ROBOTIC HARDWARE SYSTEM

UAV

(Unmanned Aerial Vehicles)

By : Muhammad Akmal Nasrullah Bin Jamalludin
1917137

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01 INTRODUCTION

INTRODUCTION

Unmanned Aerial Vehicles (**UAVs**) are aircraft with no on-board crew or passengers. They can be automated ‘drones’ or remotely piloted vehicles (RPVs). UAVs can fly for long periods of time at a controlled level of speed and height and have a role in many aspects of aviation.

In easy words, UAV is commonly known as a drone, which is an aircraft without any human pilot, crew, or passengers on board.

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.

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**.

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.

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.

The SDI surveillance drone system (1962)

- A drone of the SDI surveillance drone system, used by the Royal Artillery, is given a pre-launch check at Larkhill in Wiltshire, England, May 1962. This was the
- First of a family of new drones acquired by the Royal Artillery in the 1960s to extend observation over the battlefield and to locate targets for new long range weapons.

RPV testing (1980)

- Two British soldiers prepare to launch a Remotely Piloted Vehicle (RPV) drone from a Bedford three-ton truck on exercise in Germany, probably in the early 1980s.
- Control the drone through a remote keypad and joystick.

Midge drone

- The rocket powered Midge Drone was designed to carry out aerial photo reconnaissance on a pre-programmed flight.
- Equipped with a single camera loaded with either black and white photographic film (daylight missions) or infra-red (night missions).

Reconnaissance drone (1991)

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

Watchkeeper drone (2012)

- 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).

UAV APPLICATIONS

Aerial Photography	Weather Forecast	Geographic Mapping
Entertainment	Search and Rescue	Shipping and Delivery
Law Enforcement	Precision Agriculture	Water Quality Monitoring
Wildlife Monitoring	Disaster Management	Military

03 MAIN COMPONENTS

MAIN COMPONENTS

Robot Design

Locomotion System

Navigation & Control System

Data Collection

Data Transmission

Power Management

1. Robot Design

MULTI-ROTOR UAV

CALLED MULTI-ROTOR BECAUSE THEY HAVE MORE THAN ONE MOTOR, MORE COMMONLY TRICOPTERS (3 ROTORS), QUADCOPTERS (4 ROTORS), HEXACOPTERS (6 ROTORS) AND OCTOCOPTERS (8 ROTORS), AMONG OTHERS. BY FAR, QUADCOPTERS ARE THE MOST POPULAR MULTI-ROTOR DRONES.

SINGLE-ROTOR UAV

SINGLE-ROTOR DRONE TYPES ARE STRONG AND DURABLE. THEY LOOK SIMILAR TO ACTUAL HELICOPTERS IN STRUCTURE AND DESIGN. A SINGLE-ROTOR HAS JUST ONE ROTOR, WHICH IS LIKE ONE BIG SPINNING WING, PLUS A TAIL ROTOR TO CONTROL DIRECTION AND STABILITY.

1. Robot Design

FIXED-WINGS UAV

HAS ONE RIGID WING THAT IS DESIGNED TO LOOK AND WORK LIKE AN AEROPLANE, PROVIDING THE LIFT RATHER THAN VERTICAL LIFT ROTORS

FIXED-WING HYBRID VTOL

MERGE THE BENEFITS OF FIXED-WING AND ROTOR-BASED DESIGNS. THIS DRONE TYPE HAS ROTORS ATTACHED TO THE FIXED WINGS, ALLOWING IT TO HOVER AND TAKE OFF AND LAND VERTICALLY.

2. Locomotion System

Fixed-Wings

Fixed-wing drones depend on forward motion for lift, requiring constant forward movement through propulsion systems to create a wind stream to pass through their wings in order to get enough lift to oppose their weight, or can keep flying without propeller rotation as long as relative airspeed is constant

Rotary-Wing

This type of UAV uses rotors that spin to generate lift and propulsion. Examples include quadcopters, hexacopters, and octocopters. They are commonly used for aerial photography, videography, and inspection tasks due to their ability to hover in place and maneuver in tight spaces.

Flapping-Wing

Some UAVs mimic the flight of birds or insects by flapping their wings. This type of locomotion system is still in the early stages of development and is primarily used for research purposes.

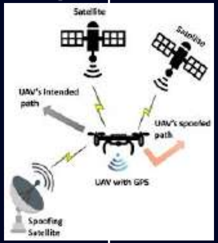
Hybrid

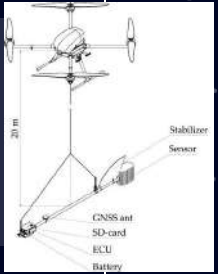
Some UAVs use a combination of different locomotion systems to achieve greater flexibility and efficiency. For example, a UAV may use a fixed-wing for long-range flight and then switch to rotary-wing for landing and takeoff.

3. Navigation & Control System

GPS (GLOBAL POSITIONING SYSTEM)

A GPS receiver is typically used to determine the UAV's location and velocity.



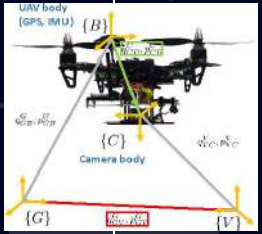


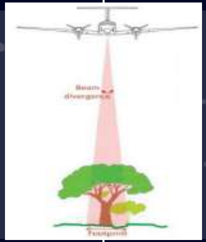
MAGNETOMETER

measures the strength and direction of the Earth's magnetic field, which can be used to determine the UAV's orientation relative to magnetic north.

INERTIAL MEASUREMENT UNIT (IMU)

IMU is a sensor package that measures the UAV's acceleration and rotation rates, which can be used to estimate its orientation and position.





BAROMETRIC ALTIMETER

This sensor is used to determine the UAV's altitude relative to sea level.

COMPUTER VISION

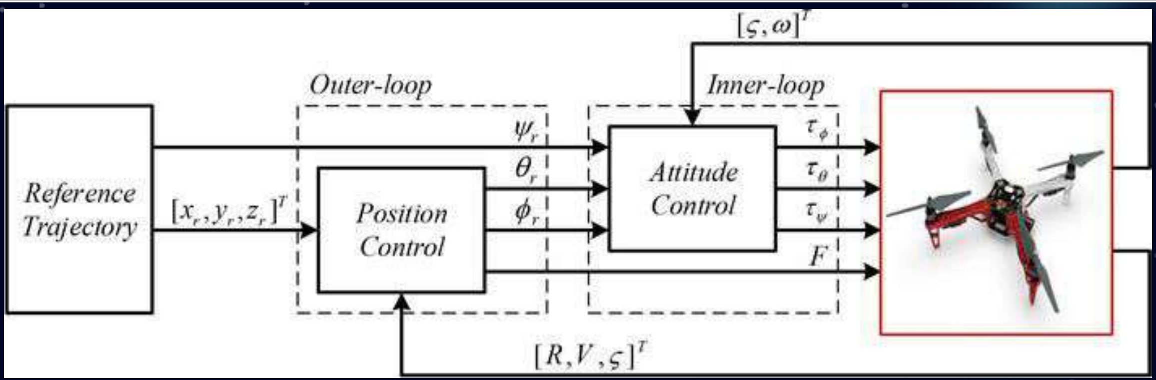
Thisalgorithms can be used to detect and track features on the ground, such as landmarks, roads, and buildings. This can help the UAV to navigate in environments where GPS signals are weak or unavailable.

FLIGHT CONTROL SOFTWARE

The UAV's flight control software integrates the sensor data and algorithms to control the vehicle's movement and adjust its trajectory as needed.

Control Theory

Course keeping control system for automatic heading and balancing of the UAV

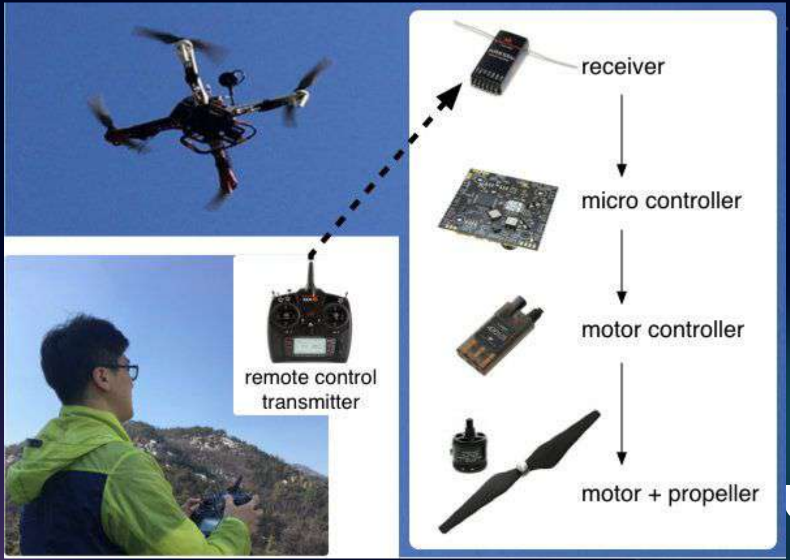


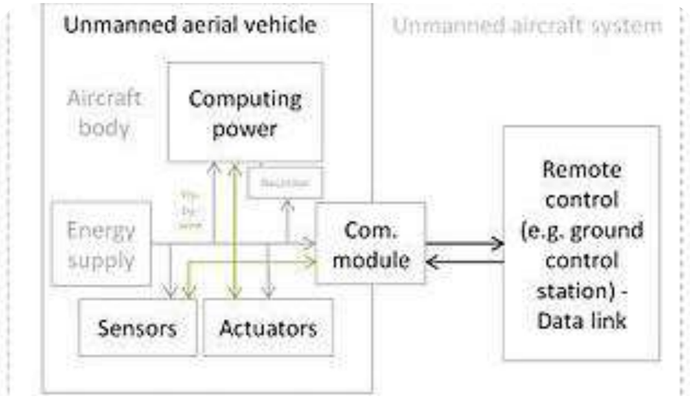
Type of internal Controller

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

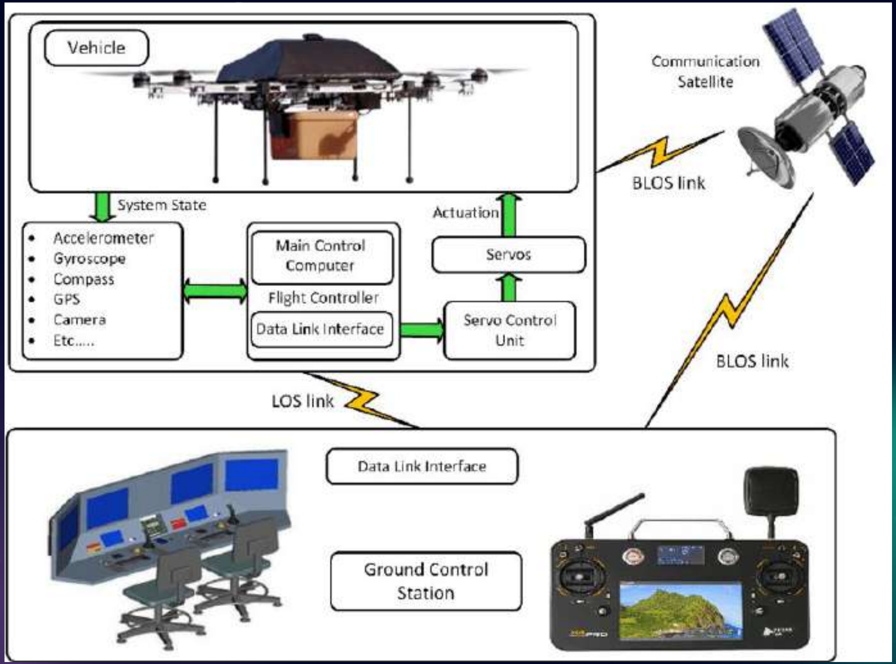
UAV and drones require flight control software and hardware elements that will allow the aircraft to be controlled remotely either directly by a pilot or autonomously by an onboard computer.

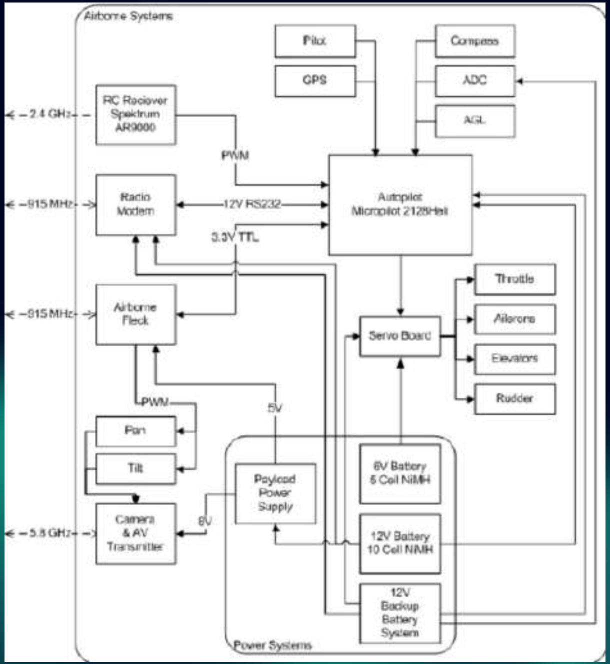




System Architecture

Structure of a remote-controlled drone. Multiple onboard sensors and control computer replace the human operator in autonomous drones.





4. Data Collection

RGB Cameras

Multispectral Cameras

Thermal Cameras

GPS (Global Positioning System)

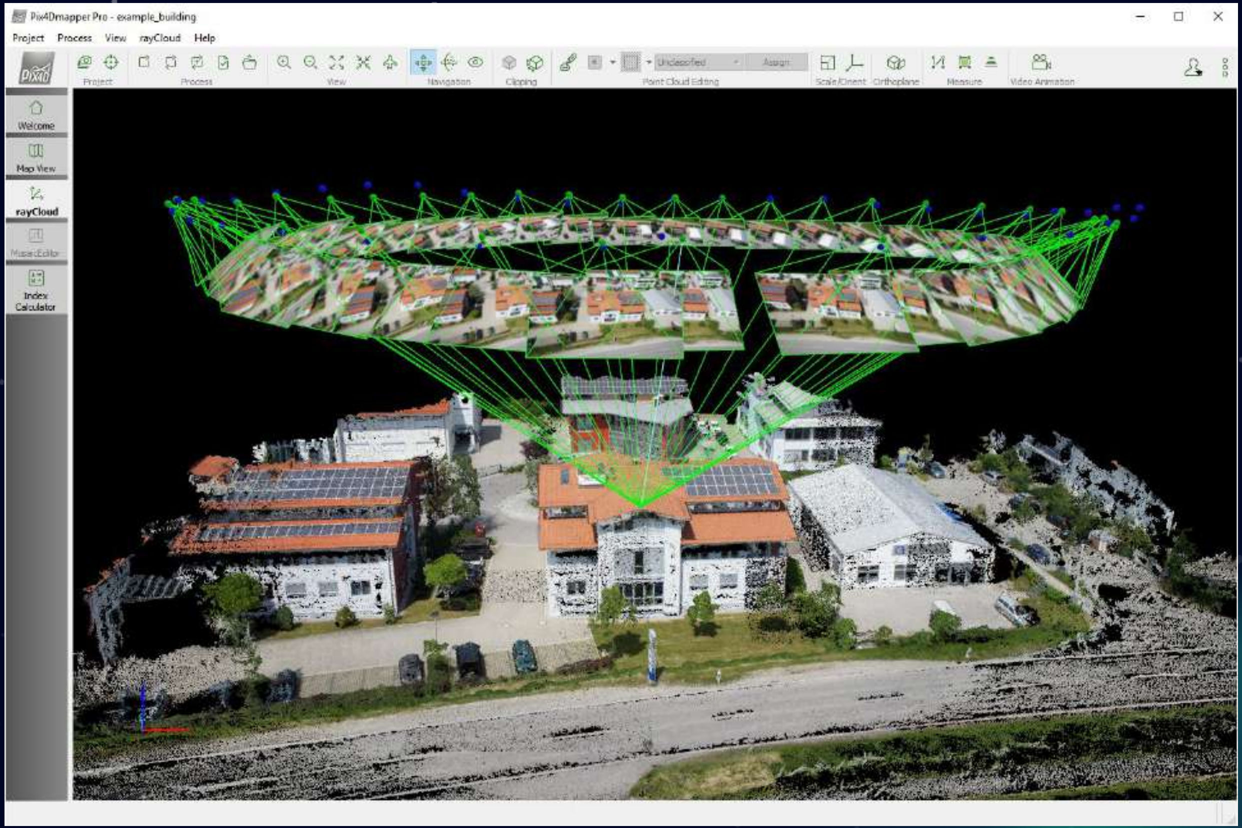
Inertial Measurement Unit (IMU)

LiDAR

Magnetometer

Data Collection Software

Pix4D

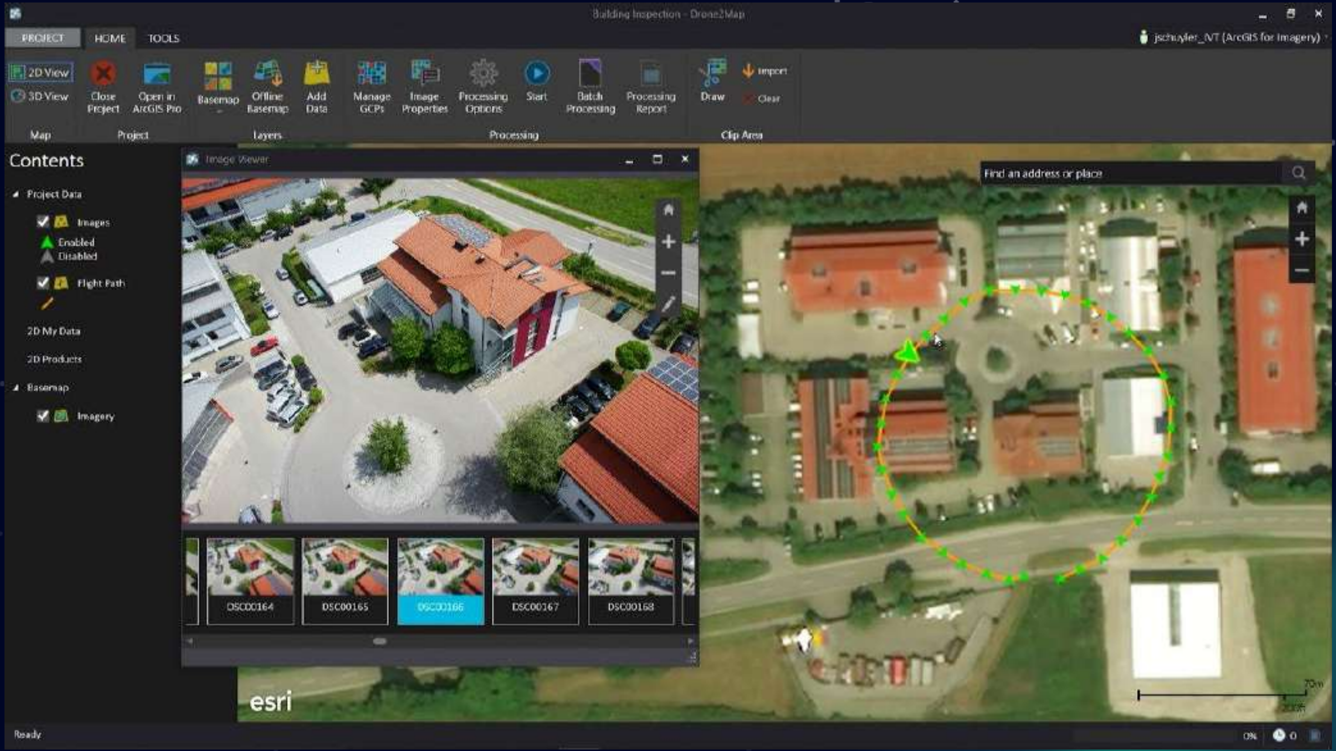


Data Collection Software

DroneDeploy

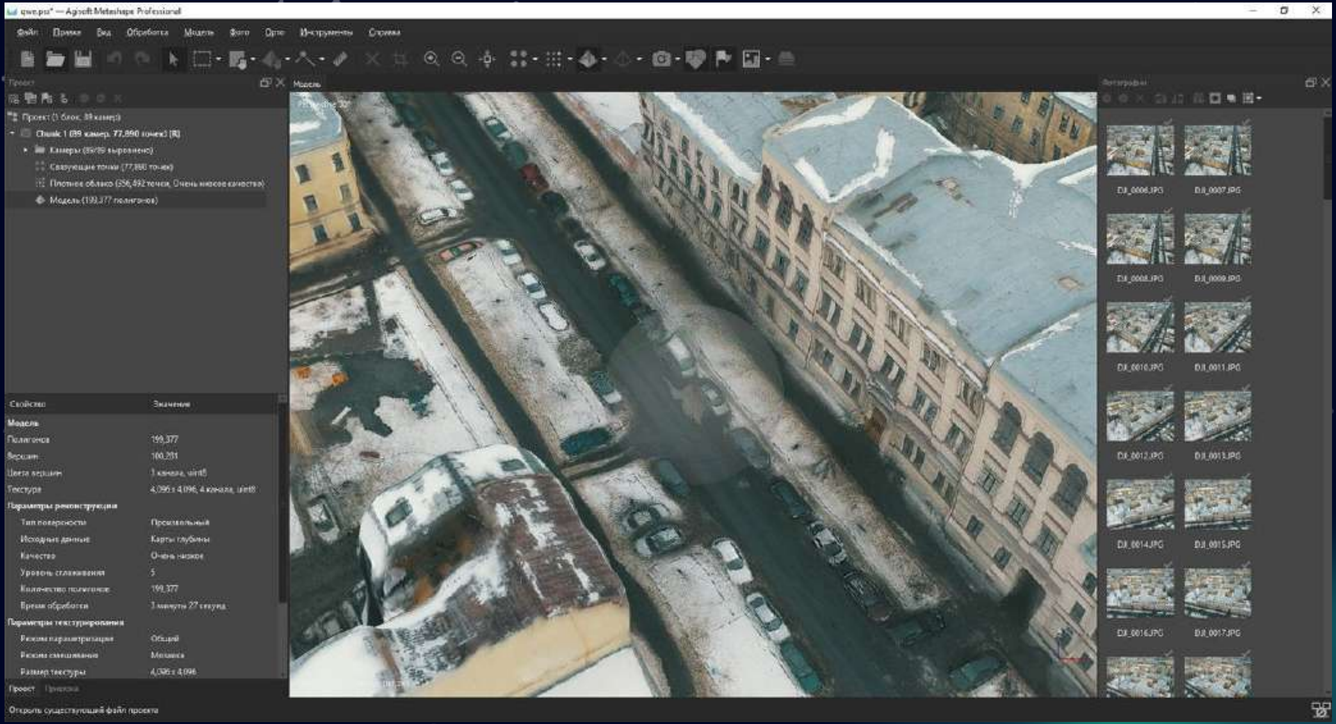
Data Collection Software

Esri Drone2Map



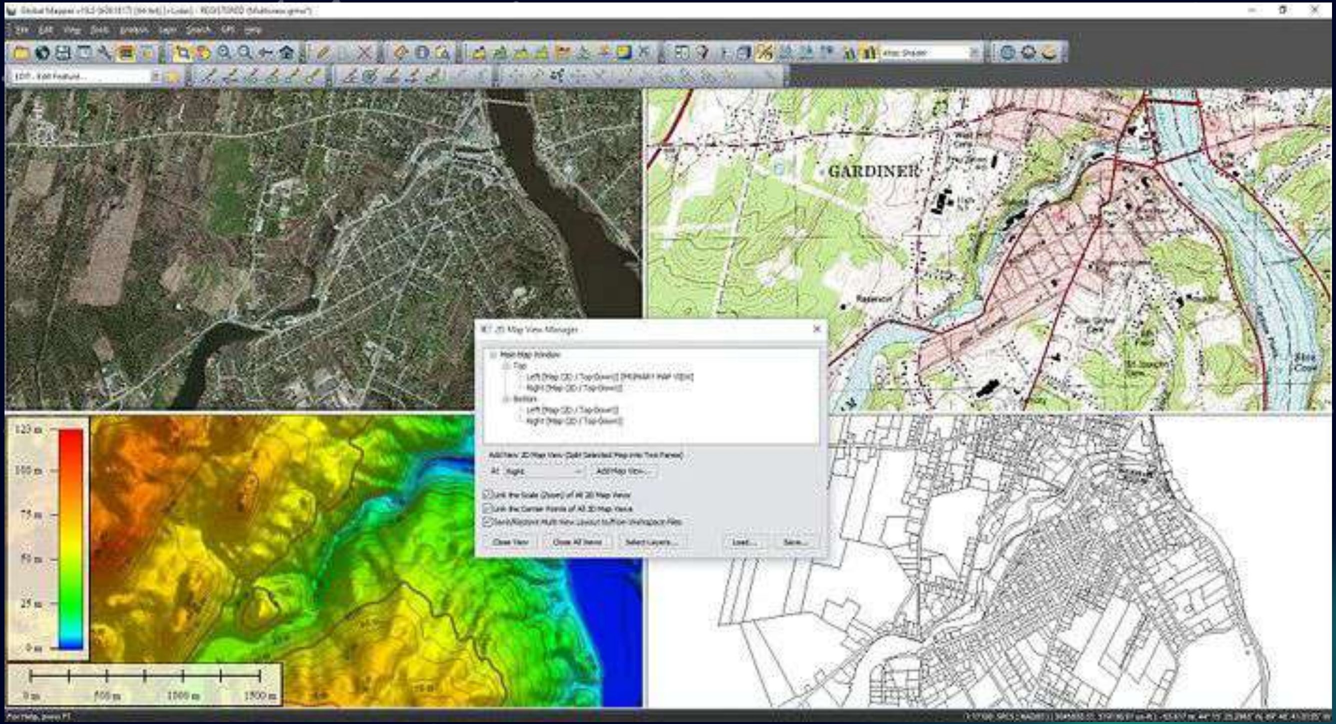
Data Collection Software

Agisoft Metashape



Data Collection Software

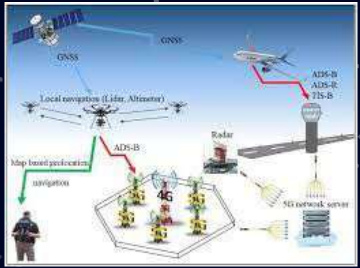
Global Mapper



5. Data Transmission

RADIO FREQUENCY (RF) COMMUNICATION

Commonly used for short-range communication and requires a direct line of sight between the UAV and the ground station.

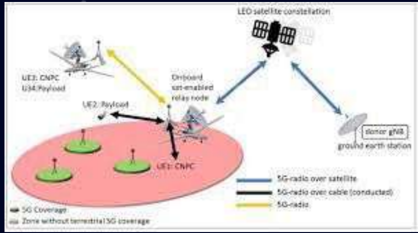


CELLULAR NETWORKS

This method is typically used for longer-range communication and allows for the transmission of large amounts of data.

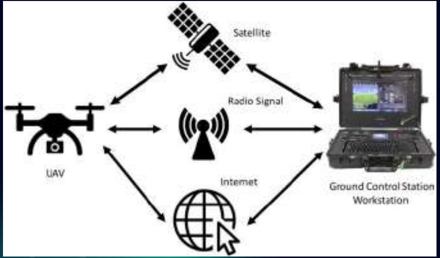
SATELLITE COMMUNICATION

This method is used when the UAV is flying in remote areas where there is no cellular network coverage.



WI-FI

Drones can be controlled remotely through mobile application over the internet. Enables the commercial drones to be remote-ready.



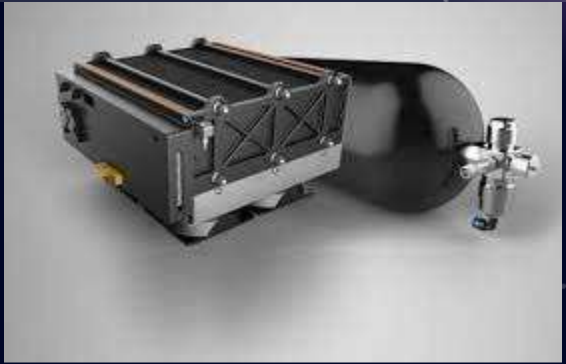
BLUETOOTH

This method is typically used for short-range communication. When in some areas that GPS signal is unstable, we can use Bluetooth location to improve the positional accuracy.

5. Power Management

1.Battery power

2.Fuel cells

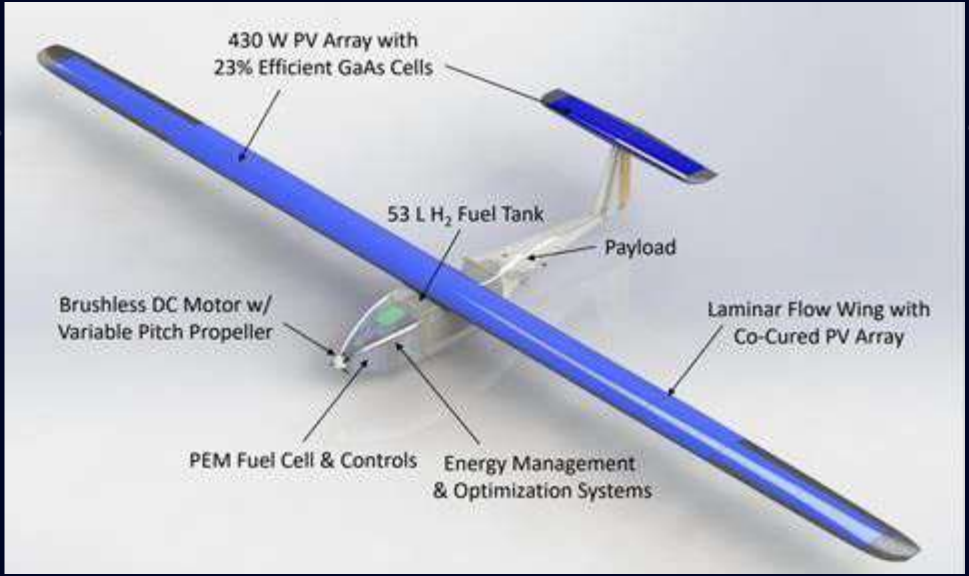


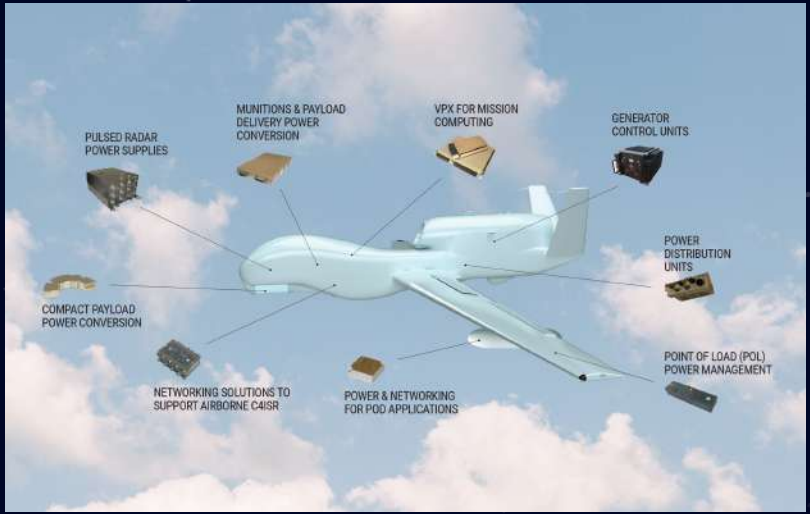
3.Gasoline or diesel engines

4.Solar power

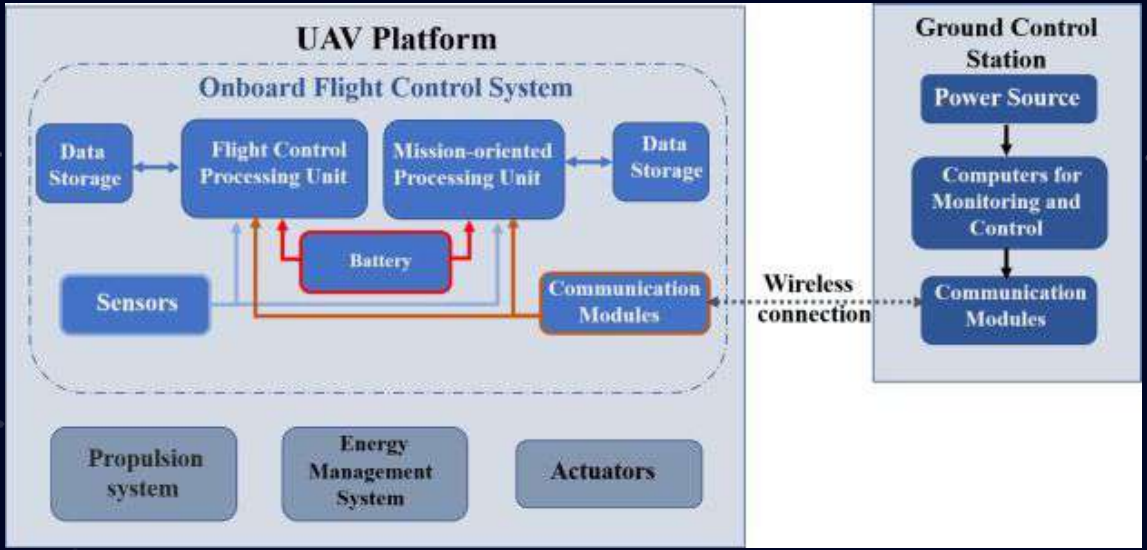
5.Tethered power

5. Power Management





5. Power Management



The "Battery" part also can be replaced by other power such as :

1. Gasoline
2. Fuel Cells
3. Solar
4. Tethered