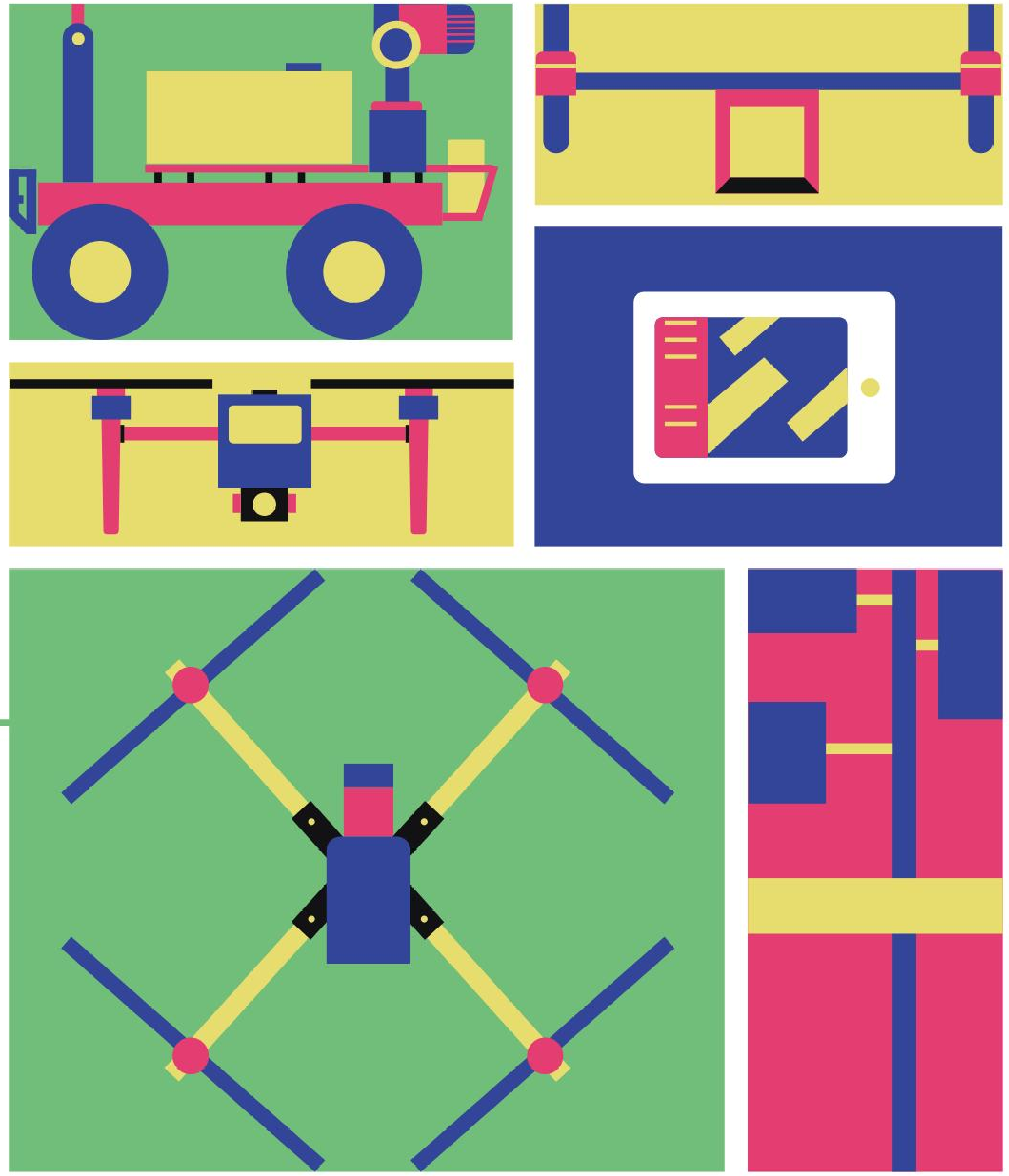
Agricultural Drone Obstacle Avoidance and Terrain Following



01 Functional Features of Each Module in the Perception System

02 Work Field Scenario Classification and Obstacle Avoidance Strategies

03 Key Points of Operation in Specific Scenarios

04 How to Handle Abnormal Situations

05 Pre-flight Inspection and Equipment Maintenance

01 | Functional Features of Each Module in the Perception System

The perception system of the P150 Max includes: FPV Camera,
Radar,
and LED Light Module.

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FPV Camera

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Function: Captures real-time video for intelligent recognition.

The viewing range can be switched through the operating

Image Sensor	1/2.7-inch CMOS-RGB image sensor, 5 million effective pixels
Field of view (FOV)	Horizontal: 100°, Vertical: 150°
focal length	1.83mm
Frame rate	30 fps
Video Resolution	1920X1080
Operating Voltage	24V

Millimeter-Wave Radar Overview

Hardware Synergy: Camera + Radar

Daytime (Good Lighting): The camera identifies objects while radar measures distance for double confirmation.

Night or Adverse Weather: Radar takes the lead in detecting obstacles, while the camera provides supplementary visuals for pilot awareness.

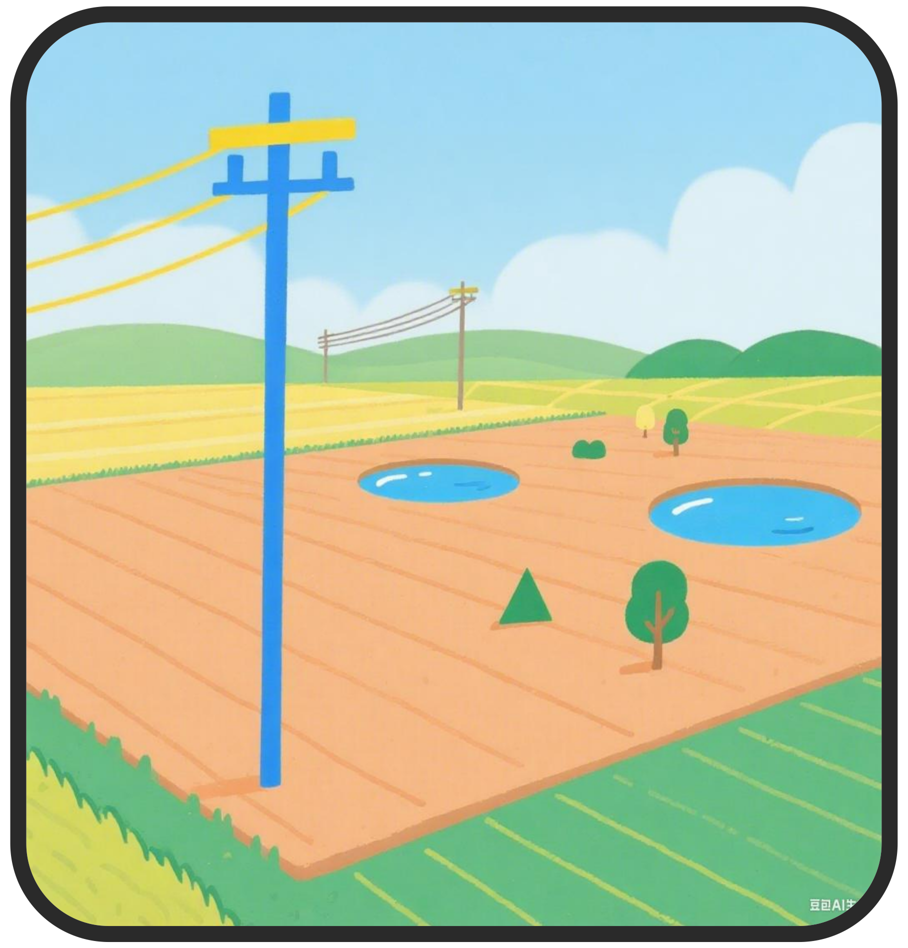
02 Work Field Scenario Classification and Obstacle Avoidance Strategies

Seven Typical Scenarios:

Large Fields

Shrimp-Crab-Fish Ponds

Fields with Obstacles



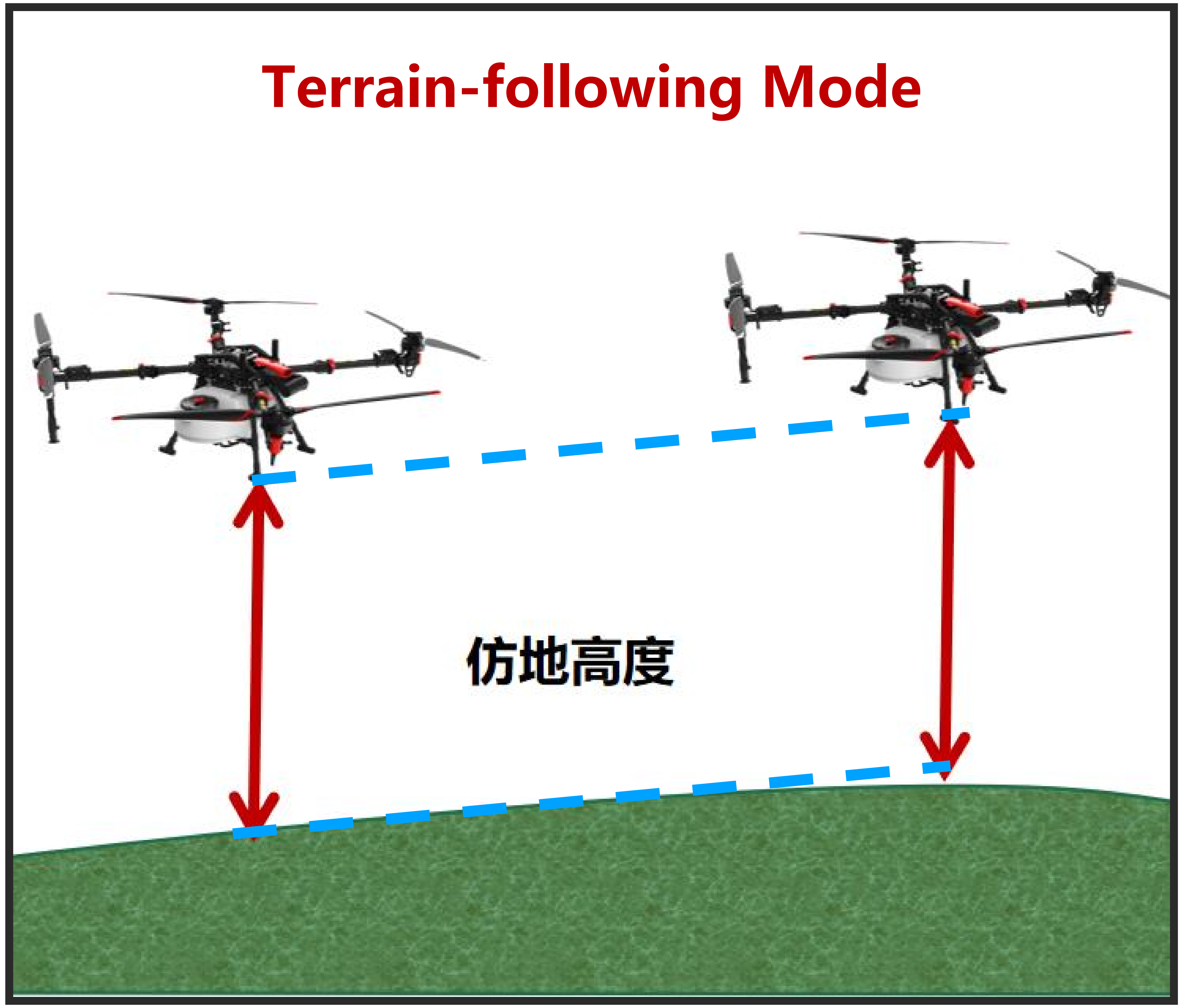
Hilly Terraces

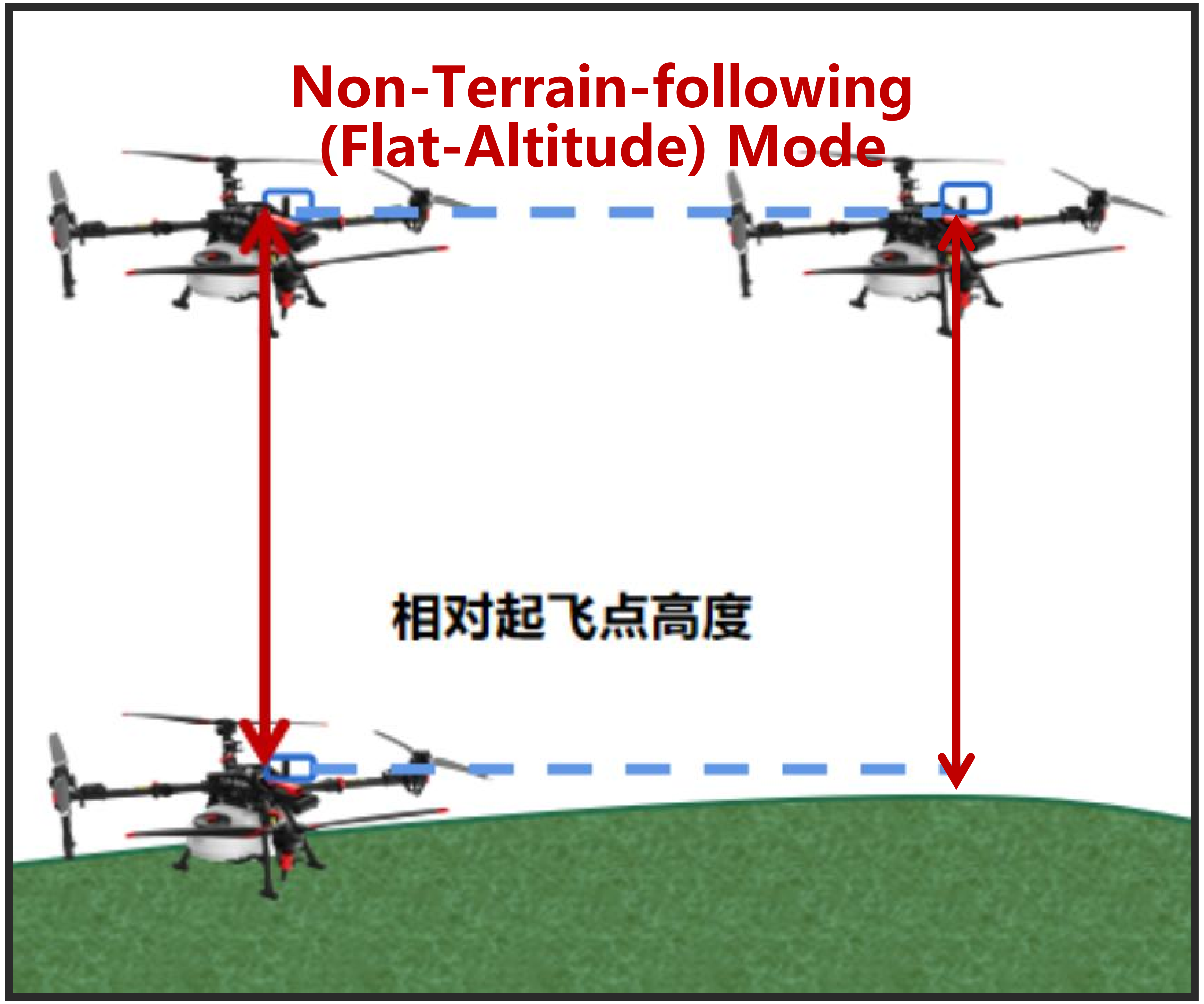
Sloped Orchards

Gentle Slopes with Obstacles

Tall Crop Areas

Autonomous Flight Modes

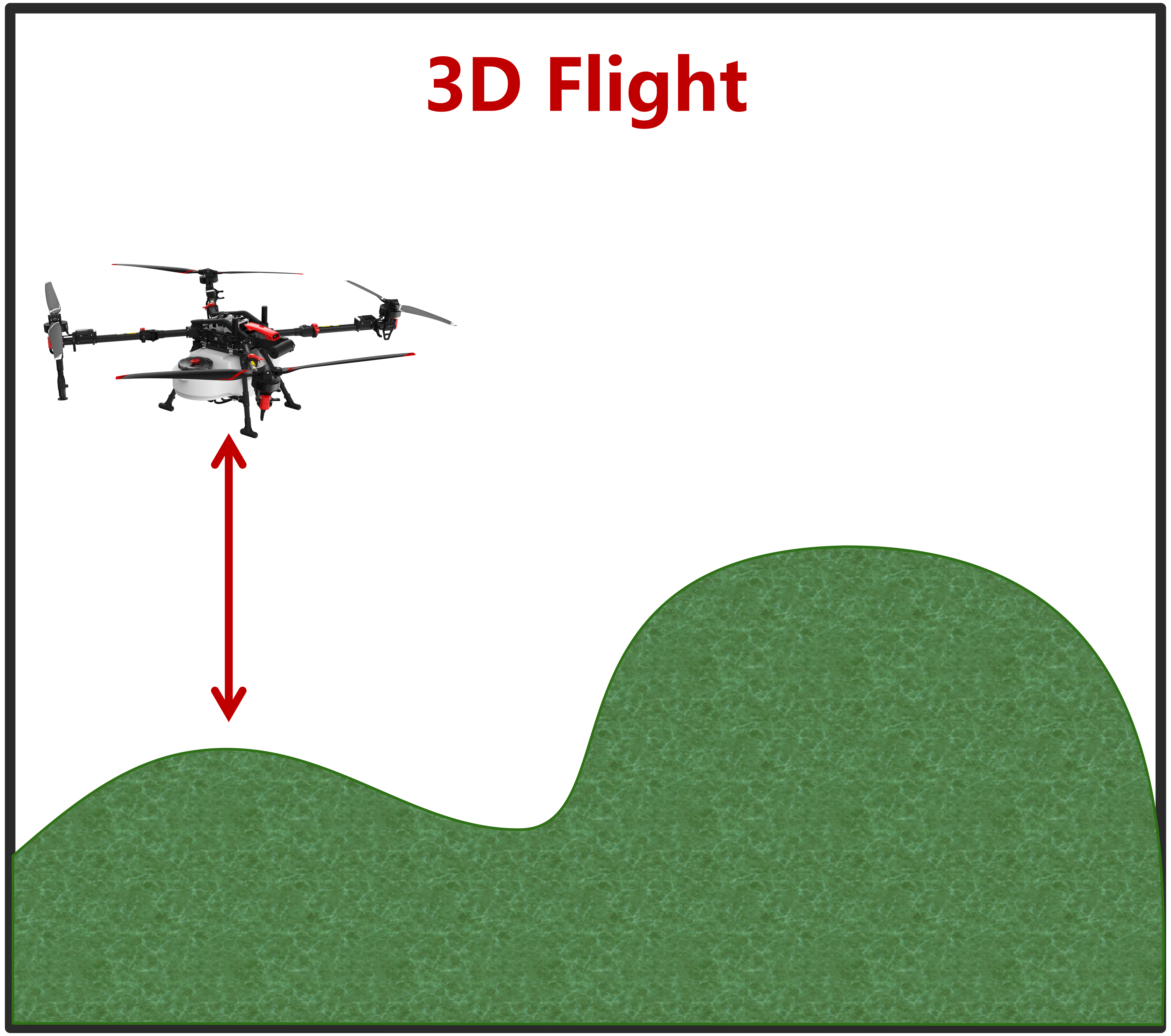


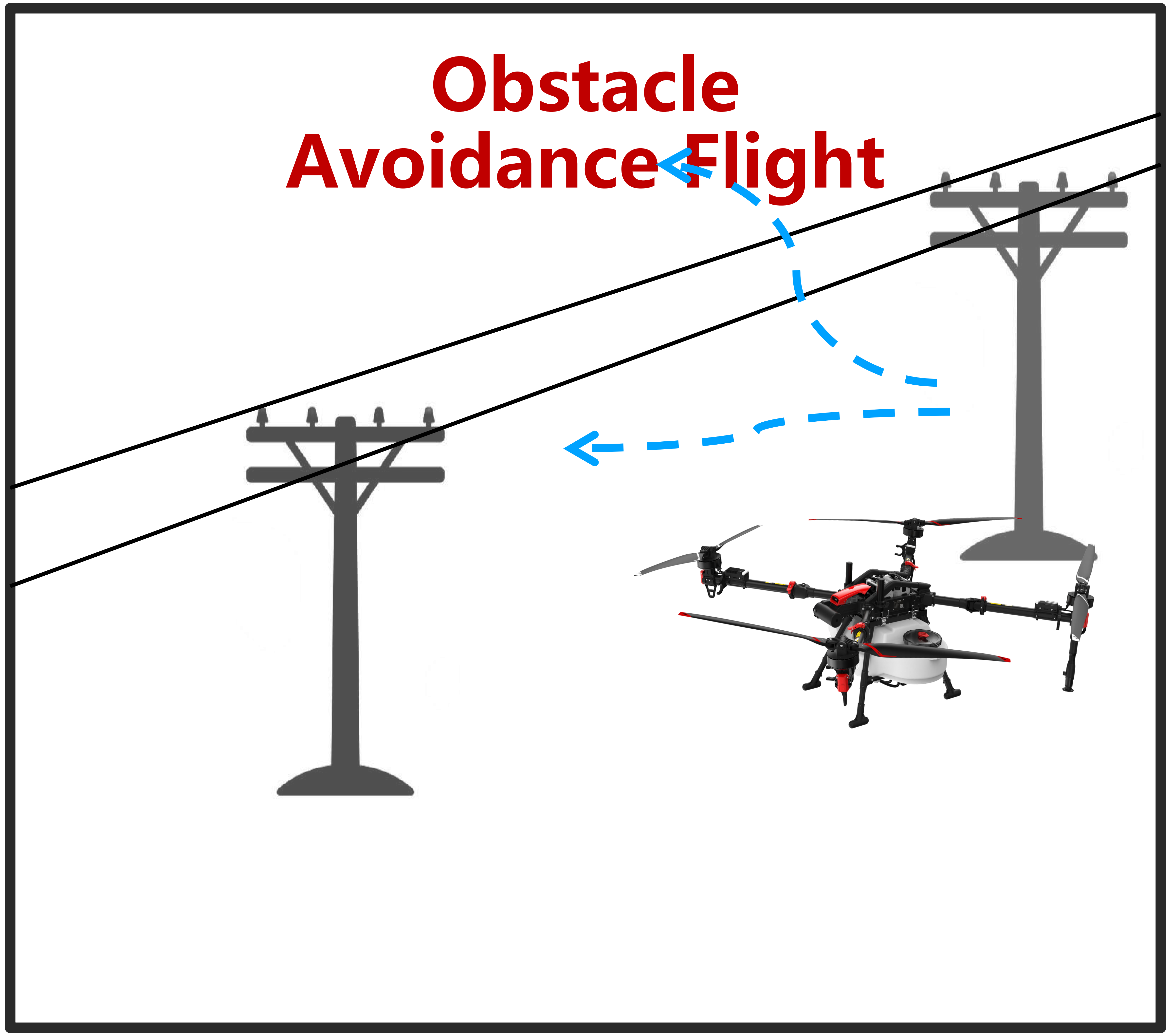


Terrain-following Altitude = Landing Gear Height − Ground Elevation

Relative Altitude from Takeoff Point (when terrain-following disabled) = RTK antenna height in air − RTK antenna height at takeoff point

3D Flight and Obstacle Avoidance Flight





Obstacle Detection Capabilities by Model

- P150 max

Can identify obstacles with a diameter greater than or equal to 5 cm

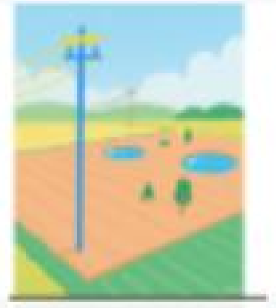
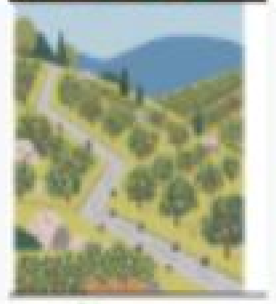
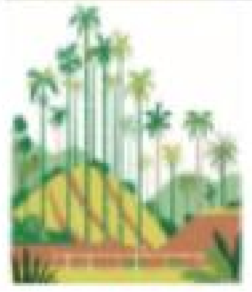
- P150, P60

Can identify obstacles with a diameter greater than or equal to 10 cm

- P100 Pro

Can identify obstacles with a diameter greater than or equal to 15 cm

Autonomous flight mode adaptation scenario

Applicable Scenarios	Illustration	Mode	Flight Characteristics	Obstacle Avoidance Switch	Terrain Following Switch
Recommended for beginners in flat farmlar		Beginner Recommended Mode	Combines terrain following and obstacle avoidanc	On	On
Paddy fields without obstacles		Terrain Following Off - Flies at an altitude relative	Flies at the take-off point altitude, does not detect	Off	Off
Flat farmland with obstacles such as utility		Obstacle Avoidance Flight	Detects obstacles on a fixed-altitude basis. If a ut	On	Recommended to be on
Flat farmland (no obstacles)		Terrain Following Flight	Flies in conjunction with the ground topography (a	Off	On
Orchard on a gentle slope		Terrain Following Flight	Flies in conjunction with the ground topography (a	Recommended to be on	On
Orchard on a gentle slope		Mapless 3D Operation	Flies in conjunction with the terrain topography, su	On by default	On by default
Complex scenarios such as mountains, hill:		3D Route Operation	Flies in conjunction with the terrain topography, su	On by default	On by default

Relationship Between Terrain Slope and Flight Speed

Assuming terrain slope is α, then based on trigonometry:

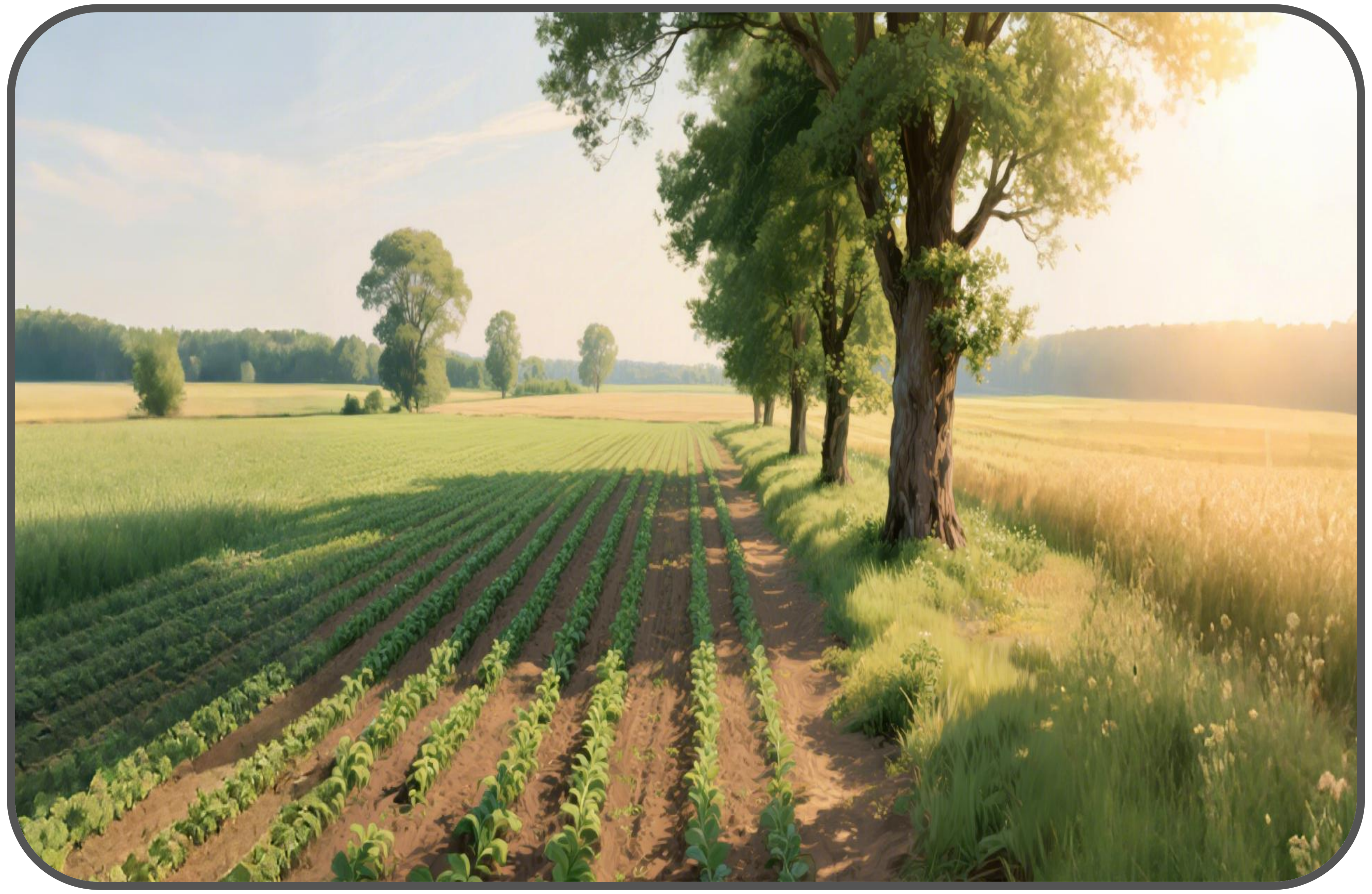
$$V = 2 / \tan(\alpha)$$

slope a	Maximum rising speed 2m/s	It is recommended that the speed is no higher than V	$\tan^{\alpha}$
10°	2	12	0.18
15°	2	8	0.27
20°	2	6	0.36
25°	2	4	0.47
30°	2	3	0.58
35°	2	2	0.7
40°	2	2	0.84
45°	2	2	1

03 | Key Points of Operation in Specific Scenarios

Scenarios with Power Lines or Trees Around the Field

Working area with wires

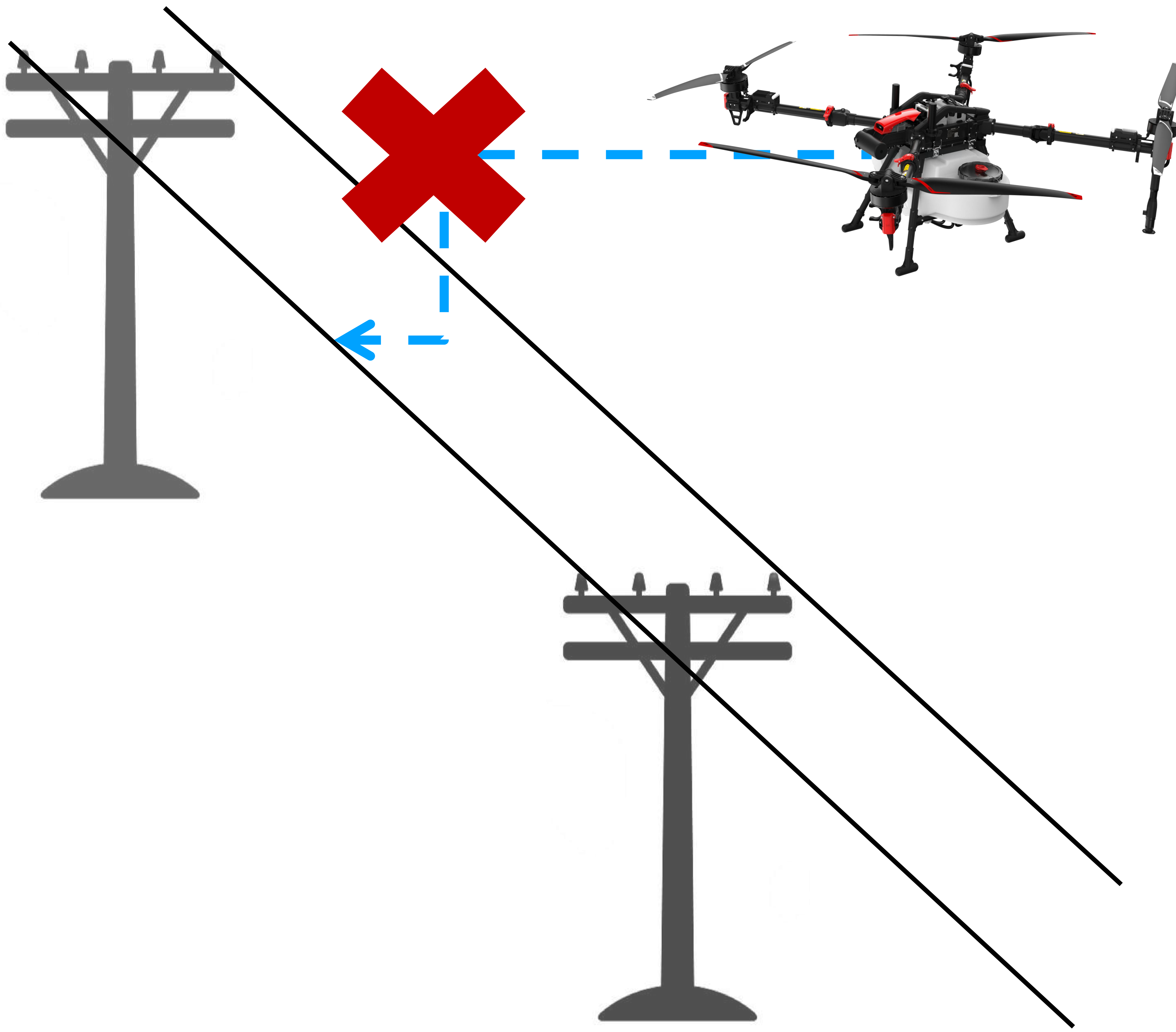


There are trees around the plot or in the field

Power Line Scenario

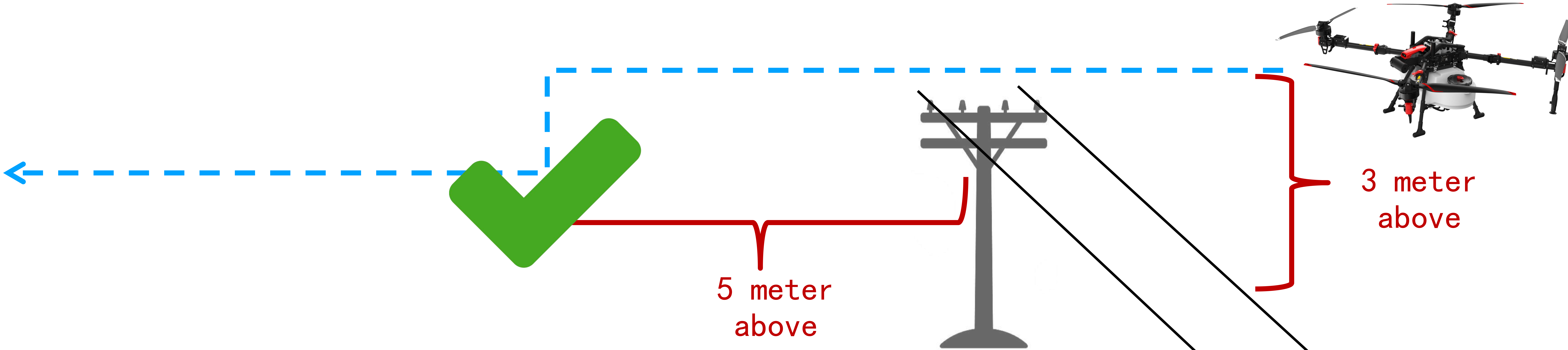
Case 1: Safety Point Set on the Power Line

a. Failure Example:After operation, the drone descends vertically from above the power line. Radar scanning downward fails to detect the wire, resulting in a crash.



b. Root Cause:The safety point was set above the wire, and radar focuses on ground clearance rather than obstacle detection in this context.

Correct Operations:



- Before flight, check if the safety point is at least 5 meters away from power lines.
- Keep a safe distance of ⩾ 3 meters between drone and wire.
- If the drone is about to land on or near the wire, use the remote controller or Point-to-Point Flight to move at least 5 meters away horizontally before ascending or descending.

Power Line Scenario

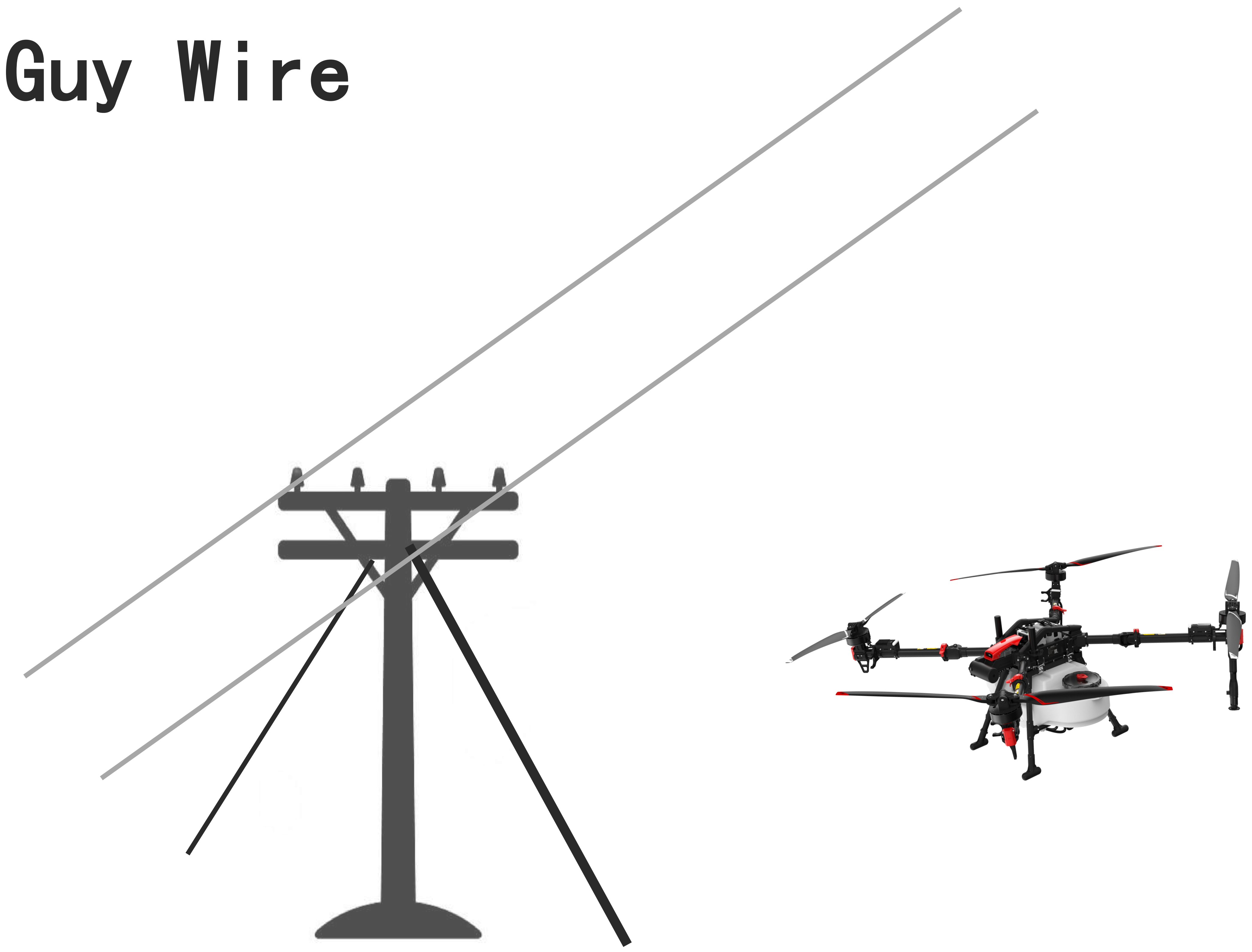
Case 2: Unmapped Guy Wire

a. Failure Example:

A slanted guy wire in the field was not mapped. When the drone flew near at high speed, radar failed to detect it due to the "oblique angle blind spot", leading to a collision.

b. Cause Analysis:

At a 45° angle, millimeter-wave radar receives very weak signals, similar to how a human might miss a tight fishing line viewed from the side.



Correct Operations:

Survey the field before operation and mark all guy wires.

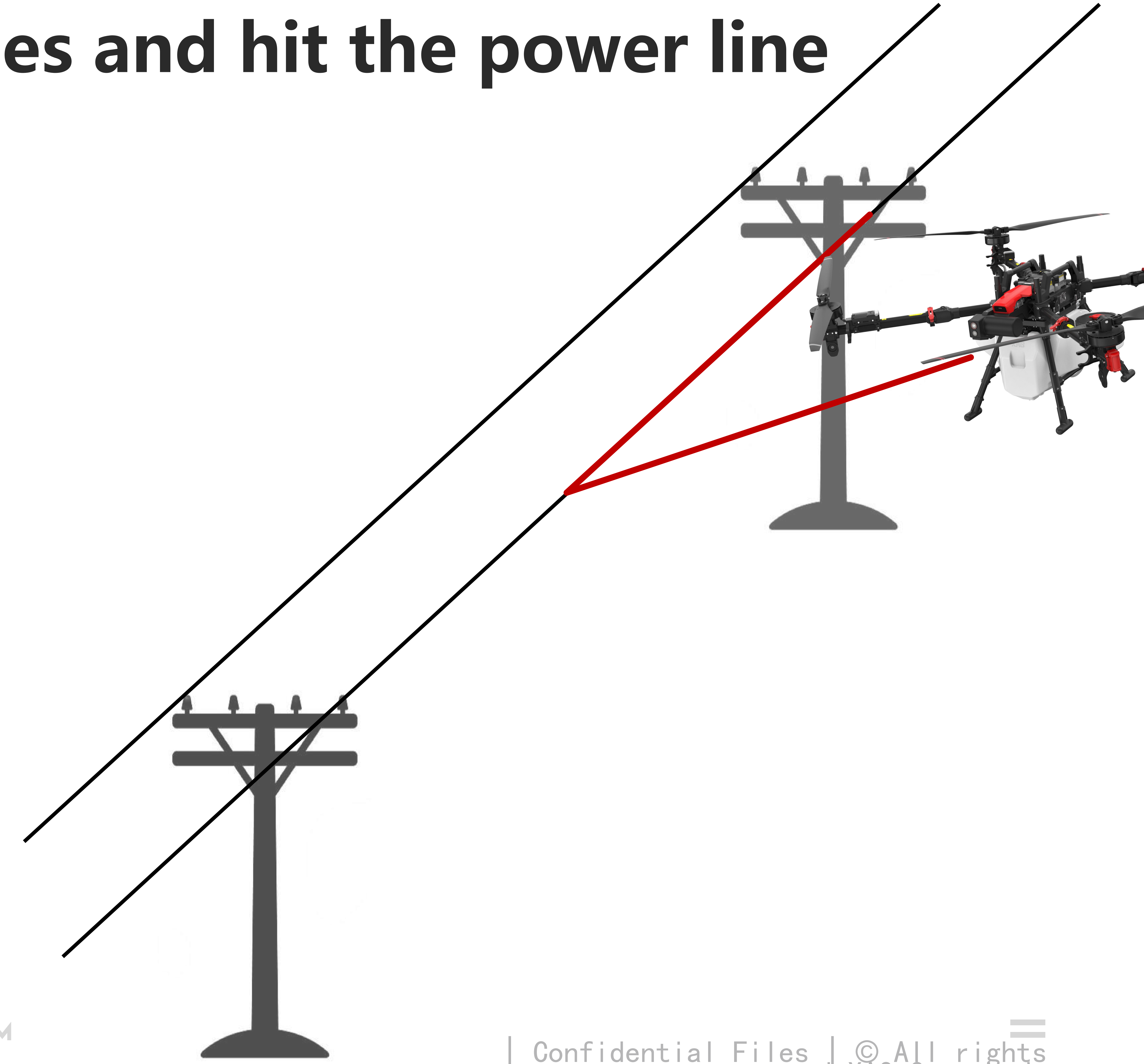
Mark points 2 meters beyond each guy wire connection to avoid entanglement.

Key points for working in the power line area

Scenario 3: Avoid obstacles and hit the power line

a. Failure: The drone's flight path passes through power lines. For example, if the angle between the flight path and the power lines is less than 60°, the millimeter-wave radar cannot effectively identify the power lines due to the detection angle.

b. Cause Analysis: Millimeter-wave radar has a weak ability to detect thin linear obstacles (such as power lines) that are nearly parallel to the flight path. This is similar to a person looking at a thin wire out of the corner of their eye; it is very easy to "miss" it.



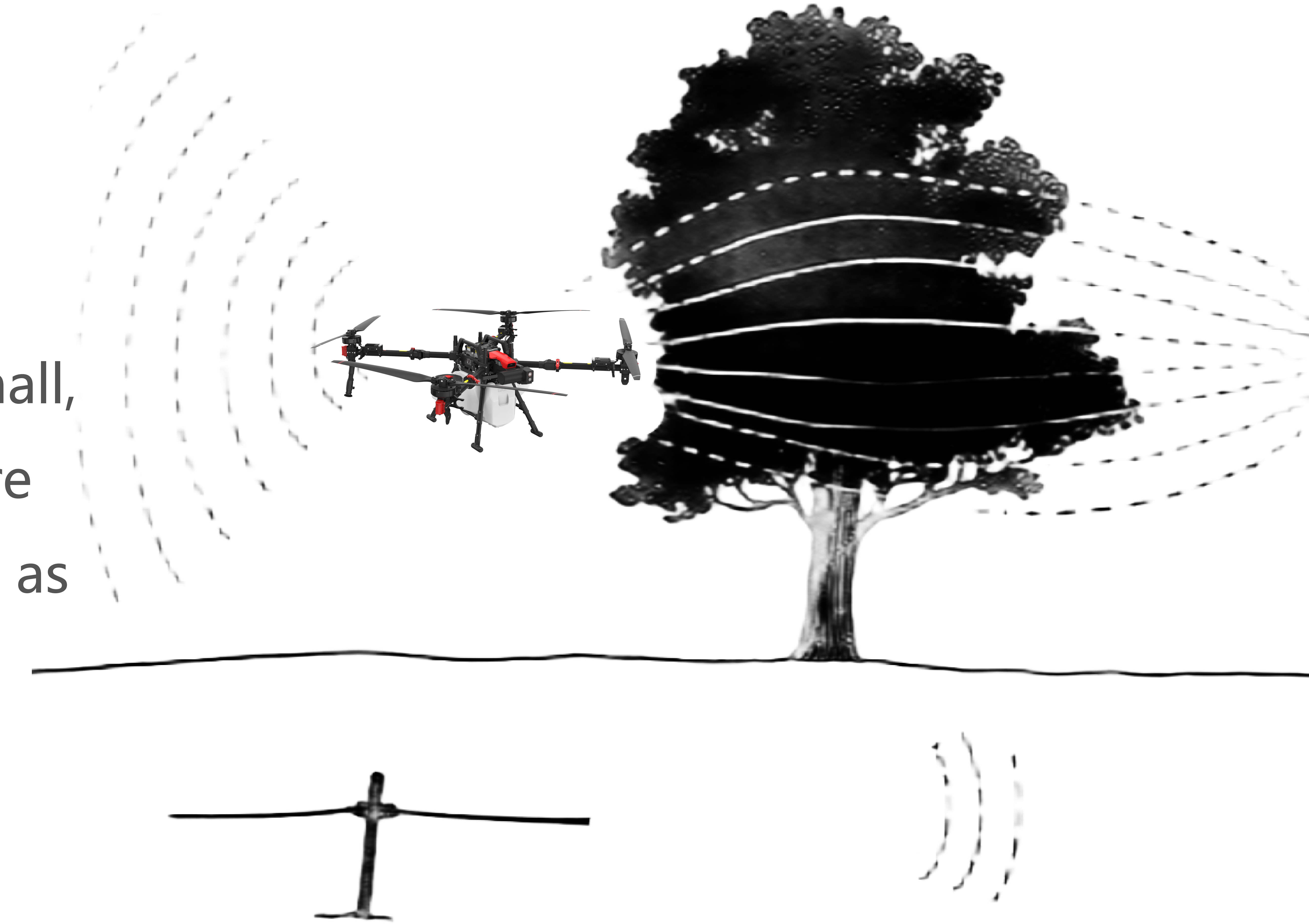
Limitations of radar obstacle recognition

Why are small obstacles so difficult to avoid?

Core Cause: Reflected Energy and Angle

Insufficient Energy

Objects like wires and thin branches are small, and the reflected electromagnetic waves are weak, making them easily ignored by radar as "noise."



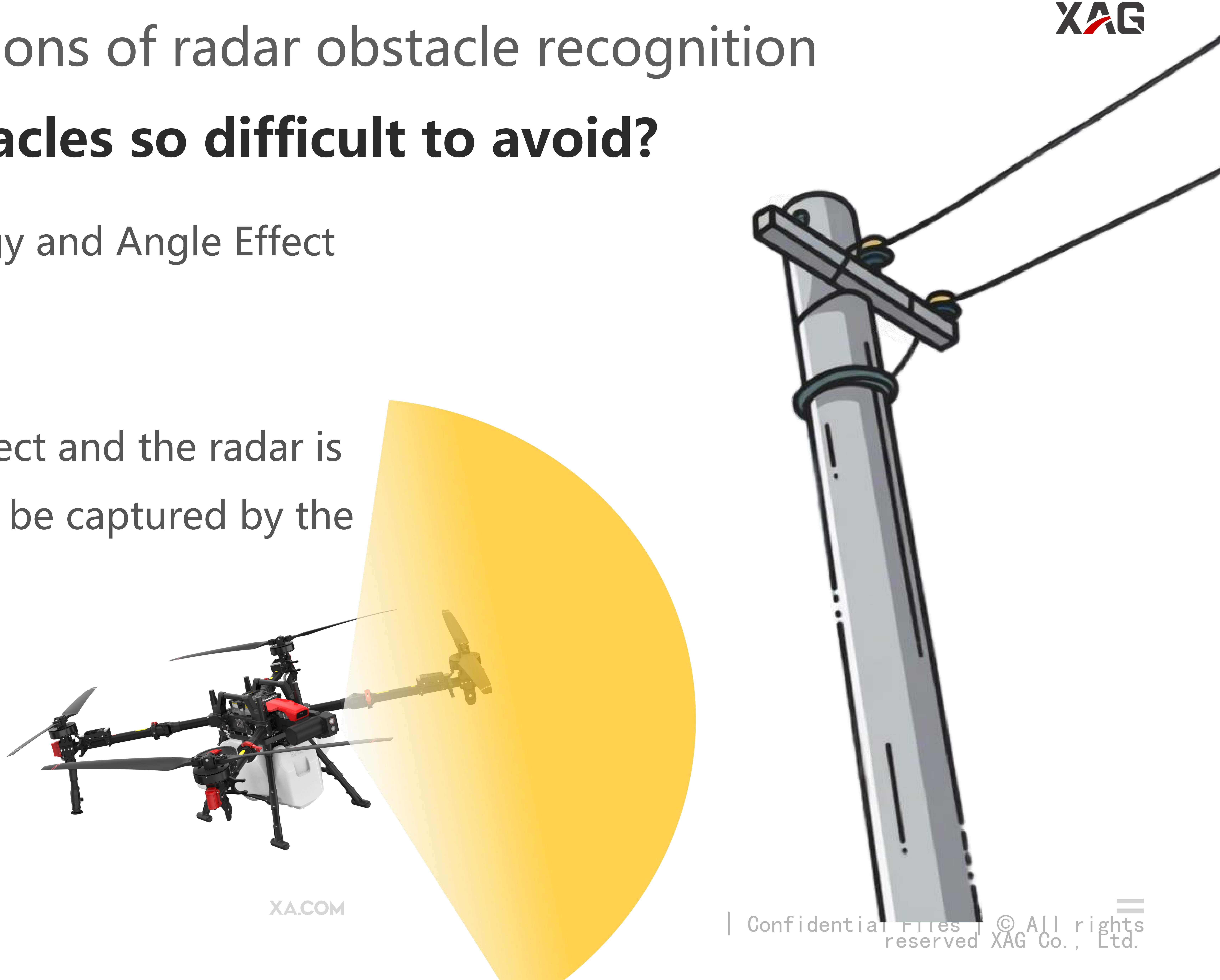
Limitations of radar obstacle recognition

Why are small obstacles so difficult to avoid?

Core Cause: Reflected Energy and Angle Effect

Angle Effect

If the angle between an object and the radar is too large, the echo may not be captured by the receiving antenna.

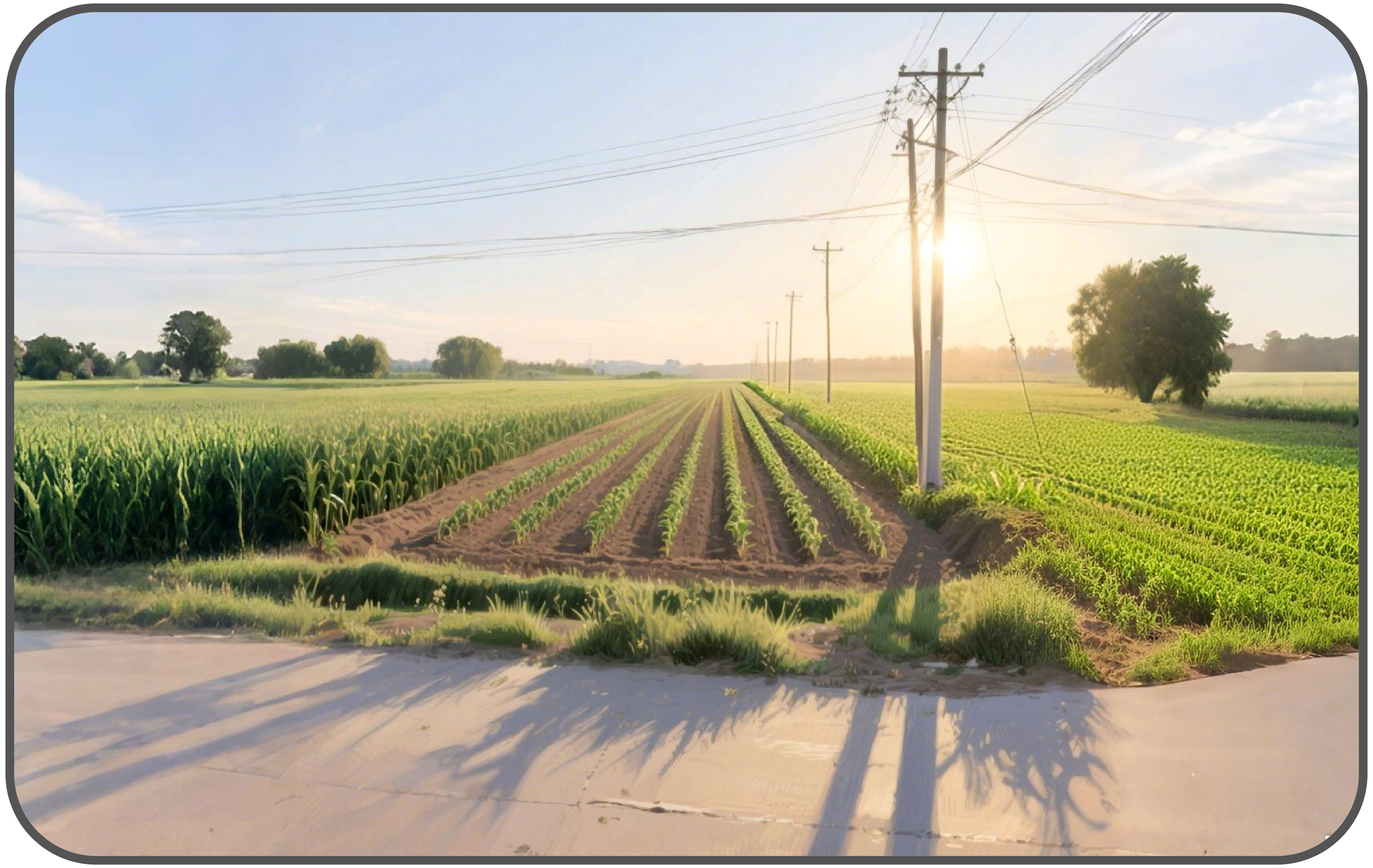


Key points for working in the power line area

Type 2: There are power lines that cannot be avoided in and out of the route

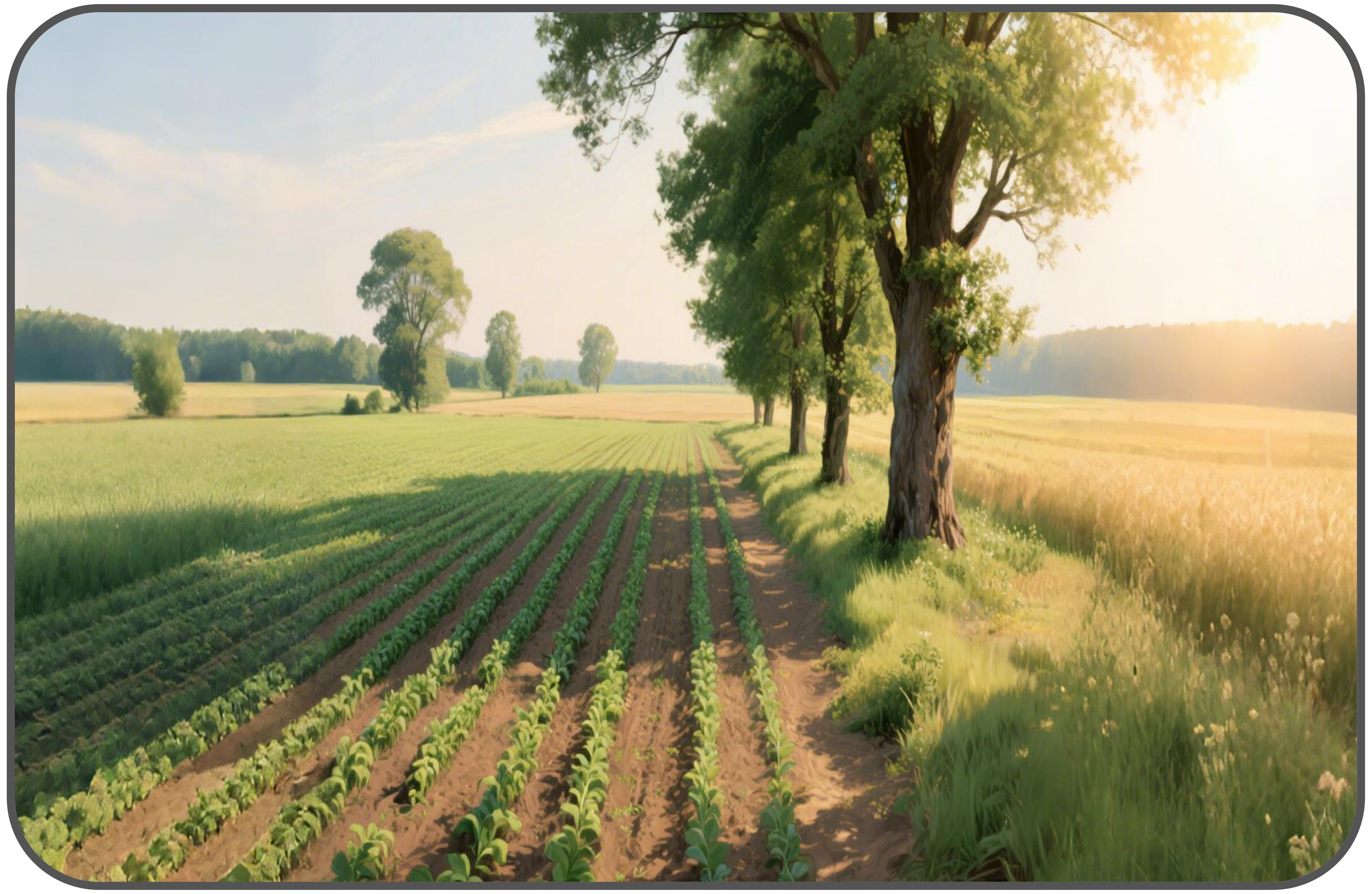
1. Adjust the takeoff and landing point
Move the drone's takeoff and landing point to avoid power lines.

2. Adjust the altitude of the incoming and outgoing routes
Note: Ensure the drone maintains a safe distance of at least 3 meters from power lines when flying.



Key points of work in specific scenarios

Working areas with electrical wires



There are trees around the plot or in the field

Trees around the plot or within the field

Key Points for Tree Mapping and Obstacle Avoidance

a. Failure Symptom: Tree branches extend into the field at the boundary or within the field, causing the aircraft's propeller blades to strike or even become entangled in the branches, resulting in a crash and property damage.

b. Cause Analysis: When setting flight parameters, the boundary safety distance or obstacle safety distance was set too low. The wind generated by the aircraft caused the branches to sway, potentially colliding with or becoming entangled in the propeller blades.

There are trees around or within the plot.

Key Points for Tree Mapping and Obstacle Avoidance

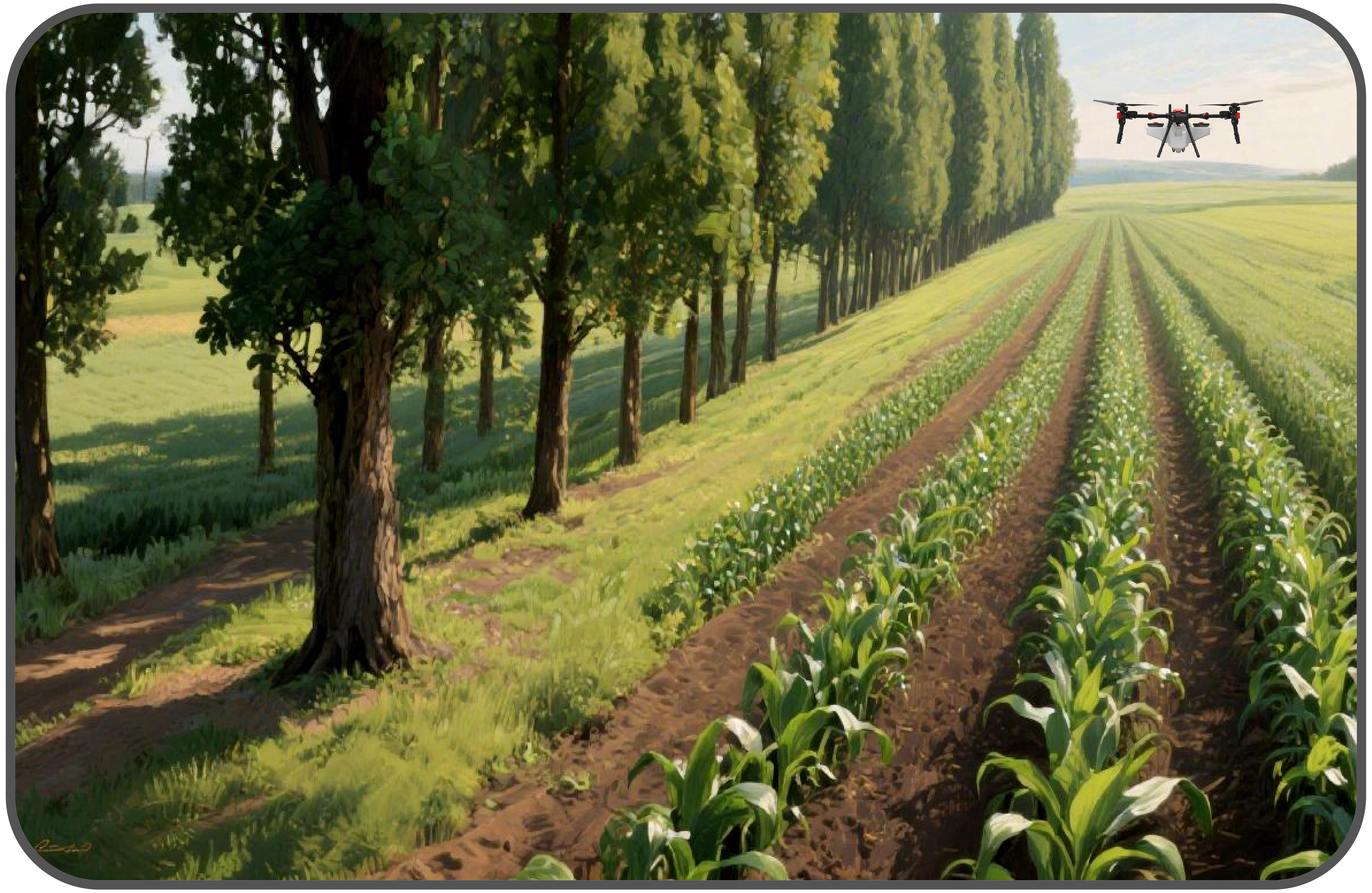
C. Correct Operation: When mapping obstacles such as trees, stand 2 meters away from the outermost branches to avoid colliding with them at high speeds.

There are trees around the plot or within the field.

Key Points for Windbreak Mapping and Parameter Setting

a. Failure Symptom: The drone lost its direction and did not fly along the planned route.

b. Cause Analysis: Windbreaks often have tall trees (over 10 meters) and are close to the plot boundary (40-50 cm). These trees can easily block the aircraft's RTK signal, resulting in inaccurate positioning of the drone.



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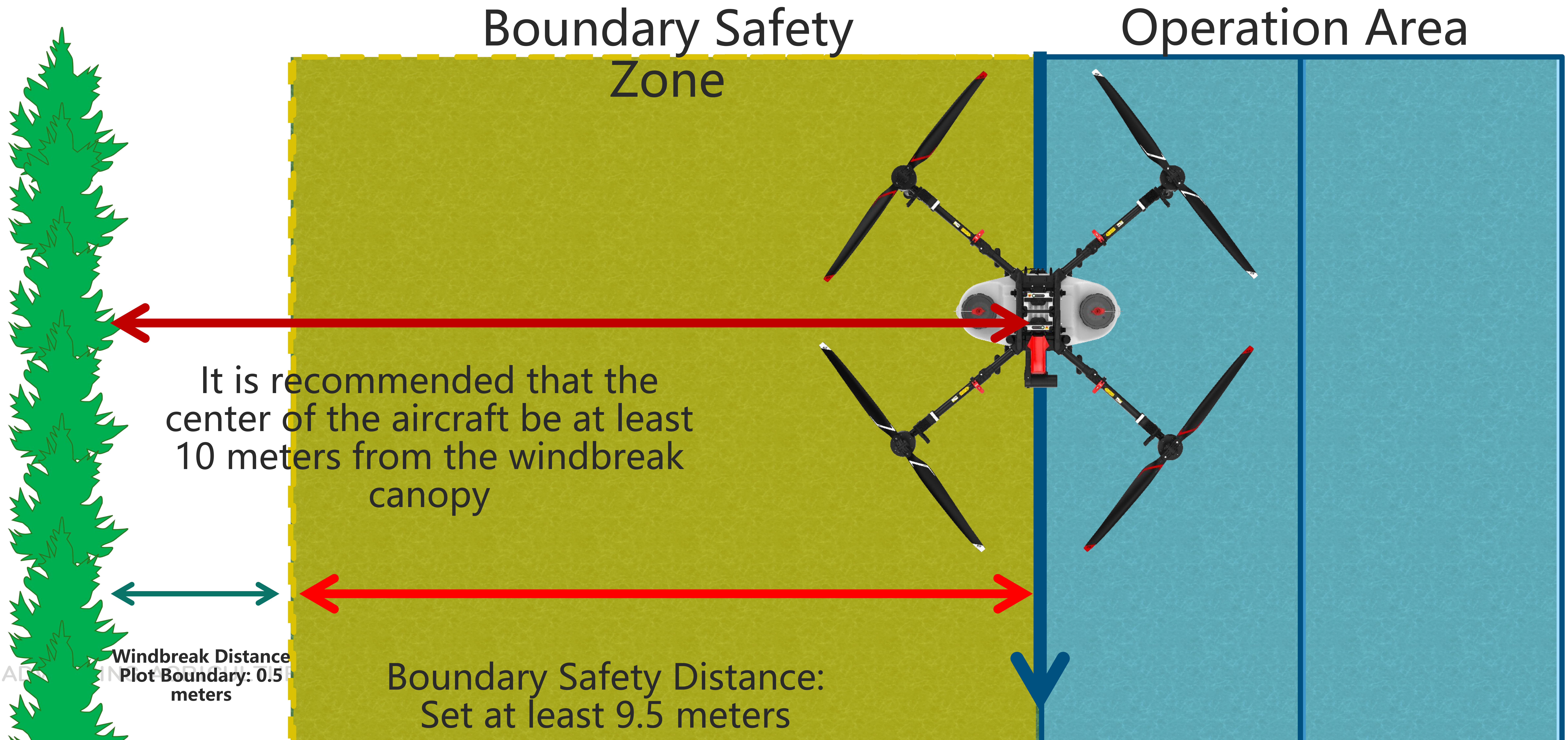
Trees around the plot or within the field

Key Points for Windbreak Mapping and Parameter Setting



There are trees around the plot or within the field.

Key Points for Windbreak Mapping and Parameter Setting

C. Correct Operation:

If a windbreak exists near the plot and operations are necessary, maintain an appropriate safety distance and avoid using sweeping techniques.

It is recommended to set a boundary safety distance of 10 meters or more to prevent flight anomalies caused by windbreaks blocking the signal.

It is recommended to appropriately reduce the flight speed and altitude, generally maintaining a speed of 5-10 meters per second and an altitude of approximately 3 meters, to reduce ground misdetection.

During operations, closely monitor the drone's flight status so that you can intervene promptly if any anomalies occur.

04 How to Handle Abnormal Situations

1. Drone Does Not Fly in a Straight Line

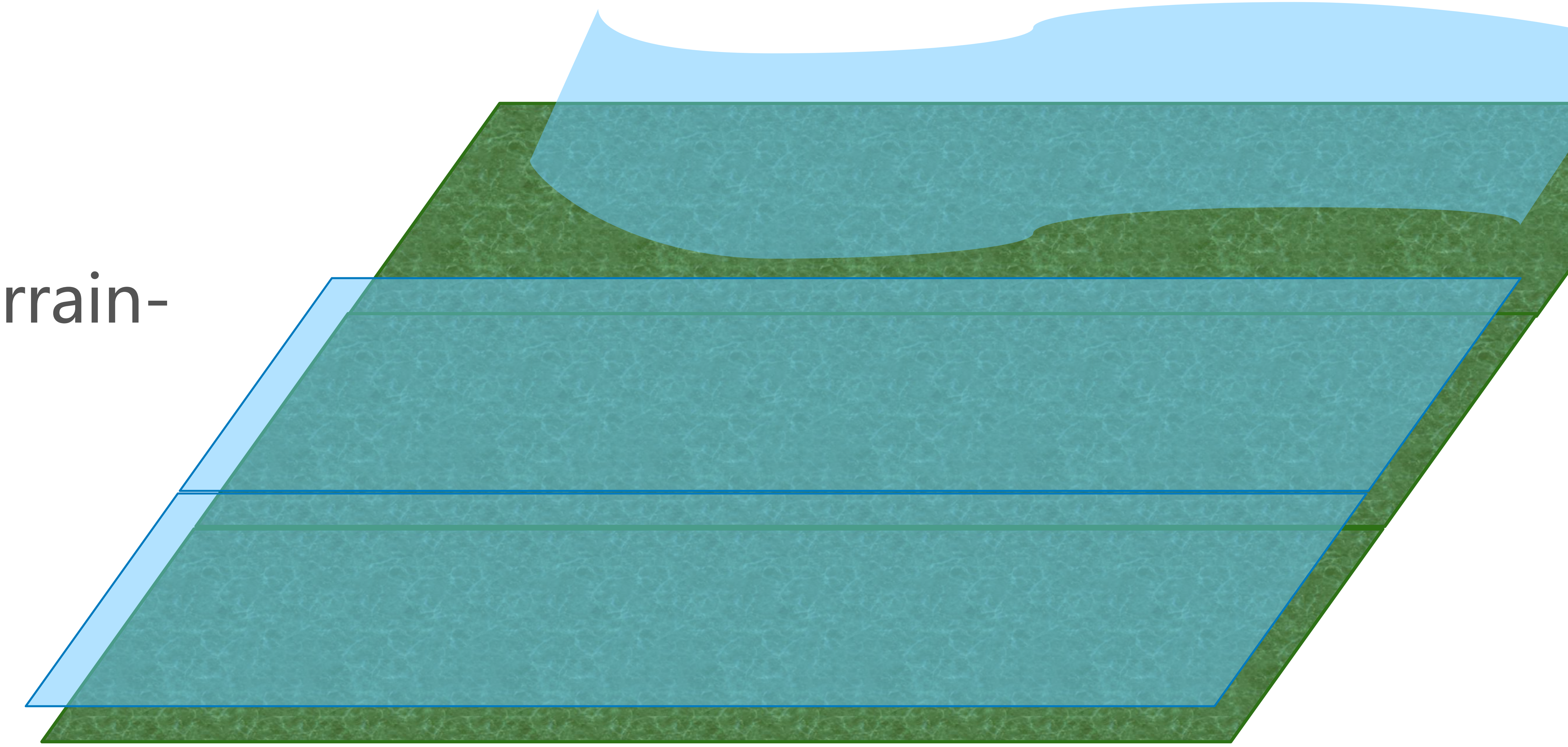
Cause:

Obstacles in the route or radar misjudgment.

Solution:

Check for obstacles like wires or dead trees.

If terrain or crop height interferes, enable terrain-following or raise flight altitude.



2. Hovering at Field Edge Due to Obstacle Avoidance Failure

Cause:

Tall trees or protruding branches along the boundary can trigger avoidance.

Solution:

If you see a "Obstacle Avoidance Failed" message, take over manually or use Point-to-Point Flight.

If no message appears, click "Continue Operation" or "Return Home", adjust boundary distance or parameters after return.

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Important Reminder

- **Ensure drone head orientation matches operator before manual or pointer control.**
- **Pointer flight mode has no obstacle avoidance — operate cautiously.**

3. Hovering Near Return Point

Cause:

Obstacles likely exist within 5 meters of the return point.

Solution:

Check the area around the safety point before flight.

If avoidance failure occurs, take manual control.

If not, click "Continue" or "Return", adjust return point and flight parameters afterward.

4. Low Altitude Error

Cause:

Terrain is highly uneven, radar detects ground distance <1.5m.

Solution:

Enable terrain-following or use 3D flight mode.

If not using terrain-following, increase flight altitude.

05 | Pre-flight Inspection and Equipment Maintenance

Key Pre-flight Checks:

- Firmware Update: Ensure latest obstacle avoidance algorithms.
- Takeoff Area Check: Radar field of view is limited; check for obstacles within 10 meters radius.
- Safety Point Check: Ensure no obstacles within 5 meters.
- Obstacle Mapping: Pay attention to guy wires, low cables, tree branches.
- Tree Mapping Standard: Mark points ≥2 meters away from canopy edge.
- Complex Scene Review: In orchards or power line zones, check if all obstacles are marked.
- Night Operations: Check LED lights for FPV visibility enhancement.

Routine Maintenance

- Visual Inspection:
- Ensure radar and camera surfaces are clean and mounted securely.
- Clean using towel + soapy water, rinse and air-dry.
- System Check:
- Before each flight, check radar and ground-sensing data for normal functionality.

THE
END