Drone Components and Architecture

DI05000081: Drone Technology — Unit 2

Drone Technology

Gujarat Technological University

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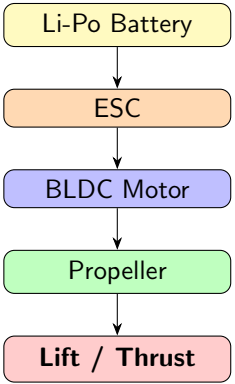
Unit 2 Roadmap

Topics Covered in Unit 2

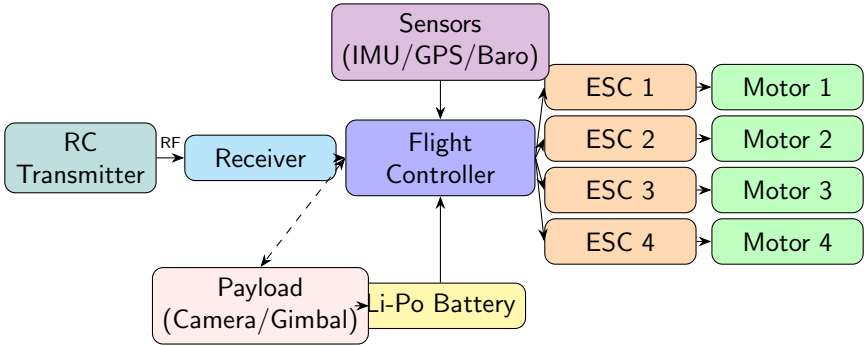
1. **Basic architecture** block diagram
2. **Frame** and mechanical structure
3. **Brushless DC motors** (BLDC)
4. **Electronic Speed Controller** (ESC)
5. **Propellers** and thrust generation
6. **Power system** — Li-Po battery
7. **Payload systems** (camera, gimbal, sensors)

Approach

We trace the **power path**: Battery → ESC → Motor → Propeller → Lift



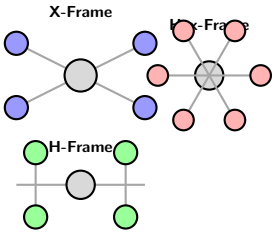
2.1 Basic Block Diagram of a Drone System



2.2 Frame and Mechanical Structure

Types of Frames

Type	Motors	Use-case
H-frame	4	General purpose
X-frame	4	Acrobatic / FPV
+-frame	4	Stable payload
Hex/Octo	6/8	Heavy lift
Spider	6	Camera drones



Materials Used

- **Carbon Fibre**: Lightest, strongest; expensive
- **Aluminium**: Rigid, heavier, cost-effective
- **Nylon / ABS**: 3D-printed parts; flexible

2.3 Brushless DC (BLDC) Motors

Construction

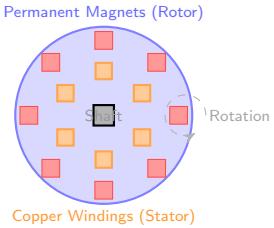
- **Stator**: Fixed copper windings (electromagnets)
- **Rotor (bell)**: Permanent magnets rotate around stator
- **No brushes** $\Rightarrow$ less friction, longer life

Working Principle

ESC sequentially energises stator coils creating rotating magnetic field $\rightarrow$ rotor magnets follow $\rightarrow$ shaft rotates

KV Rating

$$\text{RPM} = \text{KV} \times V_{\text{motor}}$$



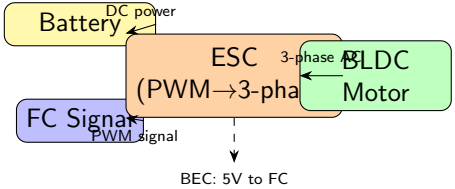
2.4 Electronic Speed Controller (ESC)

Function of ESC

- Converts FC PWM signal to **3-phase AC** for BLDC motor
- Controls **motor speed** (RPM) precisely
- Contains a **BEC** (Battery Eliminator Circuit) to power FC at 5V
- Provides **motor braking** and current protection

Connections

Input	Battery (+ and −)
Input	Signal wire from Flight Controller
Output	3 phase wires to BLDC Motor



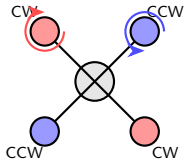
2.5 Propellers and Thrust Generation

Propeller Notation: e.g., 10×4.5

- **Diameter (10")** — larger ⇒ more air moved ⇒ more lift (low KV motor)
- **Pitch (4.5")** — distance prop would travel in one rotation; higher pitch = more aggressive

CW and CCW Propellers

- Quadrotor uses **two CW + two CCW** props
- Counter-rotation **cancels torque reaction** (prevents spin)
- Diagonal motors spin same direction



CW + CCW = No net torque

2.6 Power System — Li-Po Battery

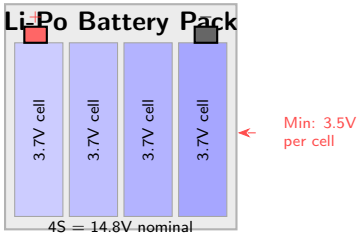
Li-Po Battery Notation: e.g., 4S 5000 mAh 30C

S (cells) Number of cells in series; 1S = 3.7V nominal

Capacity Energy stored; 5000 mAh = 5 Ah

C Rating Maximum discharge rate; $I_{max} = C \times \text{Capacity}$

Example: 4S = $4 \times 3.7 = 14.8$V; 30C $\times$ 5Ah = 150A max discharge



Charging and Safety

- Always charge at **1C rate** (5A for 5000 mAh)
- Never discharge below **3.5V per cell**

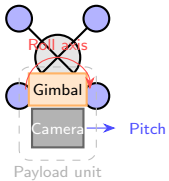
2.7 Payload Systems

Camera

- Action cameras (GoPro), RGB cameras, thermal/IR, multispectral
- Resolution and frame rate determine video quality
- Weight directly reduces flight time

Gimbal

- **3-axis stabilisation** (pitch, roll, yaw)
- Uses brushless motors + IMU feedback
- Isolates camera from drone vibration
- Enables smooth video during flight



Additional Sensors / Components

Unit 2 — Summary

Key Takeaways

- A drone is built on a **frame** (carbon fibre / aluminium)
- **BLDC motors** driven by **ESCs** spin the propellers
- **KV** rating tells RPM per volt of a motor
- **CW + CCW propeller pairs** cancel torque reaction
- **Li-Po battery**: capacity (mAh), voltage (S-rating), discharge (C-rating)
- Payload includes **camera + 3-axis gimbal** for aerial imaging

Review Questions

1. What is the KV rating of a motor?
2. Why does a quadrotor use two CW and two CCW props?
3. What does a 4S 3000mAh 30C Li-Po battery tell you?
4. What is the function of an ESC?
5. What is a gimbal and why is it used?

Next: Unit 3