

Communication and Navigation Systems

DI05000081: Drone Technology — Unit 4

Drone Technology

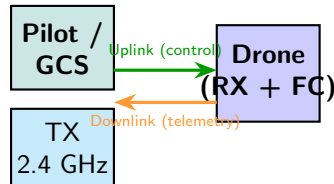
Gujarat Technological University

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Unit 4 Roadmap

Topics Covered in Unit 4

- 1 Basics of Drone Communication
- 2 Radio Transmitter and Receiver
- 3 Channels in drone communication
- 4 Communication Frequency Bands
- 5 Telemetry Systems
- 6 Ground Control Stations (GCS)
- 7 Waypoint Navigation



Two Key Links

Uplink: Pilot → Drone (control)

Downlink: Drone → Pilot (telemetry / video)

4.1 Basics of Drone Communication

Definition

Drone communication is the **exchange of information** between the drone (UAV) and the ground (pilot / GCS) using wireless radio links.

Why is a Communication System Needed?

- To send **pilot commands** to the drone in real time
- To receive **telemetry data** (battery, GPS, speed, altitude)
- To stream **live video** (FPV or camera feed)
- To enable **autonomous missions** (upload waypoints)

Two Types of Communication

Control Comm. Pilot → Drone;
carries stick commands (throttle, pitch, roll, yaw, switches); must be *low-latency* (<20 ms)

Data Comm. Drone → Ground;
carries telemetry packets (GPS, attitude, battery); can tolerate higher latency

Communication Links

Video (DOWN)

Telemetry (DOWN)



4.2 Radio Transmitter and Receiver

Transmitter (TX)

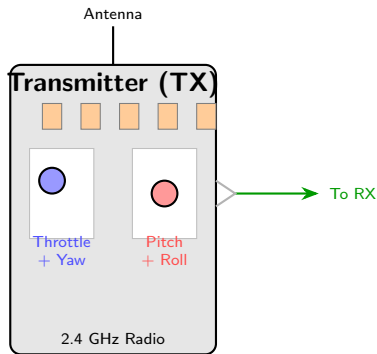
Handheld controller operated by the pilot

- **Control sticks** (2): Left stick (Throttle + Yaw), Right stick (Pitch + Roll)
- **Switches**: Toggle flight modes, RTH, gimbal tilt
- Encodes stick positions into **channel values**
- Sends encoded signal over RF link to receiver

Receiver (RX)

Small module mounted inside the drone

- Receives RF signal from transmitter



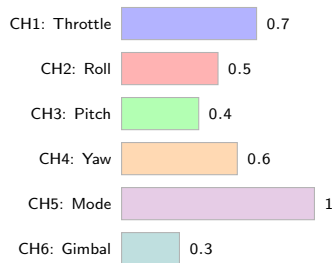
4.3 Channels in Drone Communication

What is a Channel?

A **channel** is an independent control signal sent from the transmitter to the receiver. Each channel carries one piece of information (e.g., throttle position).

Minimum 4 Channels Required

Ch.	Control	Function
CH1	Roll	Bank left / right
CH2	Pitch	Nose up / down
CH3	Throttle	Altitude / power
CH4	Yaw	Rotate left / right



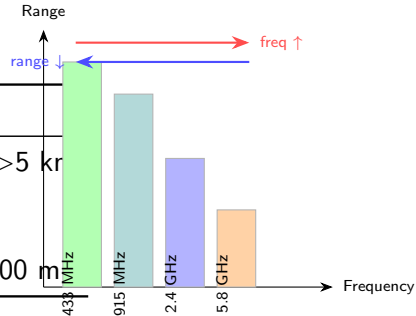
4.4 Communication Frequency Bands

What is Frequency?

Frequency is the number of radio wave cycles per second (Hz). Higher frequency $\Rightarrow$ shorter wavelength $\Rightarrow$ more data but shorter range.

Common Bands Used in Drones

Band	Use	Range
433 MHz	Telemetry	Long (>5 km)
915 MHz	Telemetry / Control	Long
2.4 GHz	RC Control (most common)	1–2 km
5.8 GHz	FPV Video downlink	500–1000 m



Key Trade-off

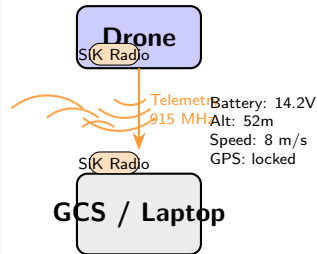
4.5 Telemetry Systems

Definition

Telemetry is the **automatic transmission of data** from the drone to the ground station for real-time monitoring.

Purpose of Telemetry

- Monitor **battery voltage and remaining capacity**
- Track **GPS position** on a map
- View **altitude, speed, heading** in real time
- Monitor **flight mode** and arm/disarm state
- **Detect errors** (GPS lock, compass error)
- Log flight data for post-flight analysis



4.6 Ground Control Stations (GCS)

Definition

A **Ground Control Station** is the hardware and software used by the pilot/operator on the ground to communicate with, monitor, and control the drone.

Types of GCS

Laptop-Based Full-featured software (Mission Planner, QGroundControl); used for mission planning and detailed monitoring

Mobile-Based Smartphone / tablet apps; portable and convenient

Popular GCS Apps

Software	Platform
Mission Planner	Windows (PC)
QGroundControl	Win/Mac/Linux/Mob
DJI GO / DJI Fly	iOS / Android
Litchi	iOS / Android
Tower (Droidplanner)	Android

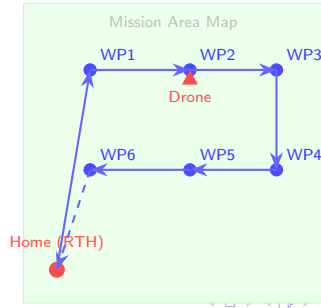
4.7 Waypoint Navigation

Definition

A **waypoint** is a set of GPS coordinates (latitude, longitude, altitude) that the drone must fly to autonomously.

Concept with Example

- 1 Pilot defines a **sequence of waypoints** on the GCS map
- 2 Mission is uploaded to drone's flight controller
- 3 In **Auto mode**, FC navigates drone from waypoint to waypoint using GPS
- 4 At each waypoint, specific actions can be triggered: take photo, loiter, change altitude



Unit 4 — Summary

Key Takeaways

- Two links: **control uplink** (pilot→drone) and **telemetry downlink** (drone→pilot)
- RC transmitter sends **channel values**; receiver decodes and forwards to FC
- Minimum **4 channels**: Throttle, Pitch, Roll, Yaw
- **2.4 GHz** control, **5.8 GHz** video, **433/915 MHz** telemetry
- Telemetry provides real-time battery, GPS, altitude data
- GCS is laptop/mobile software (Mission Planner, DJI Fly)
- Waypoints enable autonomous GPS missions

Review Questions

- ① What is the difference between uplink and downlink?
- ② What is a channel in RC communication?
- ③ Why is 2.4 GHz used for RC control?
- ④ What is telemetry and why is it needed?
- ⑤ Define waypoint navigation with