Introduction to Drone Technology

DI05000081: Drone Technology — Unit 1

Drone Technology

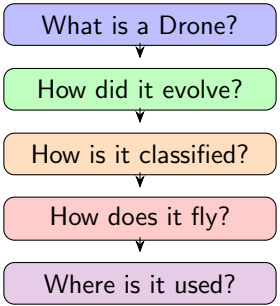
Gujarat Technological University

Academic Year 2024–25

Unit 1 Roadmap

Topics Covered in Unit 1

1. **Definition** of UAV and Drone
2. **History and evolution** of drones
3. **UAV vs. UAS vs. Drone**
4. **Classification** of drones
5. **Basic terminology**: Pitch, Roll, Yaw, Throttle, Altitude
6. **Forces acting** on a drone
7. **Advantages and Limitations**
8. **Applications** of drones



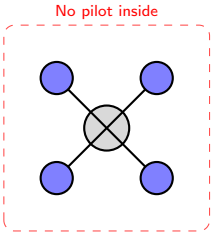
1.1 Definition of UAV and Drone

UAV — Unmanned Aerial Vehicle

- An aircraft that operates **without a human pilot on board**
- Controlled remotely or autonomously
- Also called *remotely piloted aircraft* (RPA)

Drone

- Popular/informal term for a UAV
- Originally referred to **target practice aircraft** in military use
- Today covers any unmanned, powered, free-flying aircraft



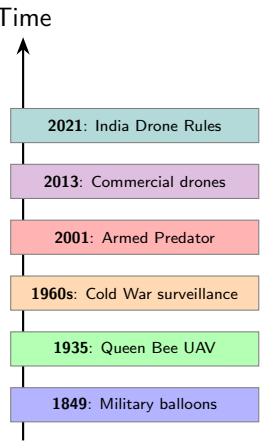
Quadrotor (top view)

Key Point

1.2 History and Evolution of Drones

Timeline of Key Milestones

Year	Event
1849	Austria uses unmanned balloons in war
1916	First radio-controlled aircraft (UK)
1935	DH.82B Queen Bee — first modern UAV
1960s	Military surveillance drones (Cold War)
1982	Israel uses drones in Lebanon war
2001	Predator drone armed missions begin
2006	FAA issues first commercial drone rules
2013	Amazon announces Prime Air delivery
2014	DJI Phantom popularises consumer drones
2021	India's New Drone Rules released



1.3 UAV vs. UAS vs. Drone

Definitions

UAV *Unmanned Aerial Vehicle* — the aircraft only

UAS *Unmanned Aircraft System* — UAV + Ground Control Station + Communication links + Payload

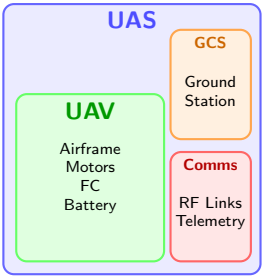
Drone Informal/popular term; often used interchangeably with UAV

Analogy

UAV = Car body

UAS = Car + driver + road + fuel station

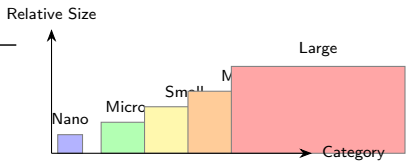
Drone = the word people actually use!



1.4 Classification of Drones — By Size / Weight

Weight-Based Categories (DGCA India)

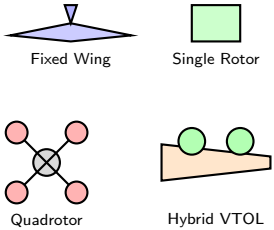
Category	Max Takeoff Weight	Example
Nano	≤ 250 g	Toy drones
Micro	250 g–2 kg	DJI Mini
Small	2 kg–25 kg	DJI Mavic
Medium	25 kg–150 kg	Survey drones
Large	> 150 kg	Military UAVs



1.4 Classification by Structure / Design

Main Design Categories

- **Fixed-Wing**: Plane-like; efficient for long range
- **Single-Rotor (Helicopter)**: High payload; complex
- **Multi-Rotor**: Quad/Hex/Octo; stable; most common
- **Hybrid**: VTOL + fixed-wing; best of both



Most Popular

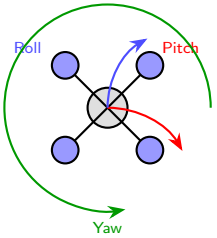
Quadrotor (4 motors) dominates the consumer and prosumer market due to simplicity and stability.

1.5 Basic Drone Terminology

Six Degrees of Freedom (6-DoF)

Pitch	Nose up / down rotation (X-axis)
Roll	Left / right tilt (Y-axis)
Yaw	Rotation around vertical Z-axis (spin)
Throttle	Engine/motor power controlling altitude
Altitude	Height above ground / sea level

Throttle = vertical power
Altitude = height above ground



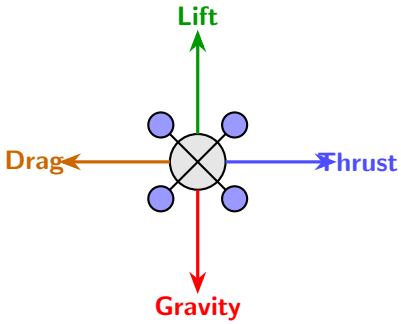
Remember

Pitch = **P**lane nose tilts forward/back
Roll = **R**ocks side to side
Yaw = **Y**aws left/right (compass heading)

1.6 Forces Acting on a Drone

The Four Forces of Flight

Lift	Upward force from spinning propellers (opposes gravity)
Gravity	Downward force due to weight of drone
Thrust	Forward propulsive force (horizontal)
Drag	Air resistance opposing motion



Conditions for Stable Hover

$$\text{Lift} = \text{Gravity} \quad \text{and} \quad \text{Thrust} = \text{Drag}$$

Key Insight

1.7 Advantages and Limitations of Drones

Advantages

- **No pilot risk** in dangerous missions
- Low cost compared to manned aircraft
- Can hover and fly in tight spaces
- Easy to deploy and operate
- Generates large amounts of aerial data
- Reduces manpower in repetitive tasks
- Reaches remote / inaccessible areas

Limitations

- **Limited battery life** (15–30 min typical)
- Payload capacity constraints
- Vulnerable to wind and weather
- RF interference / signal loss
- Privacy and security concerns
- Strict regulatory requirements
- Limited range without relay / satellite

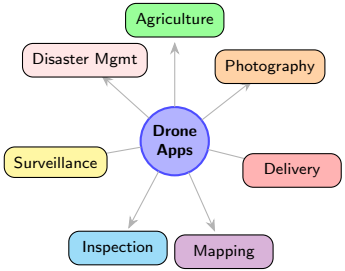
Ongoing Challenges

Battery energy density and sense-and-avoid technology are two of the biggest active research areas in drone development.

1.8 Applications of Drones

Major Application Domains

- **Agriculture**: Crop monitoring, spraying, soil mapping
- **Aerial Photography/Videography**: Films, events, real estate
- **Disaster Management**: Search & rescue, damage assessment
- **Surveillance & Security**: Border patrol, crowd monitoring
- **Infrastructure Inspection**: Bridges, towers, pipelines
- **Parcel Delivery**: Last-mile logistics (Amazon, Swiggy)
- **Mapping & Surveying**: GIS



Unit 1 — Summary

Key Takeaways

- UAV = aircraft only; UAS = complete system including GCS and comms
- Drones evolved from 1849 balloons to today's AI-powered systems
- Classified by **weight**, **altitude**, and **structure**
- Flight described by **Pitch, Roll, Yaw, Throttle, Altitude**
- Four forces: **Lift, Gravity, Thrust, Drag**
- Wide applications but limited by **battery life and regulations**

Next: Unit 2

Drone Components & Architecture — what's inside

Review Questions

1. What is the difference between a UAV and UAS?
2. Classify drones based on structure with examples.
3. Define Pitch, Roll, and Yaw.
4. State the four forces acting on a drone.
5. List any four applications of drones.