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TOPODRONE DJI PHANTOM 4 PRO L1/L2 PPK

USER MANUAL





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1. Drone preparation

1.1 First steps before work

DJI Phantom 4 Pro Topodrone PPK – is a ready-to-fly geodetic survey solution based on DJI Phantom 4 Pro drone. It is strongly recommended to learn the DJI P4P manual first, you can find it on the official web-site: <u>https://www.dji.com/ru/phantom-4-pro/info#downloads</u>. Correct preparation of the drone means following exact rules to ensure flight safety and the best orthophoto or 3D-model quality. Flight safety is the main basis of our company.

- 1. <u>Checking.</u> All components of the drone must be in a condition: no damages, cracks or malfunctions. It is needed to carefully inspect blades, motormounts, motors, arms, gimbal, micro-SD cards, cables and connectors, especially if the drone has been in a public use. Always check your DJI Phantom 4 Pro Topodrone PPK before large orders and far business trips.
- 2. <u>Charging.</u> You should charge all batteries of the drone, the remote controller (RC) and the mobile device up to 100%. Never use a DJI Intelligent Battery charged lower than 90%, especially if the battery has started its storage discharging. It can cause premature termination of the flight mission.
- 3. <u>Exploring.</u> Before moving to the working area, explore locality in an on-line geo-service like <u>DJI GEO</u>, <u>AirMap</u>, and <u>PilotHub</u>, to provide yourself with more knowledge about the places and objects located nearby. It is not allowed to fly in No-Fly-Zones: airports, prisons, sports stadiums. Military bases, state institutions, objects of strategic importance (CHP, hydroelectric power plants, nuclear power plants, etc.) are particularly dangerous, but they are not marked at GEO-services. Electricity transmission lines, located at the place you need to capture, can cause radio and magnetic interference during the flight.



- 4. <u>Setting</u>. In the DJI Go 4¹ App set all parameters for comfort flying in a manual mode:
 - 1. Distance limit "turn off" value is recommended
 - 2. Maximum Flight Altitude 500 meters² value is recommended
 - 3. Return to home altitude 100 meters or higher value is recommended. Anyway, it can be changed during the mission planning in other apps.
 - 4. RC MODE settings set the axes of your sticks, value 2 is strongly recommended
 - 5. EXP tuning allows you to control your drone more accurately, 0.10 value is recommended
 - 6. RC signal lost an action that drone will make in case of RC signal loss. Value "Return to home" is recommended
 - 7. Low battery warning set at the minimum, 30% value is recommended³

NOTICE 1. DJI Go 4 App is the basic application for DJI Drones. You may not be able to set several parameters via other apps. It is recommended to make manual flights using DJI Go 4 App.

NOTICE 2. In some countries the maximum allowed flight altitude for UAVs is 120 meters. Setting 500 meters value in maximum flight altitude menu makes your drone follow the terrain, flying higher than 120 meters with respect to the altitude of home point, but not to the terrain.

NOTICE 3. If the area of photographing is located far from you (more than 1 km), increase this value up to 40%

NOTICE 4. Camera settings are described in the paragraph 1.3 of this manual.



1.2 Compass calibration.

As the basic model, on DJI Phantom 4 Pro Topodrone PPK needs the compass calibration (CC) each time you move to the new location. CC helps your drone to adapt to local magnetic field lines. During CC, the accelerometer and the compass of your drone make two rotations in different axes. After that, the drone makes an adjustment between the values of each sensor. To perform correct CC, follow the next steps:

- 1. CC is performed directly before the first flight at an open outdoor area. Making CC indoor is useless.
- 2. Remove the gimbal holder.
- 3. Turn on the drone and the RC, insert the mobile device.
- 4. Make sure that there are no large metal constructions or magnetic fields in 50 meters range.
- Turn your drone into CC mode. At least there are two ways:
 a) In the DJI Go 4 app open MC Settings / Advanced settings / Sensors state / Compass / Calibrate compass / OK
 - b) At the front left side of RC, rapidly move the slider to S and T positions not less than 4 times.
- 6. Ensure that rear LEDs of the drone lights are solid yellow.
- 7. Put the RC in the left arm and take the drone with your right arm. Hold drone from the top under the battery or like on the photo. Do not change the orientation of the drone!
- 8. Rotate your drone to the left side (counter-clock wise) in 380 degrees (a bit more than 1 turn). Stop when the rear LEDs will change their color from solid yellow to solid green.
- 9. Change the orientation of your drone, turning it in 90 degrees in a longitudinal axis.
- 10. Rotate the drone to the left side (counter-clock wise) in 380 degrees (a bit more than 1 turn). Stop when the rear LEDs will change their color from solid green to blinking green.
- 11. After using the 5a way entering CC mode, turn the Flight Mode slider to P (central position). This is especially important!
- 12. Compass calibration now is complete.

Before and after CC you can check the value of magnetic interference in the DJI Go 4 App - it should be at the green zone after CC. If the app notices that you have failed, the compass calibration (rear LEDs blinking red rapidly) - recalibrate the compass at another place nearby.

Notice 1: no magnetic or ferromagnetic objects on the pilot's body are allowed. For example: massive jewelry, metal inserts or magnets on the back plate of the iPad tablet etc. If you have some of these objects, even after successful CC, your drone will have "Compass Error" after taking off.

Notice 2: CC increases flight stability of the drone during the flight. But compass error can appear even after absolutely correct calibration. It is usually caused by different external interferences such as metal objects, large antennas, electricity transmission lines (ETL)











1.3.Camera calibration and settings

Before the shooting process will be started, you should calibrate the focus of your DJI Phantom 4 Pro PPK camera and set optimal image settings. It is recommended to use the next order.

- 1. You should determine your drone's working altitude. This value depends on many factors: scale of the final orthophoto map, properties of the lens, height of the obstacles, features of relief, etc. Usually, working altitude varies from 60 to 12 meters.
- Set correct image ratio. Go to the image menu, tap the second tab. Use the Image Ratio 3:2 value, it allows to use all surface area of camera's matrix. Do not use 16:9 Ratio! Check other values of this menu – all defaults.
- 3. Lift off the drone to the working altitude and move the gimbal to 90 degrees (nadir). Ensure that the focusing method now is in the AF value. Then tap the center of the screen to let the camera focus at the surface. After that change the focusing method in the



MF value - manual focus scale will appear. Do not touch it! Now your drone's camera is focused at the selected height value. It will not change in the future.

4. Now it is time to set the best camera settings. All parameters are set auto as default. In this case, your drone will change image brightness and smoothness during the flight. But this method is bad for triangulation image processing: the key points at different images will be different. To get the best image quality during the flight it is strongly recommended to set image params as follows:

ISO: from <u>100</u> to <u>200</u>. Upper values increase image noise, and decrease ortophoto map quality **Aperture:** from <u>2.8</u> to <u>4</u>. Upper values decrease stream of light, so images will be darker **Shutter:** from <u>1/1600</u> to <u>1/640</u>. Upper values increase image motion blur, lower ones does not allow the camera to use mechanical shutter, so images will be distorted.



Also using values upper than 1/1600 will not let writing GNSS marks correctly!



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1.4. IMU calibration and settings

IMU calibration is needed very rarely. However, some things can affect the sensor states: falls and bumps, temperature changes and long stand by time. Because of using the additional module upper the shell of DJI Phantom 4 Pro PPK, the process of IMU calibration is not the same as the default. To calibrate IMU you need to do next:

- 1. Remove the props from the motors if needed
- 2. Remove the gimbal holder and turn on the drone and the remote controller
- 3. Prepare two tables, standing close to each other, or another flat surface with a hall: the horizon should



- or another flat surface with a hall: the horizon should be aligned with the bubble level
- 4. Start the IMU calibration process and make steps 1-5 as they are.
- 5. At the step 6 place the drone head over heels. Use the edge of two tables to make this step. Place your drone like at the photo below



- 6. When the step 7 is complete, rotate the drone and place it normally
- 7. IMU calibration now is now complete



1.5. GNSS receiver settings

GNSS module is located in front of the drone in a special plastic shell. The receiver body has three holes in a row. The state of the receiver is shown by a single led. The signal led is located in the middle.



- 1. Dual frequency (L1/L2) antenna
- 2. Signal LED. Indicates power supply, GNSS state, Error.
- 3. Micro-SD slot.

LED State	Description
Blinks green/red	Satellite search mode
Solid green	The signal from the satellites is received
Blinks green	Flash card write mode (each interrupt means 4 KB of data is written)
Solid red	Micro-SD card error

4. GNSS cable, it should be plugged, do not touch it.

Each time the receiver is turned on, a new .ubx file is created in the folder with the date of the DDmm-yy format and the name of the HH-mm-ss format. It is important that the time is recorded in UTC, and the file is created only after the GNSS receives the satellite signal.

It is forbidden to insert or remove the memory card "on hot". This process should only be performed when the power is turned off. It is allowed to use cards with a maximum capacity of 64 GB.

The standard configuration of the receiver is to record a UBX file with a frequency of 10 Hz and receive GPS and GLONASS satellites at L1 and L2 frequencies.



2. GNSS DATA POST PROCESSING AND IMAGES GEOTAGGING

2.1 Data preparation

- Remove the SD card with images from your drone and copy photos to your computer.
- Divide the whole image dataset into separate flights and store photos from each mission in separate folders. For example, Flight 1, Flight 2 etc.

NOTICE. Do not delete any images.

- Remove the SD card from the GNSS receiver installed on the drone and copy ubx files to your computer to a folder ROVER (for example).
- Download GNSS static logs from the base station and convert them to Rinex format. Copy Rinex files to a folder BASE (for example)
- Measure coordinates of ground control points (GCPs) and coordinates of the base station.

NOTICE. Coordinates of the base station should be in Latitude, Longitude, Ellipsoid high, WGS 84 coordinate system.

2.2 GNSS data post processing

		r usincp
TopoSetter 2.0		- 🗆 X
1. Path to the photos from the rover:	Logs:	Open log file
2. Path to the ubx file from the rover:		
3.Specify the path to the base station data file:		
4. Base coordinates:		
Degree d°m′s″		
Latitude - degree		
Longitude - degree		
Elevation (meters) -		
5 Base antenna height: 0.000 Ameters		
6. Rover antenna offset:		
Height meters		
Offset forward/backward - 0.00 + meters		
Offset left/right - 0.00 🖨 meters		
7. Output folder:		
·		
Processing steps:		
1. 🗹 Data conversion		
2. GNSS data postprocessing		
3. Images matching and geotegging		
Advanced settings Stop		

Step 1. Run TOPOSETTER 2.0 application



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Step 2. Select a folder with photos

TopoSetter 2.0	-		×
1. Path to the photos from the rover	Logs:	<u>Open log fi</u>	le
E:\TUTORIAL\FLIGHT 1	26.11.2019 13:50:16: Read metadata from photos 26.11.2019 13:50:26: Done!		
2. Path to the ubx file from the rover:	26.11.2019 13:50:26: Found 397 photos		
3.Specify the path to the base station data file:			
4. Dase cooldinates.			
Latitude - degree			
Longitude - degree			
Elevation (meters) -			
5. Base antenna height: 0.000 💼 meters			
6. Rover antenna offset:			
Height - 0.00 🜩 meters			
Offset forward/backward - 0.00 🜩 meters			
Offset left/right - 0.00 🖨 meters			
7. Output folder:			
E:\TUTORIAL\FLIGHT 1\Output			
Processing steps:			
Data conversion			
C Y GNSS data postprocessing Start			
· · · · · · · · · · · · · · · · · · ·			
Advanced settings Stop			
			0



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Step 3. Select a UBX file from a drone

TopoSetter 2.0	-	· □ ×
1. Both to the electric from the muse	Logs:	Open log file
	26.11.2019 13:50:16: Read metadata from photos	
2. Path to the ubx file from the rover:	26.11.2019 13:50:26: Found 397 photos	
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx #		
3.Specify the path to the base station data file:		
4. Base coordinates:		
Degree d'm's		
Latitude - degree		
Longitude - degree		
Elevation (meters) -		
5. Base antenna height: 0,000 🐨 meters		
6. Rover antenna offset:		
Height - 0.00 🚖 meters		
Offset forward/backward - 0,00 📩 meters		
Offset left/right - 0,00 🖨 meters		
7. Output folder:		
E:\TUTORIAL\FLIGHT 1\Output		
Processing steps:		
1. 🗹 Data conversion		
2. GNSS data postprocessing		
3. Images matching and geotegging		
Advanced settings		
oop		



Step 4. Select a Rinex or UBX file from the base station

🗮 TopoSetter 2.0			– 🗆 X
		Logs:	Open log file
1. Path to the photos from t	the rover:	26.11.2019 13:50:16: Read metadata from photos	
	•••	26.11.2019 13:50:26: Done! 26.11.2019 13:50:26: Found 397 photos	
	the rover:		
E. TOTORIAL NOVER (13-03-27			
	ase station data file:		
E:\TUTURIAL\BASEVaw_20190	J32/1437.UDX		
4. Base coordinates:			
Degree d°m′s″			
Latitude -	degree		
Longitude -	degree		
Elevation (meters) -			
5. Base antenna height:	0,000 👤 meters		
6. Rover antenna offset:			
Height -	0.00 🖨 meters		
Offset forward/backward -	0.00 🖨 meters		
Offset left/right -	0,00 🗼 meters		
7. Output folder:			
E:\TUTORIAL\FLIGHT 1\Output			
Processing steps:			
1. 🗹 Data conversion			
2. 🗹 GNSS data postproc	cessing		
3. Images matching an	d geotegging		
A.L			
Advanced settings	Stop		
			0



Step 5. Impute coordinates of the base station in WGS 84. Define antenna offset for the drone.

TopoSetter 2.0	– 🗆 X
	Logs: Open log file
	26.11.2019 13:50:16: Read metadata from photos
2. Path to the uby file from the over	26.11.2019 13:50:26: Found 397 photos
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx	
3.Specify the path to the base station data file:	
E:\TUTORIAL\BASE\raw_201909271437.ubx	
4. Base coordinates:	
Degree d'm's	
Latitude - 36.523717043 degree	
Longitude4.663284915 degree	
Elevation (meters) - 152.6403	
5. Base antenna height: 0.000 🖨 meters	
6. Rover antenna offset:	
Height - 0,07 🚖 meters	
Offset forward/backward0.02	
Offset left/right - 0,00 ≑ meters	
7. Output folder:	
E:\TUTORIAL\FLIGHT 1\Output	
Processing steps:	
1. 🗹 Data conversion	
2. GNSS data postprocessing	
3. Images matching and geotegging	
Advanced settings Stop	
	6

NOTICE.

FOR DJI MAVIC 2 PRO PPK use the following parameters Height: 0.07 Offset forward/backward: -0.02

FOR DJI PHANTOM 4 PRO PPK use the following parameters Height: 0.17



Step 6. Setup data processing setting. Click advanced setting. Advanced setting will appear. To embed precise coordinates to photos EXIF tags check Burn exif check box. This option may lead to increasing of the data processing time. To save the list of coordinates check Save text file check box. Select the format of the text file Pix4D or Metashape.

Click Save button.

TopoSetter 2.0		, , , , , , , , , , , , , , , , , , ,	- 🗆 X
		Logs:	<u>Open log file</u>
I. Path to the photos from the rover:		26.11.2019 13:50:16: Read metadata from photos	
2 Path to the uby file from the rover		26.11.2019 13:50:26: Done! 26.11.2019 13:50:26: Found 397 photos	
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx	(
3. Specify the path to the base station data f	le:		
E:\TUTORIAL\BASE\raw_201909271437.ubx			
4. Base coordinates:			
Degree d°m′s*			
Latitude - 36.523717043	degree		
Longitude4.663284915	degree TopoSetter 2.0: Advanc	ed settings X	
Elevation (meters) - 152.6403	Display utility windows	GLONASS satellites	
5. Base antenna height: 0,000 🛓 me	ers 🔽 Burn exif Satellite i	mask angle: 15 🚖 degree	
6. Rover antenna offset:	Save text file	at text file:	
Height - 0.07 🌲 met	ers) PIX4D 🔿 Metashape	
Offset forward/backward0,02 🖨 met	ers	Save	
Offset left/right - 0,00 🚔 met	ers		
7. Output folder:			
E:\TUTORIAL\FLIGHT 1\Output			
Processing steps:			
1. 🗹 Data conversion			
2. GNSS data postprocessing	C 1		
3. Images matching and geotegging	Start		
Advanced settings	Stop		
na rando a dotango	orob		

NOTICE. To look at data processing progress check Display utility windows option.

Click Start button



After finishing all steps of the data processing (data conversion, GNSS data post processing, images matching and geotagging) all results will be stored in the Output folder.

File Coordinates.txt is stored in the PIX4D or Metashape folder.

Photos with updated EXIF tags are stored in the UpdateTags folder.

Files with .pos extension are the results of the GNSS data postprocessing.



NOTICE. The coordinate system is WGS84.



Step 7. Checking the processing results.

After the processing finishes, the following buttons will appear.

TopoSetter 2.0	- 🗆 X
	Logs: Open log file
	26.11.2019 13:50:16: Read metadata from photos
E:\TUTURIAL\FLIGHTT	26.11.2019 13:50:26: Done! 26.11.2019 13:50:26: Found 397 photos
2. Path to the ubx file from the rover:	26.11.2019 14:07:06: Convert rover raw data log to RINEX
E:\TUTORIAL\ROVER\19-09-27\14-40-32.ubx	26.11.2019 14:07:26: cancel operation
3.Specify the path to the base station data file:	26.11.2019 14:07:26: The work is completed!
E:\TUTORIAL\BASE\raw_201909271437.ubx	26.11.2019 14:07:32: Convert rover raw data log to RINEX
4. Base coordinates:	26.11.2019 14:08:03: E:\TUTORIAL\ROVER\19-09-27\14-40-32.obs 26.11.2019 14:08:03: E:\TUTORIAL\ROVER\19-09-27\14-40-32.nav
Degree d°m′s″	26.11.2019 14:08:03: Done!
	26.11.2019 14:08:11: E:\TUTORIAL\BASE\raw_201909271437.obs
Latitude - 36.523717043 degree	26.11.2019 14:08:11: Done! 26.11.2019 14:08:11: Calculate output position solutions
Longitude4.663284915 degree	26.11.2019 14:16:25: E:\TUTORIAL\FLIGHT 1\Output\14-40-32_events.pos
Elevation (meters) - 152.6403	26.11.2019 14:16:25: Parsing output position solutions
	26.11.2019 14:16:25: Output position solutions contains 397 rows 26.11.2019 14:16:25: Done!
5. Base antenna height: 0,000 🖨 meters	26.11.2019 14:16:25: Compare the coordinates of events pos with the photo
	26.11.2019 14:16:25: The number of photos matches the number of photos. We do not use time of 26.11.2019 14:16:25: In the photo Exposure/SpeedX/SppedY tags are not complete, we do not tag
6. Nover antenna ottset:	26.11.2019 14:16:25: The work is completed!
Height - 0.07 🚔 meters	26.11.2019 14:16:25: Done!
Offset forward/backward0.02 🖨 meters	26.11.2019 14:16:25: Number of shots: 397 pc. 26.11.2019 14:16:25: Number of coordinates: 397 pc.
Offset left/right - 0.00 🚔 meters	26.11.2019 14:16:25: Successfully combined: 397 pc. 26.11.2019 14:16:25: Generate a coordinate file in PIXAD format
	26.11.2019 14:16:25: File created: E:\TUTORIAL\FLIGHT 1\Output\PIX4D\coordinates.txt
7. Output folder:	26.11.2019 14:16:25: Done!
E:\TUTORIAL\FLIGHT 1\Output (
Processing steps:	
1. Data conversion	
2. GNSS data postprocessing	
3 I Images matching and cost orging Start	
- E mogos natoring and goologging	
Advanced settings Stop	< >>
	0

NOTICE.

Click buttons in front of the Rover or Base fields to open GNSS observation files and check the quality of GNSS signal.

To check the quality of GNSS data postprocessing click

button in front of output results.



On the map you can see the results of the GNSS data postprocessing. Green points of photos events stand for Fixed solution Yellow points – Float solution Red points – Single solution



NOTICE.

If there are only red points on the map it means that the GNSS data from the drone and the base station were not collected at the same time.

If there are only yellow points (float solution) you should check the coordinates of the base station or the quality of the signal. To remove noisy GNSS signal try increasing the satellite mask angle or excluding the GLONASS satellite system in Advanced setting menu.



3. PHOTOGRAMMETRY PROCESSING IN PIX4D MAPPER SOFTWARE 3.1 Creating pix4d mapper project

Run PIX4D mapper application.

E Pix4Dmapper Pseview			- ø ×
			2. 🗆
Anger Andrea		Dixto Pix4D mapper	
Editor E	Projects Help Demo Proj	iect	
Teles Galalator	+ Follow the witard to create a new project with your own detaset.	Open Project Open an existing project.	
	PIX4D.p4d 427 images Last modified: 87 wor 26 2019	QATAR.p4d 326 images Last modified: Bc Hos 24 2019	
	test2.p4d 315 images Last modified: 4t war 21 2019	test1.p4d 130 images Last modified: Cp Hort 20 2019	
	News	Tips	
	Pix4D User Conference Be part of it on Oct 2-3 in Deriver, Colorado	Did you know How to generate the Point Cloud Classification?	
Processing VB VS VS Another Another VS Another VS Another			

Click New Project. Select a project folder location. Click next

New Project This wizard creates a new project. Choose a name, a directory location and a type for your new project. Name: PIX4D Create In: E:/TUTORIAL Use As Default Project Location Project Type Image: New Project Image: Project Merged from Existing Projects					
This wizard creates a new project. Choose a name, a directory location and a type for your new project. Name: PIX4D Create In: E:/TUTORIAL Use As Default Project Location Project Type O New Project Project Merged from Existing Projects	New Pro	ject			×
Choose a name, a directory location and a type for your new project. Name: PIX4D Create In: E:/TUTORIAL Use As Default Project Location Project Type Image: New Project Or Project Merged from Existing Projects	This wizard	creates a new project.			
Name: PIX4D Create In: E:/TUTORIAL Use As Default Project Location Project Type New Project Project Merged from Existing Projects	Choose a n	ame, a directory location and a type for your new project.			
Name: PIX4D Create In: E:/TUTORIAL Use As Default Project Location Project Type New Project Project Merged from Existing Projects 					_
Create In: E:/TUTORIAL Browse Use As Default Project Location Project Type New Project Project Merged from Existing Projects	Name:	PIX4D			_
Use As Default Project Location Project Type New Project Project Merged from Existing Projects	Create In:	E:/TUTORIAL		Browse	
Project Type Image: Type Project Project Merged from Existing Projects	Use As	Default Project Location			
New Project Project Merged from Existing Projects	Project T	10 0			
O Project Merged from Existing Projects	New I	ype Droiert			
Project Merged from Existing Projects		n Marca di Gara Evictica Basicata			
	O Proje	ct Merged from Existing Projects			



Select images to be processed from output\UpdateTags folder. Click next

🧧 New Project					×
Select Images					
Enough images are selected; press Next to proceed					
205 image(s) selected.	Add Images	Add Directories	Add Video	Remove Selected	Clear List
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_038	6.JPG				^
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_038	7.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_038	8.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_038	9.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	0.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	1.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	2.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	3.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	4.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	5.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	6.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	7.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	8.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_039	9.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	0.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	1.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	2.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	3.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	4.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	5.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	6.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	7.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	8.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_040	9.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_041	0.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_041	1.JPG				
E:/TUTORIAL/FLIGHT 1/Output/UpdateTags/DJI_041	2.JPG				~
Help			< <u>B</u> ad	k <u>N</u> ext >	Cancel



Software will read the precise coordinates of the images and the accuracy settings automatically. Click Next.

	olocation						
Coordinat	te System						
⊘ ∉	Datum: World (Geodetic System 1984	4; Coordinate System	: WGS 84			Edit
Geolocati	on and Orientation	I Contraction of the second					
🕑 Geo	olocated Images: 2	203 out of 203		Clear	From EXIF	From File	o File
Geolocati	on Accuracy: 🔘	Standard 🔾 Low	Custom				
0	L1D-20c_10.3_5	472x3648 (0K8TG74	0120251) (RGB)			1	Edit
-							
Enabled	lmage	Group	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Ac V
\checkmark	DJI_0389.JPG	group1	36.52239990	-4.66220570	221.339	0.003	0.006
\checkmark	DJI_0390.JPG	group1	36.52251434	-4.66216040	221.160	0.003	0.006
	DJI_0391.JPG	group1	36.52263260	-4.66211557	221.198	0.003	0.006
\checkmark	DUL 0202 ID.C	group1	36.52274323	-4.66207075	221.162	0.003	0.006
2 2	DJI_0392.JPG				221.005	0.003	0.006
9 9 9	DJI_0392.JPG	group1	36.52285767	-4.66202545			
9 9 9	DJI_0393.JPG DJI_0393.JPG DJI_0394.JPG	group1 group1	36.52285767 36.52297211	-4.66202545 -4.66197968	220.971	0.003	0.006
9 9 9 9	DJI_0393.JPG DJI_0394.JPG DJI_0395.JPG	group1 group1 group1	36.52285767 36.52297211 36.52308655	-4.66202545 -4.66197968 -4.66193438	220.971 220.926	0.003	0.006
9 9 9 9	DJI_0392.JPG DJI_0393.JPG DJI_0394.JPG DJI_0395.JPG DJI_0396.JPG	group1 group1 group1 group1	36.52285767 36.52297211 36.52308655 36.52320099	-4.66202545 -4.66197968 -4.66193438 -4.66189003	220.971 220.926 220.824	0.003 0.003 0.003	0.006

NOTICE. It is possible to upload the coordinates from the .txt file. Click From File button and select the coordinates.txt file

It is recommended to check the camera settings. Click Edit button and check if the Linear rolling shutter camera model is enabled if you have used a DJI MAVIC 2 PRO for survey.



Select an output coordinate system and click Next.

New Project		X
Select Output Coordinate System		
Selected Coordinate System		
Datum: World Geodetic System 1984 × Y Coordinate System: WGS 84 / UTM zone 30N		
Output/GCP Coordinate System		
Unit: m 💌		
O Arbitrary Coordinate System [m]		
Auto Detected: WGS 84 / UTM zone 30N		
O Known Coordinate System [m]		
Q Search Coordinate System		
Advanced Coordinate Options		
Help	< <u>B</u> ack <u>N</u> ex	(t > Cancel



Select a type of data processing options. Click Finish.

Standard	3D Models
3D Maps 3D Models Ag Multispectral Rapid	Generate a 3D Model from any set of overlapping images.
3D Maps - Rapid/Low Res 3D Models - Rapid/Low Res Ag Modified Camera - Rapid/Low Res Ag RGB - Rapid/Low Res	oblique flight terrestrial Outputs Quality/Reliability
Advanced	Low High
Ag Modified Camera Ag RGB Thermal Camera ThermoMAP Camera	Processing Speed
	Input Image Recommendations Any images with a high amount of overlap such as images taken from the ground or oblique aerial images (free flight).
	Outputs Generated 3D Mesh Point Cloud



3.2 Initial aerial triangulation

Once the images with precise coordinates are loaded to the project, we can start the initial aerial triangulation. Select the initial processing checkbox and start processing.





3.3. Camera calibration

In order to calibrate the focal length of the camera you need at least one GCP.

Click GCP/MTP button.





Select the coordinate system of ground control points and import GCPs. Click OK.

Label Type Latitude [degree] Longitude [degree] Altitude [m] Accuracy Horz [m] Accuracy Vert [m] Accuracy Vert [m] Im Base 3D GCP 36.52371704 -4.66328492 152.506 0.020 0.020 Im Point 1 3D GCP 36.52372766 -4.66311001 148.133 0.020 0.020 Im	M	TP Table								
Base 3D GCP 36.52371704 -4.66328492 152.506 0.020 0.020 Point 1 3D GCP 36.52372766 -4.66311001 148.133 0.020 0.020 Point 2 3D GCP 36.52377147 -4.66240655 153.482 0.020 0.020 Point 3 3D GCP 36.52340747 -4.66240828 153.772 0.020 0.020 Point 4 3D GCP 36.52320690 -4.66257781 149.481 0.020 0.020 Point 5 3D GCP 36.52224430 -4.66288253 138.133 0.020 0.020 CGCPs with enough image marks Import Marks Experimental State S		Label	Туре	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Accuracy Vert [m]	^	Import GCF
4 Point 1 3D GCP 36.52372766 -4.66311001 148.133 0.020 0.020 Point 2 3D GCP 36.52377147 -4.66264965 153.482 0.020 0.020 Point 3 3D GCP 36.52340747 -4.66240828 153.772 0.020 0.020 Re Point 4 3D GCP 36.52340747 -4.66240828 153.772 0.020 0.020 Re Point 5 3D GCP 36.5224430 -4.66288253 138.133 0.020 0.020 Re GCPs with enough image marks Import Marks Exc MTP Editor der to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images. der to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked. ing GCPS/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize. GCPS/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor. Lise the Basic Editor either		Base	3D GCP	36.52371704	-4.66328492	152.506	0.020	0.020		
Point 2 3D GCP 36.52377147 -4.66264965 153.482 0.020 0.020 Point 3 3D GCP 36.52340747 -4.66240828 153.772 0.020 0.020 Point 4 3D GCP 36.52320690 -4.66257781 149.481 0.020 0.020 Re Point 5 3D GCP 36.52224430 -4.66288253 138.133 0.020 0.020 Exp GCPs with enough image marks Import Marks Import Marks Exp MTP Editor	4	Point 1	3D GCP	36.52372766	-4.66311001	148.133	0.020	0.020		
Point 3 3D GCP 36.52340747 -4.66240828 153.772 0.020 0.020 Re Point 4 3D GCP 36.52320690 -4.66257781 149.481 0.020 0.020 Re Point 5 3D GCP 36.52224430 -4.66288253 138.133 0.020 0.020 Re GCPs with enough image marks Import Marks Exp MTP Editor der to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images. der to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked. ing GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize. GCP/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor. Lise the Basic Editor either		Point 2	3D GCP	36.52377147	-4.66264965	153.482	0.020	0.020		
Point 4 3D GCP 36.52320690 -4.66257781 149.481 0.020 0.020 Point 5 3D GCP 36.52224430 -4.66288253 138.133 0.020 0.020 Import Marks Exp GCPs with enough image marks Import Marks Exp Import Marks Exp MTP Editor der to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images. der to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked. ing GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize. GCP/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor. Lise the Basic Editor either		Point 3	3D GCP	36.52340747	-4.66240828	153.772	0.020	0.020		Add Poir
Point 5 3D GCP 36.52224430 -4.66288253 138.133 0.020 0.020		Point 4	3D GCP	36.52320690	-4.66257781	149.481	0.020	0.020		Remove Po
I GCPs with enough image marks Import Marks Exc MTP Editor der to compute the 3D position of a GCP/MTP, it needs to be marked on at least two images. der to take GCPs into account for georeferencing the project, at least 3 GCPs need to be marked. ing GCPs/MTPs after step 1. Initial Processing requires the user to run Process > Reoptimize. GCPs/MTP accuracy can be verified in the Quality Report or in the rayCloud Editor. Use the Basic Editor either		Point 5	3D GCP	36.52224430	-4.66288253	138.133	0.020	0.020		
ommended) Use the rayCloud Editor after 1) before running step 1. Initial Processing, or	M rde rde cin G(CPs with enough im TP Editor er to compute the 31 er to take GCPs into g GCPs/MTPs after : CPs/MTP accuracy commended) Use the r	age marks D position of a GCP/MTP, account for georeference step 1. Initial Processing an be verified in the Qua ayCloud Editor after	it needs to be marked on ing the project, at least 3 requires the user to run P ity Report or in the rayCl	at least two images. 3 GCPs need to be mark Yocess > Reoptimize. oud Editor.	ed. Use the Basic Editor eith 1) before running step :	ier L. Initial Processing, or	Import M	larks	Export Marl
Recommended) Use the rayCloud Editor after 1) before running step 1. Initial Processing, or tep 1.Initial Processing is done. This allows a stand precise point marking. 2) when using non-geolocated images, or	rkin e G(ecor p 1 t ar	g GCPs/MTPs after s Ps/MTP accuracy content nmended) Use the r Initial Processing is d precise point mar	step 1. Initial Processing an be verified in the Qua ayCloud Editor after done. This allows a king.	requires the user to run F ity Report or in the rayCl	rocess > Reoptimize. oud Editor.	Use the Basic Editor eith 1) before running step 1 2) when using non-geol	ner 1. Initial Processing, or ocated images, or			

Change the GCP type to Check point.

	Label	Туре	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Accuracy Vert [m]	^ Im	port GCP
) E	Base	Check Point	36.52371704	-4.66328492	152.506				
14 F	Point 1	Check Point	36.52372766	-4.66311001	148.133				
) F	Point 2	Check Point	36.52377147	-4.66264965	153.482				A LL D. C
) F	Point 3	Check Point	36.52340747	-4.66240828	153.772			D.	Add Poin
) F	Point 4	Check Point	36.52320690	-4.66257781	149.481			Ke	eniove Po
) F	Point 5	Check Point	36.52224430	-4.66288253	138.133				
/MTF order order king GCP	P Editor to compute the 3D to take GCPs into GCPs/MTPs after s s/MTP accuracy ca) position of a GCP/MTP, account for georeferent tep 1. Initial Processing in be verified in the Qua	it needs to be marked on ing the project, at least 3 requires the user to run P itv Report or in the ravCk	at least two images. GCPs need to be marke rocess > Reoptimize. oud Editor.	ed.		Import Ma	arks Exp	port Marl



All GCPs will be shown on the map.



Select one GCP, define the position of the ground control point at each image, change the type of the selected(?) GCP to 3D and set the horizontal accuracy to 50 meters.







Click Reoptimize button. Click Ok on all warning messages.

After finishing the reoptimization process click the Image property editor button.





Click the Edit camera model buttons in the Image Properties Editor window and in the Edit Camera Model window

Coordina	te System						EXIF ID: L1D-20c_1	0.3_5472x3648 (0K8	3TG740120251)		
⊘ ∉	Datum: World (Geodetic System 198	4; Coor <mark>d</mark> inate Syster	n: WGS 84	Ed	dit	Camera Model Name: 🖉 L 1D-20	0c_10.3_5472x3648	(0K8TG740120251)		
Geolocati	ion and Orientation	1							Remove	Edit	New
🎯 Ge	olocated Images: :	203 out of 203	Clear	From EXIF Fro	om File To	File	Camera Model Bands				
Geolocati	on Accuracy: O	Standard O Low	Custom				Bandra PCR			•	Edit
Selected	Camera Model						bunds. Kob				Luiterre
0	L1D-20c_10.3_5	472x3648 (0K8TG74	0120251) (RGB)		Ed	lit	Camera Model Parameters				
							Clear Estimate from EX	XIF Load Optimized	Parameters		
Enabled	Image	Group	Latitude [degree]	Longitude	Altitude	^	Warning: Wrong parameters can o	cause failure in the re	econstruction. Read the Help fo	r more informati	ion.
2	DII 0389.IPG	groun1	36.52239990	-4.66220570	221,339	0	Perspective Lens	Fisheye Lens	Shutter Model: Linear R	tolling Shutter	
	DII 0300 IBG	group1	26 52251/2/	-4 66216040	221 160		O Image Width [pixel]:	5472	O Sensor Width [mm]:	12.825	
-	D11_0390.0PG	group	30.32231434	-4.00210040	221.100		Image Height [pixel]:	3648	Sensor Height [mm]:	8.55	
⊻	D11_0391'16	group1	36.52263260	-4.66211557	221.198	0			Pixel Size [µm]:	2.34375	
~	DJI_0392.JPG	group1	36.52274323	-4.66207075	221.162	0	Focal Length [pixel]:	4324.02	Focal Length [mm]:	10.1344	
\checkmark	DJI_0393.JPG	group1	36.52285767	-4.66202545	221.005	0 🗸	Principal Point x [pixel]:	2742.25	Principal Point x [mm]:	6.42715	
٢						>	Principal Point y [pixel]:	1812.8	Principal Point y [mm]:	4.24875	
				OK	Cancel	Help	Camera Model with Distortions	s: 5 👻			
						Страница	Radial Distortion R1:	-0.012488	Tangential Distortion T1:	-0.00176074	
						parinda	Radial Distortion R2:	0.033735	Tangential Distortion T2:	-0.000554806	
							1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				



Click Load Optimized parameters. Copy the Focal Length value for the future work.

Camera Model		
EXIF ID: FC6510	_8.8_5472x3648 (c24	4fce2ed046c7d981071386a98b4570)
Camera Model Name: SFC6	5510_8.8_5472x3648	۲
		Save to DB Cancel Edit
Camera Model Bands		
Bands: RGB		▼ Edit
Camera Model Parameters		
Clear Estimate from	EVIE Load Optimiz	red Parameters
Clear Estimate from		red Parameters
Warning: Wrong parameters ca	an cause failure in the	reconstruction. Read the Help for more information.
Perspective Lens) Fisheye Lens	Shutter Model: Global Shutter or Fast Readout 🔻
O Image Width [pixel]:	5472	Sensor Width [mm]: 12.8333
Image Width [pixel]:	5472 3648	Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554
Image Width [pixel]: Image Height [pixel]:	5472 3648	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527
Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]:	5472 3648 3689.45	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: 	5472 3648 3689.45 2730.91	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: 	5472 3648 3689.45 2730.91 1829.69	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: Camera Model with Distortion 	5472 3648 3689.45 2730.91 1829.69 ons: 5 ▼	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: Camera Model with Distortion Radial Distortion R1: 	5472 3648 3689.45 2730.91 1829.69 ons: 5 ▼ 0.00337736	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: Camera Model with Distortion Radial Distortion R1: Radial Distortion R2: 	5472 3648 3689.45 2730.91 1829.69 ons: 5 ▼ 0.00337736 -0.0107165	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111 Tangential Distortion T1: 0.000668314 Tangential Distortion T2: 0.000920046
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: Camera Model with Distortion Radial Distortion R1: Radial Distortion R2: Radial Distortion R3: 	5472 3648 3689.45 2730.91 1829.69 0.00337736 -0.0107165 0.0106237	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111 Tangential Distortion T1: 0.000668314 Tangential Distortion T2: 0.000920046
 Image Width [pixel]: Image Height [pixel]: Focal Length [pixel]: Principal Point x [pixel]: Principal Point y [pixel]: Camera Model with Distortion Radial Distortion R1: Radial Distortion R2: Radial Distortion R3: 	5472 3648 3689.45 2730.91 1829.69 0.00337736 -0.0107165 0.0106237	 Sensor Width [mm]: 12.8333 Sensor Height [mm]: 8.55554 Pixel Size [µm]: 2.34527 Focal Length [mm]: 8.65275 Principal Point x [mm]: 6.40471 Principal Point y [mm]: 4.29111

NOTICE. It will be possible to use the calibrated value of the focal length for the processing if you do not change your focus settings for the future flights.



3.4 Accuracy estimating

Load the ground control points. Set them up as check points. Select position of all check points at images to check accuracy.





Go to the Processing options menu. Select None for Internal Parameters Optimization. Click Ok. Click Reoptimize.





After finishing the optimization process go to Process Menu, click Generate quality report.

Data processing report will be generated. Go to Geolocation Details to estimate the accuracy of the project.

PDF		>							💭 Online Su
				lachicol	[degree]	[degree]	Displacement X [m]	Displacement i [iii]	Displacement 2 [m]
Mean	0.120	0.128	0.004	0.016	0.008	0.005	0.004	0.005	0.010
Sigma	0.073	0.074	0.001	0.004	0.002	0.002	0.001	0.001	0.002
Geol	ocat	tion	ı De	tails					(
Grou	Ind Cor	ntrol F	Points	acy XV/7 [m]	1 out of 12 che	ck points have t	been labeled as inaccu	Irate.	Varified/Marked
Point 1	ontival	ie -	Accura	icy x nz [iii]	-0.004	.0.024	_0.012		14/14
Point 2					-0.004	-0.031	-0.012	1.454	0/0
Point 2					-0.004	-0.040	-0.005	0.706	0/0
Point 4					0.002	-0.044	-0.003	0.700	7/7
Point 4					0.003	0.001	-0.025	0.777	0.0
Point S					0.015	0.040	-0.040	0.791	0/0
Point 7					0.031	0.079	-0.010	0.485	10/10
Point 7					0.020	0.004	-0.037	1.135	8/8
Point 8					0.030	0.028	0.030	0.035	12/12
Point 40					0.020	0.019	-0.037	0.005	0/0
Point 10					0.020	-0.019	-0.064	0.910	4/4
Moon In	-1				-0.000	-0.027	-0.040	0.000	12712
Niedri (ri					0.012070	0.00507	2 -0.024380		
Sigina (i	nij ror [m]				0.013200	0.04131	4 0.028233		
RMS En	tor full				0.010440	0.04170	0.037300		



4. PHOTOGRAMMETRY PROCESSING IN AGISOFT METASHAPE SOFTWARE

4.1 Creating a project, photo alignment

The following process should be performed in the Agisoft Metashape software. Add photos to the project.



Import positions from the file coordinates.txt. Go to Reference. Click Import button, select coordinates.txt file from folder with photos

🖬 Untitled" — Agisoft Metashape Professional		– a ×
Eile Edit View Workflow Model Photo Ortho Iools Help		
Reference 6>	K Model Ontho	
	Fregerine 30*	
Ca Import Reference gitude Latitude Altitude (m) Accuracy (m) Error (m) Yaw (*		
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DJL_0390 -4.662146 36.522557 110.800000 10.000000 11.000000	8	
Image: March 100		
DJI_0393 -4.662012 36.522897 110.900000 10.000000 [] 15		
DI_0394 -4.661966 36.523013 110.900000 10.000000 [1:		
DII_0095 -4.661921 06.520129 111.000000 10.000000 [15		
Image: Control Control Image: Control Control Control Image: Control Control Control Image: Control Control Control Image: Control Control Control Control Control Image: Control Contro Control Control Control Control Control Control Control Control		
☑ DJI_0398 -4.661789 36.523469 110.900000 10.000000 □ 15		
ICI III 0399 -4.661741 36.523591 110.800000 10.000000 □ 15."		
Markers Longitude Latitude Attitude (m) Accuracy (m) Error (m) Project		
Control points		
Check points		
	00 ° 0 00 0 ° 0 00 0	
¢	0° 6° 60 60 0 2 4°	
Scale Bars Distance (m) Accuracy (m) Error (m)	· · · · · · · · · · · · · · · · · · ·	
Total Error	0 0 00 00	2.42
Control scale	B	
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		12.01.2020



Select WGS 84 coordinate system, setup columns order 1,3,2,4, click Accuracy checkbox, select field 5, click OK

UNUS OF LEPSIS	1326)							
Rotation angles:			Yaw Pitch P	oll				
			Tawy Pitchy K	011				
Ignore labels			Threshold (m):		0.1			
Delimiter		Columns						
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O Semicolan		Label.						
Semicoion		Longitude:	3 🗘 5	÷	Yaw: 5	5 💂	9	
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O Space						· · · ·	-	
O Other:		Altitude:	4 🗘 5	÷	Roll: 7	7 -	9	
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itart import at row: irst 20 lines previev Label Name DJI_0386.JPG DJI_0387.JPG	1 • w: Latitude Latitude 36.523661137 36.5221056845317	Longitude Longitude -4.663068715 -4.66232114533	Altitude Altitude 147.68380052109 221.010430292536	Location Ac Accuracy 0.010 0.010	ccuracy	Item	s: All	
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tart import at row: irst 20 lines preview DJI_0386.JPG DJI_0387.JPG DJI_0388.JPG DJI_0389.JPG DJI_0399.JPG DJI_0391.JPG DJI_0393.JPG DJI_0394.JPG	1 •• V: Latitude 36.523661137 36.5221056845317 36.522860844363 36.5224010804326 36.5225160334709 36.5226306035956 36.5227431767471 36.5228566580435 36.522732876239	Longitude Longitude -4.663068715 -4.66232114533 -4.66225057902 -4.66220581866 -4.66210540151 -4.66207096454 -4.6620256512539 -4.66197984568 -4.66197984568	Altitude Altitude 147.68380052109 221.010430292536 221.377707372442 221.241127832579 221.062872597887 221.099880851059 221.062823904092 220.907277145259 220.872190284877	Location Ac Accuracy 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010 0.010	ccuracy	Item	s: All	

Accurate X,Y,Z coordinates and accuracy values will appear in the Reference window





Go to Tools, click Camera calibration and input the calibrated parameter for focal length 10.4777, select fixed F parameter

🖬 Camera Calibrat	ion											\times
	0.26mm)	Camera t	/pe:				Fram	e				-
397 images	s, 5472x3648	Pixel size	(mm):				0.00	241071		x 0.00241071		
		Focal leng	th (mm):				10.4	777				
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		Initial	Adjusted	Bands	GPS/INS	Offset						
			,									
		Type:		Auto		•				E	3 🗒 🖬	
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		k4: 0					b2:	0				_
		Fixed p	arameters:		None					Select		
		Image-	variant parame	eters:	None					Select		
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	k4			b 2						2019:09:27 16:5	52:24	
										2019:09:27 16:5	52:26	
<			OK	Ca	ncel					2019:09:27 16:5	52:28	~
				ОК	Ca	ncel						

Go to Workflow and click Align Photos for aerial triangulations





After finishing the aerial triangulation go to the Reference, click "Optimize Camera Alignment" and click on Fit additional corrections check box. Click OK.



😈 Optimize Camera /	Alignment	×
General		
Fit f	Fit cx, cy	
Fit k1	Fit p1	
Fit k2	Fit p2	
Fit k3	Fit b1	
Fit k4	Fit b2	
Fit additional corre	ctions	
Advanced		
Adaptive camera r	nodel fitting	
Estimate tie point	covariance	
ОК	Cancel	



4.2 Accuracy estimating

After finishing the aerial triangulation go to the Reference, click "Import" and load the GCP.txt file. Use the following settings and click OK

Reference					e ×	Model Ortho									
	10 30	R H K				Perspective 30*	ASSESS								
Carrace Carrac	Longitude - 4.64009 - 4.64221 - 4.64009 - 4.64221 - 4.64029 - 4.64221 - 4.64019 - 4.64211 - 4.64017 - 4.64017 - 4.64019 - 4.64019	at at bit bit 1 bit bit	Albitude (m) 147,663801 221,010430 221,377707 221,241128 221,063024 221,063024 220,0672190 220,827559 220,726049 220,651363 220,661364 220,651363 220,651363 220,651363 220,651363 220,651363 220,651363 220,651363 220,651363 220,513659 220,546595 220,546595 221,079240 221,546595 221,5465	Accuracy (m) 0.010000 0.00000000	Errer (m) 0.164313 0.045359 0.040313 0.045359 0.040313 0.043334 0.043435 0.04343 0.04343 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.04443 0.0444 0.0444 0.0444 0.0444 0.0444 0.0444 0.044	Import CSV Coordinate System VGS 84 (BPSG::4326) Rotation angles: Delimiter Tab Space Comma Space Conter Common Start import at row: Label Label Longitude Point 1 - 4-66310000 Point 3 - 4-66340477 Point 3 - 4-6634077812 Point 5 - 4-663872781 Point 5 - 4-663872781 Point 5 - 4-66388279 Point 5 - 4-663882	Terr, Pitch, Roll Tree, Pitch, Roll Treehold (n): Columos Labitude: Labitude: 2 S C Attitude Attitude Attitude Sizz271/6 Hattude: 55.3271/67 153.4018 55.3271/67 143.433512 55.3271/67 143.433512 55.3271/67 143.433512 55.3271/67 143.433512 153.4218 55.3271/67 143.430774 155.22184 153.4218 154.22143 154.22143 154.22143	XX							
Markers Total Error Control points Check points	Longitude	Latitude	Altitude (m)	Accuracy (m)	Error (m)	Point 7 - 4.66396477 Point 8 - 4.663964775 Point 9 - 4.663967751 Point 10 - 4.663459245 Point 11 - 4.663329255	36.5227466 140.5192487 36.52318291 132.7402509 36.5241231 143.549433 36.5241231 145.549433 36.524235 153.1832755	~							

Click «Yes to All» button. GCPs will be shown at the Model window.





Select the locations of each GCP on photos and look at accuracy report



Markers	Long. err (m)	Lat. err (m)	Alt. err (m)	Accuracy (m)	Error (m)
🗹 Ҏ Base				0.005000	
🗹 🏴 Point 1	-0.020751	0.009341	-0.002620	0.005000	0.022907
🗹 Þ Point 2	0.002236	-0.006212	-0.002281	0.005000	0.006986
🗹 🏴 Point 3	-0.004677	0.017604	-0.025207	0.005000	0.031099
🗹 🏴 Point 4	0.002501	0.008115	-0.006682	0.005000	0.010805
🗹 🏴 Point 5	0.001971	0.013253	-0.027664	0.005000	0.030738
🗹 🏴 Point 6	-0.033238	0.012153	-0.016319	0.005000	0.038971
🗹 🏴 Point 7	-0.026095	-0.009947	0.017565	0.005000	0.032991
🗹 Þ Point 8	-0.013413	0.028866	0.010123	0.005000	0.033401
🗹 Þ Point 9	-0.008357	-0.016478	-0.015182	0.005000	0.023914
🗹 Þ Point 10	-0.014143	0.005331	0.008472	0.005000	0.017327
🗹 🏴 Point 11	0.004201	-0.007407	0.019909	0.005000	0.021653
Total Error					
Control points	0.015727	0.013856	0.016049		0.026399
Check points					



4.3. Camera calibration

To calibrate your camera focal length, load the images, import accurate coordinates of photos, perform the photo alignment (do not fix F parameter) and import the GCPs. Define the position of every marker on each photo. Select 2-3 markers.

Untitled* — A	igisoft Metashape I	Professional					-	ø ×
Eile Edit Vie	w Workflow N	odel Photo (2rtho Iools ∐e	lp				
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Reference					e x	Model Ortho	tho 0J_0739	
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	10 L 🛠				Perspective 30*		
Cameras	Long. err (m)	Lat. err (m)	Alt. err (m)	Accuracy (m)	Error (m)			
🗆 🚨 DJL_0386				0.010000				
DIL_0387	-0.026491	-0.140581	-0.067730	0.010000	0.158278			
DI_0388	0.004914	-0.033859	-0.051794	0.010000	0.062075			
	-0.020921	-0.009848	-0.054605	0.010000	0.059299			
	-0.002933	-0.004620	-0.031484	0.010000	0.012658			
	-0.012016	0.018862	-0.038520	0.010000	0.044541			
P 1 0393	-0.011020	0.010964	-0.032949	0.010000	0.036432			
DJ_0394	-0.008585	0.011318	-0.039016	0.010000	0.041522			
🗹 🚨 DJI_0395	-0.013350	0.006064	-0.030248	0.010000	0.033614			
🗹 🚨 DJI_0396	-0.025068	0.013915	-0.024486	0.010000	0.037704			
🖂 🚨 DJL_0397	-0.022734	0.028284	-0.020028	0.010000	0.041448			
E 🔽 DII_0398	-0.021779	0.036670	-0.016831	0.010000	0.045851			
M 🖬 DII_0399	-0.010628	0.046132	-0.030221	0.010000	0.056164			
	-0.008658	0.035641	-0.031218	0.010000	0.048164			
	-0.013010	0.007994	-0.032576	0.010000	0.035964			
	-0.003212	0.014908	-0.031224	0.010000	0.034749		226 (
<					>			
Markers	Long. err (m)	Lat. err (m)	Alt. err (m)	Accuracy (m)	Error (m)	1		
Base	condition find	000 00 004	100 00 000	0.003000				
Point 1	-0.022903	0.010387	0.103338	0.005000	0.106354			
Point 2	0.002971	-0.007214	0.093960	0.005000	0.094283			
🗌 🏴 Point 3	-0.003905	0.019446	0.050995	0.005000	0.054717			
Point 4	0.003196	0.008586	0.093348	0.005000	0.093796			
Point 5	0.000117	0.007855	0.035598	0.005000	0.036454			
Point 6	-0.040231	0.001130	0.039265	0.005000	0.056228			
D Point /	-0.029160	-0.012084	0.145456	0.005000	0.151775			
Depart 9	-0.009162	-0.018195	0.088839	0.005000	0.091145			
Point 10	-0.015743	0.005856	0.107375	0.005000	0.108681			
Point 11	0.004044	-0.007899	0.138764	0.005000	0.139048			
Total Error						40		
Control points	0.028448	0.005612	0.037476		0.047384			Y
Check points	0.014883	0.015784	0.111733		0.113819			
								2X
						200,070 points		
¢					>			
Scale Bars	Distance err (m)	Accuracy (m)	Error (m)			Photos		8>
Total Error						OOX 3	195. AS 🚔 🖸 🖷 🐹 🗝	
Control scale	-					-		
Check scale b.						A Martin of State	فأحجب فأججع فأججع كأعجم فأعده فأحده فأحجه فأحجه فأحجه فأحجه فأحجه فأحجه فأ	i - 1
								4
						and the second		
Workspace R	eference					Photos Consol	Januale Jabs	Па

Click Optimize camera Alignment, use the following settings and click OK





After finishing the aerial triangulation, go to Tools, click Camera calibration. Select adjusted and Save button.



Select Info Camera Calibration format and save file.

💟 Сохранение	☐ Сохранение ×														
$\leftarrow \rightarrow \checkmark \uparrow \square \ll Da$	🗧 🔶 🔹 🕇 🦲 « Data (D:) » _PROJECT » SPAIN » ATYGES » IMAGES » Output » Metashape 🛛 🗸 🖉 Поиск: Metashape 🖉														
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.sync ^	Имя	Дата изменения	Тип Р	Размер											
🛃 Скриншоты	📄 calibration.txt	12.01.2020 10:13	Текстовый докум	1 КБ											
💻 Этот компьютер	coordinates.txt	12.01.2020 9:25	Текстовый докум	29 КБ											
🚆 Видео															
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Тип файла: Inpho	o Camera Calibration (*.txt)					~									
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Open txt file and copy the focal length value

\$TYPE : FC6510 (8.8mm)	
\$DATE : 00:30:57 06/11/2019	
\$BRAND : Custom	
\$KIND : CCDFrame	
\$CCD_INTERIOR_ORIENTATION :	
414.545 -0 2723.86	
0.000000000 -414.545 1821.52	
\$CCD_COLUMNS : 5472	
\$CCD_ROWS : 3648	
<pre>\$PIXEL_REFERENCE : CenterTopLeft</pre>	
\$FOCAL_LENGTH : 8.81713	
\$PRINCIPAL_POINT_PPA : 0.000000 0.000000	
<pre>\$DISTORTION_TYPE : Polynomial</pre>	
\$RADIAL_COEFFS :	
0 5.32009e-005 -1.30922e-006	1.72296e-008
-6.46663e-012 0 0 0	
\$DECENTRE_COEFFS :	
-5.63946e-005 5.98996e-008 0	0
\$GPS_ANTENNA_OFFSET : 0.000000 0.000000 0.000000 \$CAMERA_MOUNT_ROTATION : 0.000000	

NOTICE. It will be possible to use the calibrated value of your camera's focal length for the processing in future, if you do not change your focus settings.

NOTICE. It is possible to use the calibrated value of your camera's focal length for the processing if you do not change focus settings for future flights.



4.4. Aerial triangulation accuracy improvement. Tie points filtering

In order to increase the accuracy of your model, we suggest filtering tie points with the Gradual Selection tool. Open Model menu, click Gradual Selection.

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E IN_0389	-4.662206	A Draw Polyline		0.010000	0.055564		1	S. S. State	Contra State		the same in the	and the	3 26 Sala	Rint, Cast	R. C.		
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2 DJ_0392	-4.662071	Kuler		0.010000	0.034955				The Ast is		See 1		A	AND SHE WAS	Frank Pa	Start .	
🗹 🚨 DJI_0393	-4.662026	Transform Object	ct t	0.010000	0.027755		1.1	1 Alton	3. The	Part and		and the second	Point 2	Contraction of	15-5-1-22	0.3697	
☑ IDI_0394	-4.661935	Transform Regio	on •	0.010000	0.035786		1.4%	and a start of the start	1.425 3.4 20	Service State	and the	Point 1	·	- CAMARA	1. 1. 1. 1.	333	
🗹 💶 DJL_0396	-4.661890	Show/Hide Item	ns •)	0.010000	0.027655		1. 1. 1.	the Beach	12 2 8 81	a far and the	14 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	A. 25-30	in the	3 Caller 4			
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Base	-4.663285	36.523717	152.506339	0.005000			San Star	and the second	Dord 5	1			Port 4	to any a	and the second		Y.
Point 1	-4.663110	36.523728	148.133351 153.481800	0.005000	0.156675		25 25 654	S 8 18	State 1				and the start	S.C. Sala	Set in		
🔲 🏲 Point 3	-4.662408	36.523407	153.771967	0.005000	0.123390			13 th 1 1	21 42 -					and the states	1. 1. 1. 1.		
Point 4	-4.662578	36.523207	149.480971	0.005000	0.124691	124,723 points	C. S.	Acres 1				1.15		3 . 2. 6	A CONTRACTOR		
🔲 🍽 Point 6	-4.663660	36.522344	123.894414	0.005000	0.168460		Salata Maria	A Maria Weith Contractor		. M S	1. S. C. S.		11111111111	10 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1. C.		
Point 7	-4.663965	36.522875	140.519249	0.005000	0.180946	Photos	1 AA 20 30 10 -										8 ×
Point 9	-4.663987	36.524132	144.569433	0.005000	0.158314	99 A 20 00	- 100 🗠 🕾 👪 -										A
Point 10	-4.663459	36.524493	157.848062	0.005000	0.144611	NEW YORK OF THE R.				No. of Concession, Name	North Color		-	and a state of the	NAME AND ADDRESS OF	NAME AND ADDRESS OF	
Total Error	-4.003329	39.304239	153.183276	0.005000	0.200531	200 - C	and the second	State 1.	154 7		Sec. 1	A MARINE	informa :	1 45-18 · · ·	145		
Control points				_	, v	100	a second	中	Carlo P	· 图2 10	and the	1	- 4 P	Start Start	and for a in	11	
Scale Bars	Distance (m)	Accuracy (m)	Error (m)			DJI_0386	D//_0387	DJI_0388	DJI_0389	DJI_0390	DJI_0391	DJI_0392	DJI_0393	DJI_0394	DJI_0395	DJI_0396	
Total Error Control scale							~		~			~	~	~		~	
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Select Gradual selection and input 0.35 value

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Go to Edit menu and delete the selected points



Click "Optimize Camera Alignment"

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Check the accuracy and repeat the steps described above until the Reprojection error reaches 0.65-0.35 value.