LiAir X3

UAV LIDAR System User Guide

GreenValley International Inc.

Table of Contents

Content
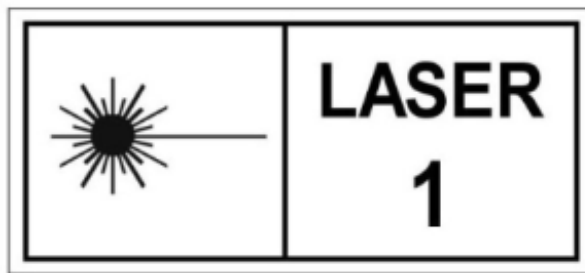
1. Read This First

Important Notices

1. LiAir X3 system use Class 1 (IEC60825-1:2014) eye-safe laser sensors. If you have any concerns, please contact GVI for details.

2. Please read this manual carefully before operating the system, and the system operator must be at least 18 years old.

3. Please stop using the system if you hear noticeable noises, warnings, or while the device is damaged. Contact the manufacturer's technicians for maintenance in time. Forcible use may cause permanent damage to the system.

4. Strictly follow the tutorials, advises, warnings, and other cautions included in this user guide as well as other documents provided by GVI.

5. Do NOT use any power supply outside the specified voltage range (12~24V, 0.9A@24VDC). Incorrect voltage supply may cause permanent damages to the integrated instruments and other hazards. Damage caused by the use of an unauthorized power supply are not covered by the Product Warranty.

6. Keep the power, USB, network and other connector ports clean and dry, and do not insert other objects other than the connector.

7. Tampering with the product is strictly prohibited and will void the Product Warranty. Any repair, modification, or upgrade must be performed by GVI technician or authorized service provider.

8. This product is a high-precision mapping and surveying instrument that must be handled with care. This product should by stored and transported in the protective case provided with the LiAir V70 at the time of purchase or in a productive case authorized for use by GVI.

9. When not in use, store LiAir X3 system and accessories in a cool and dry environment. Make sure the device is powered off when performing maintenance and cleaning.

10. The working temperature of this equipment is -20 °C ~50 °C . Below/exceed this temperature range, it may cause wrong measurement results, data loss or equipment damage.

11. Before using the equipment, please ensure that the operating environment is far away from the source of electromagnetic interference.

12. There are corresponding specifications for battery use and storage. Please refer to the lithium battery use/storage specifications for details.

13. After the equipment is scrapped, please do not throw it directly into the trash can. It can be sent back to the manufacturer, and the manufacturer will handle it on your behalf.

GreenValley International Inc. reserve the right to explain the above terms

GreenValley International Inc. April 2nd, 2022

2. LiAir X3 System

LiAir X3 is a new generation of light-weight UAV LiDAR system developed by GreenValley International. It integrates light-weight LiDAR scanner, self-developed inertial measurement unit, 2600MP high-resolution mapping camera and high performance computing platform. It can be mainly used for topographic mapping, forestry surveying, power inspection, etc. With the LiPlan, LiGeoreference, LiDAR360 software developed by GreenValley International, it can provide users with complete surveying and mapping solutions.

The LiAir X3 system intergration is comprised of multiple technologies, including:

1. A dynamic differential GNSS receiver for measuring the spatial position of the reference point of the laser signal transmission.

2. Attitude measurement equipment for measuring the attitude parameters, namely inertial measurement unit (IMU).

3. Laser ranging equipment used to measure the distance between the laser signal emission reference point and the ground point, that is, the core part of the entire integrated system, the laser scanner.

4. The storage control system, which is used for data storage and device control, receiving the signals transmitted from the ground to the airborne, and controlling the parameters adjustment, data acquisition and downloading.

5. Power supply and management unit.

System Principles:

1. The system collects data by receiving and executing hardware switches or commands sent by LiPlan to control the device.

2. All the collected raw data are stored in the TF card, and after the data collection is completed, it is copied to the local computer for data processing.

3. Use LiGeoreference software to fuse the position and angle information under the LiDAR system coordinate system with the POS data to obtain accurate geographic coordinates.

5.1 Technical Specification

X3 Specifications	
Weight	1.2 kg
Scan Range （Sunny, Outdoor @100 klx）	190 m @ 10% reflectivity 230 m @ 20% reflectivity 320 m @ 80% reflectivity
Field of View (Repetitive Mode)	70.4°（horizontal）× 4.5°（vertical）
Number of Returns	Triple Return
Scan Rate	240,000 points/s (first or strongest return) 480,000 points/s (dual return) 720,000 points/s (triple return)
Camera Resolution	26 MP
POS Performance – Attitude (after post-processing)	0.008°
POS Performance - Azimuth（after post-processing）	0.038°
System Accuracy (Vertical)	5 cm @ 70 m
Voltage	12~24 V，0.9 A @ 24V DC

Consumption	22 W
Working Temperature	-20 ~ 50°C
Storage Temperature	-30 ~ 60°C
Drone Model	DJI M300 RTK
Display and Control Application	LiPlan
Georeferencing Software	LiGeoreference

2.2 Product Structure
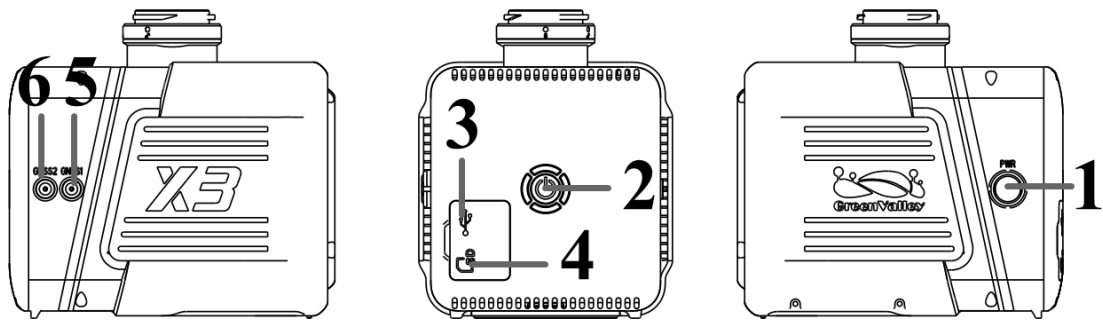
1 — Power Port (PWR): Connects the power cable to power up the system.

2 — Switch button (ON/OFF) and indicator light: powers the system on and off, also used to create project (shared), display system working status.

3 — USB-C Port: used for communication between computer and system, such as firmware update, data download, etc.

4 — Memory card slot: built-in 256GB TF card for data storage.

5 — GNSS1: first (main) antenna port.

6 — GNSS2: second antenna port.

Explanation of ON/OFF button operation and LED light status descriptions		
LED	Color/Status	Description
ON/OFF	Flashing Red (Four Times a Second)	System is powered on and initializing
	Solid Green	System initialization completed
	Flashing Green	The project has been created, the inertial navigation data is being recorded, and the system is working normally
	Flashing Red (Once a Second)	The project has been created, the inertial navigation data is being recorded, and the system is working abnormally
	Solid Red	The system status is abnormal, the reasons include: 1. TF card space is less than 15G 2. M300 RTK PSDK module is not activated 3. IMU misalignment 4. Camera self-test failed 5. The laser scanner is not synchronized

2.3 Product Composition

2.3.1 Laser Scanner

The laser scanner is the core of the system. The LiDAR uses the laser as the emitting light source and the photoelectric detection sensor as the receiving element. According to the principle of laser ranging, the distance and angle are measured and recorded, so as to determine the azimuth information of the measured object.

The transmitter in the LiDAR emits a beam of ultra-short light pulses on the object and diffusely reflects back to the receiver. The speed of light is known, and the distance from the target object to the sensor is calculated by the flight time of the laser beam in the air.
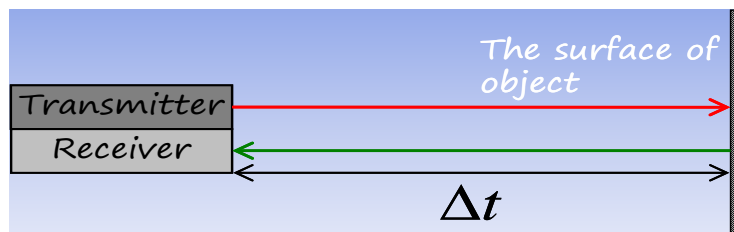

LiDAR Ranging Formula:

$$S = \frac{1}{2} \times c \times \Delta t$$

S is the distance from the sensor to the target, c is the speed of light, and Δt is the round-trip time of the laser.

The LiAir X3 product integrates the Livox Avia laser and supports two modes of non-repetitive scanning and repetitive scanning. This product uses the repetitive scanning mode, with a FOV of 70.4° horizontally and a FOV of 4.5° vertically, as shown in the figure below.
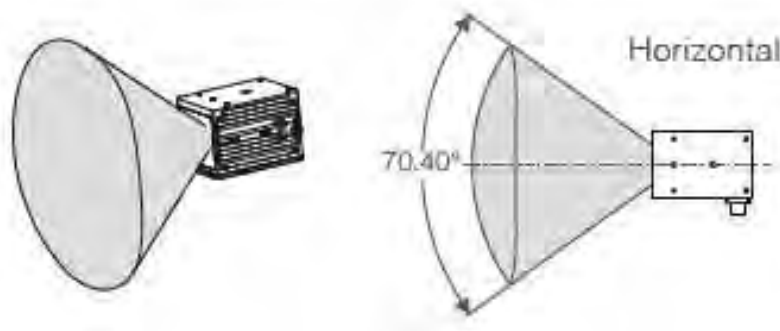
Please note that the effective range of Livox Avia is different in different FOV regions. The closer to the edge of the FOV, the shorter the effective range. Please be careful with the range to avoid incomplete acquisition coverage. The measuring range can refer to the following figure:
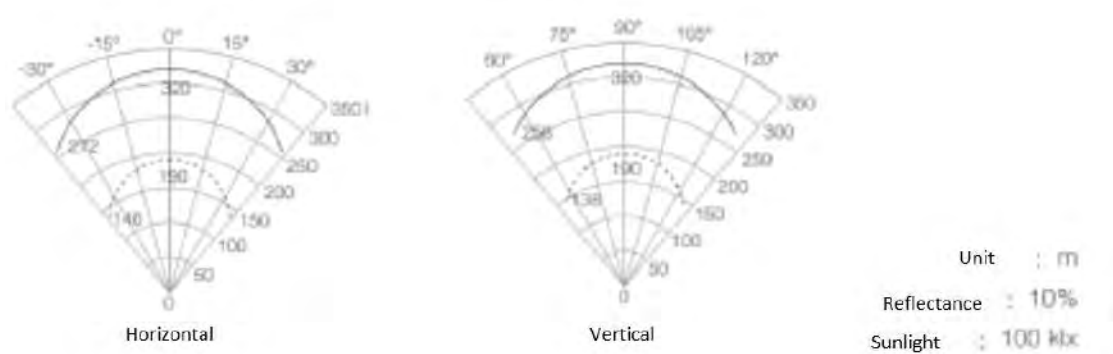
LiDAR Sensor Specifications	
Model	AVIA
Detection Range (Sunny, Outdoor @100 klx)	190 m @ 10% reflectivity 230 m @ 20% reflectivity 320 m @ 80% reflectivity
Distance Random Error (1σ@20m)	2 cm (Tested in an environment at a temperature of 25°C with a target object that has a reflectivity of 80% and is 0.2 meters away.)
Angular Random Error	1σ<0.05°
Points Rate	240,000 points/s (first or strongest return) 480,000 points/s (dual return) 720,000 points/s (triple return)
FOV	Repetitive scanning pattern: 70.4°（horizontal）×4.5°（vertical) Non-repetitive scanning pattern: 70.4°（horizontal）× 77.2°（vertical)
Laser Safety	Class 1 (IEC 60825-1:2014) (Safe for eyes)
Voltage	10~15V DC (recommended 12 V DC and 30 W or higher)

Consumption	10 W (average)
Working Temperature	-20 ℃ ~ 65 ℃
IP Rating	IP67

> Note: The laser sensor cannot be directly irradiated with strong laser light (including two sensors facing the light), so as to avoid high-intensity laser damage to the receiving sensor.

2.3.2 Position and Orientation System (POS)

The airborne Position Orientation System (POS) is an inertial measurement unit (IMU) and Global Navigation Satellite System (GNSS). POS systems are used to accurately determine system velocity, position, and attitude values at specific moments in time.

1.   Global Navigation Satellite System (GNSS)

Global navigation satellite system, or (GNSS) on LiAir X3 supports, mainly includes GPS, GPS (the U.S.), Galileo satellite navigation system (Europe), BeiDou Navigation Satellite System (China), and GLONASS (Russia). The GNSS of LiAir X3 includes the aviation GNSS antenna and the base station antenna.

2.   Inertial Measurement Unit (IMU)

Inertia measurement unit, or IMU, consists of a high-accuracy three-axis gyroscope and a high-accuracy three-axis accelerometer. It is the benchmark center of the LiDAR system. Its role is to get the position and orientation information without external reference data.
The LiAir X3 integrates a 3-axis MEMS (Micro-Electro-Mechanical System) gyroscope, 3-axis MEMS accelerometer and dual GNSS/BD receivers into one system, the POS system. Together the POS system components gather multi-reference parameters that provide accurate, effective and reliable by optimization algorithm of integrated navigation system.

3. LiAir X3 POS System Performance (after post-processing)

System Accuracy	Azimuth	0.038°(1σ)
	Attitude	0.008°(1σ)
Data Frequency	200 HZ	

2.3.3 Control and Storage Unit

Function:

1. Receiving the commands from the computer and executes the commands.

2. Controlling and coordinating each sensor to work properly.

3. Storing the data. Store the data of IMU, camera, and device log.

2.3.4 Integrated Camera

This product has a built-in GVI self-developed camera. The main parameters of the camera are as follows:

Image Sensor Format	APS-C
Lens	16 mm fixed focal length lens
Effective Pixels	26 megapixels
Picture Element Size	3.76 um
Image Size	6252 * 4168
DFOV	83°

2.3.5 GNSS Base Station

The main function of the ground GNSS base station is to observe the same point for a long time, so that it has a high single-point accuracy and serves as a differential reference for the UAV mobile station. GPS base station composition: GPS antenna + GPS receiver + power supply.

Base Station Information

1 — Power Port (9-30 V，0.3 A @ 12 V)

2 — USB Port: Connect to a computer via a double-ended USB cable for base station data downloading

3 — System Status Indicators: Used to indicate base station status

4 — RTK Button (Cancelled)

5 — Save Button: Base station data storage/end storage function (long press)

6 — RTK Antenna Port

7 — GNSS Antenna Port: Connect GNSS antenna and base station through feeder cable

8 — RTK Antenna

Base Station Indicator Lights		
LED	Light Status	Status Description
	Solid Red	Base station power supply is normal, 3.6 W
	Flashing Red	Low battery, battery needs to be replaced
	Solid Blue	Recording base station data
	Flashing Blue	Internal SD card error or remaining storage space is less than 1 GB
	Off	Not recording base station data
	Solid Green (Cancelled)	RTK function normal
	Flashing Orange	Locating satellites
	Solid Orange	Satellite positions locked

Base Station Specifications:		
System Performance	Signals	120 dynamic channels GPS:L1，L2，L2C,LC GLONASS:L1，L2，L2C BDS:B1，B2 GALILEO:E1,E5a,E5b,ALtBOC,SBAS,QZSS, L-band
	Horizontal Positioning Accuracy	Single point L1: 1.5 m Single point L1/L2: 1.2 m SBAS: 0.6 m DGPS: 0.4 m RT-2: 1 cm + 1 ppm Initialization time: <10 s Initialization reliability: >99.9%
	Positioning Accuracy	0.2/m
	Data Update Rate	Raw data: up tp 50 Hz Position data: up to 50 Hz
	First Position Time	Cold start: <50 s Warm start: <35 s
Dimensions and Electrical Parameters	Dimensions (mm)	130 X 90 X 32
	Weight	300 g
	Input Voltage	12 V
	Consumption	4 W
Communication Port	Data Download	USB Port, insert USB stick to download base station data automatically
Operating Environment	Temperature	Working temperature: -40°C - +75°C Storage temperature: -40°C - +85°C
	Relative Humidity	95% no condensation

3.Product Components

① LiAir X3 LiDAR System ② USB Cable ③ GNSS Antenna Kits

④ 256GB TF Card ⑤ Card Reader ⑥ Documentation/User Guide

Note: Please refer to the actual product list for delivery.

4. Data Acquisition

5.1 Set Up GNSS Base Station

1. Select an open area for positioning

Place the GNSS antenna at an open area in order to ensure the antenna can get access to the GNSS satellites as many as possible. Apart from this, the placement spot of the GNSS antenna should be stable and far away from the electromagnetic interference.

● Open areas refer to those places which are not covered by high objects. The maximum elevation mask angle of surrounding objects should be less than 15°.

● The source of strong electromagnetic interference might be cellular base station, high voltage transmission lines, or objects with high reflectance (e.g. mirror, large water body) which may cause the multipath propagation.

2. Set up base station

Connect the GNSS antenna to the GNSS receiver by the feeder cable and connect the battery to the GNSS receiver by the power cable as it shown below:

Note: When connecting the base station and the base station power cable, you need to align the red dot on the power cable with the recessed part of the interface before connecting.
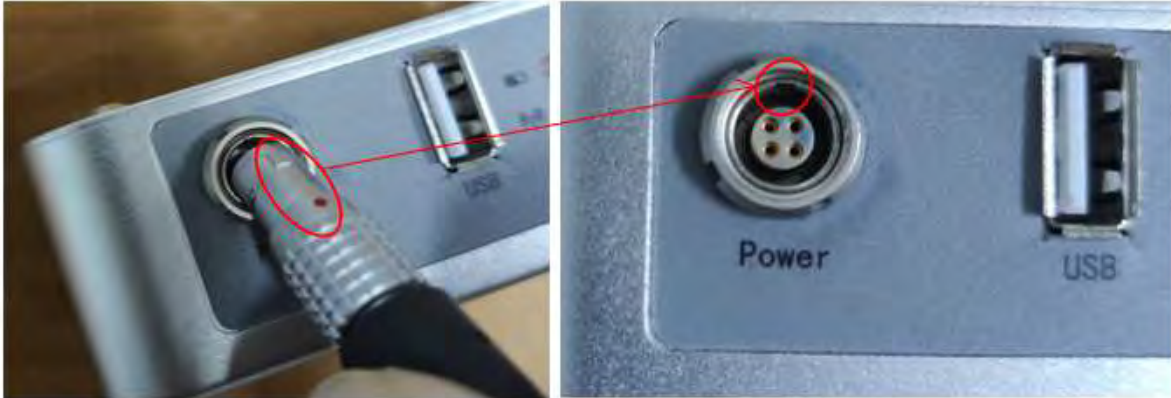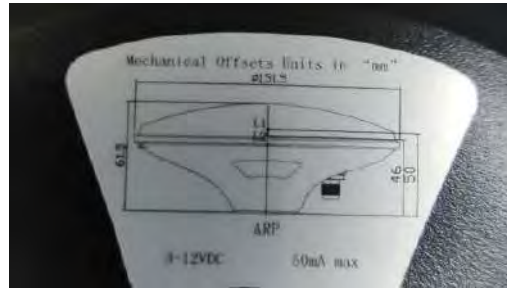

3.   Calculate the antenna height

Measure the oblique distance from antenna bottom edge to the ground for more than three-times, take the mean value as H1.

Antenna height (m)=(0.05-0.046)+ √ (〚(H1)〛 ^2- 〚(0.1515/2)〛 ^2) Antenna height (m)=(0.05-0.046)+ √ (〚(H1)〛 ^2- 〚(0.1515/2)〛 ^2)

Take the above picture as an example, if the height of the measuring instrument is 1.6 meters, the actual height of the base station antenna is:

$$\text{Antenna Height=} \quad (0.05-0.046)+\sqrt{1.6^2-\left(\frac{0.1515}{2}\right)^2}$$

4.   Record base station data

Procedures:

a)   Power on the base station，then and indicator lights are always on.

b)   Wait for the orange GPS satellite signal light to become solid (in this case, the GPS signal is stable), press and hold the Save button (>2s), release the button, indicator light will turn on and start recording data.

c)   After the outdoor data collection work is completed, press and hold for more than a second, the indicator light will be off, and the base station will stop recording data.

d) Power off the base station.

> Note: When the base station is set up on an unknown point, the base station needs to start collecting data 15 minutes before the flight operation, and stop collecting data 15 minutes after the operation ends. When the base station is set up on a known point, the base station acquisition time only needs to cover the entire LiDAR acquisition time period.

5.2 Device Installation

1. Mount the system on the DJI M300 drone, remove the dust cover and confirm that the shock-absorbing ball is not broken.
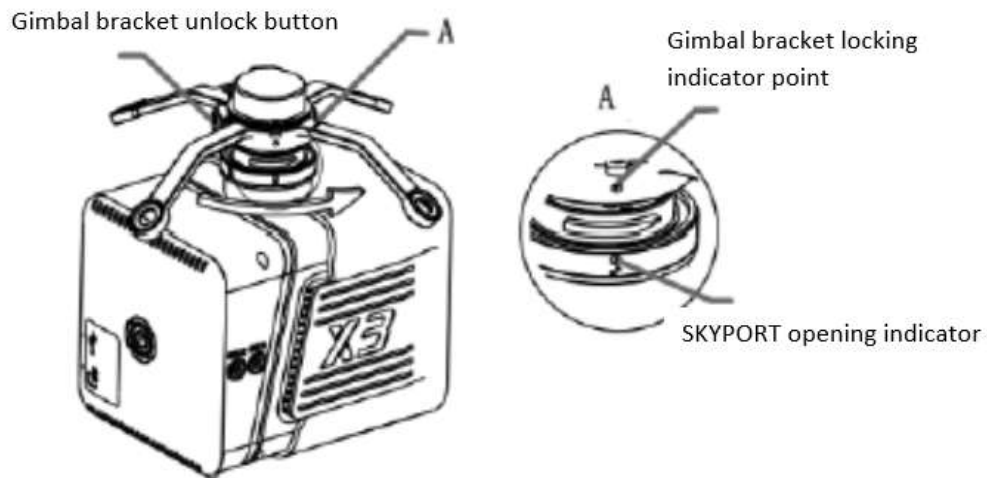
2. Install the GNSS Antenna Kits, GNSS1 is connected to the rear antenna, and GNSS2 is connected to the front antenna (front refers to the flight direction).
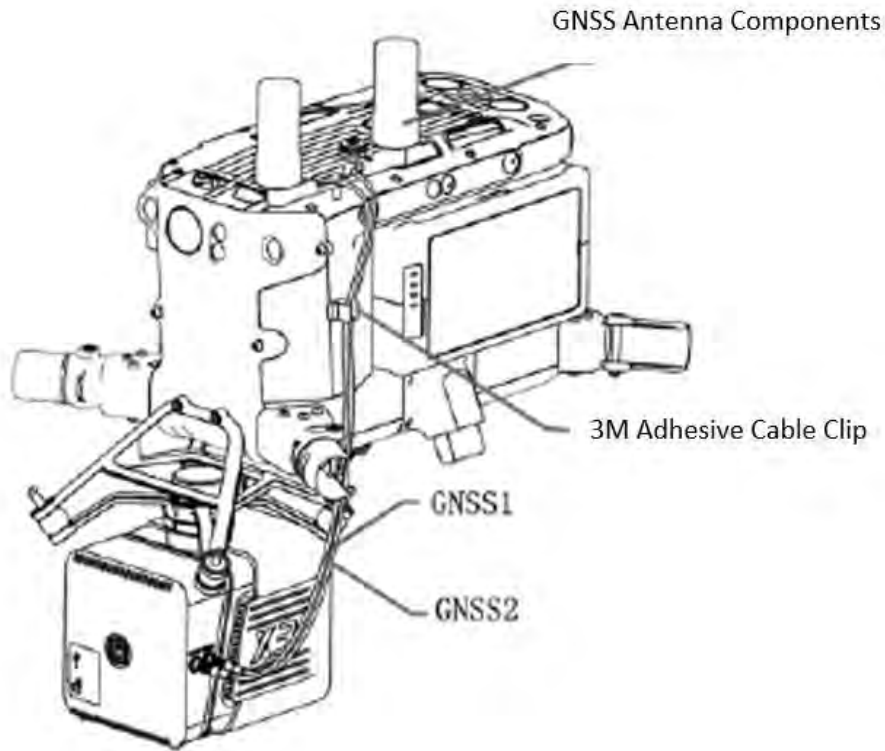
3. Make sure there is enough space for the TF card and insert it into the system, then remove the dust cover from the bottom of the device.

4. Turn on the controller and power on the drone.

5. Press and hold the ON/OFF button of the device for more than 3 seconds to turn it on.

6. Observe the status of the button indicator. The red flashing quickly means that the system is powered on and initializing, and the steady green light indicates that the system initialization is complete and the device is working normally. For more specific meanings of indicator lights, please refer to the meaning of system lights.
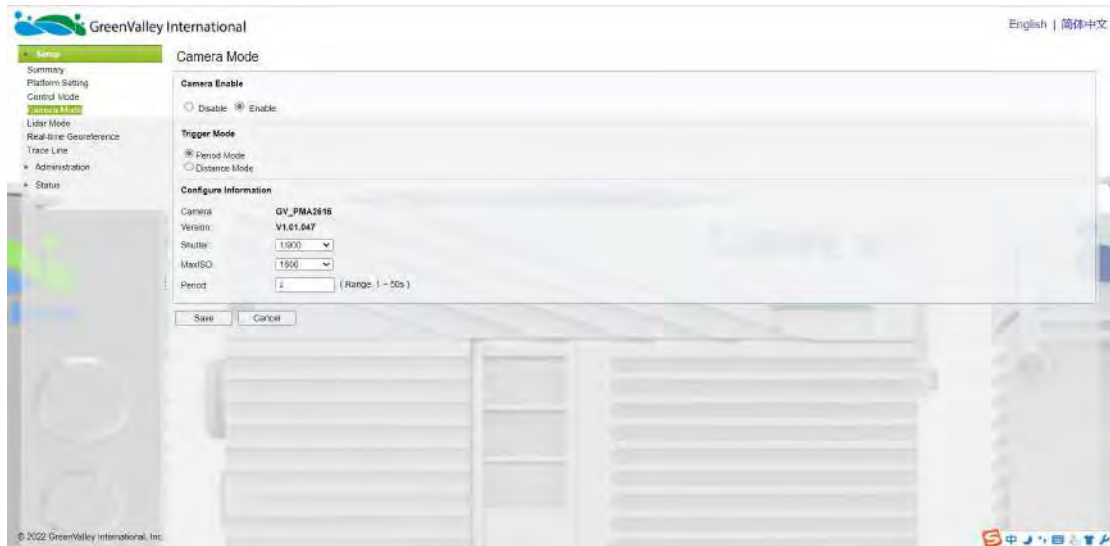
5.3 Parameter Setting

The LiAir X3 system will remember the parameters set last time, if there is no need to modify, the setting steps can be skipped. The acquisition parameters of LiAir X3 mainly include laser parameters, camera parameters, etc. It can be modified by logging in to the web configuration interface of the device or the LiPlan application. The parameters supported by the two methods are not exactly the same.

1. **Web Settings**
a) Use WIFI to establish communication between the device and the computer or mobile phone. After the device is powered on, search for the wireless network named LiAir_XXXXXX, click "Connect", and the password is 66666666.

b) Enter http://192.168.1.88 in the browser to open the LiAir X3 web configuration interface, user name: root, password: 888888. Click "System Settings" to set device parameters.

Note: Google Chrome or IE11 browser is recommended.

2. LiPlan Settings

Open the LiPlan application and click "Route Planning" to enter the route planning interface.

Click ▦ setting button to set the device parameters.

3. Parameter Settings

This document only introduces common device parameters. For complete parameter descriptions, please refer to the LiAcquire-Web manual.

a) Control Mode

This section can be used to configure the laser and camera data acquisition modes. The LiAir X3 device has the following acquisition control modes:

Flight Mode： This mode is the factory default setting. In this mode, when the device is stationary on the ground, the device does not collect LiDAR and camera data, and automatically starts LiDAR and camera data collection after the drone takes off into the air, and automatically stops LiDAR and camera data collection when the drone is landed.

Fast Mode: Click the power (ON/OFF) button, create new project, and synchronize the collection of both IMU data and LIDAR data simultaneously.

Manual mode: In this mode, the device automatically starts lidar and camera data collection when it reaches the first waypoint, and automatically stops data collection when it reaches the last waypoint.

b) Camera Settings

Camera Enable: Used to set whether to activate the camera

Trigger Mode: The period mode is isochronous triggering, that is, the camera is triggered according to the set time interval, the default is 2s, and the range is 1-50s. The distance mode is equidistant triggering, and the camera is triggered according to the set distance interval, the default is 50m.

Configure Information: Set the time or distance interval, which is the same to the "camera interval" setting function of LiPlan application.

5.4 Workflow

1. Power on the drone, press and hold the ON/OFF button of the system for at least 3 seconds to turn it on, and wait for the indicator light to be solid green, which means the system is in a normal state.

2. Short press the ON/OFF button for 0-2 seconds after the system indicator light is normal, the indicator light flashing in green (1 time/s), which means the project is created and the IMU data recording starts.

3. After take-off, the laser scanner and camera will start collecting data automatically.

4. After completing the flight routes and landing, the data collection of the laser and camera will automatically stop.

5. Short press the ON/OFF button for 0~2 seconds to stop the IMU data recording and finish the project, then the indicator light will be solid green again.

6. Press and hold the ON/OFF button for at least 3 seconds, the indicator light will turn off and the system will be powered off.

7. Power off the drone.

5. Data Downloading

5.1 LiAir X3 Data Download

LiAir X3 data is stored in the TF card, including project files, LiDAR data, IMU data, log files, etc. Insert the TF card into the computer, and copy the corresponding project files to the computer (Not the folder with _NAV suffix).

5.2 Base Station Data Download

1. Connect the computer and the base station

2. Place the base station file into the Base folder within the corresponding project folder. Disconnect the connection.

Note: Base station file name in SD card: UTC time + suffix (log), for example: 20170810063808.log.

6. Data Processing

LiGeoreference is a LiDAR point cloud georeferencing software developed by GreenValley which allows users to merge range measurements collected by mobile, UAV or airborne laser scanning systems with position and orientation information recorded by integrated IMU and GNSS sensors. Point clouds can also be attributed with RGB imagery using LiGeoreference's data fusion capabilities to produce a true-color 3D model of an object or area surveyed. LiGeoreference is now available as a stand-alone application with a helpful graphical user interface as well as a command-line interface for scripting and easy integration with third party software. In this article, the main purpose to produce this chapter is to show the data post-processing procedure resolved by LiGeoreference.

> Note: For more information, introduction of assembling LIDAR system together with Drones is detailed in LiGeoreference User Handbook section.

6.1 Project Folder Structure
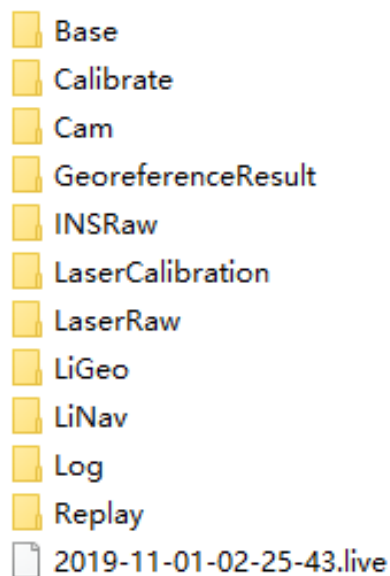
Project folder is named with UTC Time, including:

- Base folder is used to store the ground GPS base station data.

- Calibrate folder is used to store calibrated files (*.cal). Please notice that: do not remove or delete this folder, otherwise, the performance of georeferencing will fail.

- Cam folder is used to store the information of exposure time, location, and attitude angles of each image (.cam). And the image needs to be moved to "Cam" -> "Images" folder copied from Camera's SD card.

- GeoreferenceResult folder is used to store the post-processed point cloud data calculated by the Georeference software.

- INSRaw folder is used to store the raw IMU data (*.rgps,*.rimu,*.rnav).

- LaserCalibration folder is used to store the calibrated file of liDAR (*.csv) but only available to partial series like LiAir 200 and LiAir 220.

- LaserRaw folder is used to store the raw data of laser scanner's point cloud (*.vpts). After being post-processing, it is convenient for users to convert the data's format as needed.

  Note: *.vpts is the default format developed by GVI.

- LiNav folder is used to store the intermediate file when processing the data of integrated navigation system. What's more, the finial-georeferencing results of POS data is suitable to be stored as well.

- Log folder is used to store the log information of the project showing detailed operation process.

- Replay folder is used to store the replay file of recorded trajectory and point cloud data, but only available to the specified device which supports real time display.

- *.Live (project file) is used to record the information of project organization, configuration values, etc.

6.2 Open Project

1. Open LiGeoreference software, Click "File" icon on the toolbar to open LiGeoreference project file (.live) through "Browse" icon.

2. Users can also open the project file via "Recent Projects" icon which refers to history project opened before.


3. After opening the project, the georeferencing tool will automatic import the IMU file.
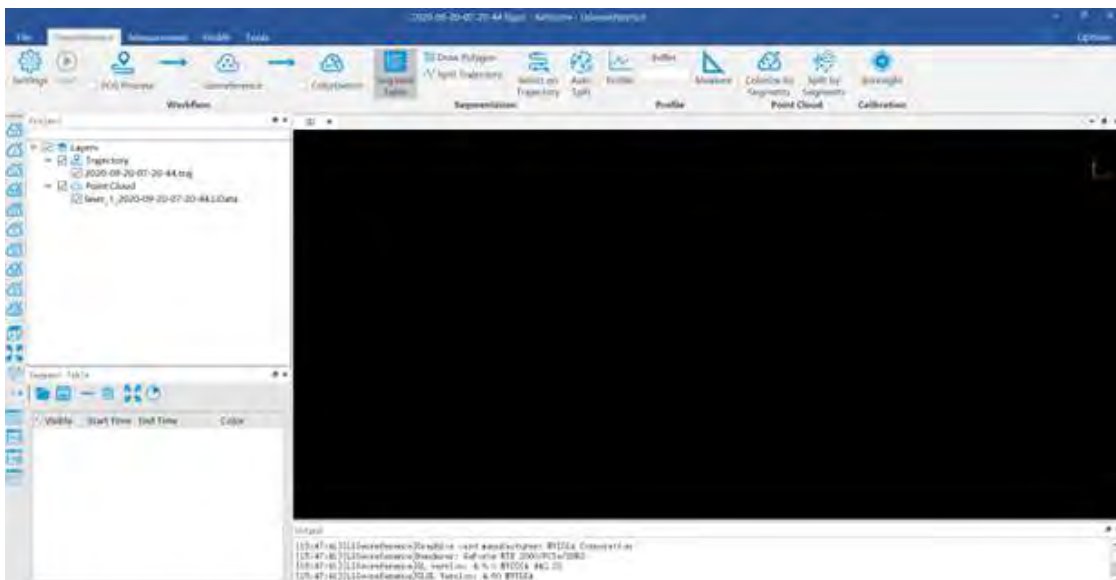
6.3 Select and Configure Parameters

Before undertaking post-processing procedure, users can use the "Settings" function to set the calculation parameters, including laser settings, camera settings, pos process, target coordinate system, classification, and smooth settings. Normally, users only need to set pos process settings and target coordinate system settings.
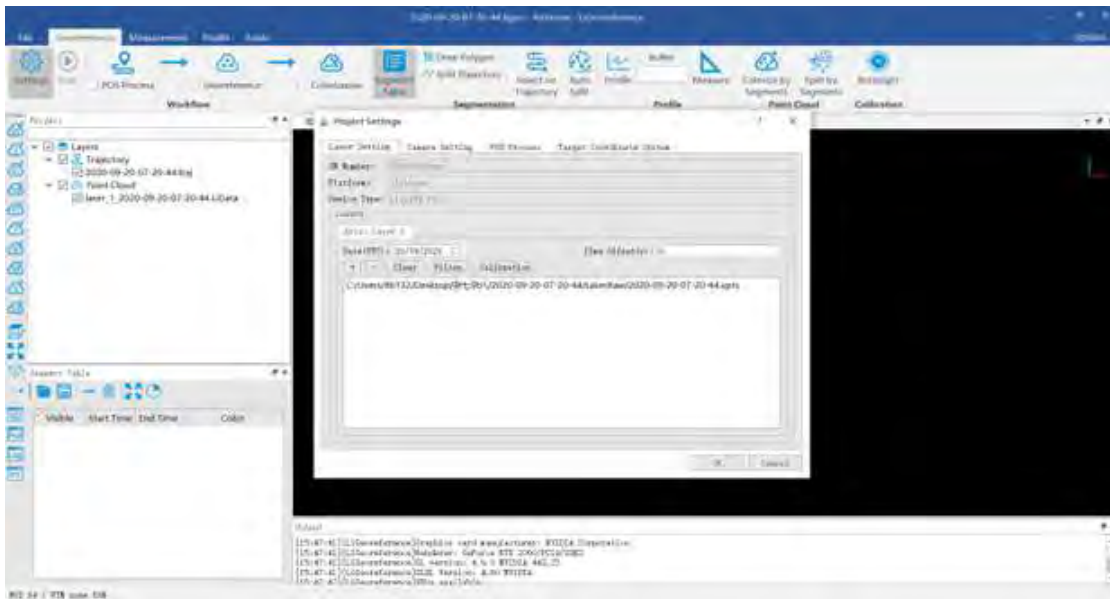
6.3.1 POS Processing Settings

LiGeoreference software has pos calculation and point cloud calculation functions. Users could directly use LiGeoreference software to calculate LiAir X3-H's trajectory, or choose to use other third-party software to perform pos processing procedure.

1. Using LiGeoreference to Perform POS Processing

   Click the "POS Process" button in the setting interface.
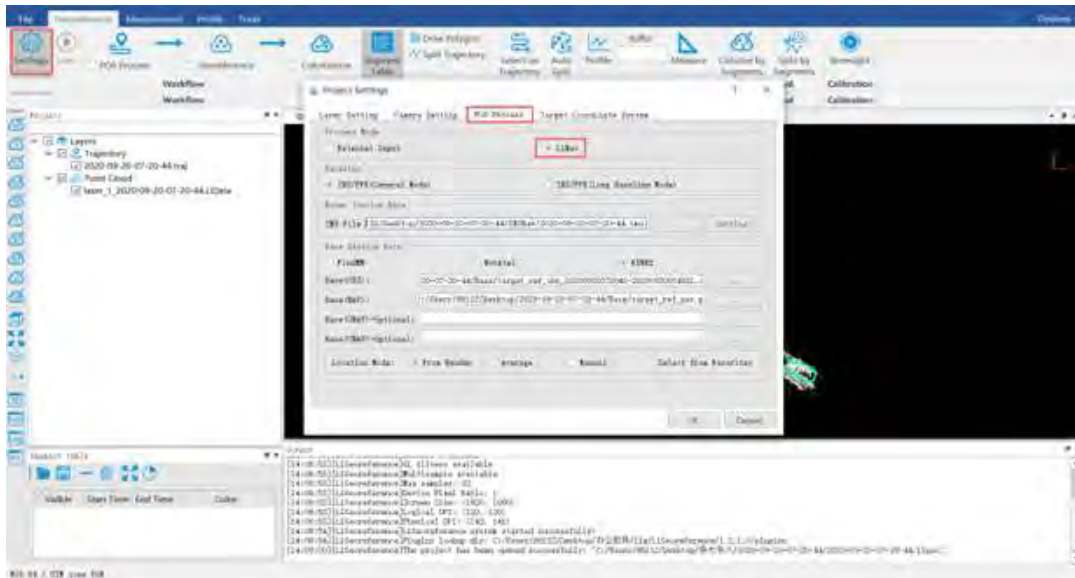
(1) Select LiNav processing mode

(2) Select the processing mode according to the length of the trajectory. It is recommended to use the general mode. When the length of the trajectory is more than 10 km, the long baseline mode can be selected.

(3) Load rover station data, under normal circumstances, the software will automatically read the rover station data under the project folder.

(4) Select base station data

Under normal circumstances, the software will automatically read the base station data in the project folder, or manually load the base station data.

If the format of the local base station is the Rinex format, select the Rinex option to load the base station data.

If the local base station format is Log format, select the NovAtel option.

(5)　　Enter the Base Station Coordinates

● When there is no precise base station coordinate, users could select "Average" mode. And the positioning principle is single point positioning, which leads to meter-level errors between the point cloud coordinates calculated by this method and the true coordinates.

● When there are accurate base station coordinates, users could manually input the base station coordinates. Additionally, users could use "Save to Favorites" function to save the entered base station coordinates, and later can directly use the saved base station coordinates through "Select from Favorites".

● Analyze from the data header: some base station files and base station coordinates are stored in the header file. "From Header" option needs to be clicked when users want to use this function. For example, Cloud Trajectory base station is normally stored in this mode.

● Select from favorites: Users could select the base station coordinates stored in the software.
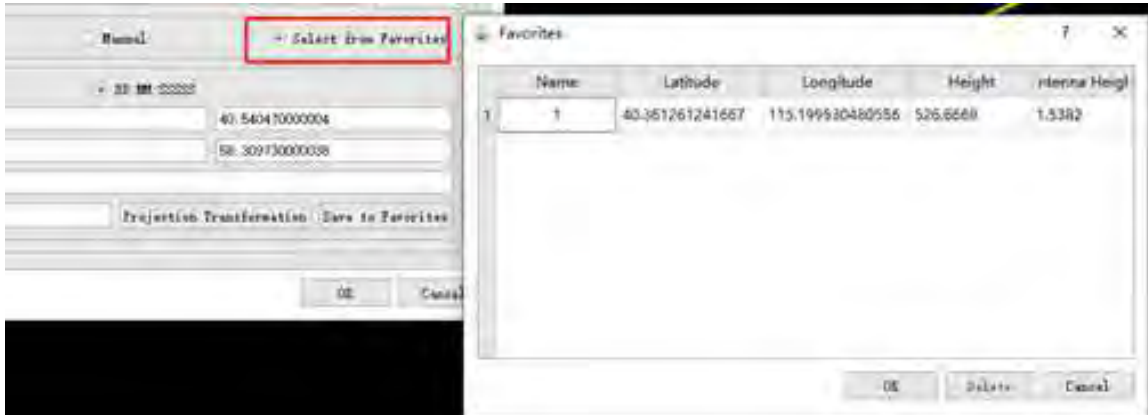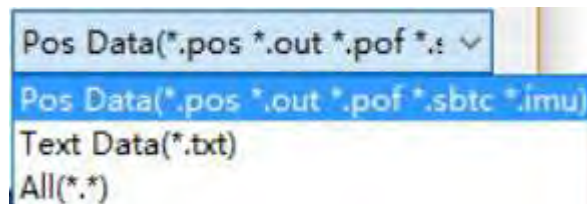
2. Import External IMU or Existing POS Data

Select "External Input" under Process Mode to import .pos data.
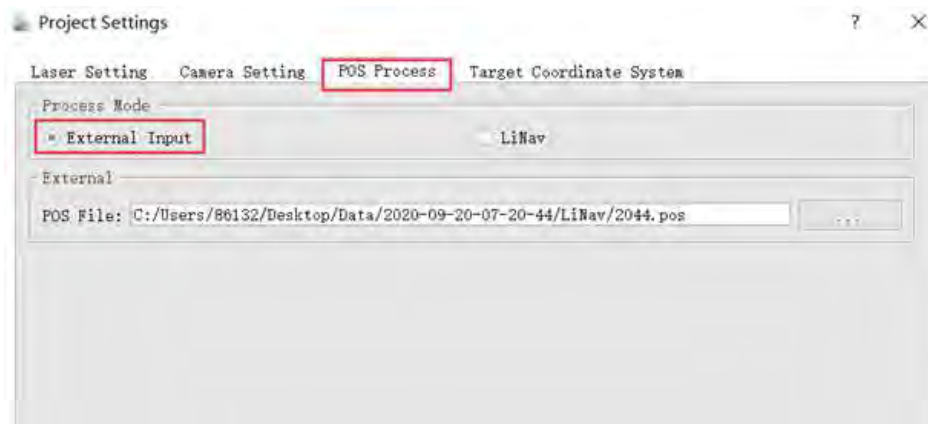
The external input function supports importing the original IMU data and the processed POS data, and the specific format includes *.pos, *.out, *.pof, *.sbtc, *.imu.

6.3.2 Laser Scanner Settings

Normally, the user does not need to change the parameters of the laser setting interface. If users want to limit the output power range by reflectivity, distance and scanning angle, users could change the range via clicking "Filter" to set the parameters. For more details, please visit LiGeoreference users guide.
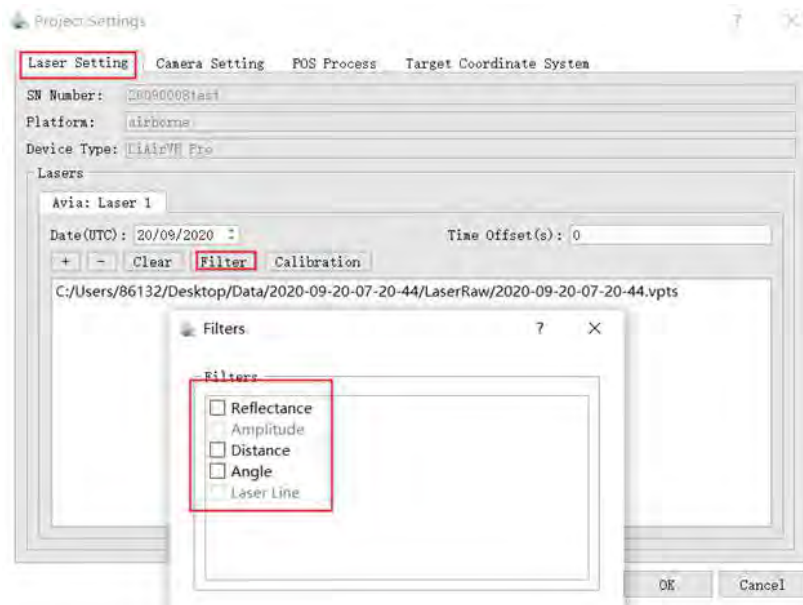
6.3.3 Camera Settings

Normally, users do not need to change the parameters of the camera setting interface. Uniform Color Function: sometimes the shooting is affected by the light and the uniform color function will make the light and dark more uniform, but will blur the color slightly.
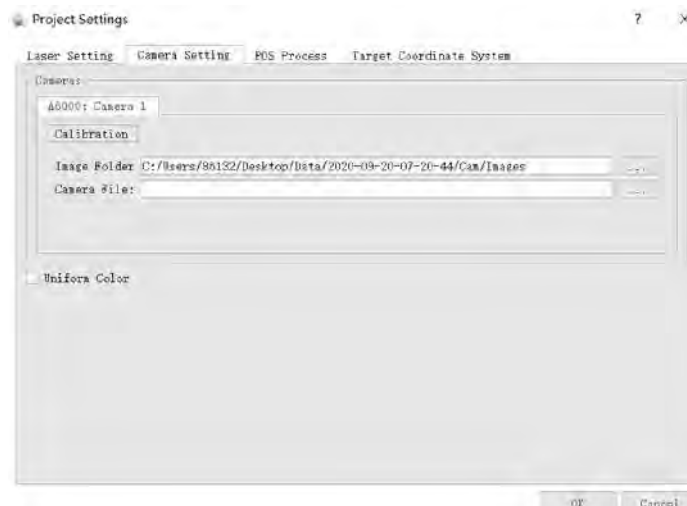
6.4 Georeferencing Point Cloud Data

1. Select Georeference Rage

Users could select the range to be georeferenced as needed. And there are two modes to be selected, including "trajectory selection" or "draw polygon". And this document only introduces the operation process of using the "trajectory selection" tool. The way of "drawing polygon" could be found in the user manual of LiGeoreference software.

(1) Click the "Select On Trajectory" button on the main interface of the software, and a table will automatically pop up at the same time, select the trajectory which needs to be georeferenced, and click OK.
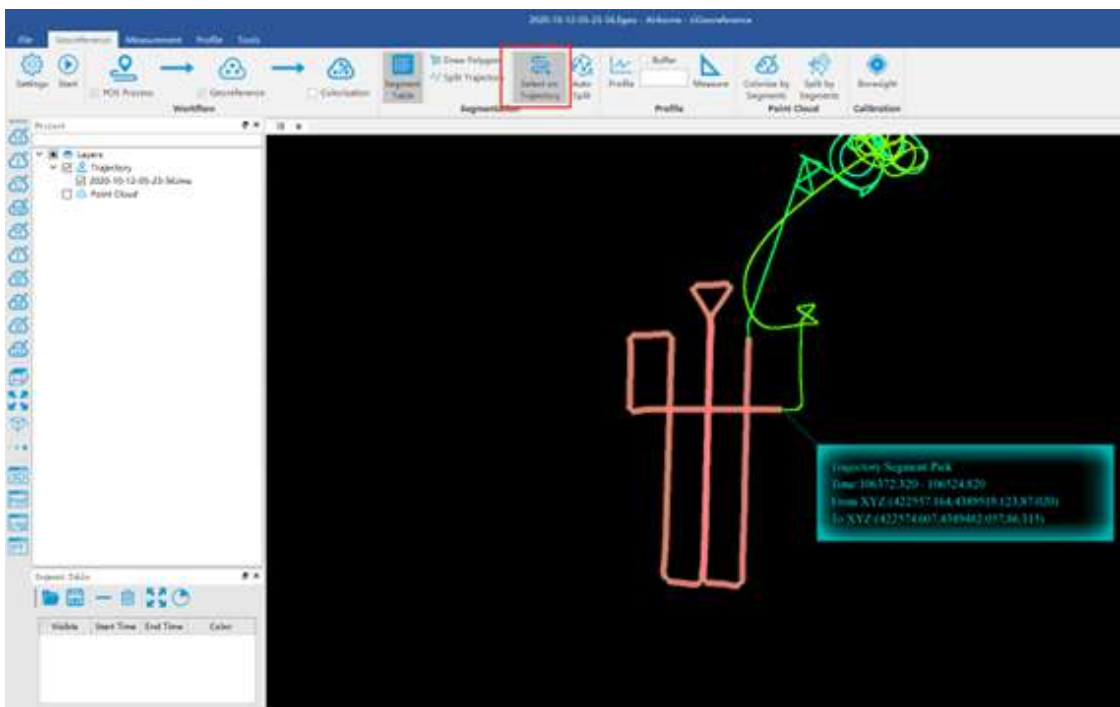

(2) If needed to select multiple trajectories, then repeat the above operation, and the selected trajectory segments will be displayed in the cutting table at the lower left corner.
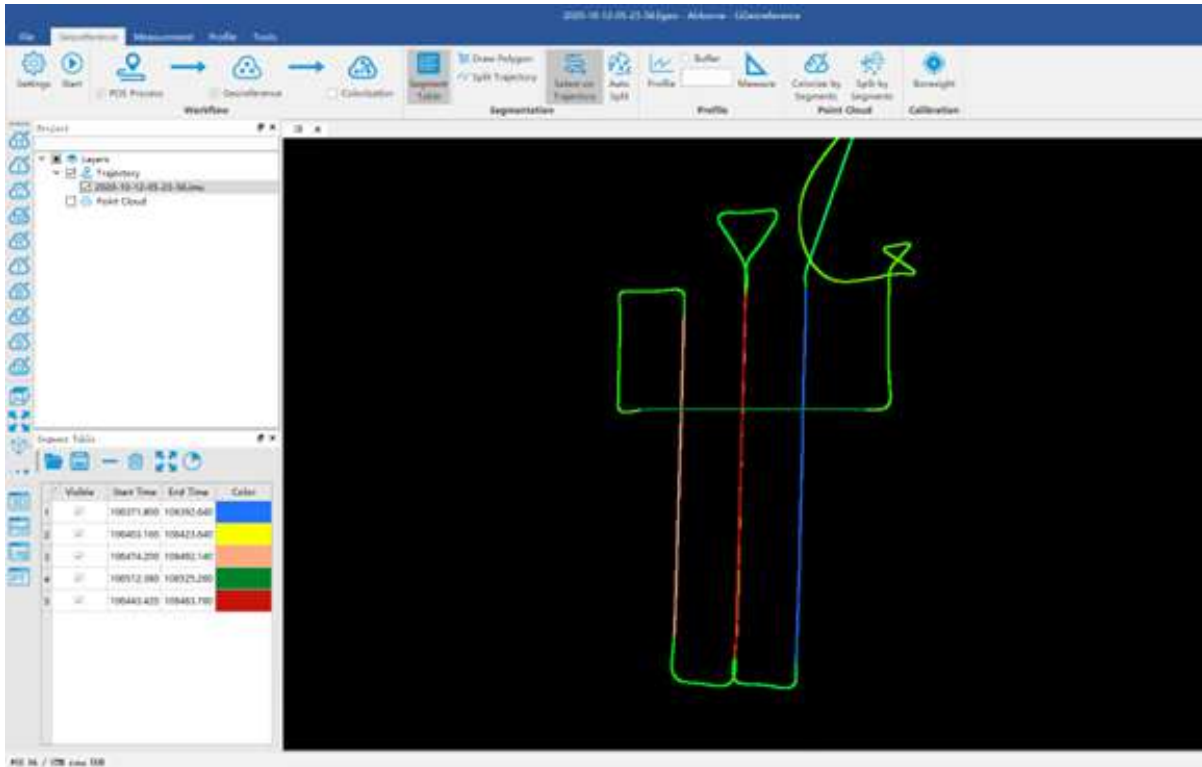
2. Select Processing Module

After opening the project, LiGeoreference will select "POS Process" and "Georeference" module by default. Users could check and re-choose the function modules as needed.
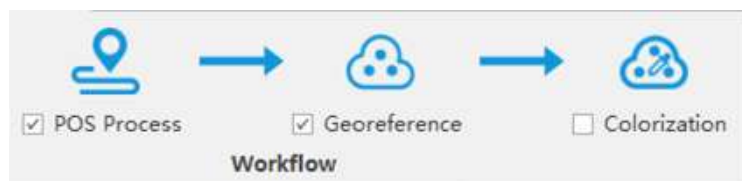
Note: If there is no image data, please do not choose "Colorization" module, otherwise the program will prompt an error.

3. Data Georeferencing

Click "Start" button to start data calculation. After the calculation is completed, the point cloud is automatically displayed in the main window.
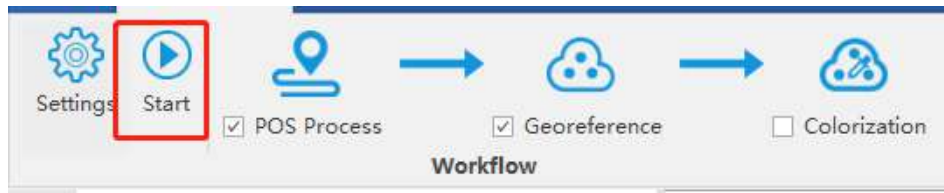
4. Data Quality Assessment Reports

If the user needs to view the "Trajectory Report" and the "Image Overlap Report", click the "Trajectory Plot" (or " Trajectory Report ") or "Image Overlap Report" (only suitable for devices with cameras) under the "Tools" bar.
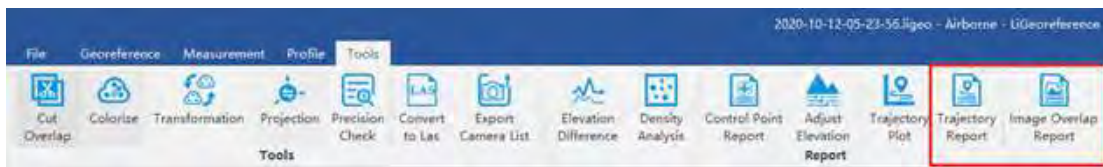

(a) POS Trajectory Report

There are 11 POS accuracy evaluation criteria included in the software. Usually, the number of satellites, data coverage, estimated attitude accuracy, estimated position accuracy and PDOP value are mainly checked during data quality inspection. Users can click the evaluation index of a certain plot, or directly click "Trajectory Report" to generate a complete track accuracy report.
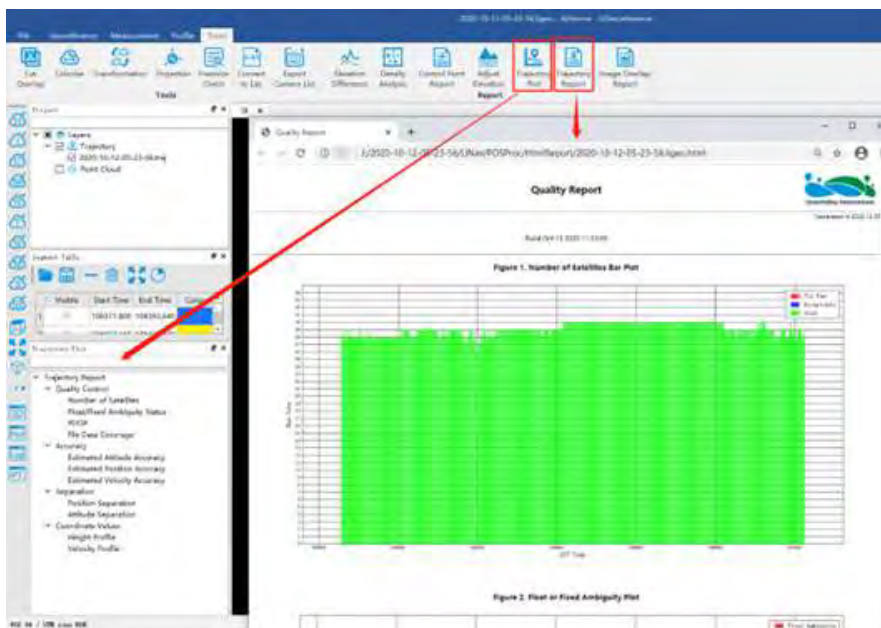
Satellites Number: Click to open the plot to show the relation between number of satellites, which can be reached, and the GPS time. This tool is used to show the number of satellites can be reached by the device each time during the data acquisition. Satellites number is shown on the Y-axis. The green part on the plot means the number of satellites is good at that time. The blue part on the plot means the number of satellites is just acceptable at that time. While the red part means the satellite number is too few to meet the requirement. The insufficient GNSS signal will result in poor data quality. If the number of satellites can be reached by the device is too few during a period of data acquisition, user can select the time period and right-click on that. Then click "Go to Time" button to find out the corresponding period on the trajectory.
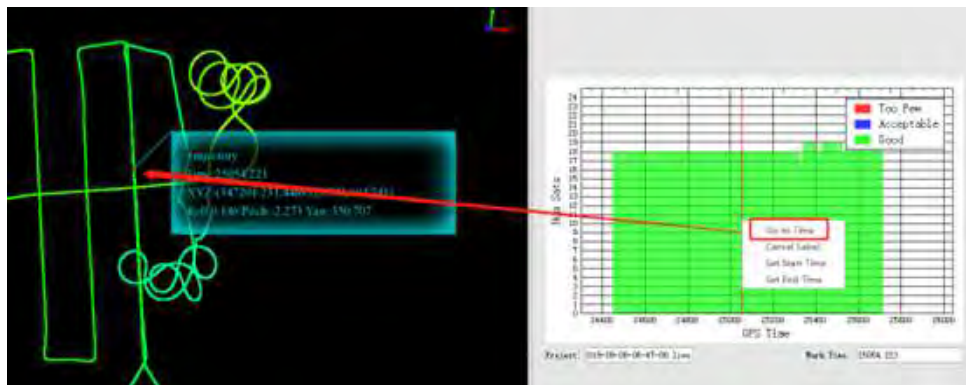

Floating/Fixed ambiguity status: Click to show the plot of ambiguity resolution status. This is used to show the situation of cycle ambiguity resolution. If the status is shown as green on the plot, it means the cycle ambiguity resolution is fixed. If it is red on the plot, it means the cycle ambiguity resolution is floating.

PDOP: Position dilution of precision, or PDOP, shows the distribution of the GNSS satellites. Click to show the plot of PDOP. The smaller PDOP is, the better the distribution is.
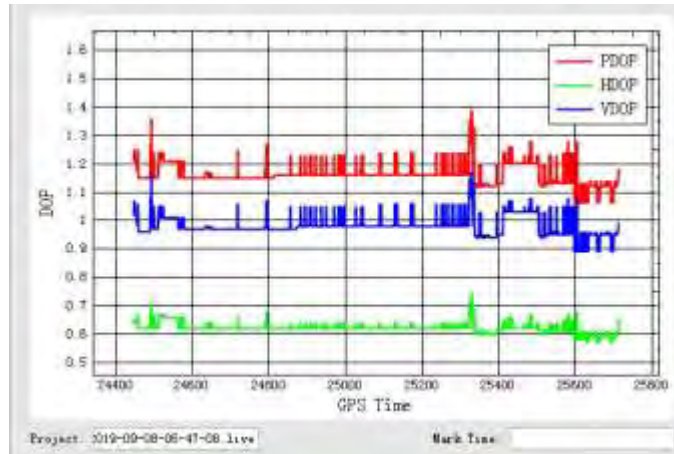

File Data Coverage: Click to show the plot of data coverage situation. This is used to show the data coverage relation among base station data, IMU data, and GNSS data of the moving device.
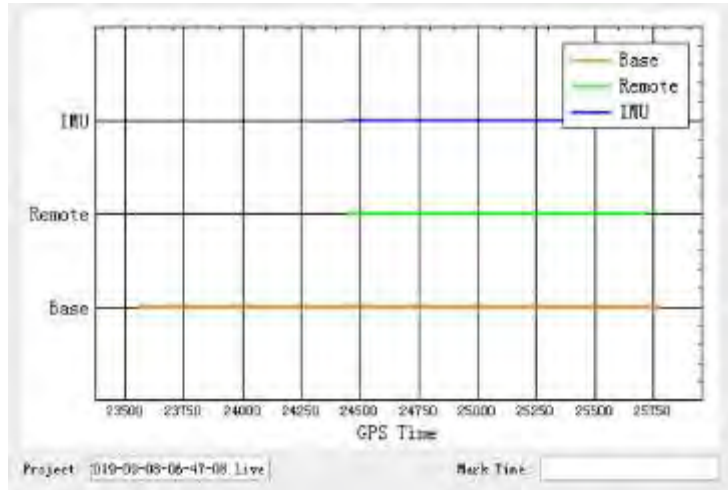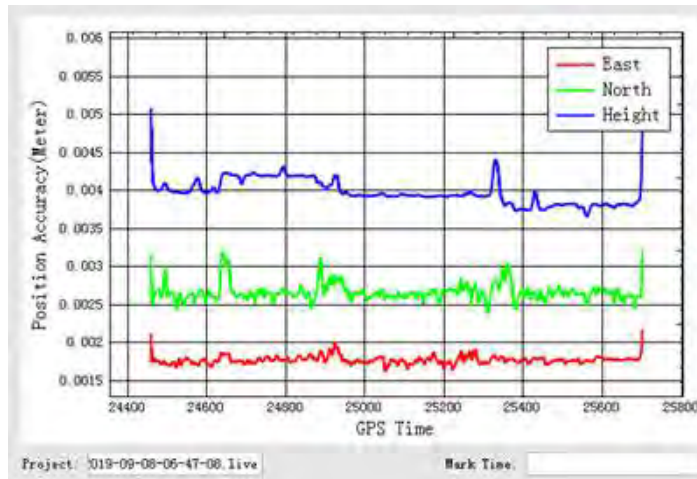

Estimated Attitude Accuracy: Click to show the plot of attitude accuracy. This plot is used to show that if the accuracy exceeds the limitation of the IMU accuracy. The X-axis shows the GPS time. The Y-axis shows the attitude accuracy. Red line is for changes in Roll direction. Green line shows the changes in Pitch direction. While the blue line shows the changes in the heading direction.
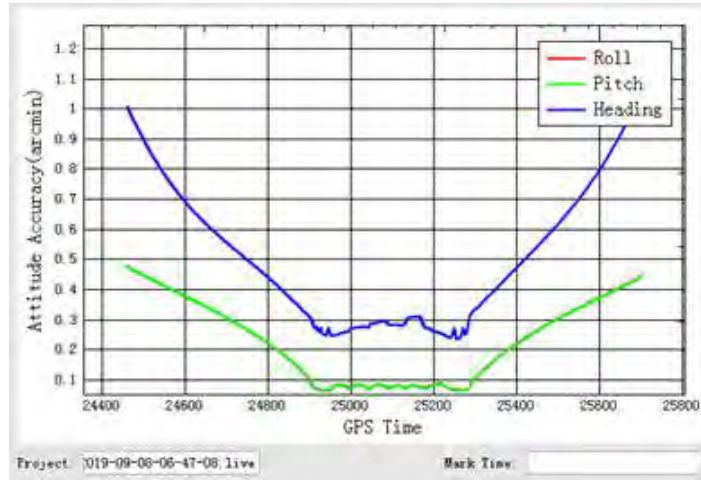
Estimated Position Accuracy: Click to plot the position accuracy. The X-axis shows the GPS time. The Y-axis shows the position accuracy. Red line is for position accuracy in East direction. Green line shows the position accuracy in North direction. While the blue line shows the position accuracy in height direction.


Estimated Velocity Accuracy: Click to plot the velocity accuracy. The X-axis shows the GPS time. The Y-axis shows the velocity accuracy. Red line is for velocity accuracy in East direction. Green line shows the velocity accuracy in North direction. While the blue line shows the position velocity in height direction.
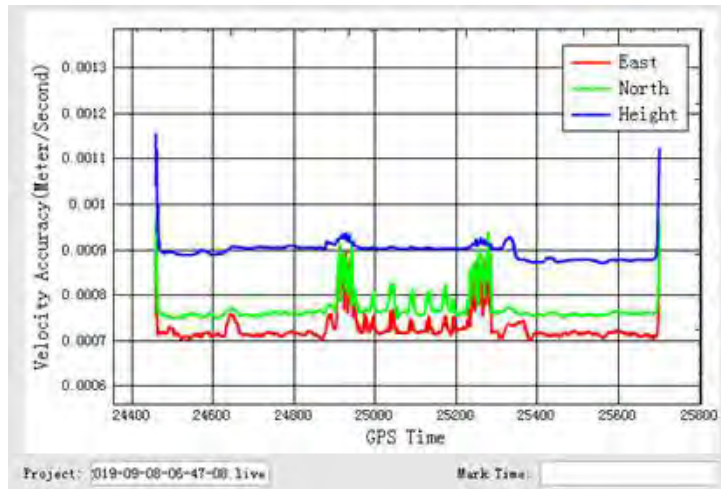
Position Separation: Click to plot the position separation. This plot shows the differences of position in East, North, and Up directions during the forward-backward processing.
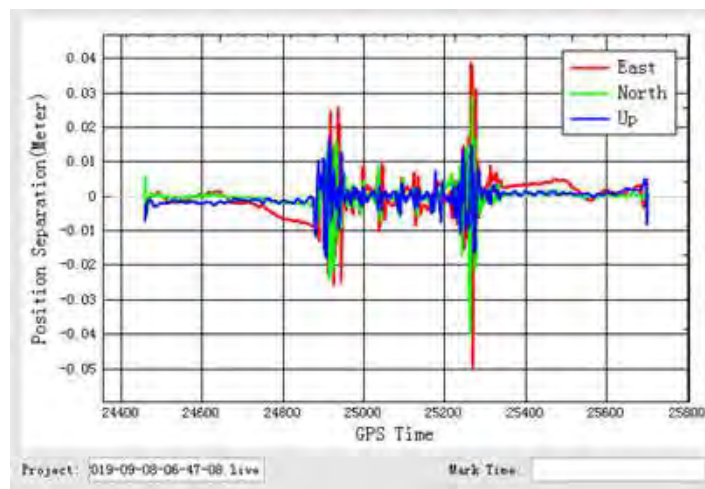

Attitude Separation: Click to show the plot of attitude separation. This plot is used to show the difference among the angles in Roll, Heading, and Pitch directions during the forward-backward processing. The smaller the value is, the better the matching degree of the forward-backward processing is.
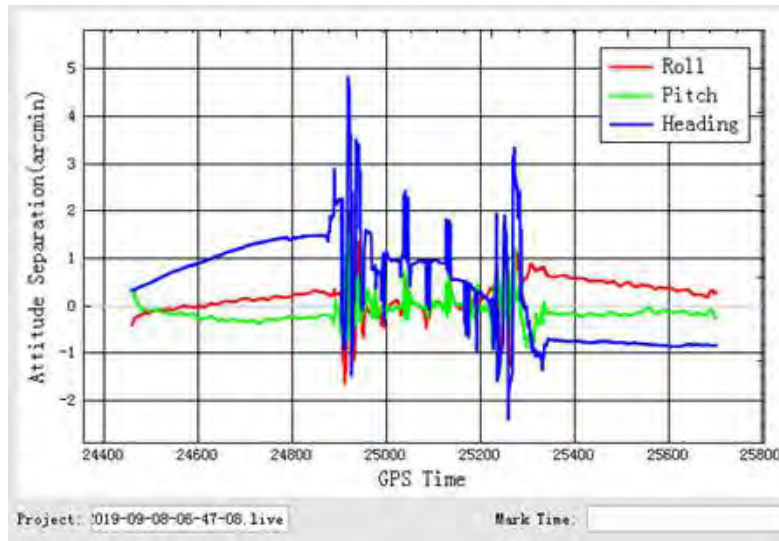
Height Profile: This plot shows the changes in height during the data acquisition.


Velocity Profile: This plot shows the changes in velocity during the data acquisition. Red line is for the changes in East direction. Green shows the changes in North direction. While the blue line shows the changes in up direction to the ground.
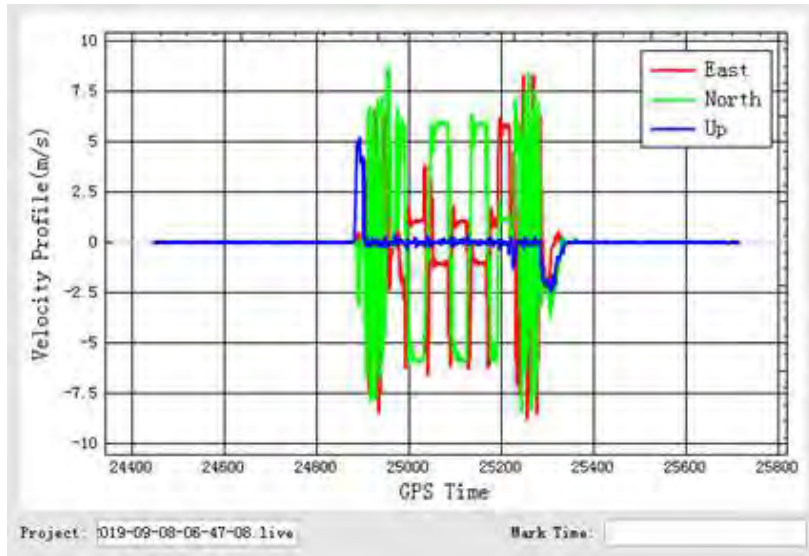
(b)   Image Overlap Report

The image overlap report lists the image overlap. The report could check whether the photos are lost.
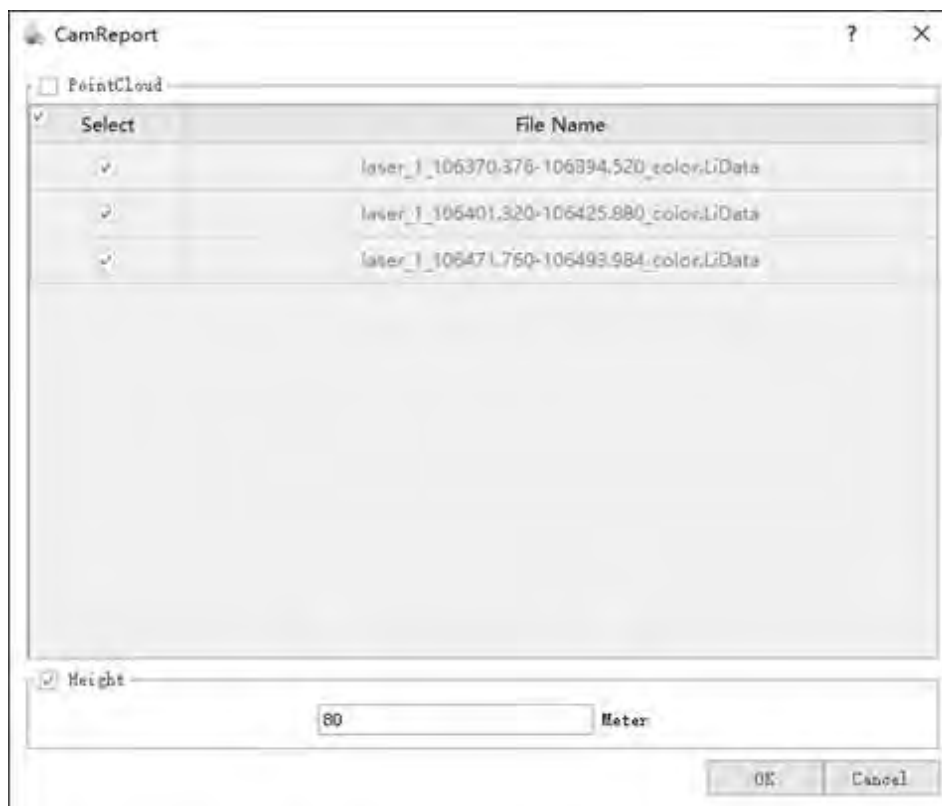
7.System Transportation and Maintenance

7.1 Operation Notice

To ensure the reliable use of the system and the safety of the operation personnel, please observe the following notices during installation, use and maintenance.

1. Pay attention to the protection of the scanning lens to prevent scratches.

2. Handle with care during installation to prevent the system from falling or being impacted.

3. Before scanning, please make sure the scanning lens is clean and dust-free.

4. Avoid sudden changes in temperature to prevent damage to the system.

5. During the operation, it is forbidden to directly contact the laser scanning lens with any part of the body.

6. If the system needs to be transported, it must be stored within appropriate packages.

7. The operating temperature of the system is -20°C~50°C. In case of rain, snow, fog, sand and other bad weather, the operation should be stopped. It can prevent equipment damage and on the other hand, it can ensure the measurement accuracy. In case of sudden bad weather during work, please move the device to a safe place in time.

8. Please pinch both ends of the connector when pulling out the OSDK communication cable, and prohibit violent insertion and removal.

9. Non-professionals, without permission, please do not try to disassemble the equipment, do not repair it without permission, so as to avoid accidents or aggravate the damage of the equipment. If the equipment is modified or disassembled not authorized by GreenValley International Inc., the warranty will be void.

7.2 Equipment Maintenance

1. Before turning on the device, check whether the scanner lens is clean, if there is any stains, it should be cleaned immediately.

2. After the equipment is used, check whether the scanning window of the scanner is dirty. If it is dirty, it should be cleaned up immediately

3. Regular cleaning: Use special lens paper to gently wipe the laser scanning lens, and wipe from the inside to the outside in a circular manner.

4. The storage temperature range of LiAir system is -30°C ~+60°C , and the storage environment requires ventilation and dryness.

5. Make sure that all power is turned off before storage, and the equipment is stored in an appropriate box.

6. If the storage time is more than one month, the power-on test should be carried out.

7. During the transportation of LiAir equipment, the packing box equipped at the factory should be used.

8. If it needs to be packed separately due to special circumstances, please ensure that the packing box has a certain pressure resistance, and label the outside of the box with signs such as "Precision Instrument", "Handle with Care", "Fragile", etc. to avoid equipment damage.

9. The instrument is a precision instrument, avoid violent impact during transportation and handling, and avoid damage to the optical components in the instrument or cause direction deviation.

10. During the warranty period, customers can enjoy free firmware update services. After the warranty period is expired, customers can purchase firmware update services.