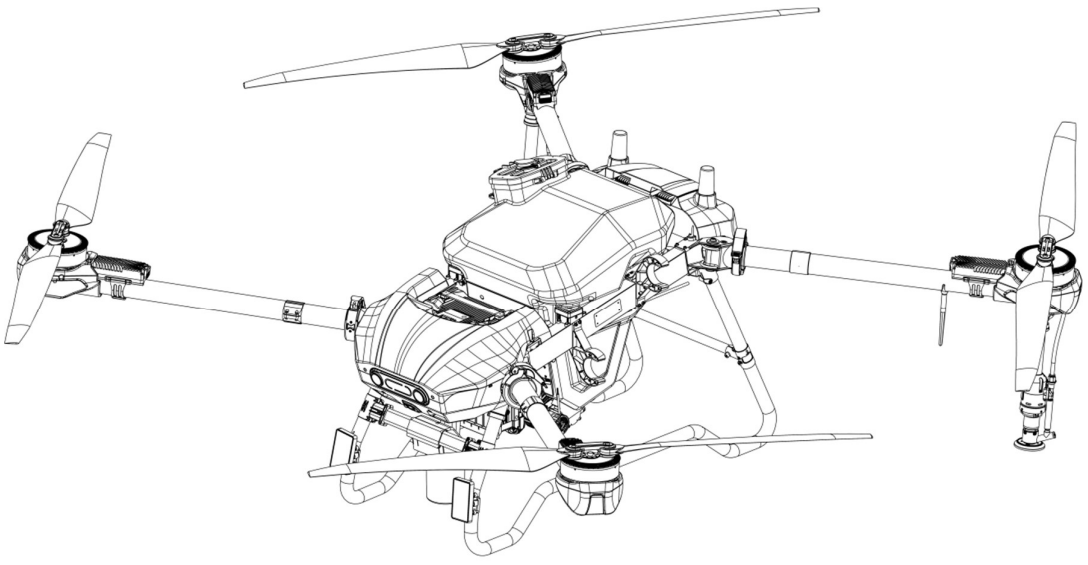
Agricultural Drone Instruction Manual

Various Operating Environments

Version 1.0



VECTOR AGR

Summary of Operation Techniques

1. Flat Terrain Techniques

(1) Terrain Characteristics

The terrain is flat with few obstacles; however, improper control of flight height and speed may cause uneven spraying coverage.

(2) Key Operation Points

Flight Parameter Settings

a. **Height:** Maintain a flight altitude of 1.5–3 meters above ground to ensure even droplet deposition (too low may cause phytotoxicity; too high may increase drift due to wind).

b. **Speed:** Fly at 8–12 m/s, adjusted based on pesticide type (e.g., slower for emulsifiable concentrates, faster for water-based formulations).

c. **Spraying Swath:** Flight routes are planned based on the drone’ s standard spraying swath (typically 8–10 meters), with adjacent flight lines overlapping

by 10% to 15% to avoid missed spraying.

Flight Route Planning

a. Use parallel boundary flight routes. Select takeoff and landing points at the edges of the field in open areas to avoid pesticide residue buildup.

b. Whenever possible, choose takeoff and landing sites in open spaces, and avoid flying the drone fully loaded on long-distance flights to isolated points.

Precautions

a. Clear ground debris (such as straw and stones) before operation to prevent collisions during drone takeoff and landing.

b. For large fields, divide the area into zones and mark sprayed sections.

c. Use long flight lines whenever possible during spraying.

d. Use shorter flight lines whenever possible during broadcasting operations.

2. Techniques for Operating on Sloped Terrain

(1) Terrain Characteristics

Significant slope variations cause drone altitude fluctuations during uphill and downhill flights, leading to uneven spray swath and droplet accumulation.

(2) Key Operation Points

- **Slope Classification and Response**

a. **Gentle Slopes (<15°):** Maintain flight height similar to flat terrain. Fly along contour lines (crossing slopes laterally) to avoid flying uphill and downhill, which may cause uneven pesticide application due to altitude changes.

b. **Steep Slopes (≥15°):** Use a "layered operation" mode, dividing the slope into 2–3 altitude layers, planning flight routes separately for each layer. Adjust flight height based on slope gradient (e.g., lower height when flying uphill, raise height when flying downhill) to maintain relatively stable altitude relative to the ground.

   Reduce flight speed to 6–8 m/s to avoid excessive drone attitude adjustments caused by slope changes.

(3) Equipment Adjustment

Enable the drone's ground avoidance radar (recommended for gentle slopes under 15° with relatively smooth terrain). This allows real-time terrain sensing and automatic flight altitude adjustment. Some advanced models support terrain-following functionality.

(4) Safety Tips

a. Avoid takeoff and landing at ridge tops or valley bottoms to prevent drone loss of control caused by turbulent airflow.

b. Maintain a safe distance of 5–10 meters from slope edges during operations to avoid collisions with terrain.

3. Techniques for Operating in Mountainous Terrain

(1) Terrain Characteristics

he terrain has significant elevation differences and complex topography, often accompanied by strong winds and turbulent airflow. Additionally, signals are easily obstructed by mountainous formations.

(2) Key Operation Points

Pre-operation Survey and Planning

a. Conduct terrain reconnaissance using satellite maps or drone pre-flight surveys. Mark mountain peaks, valleys, and wind-prone areas to avoid turbulent airflow zones.

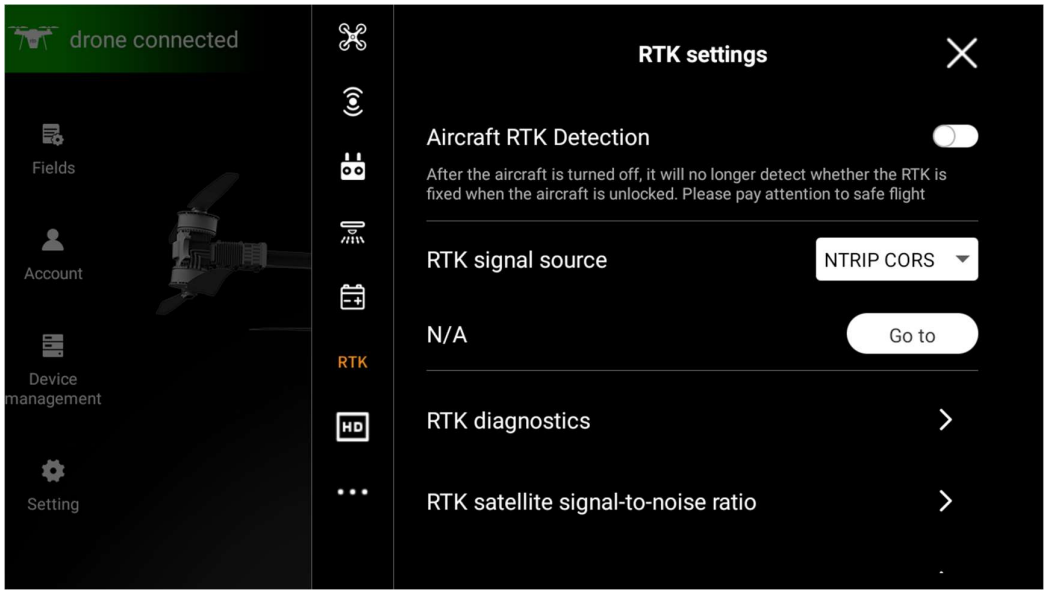
b. Plan flight routes that detour along mountain contours, avoiding straight-line crossings over valleys (which are susceptible to crosswinds). Prefer flying parallel along ridgelines on both sides.

Flight Parameter Optimization

a. **Height:** Maintain a minimum flight altitude of 5 meters to avoid collisions. When flying near mountain tops, keep an altitude of 10–15 meters and stay at least 30 meters away from ridgelines to avoid updrafts or downdrafts.

b. **Speed:** Fly at 5–8 m/s. Pause operations when encountering gusts and resume only when wind speed drops below level 3 (≤6.1 m/s).

c. **Positioning System:** Enable RTK centimeter-level positioning (For operations outside China, base stations need to be set up.) to ensure accurate positioning even in weak signal areas in mountainous terrain.



Emergency Measures

Set the "One-Key Return" point in an open area on the outskirts of the mountainous region to avoid return paths crossing complex terrain. Initiate immediate return when battery level drops below 30%.

4. Techniques for Operating in Forested Areas

(1) Terrain Characteristics

The area is densely forested, with branches and foliage obstructing signals and increasing the risk of signal loss. Low-altitude flights require strong obstacle avoidance capabilities, and the spray droplets must have high penetration to reach target surfaces effectively.

(2) Key Operation Points

Flight Path and Altitude Control

a. Use the "low-altitude shuttle" mode. Adjust flight height based on tree height—typically 2–3 meters above the tallest canopy, or 5–8 meters above ground—to prevent propellers from becoming entangled in branches.

b. Set the atomization level to ultra-fine, and reduce the drone's flight speed to 2–3 m/s.

c. Plan flight routes parallel to forest belts or in a zigzag pattern (it is recommended to turn off the terrain-following radar during operation). Apply

a 20% overlap between adjacent flight paths to enhance droplet penetration. When controlling pests and diseases in orchard trees, downwash airflow can be used to help droplets penetrate the canopy.

Equipment Adjustment

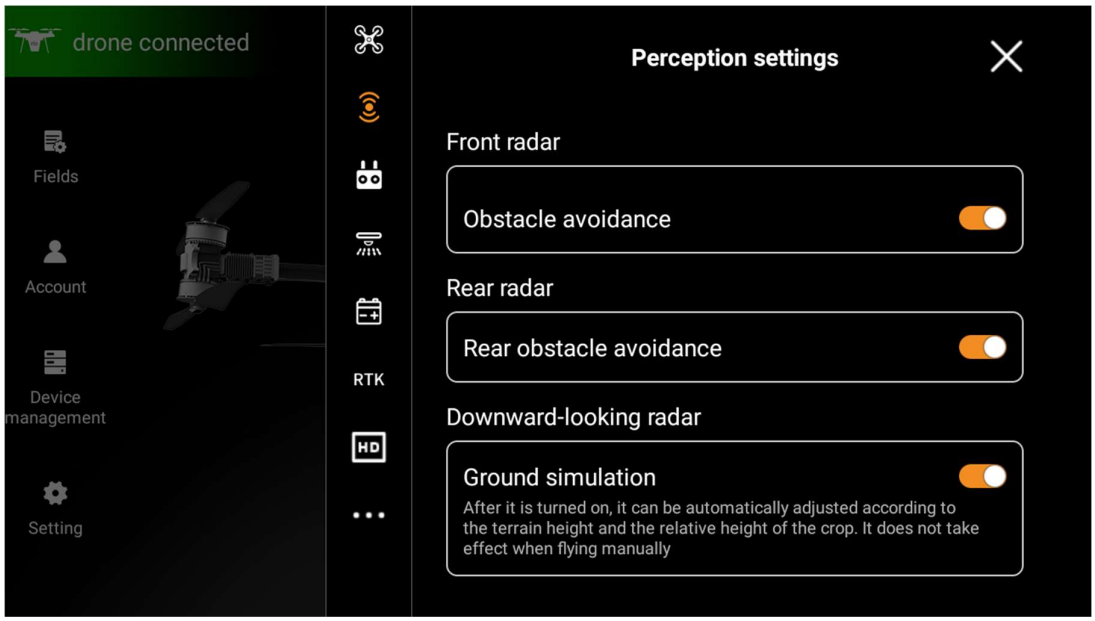
a. Reduce flight speed and increase obstacle avoidance sensitivity.

b. Disable terrain-following radar to prevent sudden altitude drops due to large variations in tree height.

Chemical and Spraying Strategy

a. Use high-adhesion formulations and apply fine droplets (100–200 μm in diameter). Utilize the drone’ s downward airflow to drive droplets through the canopy.

b. Schedule operations during early mornings with calm or light wind conditions to minimize droplet drift.



5. Techniques for Operating in Fields with Obstacles

(1) Terrain Characteristics

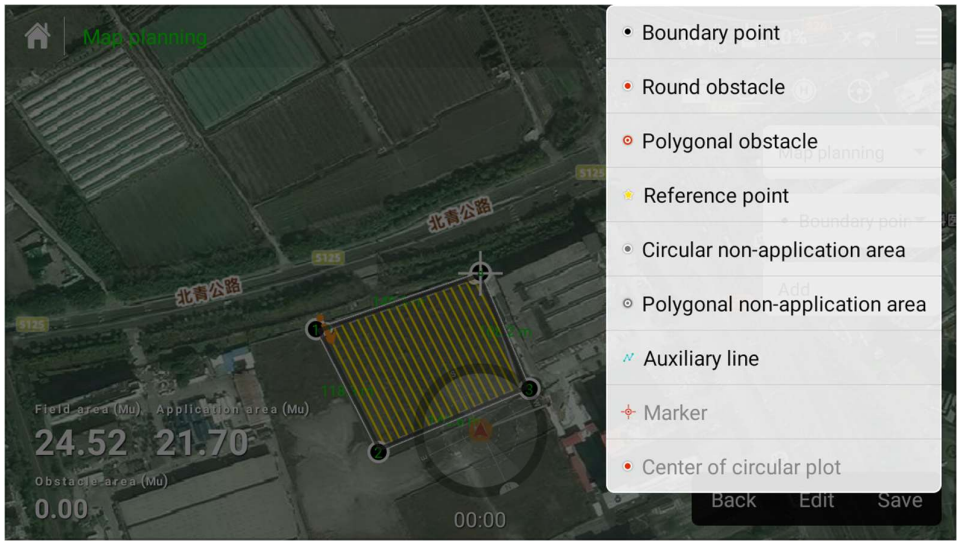
The field contains obstacles such as buildings, utility poles, irrigation ditches, and orchard trees, requiring precise obstacle avoidance and optimized flight route planning.

(2) Key Operation Points

Obstacle Classification and Handling

a. Fixed Obstacles (e.g., buildings, utility poles):
Before operation, mark obstacle locations on the map. When planning flight routes, reserve a safety buffer of 7–10 meters and use either a bypass or turnaround pattern (e.g., fly 3–5 meters above the obstacle’ s height).

For isolated obstacles (such as a single tree), define them as circular obstacles with an expanded radius of 6–7 meters, allowing the drone to automatically detour around them.



b. Moving Obstacles (e.g., field workers, livestock):

Enable audio and visual alerts during operation to increase awareness. Maintain a safe distance of at least 20 meters from moving obstacles. Pause the operation if necessary to ensure safety.

- **Flight Route Planning Tips**

Use the field segmentation method / route partitioning, dividing the field into multiple sub-areas based on obstacle distribution. Plan rectangular flight paths for each sub-area separately to avoid cross-zone detours and minimize pesticide waste.

- **Manual Assistance**

In the presence of complex obstacles, switch to manual mode and carefully maneuver the drone to fly around them. Monitor the real-time video feed to ensure safe and accurate navigation.

6. General Safety and Efficiency Principles

Pre-Operation Check: Regardless of terrain type, always inspect the drone's battery, propellers, spraying system, and positioning signal before each mission. Perform a test flight to ensure all systems are functioning properly.

Weather Conditions: Avoid operations during rain, strong winds (≥ Level 4), or intense sunlight (which may accelerate pesticide evaporation). The optimal operation periods are before 10:00 AM or after 4:00 PM.

Data Recording: Use the drone' s built-in app to record operation data such as flight paths, pesticide consumption, and covered area. This facilitates post-operation analysis and continuous optimization.

By flexibly adjusting strategies according to terrain, and combining drone capabilities with pesticide characteristics, precision and safety in plant protection operations can be maximized.