UAV Training Manual

Guidebook 2024











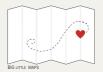


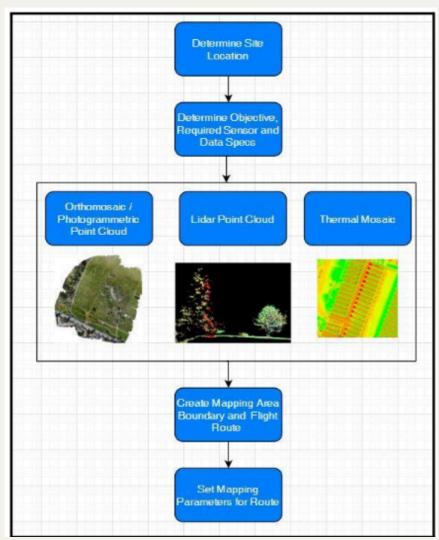
Table of Contents

Flight Planning in DJI Pilot 2	1
Photogrammetric Flight Planning	3
LiDAR Flight Planning	15
Video Tutorials	30
GNSS Processing	31
Thermal (H2OT) Processing	44
LiDAR (L1) Processing	52
Photogrammetry (P1) Processing	58

Flight Planning in DJI Pilot 2

Flight Planning Overview:

- Flight plans or routes, enable automated survey of a study site maintaining flight parameters
- Flight planning parameters directly influence the quality of data, appropriate applications, and duration of survey
- Saved routes can be recalled and reflown at a later date ensuring consistent data is collected over multiple dates
- In DJI Pilot 2 there are many types of routes, this presentation focuses on "Mapping" routes for photogrammetry and LiDAR

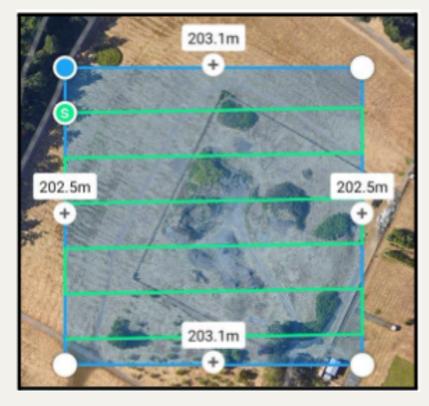


General Workflow:

Basic Pre-Flight Knowledge:

Determine Objective, Sensor, and Data Specs:

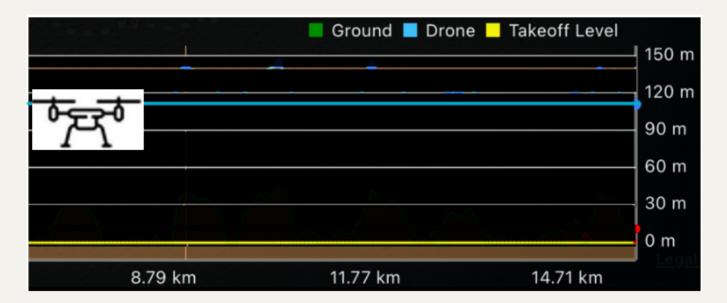
- The objective of the mission will help determine what sensor(s) to use, a ground control strategy, and what specifications are intended for the final data
- Some sites and applications may not require all sensors or have the same ground control requirements



Mapping Area:

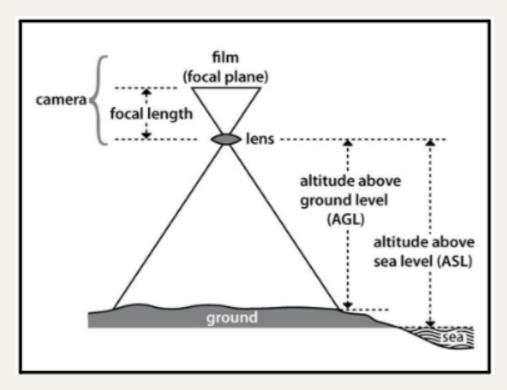
- Mapping Area (blue) defined by polygon with vertices (white circles)
- Starting point (S)
- Flight lines (green) that indicate where the drone will fly during the mission
- The number of flightlines required to map a given area is related to flight altitude and side overlap
- For Photogrammetric missions, overlapping photos are acquired consecutively

Altitude Relative to Takeoff Point:

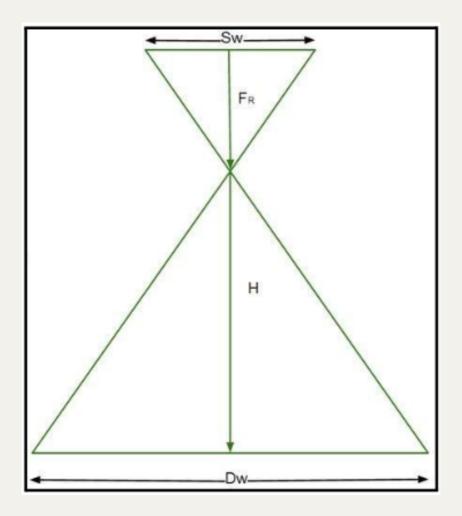


Photogrammetric Flight Planning

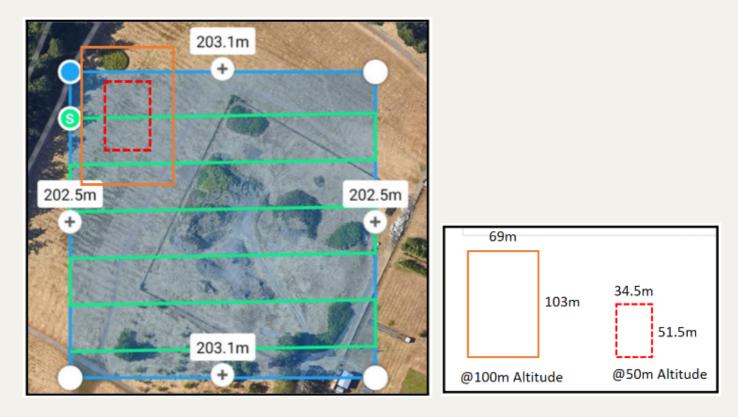
Basic Flight Parameters - Photogrammetric



- Altitude or Height (H), is referenced to the take off point, or to a Digital Elevation Model (DEM)
- Image Width at ground (Dw)
- Increase in H will increase image footprint and width (Dw) at ground

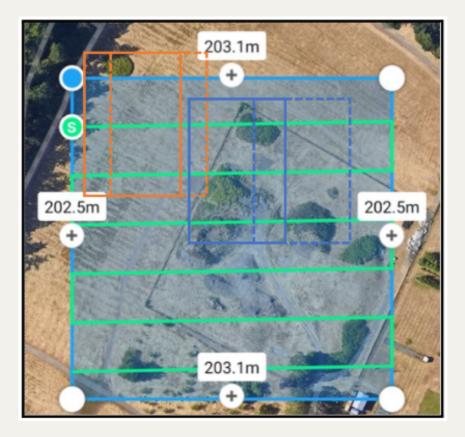


Photogrammetric Mapping - Image footprint and GSD

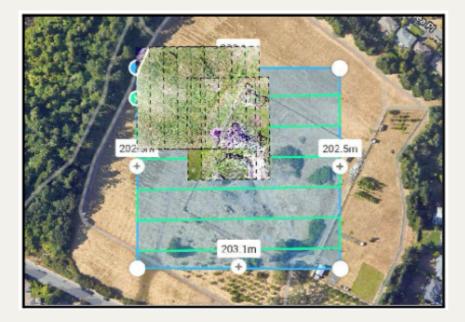


- Image footprint is proportional to flying height
- An individual pixel in an image from the Zenmuse P1 35mm lens camera taken at 100m represents 1.26cm on the ground – this is termed Ground Sample Distance or GSD
- For this camera it is approximated by GSD (cm) = Altitude/80

Photogrammetric Mapping - Forward and Side Overlap



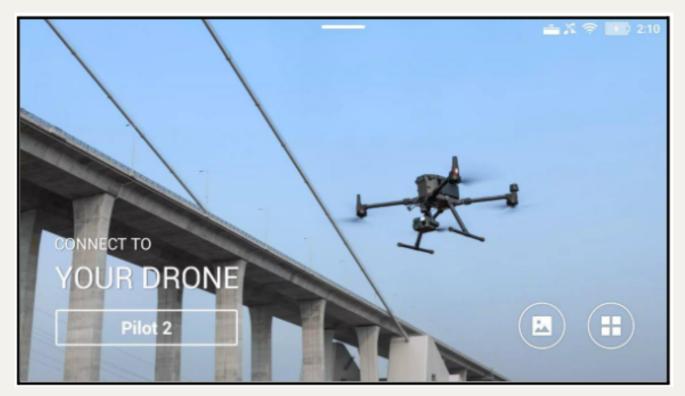
- For camera missions, overlapping photos are taken consecutively along the flightlines
- The amount each photo overlaps a previous one is termed forward overlap ratio
- The amount a photo overlaps between adjacent flightlines is termed side overlap ratio
- For general mapping the default forward overlap ratio of 80% and side overlap of 70% works
- For undulating terrain and forestry this should be set at 80% forward / 80% side or higher
- For a fixed altitude mission time will increase with higher ratio values but quality of reconstruction will increase

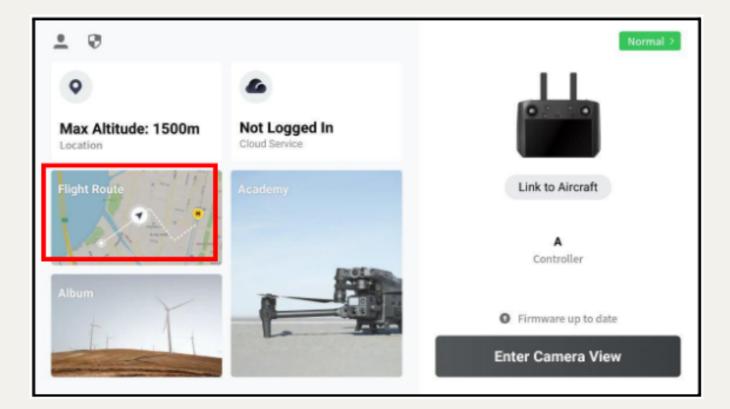


Basic Photogrammetric Mapping Scenario - DJI Pilot 2

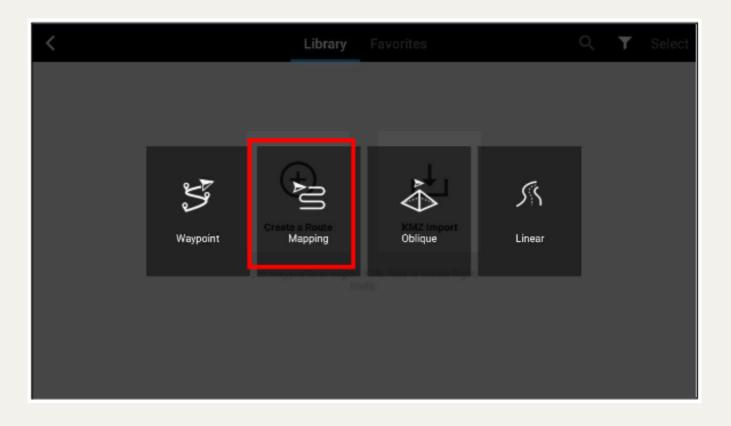
- Live Demo with follow along handout and settings
- Site is mostly flat, no terrain model available, an orthomosaic is required to provide a snapshot of site conditions, it is not anticipated that other datasets or sensor will be integrated

Visual Steps:





<	Library	Favorites	Q	T	Select
	Create a Route	KMZ Import			
		rt KML files to create flight oute.			





< N	I/A		Almoraft diagonage	ted			.80	RC ×	8=	4	
	ALC: NO	27 93.95 364.296 2.28 14 mm 1	Zenmuse P1	Mappi		Û					
		53 11111	Zenmuse L1	Advantage 1							
nanuel Baptist 🕇		50 mm	Zenmuse H20/H20T	Geleut	Carrier	a				÷	
(8)	Karate Brothers	Lever,	Zenmuse H20N	GSD		0.00cm/pixel					
			Matrice M30	Terrain Follow							
	C Henderson	Para Henderson	DJI Mavic 3E	Flight I	Route A	Altitude					
		Recreation Centr	DJI Mavic 3T	-100	-10	_1	100	+1	+10	+100	
non-Supply		No Park	PSDK 102s	, <u> </u>		-1	100		+ ju	9100	
	E C	San Rose Mar	Custom Camera	(12~15)		d/m /o)					
Distance in International ation U 0 m issue	Estimated Time 0 m 0 s	Waypoints F O	Photos Mapping Area 0 0.0 m ²	lakeol	rspee	d(m/s)	•			10	

<	N/A		Aircraft disconnected		*** RC * 8
	T		C/ –	Mapping	•
-18		University Of A Victoria Trail	×	Mapping1	
nanuel Bapt Shurch Victo			E 3	Zenmuse P1 35 mm	>
8	Karate Brother		1 pag	Smart Oblique 🕡	
	ark 🕐	ERX	1 - Tay	GSD	1.26cm/pixel
A STATE	C Hen:	erson Hars vende sor recreation Centre	HEIB	Terrain Follow	
rier Supply	The second	TODILI -	Ads	ASL/ALT	
		A Vander optimized	Mo	Relative to Take	eoff Point (ALT) V
Distano		e Waypoints Photos	Mapping Area	Flight Route Altitude	
ia Internation ation U.O.M.		0 0	0.0 m²		· · · · · · · · · · · · · · · · · · ·



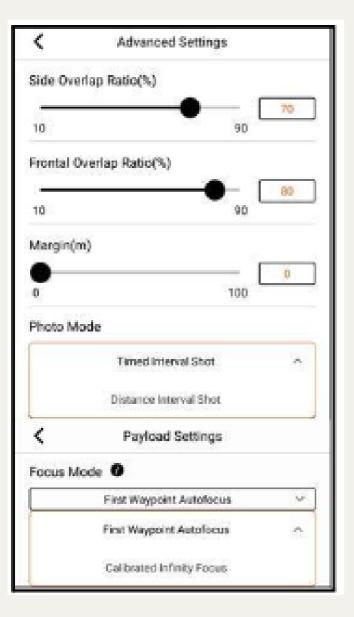


Selecting DJI Pilot 2 Parameters for P1 - ALT Relative to Take Off Point

Mapping	0
Mapping1	
Zenmuse P1 35 mm	>
Smart Oblique	•
	26cm/pixel
	country pixer
Terrain Follow	•
ASL/ALT	
Relative to Takeoff Point (ALT) Relative to Takeoff Point (ALT)	~
CARLES STOLEN AND ACCOUNTS ON A STOLEN	
ASL (EGM96)	
Flight Route Altitude	
-100 -10 -1 100 +1 -	+100
(12~1500m)	
Target Surface to Takeoff Point	
-100 -10 -1 0 +1	+100
(-200~1500m)	
Takeoff Speed(m/s)	
1 15	10
Speed(m/s)	
•	15
1 15	
Course Angle(")	
0 359	<u> </u>
Elevation Optimization	
Upon Completion	
Return To Home	~
Exit task	<u>*</u>
Return To Home	_
Land	
Return to start point and hover	
Advanced Settings	>
Payload Settings	>

Standard Settings

- Mission Name The name of the mission
- Camera and options The camera selected (Zenmuse P1) and focal length of lens
- **Smart Oblique** When this is turned on, oblique images and nadir images are captured in a single flight. Unless facades are the primary goal this is typically turned off. Smart Oblique is not available when terrain following is selected.
- **GSD** The ground sample distance is the size of 1 image pixel on the ground. It is proportional to the flight altitude and can be approximated for the Zenmuse P1 35mm lens by GSD(cm)=Flight Altitude (m) / 80
- **Terrain Follow** Terrain following will maintain the UAV altitude relative to the height of a provided Digital Elevation Model. When this is turned off, Flight Route Altitude is used.
- **ASL/ATL** Relative to takeoff point or relative to EGM96 Geoid, leave as default (Only Available when Terrain following is turned OFF)
- **Flight Route Altitude** The altitude or height relative to the take off point that the route will be flown at (Available only when terrain following is Turned OFF)
- Target Surface to Takeoff Point An offset that is added or Subtracted if the drone is launched from a platform or surface above the ground, or below the ground surface to be mapped. (Available only when terrain following is Turned OFF)
- **Take off Speed** Once the drone has been launched and reached the Flight Route Altitude, the speed that the drone will fly to the Starting waypoint.
- **Speed (m/s)** This is the maximum speed the drone will fly during the mission. The maximum speed is a function of forward overlap ratio. When the forward overlap ratio is kept fixed, an increase in altitude will enable increased speeds.
- **Course angle** The course modifies the orientation of the flight lines. In general the default orientation is often the most efficient.
- **Elevation optimization** This helps create a higher accuracy elevation model by taking oblique images at the end of the flight; however, this will also increase the time required for a mission.
- **Upon Completion** At the end of the flight, what action is taken. For most missions it is best to leave this as the default Return to Home



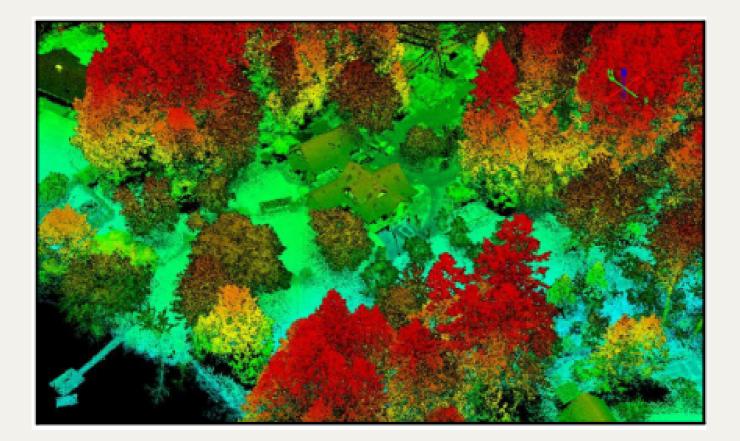
Advanced Settings

- Side overlap Ratio The side overlap ratio determines the image footprint overlap between adjacent flightlines. Increasing sidelap, reduces the spacing between adjacent flightlines and typically requires more flightlines and therefore a longer mission duration. The default value of 70% works for many sites but should be increased to 80 or 90% for complex terrains or sites where forest and trees are the dominant feature.
- Forward overlap Ratio The forward overlap ratio determines the image footprint overlap between consecutive images, the default is 80%. Increasing overlap will decrease the maximum speed possible for the flight. For sites with complex undulating topography or features dominated by tall features such as trees, it is recommended to increase this value 90%.
- **Margin** The margin is used to buffer the extents of a study area. For example, by setting the margin at 10m, the mapping area will be increased outward by a radius of 10m.

• **Photo Mode** – Photos are either taken using a timed interval, or based on a distance interval. DJI previously had recommended using timed interval, however distance interval is now recommended in Pilot 2 training modules and will produce a dataset with fewer photos during the turns and should also process faster.

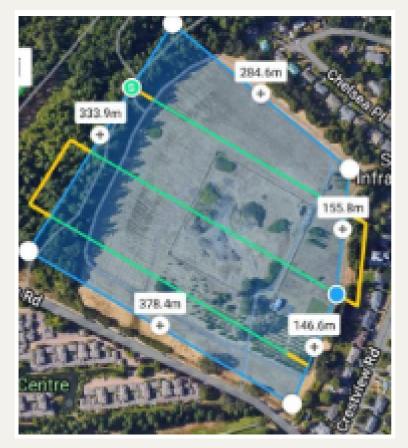
Payload Settings

- **Focus Mode** The Focus mode is either at First Waypoint Autofocus or Calibrated Infinity. For First Waypoint Autofocus the platform will fly to the first waypoint and then focus on the ground at that location. Calibrated Infinity requires precalibrating the lens before the flight and should only be set when this technique has been learned and understood.
- **Dewarping** Dewarping should be left off for mapping missions



LiDAR Flight Planning

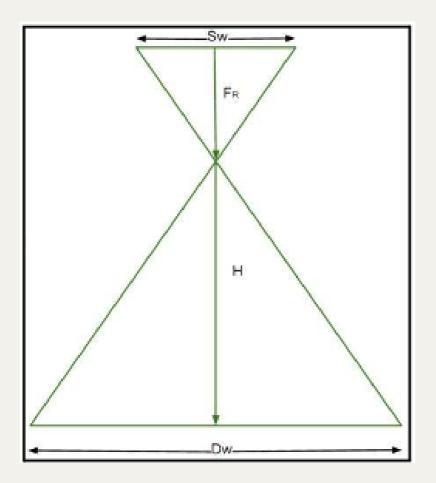
Mapping Area - LiDAR



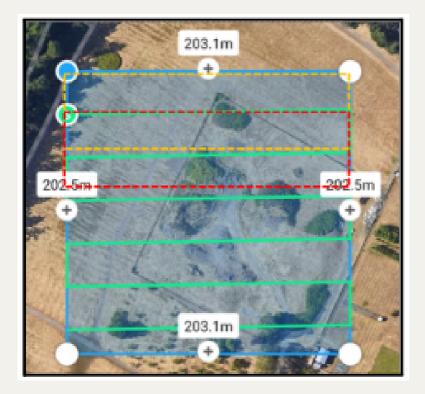
- Mapping Area (blue) defined by polygon with vertices (white circles)
- Starting point (S)
- Flight lines (green) that indicate where the drone will fly during the mission
- Yellow line portions indicate where the IMU calibrates and are included within the mapping area, and outside
- The number of flightlines required to map a given area is related to flight altitude and side overlap

Parameters - LiDAR

- Altitude or Height (H), is referenced to the take off point, or to a Digital Elevation Model (DEM)
- Field of view determines the angle covered by a flightline on the ground (L1 is 70.4°)
- Flightline width at ground (Dw)
- Increase in H will increase flightline width (Dw) at ground

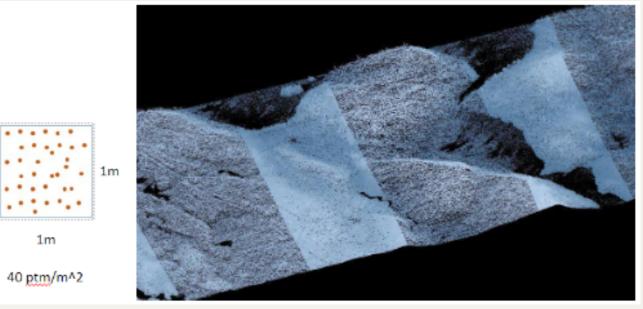


LiDAR Mapping - Flightline Side Overlap



- Lidar sensors emit and record laser pulses continuously during flightlines
- Flightlines have side overlap but depending on the site and application this can be much lower, 20-50% than photogrammetric missions ~60-95%
- RGB images can be taken concurrently with built in camera and have their own forward and side overlap values but usually there is not enough overlap for creating an orthomosaic

LiDAR Mapping Parameters



Source: https://gis.stackexchange.com/questions/270961/open-source-approach-to-classifying-and-removing-lidar-points-from-overlapping-s

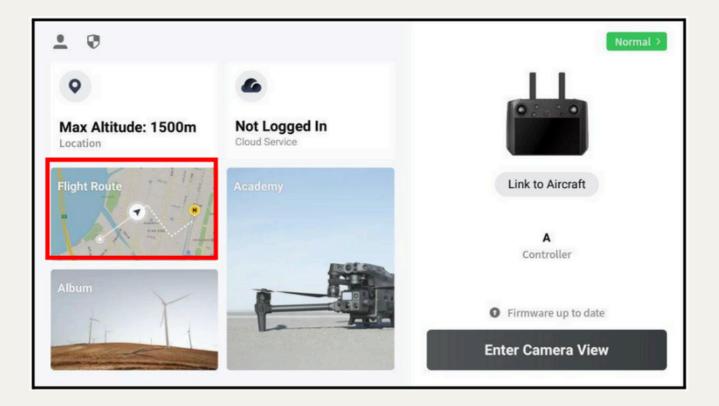
- Point Density the number of measurements per m²
- Point Density is a function of the speed of platform, the sampling rate, and the scanning mode
- Where flightlines overlap the final point density will be approximately doubled

Basic LiDAR Mapping Scenario - DJI Pilot 2

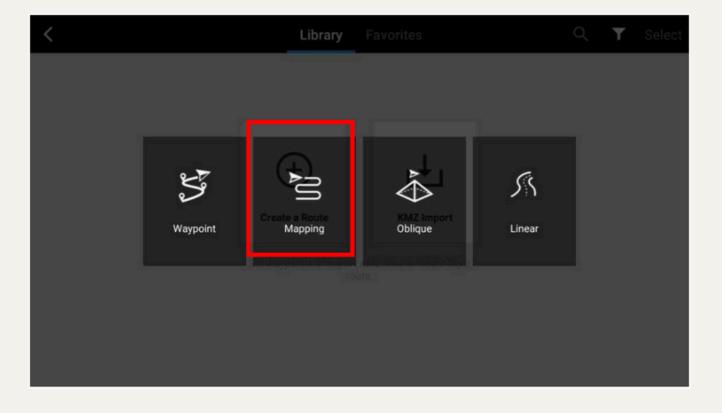
- Live Demo with follow along handout and settings
- Site is mostly flat, no terrain model available, a lidar point cloud is required with the intent to create digital terrain model that extends below Tree canopies.

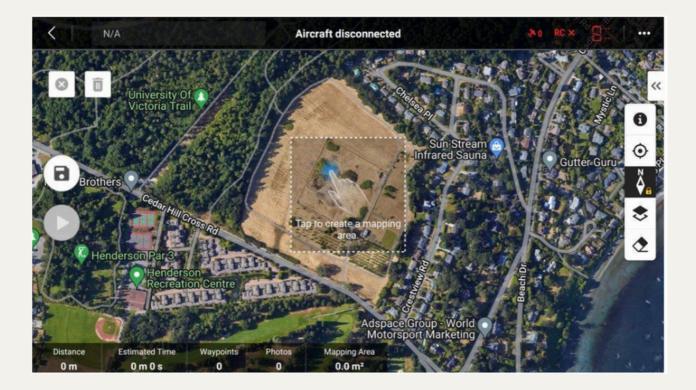
Visual Steps:





Library	Favorites	Q	T	Select
te a Route	KMZ Import rt KML files to create flight oute.			

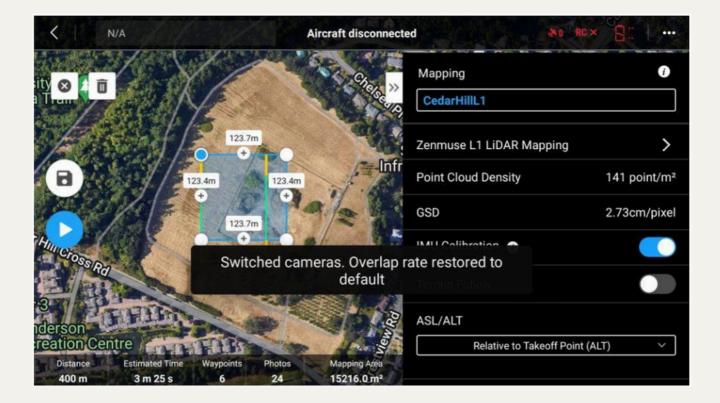


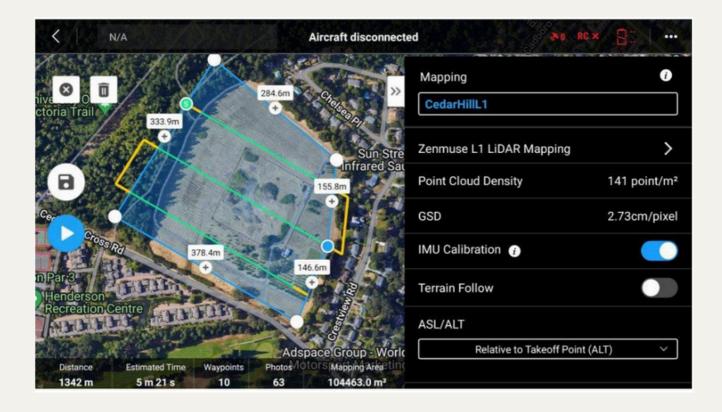


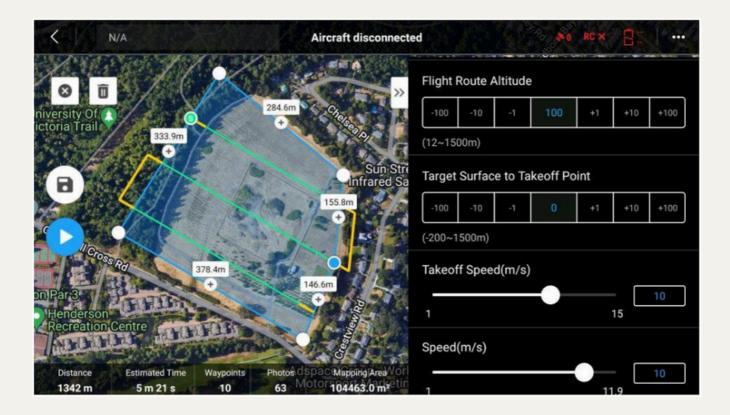
<	N/A		Air	rcraft disconnecte	d			30	RC×	8.	
	niversity Of		X	×	Маррі	ng					Û
			K		Марр	ing1					
	6/6		•	123.7m	Select	Camer	а				>
B			123.4m	123.4m	GSD					0.00cr	m/pixel
minia of the second second	Cedar		14	123.7m	Terrain	Follow	v				
	Cedar Hill Cross Ro		-		Flight f	Route /	Altitude				
	mPar 3			See.	-100	-10	-1	100	341	+10	+100
	Henderson	FFIN	-	All and	(12~150	00m)					
Distance	Recreation Ce	A PIPE LA	Photos	Manning Area	Takeof	f Spee	d(m/s)				
0 m	0 m 0 s	Waypoints 0	0 Photos	Mapping Area 0.0 m ²				-			10

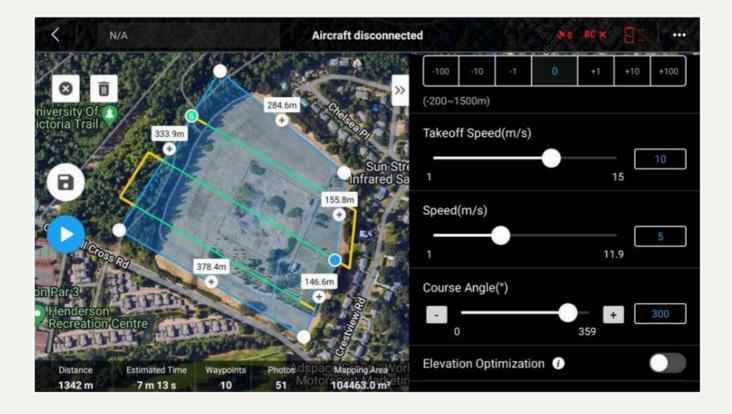
<	N/A		S.C.	Air	craft disconnecte	d			40	RC ×	8:	1
		Y	//		Ch-	Mappi	ng					Ì
Them		A	E.	X	else n	Ceda	rHillL1					
1			123.7m		all	Select	Camer	a				>
(8)		123.	Contraction of the local diversion of the loc	123.4m	Infr	GSD					0.00cr	n/pixel
	1/1		123.7m			Terrain	Follow	v				
Fillectos	SIDA		+ *******	J.	·	Flight F	Route	Altitude				
	40	m				-100	-10	-1	100	+1	+10	+100
3	CE EL	Sam		and the second	Re 1	(12~150)0m)					
Statement of the local division of the local	Centre	4.3	ALB.	Sign		Takeof	f Spee	d(m/s)				
Distanc 0 m	e Estimate 0 m		Waypoints 0	Photos 0	Mapping Area 0.0 m ²							10

<	N/A		Aircraft disconnect	ed			3.0	RC ×	8:	1			
			Zenmuse P1	Маррі		ì							
Them		LiDAR Mapping	Zenmuse L1	Ceda	rHillL1								
		Zenmuse H20/H20T Select Camera							>				
(8)		123.4m	Zenmuse H20N - 100 r	GSD		0.00cm/pixel							
	2/1	+ 123.7m	Matrice M30	Terrain Follow									
Filling	1000 K	•	DJI Mavic 3E	Flight Route Altitude									
Cross	Rd	N	DJI Mavic 3T	-100	-10	-1	100	+1	+10	+100			
3	FHIS		PSDK 102s	(12~150	00m)								
reation (AL FUR	Custom Camera	Takeof	f Spee	d(m/s)							
Distance 0 m	Estimated T 0 m 0 s		Photos Mapping Area 0 0.0 m ²							10			

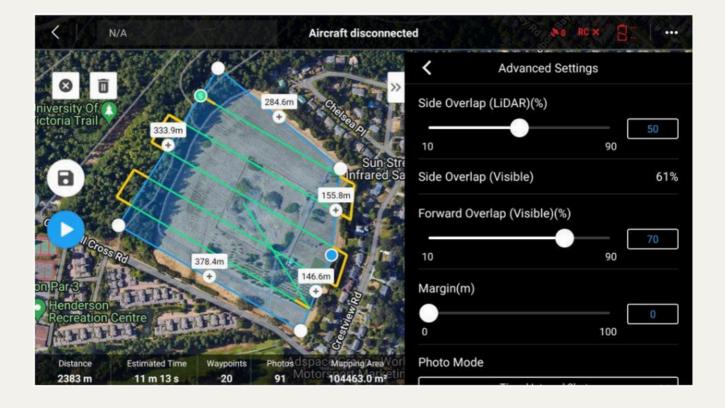












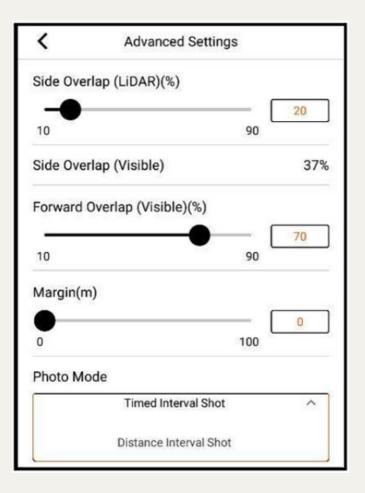


Selecting DJI Pilot 2 Parameters for L1 - ALT Relative to Take Off Point

Mapping		0						
CedarhillCorner	.1							
Zenmuse L1 LiDA	Zenmuse L1 LiDAR Mapping							
Point Cloud Dens	ty	141 point/m ²						
GSD		2.73cm/pixel						
IMU Calibration	•	-						
Terrain Follow								
ASL/ALT								
Relative	to Takeoff P	oint (ALT) V						
Relative	to Takeoff Po	oint (ALT) ^						
	ASL (EGM96)						
Flight Route Altitude								
-100 -10 -1	100	+1 +10 +100						
(12~1500m)								
Target Surface to Takeoff Point								
100 -10 -1	0	+1 +10 +100						
(-200~1500m)								
Takeoff Speed(m	/s)							
1	-•	15						
Speed(m/s)								
1		11.9						
Course Angle(*)								
		359						
Elevation Optimiz	ation	-						
Upon Completion								
I	ietum To Ho	me v						
	Exit task	^						
	eturn To Hor	ne						
_	Land							
Return t	start point	and hover						
Advanced Setting	s	>						
Payload Settings		>						

Standard Settings

- Mission Name The name of the mission
- **Camera and Options** In this case it is either Zenmuse L1 in Lidar Mapping Mode, or Zenmuse L1 in Photogrammetric Mode
- **Point Density** The Point density is and estimation of the density of lidar points / m^2. This is a function of speed, side overlap, sampling rate, and Scanning mode.
- **GSD** The ground sample distance is the size of 1 image pixel on the ground at a given altitude. It is proportional to the flight altitude and can be approximated for the Zenmuse L1 lens by GSD(cm)=Flight Altitude (m) / 36.5
- IMU Calibration IMU calibration should be turned on for most mapping missions. The IMU Calibration shows up as yellow coloured route segments where the drone will fly back and forth in a calibration maneuver. Calibration segments will extend outside of the mapping area so it is important to ensure no obstructions are in the way.
- **Terrain Follow** Terrain following will maintain the UAV altitude relative to the height of a provided Digital Elevation Model. When this is turned off, Flight Route Altitude is used.
- **ASL/ATL** Relative to takeoff point or relative to EGM96 Geoid, leave as default (Only Available when Terrain following is turned OFF)
- **Flight Route Altitude** The altitude or height relative to the take off point that the route will be flown at (Available only when terrain following is Turned OFF)
- **Target Surface to Takeoff Point** An offset that is added or Subtracted if the drone is launched from a platform or surface above the ground, or below the ground surface to be mapped. (Available only when terrain following is Turned OFF)
- **Take off Speed** Once the drone has been launched and reached the Flight Route Altitude, the speed that the drone will fly to the Starting waypoint.
- **Speed** This is the maximum speed the drone will fly during the mission. For open sites or for applications that do not require high point densities this could be run towards the maximum. For forestry and sites requiring canopy penetration of high point densities it is recommended to decrease this to ~5 m/s.
- **Course angle** The course modifies the orientation of the flight lines. In general the default orientation is often the most efficient.
- **Elevation Optimization** This helps create a higher accuracy elevation model by taking oblique images at the end of the flight; however, this will also increase the time required for a mission.
- **Upon Completion** At the end of the flight, what action is taken. For most missions it is best to leave this as the default Return to Home



Advanced Settings

- Side overlap (Lidar)(%) The side overlap LiDAR ratio determines the percentage that adjacent flight lines overlap. The areas where side overlap occur will tend to have increased point densities. Applications such as forestry where canopy penetration is important may increase this up to 50% to maximize returns from the ground. Increasing side overlap will increase the number of flightlines necessary and increase overall flight duration.
- **Side overlap (Visible)** The side overlap ratio determines the image footprint overlap between adjacent flightlines. Increasing sidelap, reduces the spacing between adjacent flightlines and typically requires more flightlines and therefore a longer mission duration. If a photogrammetric reconstruction is a goal for the mission using the L120MP camera it is important that this value is considered to be successful.
- Forward overlap (Visible) The forward overlap ratio determines the image footprint overlap between consecutive images, the default is 70%. Increasing overlap will decrease the maximum speed possible for the flight. If photogrammetric reconstruction is important this value should be considered.
- **Margin** The margin is used to buffer the extents of a study area. For example, by setting the margin at 10m, the mapping area will be increased outward by a radius of 10m.
- **Photo Mode** Photos are either taken using a timed interval, or based on a distance interval. DJI previously had recommended using timed interval, however distance interval is now recommended in Pilot 2 training modules and will produce a dataset with fewer photos during the turns and should also process faster.

<	Payload Settings	
Return M	ode	2010
	Single	^
	Dual	
Į	Triple	
Sampling	Rate	
	240KHz	~
	180KHz	
	120KHz	
	60KHz	
Scanning	Mode	
	Non-repetitive	^
	Repetitive	
RGB Colo	ring	

Playload Settings

- **Return Mode** The return mode is the number of return possible for an outgoing pulse. For flat surfaces this can be left at single, for forestry it should be set at triple. In single and dual mode the max sampling rate is 240Khz, in triple mode it is 180Khz.
- **Sampling Rate** The sampling rate is the number of outgoing laser pulses per second. Higher sampling rates produce higher point densities.
- **Scanning Mode** Two modes and scan patterns are supported, Repetitive, and Non Repetitive. Repetitive provides lower point densities but higher quality data and is recommended for topographic and forestry surveys. Non Repetitive is best for façade scanning or applications where accuracy is not as important.
- **RGB Coloring** RBB Coloring when turned on will use color lidar returns using the built in camera. This is recommended to be turned on.

Terrain Follow



Other Considerations

- Sighting launch and recovery location
- Are flightline lengths manageable consider splitting into two overlapping blocks and two launch recovery locations?
- Ground Control Targets are visible and within mapping area

Video Tutorials

Four video tutorials were created for the project. These video presentations provide a more in-depth and audio-visual way to follow the step-by-step detailed workflow guide, which is provided later in this document. The videos feature live screen recordings of each step for each of the different data types individual processing method, along with a voice-over explaining what is happening and why at each step.

The videos which were created:

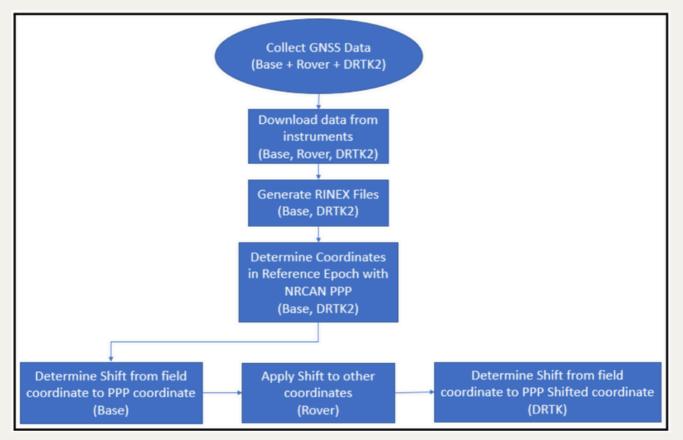
- 1. GNSS Data Processing Training
- 2. Thermal (H2OT) Data Processing Training
- 3. LiDAR (L1) Data Processing Training
- 4. Photogrammetry (P1) Data Processing Training

GNSS Processing

Why do we need to process the GNSS data?

Coordinate reference systems provide the ability to describe a position on the earth's surface using latitude, longitude, and ellipsoidal height, in Canada we commonly use the Canadian Spatial Reference System version of the North American Datum 1983 (NAD83(CSRS)). As tectonic movement happens over time a coordinate representing a feature on earth's surface will also move (mm/year). To account for this and minimize positional errors between repeat surveys, we need to convert coordinates collected on a particular day into a standard epoch. On the mainland of BC, the standard is to use NAD83(CSRS) with the 2002.0 epoch. For more information about the Canadian Spatial Reference System <u>see this webpage</u>.

General Workflow:



Detailed Workflow Steps:

1.0 Retrieving Data

- 1. Get base files off SP85 head unit
 - a. Connect USB to base head
 - b. Power on unit
 - c. Open Spectra File Manager
 - d. Search for the port that shows the USB connection

Port:	💱 COM5	· 115200	~	Connect	Disconnect

e. In the Device window navigate into internal memory

Device				
Filename	File size	File type	Last modified	
Internal memory		Fixed Drive		

f. Search for the file(s) ending with .### where ### is the day of the year for the survey (check day of year <u>here</u>)

Filename	File size	File type	Last modified
Filename	rile size	File type	Last modified
<u>iii</u>			
G0092A21.213	55,200	213 File	2021-08-01 3:37:10 AM
uploading.log	7,282	LOG File	1970-01-01 12:00:34 AM
G0092A22.041	3,727,416	041 File	2022-02-10 11:26:11 PM
G0092A22.056	40,732	056 File	2022-02-25 7:10:20 PM
G0092B22.056	514,378	056 File	2022-02-25 7:27:05 PM
G0092C22.056	317,590	056 File	2022-02-25 7:41:31 PM
G0092D22.056	5,873,668	056 File	2022-02-25 10:49:24 PM
G0092A22.060	14,371	060 File	2022-03-01 10:18:58 PM
G0092A22.065	8,918,196	065 File	2022-03-07 12:52:14 AM
G0092A22.066	9,830,400	066 File	2022-03-07 11:10:50 PM
G0092A22.089	1,356,177	089 File	2022-03-30 5:28:12 PM
G0092A22.091	2,792,150	091 File	2022-04-01 4:41:40 PM
G0092A22.101	5,111,808	101 File	2022-04-12 1:00:38 AM
G0092A22.105	0	105 File	2022-04-12 1:01:07 AM
G0092B22.105	137,956	105 File	2022-04-15 6:34:10 PM
G0092C22.105	13,172,736	105 File	2022-04-15 10:50:45 PM
G0092D22.105	97,476	105 File	2022-04-15 10:54:43 PM
G0092E22.105	734,364	105 File	2022-04-15 11:11:12 PM
G0092A22.116	28,083,287	116 File	2022-04-26 10:39:25 PM
G0092A22.117	0	117 File	2022-04-26 10:39:46 PM
00000000117	05 074	447.04	2022 04 27 5 20 14 514

g. On the computer side navigate to the folder where you want to copy data to.

C:\Users\Jason\Desktop\Data			
Filename	File size	File type	Last modified
Jrones		File Folder	2022-12-08 2:51:23 PM

h. With the selected sp85 files highlighted click copy and the files will be copied off the base unit.

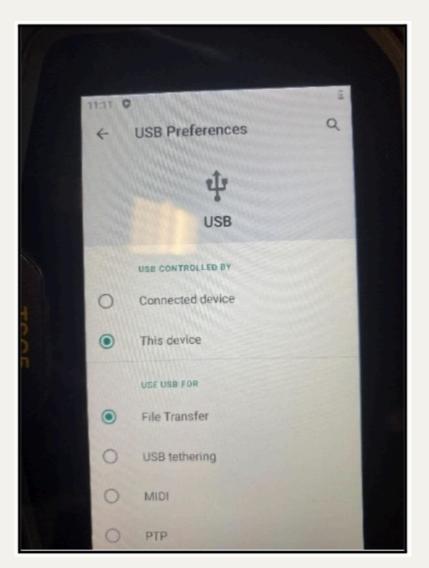
lort:	~	F	Refresh Disconnect	Сору	Delete Can	cel	
:\Users\Jason\Desktop\Data				Internal memory\			
Filename	File size	File type	Last modified	Filename	File size	File type	Last modified
Drones		File Folder	2022-12-08 2:51:23 PM	G0092A21.213	55,200	213 File	2021-08-01 3:37:10 AM
G0092A22.065	8,918,196		2023-01-10 10:54:29 AM	uploading.log	7,282	LOG File	1970-01-01 12:00:34 A
				G0092A22.041	3.727.416	041 File	2022-02-10 11:26:11 P
				G0092A22.056		056 File	2022-02-25 7:10:20 PM
				G0092B22.056	514,378		2022-02-25 7:27:05 PM
				G0092C22.056	317,590		2022-02-25 7:41:31 PM
				G0092D22.056	5.873.668		2022-02-25 10:49:24 PI
				G0092A22.060		060 File	2022-03-01 10:18:58 PI
				G0092A22.065	8,918,196	065 File	2022-03-07 12:52:14 AI
				G0092A22.066	9.830.400		2022-03-07 11:10:50 PM
				G0092A22.089	1,356,177	089 File	2022-03-30 5:28:12 PM
				G0092A22.091	2,792,150	091 File	2022-04-01 4:41:40 PM
				G0092A22.101	5,111,808	101 File	2022-04-12 1:00:38 AM
				G0092A22.105	0	105 File	2022-04-12 1:01:07 AM
				G0092B22.105	137,956	105 File	2022-04-15 6:34:10 PM
				G0092C22.105	13,172,736	105 File	2022-04-15 10:50:45 PM
				G0092D22.105	97,476	105 File	2022-04-15 10:54:43 PM
				G0092E22.105	734,364	105 File	2022-04-15 11:11:12 PM
				G0092A22.116	28,083,287	116 File	2022-04-26 10:39:25 PM
				G0092A22.117		117 File	2022-04-26 10:39:46 PM
				000000000000	05.074	*****	2022 01 27 5 20 11 01
N		0		0			
Device filename nternal memory\G0092A22.065		Size 8,918,196	Action Status Copy Succeeded	Progress 100%	Bytes transferred 8.918.196		

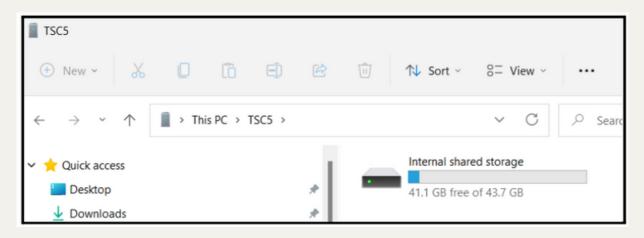
2. Get rover files off TSC5

- a. Power up TSC5 and open Trimble Access
- b. Navigate to the appropriate project folder
- c. Select the job
- d. Select export

ort httributes	File name Katzie IR2 First Survey.csv	
ew created file	Yes	
	Accept	

- e. Connect TSC5 to computer
- f. Enable file transfer





g. Navigate into TSC5 files

BCSRIF BCSRIF		- o ×
⊙ New ~ 🔏 🚺 🔂 🗊	🖹 🗊 🔁 Sort - 8= View	
$\leftarrow \rightarrow - \uparrow$ \uparrow This PC \rightarrow TSCS \rightarrow In	ernal shared storage > Trimble Data > Projects > BCSRIF	✓ Ø Search BCSRiF
 ✓ ★ Quick access ■ Desktop 	Katzle IR2 First Survey.cov Katzle IR2 First Survey.cov Katzle IR2 First Survey.cov Katzle IR2 First Survey.cov Isak Scheduler Task Object Id. Fire Jak Inpres	Projectinformation.cml XML Document 6.20 KB
Downloads Documents Portuges	Whonnock IR1 Survey 1 cev Microsoft Excel Comma Separate 6)4 bytes Using Schedules Task Object 21.6 KB	

h. Copy rover csv files

3. Get base files off DRTK2 a. Power up DRTK2 and connect to computer b. Navigate to folder/log/rtcmraw

Copy On the second						
← → ~ ↑ 🔁 > USB Drive (E) > log > rtcmraw						
> la OneDrive - Personal		Date modified	Туре	Size		
✓ ➡ This PC ■ RTK014_202202252200_13ALH4M00500YW.DAT 2/25/2022 10.28 PM DAT File 1			1,472 KB			
				2,343 KB		
> ☐ Documents > ↓ Downloads ☐ RTK016_202203062200_13ALH4M00500YW.DAT 3/6/2022 11:00 PM DAT File		3,363 KB				
> 🕖 Music	RTK017_202203062300_13ALH4M00500YW.DAT	3/7/2022 12:00 AM	DAT File	3,503 KB		

c. Select the files with the appropriate date and copy to computer

2.0 Creating RINEX Files

- 1. SP85 Base a. Open SP85 RINEX converter b. Add file(s) downloaded from SP85

🖗 RINEX Conv	erter 5.0.8		-		×				
Convert Ra	Convert Raw Data File(s) Add Remove Info								
	Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\G0092A22 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920 PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\00920	165a.22o 165a.22n 165a.22g 165a.22h 165a.22b							
Into:	RINEX Raw Data Files version 2.11 Vising file	compressio	on: 🗌 Hatanak	ka 🗌 Z	φ				
In folder:	Same as input file folder			~					
Including:	🗹 GPS 🔽 GLONASS 🔽 SBAS 🛛 🔽 ALL								
Ask before over	writing any file V	onvert							
Adding file G009	2A22.065Success								
	Trimble Inc. All rights reserved. al is a Division of Trimble Inc.		spectrageos	spatial.com	1				

c. Convert into RINEX files

🖗 RINEX Conve	erter 5.0.8		-		×		
Convert Ra	Convert Raw Data File(s) Add Remove Info						
F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\G0092A22.065 F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.220 F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22n F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22g F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22h F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22b F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22b F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22b F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22b F:\PhD\Applications_Credentials\GEOG_590_1\Data\065\GPS\Base\0092065a.22b							
Into:	Into: RINEX Raw Data Files version 2.11 V Using file compression: Hatanaka Zip						
In folder:	Same as input file folder			~			
Including: ☑ GPS ☑ GLONASS ☑ SBAS ☑ ALL Ask before overwriting any file ✓ Convert							
Adding file G0092A22.065Success Converting file G0092A22.065Success							
	Trimble Inc. All rights reserved. ial is a Division of Trimble Inc.		spectrageos	apatial.com	1		

2. DRTK2

- a. Open RTKLib:rtkconv
- b. Navigate to .DAT file from DRTK2 c. Change format to RTCM3

TKCONV ver.2.4.3 b34		– 🗆 X
Time Start (GPST) Time End (GPST) 7 2020/01/01 00:00:00 2020/01/01 00:00:00	00	□ Interval □ Unit 1 ∨ s 24 H
RTCM, RCV RAW or RINEX OBS ? D:\GEOG_590_1\Working\Katzle\GNSS\DRTK\RTK015_20	2203062116_13ALH4M00500YW.DAT	v 🗉
Output Directory C:\Users\admin\Desktop\RogerCHILL_Test_Delete		Format RTCM 3 V

d. Click convert and set log start time to the same in the .dat file name

TKCONV ver.2.4.3 b34		- [\times
□ Time Start (GPST) ? □ Time End (GPST) ? 2020/01/01 ↓ 00:00:00 ↓ 2020/01/01 ↓		Interval	U U	nit H
RTCM, RCV RAW or RINEX OBS ?				
D:\GEOG_590_1\Working\Katzie\GNSS\DRTK\RTK015_202203062116_13ALH4M00500YW.DAT				••••
Output Directory		Form	nat	
C:\Users\admin\Desktop\RogerCHILL_Test_Delete		RTC	M 3	~
RINEX OBS/NAV/GNAV/HNAV/QNAV/LNAV/CNAV/INAV and SBS C D:\GEOG_590_1\Working\Katzie\GNSS\DRTK\RTK015_202203062116_13ALH4M00500YW.ob	Start Time			×
D:\GEOG_590_1\Working\Katzie\GNSS\DRTK\RTK015_202203062116_13ALH4M00500YW.na	Approximated Log Sta	rt Time (GP	ST)	
D:\GEOG_590_1\Working\Katzie\GNSS\DRTK\RTK015_202203062116_13ALH4M00500YW.gn	2022/03/06 🖕 21:	16:00	File	Time
C:\GEOG_590_1\Working\Katzie\GNSS\DRTK\RTK015_202203062116_13ALH4M00500YW.hn	ОК	Canc	el	
D:\GEOG_590_1\\Working\Katzie\GNSS\DRTK\RTK015_202203062116_134LH4M00500\VW_gp				

3.0 Creating RINEX Files

- 1. SP85 Base PPP
 - a. Navigate to NRCAN Precise Point Positioning (PPP)
 - b. Once logged in start a static processing upload using NAD83 datum

Processing mode					
• Static	Static ○ Kinematic				
NAD83	ITRF				

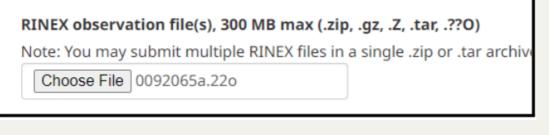
c. Choose a standard reference frame (epoch) to use for the coordinate. (Note: The standard epoch for work on the mainland of BC is 2002.0, and for work on Vancouver Island is 1997.0)

Epoch <u>(Ado</u> p	oted)	
2002.0	~	

d. Set the vertical datum for orthometric heights (common is CGVD2013)

Vertical datum				
CGVD2013	~			

e. Upload the RINEX file (.22o) that was produced by the SP85 RINEX converter



f. Submit to PPP and wait for the report to be emailed back

2. DRTK2 base PPP

a. Repeat the PPP process using the same settings but instead upload the converted DRTK2 RINEX File (.obs)

RINEX observation file(s), 300 MB max (.zip, .gz, .Z, .tar, .??O)

Note: You may submit multiple RINEX files in a single .zip or .tar archi

Choose File RTK015_202...00500YW.obs

b. Submit to PPP and wait for the report to be emailed back

4.0 Create Shift Vectors

1. SP85 shift vectors

a. Open the .csv file that contains the Rover data exported from the TSC5 and save as .xlsx

X AutoSave 🤇		- ୧ -	≂ leech	tunneljuly13.xlsx
File <u>Home</u>	Insert Pag	e Layout	Formulas	Data Revi
Paste 💞 Form	w v	Calibri B I <u>U</u>	->[11 -> ⊞ ->	
Clipboar	d 🖬		Font	ا <u>ت</u> ا
A17 ~	$: [\times \checkmark f_x]$			
A	В		С	D
1 Name	Easting		Northing	Elevation
2 Base	44	3478.823	5372975.76	223.536
3 thermal1	44	3319.493	5372943.11	186.789
4 thermal2.1	44	3324.332	5372938.38	186.928
5 thermal3.2	44	3350.589	5372931.06	185.434
6 targetriver1.1	44	3359.683	5372924.31	187.447
7 thermal4.1	44	3373.468	5372920.95	185.473
8 thermal5.1	44	3388.341	5372908.96	183.393
9 targetriver2.1	44	3388.961	5372915.2	185.289
10 targetroad1.1	44	13570.073	5372787.07	214.211
11 targetroad2.2	44	3328.701	5372843.24	228.67
12 targetroad3.1	44	3726.277	5372844.03	233.388
13 DRTK2.1	44	3476.707	5372975.51	221.689

b. Add row for DRTK APC (Note: DRTK offset is 1.801m)

DRTK2.1	443476.707	5372975.51	221.689
DRTKAPC	443476.707	5372975.51	223.49

c. Copy the initial recorded base coordinates in preparation for the shift calculation.

	Easting	Northing	Elevation
Emlid Rover Base	443478.823	5372975.756	223.536

d. Open the PPP report for the SP85 base.

A A A	CSRS-PPP 3.54 reach-base_raw_20		Count con
Data Start	Data	End	Duration of Observations
2023-07-13 17:51:43.00	2023-07-13	21:54:15.01	4:02:32.010
Processing Time			Product Type
21:05:32 UTC 2023/07/17			NRCan Rapid
Observations	Frequ	ency	Mode
Phase and Code	Dou	ble	Static
Elevation Cut-Off	Rejected Epochs	Fixed Ambiguitie	es Estimation Steps
7.5 degrees	0.54 %	14.23 %	1.00 sec
Antenna Model	APC to	ARP	ARP to Marker
EML_REACH_RS2 NONE	L1 = 0.135 m	L2 = 0.137 m	H:0.000m / E:0.000m / N:0.000m
(APC	- antonna phaso contor: /	APD - antonna referen	co point)

(APC = antenna phase center; ARP = antenna reference point)

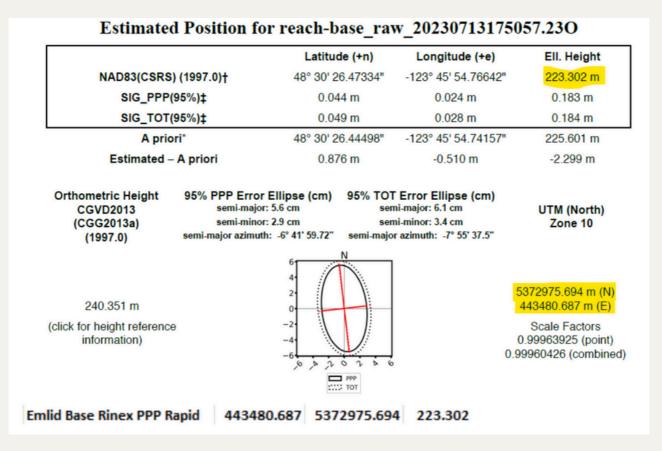
Estimated Position for reach-base_raw_20230713175057.23O

		Latitude (+n)	Longitude (+e)	Ell. Height
NAD83(CSRS)) (1997.0)†	48° 30' 26.47334"	-123° 45' 54.76642"	223.302 m
SIG_PPP(95%)‡	0.044 m	0.024 m	0.183 m
SIG_TOT(95%)‡	0.049 m	0.028 m	0.184 m
A prio	ri*	48° 30' 26.44498"	-123° 45' 54.74157"	225.601 m
Estimated –	A priori	0.876 m	-0.510 m	-2.299 m
Orthometric Height CGVD2013 (CGG2013a) (1997.0)	95% PPP Error Elli semi-major: 5.6 semi-minor: 2.9 semi-major azimuth: -6	cm se	DT Error Ellipse (cm) emi-major: 6.1 cm emi-minor: 3.4 cm ior azimuth: -7° 55' 37.5"	UTM (North) Zone 10

e. Confirm the data start time (UTC), end time (UTC), and duration make sense

f. Confirm the type of PPP product (Ultra rapid/Rapid/Final)

g. Add the corrected base coordinates (highlighted in yellow) to the excel sheet



h. Subtract the updated coordinates from the original coordinates to get the coordinate shifts.

N	0	Р	Q
	Easting	Northing	Elevation
Emlid Rover Base	443478.823	5372975.756	223.536
Emlid Base Rinex PPP Rapid	443480.687	5372975.694	223.302
delta (Rover Base - PPP)	-1.864	0.062	0.234

i. Apply coordinate shift to all rover positions

Station	northing	easting	height	n_final	e_final	z_final
Katzie Base	5449197.384	525101.651	-14.982	5449196.62	525103.501	-14.416
Photo Target 1	5448882.63	525028.362	-13.563	5448881.866	525030.212	-12.997
Photo Target 2	5449126.994	524977.465	-15.049	5449126.23	524979.315	-14.483
Photo Target 3	5449177.307	525033.297	-15.199	5449176.543	525035.147	-14.633
Photo Target 4	5449201.716	525094.418	-15.718	5449200.952	525096.268	-15.152
DRTK	5449203.911	525099.186	-14.752	5449203.147	525101.036	-14.186
DRTK APC	5449203.911	525099.186	-12.951	5449203.147	525101.036	-12.385

2. DRTK Shift Vector

a. For each of the P1 and H20T sensors find the appropriate DRTK file for each session.

Location	Sensor	Time	DRTK File
Katize	H20T	2022-03-06 16:00	RTK018_202203070000_13ALH4M00500YW
Katzie	P1	2022-03-06 13:00	RTK015_202203062116_13ALH4M00500YW

b. Open the PPP reports for each file and record the A priori positions (highlighted in yellow) (Note: the height coordinate needs to have 1.801 subtracted from it)

Estimated Position for RTK174_202307131929_13ALH4M00500YW.obs							
	Latitude (+n)	Longitude (+e)	Ell. Height				
NAD83(CSRS) (1997.0)†	48° 30' 26.46294"	-123° 45' 54.86056"	223.566 m				
SIG_PPP(95%)‡	0.236 m	0.253 m	0.658 m				
SIG_TOT(95%)‡	0.237 m	0.254 m	0.658 m				
A priori*	48° 30' 26.51449"	-123° 45' 54.94979"	229.060 m				
Estimated – A priori	-1.592 m	1.831 m	-5.494 m				

c. Navigate to the **NRCAN TRX site**

i. Start a single calculation with the reference frame being ITRF 2014 and the epoch being the date of data collection

Single Calculation	
Epoch Transform	ation 🗆 Longitude Positive West
Origin	
Reference Frame	Epoch
ITRF2014 ~	2022-03-06

- ii. Enter the coordinates after converting to decimal degrees.
 - 1. 48° 30' 26.5149″
 - 2. To calculate the minutes = 30 + (26.5149/60) = 30.441915
 - 3. To calculate the decimal degrees = 48 + (30.441915/60) = 48.5073652

Geogr	aphic	Cartesian	Projection			
Latitu	ıde		Longitude		<u>h</u> (metres)	
48.5	073652		-123.7652	64	229.060	

iii. Select the same reference frame and set the projection to the appropriate UTM zone

Destination					
Reference Fra	me	Coordinates		Zone (<u>select zone)</u>	
ITRF2014	~	Projection	~	UTM10	

iv. Select Calculate and record the results into the excel sheet

Results		
Easting (metres)	Northing (metres)	h (metres)
443476.926	5372977.010	229.060
DRTK AP	443476.926 5372	977.01 227.259

v. Copy the updated DRTK (NOT APC) coordinate from the rover sheet and subtract from the TRX coordinate

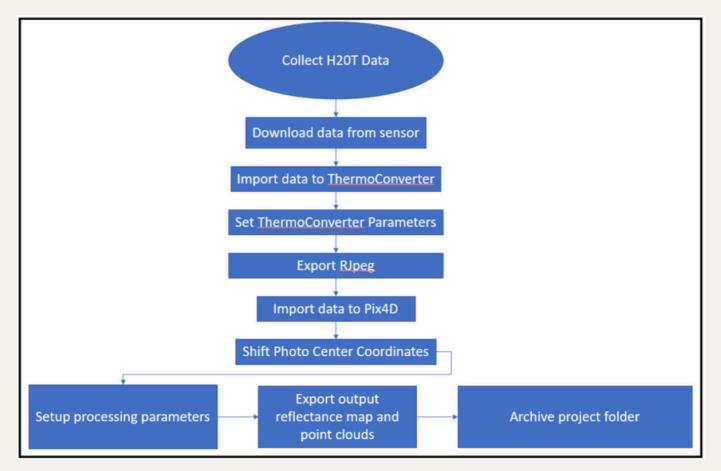
DRTK AP	443476.926	5372977.01	227.259
DRTK PPP	443478.571	5372975.443	221.455
	-1.645	1.567	5.804

Thermal (H2OT) Processing

H20T Processing Overview:

When capturing thermal imagery, we are relying on detecting energy outside of the visible range of the electromagnetic spectrum in an area known as the infrared range. Every object will emit some amount of infrared energy and with a thermal camera as well as appropriate collection and processing methods we can detect and measure this energy and relate it to temperature. Before we move further into the processing, we will first define some key terms: 1) Emissivity: a measure of the effectiveness of a material in emitting thermal energy (i.e. the ratio between a target object's emission and that of a perfect emitter at the same temperature); 2) Reflected temperature: thermal energy originating from other objects (i.e. sun) that reflects off the target (less impactful with high emissivity objects like water); 3) Ambient temperature: Air temperature of the environment.

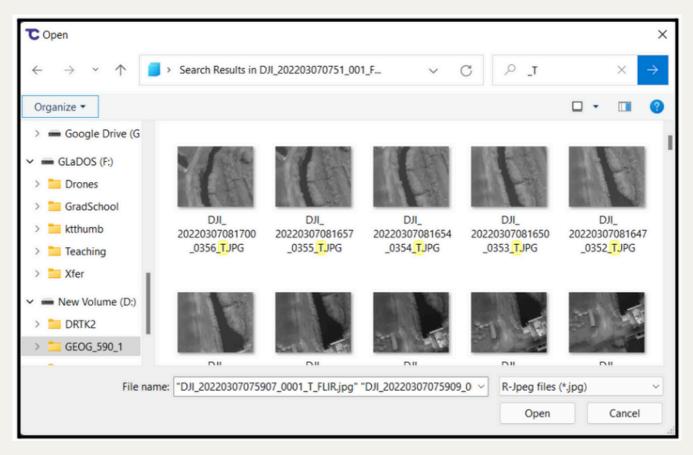
General Workflow:



Detailed Workflow:

- 1. Download photos
- 2. Open thermo converter
- 3. Click upload and navigate to the folder with thermal images



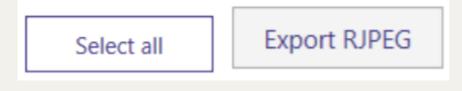


4. Search for " $_T$ " to filter only the thermal images

5. In the Export settings tab set the emissivity value of target feature (water generally 0.95-0.98) and aircraft height (distance). Also set temperatures to best available temperature during flight.

C Thermo Converter		
	RJPEG	TIFF
	Image Parameters	Min ť
	Palette	Value
Thermal images	Emissivity	0.98
mermarinages	Reflected Temperature	8.7℃
Export settings	Ambient Temperature	8.7°C
	Distance	100m
	External Optics Temperature	8.7°C
	External Optics Transmission	1
	Span	
	Auto adjust	
	Min Temperature	-40°C
	Max Temperature	550°C
Account Website Support		
Copyright 2022 VantageUAV Limited v1.7.0.0	Destination: D:\GEOG 590 1\Working\K	atzie\H20T\Adiusted

6. In the thermal images tab click select all and then Export RJPEG



7. Open Pix4d mapper

8. Start a new project

🧧 New Pro	oject				Х
This wizaro Choose a n	d creates a new project. name, a directory location and a type for your new project.				
Name:	Test				
Create In:	C:/Users/admin/Documents/pix4d/test			Browse	
Use As	Default Project Location				
Project T	уре				
O New					
O Proje	ect Merged from Existing Projects				
Help		< Back	Next >	Cancel	

9. Add converted thermal images

New Project					×
Select Images					
Enough images are selected	cted: press Next to	proceed.			
448 image(s) selected.	Add Images	Add Directories	Add Video	Remove Selected	Clear List
D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working	/Katzie/H20T/A /Katzie/H20T/A /Katzie/H20T/A /Katzie/H20T/A	djusted/DJI_20220 djusted/DJI_20220 djusted/DJI_20220 djusted/DJI_20220	307075909_00 307075912_00 307075915_00 307075919_00	02_T_FLIR.jpg 03_T_FLIR.jpg 04_T_FLIR.jpg 05_T_FLIR.jpg	I
D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working	/Katzie/H20T/A /Katzie/H20T/A /Katzie/H20T/A	djusted/DJI_20220 djusted/DJI_20220 djusted/DJI_20220	307075928_00 307075931_00 307075934_00	08_T_FLIR.jpg 09_T_FLIR.jpg 110_T_FLIR.jpg	
D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working	/Katzie/H20T/A /Katzie/H20T/A /Katzie/H20T/A	djusted/DJI_20220 djusted/DJI_20220 djusted/DJI_20220	307075942_00 307075946_00 307075949_00	113_T_FLIR.jpg 114_T_FLIR.jpg 115_T_FLIR.jpg	
D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working D:/GEOG_590_1/Working	/Katzie/H20T/A /Katzie/H20T/A /Katzie/H20T/A	djusted/DJI_20220 djusted/DJI_20220 djusted/DJI_20220	307075955_00 307075958_00 307080001_00	117_T_FLIR.jpg 118_T_FLIR.jpg 119_T_FLIR.jpg	
Help			< Back	Next >	Cancel

10. Export photo centers as a .csv with the name, coordinates, orientation, and accuracy

🦲 New Project		
Image Properties		
Geolocation and Orientatio		Edit
Geolocated Images:		To File
Geolocation Accuracy:) Standard 🔘 Low 🔾 Custom	Export
	9 9	
Export Image (Geolocation X	
Attributes:	Name, Coordinates, Orientation, Accuracy $$	
Coordinates Order:	Latitude, Longitude, Altitude 🗸 🗸	
Delimiter:	Comma ~	
File:	Photo_Centres_Orig_P4d2.csv Browse	
ОК	Close Cancel Help	

11. Make a copy of the csv named TRXin and keep only the photo name, latitude, longitude, and height columns

12. Open TRXin.csv and label the columns as: Station, latitude, longitude, height

13. Navigate to the **NRCAN TRX site**

14. Start a batch processing calculation with the reference frame being ITRF 2014 and the epoch being the date of data collection

Single Calculation	Batch Processing			
Batch Processing				
Epoch Transformation				
Origin				
-				
	Epoch			
	Epoch 03/06/2022 ा≣			

15. For destination select the same reference frame and set the projection to the appropriate UTM zone

Reference Frame C	oordinates	Zone (<u>select zone)</u>
ITRF2014 ~	Projection ~	UTM10

16. Upload the photo center .csv file and click send to download the results

17. Make a copy of the photo center .csv file and change the coordinates to the projected coordinates downloaded from TRX (Note: ensure the same order of photos as the original file)

18. Apply the DRTK shift vector for the northing, easting, and height coordinates to the projected photo coordinates

19. Add the accuracy, kaapa, phi, and omega columns back from the original export from pix4d ensuring the same order

20. In Pix4d edit the coordinate system to NAD83(CSRS) with an appropriate UTM zone

New Project		
age Properties		
Image Geolocation		
Coordinate System		
📀 🌐 Datum: WGS	5 1984; Coordinate System: WGS 84 (EGM 96 Geoid)	Edit
Geolocation and Ori	Select Image Coordinate System X	
Geolocated Im		To File
Geolocation Accurac	Selected Coordinate System	
Selected Camera Mo	Datum: NAD83 Canadian Spatial Reference System Coordinate System: NAD83(CSRS) / UTM zone 10N (EGM 96 Geoid)	
📀 💿 ZH20T_0.:	Coordinate System Definition	dit
⊘ Ø ZH20T_13	Unit: m 🗸	dit
~	Arbitrary Coordinate System [m]	-
Enabled In	• Known Coordinate System [m]	ngitude [deg]
DJI_202	Q NAD83(CSRS) / UTM zone 10N	464700
DJI_202	Advanced Coordinate Options	458033
DJI_202	OK Cancel	445978

21. Import the shifted coordinate .csv

Geolocation and Orientation							
Geolocated Images: 448 out of 448	Clear	From EXIF	From File To File				
Geolocation Accuracy: 🔘 Standard 🔘 Low	Custom		Import image position an				
Geolocation and Orientation							
Geolocation and Orientation							
Geolocation and Orientation Geolocated Images: 448 out of 448	Clear	From EXIF	From File To File				

22. Set the output coordinate system to also be NAD83(CSRS) with the appropriate UTM projection

23. Select the thermal camera pix4d template

Standard 3D Maps 3D Models Ag Multispectral Rapid 3D Maps - Rapid/Low Res 3D Models - Rapid/Low Res Ag Modified Camera - Rapid/Low Res Ag RGB - Rapid/Low Res Advanced Advanced Ag Modified Camera Ag RGB Thermal Camera ThermoMAP Camera	Thermal Camera Generate a thermal reflectance map. Image Acquisition nadir flight thermal camera Image Acquisition Image Acquisition nadir flight thermal camera Image Acquisition Image Recommendations Image Acruit images from a Tau 2-based thermal camera (such as FLIR Vue Pro, FLIR XT), acquired at high overlap using a grid flight plan. Outputs Generated Reflectance Map

24. Select start to process with the default options.

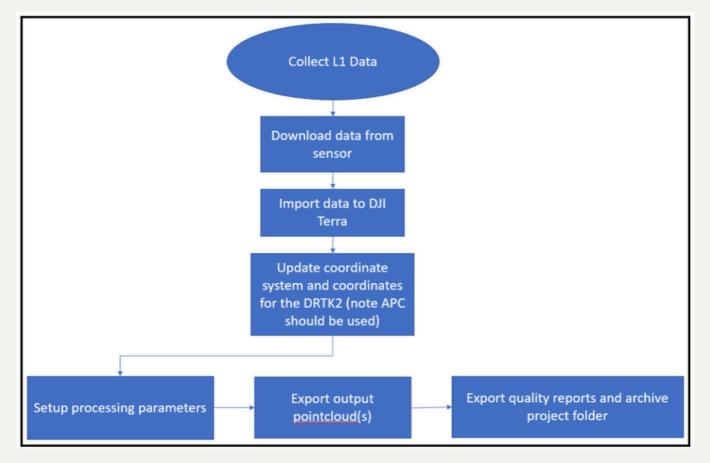
Ċ		Bridge	103	and.	an an	A.		Y	11
Processing	Process	sing						×	
LGG	🔽 1. Initia	I Processing	🔽 2. Point (Cloud and Mesh	3.	DSM, Ortho	omosaic a	nd Index	
Log Output	Current:							0%	
•	Total:		1.			2.	3.	0/12	
Processing Options	Output Sta	itus		Start		Cancel	н	elp	
				Sta	art proc	essing all	steps tha	at are enabled.	

LiDAR (L1) Processing

L1 Processing Overview:

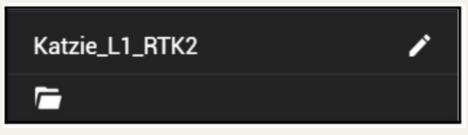
For a brief overview of how LiDAR works and what it can be used for please watch this short video from Open Topography (<u>https://youtu.be/chSywRqgIGY</u>). As mentioned in the video, we can use the GNSS system to know with very high accuracy the relative position between the DRTK2 and the UAV throughout the whole LiDAR collection. Once we complete the GNSS processing we will then have an updated coordinate representing the antenna of the DRTK2. The software (DJI Terra) will then use this updated coordinate to determine the trajectory of the UAV during the mission. Next from each position of the trajectory the software uses the distance and orientation of each laser return to determine the coordinates for each point. This process where a coordinate can be directly translated from a point on the aircraft and back to a point on the target surface is known as direct geo-referencing and is different from how geo-referencing is done with photogrammetry.

General Workflow:



Detailed Workflow Steps:

- 1. Download data
- 2. Open DJI Terra and select New reconstruction mission
- 3. Select LiDAR Point Cloud
- 4. Give a name to the project



- 5. Select the folder icon, navigate to the L1 Data and select the whole folder
- 6. Enter the Base Station Center Point Settings menu

Base Station Center Point Settings

	Base Station Center Point Settings								×
	Coordinate System Coordinate Sy WGS 84 Search								
Da	ata List								
Latit.	0		Lon	0	Altit	0		Batch Edit	
	No.	Folder Nam	e		Center	Point		ତ	
•	1	L1			Latitud Longitu Altitude	ıde:			
								Save	

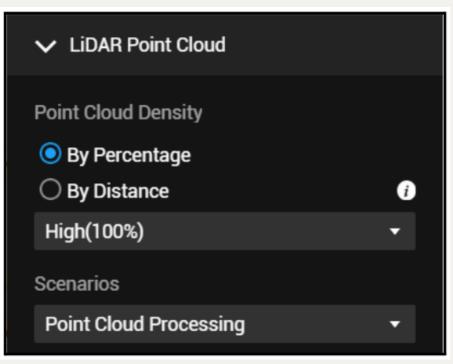
7. Set the coordinate system to NAD83(CSRS) with the appropriate UTM zone

Select Coordinate System							
Q NAD83(CSRS) / UTM Zone 10							
Coordinate Systems	Aut	Authorization Code					
 Projected Coordinate Systems 							
NAD83(CSRS) / UTM zone 10N	EPS	EPSG:3157					
	Cancel	ОК					

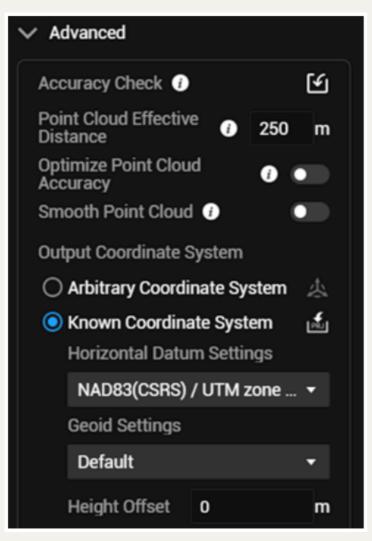
8. Update to coordinate to the PPP adjusted coordinate for the DRTK2 APC

	Da	ita List							
)	{/E :	0		Y/N:	0	Z/U :	0		Batch Edit
		No.	Folder Nam	e		Center	Point		ত
						• X/E:		443476.926	
		1	L1			• Y/N:		5372975.44	3
						• Z/U:		223.256	

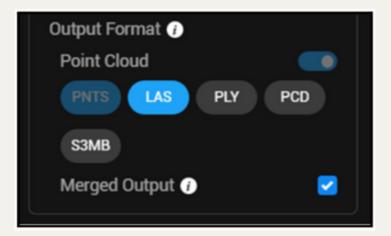
9. Under LiDAR Point Cloud Options set point cloud density and Point Cloud Processing



10. In the advanced tab leave default settings and adjust the output coordinate system to NAD83(CSRS) and the appropriate UTM zone



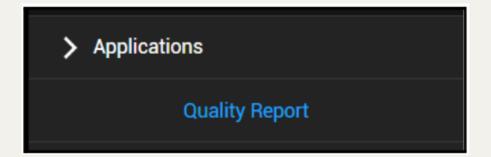
11. Set the output point cloud be LAS with merged output



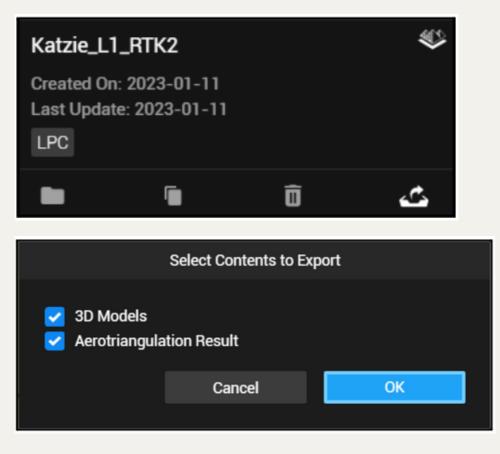
12. Confirm reconstruction parameters and run

Reconstruction Parameter Checklist					
LiDAR Point Cloud					
Scene Point Cloud Processing					
Point Cloud Density (By High(100%)					
Accuracy Check No					
Point Cloud Effective Di 250m					
Optimize Point Cloud A No					
Smooth Point Cloud No					
Output Format					
Point Cloud LAS					
Coordinate Systems NAD83(CSRS) / UTM zone 10N					
Altitude Settings Default					
Do not show again OK					

13. After the run is complete generate quality report



14. Export a copy of the mission for long term storage



15. Copy the mission folder from the DJI terra folder to a "working" drive for further processing and analysis

16. Inside the folder the quality report is in the report folder and point cloud results in the lidars folder (lidars/terra_las/***.las)

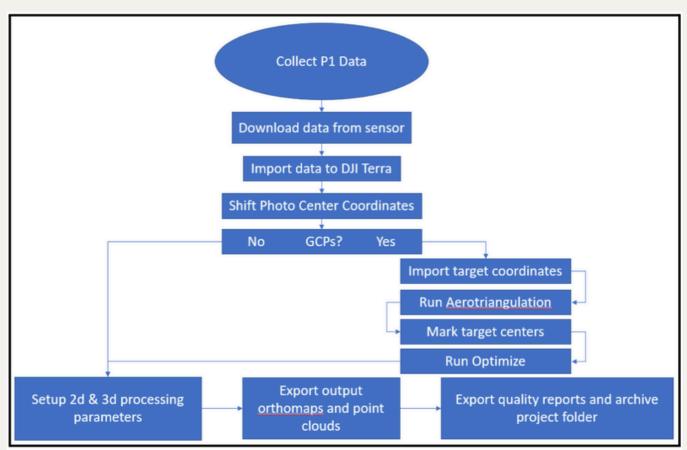
17. At this point if storage room on the DJI Terra computer is a concern you can delete the project from DJI Terra.

Photogrammetry (P1) Processing

P1 Processing Overview:

Key Points:

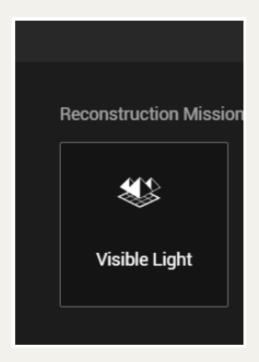
- SfM relaxes some of the requirements of traditional photogrammetry
- Advantageous for UAV missions (can incorporate numerous view angles)
- Direct georeferencing only as accurate as onboard GPS system, where indirect georeferencing (including GCPs) can improve accuracy



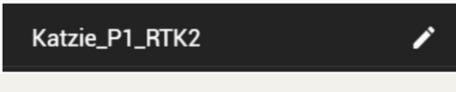
General Workflow:

Detailed Workflow Steps:

- 1. Download data
- 2. Open DJI Terra and select New reconstruction mission
- 3. Select Visible Light



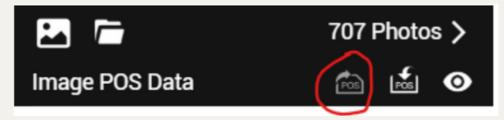
4. Name the project



5. Click on the folder icon to import photos



6. Export the positions of the photos



💿 Save As	
$\leftarrow \rightarrow \cdot \uparrow$ $\blacksquare \rightarrow$ New Volume (D:)	> GEOG_590_1 > Working > Katzie > P1
Organize - New folder	
 Music Pictures Videos OS (C:) New Volume (D:) SP PHD U3 (E:) GLaDOS (F:) GlaDOS (F:) GlaDOS (F:) Drones GradSchool ktthumb Teaching Xfer New Volume (D:) DRTK2 GEOG_590_1 	Katzie_P1_DRTKS hift_Terra.csv
File name: Katzie_P1_Orig_Terra.csv	
Save as type: csv (*.csv;*.CSV)	

7. Open the .csv and label the columns as: Station, latitude, longitude, height

8. Navigate to the **NRCAN TRX site**

9. Start a batch processing calculation with the reference frame being ITRF 2014 and the epoch being the date of data collection

Single Calculation	Batch Processing			
Batch Processing				
Epoch Transformation				
Epoch Transform	mation			
 Epoch Transform Origin 	nation			
	Epoch			

10. For destination select the same reference frame and set the projection to the appropriate UTM zone

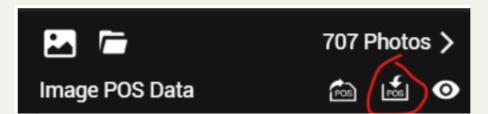
Destination					
Reference Fram	ne	Coordinates		Zone (<u>select zone)</u>	
ITRF2014	~	Projection	~	UTM10	
ITRF2014	~	Projection	~	UTM10	

11. Upload the photo center .csv file and click send to download the results

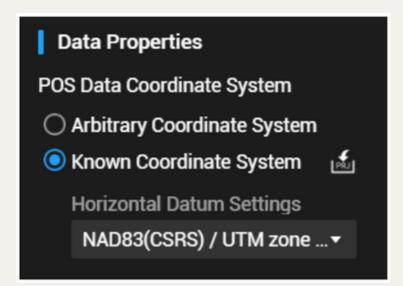
12. Make a copy of the photo center .csv file and change the coordinates to the projected coordinates downloaded from TRX (Note: ensure the same order of photos as the original file)

13. Apply the DRTK shift vector for the northing, easting, and height coordinates to the projected photo coordinates

14. In DJI Terra import the new shifted photo coordinates



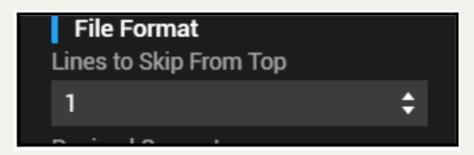
15. Define the coordinate system



16. Match column headers to first row of sheet

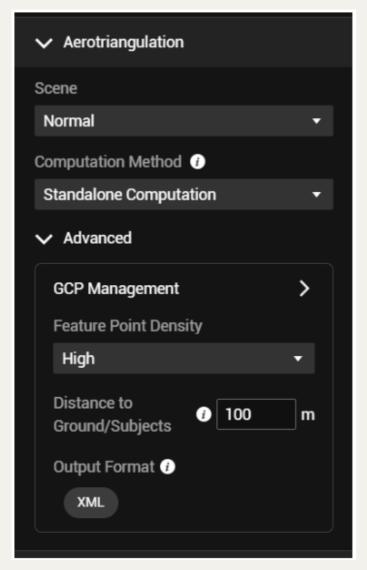
Define Data Column Total Rows: 708							
Photo Name▼	Y/N 🔻	X/E 🔻	Z/U 🔻	Yaw 🔻	Pitch 🔻	Roll	
Photo Name	utm_n	utm_e	height	Yaw	Pitch	Roll	

17. Skip the first row to remove the original column headers



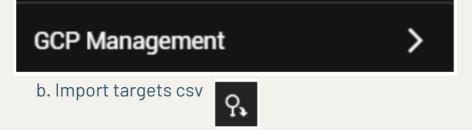
18. Click import

19. In the aerotriangulation section leave the default settings



20. If using GCPs

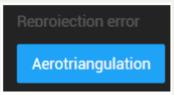
a. Open GCP management



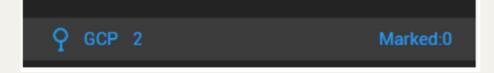
c. Set target coordinate system and columns

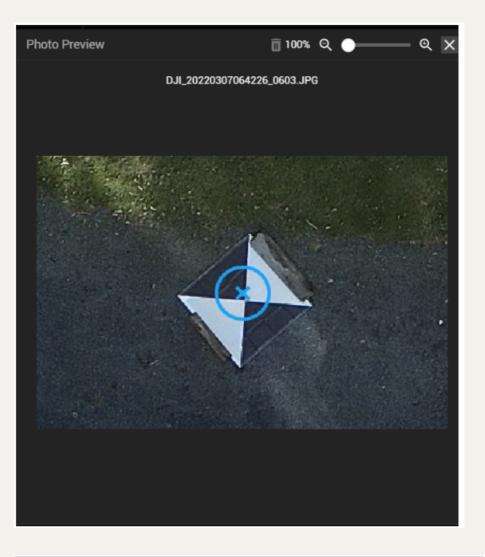
				Fo	ormat	and Proper	ties					
File Format Lines to Skip From Top		Preview										
1	¢											
Decimal Separator												
Period (.)												
Column Separator												
Comma (,)	•											
Treat combined separators a one	s											
Data Properties		Define D	ata Co	olumn 3								
GCP Coordinate System		Name	•	Y/N	•	X/E	•	Z/U	•	Undefined 🔹	Undefined 🔹	Horizontal Accuracy
O Arbitrary Coordinate System												0.005
Known Coordinate System	£											0.005
Horizontal Datum Settings												0.005
NAD83(CSRS) / UTM zone												
Geoid Settings												
Default	•											
GCP Accuracy												
Use Default DJI Terra Accuracy												
		i Data in	noort r	ormal								
		• • • • • •										
											Cancel	Import

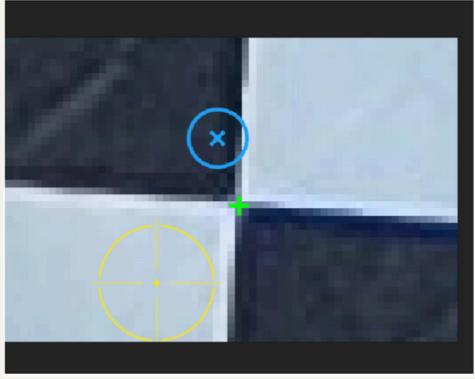
d. Run Aerotriangulation



e. Select each GCP and start marking targets







- f. Continue marking targets if they have a clear visible center point until all photos for each GCP have been gone through
- g. Set each point as either a control point or check point

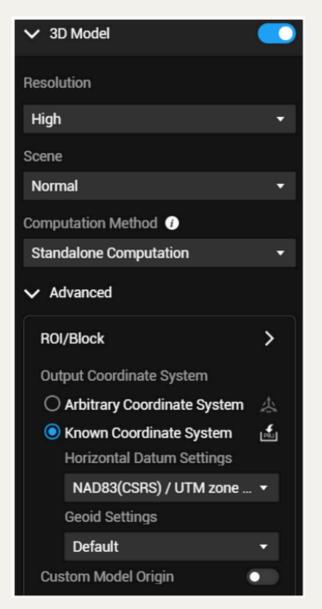
Туре	
GCP	*

h. Run Optimize

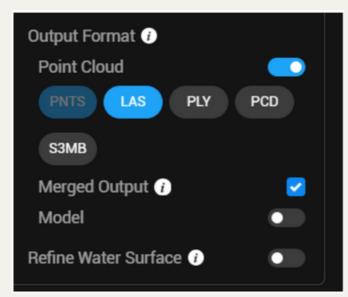
21. In the 2d section leave the default settings except for changing to output coordinate system to NAD83(CSRS) and an appropriate UTM zone

✓ 2D Map	
Resolution	
High	•
Scene	
Urban	•
Computation Method ()	
Standalone Computation	•
V Advanced	
Region of Interest	>
Output Coordinate System	
O Arbitrary Coordinate System	杰
Known Coordinate System	PRU
Horizontal Datum Settings	
NAD83(CSRS) / UTM zone	. 🕶
Geoid Settings	
Default	•
Map Grid 🕧	
Light Uniformity ()	
Haze Reduction (i)	

22. On the 3d section also use the default settings and change the output coordinate system to NAD83(CSRS) and an appropriate UTM zone



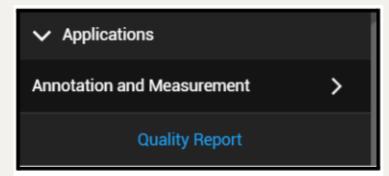
23. In the 3d model output settings set the point cloud output to LAS and turn off the model output and check merge output



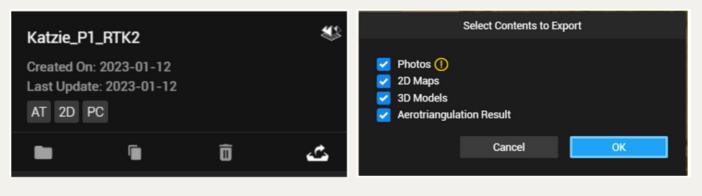
24. Confirm reconstruction parameters and run

	Reconstruction Para	ameter Checklist ×	× 3D Model	
I	Image POS Coordinate System POS Vertical Datum Set	NAD83(CSRS) / UTM zone 10N Default	Scene Resolution Computation Method	Normal High Standalone Computation
I	Aerotriangulation Computation Method GCP GCP Coordinate System GCP Vertical Datum Set Feature Point Density Distance to Ground/Su Output Format	Standalone Computation None WGS 84 Default High 100m None	Region of Interest Block Splitting Options Coordinate Systems N Altitude Settings Output Format Point Cloud Model Refine Water Surface	No Auto AD83(CSRS) / UTM zone 10N Default LAS None No
	2D Map Scene Resolution Computation Method Region of Interest Coordinate Systems Altitude Settings Map Grid Light Uniformity	Urban High Standalone Computation No NAD83(CSRS) / UTM zone 10N Default No No		

25. After run generate quality report

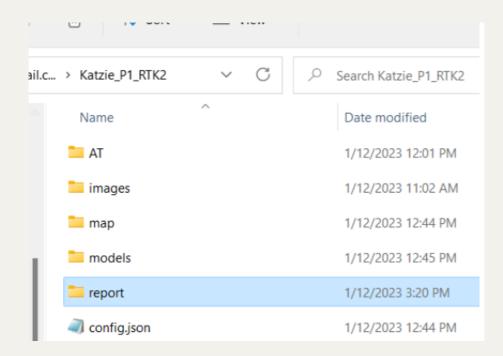


26. Export a copy of the mission for long term storage



27. Copy the mission folder from the DJI terra folder to a storage unit

28. Inside the folder the quality report is in the report folder



29. The ortho map output is in ./Map/result.tif and point cloud results in ./models/pc/..../terra_las/cloud_merged.las

30. At this point if storage room on the DJI Terra computer is a concern you can delete the project from DJI Terra.