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Training Manual for UAV preflight planning and Safety Guidelines

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NSF drone eelgrass mapping project along the west coast of North America

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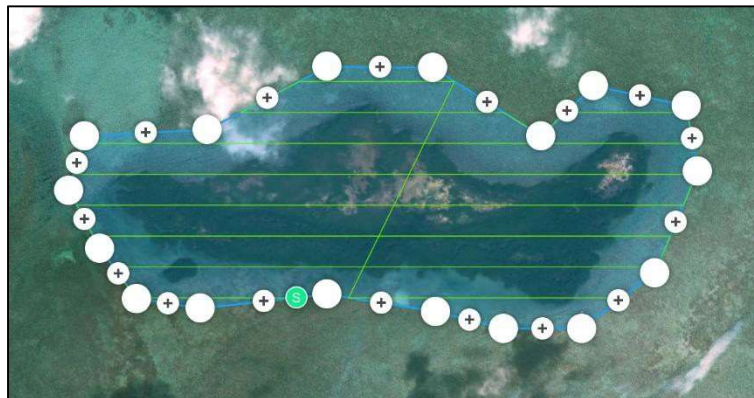
1. Flight Planning in DJI GS Pro

1.1 Moving Around the Map

When you load DJI GS Pro, you'll be given a map of the world. Using your fingers, you can pan, rotate, and pinch to zoom. Once you are comfortable with maneuvering around the map, follow the instructions in the sections below to plan and fly your desired area.

1.2 Creating a New Flight Area

1. Open **DJI GS Pro**.
2. Once you have identified your flight area, press *New* in the bottom-left corner.
3. Select *3DMap Area* from the list of options.
4. Next choose the *Tap* option.
5. You can now tap on the screen to place your initial flight area. A small box will be created that can have its shape altered (see image below).
 - a. Each dot represents a vertex for your flight area. The “+” dots allow you to create a new vertex which enables a variety of shapes to be created.
 - b. Press and hold the vertices and move your finger around the screen. This will allow you to adjust the shape of your flight area. Using both current and new vertices, create a polygon around the area you wish to fly (see image below).
 - c. The green lines within your flight area are flight lines and represent the path in which the UAV will take when conducting a flight.
 - d. The small, green circle with an “S” is the starting location of the UAV flight plan.



6. Once the flight area is created, you can adjust the flight parameters as discussed below.

1.3 Setting Flight Parameters

The box on the right of the screen is your mission specifications tab. The top banner of the tab contains information on your flight area. You can swipe left and right to see all the information that is available. Most of the information is self-explanatory but the main parameters to note are total area covered, estimated flight time, and estimated images to be captured. These factors are important when planning a flight area and will fluctuate depending on your flight parameters. Pay attention to these factors when planning a flight area so you better understand what is needed when conducting the flight.

1. Tap the pencil icon next to the mission name.
2. Change the name of the mission to reflect the area that will be flown (ex. Eelgrass site1).

While under the *Basic* settings:

- **Camera Model:** choose the UAV you will be using.
- **Shooting Angle:** set to *Parallel to Main Path*.
- **Capture Mode:** the method in which your UAV will capture imagery while moving through its flight. The options available are:
 - **Hover & Capture:** the UAV will stop at various points along the flight lines and take a picture.
 - **Capture at Equal Time:** the UAV will take a picture every few seconds, as determined by the flight parameters.
 - **Capture at Equal Distance:** the UAV will take a picture every few meters, as determined by the flight parameters.
 - **Note:** Open Reef typically chooses *Capture at Equal Time* when conducting flights. You may want to adjust this depending on your own preferences.
- **Flight Course Mode:** set to **Inside Mode**.

Once you have chosen your camera model, shooting angle, capture mode, and flight course mode, you will be able to adjust your flight speed and altitude. The sliders at the bottom of the mission specifications tab control flight speed and UAV altitude. If *Capture Mode* was set to Hover & Capture, then both sliders can be adjusted, otherwise only altitude can be adjusted.

1. Using your finger, slide the altitude and flight speed to your desired settings.
 - a. Note: Higher altitudes are advised with larger areas to reduce flight time (recognizing local/regional/national policies and altitude restrictions).
2. Next we will adjust settings under the Advanced tab.

While under the *Advanced* settings:

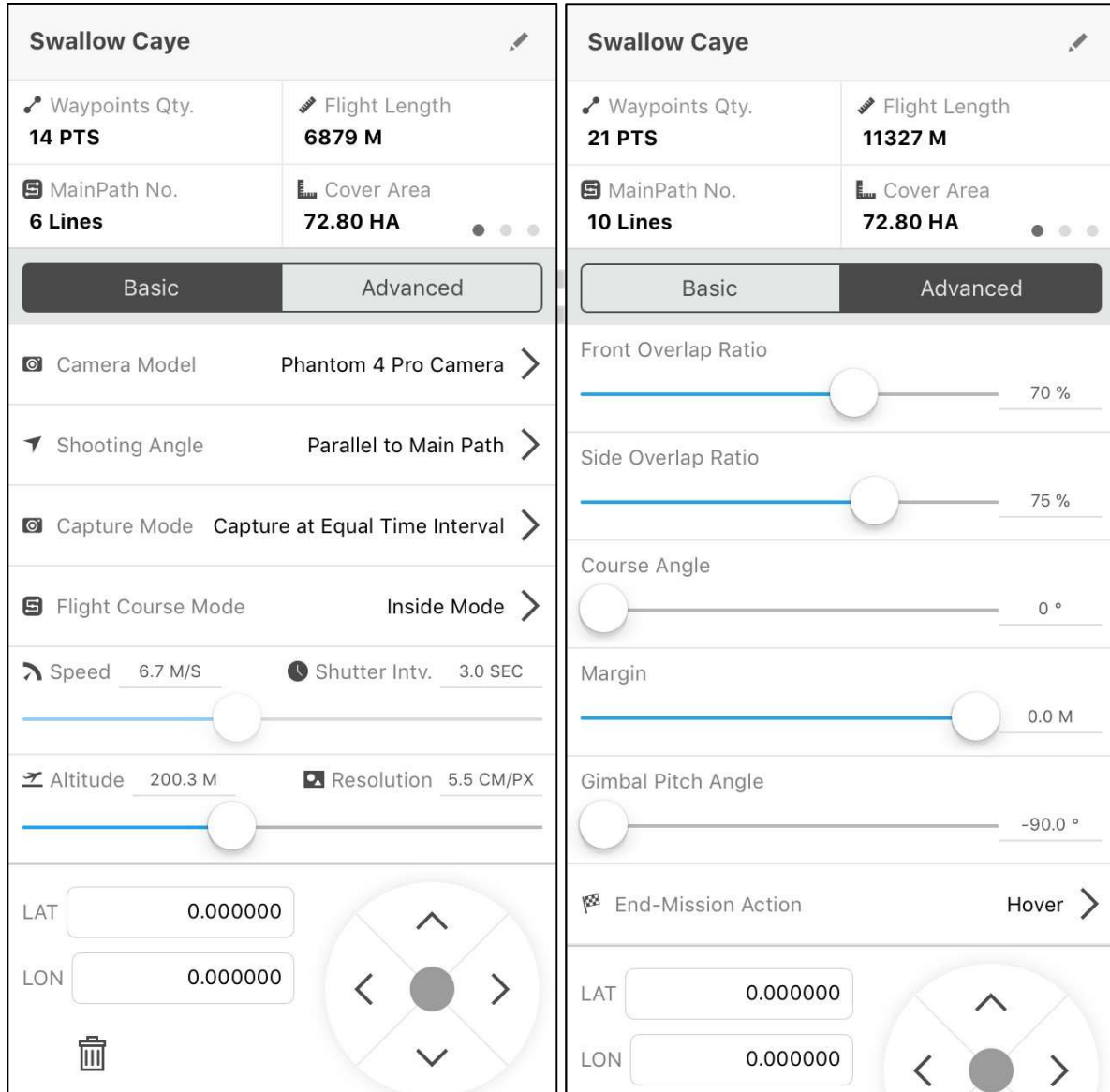
- › **Front Overlap Ratio:** determines the frequency in which the UAV will take a picture while moving forward.
- › **Side Overlap Ratio:** determines the distance between flight lines.
- › **Course Angle:** changes the angle of the flight lines within the flight area.
- › **Margin:** adjusts the margin between the flight lines and the flight area boundary.
- › **Gimbal Pitch Angle:** changes the angle of the camera on the UAV.

Of these options, the only parameters you should be changing are the front overlap, side overlap, and possibly the course angle. For now, only do the following:

1. Set *Front Overlap* to a minimum of 70%.
2. Set *Side Overlap* to a minimum of 75%.
 - a. **Note:** Overlap settings may be adjusted depending on UAV altitude. If flying at higher altitudes then decrease the overlap. If flying at lower altitudes then increase the overlap.
3. Click *End-Mission Action* and select “Hover.”
 - a. **Note:** This option means the UAV will hover at the end once it has completed the flight area, thus allowing a manual return home.
4. When you are done adjusting all your settings, press the *Save* icon in the upper-left corner.



5. Your flight parameters should look similar to the images below.
6. Press the back arrow in the upper-left corner to return to your flight listings



1.4 - In-field Flight Run

1. On the flight listings menu, tap the area you wish to fly to highlight it.
2. Press *Edit* at the bottom.
3. If needed, make any last-minute settings adjustments and press the *Save* icon.
4. Plug your device into the UAV controller.

5. Power on the UAV controller.
6. Power on the UAV.
7. Calibrate the UAV by facing it forward and spinning in a circle, then face the UAV downward and spinning in a circle. Everything else that you may need to know regarding compass calibration can be found here:
<https://www.phantomhelp.com/tips/dji-phantom-compass-calibration-guide.30>
8. Place the UAV at the launch location, facing away from the RPIC and crew.
9. Once you are ready, manually launch the UAV by bringing both control sticks down and inward.
10. Manually raise the UAV to approximately 30 meters altitude.
11. Press the *Launch* icon in the upper-right corner of your screen.



12. The flight plan will begin to upload to the UAV.
13. Once the flight plan is uploaded, press the *Start to fly* button.
14. The UAV will move to the starting location of the flight area and begin mapping.

Multiple Launches for a Single Flight Plan

When the UAV battery reaches 33% it is recommended that you bring the UAV back for a battery change. To do this, you will need to pause the flight, manually bring the UAV back, switch the batteries, and launch the UAV again. You can do this by following these instructions:

1. Pause the flight by pressing the *Pause* button in the upper-right corner (previously the *Launch* button)
2. Manually fly the UAV back to you and land.
3. Replace the battery and relaunch the UAV.
4. Manually raise the UAV to approximately 30 meters altitude
5. Press the *Continue* button (previously the *Pause* button) in the upper-right corner.
6. Choose *Return to Last Waypoint* from the options.
7. The UAV will automatically fly to its last waypoint and continue the flight.

8. Repeat **Steps 1-7** if the battery needs to be replaced multiple times.

2. Safety Guidelines

2.1 In-field Roles

Identifying key personnel roles before conducting flight operations is important to maintaining organized in-field operations. Roles should only be transferred to others in-between flights and not during. The key roles and their responsibilities are as follows:

Command: The command role oversees route planning, safe flight operations, role management, and UAV maintenance.

Remote pilot in command (RPIC): The RPIC is in charge of controlling the UAV during each flight.

Visual Observer (VO): The VO is responsible for ensuring the UAV position is known at all times and to ensure a safe area of operation. This includes monitoring weather conditions, airborne wildlife, and other air traffic. Should a potential obstruction approach the area in which the UAV is operating, the VO will need to inform the RPIC to either maneuver the UAV to a safe location or to cease flight operations.

In the event that there are only two in-field operators, one person will maintain both command and RPIC roles while the other will be VO. At no point should a VO also have the role of command or RPIC during a single flight.

2.2 Launch and Landing Operations

Launching from Land

1. When launching from non-moving, flat ground you will need to ensure there is nothing within a 2 meter radius of the UAV.
2. All personnel, including the RPIC will need to maintain a minimum distance of 3 meters for safe flight operations.
3. Launch the UAV and raise it to an altitude of 30 meters.
4. From there the RPIC can launch the flight plan for the area to be flown using DJI GS Pro.

Landing on Land

1. When landing, ensure the landing area is free of personnel, equipment, and any other items.
2. Slowly decrease the altitude of the UAV over the landing area until the UAV is brought to the ground.
3. Hold down the left control stick until the propellers disengage.
4. Turn off the UAV controller before allowing anyone to approach and pick up the UAV.
5. Turn off the UAV.

Launching from Boat

Only launch a UAV from the boat if wind is extremely minimal and wave action is nearly nonexistent. **Launching a UAV from a boat with moderate wind and/or wave action will cause severe safety risks to the crew.** If the conditions do not feel safe to fly in: then cease flight operations until conditions improve or move to another location.

1. The bow is typically the largest and flattest part of a boat to launch from so it is advised to use that as your launch area.

Note: Open Reef typically launches the UAV from the bow of the boat.

2. Ensure there are no ropes, anchor chains, boxes, or equipment on the bow before launch.
3. Equip the VO with durable workers gloves and have them stand approximately 1 meter from the UAV.

Note: Should anything go wrong, the VO will be the first line of defense to block the UAV from injuring any persons on the vessel.

4. The RPIC will stand behind the VO and all remaining crew behind the RPIC.
5. Launch the UAV and raise it to an altitude of 30 meters.
6. From there the RPIC can launch the flight plan for the area to be flown using DJI GS Pro.

Landing on Boat

Landing a UAV on a boat can only be done by having a crewmember catch the device.

Landing your UAV on a boat takes practice, skill, and trust. This is something that should be practiced ahead of time to safely and efficiently land a UAV in the field.

1. Equip the VO with durable work gloves and disperse the crew so that the VO is at the front of the boat, the RPIC is behind them, and the remaining crew are behind the RPIC.
2. The VO will need to extend their arms in preparation to catch the UAV once it is approximately 5 meters from the boat.
3. The RPIC will need to slowly decrease the altitude of the UAV over the VO until it is within arms reach.
4. The VO will then carefully grab both legs of the UAV while avoiding pulling it down.
5. The RPIC will then hold down the left control stick to disengage the UAV propellers.
6. The RPIC will need to turn off the UAV controller before the VO brings the UAV down.
7. Turn off the UAV.

IMU Calibration

IMU (Inertial Measurement Unit), if not calibrated properly, will negatively affect stability and maneuverability while flying. The IMU will automatically calibrate every time the DJI Phantom 4 drone is connected to the DJI Go 4 app. Keep the drone on a flat surface during IMU calibration.