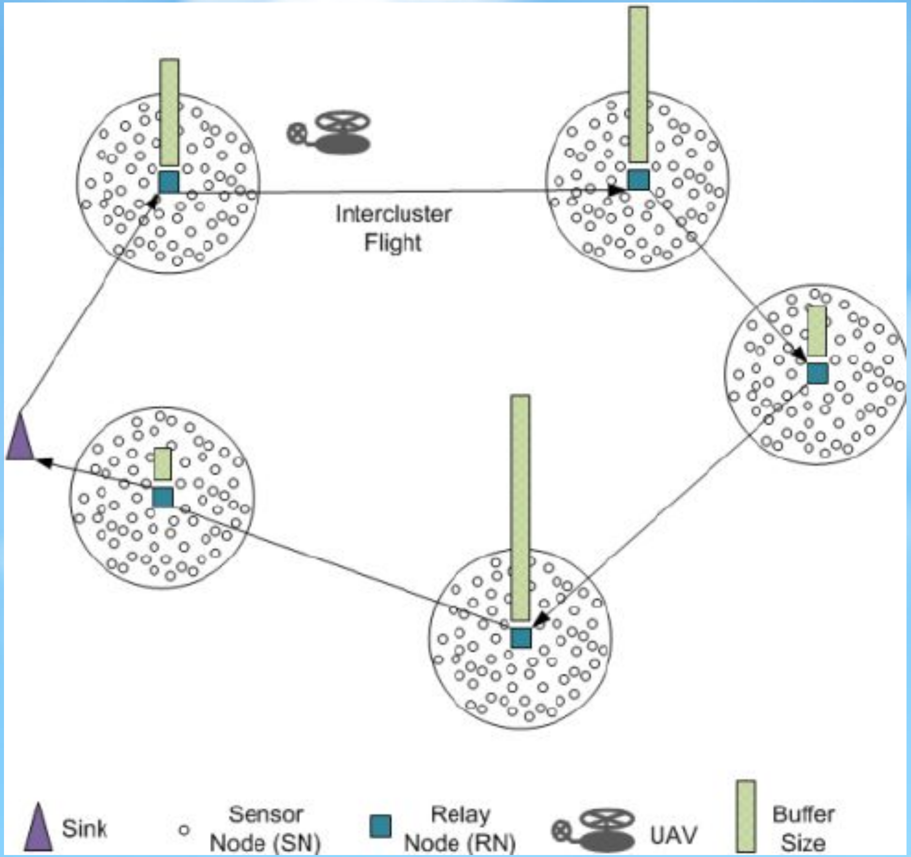
| Type of Data Collection | Devices/Electronics Used |
|---|---|
| Aerial Photography | Camera, Gimbal, GPS |
| LiDAR Mapping | LiDAR Sensor, GPS |
| Thermal Imaging | Thermal Camera, GPS |
| Multispectral Imaging | Multispectral Camera, GPS |
| Hyperspectral Imaging | Hyperspectral Camera, GPS |

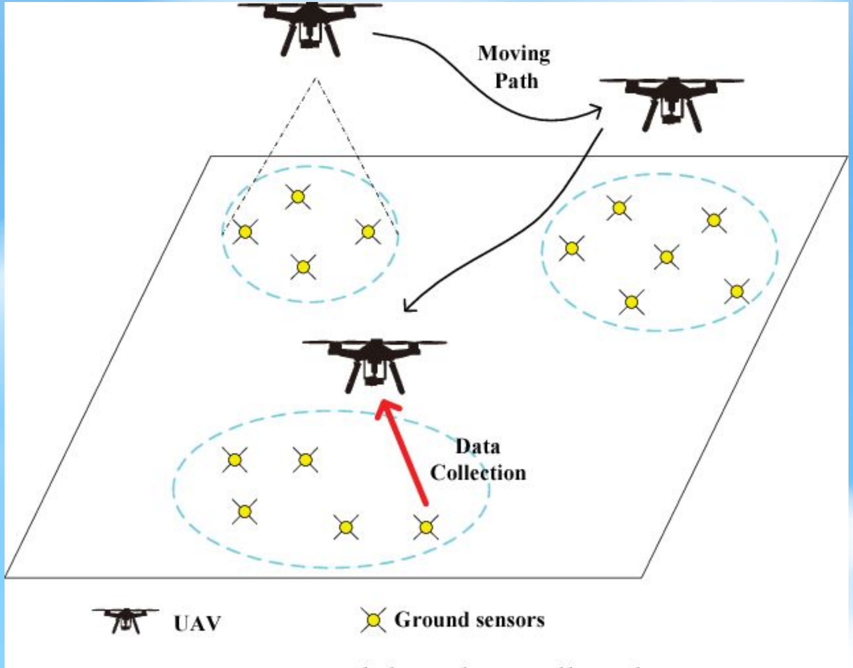
# 4.4 Data Collection




https://www.henrylab.net/pubs/uav-enabled-data-acquisition-scheme-with-directional-wireless-energy-transfer-for-internet-of-things/

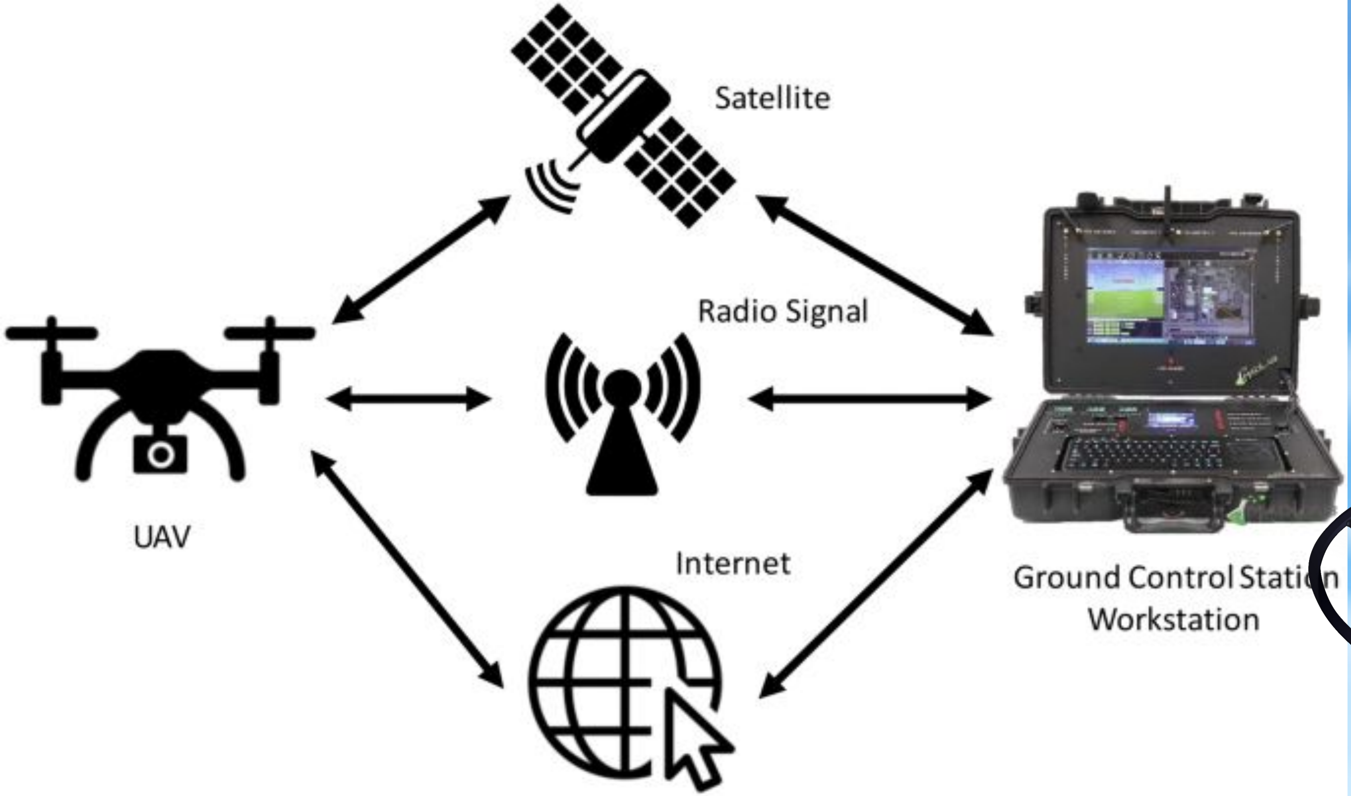
# UAV-Based data collection in WSNs: Round robin UAV routing strategy.



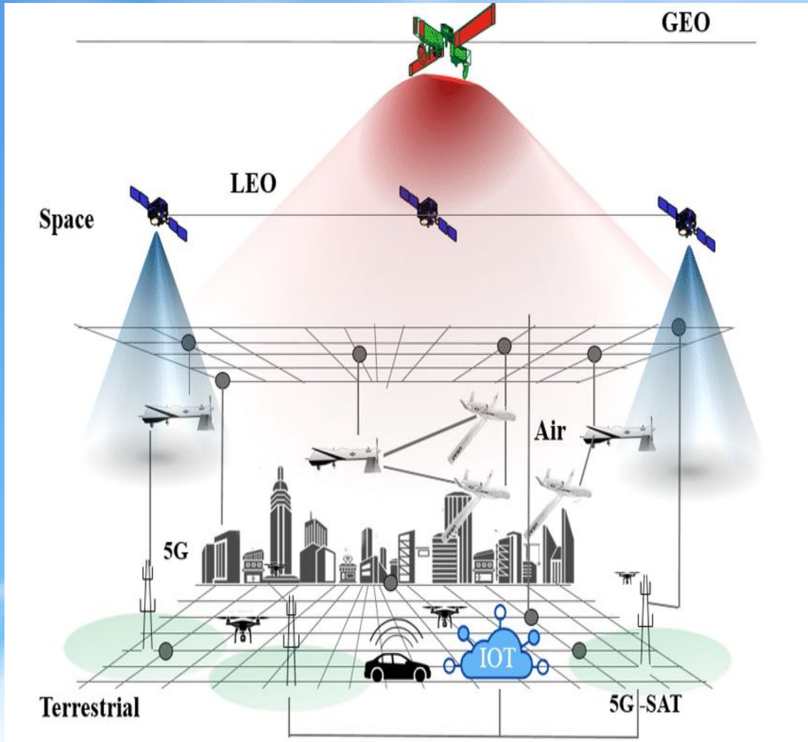
# UAV-Based data collection for mapping

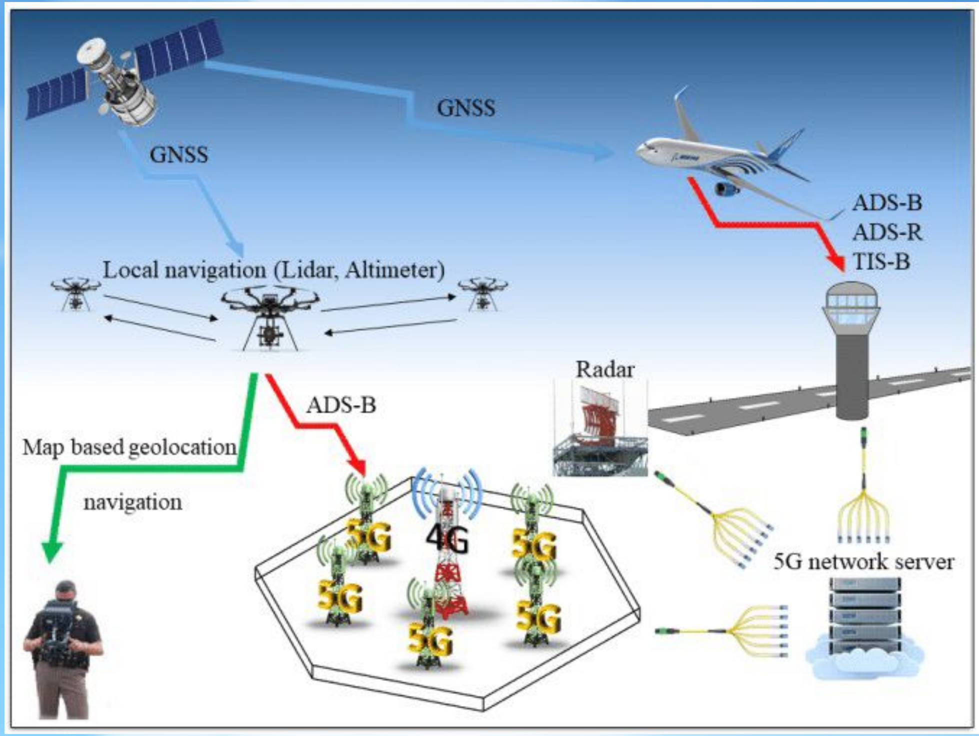
# 4.5 Data Transmission




https://link.springer.com/article/10.1007/s42452-020-2749-5

# 4.4 Data Transmission



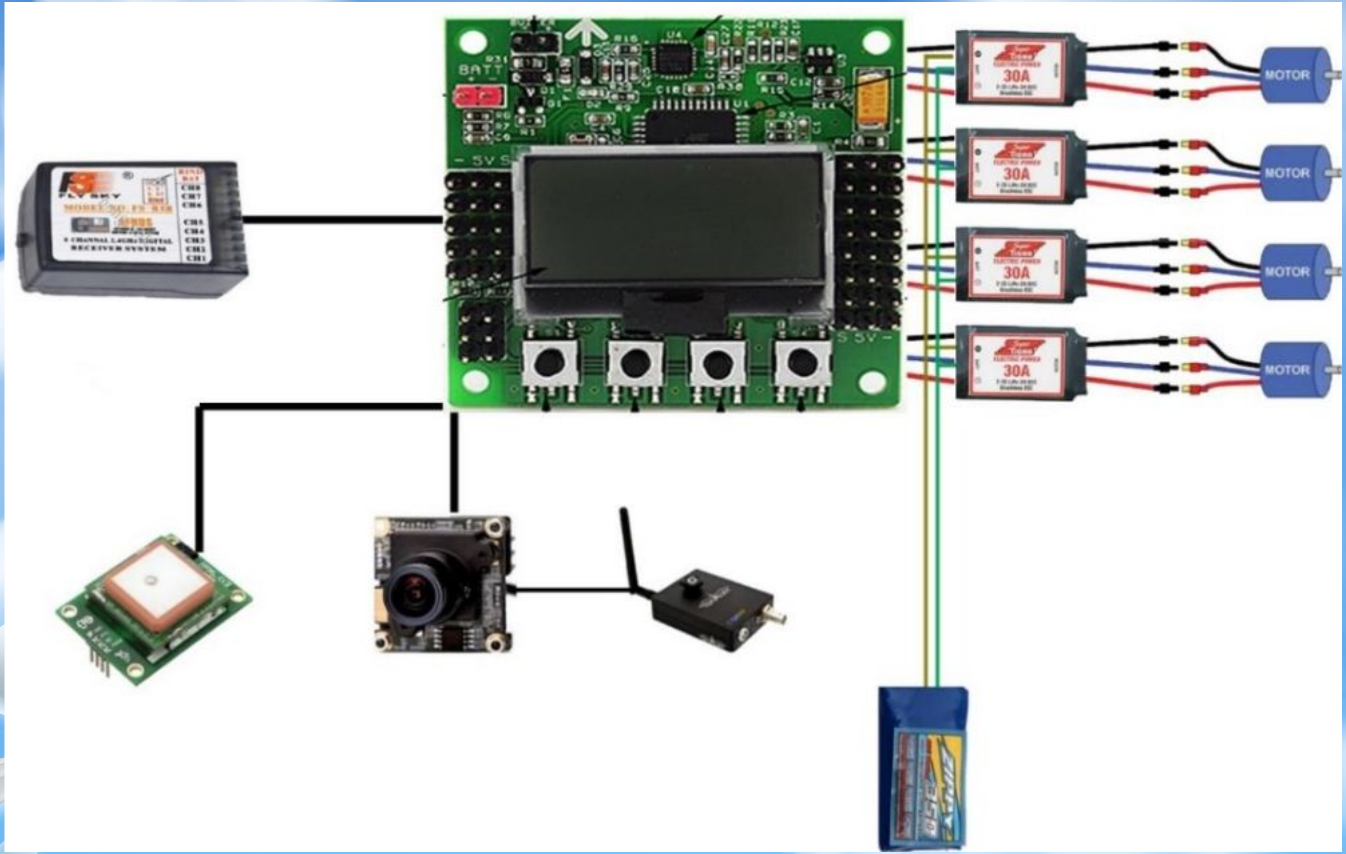




https://www.researchgate.net/figure/Overall-view-on-5G-UAV-navigation-and-surveillance_fig3_333919084

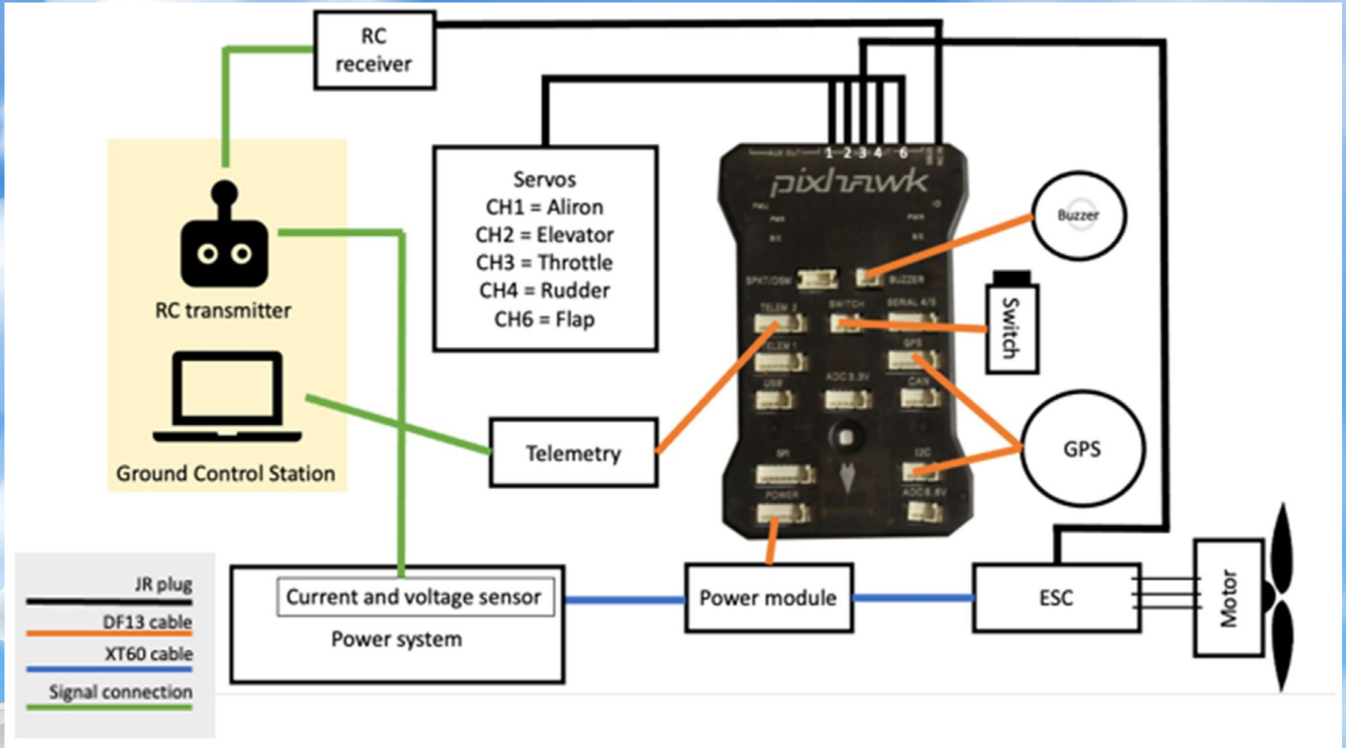
# 4.6 Power System Management

| Type | Key Specifications | Advantages | Disadvantages |
|---|---|---|---|
| Battery | Capacity, Voltage, Weight | Lightweight, Portable, Easily replaceable | Limited flight time, Expensive, Low energy density |
| Fuel | Fuel type, Fuel capacity, Fuel efficiency | Long flight time, High energy density | High cost, Difficult to handle, Risk of explosion |
| Solar | Solar panel efficiency, Surface area | Renewable, Long flight time, Low operating cost | Limited power output, Weather-dependent, Heavy |
| Tethered | Cable length, Power output | Unlimited flight time, Continuous power supply, Increased payload capacity | Limited mobility, Safety concerns, Higher cost |

# 4.6 Power System Management



# Pixhawk flight controller



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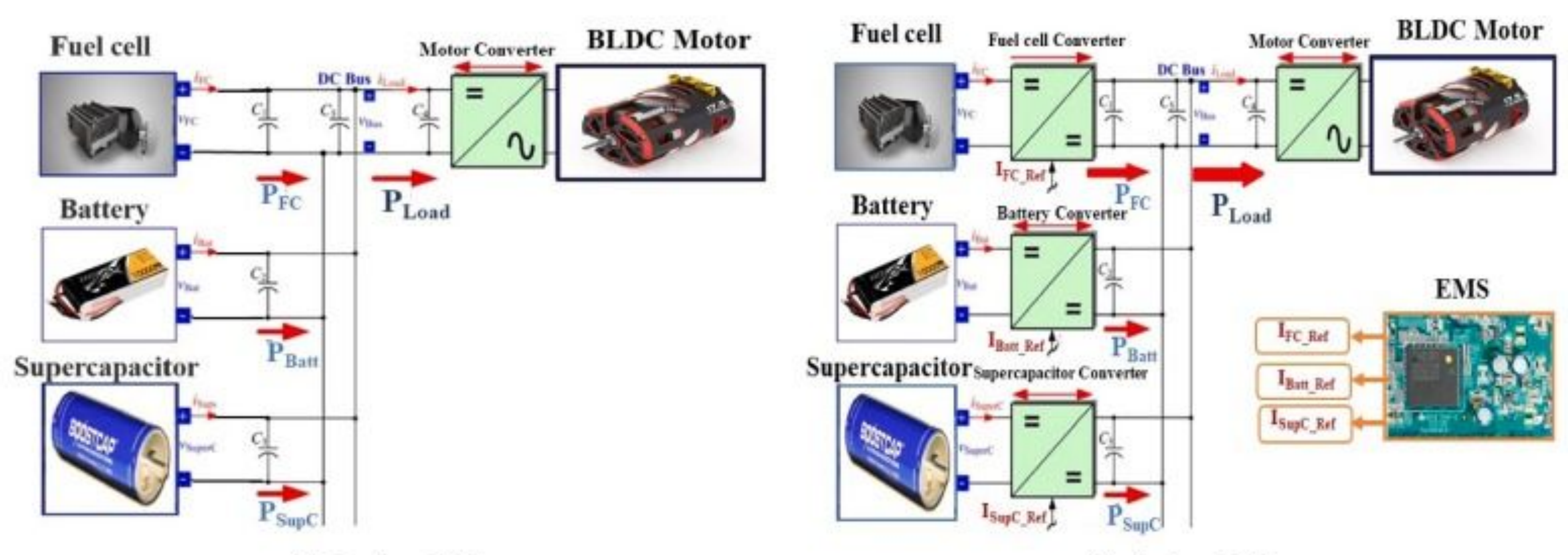


(a) Passive PMS. (b) Active PMS.

# Tethered power system

# Thanks!