Mapping with the Phantom 4 Advanced & Pix4Dcapture

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The DJI Phantom 4 is a popular, easy-to-fly UAS that integrates a decent camera (1" CMOS 20 Mpixel 100-12800 ISO, FOV 84° 8.8 mm (24 equiv) f/2.8-f/11, autofocus) on a gimbal. One advantage over the Phantom 3 are locking propellers.

This field guide provide some clues on using Pix4Dcapture and this UAS. It doesn't replace the manuals for the Phantom and Pix4Dcapture, which you should refer to, but provides some key things to understand that may not be clear in the manuals, and ends with a one-page checklist once you've learned it but need a reminder. This guide doesn't describe the next step, processing in Pix4D Mapper.
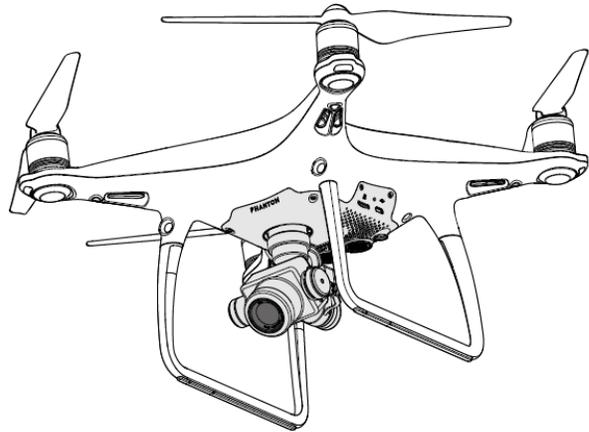
Figure 1. DJI Phantom 4 Advamced.

Assumptions before you're ready to map

You should already be familiar with the remote controller (RC) and how to fly the drone manually using the RC and the djiGO app. It's important to be confident with manual flying before autonomous missions because automated landing frequently requires manual control. You'll also want to practice using the camera and learn how to set it to manual exposure. *If you are going to be away from the internet,* you'll probably want to prep the mission in advance with cached image basemaps. See https://support.pix4d.com/hc/en-us/articles/115002056523#gsc.tab=0 and the discussion below in Run a Mission.

Preparation before going in the field

1. Charged batteries for UAV and the RC; one charger does both, with separate plugs for battery and controller. They will light up when charging and the lights will turn off when done.
2. Gather all of the gear:
   a. UAV, with the camera and gimbal secured with the gimbal clamp. Figure 2 shows how it connects or disconnects -- line it up right and find a little slot to match up, camera forward.
   b. Batteries.
   c. SD card with sufficient capacity installed.
   d. Remote controller.
   e. Propellers.
   f. Tablet – make sure that you've connected it successfully once before leaving the lab, since you will need an internet connection the first time. Apps needed on the tablet:
      i. DjiGO.
      ii. Pix4Dcapture
      iii. Ctrl+DJI for Android.
   g. USB cable between the tablet and the controller.
   h. A small tarp for a landing pad, and some stakes to hold it down.

Preparation in the field

1. Determine your location to map, considering good sky view for GPS, and avoiding trees and buildings (at least above a certain height).
2. Post any required signage.
3. Set out and probably stake down the tarp.
4. Pilot in Command (PIC) discusses process with visual observers (VO) and reviews safety issues and emergency procedures.
5. Hook up your tablet and USB cable to the remote controller.
6. Install a battery in the Phantom.
7. Remove the gimbal clamp.
8. Position the Phantom on the landing pad.
9. Set the function mode switch (P·S·A) to P, the normal setting and can be used by Pix4Dcapture. While Pix4Dcapture provides a button to abort the flight, and the RC can also override the software by manipulating the joysticks, I've seen in forums that S (Sport mode) may be needed to manually override, but this disables obstacle sensing. Therefore: *Remember where this switch in case you need it.*
10. Set the antennas parallel.
11. Turn on the remote controller (press once, then a second time and hold it 2 seconds).
12. Turn on the Phantom battery (same sequence).
13. Start up the djiGO app and make sure you're connected and ready to go.
14. In djiGO make any camera settings, like setting it to manual using the settings button below the shutter button while the camera is aimed to a good ground location. You can vary ISO from 100 to 1600, and the shutter speed from 8 s to 1/8000 s. Use the wheel on the back right to change the setting, toggling up or down to change from ISO to shutter speed.
15. Android: start Ctrl+DJI app and look for data, then use it to:
16. Start up the Pix4Dcapture app.
17. Safety check: BAA!
    - Battery (sufficient battery)
    - Antenna (aimed correctly)
    - Air horn (2 blasts to announce flight commencement, 2 to announce end)

Figure 2. Function model switch, video record button and gimbal control wheel. Will be controlled with your left
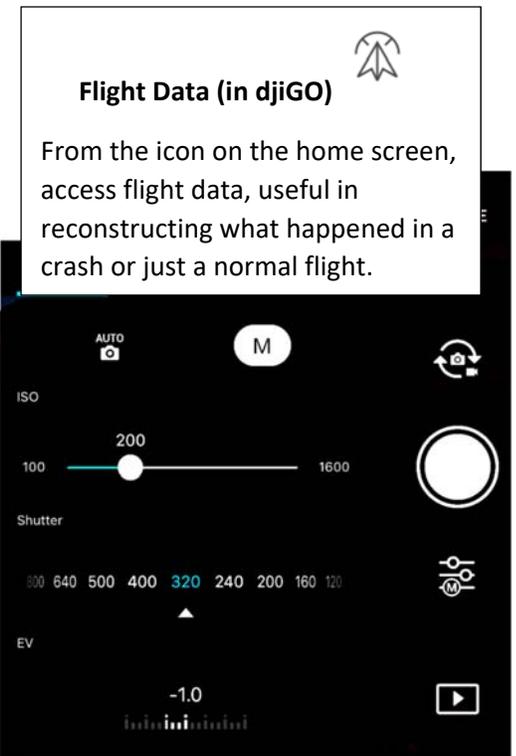
Flight Data (in djiGO)

From the icon on the home screen, access flight data, useful in reconstructing what happened in a crash or just a normal flight.

ISO

Shutter speed

Figure 2. Manual camera settings.

Capture sets of images in Pix4Dcapture

Pix4Dcapture is an app that runs on either Android or iOS devices and is designed to facilitate capturing sets of images with suitable overlap to process in Pix4D. Set the aircraft to Phantom 4 Pro. See https://support.pix4d.com/hc/en-us/articles/203873435--Android-Pix4Dcapture-Manual#gsc.tab=0 for a more complete guide on the Android version.

Ctrl+DJI: With Android, you need to add the app Pix4d Ctrl+DJI app, available free on Play Store. This allows access to DJI data and the ability to control it. Start by opening this app and using the button to connect to the Phantom. After you see data (e.g. Latitude, Longitude, etc.) being displayed, click Open PIX4DCAPTURE to go there and continue.
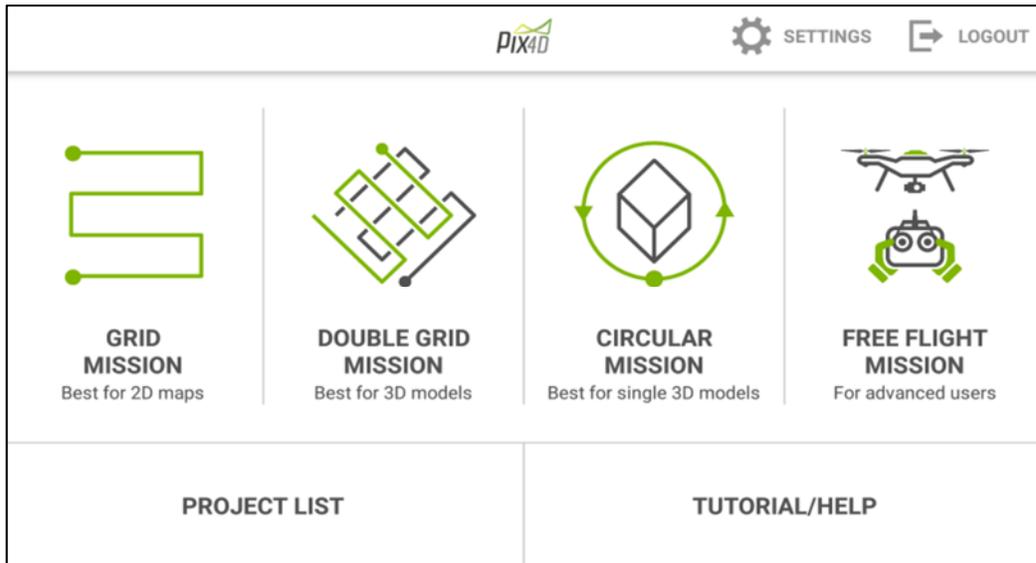
Pix4Dcapture Home Screen

Figure 3. Pix4Dcapture Home Screen (Android)

The home screen gives you access to settings (also available in other views) lets you choose different missions (polygon (not shown here), grid, double grid, circular and free flight), go to a tutorial or help, and go to a list of projects (Android) or missions (iOS). In Android, **Projects** are sets of missions where you want to keep them together. Unlike the example shown here, a project to be processed as one set in Pix4D should have overlapping missions.
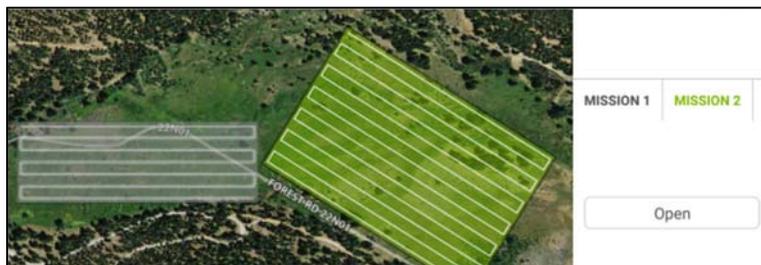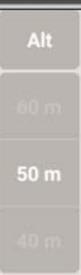

Figure 4. Project with 2 missions.

3

Map View

The map view is where you edit each mission and then start it. Once you start it and go through the checklist to launch it, some of the icons will change. Watch for messages for Too Few Images or Too Low replacing the drone name at the top.

Figure 5. Pix4Dcapture Map View

|	
	Centers the map on the mobile device's GPS position
	Centers on the current mission -- Note the size and time estimate for the mission is displayed
	Satellite view or Map view
RESET	Moves the mission grid to the center of the map
SAVE	Saves the mission, including the basemap if MapBox is the provider
START	Starts the mission by first going through a checklist, then launching
Abort	Aborts the mission to manual control. Or you can force with the joysticks.
Alt	Slide to set the altitude of the mission
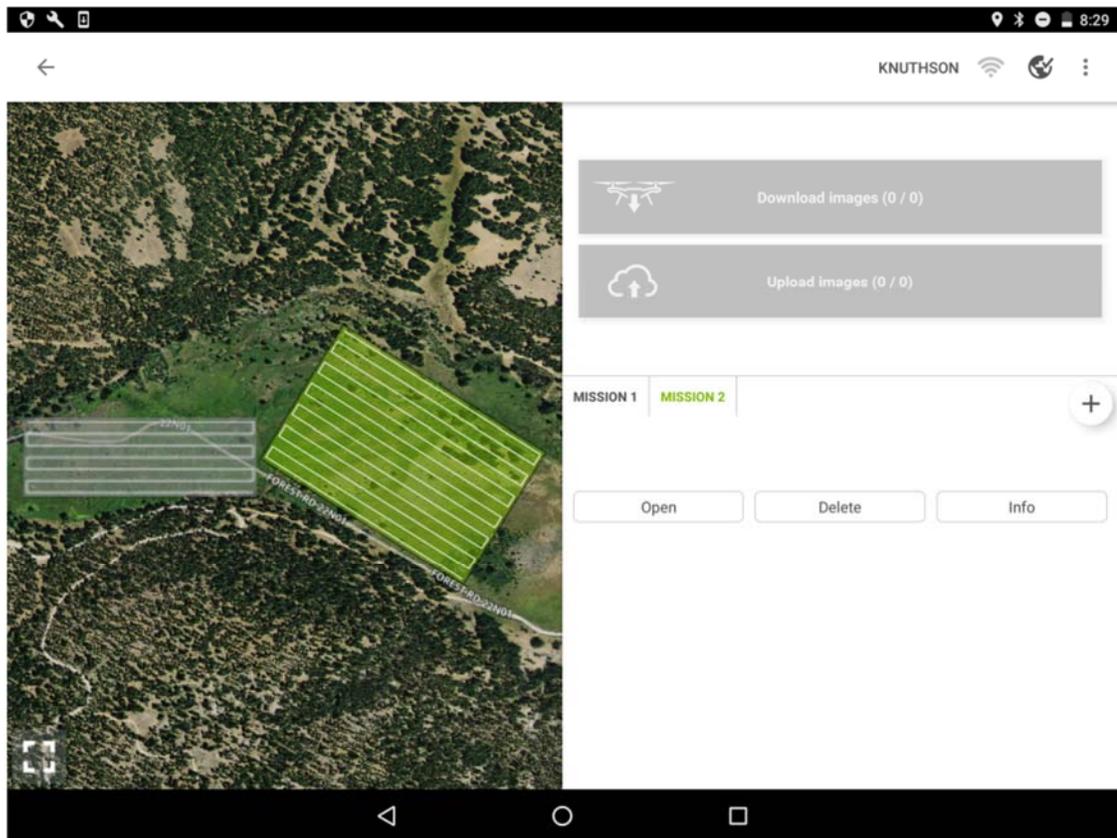
Figure 8.. Project (Knuthson) with 2 missions.

Note that missions are parts of projects. When you save a project, you can call it up again from the project list at the main page (rename with the 3-dot menu). Add missions with the + . Each mission can then be opened (or deleted) from the project window here.

For offline use: Plan your project in advance. It helps to have a GPS connection with your mobile device to move the map there rather than the GCS origin in the Atlantic. In the Android version at least, you can save your basemap with your mission. See https://support.pix4d.com/hc/en-us/articles/115002056523#gsc.tab=0 for information on this, but basically you do your mission planning zoomed into where you are going to fly it, with basemap selected:

    i.   In the Map view, focus on the area of interest with the desired map source (probably imagery) and bring the default flight to that location using the **Reset** button.

   ii.   Adjust the mission and personalize the flight settings (size, orientation, altitude, overlap, camera angle, etc.), as described in step 2 below.

  iii.   From the mission planning screen, save the project with the base map extent currently showing.

  iv.   Change the name with the menu pull down in the upper left of the project screen.

1. In Pix4Dcapture, plan your project as one or more missions. You can reposition, resize, and rotate the mission plot, in this example a grid. The locations of your mobile device and the aircraft are shown. You need to at least have GPS from your mobile device and center it there to not have the map positioned at the GCS origin in the Atlantic.

2. Adjust the mission and customize the flight settings. Set the height of the mission in meters (or feet if you choose that for units). Note that not only does the size change the layout, but the height will as well, since height changes the image size, influencing the number of images for sufficient overlap.
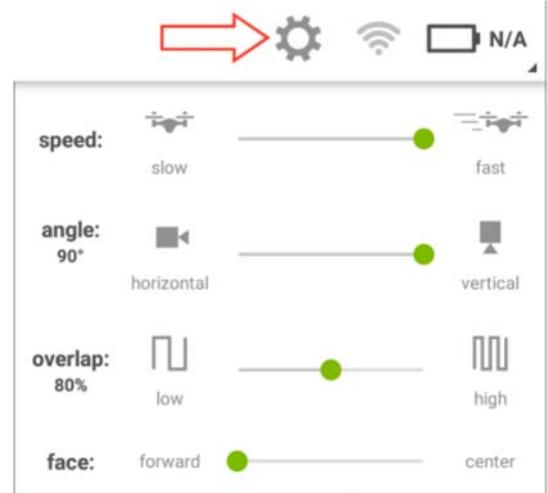

Figure 9. Custom flight settings

3. Before flying, do a quick run-through of the controls:
   a. Locate the function switch (for your left hand) labeled P·A·F that changes to manual mode (P) if necessary.
   b. Remind yourself of how each joystick works:
      i. Left stick: up or down, rotate left or right
      ii. Right stick: go forward, backwards, left, or right. *Note that the **front** of the aircraft has two **red** lights, so forward is in that direction.*
   c. Plan for turning off the propellers if necessary: left and right stick both diagonally downward.

4. When ready to fly, press START, then Next through a dialog that shows if it's connected, to a checklist dialog (Figure 10) that confirms if all is ready.

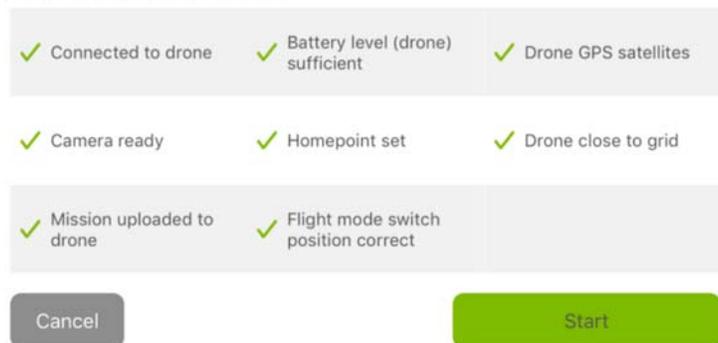5. Start launches the aircraft which proceeds through the mission.

Figure 10. Drone take off checklist.

6. At the end of the mission, the aircraft should return to above the home location and then descend. Switch to manual mode if this doesn't work.

7. After landing, images are uploaded to your tablet (they're also on the SD card) and a Pix4D file is created which you can email to yourself to open a project.

Failsafe procedures to review before flying.

It can be nerve-wracking during a mission when something goes wrong. You need to know what to do without having to look it up. So it can be critically important to review some emergency procedures in advance to know what to do, and to know what the normal response of the Phantom will be to any failures in the guidance system. This information is all covered in the Phantom manual.

Control buttons (*only work if you're connected, so make sure the antennas are set!)*:

- Power: press down twice and hold to power up
- Return to Home : *If* initial GPS position established in power-up, will return to that location. This button will work even if you're in an autonomous flight.
- Back left
    - P-S-A function switch (back left): P for normal use – uses GPS to maintain position; S (sport) same as P but higher speed allowed and no Obstacle Avoidance; A for attitude – no GPS or vision positioning—wind can blow it. You might practice with this for situations with limited GPS, but generally it's best left at P.
    - Gimbal control (back left) : up and down
    - Video on/off
- Back right
    - Shutter button
    - Camera settings dial
    - Playback button

What happens when Phantom loses GPS position?

If GPS position drops beneath a reliable threshold during flight, Phantom will automatically switch to A mode and be just controlled by the RC, but susceptible to wind. This mode does not provide the flight-stabilizing GPS functionality, but you can control the aircraft visually.

What happens when Phantom loses controller connection?
At 3 s, failsafe RTH is activated and Phantom initiates Return To Home. If under 20 m, will rise to 20 m first. If signal is re-established, operator may regain control.   The LED ring around the RTH button will blink white. *Press this button again to cancel the RTH procedure and regain control.*

What happens when battery failsafe triggers?
At low battery, Phantom initiates Return Home; it will first request this, but after 10 s will automatically go home. At *critical* low battery, the aircraft will *descend in place*.

What is the responsibility of the pilot when the above happen?
First, if the pilot in command (PIC) is not at the controls, that pilot should take control.

What are all the options for return to home and how are they set/used?

- RTH button
- If the Phantom loses controller connection
- Or you can manually fly there and land.
- Note that the aircraft will descend and land at its current location if within 20 m of the home point.

Checklist for Phantom Mapping

☐ Preparation: install tarp, any signage, clear of people. Review emergency protocols, assign roles (PIC, VOs), manual override, return-to-home method, including PAF function mode switch (F for automated from Pix4Dcapture, P to allow manual override).

☐ **Phantom**
- o Install SD card in gimbal
- o Mount propellers
- o Power up the Phantom

☐ **RC**
- o Hook up tablet with cable
- o Set the antennas parallel
- o Set the function mode to P
- o Power up the RC

☐ **djiGO**
- o Start the djiGO app and make sure you're connected and ready to go
- o Set the camera settings to manual.

☐ **Ctrl+DJI** (Android)
- o Connect to Phantom
- o Look for GPS and other data
- o Start Pix4Dcapture

☐ **Pix4Dcapture**
- o Open saved project
- o Adjust as necessary
- o Set height in meters
- o Quick run-through of controls, noting position of PAF switch. To power off propellers: left and right sticks together diagonally downward. Note that red lights are forward.
- o START, then Next through a dialog that shows if it's connected, to a checklist dialog that confirms if all is ready.
- o After progressing through mission, land or shift to manual for landing.
- o Wait for images to be downloaded.