GreenValley International

LiGrip H120

Rotating Handheld SLAM LiDAR System

LiGrip H120

User Manual (Ver A.03).

Manual revisions

Revision date	Revisions	illustrate
September 1, 2022	1	LiGrip H120 User Manual V3.0
September 30, 2022	2	Added content about the use of backpack kits
July 4, 2023	3	LiGrip H120 User Manual (Ver A.03)

Preface

Manual Use

This user manual describes the operation process of H120 from assembly, acquisition, solution, multi-engineering splicing and so on.

Scope of Application

This use applies to H120 products.

Security Technology Tips

	Note: Please read carefully the places that need to be paid attention to when you operate.
	Warning: If you do not follow the requirements, it may cause device damage, data loss, incorrect data, system crash, etc., please read it carefully.

Liability Waiver

Before operating the equipment, you must carefully read this manual, which will help you to use this product better. The company shall not be liable for the damage caused by your misoperation of this product due to failure to operate this product in accordance with the requirements of the operating manual, or failure to correctly understand the requirements of the instruction manual. The company is committed to continuously improving product functions and performance, improving service quality, and reserves the right to change the contents of the instruction manual without prior notice.

We have checked the consistency of the content stated in the printed matter with the hardware and software, and then do not rule out the possibility of deviation, the pictures in the instruction manual are for reference only, if there is any discrepancy with the actual product, please refer to the actual product.

The settings of the camera are preset by us and must not be changed by ourselves, otherwise there may be no video files, color attachment disorder, no color attachment, etc.

Your suggestions

If you have any suggestions and comments on this manual, please contact us, your feedback information will greatly improve the quality of our manual.

Contents

CHAPTER

1

01 H120 Overview

This section describes:

- Product introduction
- SLAM overview
- Applicable environment

1.1 Product introduction

The latest handheld laser 3D scanner that uses SLAM algorithms to work even where there is no GNSS signal, GreenValley International's LiGrip H120. It can be widely used in topographic surveying and mapping, forestry survey, indoor and outdoor integrated surveying, earthwork surveying, façade surveying and mapping and other fields.

The H120 backpack kit supports GNSS signal access and can directly acquire point cloud data with absolute coordinate data.

The schematic diagram of the H120 equipment is as follows, the main equipment is the equipment host, equipment battery box, B58 battery, camera, and related accessories.

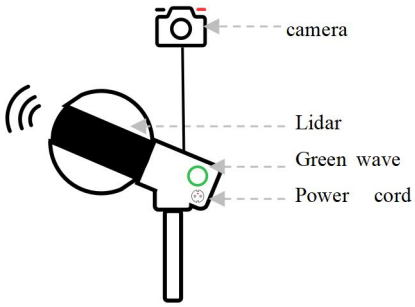


Figure 1-1 Handheld device host diagram

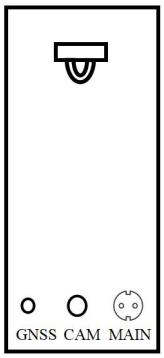
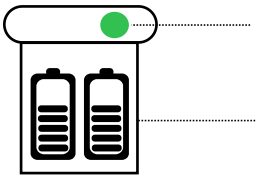


Figure 1-2 Handheld battery box



Battery compartment power on button

B58 battery

Figure 1-3 Self-developed battery

Black button: Power on and off button
Red button: End recording key

Figure 1-4 Insta 360 camera

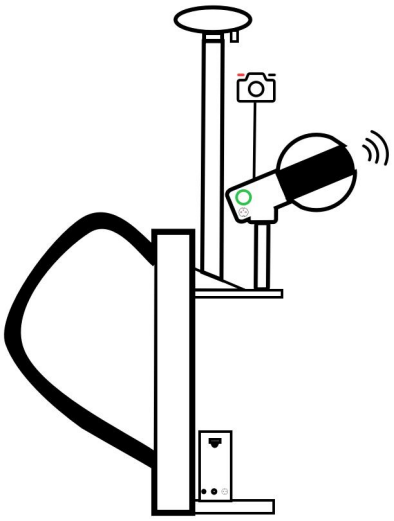


Figure 1-5 Backpack kit

1.2 SLAM overview

SLAM, Simultaneous Localization and Mapping, instant localization and map building. Starting from an unknown location in an unknown environment, locate its own position, attitude, and movement trajectory through sensor observation, and build a map according to its own location. Locate itself based on location estimation and maps during movement, that is, real-time positioning complements map construction.

Simple understanding: multi-frame point cloud data is collected during the moving process, and the SLAM algorithm analyzes and identifies the point cloud data frame by frame. The last two frames swept object A at the same time, and the point cloud data of object A in the two frames was analyzed to determine that it was the same object A, and the data of the two frames before and after were stitched accordingly. The entire map construction is formed by flattening frame by frame.

Therefore, when the SLAM algorithm has poor recognition ability, it determines that the A object in the previous frame and the B object in the back frame are the same object, and they are stitched together, and the stitched image is divorced from the real situation.

This also requires sufficient feature points in the environment. In an empty playground, where two frames cannot be stitched together, they can only be stacked here, the point cloud image becomes thicker, the three-dimensional image is not clear, and the quality decreases.

According to this principle, the SLAM algorithm will accumulate errors as the number of point cloud frames increases, and the errors will become larger and larger.

We recommend: if you need to attach color you need to stop the project within 15 minutes, without a camera you need to stop the project within 30 minutes, then Reopen a project to avoid problems caused by the accumulation of errors.

1.3 Applicable environment

Operating temperature: -10°-40°

Waterproof and dustproof level: IP54

Applicable environment: Since SLAM depends on features, it is suitable for areas where features are more obvious. Unadapted to the scene where the characteristics are not obvious, empty, with a large traffic flow, shaking leaves and flowers.

Scenarios that do not apply			
numbering	description	Scene picture	remark
1	Figures with inconspicuous features		For example: smooth tunnels
2	Empty place		For example: open flat land, roads
3	Heavy traffic of vehicles and people		National highways, bustling commercial streets with a large flow of people, intersections

4	Swaying leaves and flowers		Windy parks, wooded areas

CHAPTER

2

02 H120 Product Composition and Assembly

- Product composition
- Product assembly

2.1 Product composition

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1. Handheld device host*1

Used for lidar, IMU, video files, GNSS data.

2. Handheld device battery case*1

It is used to store LiDAR, IMU, GNSS data, and send control instructions.

3. Back Strap*1

Easy to carry the battery compartment.

4. Main unit power cord*1

It is used to supply power to the host and transmit data during acquisition.

5. Data transmission cable*1

Used to copy the acquired raw LiDAR, IMU, GNSS data.

6. B58 battery*1

Used to power the entire device.

7. Laser scanner protective cover*1

Used to protect LiDAR equipment.

8. Battery charger*1

To charge the battery.

9. USB flash drive*1

The transferred data used for copying.

10.Shipping box*1

For storage and transportation of equipment.

11.Backpack kit (optional)

Backpack kit with GNSS device.

2.2 Equipment assembly

2.2.1 H120 assembly

Figure 2-1 Inserting the battery

The power button is facing the direction of the power hole.

Figure 2-2 The host power cable is connected to the handheld device console and the battery compartment (MAIN port)

One section of the host power cable is connected to the handheld end, and one end is connected to the MAIN port of the battery box. Pay attention to the insertion of red dots to red dots, and there is a clicking sound when the insertion is successful.

Figure 2-3 Attach the strap and remove the protective cover

When removing the protective cover, please pay attention to hold the host device steady.

Figure 2-4 Assembly is complete

2.2.2 Backpack kit assembly

(1) Backpack kit composition

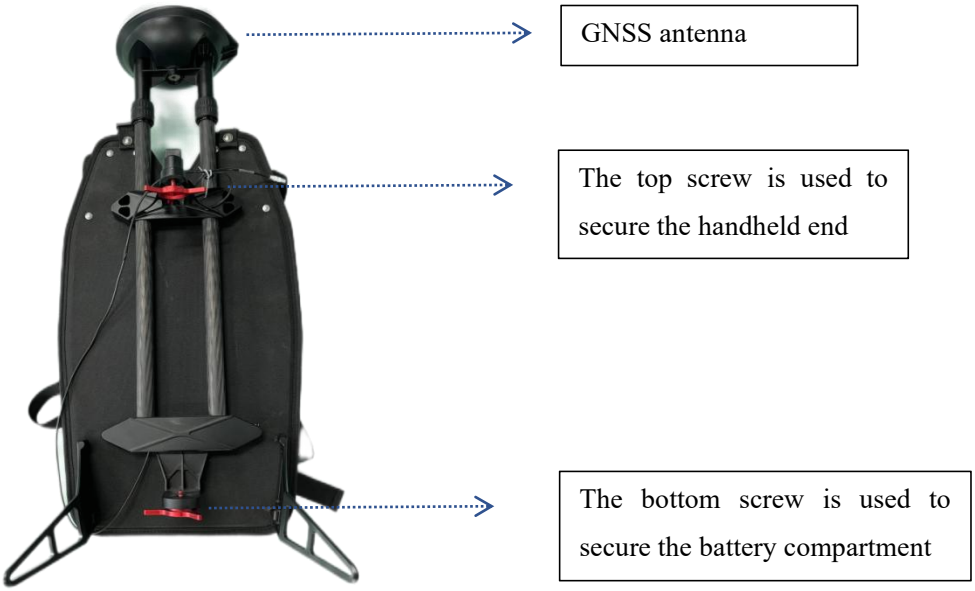

Figure 2-5 Backpack kit composition

（2）Assembly of backpack kits

Figure 2-6 Align the battery compartment with the bottom screw and tighten

Figure 2-7: Disassembling the dot base

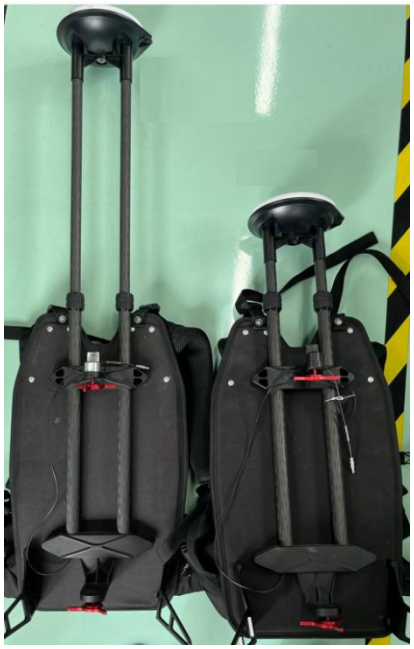

Figure 2-8 Fully withdraw the telescopic rod and tighten it

The telescopic rod must be fully withdrawn, if it is not fully withdrawn, then the measurement is inaccurate.

Figure 2-9 Hold the bottom to the top insert and tighten the screws

Figure 2-10 The GNSS cable is inserted into the GNSS port of the battery compartment

Figure 2-11 Connect the power cable (MAIN port).

When installing a backpack kit, it is best to have two people install it together to ensure the safety of the device.

At this point, the backpack kit is assembled.

CHAPTER

3

03 Path Planning, Zoning, Control Point Planning

- Path planning for outdoor scenes
- Path planning for indoor scenes
- Strip scene path planning
- Mine path planning
- Forestry path planning
- Regional division
- Control point planning

Good path planning, zoning and control point planning are the keys to acquisition success.

3.1 Closed loop

Closed-loop can greatly improve the reliability and accuracy of data, so when conditions permit, take a closed loop as much as possible.

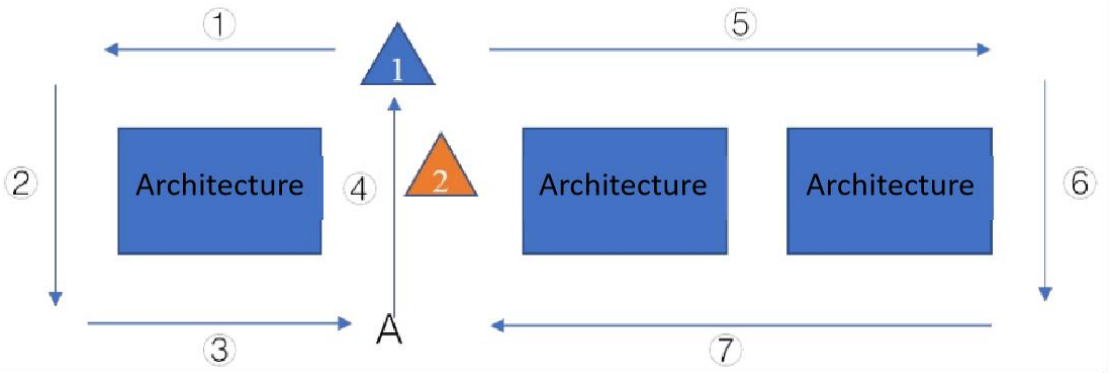

Figure 3-1 Closed loop

As shown in the figure above, buildings 1, 2, and 3 are the objects to be scanned, and it is recommended to start scanning from 1 instead of 2. Before starting the scan, plan the scanning route, according to the above rules, the driving route of the scene scan is (1)(2)(3)(4)(5)(6)(7) or (5)(6)(7)(4)(1)(2)(3).

When closing the loop, it is necessary to walk an extra 5-10 meters to ensure that the program closed-loop recognition is correct (Figure 3-2).

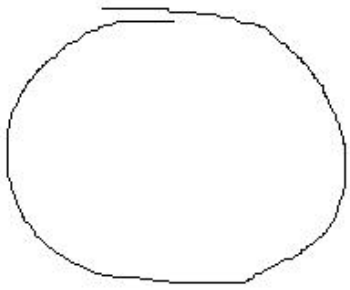

Figure 3-2 Correct Closed Loop

The following is an example of a closed loop of errors:

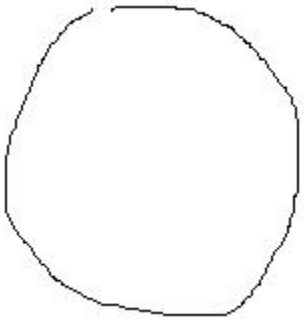

Figure 3-3 The closed-loop distance is not enough

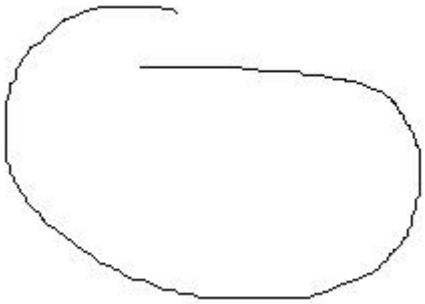

Figure 3-4 Closed-loop area error

3.2 Outdoor scene path planning

Closed-loop is an effective way to improve SLAM accuracy, so when conditions permit, try to take a closed loop, which can effectively reduce control points and improve accuracy.

The end can close the loop, have a beginning and an end, and can also improve the accuracy of the point cloud.

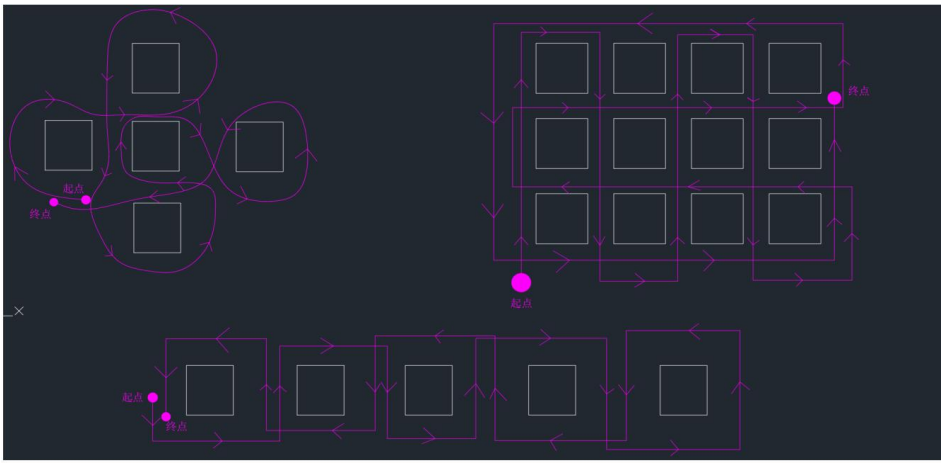

Figure 3-5 Outdoor path planning

3.3 Indoor scene path planning

Indoor can walk a closed loop, try to walk a closed loop.

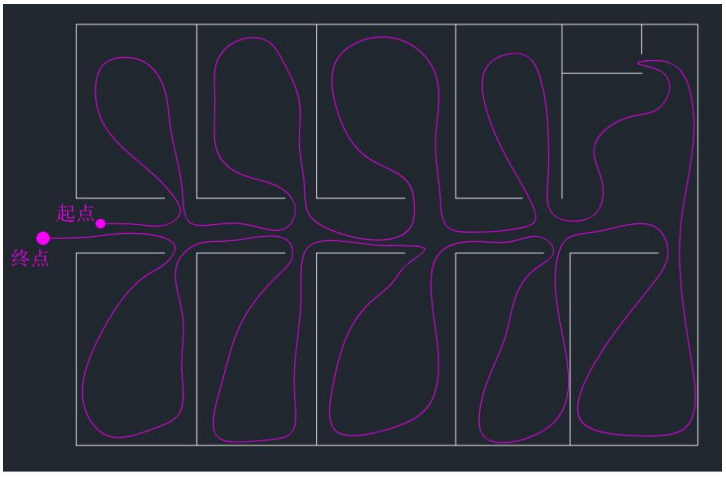

Figure 3-6 Indoor path planning

To collect multi-storey data, for example, if there are 5 floors in total, you can measure floors 1-3 and then floors 3-5 to ensure that there is at least one overlapping area on the first floor.

3.4 Path planning for strip scenes

When collecting roads, tunnels, mines, electricity, etc., it is not recommended to go back (unless necessary).

When collecting a wide road, it is recommended to collect one side, you can reduce part of the accumulated error by taking the S-shaped method, if the accuracy requirements are high, it is recommended to lay a control point at 50m.

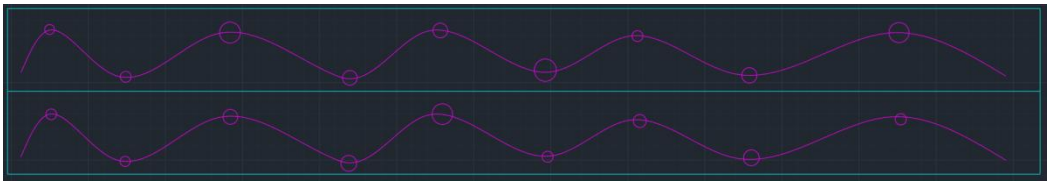

Figure 3-7 Path planning for a strip scenario

If the traffic and people flow are large, then it is recommended to do it at night when the traffic and people flow are small, such as 12 p.m. to 6 p.m.

Note: Be careful with ribbon scenes! Never place control points on a straight line, be sure to measure control points on the left and right sides of the strip scene.

3.5 Path planning of mine caves

If the path planning of the mine can be closed-loop, try to close the loop. If the loop cannot be closed, control points need to be laid and the measurement time should be controlled within 30min (if there is no light in the mine or the light is dim, and the camera has little effect, we recommend turning it off to improve the single operation time).

3.6 Path planning for forestry

Take a 30m*30m forestry sample as an example:

Path planning for the collection area, the purpose of route planning is to collect all the information of the trees, while reducing data redundancy, for the 30m*30m sample area, if the trees are more dense, use the path planning shown on the left side of the figure below, if the trees are sparse, you can use the path planning shown on the right of the figure below.

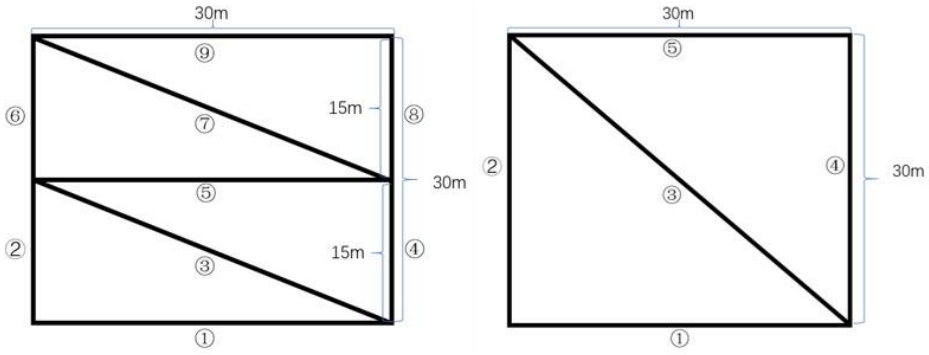

Figure 3-8 Path planning (densely wooded: left, sparsely wooded: right).

3.7 Area division

If the survey area cannot be measured in one sortie, then the measurement area needs to be divided. The division principle is as follows:

（1）The measurement time of each area is controlled within the specified time;

（2）Maintain a 10-20% overlap rate per region;

（3）There should be enough features within the overlapping areas;

（4）If absolute coordinates are required, it is recommended to ensure 3 or more control points in the overlapping area.

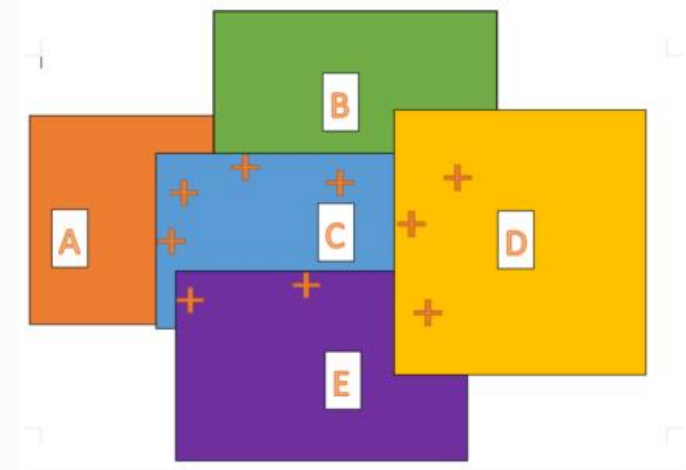

Figure 3-9 Area division

3.8 Control Point Planning

In areas with good GNSS signals, the H120 backpack kit does not need to hit control points. However, some scenarios, such as areas with poor GNSS signals (between high-rise buildings, alleys), areas without GNSS signals (underground corridors, underground parking lots) and other areas, need to lay a certain number of control points to ensure the accuracy of the point cloud.

The control points need to be evenly distributed, and the circles in the figure below represent checkpoints (the role of checkpoints is used to verify the accuracy of the point cloud in the later stage), and the triangle represents the control points, evenly covering the entire measurement area.

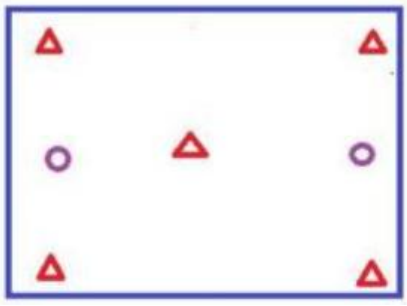

Figure 3-10 Control points evenly distribute the measurement area

Control points are strictly forbidden to be in a straight line

The correspondence between density and accuracy of control points is as follows:

The accuracy in Table 1 is for reference only, and here is only to highlight the difference in accuracy brought about by different control point densities and closed loops.

Table 1 controls point density and accuracy

Control mode \ medium error	Error in plane/cm	Medium error in elevation/cm
Straight line, 50m one control point	6.15	6.19
Straight line, 100m one control point	6.99	12.29
Closed loop, 50m one control point	3.98	6.06
Closed loop, 100m one control point	5.15	10.65

CHAPTER

4

04 Base Station Erection

Only the backpack kit requires a reference station. Third-party base stations can be used.

- PPK base station assembly

  Base station assembly

  Base station setup

  Measuring height of the instrument

  Static recording

  Data transfer

- Setting up of Virtual Base Stations (if this service is available)

  APP operation methods

The base station can use any brand of GNSS equipment

4.1 Setting up PPK Base Stations

4.1.1 Base station assembly

For more information on the use of base stations, please refer to the user manual of the base station.

4.1.2 Base station setup

Base station erection needs to be erected at a known point, and its requirements for base sites are as follows:

① The ground foundation is stable, which is convenient for the erection and operation of the base station;

② The field of view is wide, and the height angle of obstacles around the field of view should be less than 10°~15° to ensure that the satellite signal is not affected;

③ There should be no objects in the vicinity that strongly reflect the satellite signal (such as large buildings, etc.);

④ Stay away from high-power radio emission sources (such as TV stations, radio stations, microwave stations, etc.), and the distance should not be less than 200m; Stay away from high-voltage transmission lines and microwave radio signal transmission channels, and the distance should not be less than 50m.

Figure 4-1 Base station erection

The base station must be strictly centered, otherwise the data quality is unreliable.

4.1.3 Measuring height of the instrument

Instrument height = height from the ground center point erected by the base station to the measurement marker. For example, the flag position measurement shown in the red box in Figure 4-3.

Figure 4-2 Instrument high volume

Figure 4-3 The instrument is positioned in high quantities

Measure the height of the instrument with a steel tape measure from 2 directions, and if the error is less than 3mm, take the average value to calculate the antenna height.

4.1.4 Static recording

10-15 min before lidar data acquisition, start static acquisition.

Static acquisition is completed approximately 10 minutes after the end of laser data acquisition.

Note: Before handheld data collection, the base station should be set up and recorded at least 10 minutes in advance. At least 10 minutes after the end of handheld acquisition, stop recording data and turn off the base station, that is, the base station data must fully cover the time of handheld measurement.

4.1.5 Data transfer

Copy the base station data file, and if necessary, convert the static format of the GNSS receiver of each manufacturer to the common Rinex format (O file, P file).

4.2 Setting up a Virtual Base Station (Applicable in China)

The virtual base station service is applicable in China by GreenValley, that is, pre-event base station. Set up the base station before the operation (setup on the APP), and stop data recording after the scanning.

Tap Settings --> Base Station --> Create Virtual Station --> OK.

You will be prompted to enter the task name (confirm the coordinate system), and finally create it successfully.

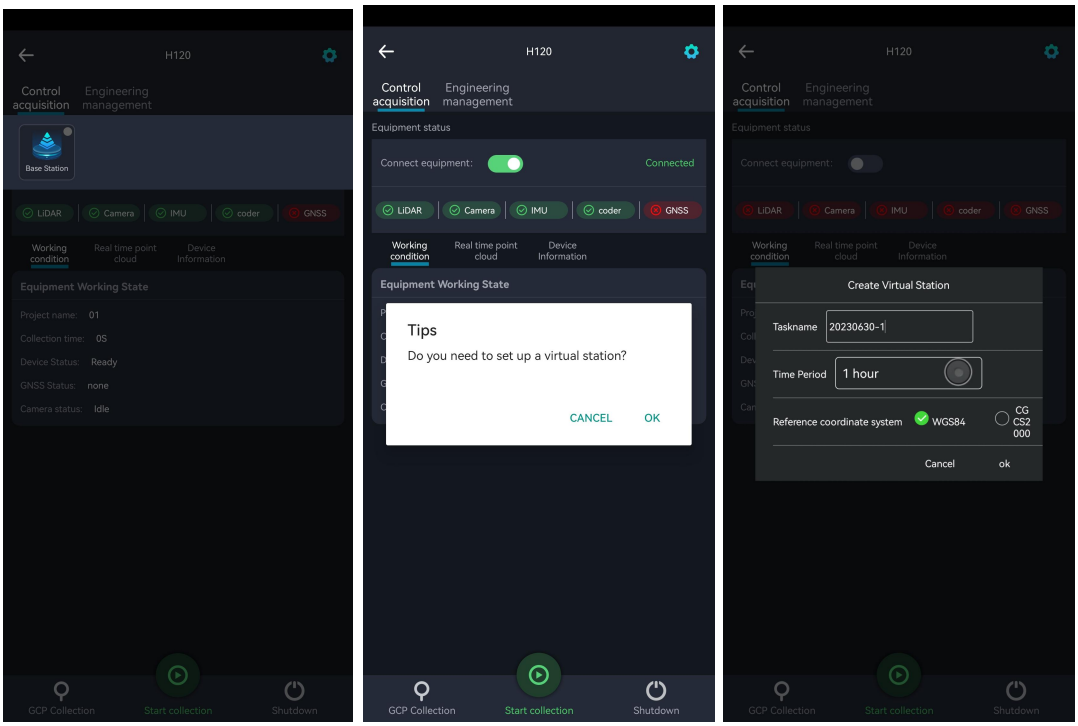

Figure 4-4 Set Virtual Base Station in app

After scanning, **tap Settings --> Base Station --> Stop virtual base station --> OK.**

After stopping, the app will generate a base station record on the LiCloud backend.

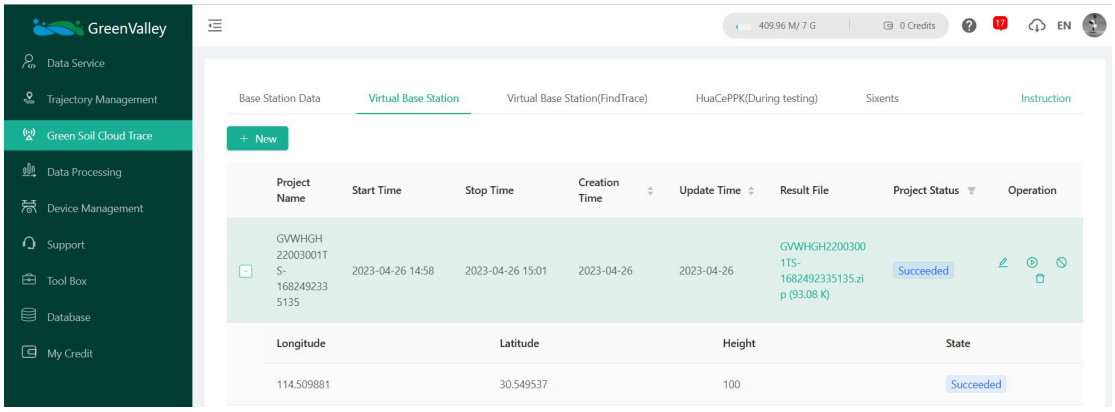

Figure 4-5 Virtual base station data download

The status “Succeed” is displayed, indicating that the data was created successfully. Data can be downloaded from the web page and imported into the LiFuser-BP for use.

CHAPTER

5

05 Data Collection

- Data acquisition
- Data collection considerations

At present, it supports button-based data collection and supports APP data collection. And when using the button to collect, the APP can display the current equipment status, real-time point cloud, and the number of satellites. When using the APP to collect, it can also be operated with a button.

Before data collection, make sure that the device has enough storage space and clean it if necessary.

If you want to delete video files, it is recommended to use the formatting feature of the Insta 360 camera itself to do all at once.

5.1 Button-based

5.1.1 Initialization

Region selection requirements for initialization:

① Choose a smooth ground or platform;

② If GNSS signal access is required, then ensure that the search for stars is good, generally more than 20;

③ Do not have strong electromagnetic interference nearby;

④ Do not initialize in places with a lot of people and traffic;

⑤ Do not initialize in an open area.

(1) Place the equipment on a stationary ground or platform

Figure 5-1 Placed on the ground or platform

The device battery compartment should be as close as possible to the handheld device host, otherwise the camera will not automatically start recording

(2) Power up the device

The battery is powered on after a short press of 1s and a long press of 2s.

Figure 5-2 Power up the device

(3) Turn on the camera

Press the camera black button shortly, the camera screen will always turn on, and the camera indicator will turn light blue.

Figure 5-3 Turn on the camera

(4) After the device is powered on

The main unit button flashes rapidly, during which the camera takes a selfie (there will be a clicking sound) and the indicator light changes to a solid state. The whole process takes about 75S.

Figure 5-4 Fast blinking to solid light

(5) Device initialization

Long press the host button to flash and then let go, keep the equipment strictly still, the laser initialization rotation about two and a half turns to stop, after a period of time the camera **automatically starts** recording (the camera indicator light changes from light blue to red), the laser rotates at a uniform speed, constructs the base map, and the

button light flashes quickly throughout the process.

After the indicator flashes from fast to slow, the device is initialized.

Figure 5-5 Press and hold the button for initialization

Figure 5-6 The camera starts recording

The camera starts recording video automatically, and there is no need to start recording manually, otherwise there will be color attachment disorder.

5.1.2 Inertial Alignment (Backpack Kit).

Wait for the device to search for stars, you can use the handheld APP to check the

status of GNSS (APP interface will display the status of the satellite, the interface shows the satellite status is green √ that is, the normal state, if the device cannot receive satellite signals, the satellite status is red ×; When the number of satellites is greater than 20, slowly pick up the device, please walk a "8" route, the time is about 1 minute and the radius of detour not less than 2 meters.

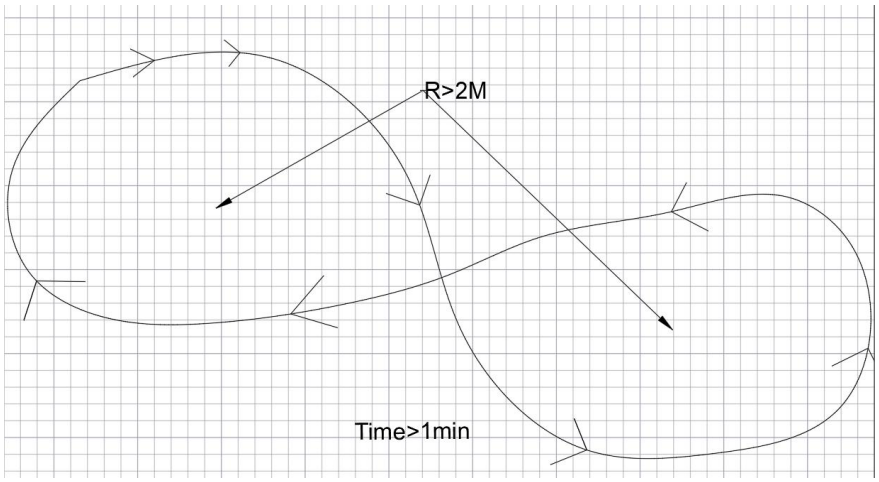

Figure 5-7 Inertial Alignment (Around 8).

5.1.3 Data Collection

Data collection follows a pre-planned route.

Acquisition time: If you want to record a video, it is recommended that the collection time be controlled within 15 minutes, or if you do not record a video, it is recommended that the time be controlled within 30 minutes.

5.1.4 Collecting Control Points

① Align the "cross" hole of the dot base with the control point and stabilize the device;

② Short press the host button, wait for a few seconds, and the light will change from slow flashing to fast flashing for one time;

③ The light **flashes slowly again,** then slowly pick up the device and continue to collect forward;

Figure 5-8 control points

Keep it strictly still when you are packing, and do not gather people around.

To have a flashing state, it means that the system has received the command to hit the dot, if the button is pressed, but not flashing, please press it again.

At this stage, the backpack kit does not support dots, and it will be supported later.

④ After the handheld dotting is over, the position of the dot should be measured by the fielder (can be measured using GNSS-RTK, total station, etc.).

5.1.5 Stop Collection

① Wrap around 8 in an open area, as described in Section 5.1.2 (only backpack **kits need to wrap around 8**).

② After circling 8, place the equipment on the ground or platform, keep it in place, press and hold the host button until the flash and let go, the laser stops rotating, and the lidar data stops collecting. After the laser stops rotating, manually press the

camera red button to stop the camera recording, the light continues to flash quickly and always on, and the data is saved.

Figure 5-9 Stop the laser before stopping the recording camera

If it is necessary to continue the collection at this time, proceed directly from section 5.1.1 (5).

To end the acquisition, turn off the fiducial station 10 minutes after the handheld acquisition ends.

The laser must be turned off and then the camera, and the order cannot be reversed. The camera red button is the end recording key, the black button is the power on and off button, don't press it wrong.

You must wait for the green light to change from fast blinking to solid before turning off the device.

5.1.6 Power down the device

Press and hold the battery button to turn off the power.

5.2 App-based

(1) The advantages of APP data collection

① Voice(audio) broadcast

Accurately understand the status of the current device and solve the problem that the green wave button flashes clearly when hitting the dots.

② Customize the project name

You can easily distinguish the data of different sorties by the project name.

③ On-site live records

The condition of the measurement area can be clearly known by taking photos, which is convenient for insiders to understand the actual situation of the scene and adjust SLAM parameters.

④ Real-time point cloud

You can view the current scan data, range, measured area trajectory, etc.

⑤ Data can be copied via **USB**

No need to go back to the industry and copy again, you can copy data on site. Especially for desktops, LAN ports are inconvenient.

⑥ Engineering data can be deleted through **mobile app**

Solved the problem that if the data is found to be full, you need to connect to the computer to delete it.

(2) APP requirements for mobile phones/tablets

Currently only Android is supported, the system requirements are as follows:

Android version: The system version is greater than 7.0

Memory requirements: RAM greater than 4GB

Storage: More than 1GB

(3) WIFI and password

SSID: LiGrip-**, the last 4 bits are the last 4 bits of the device SN number**

Password: greenvalley

5.2.1 Register, login and bind to the device

Refer to the GreenValley APP user manual

5.2.2 Control acquisition

Click the Start Collection button at the bottom of the interface, fill in the basic project information on the "New Project" page, and submit. When the APP device status changes to "Collecting", when the APP voice prompts "The device is being collected", and the number of satellites is greater than 20, you can slowly pick up the device, circle 8, and start data collection according to the planned path.

When the APP is operated, the initialization, inertial guidance alignment, and acquisition precautions of the handheld end are consistent with the button-based operation mode.

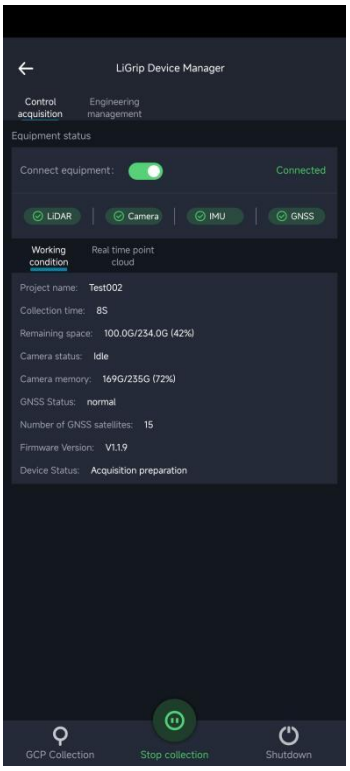

Figure 5-10 Data collection in progress

5.2.3 Ground control points collection

Align the crosswire with the control point, click the "GCP collection" button on the APP, follow the page prompts and voice broadcast to perform the dot operation, and when the status changes to collection again, you can slowly pick up the device to continue the collection.

The backpack kit does not support the “GCP collection” function, if the star search

in some areas is not good, it is recommended to use the handheld mode for collection and dotting.

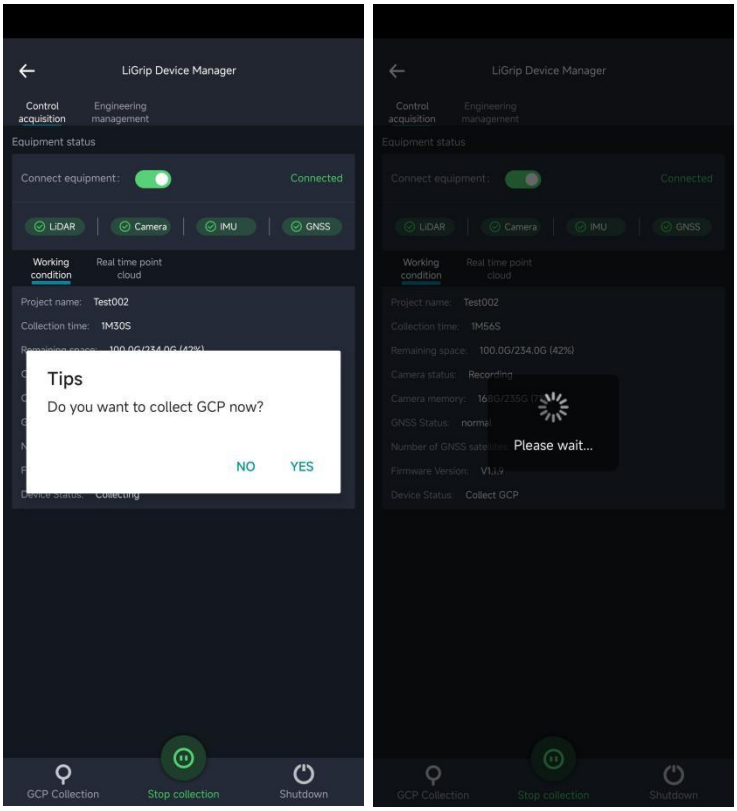

Figure 5-11 GCP collection

Coordinate acquisition of control points refer to Section 5.1.4.

5.2.4 Stop Collection

① Wrap around 8 in an open area in the same way as button-based step 5.1.2 (**only wrap 8 is required for backpack kits**).

② Click the "Stop Collection" button of the APP and follow the interface and voice prompts to stop collecting data. When the laser stops turning, manually stop the camera recording. When the progress bar of saving data disappears, APP voice announces "Data saved" and can continue to collect the next project.

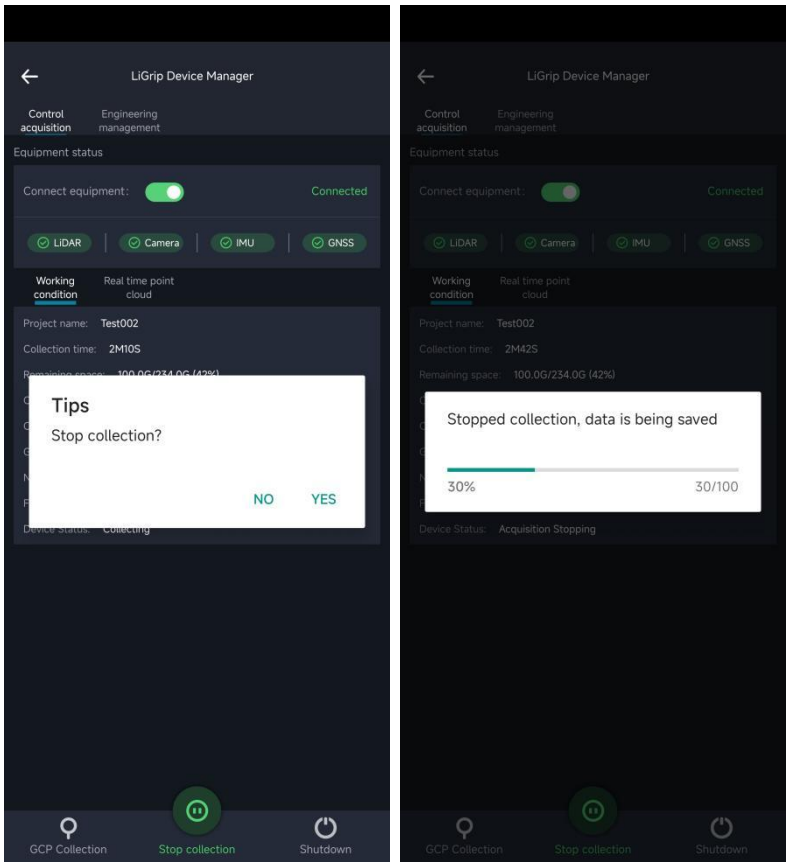

Figure 5-12 Stop collecting and saving data

5.2.5 Power down the device

Click the "shutdown" button on the control interface of the GreenValley APP, prompt "restart or shutdown", click "restart", at this time the LiGrip host will restart operation; Click "Shut down" and the LiGrip host will shut down.

5.3 Data Collection Precautions

5.3.1 Precautions for outdoor scene collection

① The walking speed is maintained at 1m/s;

② When encountering a moving vehicle or person during acquisition, turn the direction of the device so that the LiDAR is towards the stationary object; Wait for the vehicle or personnel to leave, and then resume the normal collection route;

③ If the scene collected has too many shaking flowers and trees, it is usually said to be windy weather, and you should try to avoid collecting at this time. Do not walk in lush areas;

④ Do not follow vehicles and crowds to measure;

⑤ If you encounter a dead end, it is recommended that the handheld device not change its orientation, and take the instrument out with your backhand;

⑥ Avoid periods of large crowds and vehicles when collecting.

5.3.2 Precautions for indoor space collection

① When collecting indoor space, please walk slowly and control the turning speed at 30 degrees per second;

② Turn during the collection process, please take the U-shaped route, and it is forbidden to turn in place;

③ Open the door ahead of time and do not move while measuring;

④ When entering one space into another:

When entering, scan the house as a whole outside, and then slowly enter the door. After scanning the objects in the room, exit the room, or exit the room by turning slowly and normally.

5.3.3 Precautions for data collection in cave/tunnel scenes

① Initialization is initialized in an open location;

② When collecting, it should be charged directly in front so that the laser can scan a larger range;

③ Do not let the laser get too close to the ground or wall, at least 20-40cm away;

④ When collecting tunnels, mines and other scenarios, it is not recommended to go back, and it is also recommended to mine on both sides of the road, and part of the accumulated error can be reduced by taking the S-shaped way.

5.3.4 Carrying kit collection considerations

(1) It needs to be kept strictly immobile during initialization, and it is recommended to place it on the ground and platform;

(2) The initialized area remains good for star search, greater than 20 stars;

(3) The backpack kit does not support dotting;

(4) When collecting, pay attention to the top obstacles to ensure the safety of the equipment;

(5) When entering a narrow space from a spacious space, walk slowly sideways to ensure a smooth transition of features.

(6) If it is a no/weak GNSS signal area, it is recommended to use handheld mode.

CHAPTER

6

06 Data Copy

- Cable-based copy of lidar data
- APP-based copy of lidar data
- Copy of camera files
- Base station file copy

6.1 Cable based lidar data copy

The battery box is plugged into the battery to power on, the Reimer port end of the data transmission cable is connected to the LAN port above the battery box, and the network port end is connected to the computer.

IP address: 192.168.1.99

Subnet mask: 255.255.255.0

Enter the URL "\\192.168.1.200" at the computer network to enter the internal storage space of the device. Open the "share" folder, go to the custom project directory, or under the folder named by time, copy all the files in it, and complete the data export.

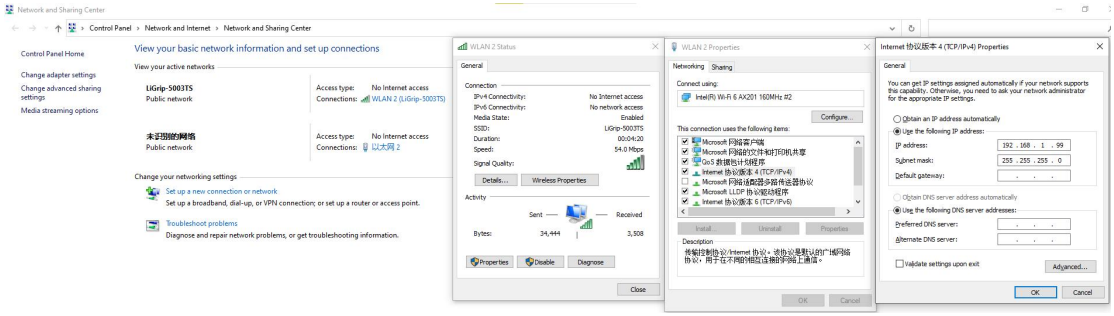

Figure 6-1 IP Settings

If you need to enter a user name and password, enter the following information:

Username: share

Password: 111111

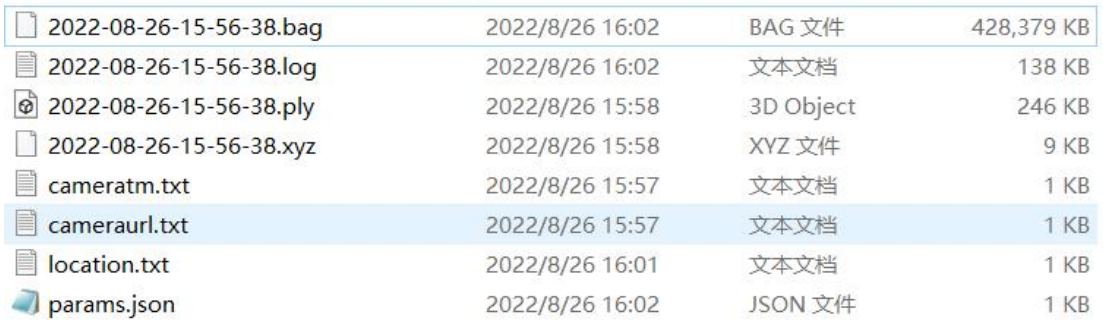

Figure 6-2 Engineering data

6.2 APP-based copy of lidar data

First of all, insert a U disk on the USB port of the host of the device, click a project in the project list, and you will be prompted to copy the project to the U disk; You can also long press to select multiple projects and click "Copy" to copy the data to the USB flash drive. There will be a progress bar during the copying process, wait for the progress bar to complete, display "Project copy successfully" after the copy is completed, click OK, and then pull out the U disk.

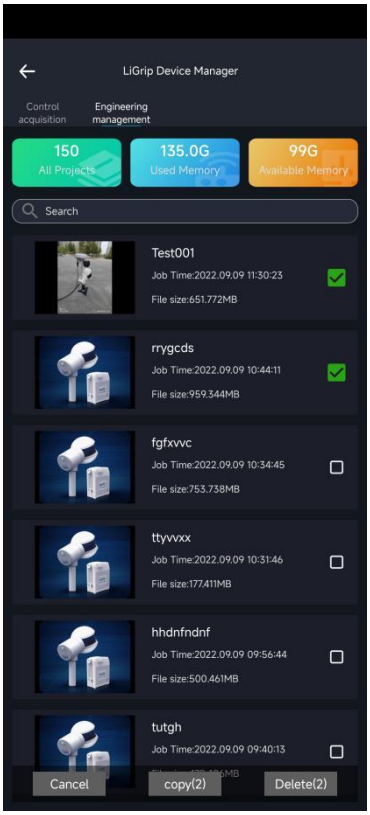

Figure 6-3 APP copies data

6.3 Copy of camera files

① Open the params.json file under the copied project data directory, which contains the project information and the corresponding video file name of the project.

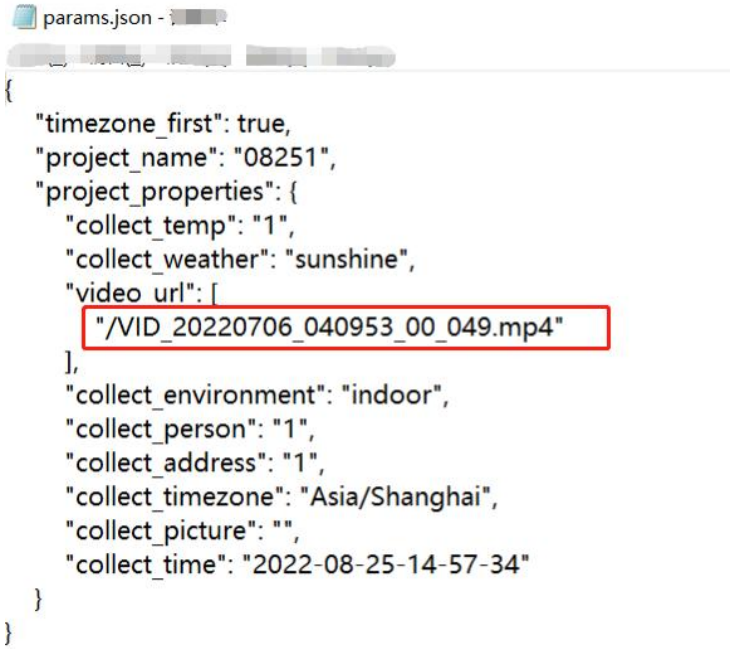

Figure 6-4 Params.json records the name of the video recorded by the project

② Use a USB cable to connect to the computer, turn on the battery power, at this time the camera is in U disk mode, copy the corresponding video file. (Copy the mp4 starting with VID).

The camera file and the bag file must be stored in the same directory, and different projects must be stored in separate folders.

6.4 Base station file copy

Refer to Section 4.1.5 and Section 4.2.

CHAPTER

7

07 Data Processing

- Data preparation
- LiFuser-BP new project
- Project processing
- GCP adjustment
- Data quality judgment

The GNSS data below contains the data of the backpack kit

7.1 Data preparation

① GNSS base station data:

I. Field GNSS receivers collect static data (if any);

II. Base site coordinates and high antenna phase (if any);

If necessary, static data needs to be converted to standard RINEX format (o file and p file).

② Lidar data: bag files.

③ GNSS mobile station data: log file (if any).

④ Camera data: the mp4 file corresponding to the bag package, **no need to modify the suffix of mp4 to insv;**

⑤ Absolute world file of dot location (txt file).

7.2 LiFuser-BP New Project

The H120 data processing uses the LiFuser-BP developed by GreenValley 

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7.2.1 Importing Original Data

Tap New -> Backpack.

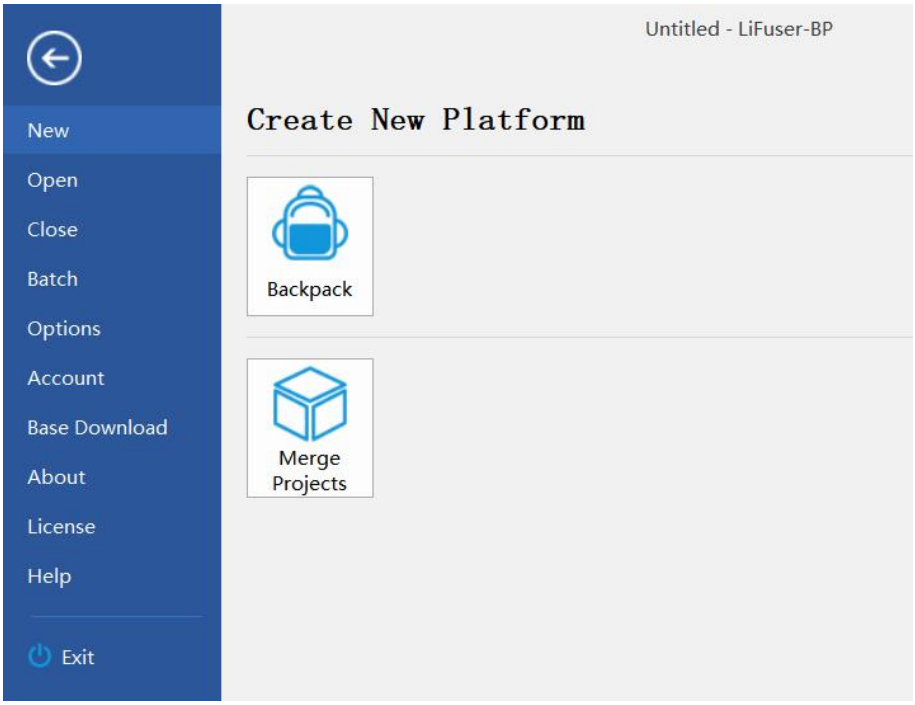


Figure 7-1 New backpack project

Set the lidar **bag path** and **video file path** (it is recommended to create a new IMG folder, and place the captured video file .mp4 in the IMG file).

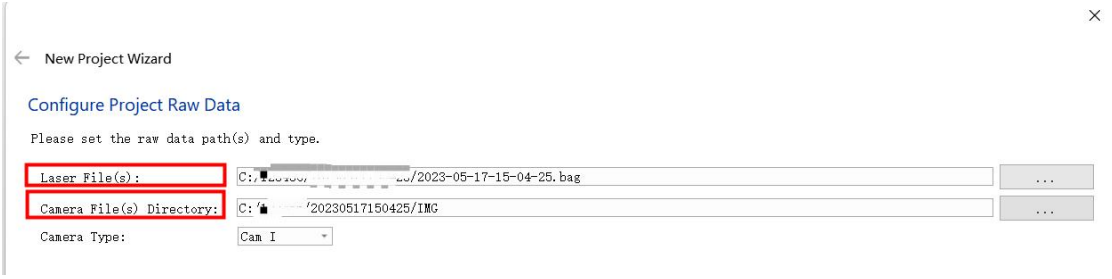


Figure 7-2 Setting .bag and .mp4 path

7.2.2 GNSS Configuration (for backpack kits, vehicle-mounted kits, and airborne kits only)

Configure GNSS mobile station data and base station data (if no GNSS data is available, deselect "Process GNSS"). On the GNSS configuration page, you can flexibly select according to the base station mode in the LiGrip H120 data processing.

7.2.2.1 PPK Mode

In GNSS mode, select **Differential GNSS**, select the **.log file** in the subproject file for mobile station data. Select the **RINEX** format for base station data, and enter the **OBS** file of the base station. The rest of the files can be read automatically by the software. Select the manual input in positioning mode, and manually enter the coordinates of

the base station and antenna height in PPK mode. Then, tap Next.

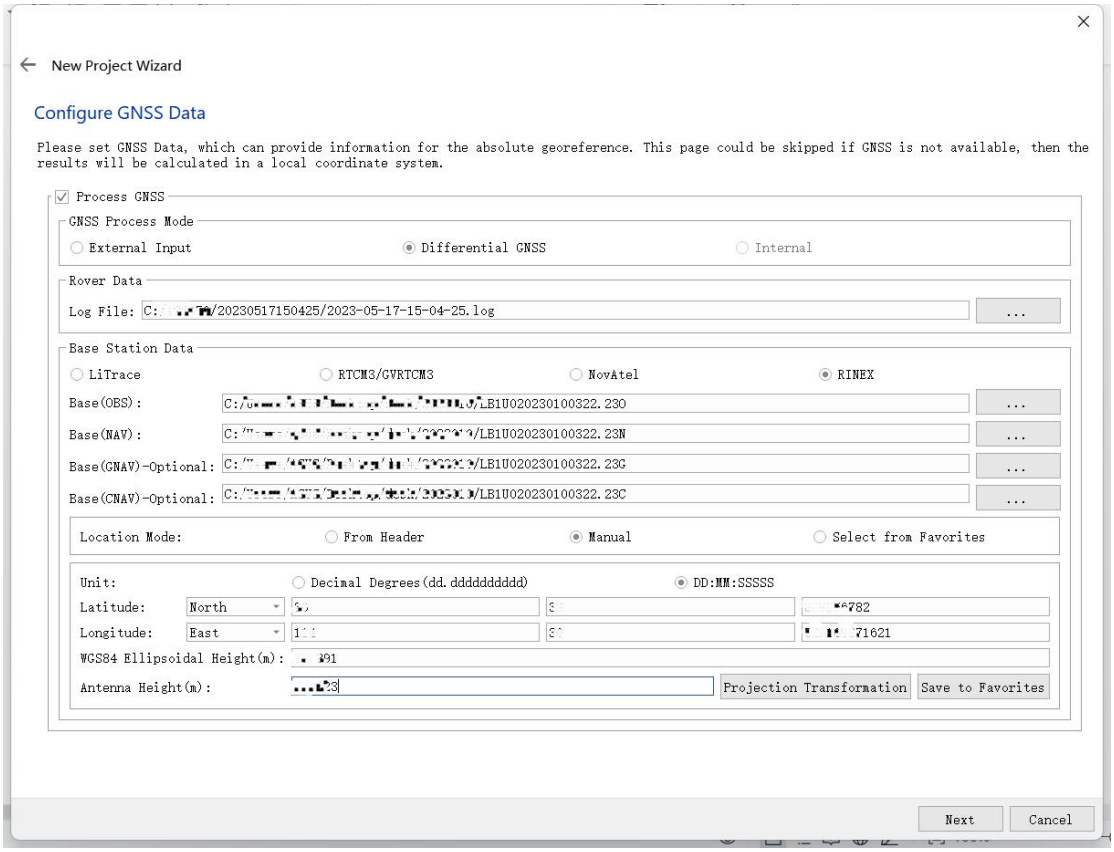


Figure 7-3 Configuring mobile station and base station data

It should be noted that the coordinates of the base station must be entered correctly and the antenna height must be the same as the actual measurement.

If there is no GNSS signal access throughout the field collection process, such as in mines, tunnels or indoors, there is no need to set the GNSS-related options.

7.2.2.2 Virtual Base Station Mode

At present, the data processing of the LiGrip H120 virtual base station mode includes two methods: Green Soil Cloud Trace and RTCM3/GVRTCM3.

（1）Green Soil Cloud Trace (batch processing is not supported at the moment)

The Green Soil Cloud Trace function is applicable to the virtual base station data set up by users in the GreenValley App.

The main advantage of Green Soil Cloud Trace function: Users do not need to log in to the LiCloud platform. Users can directly use the LiFuser-BP software to download the virtual base station data and solve it. It features simplicity, ease of use, and efficiency.

Note:

①This function does not support Batch Processing at the moment.

②When using this function, you need to log in to your LiCloud account in the account settings, and you will be prompted "Login successful! Select the virtual base station preference option.

③Make sure that the account for downloading base station data and the account for setting up base station is the same!

④Please make sure there are enough points in your LiCloud account, BP software will cost you a certain amount of points when you use Green Soil Cloud Trace for processing.

Type	Steps	LiTrace operation result
1	①✓App virtual base station erection ②✓Check the virtual base station priority ③✓ LiTrace solution	The user sets up a virtual base station in the GreenValley APP, and logs in to the LiCloud account and checks the priority of the virtual base station when the BP software solves it. At this time, the BP software will give priority to downloading the virtual base station and bring it into the solution;
2	①✓App virtual base station erection ②✕Unchecked virtual base station priority ③✓ LiTrace solution	If the virtual base station is set up in the APP, but the virtual base station priority option is not checked, the post-event base station will be downloaded when the BP software LiTrace solves;
3	①✕ The app virtual base station is not set up ②✓Check the virtual base station priorityCheck the virtual base station priority ③✓ LiTrace solution	If the virtual base station is not set up in the APP, and the virtual base station priority option is checked, the virtual base station data cannot be downloaded when the BP software litrace data is calculated, and the post-event base station data will be downloaded.

Figure 7-4 Note for Green Soil Cloud Trace data processing on the Green Soil App

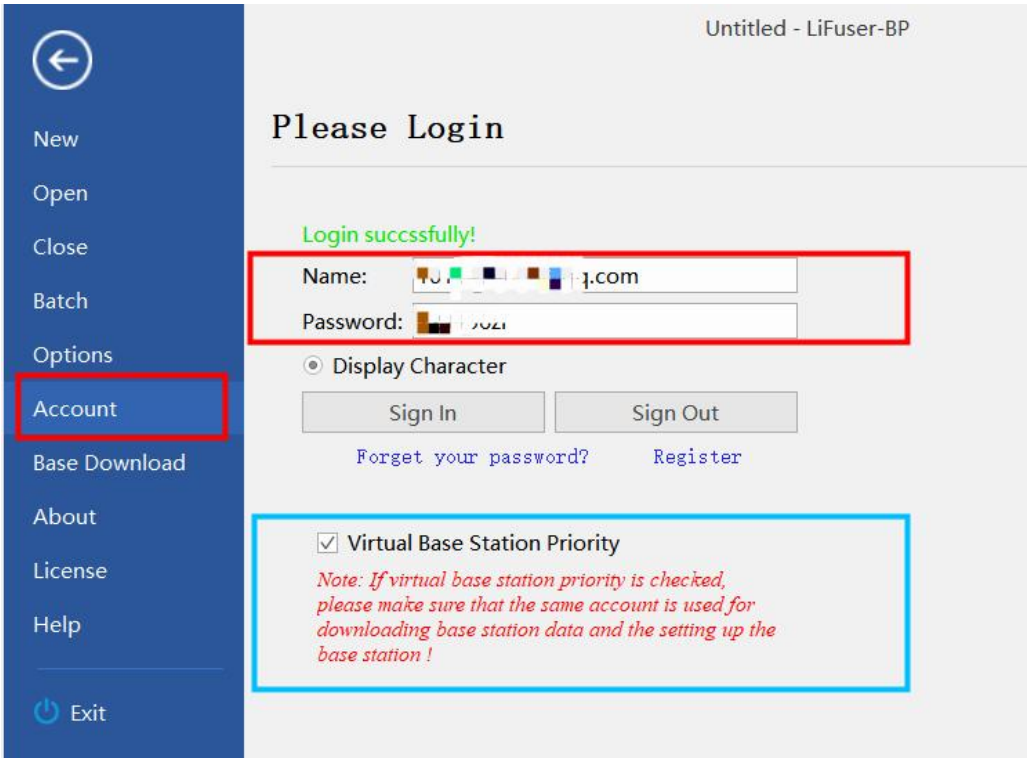


Figure 7-5 LiFuser-BP account login

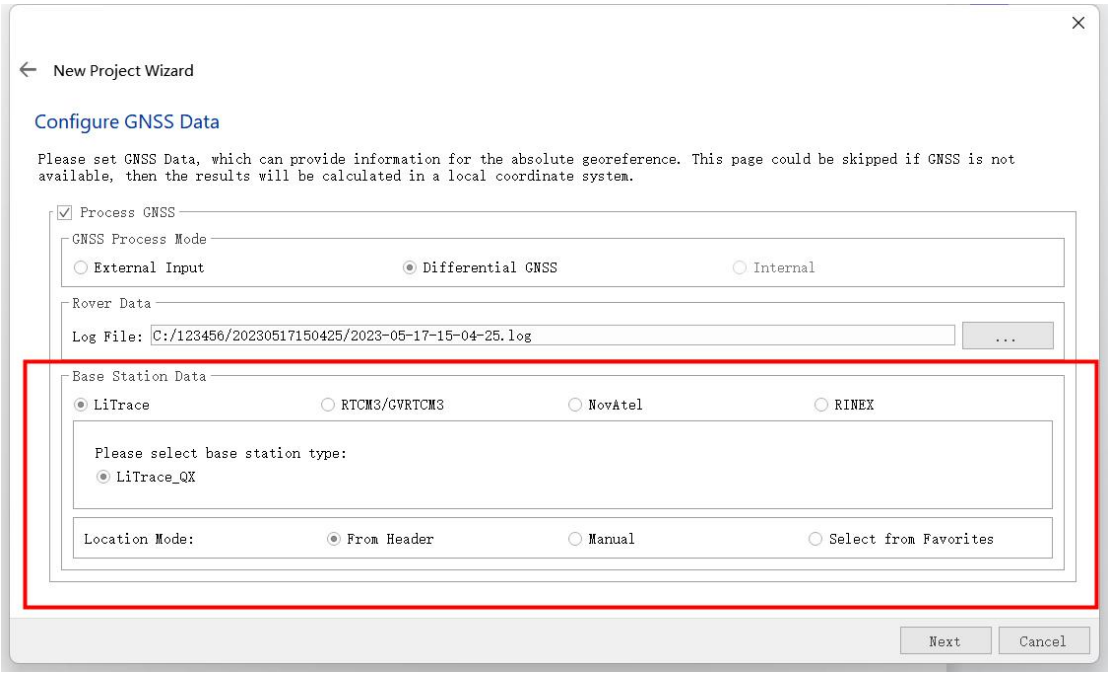


Figure 7 -6 Data processing by Green Soil Cloud Trace

（2）RTCM3/GVRTCM3

RTCM3/GVRTCM3 refers to the downloaded data format of the virtual base station or the data format of other types of base stations.

It is recommended to use Google Chrome to open the LiCloud platform (URL: https://licloud.lidar360.com/#/). Tap Green Soil Cloud Trace -> Virtual Base Station -> Result file -> Virtual base station file (.zip file)Tap it to download the .zip virtual base station file. Compress it to get the corresponding virtual base station file.

Difference between RTCM3/GVRTCM3 and Green Soil Cloud Trace for virtual base station processing:

① In the RTCM3/GVRTCM3 processing, users should log in to the LiCloud platform to download the virtual base station file package (.zip file).

②After decompression, virtual base station data (.rtcm3 or .gvrtcm3 file) can be obtained;

③Substitute the virtual base station data into BP software for processing.

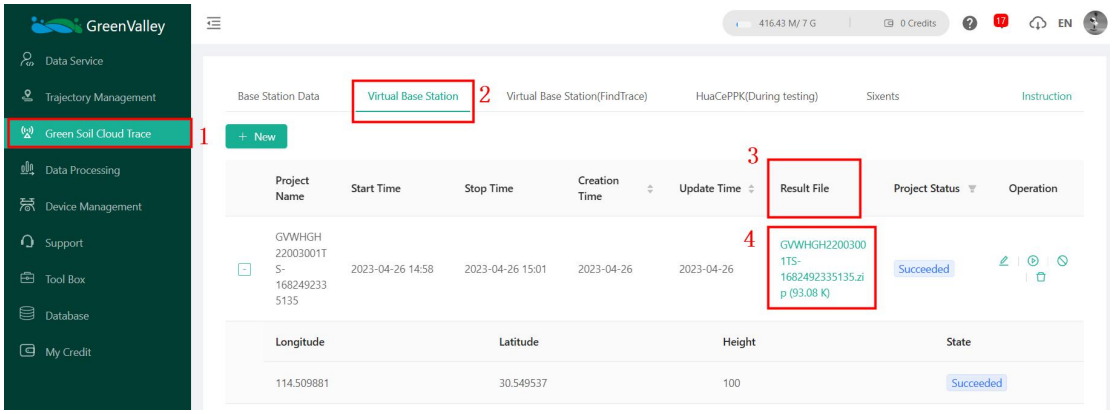


Figure 7-7 Downloading data on virtual base station in LiCloud for RTCM3/GVRTCM3

Figure 7-8 LiCloud virtual base station data download and decompression

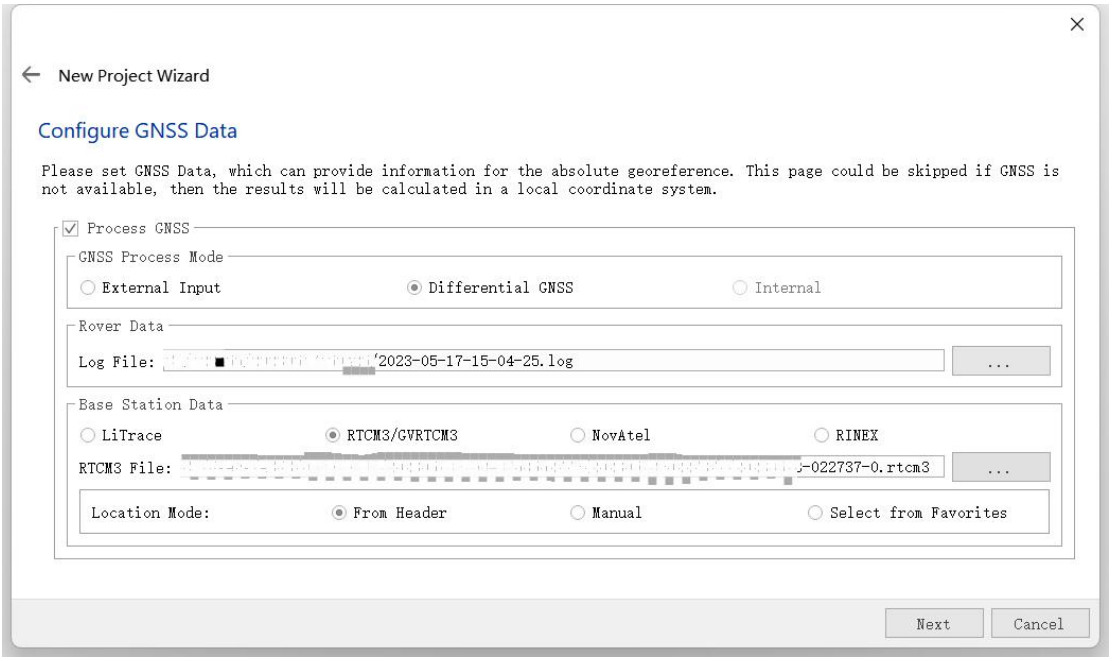


Figure 7-9 Data processing of virtual base station for RTCM3/GVRTCM3

7.2.3 Configuring Target Coordinate System

Select the target coordinate system required by the user (if no GNSS data is available, deselect "Target coordinate system").

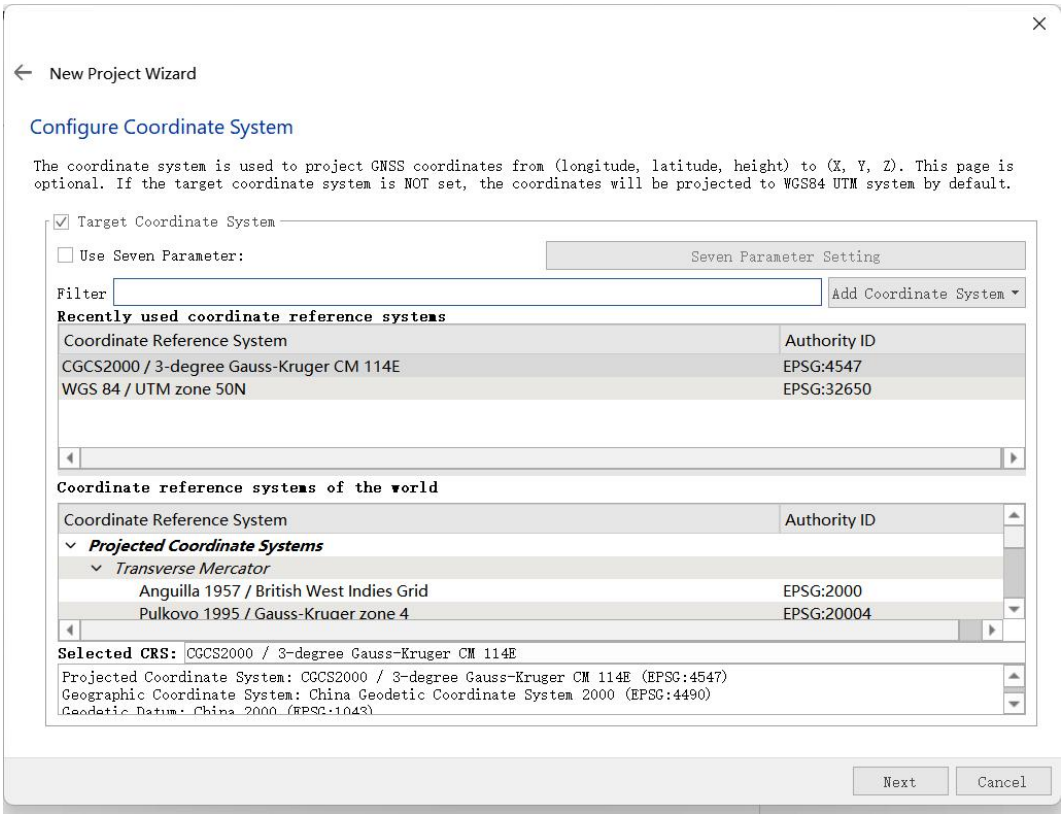


Figure 7-10 Configuring the output coordinate system

It is unnecessary to configure the target coordinate system when using the RTK mode for data processing. Since the target coordinate system has been set in advance when using RTK mode for data processing, the BP software can directly obtain the target coordinate system set during data collection.

7.2.4 Configuring the Name and Project Path to Save Files

In the Configure project path interface, select the project name and path to save files (By default, the project name after creation is the name reading bag file. The custom project name is supported).

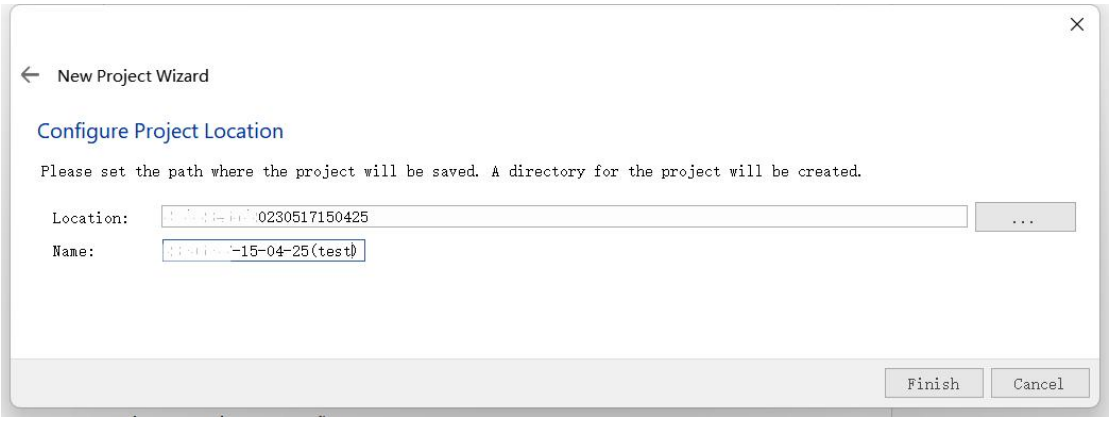


Figure 7-11 Configuring the Name and Project Path to Save Files

7.3 Running SLAM Program

In SLAM mode, select the generic mode. For other modes and more detailed settings, as well as the meaning of the parameter settings, see the BP instruction manual and the handheld FAQs.

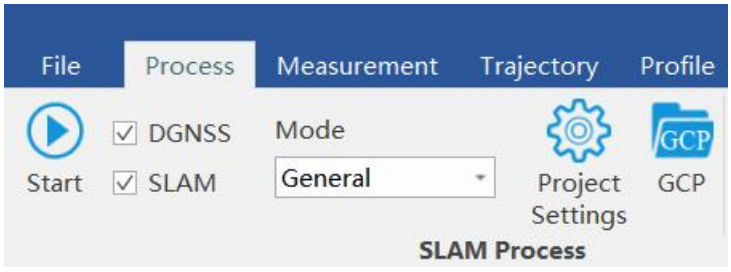


Figure 7-12 Mode selection

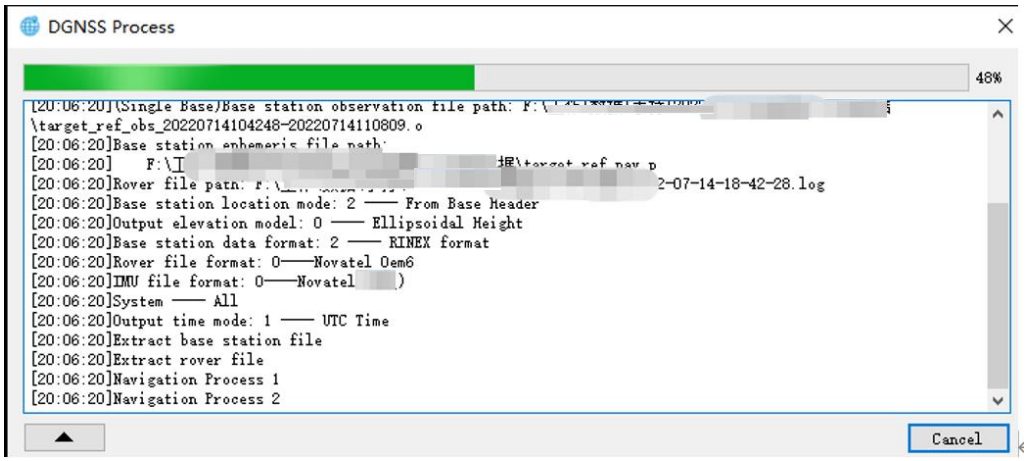


Figure 7-13 PPK processing (if GNSS data is available)

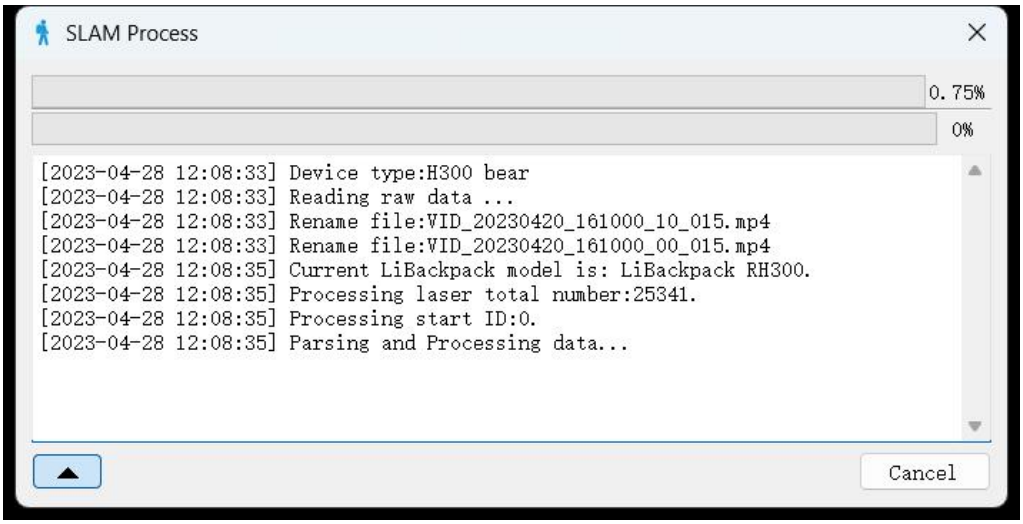


Figure 7-14 SLAM processing (the upper progress bar indicates the point cloud data processing, the lower progress bar indicates the video data processing)

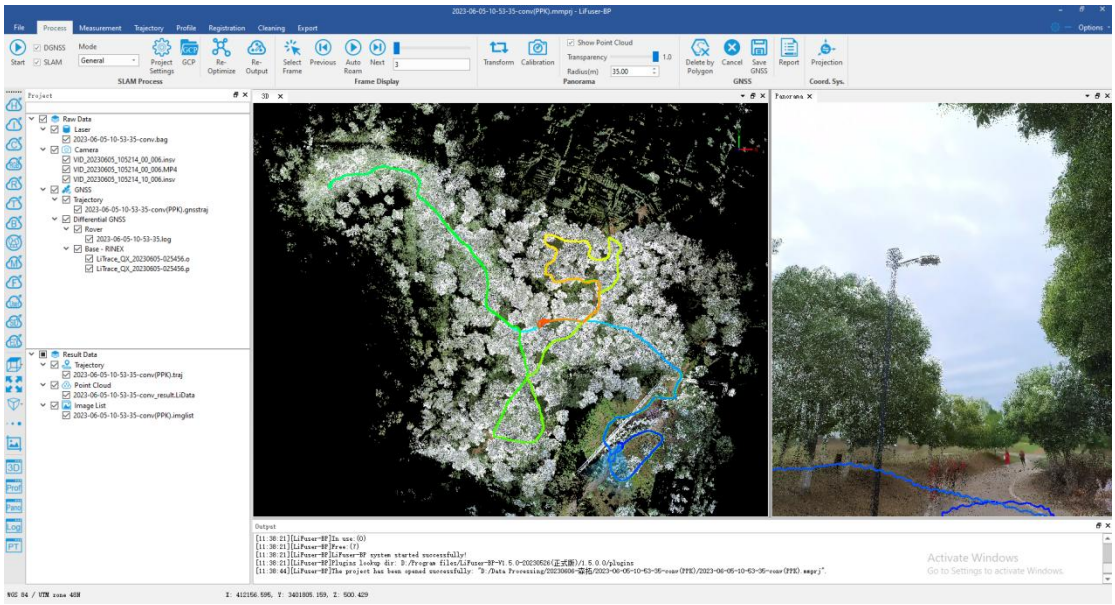


Figure 7-15 Data processing completed

After the data processing, you can view the point cloud data quality and point cloud coloring quality.

The LiFuser-BP software supports regular measurement operations (length, area, volume, and density) and track segmentation display. In addition, it supports point cloud profile operations, point cloud registration, point cloud data cleaning, and other regular operations. It provides full functions with powerful processing capability. Once the running is complete, check the data quality. For details, see section 7.5

7.4 GCP Adjustment

GCP adjustment, also known as SLAM optimization of GCP fusion, is based on field management + control point pairs, the data is adjusted and the absolute coordinates are given. Compared with the point cloud geographic coordinate correction, the **GCP adjustment** features higher accuracy. It is recommended currently, with better optimization.

7.4.1 Data Preparation

The data to be prepared for GCP adjustment includes:

（1）LiDAR data for field GCP collection;

（2）Images (if available);

（3）Control point coordinate file (need to correspond to the laser control point position one by one).

Format of Control Point: name, X, Y, Z

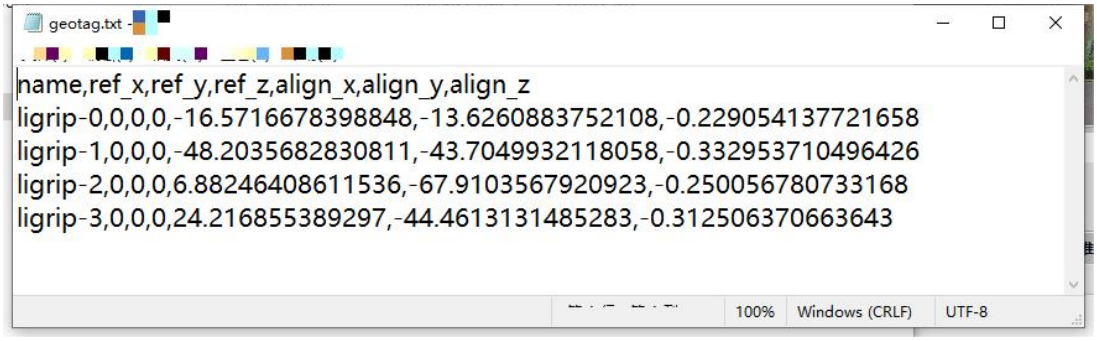


Figure 7-16 LIDAR data for the field GCP

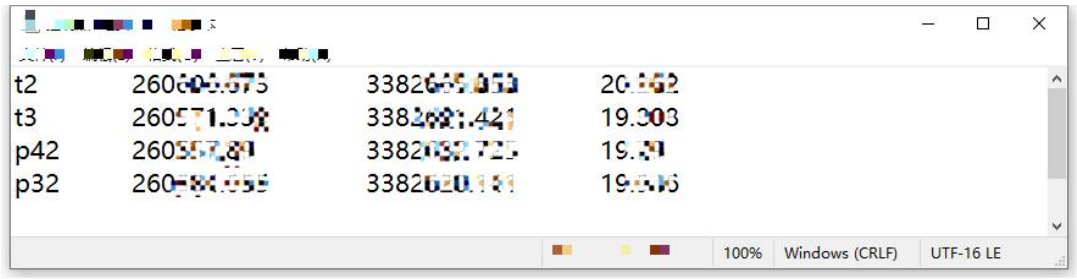


Figure 7-17 Control point coordinate file

7.4.2 SLAM processing -> GCP

In the SLAM processing interface, select the GCP button. The pairs interface appears.

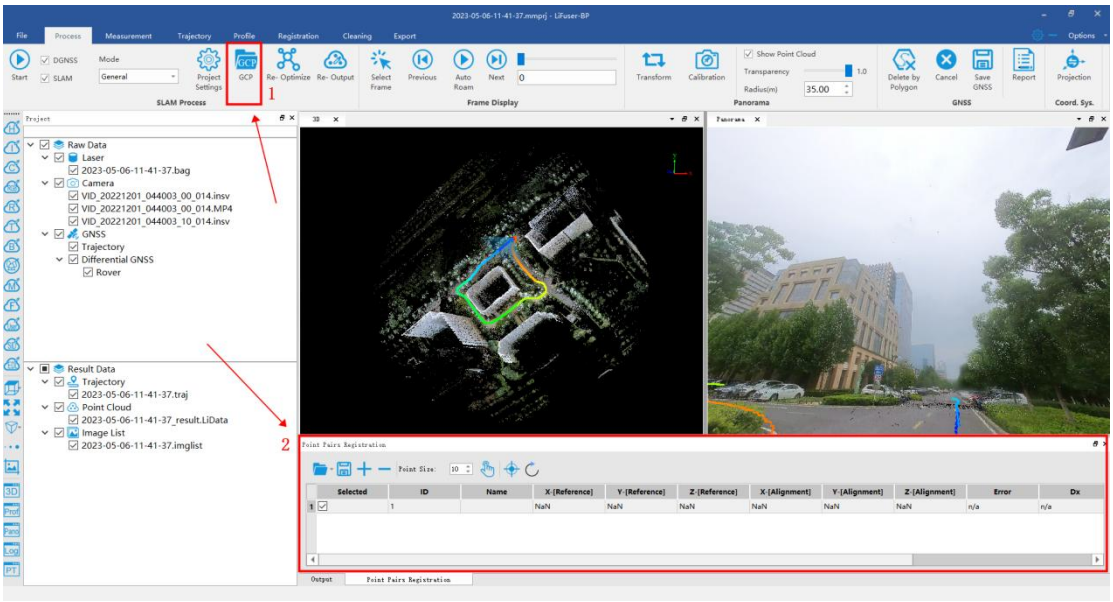


Figure 7-18 GCP adjustment

7.4.3 Loading the GCP Coordinate File (geotag.txt)

Choose **SLAM processing** -> **GCP** -> **Load points**, to load the geotag.txt file.

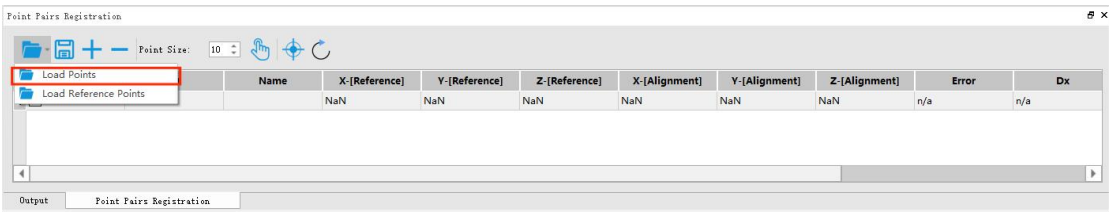


Figure 7-19 Adding geotag.txt

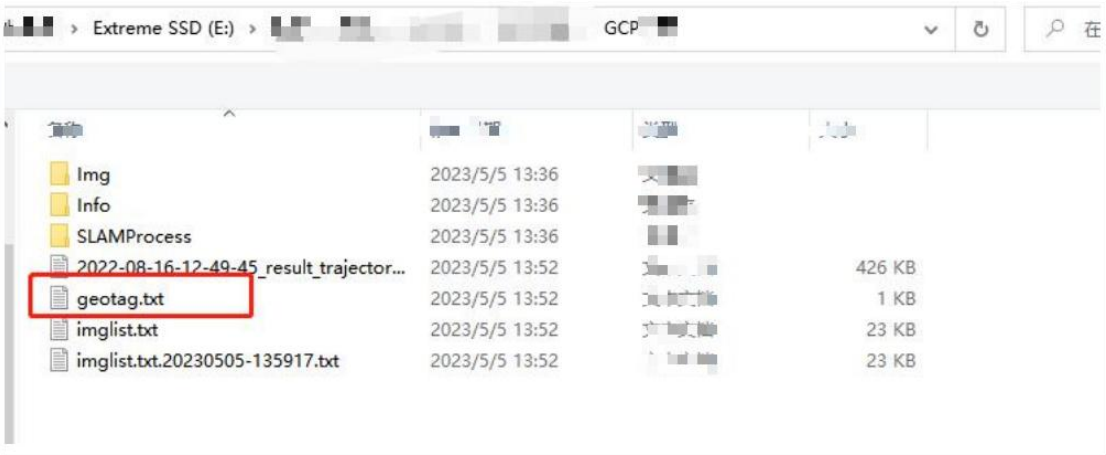


Figure 7-20 Opening geotag.txt in the folder

Set the properties corresponding to the different columns after loading the **geotag.txt** file.

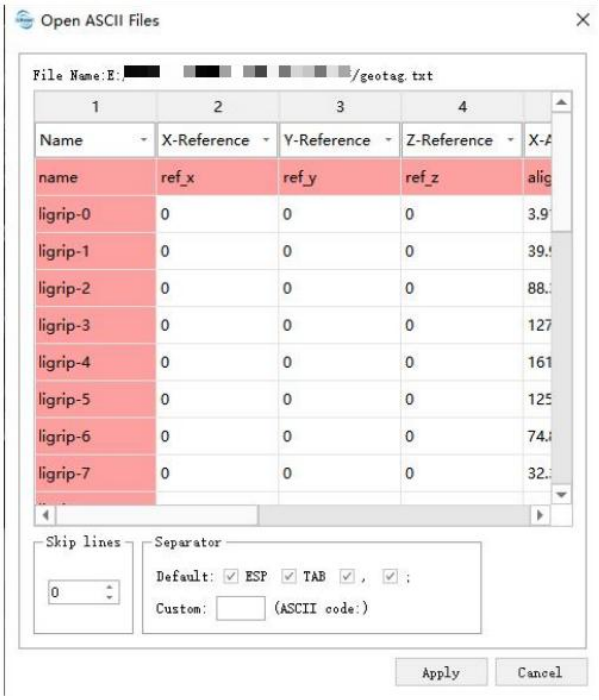


Figure 7-21 Loading geotag.txt

The software displays the field GCP location. You can check the validity.

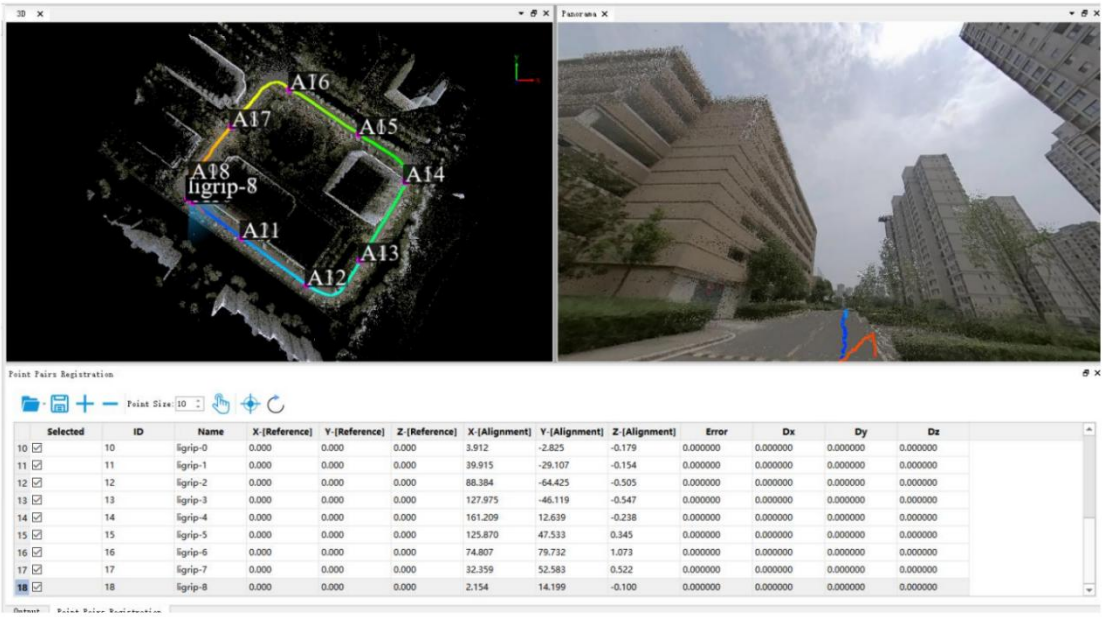


Figure 7-22 Software displaying the geotag .txt distribution area of the field GCP

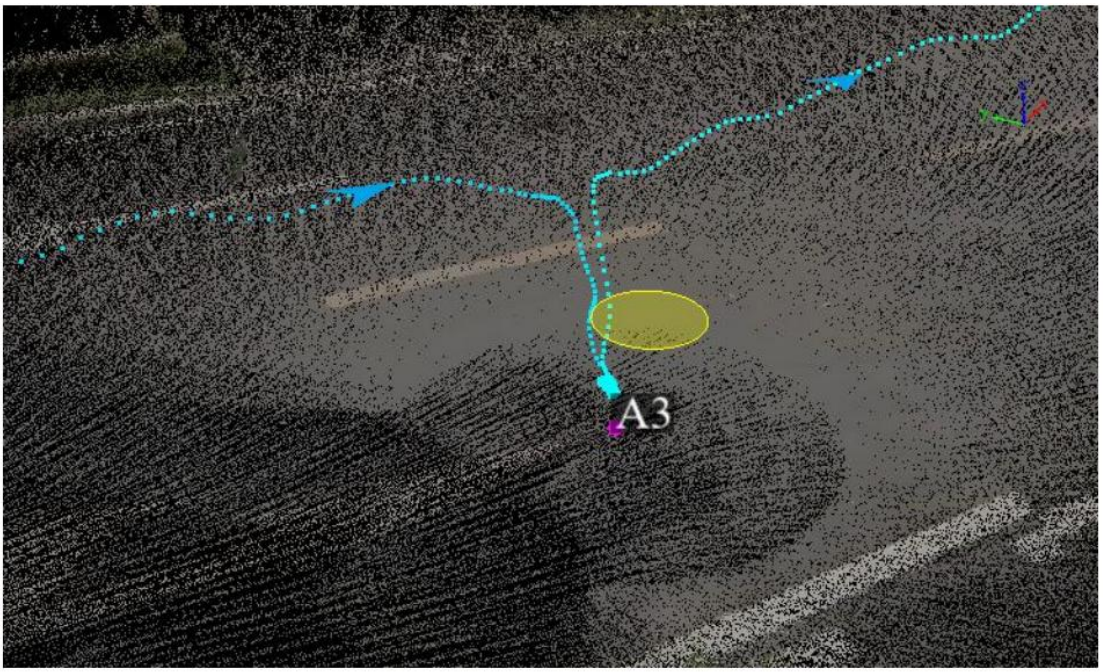


Figure 7-23 Checking field GCP

7.4.4 Importing the Coordinates of Control Points

Import control point coordinates. Supports the manual input and external input. The external import is mainly introduced. Click "**Load Reference Points**".

Format of control point: name, east coordinates, north coordinates, and elevation.

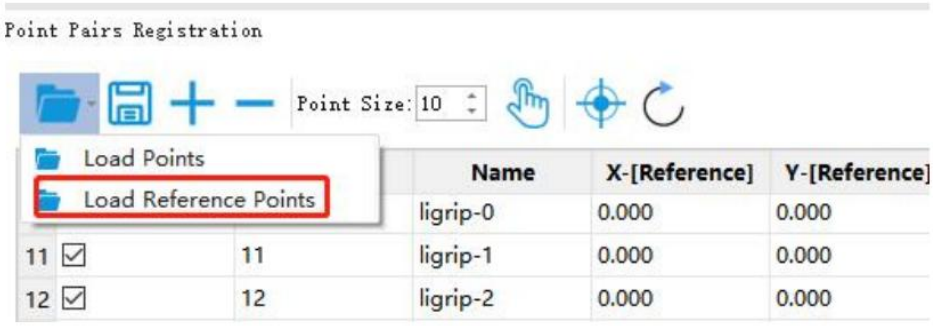


Figure 7-24 Loading reference point

In the pop-up prompt box, select Yes to open the control point file (TXT or CSV format). Select the corresponding column properties in the dialog box and click **"Apply"**.

Note: X indicates east coordinate, and Y indicates north coordinate.

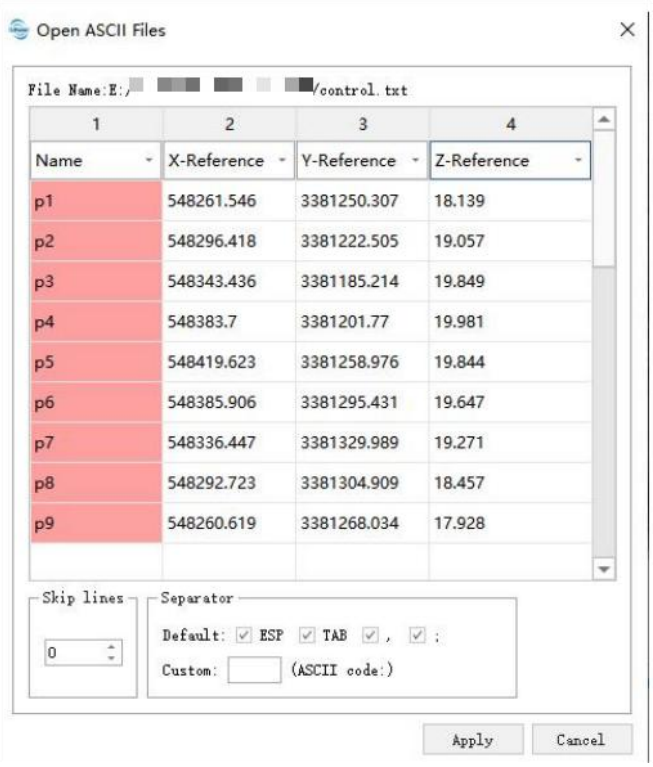
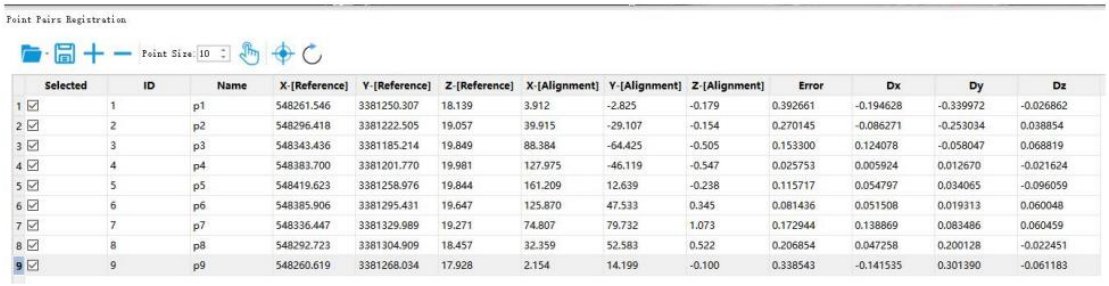


Figure 7-25 Load of reference points completed

After loading, the system will automatically calculate an error value, which represents the error between the control point and the GCP position before the adjustment. It is for reference only.


Point Pairs Registration

Point Size 10

	Selected	ID	Name	X-[Reference]	Y-[Reference]	Z-[Reference]	X-[Alignment]	Y-[Alignment]	Z-[Alignment]	Error	Dx	Dy	Dz
1	☑	1	p1	548261.546	3381250.307	18.139	3.912	-2.825	-0.179	0.392661	-0.194628	-0.339972	-0.026862
2	☑	2	p2	548296.418	3381222.505	19.057	39.915	-29.107	-0.154	0.270145	-0.086271	-0.253034	0.038854
3	☑	3	p3	548343.436	3381185.214	19.849	88.384	-64.425	-0.505	0.153300	0.124078	-0.058047	0.068819
4	☑	4	p4	548383.700	3381201.770	19.981	127.975	-46.119	-0.547	0.025753	0.005924	0.012670	-0.021624
5	☑	5	p5	548419.623	3381258.976	19.844	161.209	12.639	-0.238	0.115717	0.054797	0.034065	-0.096059
6	☑	6	p6	548385.906	3381295.431	19.647	125.870	47.533	0.345	0.081436	0.051508	0.019313	0.060048
7	☑	7	p7	548336.447	3381329.989	19.271	74.807	79.732	1.073	0.172944	0.138869	0.083486	0.060459
8	☑	8	p8	548292.723	3381304.909	18.457	32.359	52.583	0.522	0.206854	0.047258	0.200128	-0.022451
9	☑	9	p9	548260.619	3381268.034	17.928	2.154	14.199	-0.100	0.338543	-0.141535	0.301390	-0.061183

Figure 7-26 Software automatically calculating the error of the control point and GCP position before adjustment

7.4.5 App GCP Transform

After loading the control points, click App GCP Transform  , to perform GCP adjustment.

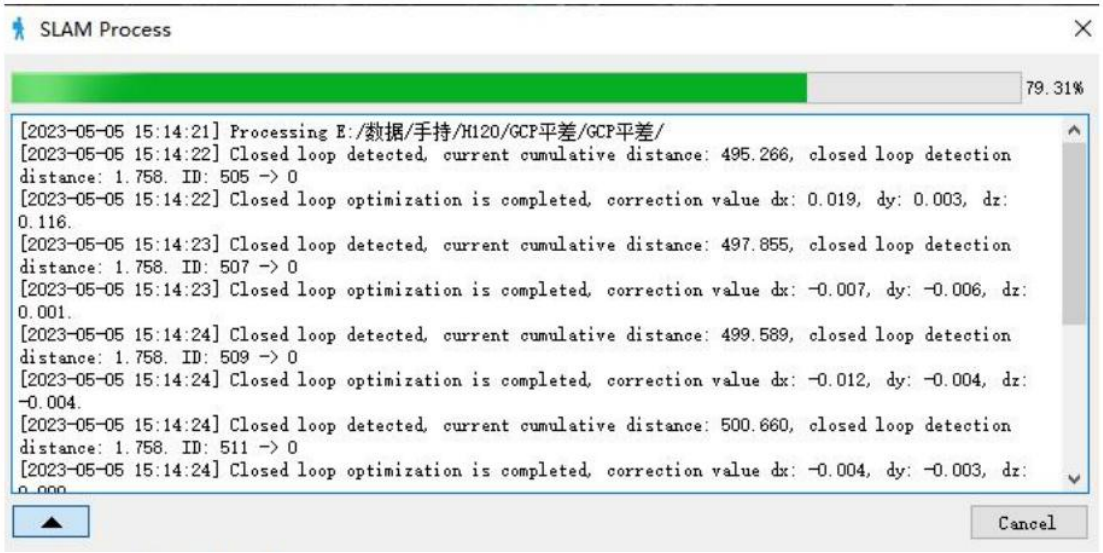
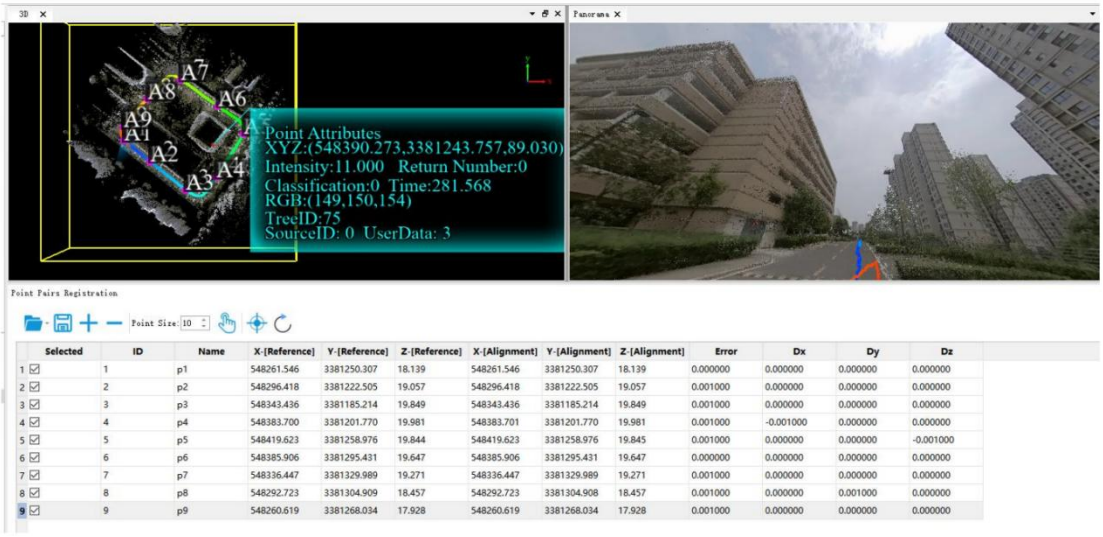


Figure 7-27 GCP adjustment

After the GCP adjustment is completed, the error of the control point becomes 0, and the point cloud has absolute coordinates.



Point Pairs Registration

Point Size: 10

	Selected	ID	Name	X-[Reference]	Y-[Reference]	Z-[Reference]	X-[Alignment]	Y-[Alignment]	Z-[Alignment]	Error	Dx	Dy	Dz
1	☑	1	p1	548261.546	3381250.307	18.139	548261.546	3381250.307	18.139	0.000000	0.000000	0.000000	0.000000
2	☑	2	p2	548296.418	3381222.505	19.057	548296.418	3381222.505	19.057	0.001000	0.000000	0.000000	0.000000
3	☑	3	p3	548343.436	3381185.214	19.849	548343.436	3381185.214	19.849	0.001000	0.000000	0.000000	0.000000
4	☑	4	p4	548383.700	3381201.770	19.981	548383.701	3381201.770	19.981	0.001000	-0.001000	0.000000	0.000000
5	☑	5	p5	548419.623	3381258.976	19.844	548419.623	3381258.976	19.845	0.001000	0.000000	0.000000	-0.001000
6	☑	6	p6	548385.906	3381295.431	19.647	548385.906	3381295.431	19.647	0.000000	0.000000	0.000000	0.000000
7	☑	7	p7	548336.447	3381329.989	19.271	548336.447	3381329.989	19.271	0.001000	0.000000	0.000000	0.000000
8	☑	8	p8	548292.723	3381304.909	18.457	548292.723	3381304.908	18.457	0.001000	0.000000	0.001000	0.000000
9	☑	9	p9	548260.619	3381268.034	17.928	548260.619	3381268.034	17.928	0.001000	0.000000	0.000000	0.000000

Figure 7-28 GCP adjustment result

If the adjustment is not satisfactory, or if the input is incorrect, you can use the GCP restore function to return to the state before the adjustment. Click  .

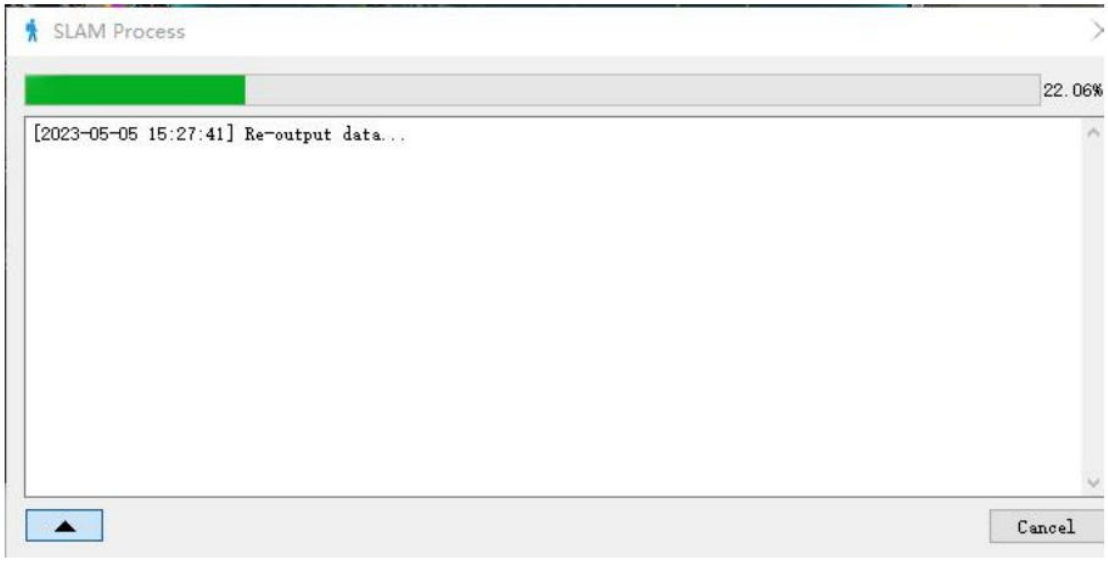


Figure 7-29 Software restore project

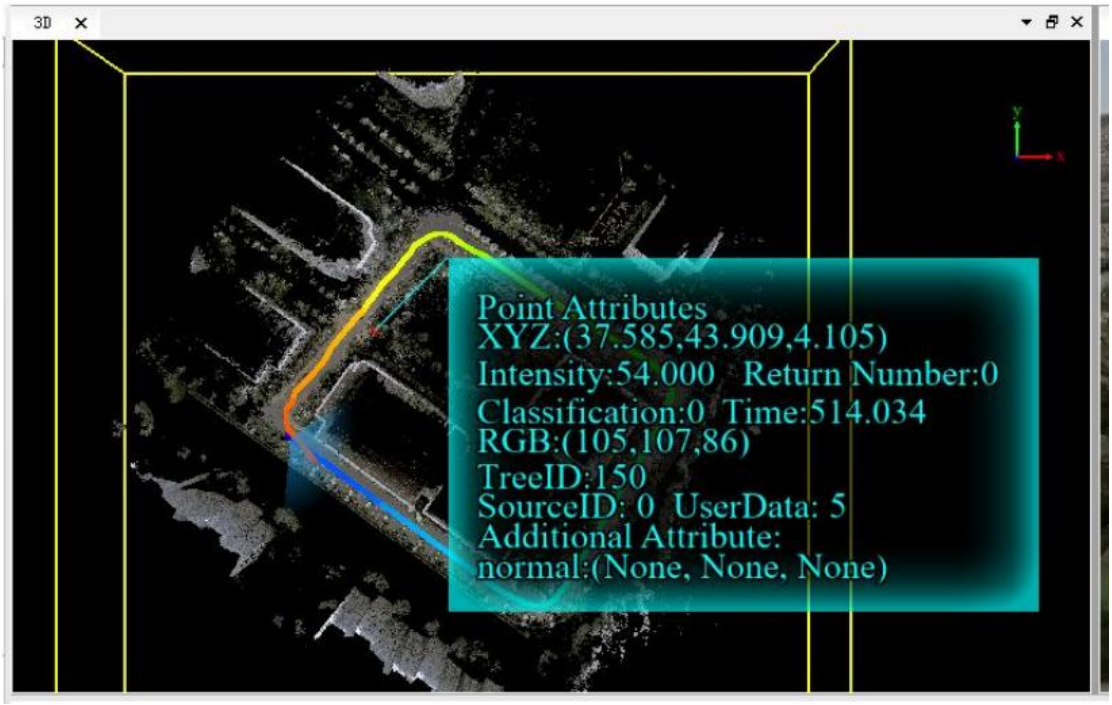


Figure 7-30 Software restoration project completed

If the GCP adjustment is not satisfactory, or if the input is incorrect, you can use the GCP restore function to return to the state before the adjustment.

7.5 Data Quality Judgment

7.5.1 Viewing the Report

Choose **SLAM Process** -> **Report** to view the PPK processing report.

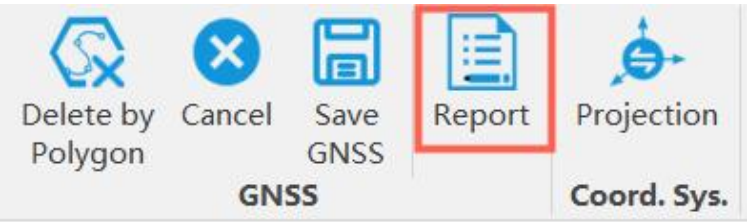


Figure 7-31 Viewing the report

If there are no field GNSS signals in indoor and mine scenarios, there is no PPK processing report.

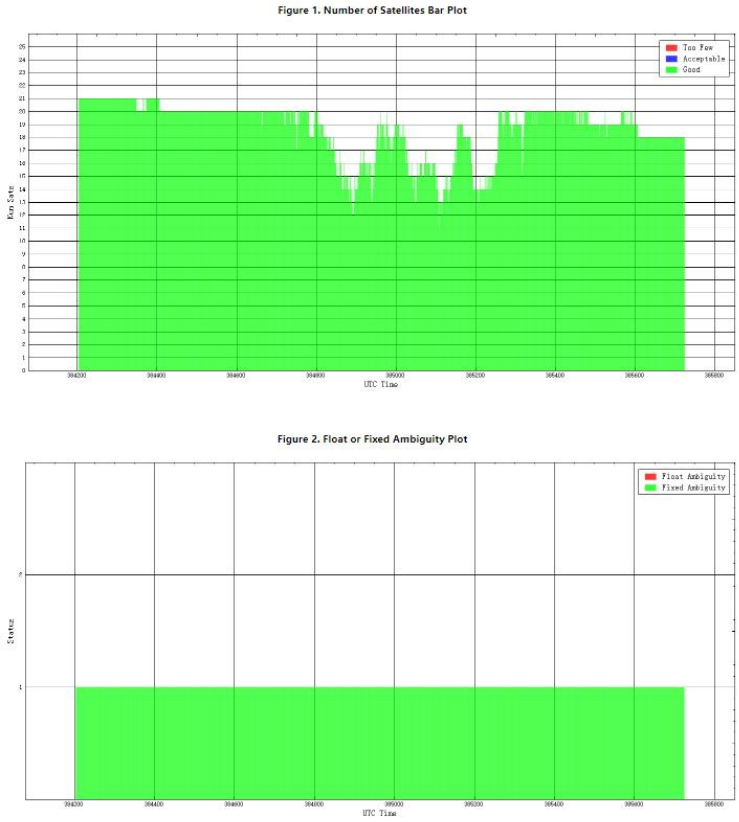


Figure 7-32 Viewing PPK quality report

7.5.2 Checking Closed Loop

If there is a closed-loop measurement, display  point cloud by time. Check the layering phenomenon at the closed loop.

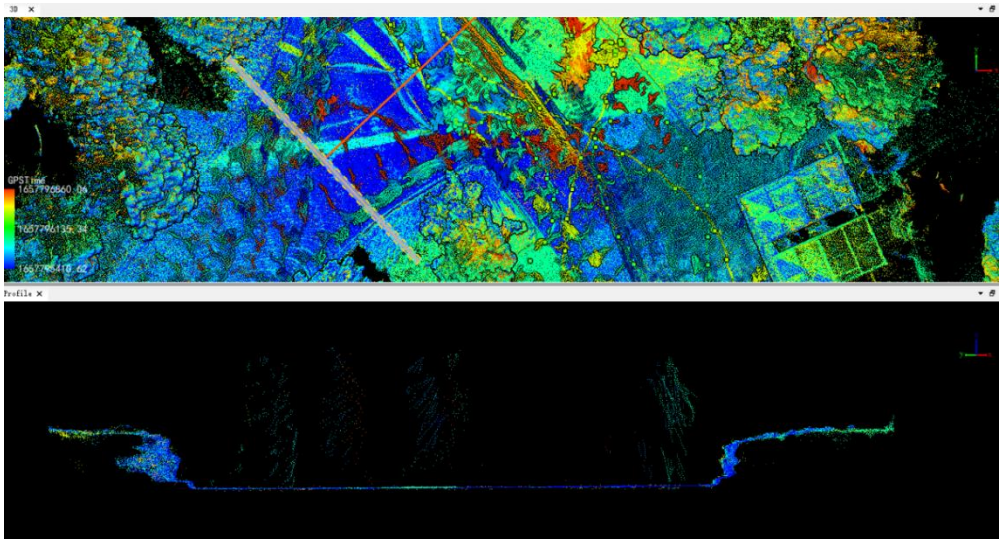


Figure 7-33 Checking the closed loop

7.5.3 Loading Checkpoints

Choose Registration -> Point pair to load the checkpoint.

Figure 7-34 Loading checkpoints

The checkpoint format should be the same as the control point format.

Set the properties corresponding to the columns.

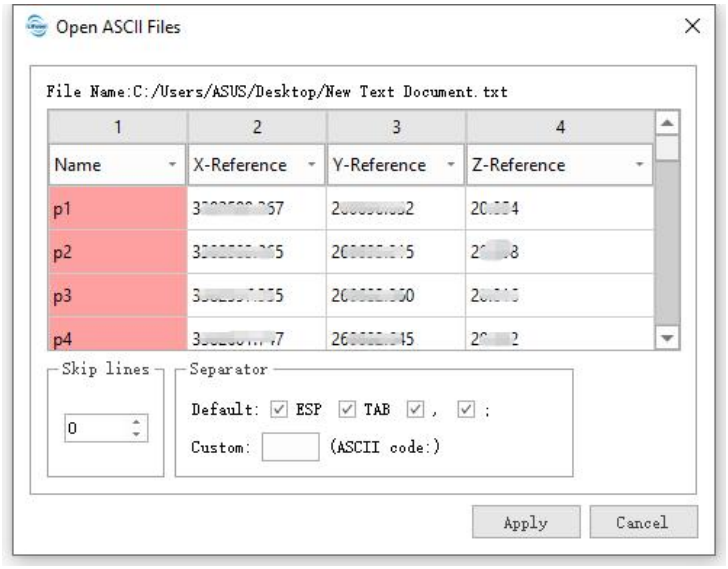


Figure 7-35 Setting the column properties

Check the differences between the checkpoints and the corresponding point cloud. See the marker line in the figure below.

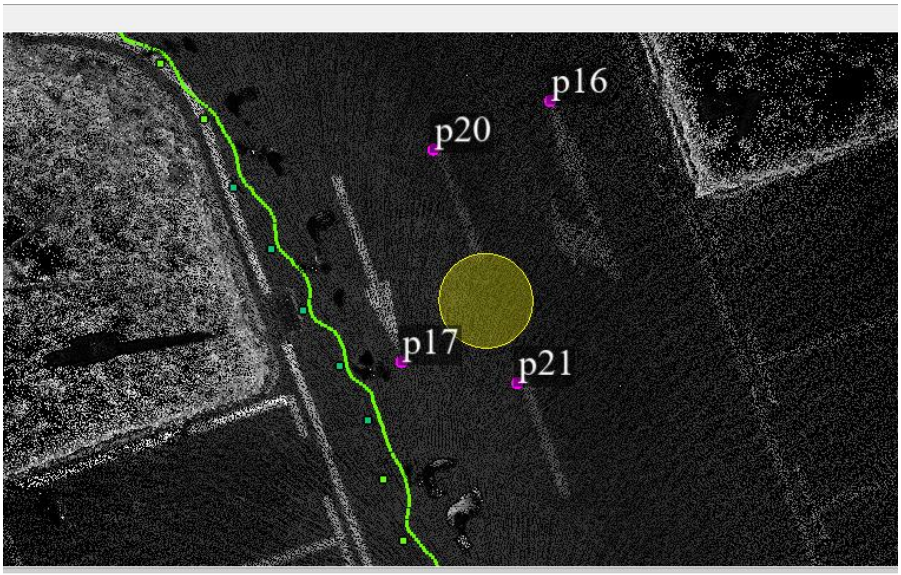


Figure 7-39 Checkpoint accuracy by visual inspection

To reflect the exact difference by a numerical value, choose Measurement -> Pick multi-point. Select the position of the corresponding checkpoint. Then add a column of properties in the list. Fill in the name of the point and save the 3D point.

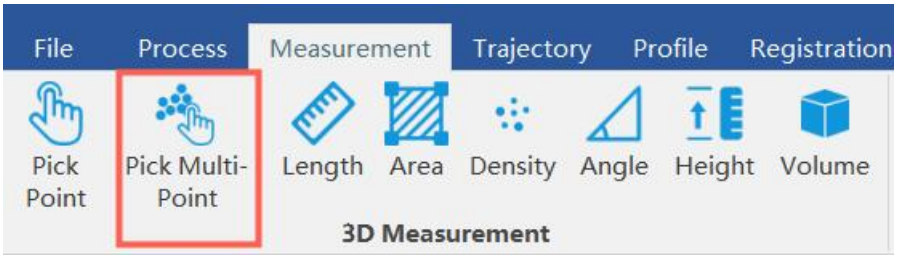


Figure 7-36 Multi-point selection

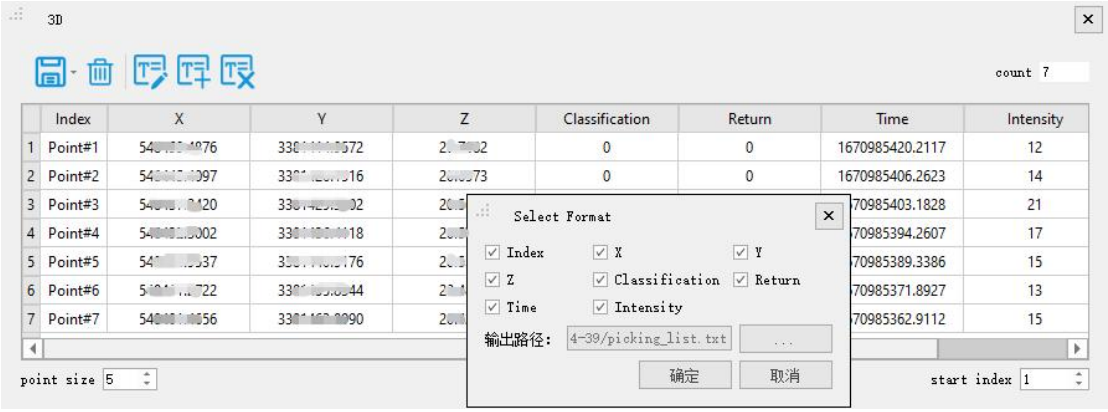


Figure 7-37 Saving points

As a result, there is the system output, with making statistics of errors.

CHAPTER

8

08 Multi-Project Splicing

- Create a new stitching project
- Establish a connection relationship
- Point cloud stitching
- Quality assessment

It is impossible to measure the measured area in one go, so it is necessary to scan the area multiple times to obtain the data of the entire measurement area. Before multi-project stitching, you need to pay attention to the following:

① A 10%-20% overlap rate is guaranteed between each project.

② There are more feature points in the overlapping area for stitching.

8.1 New splicing project

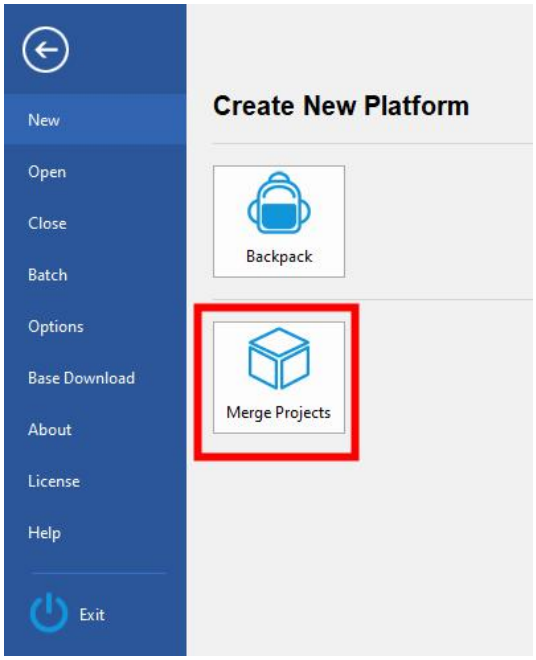


Figure 8-1 Create a new stitching project

Set the save path for multiple projects.

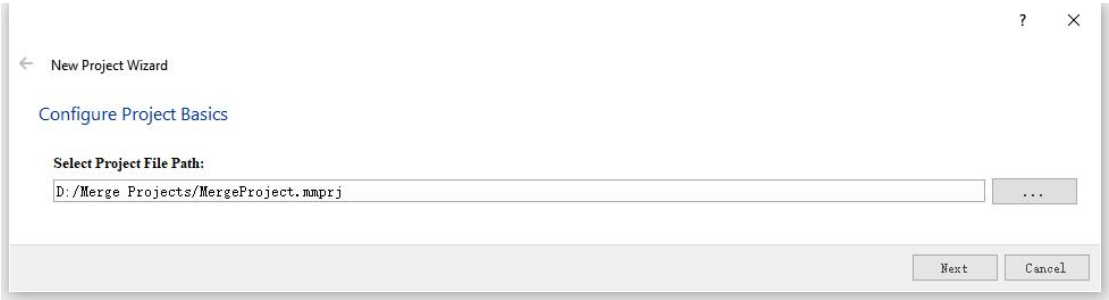


Figure 8-2 Sets the folder where the project is saved

Add the project folder after the solution and the adjustment have been prepared.

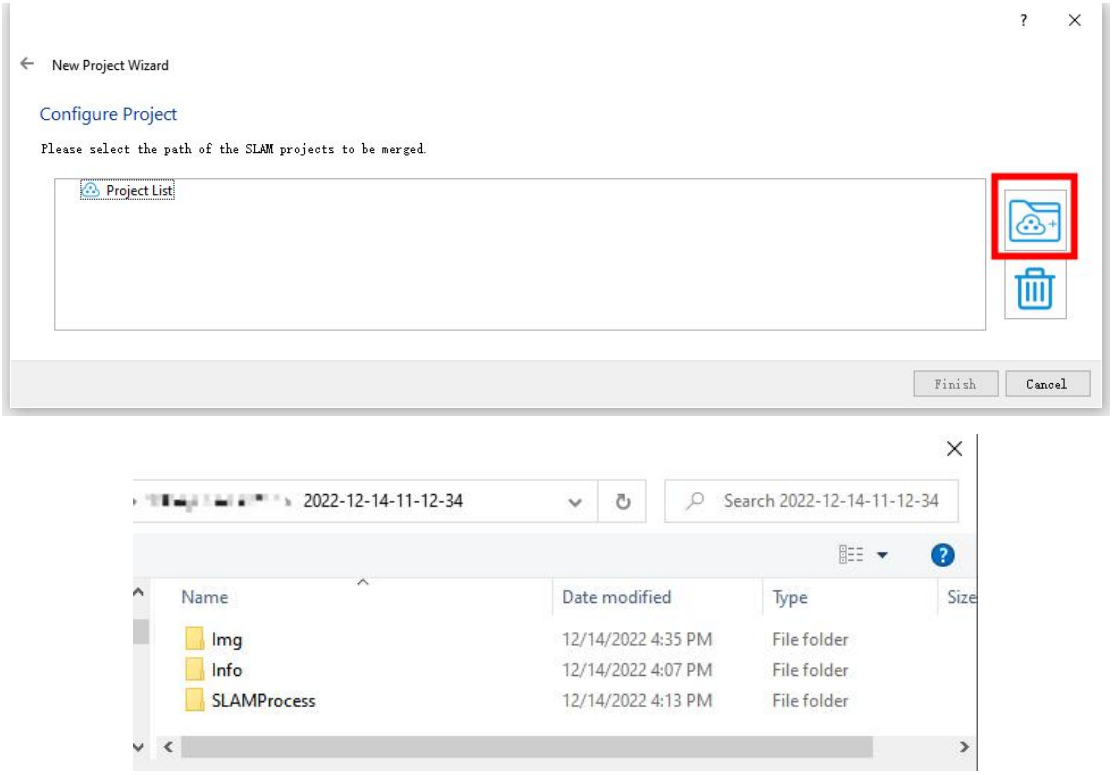


Figure 8-3 Add the project that needs to be stitched

Figure 8-4 Projects added

Finally, click Done.

8.2 Establishing connections

8.2.1 Establishing connections with absolute coordinates

At the beginning of the software, the connected (red box) is empty and the registered (blue box) contains all the data to be stitched. We need to make connections.

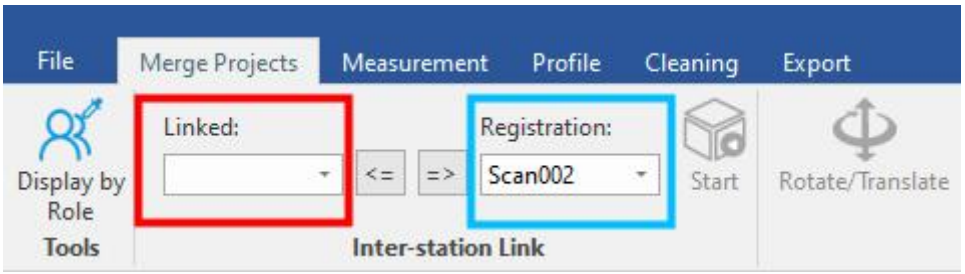


Figure 8-5 No connection is established

For example, Scan 001 establishes a connection relationship with Scan 002. Select Scan 001 from the Registration Window drop-down menu, then click the "<=" symbol to move Scan001 to Connected, and ensure that Scan 002 is selected in the Registration window.

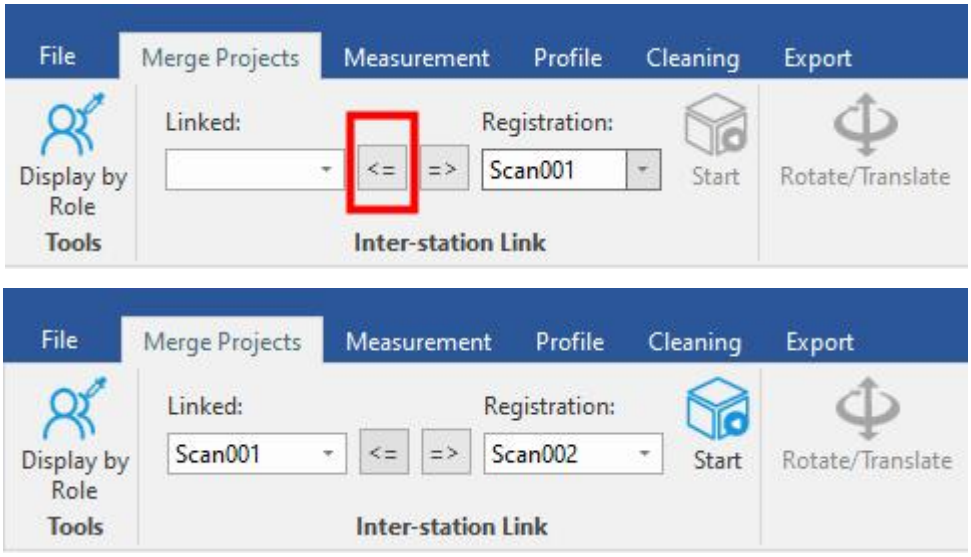


Figure 8-6 Establishing a connection relationship

Then click Start

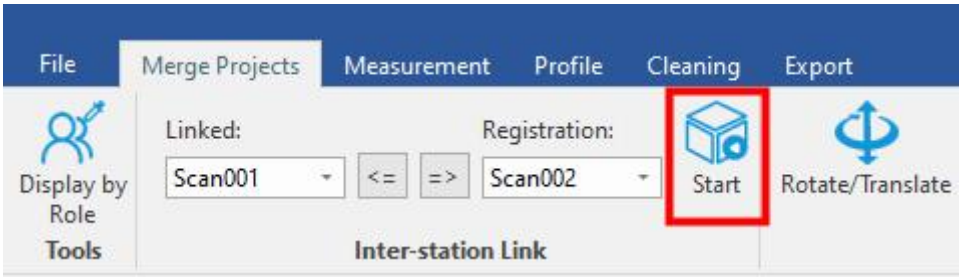


Figure 8-7 Start

The 3D view now shows a preview of the data to be stitched.

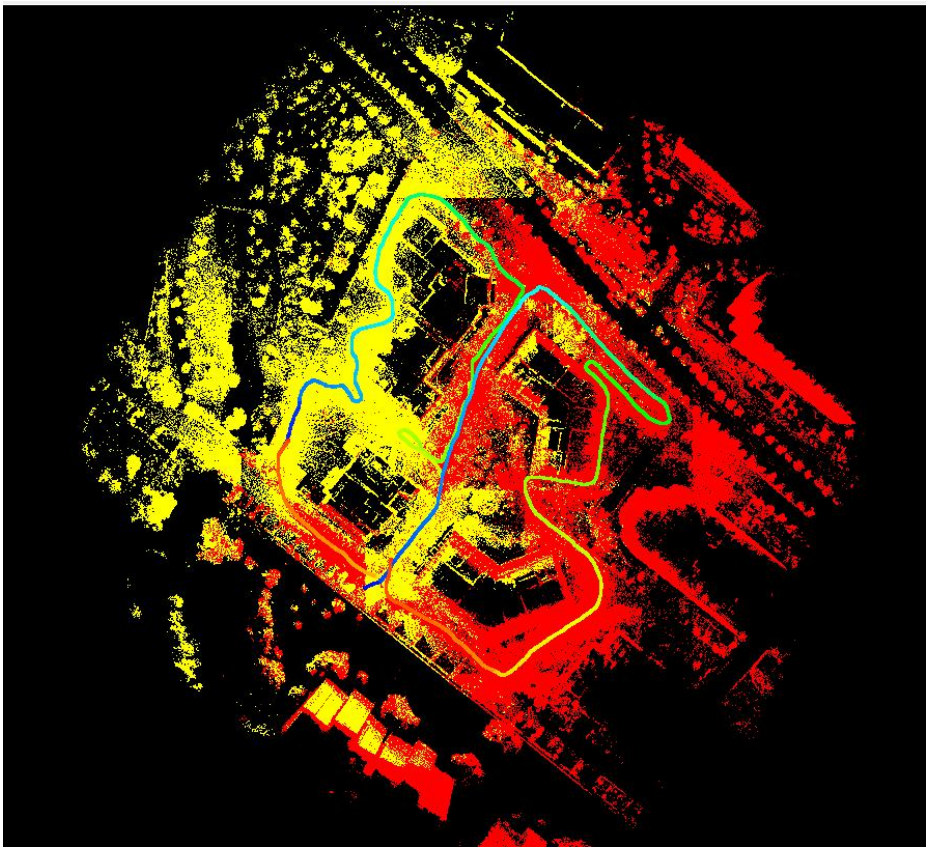


Figure 8-8 Preview the point cloud

Finally, click the "<=" symbol and move Scan 002 until connected.

At this point, Scan001 establishes a connection with Scan 002, and the same goes for all other data operations until all data is moved to the connection.

8.2.2 Relative coordinates establish a connection relationship

The difference between the relative coordinate system and the absolute coordinate system is that the relative coordinate system must be roughly spelled by rotational translation because the coordinate system is independent (shown in Figure 8-9).

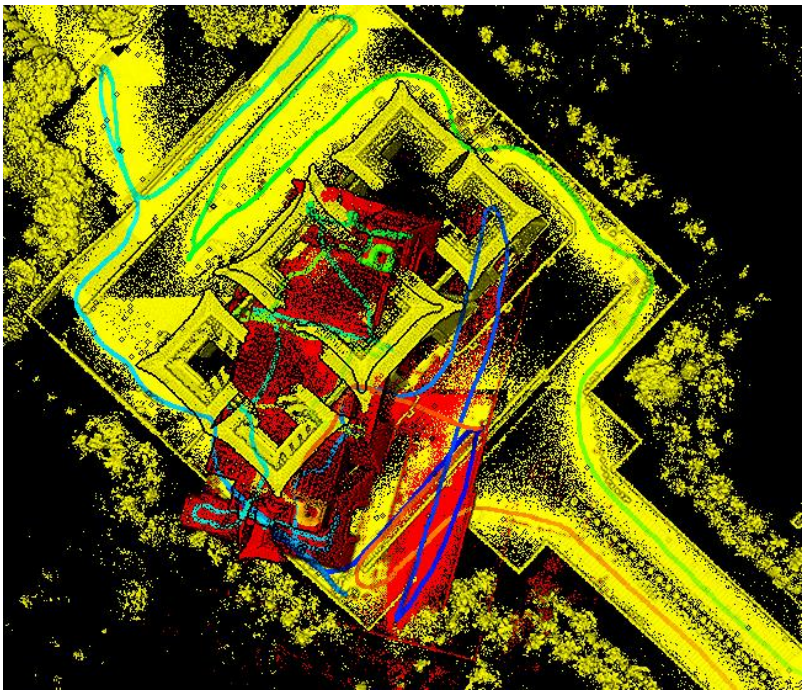


Figure 8-9 The spatial relationship of the relative coordinate system is a bit out of order

The steps to spell together are as follows:

(1) Click Rotate to pan.

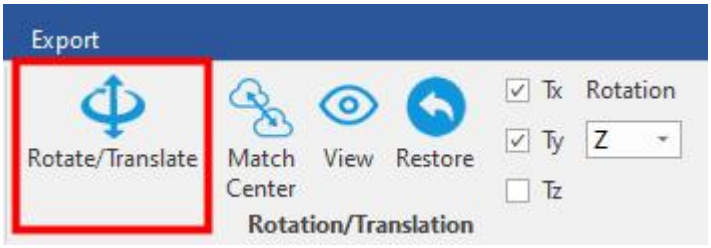


Figure 8-10 Click Rotate/Translate

(2) Adjust the direction of translation and the coordinate axis of rotation.

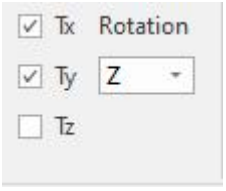


Figure 8-11 Sets the rotation translation

(3) Rotate pan to point clouds roughly together. You can see if you are together through the perspective.

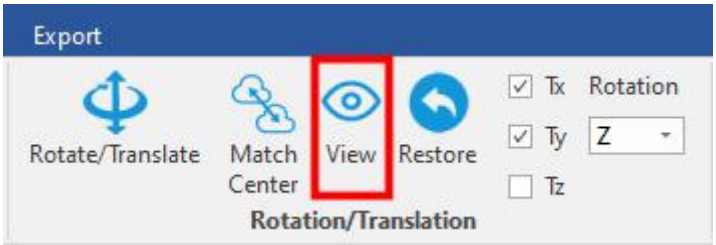


Figure 8-12 Perspective

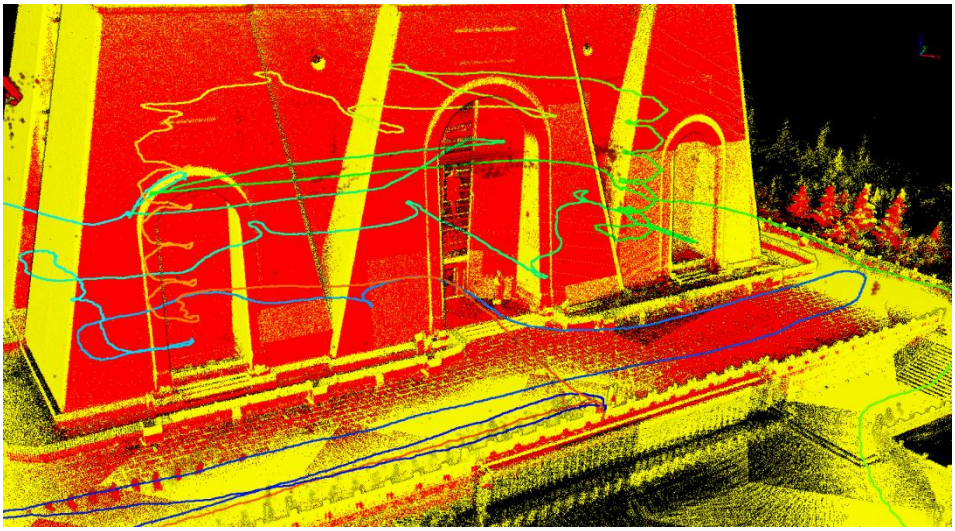


Figure 8-13 After panning by rotation, see if they are together through the viewing angle

(4) Click the matrix icon below the transformation.

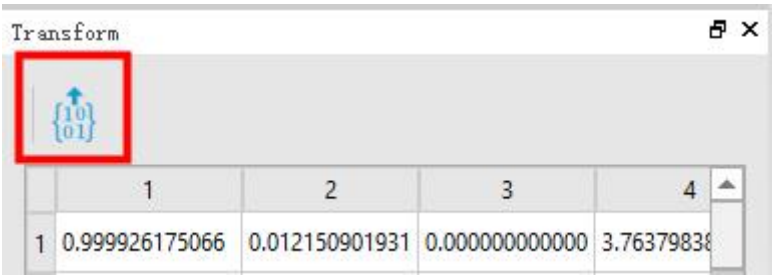


Figure 8-14 Applies the transformation

At this point, the two point clouds are connected.

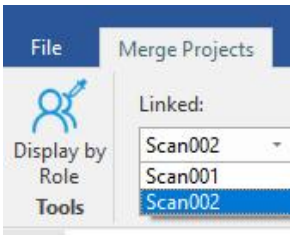


Figure 8-15 The connection relationship is established

Establish connections to other point clouds in turn.

8.3 Point cloud stitching

Before stitching, you need to set up the project.

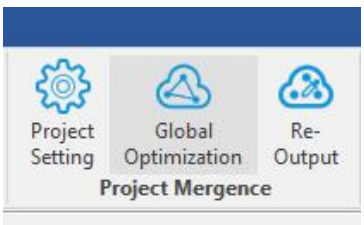


Figure 8-16 Project setup

For the significance of the maximum number of iterations, fitness score, and closed-loop distance, please refer to BP's instruction manual and FAQ document.

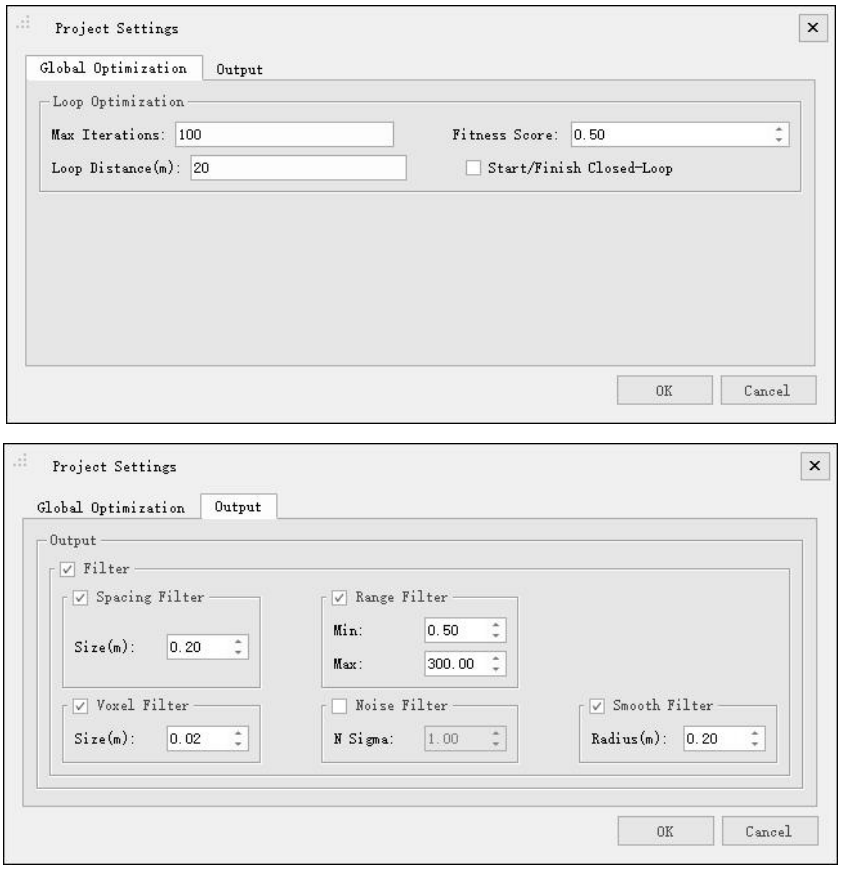


Figure 8-17 Project setup

In the output options, it is recommended to unfilter first (shown in the red box in Figure 8-18) so that we can easily view the splicing quality.

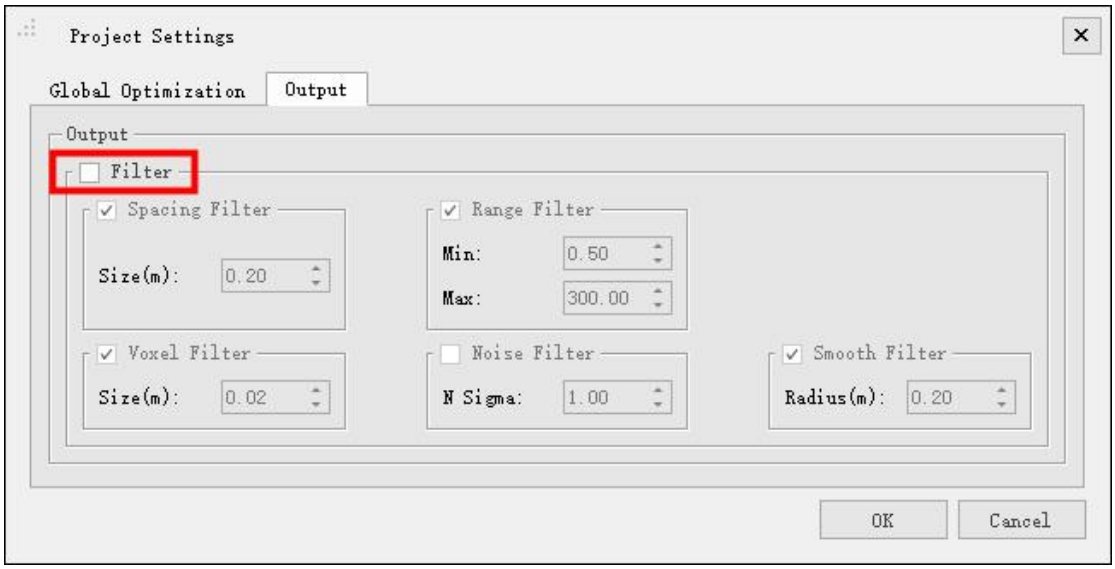


Figure 8-18 First unfiltering

Click Global optimization

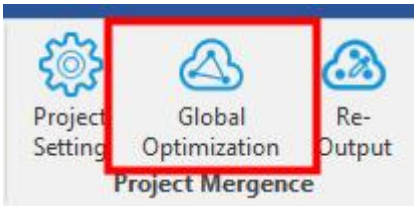


Figure 8-19 Global optimization

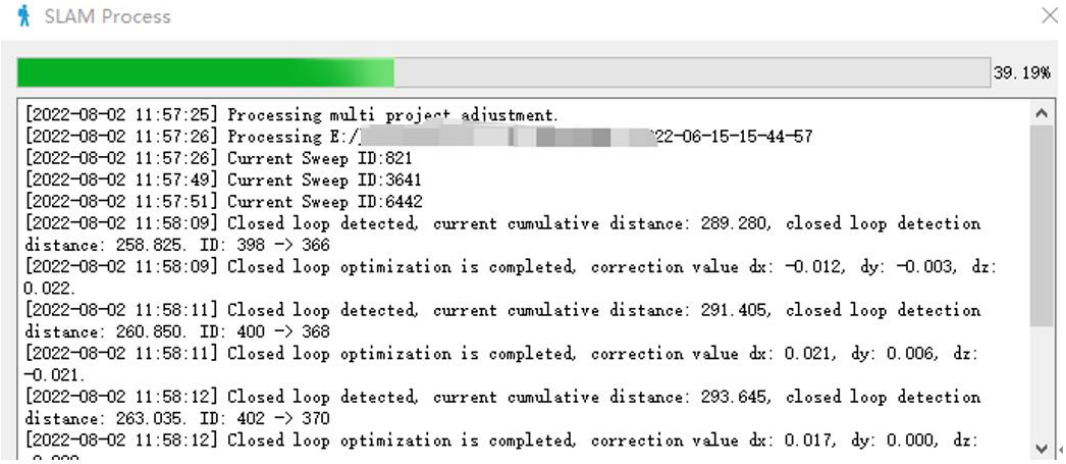


Figure 8-20 Global optimization

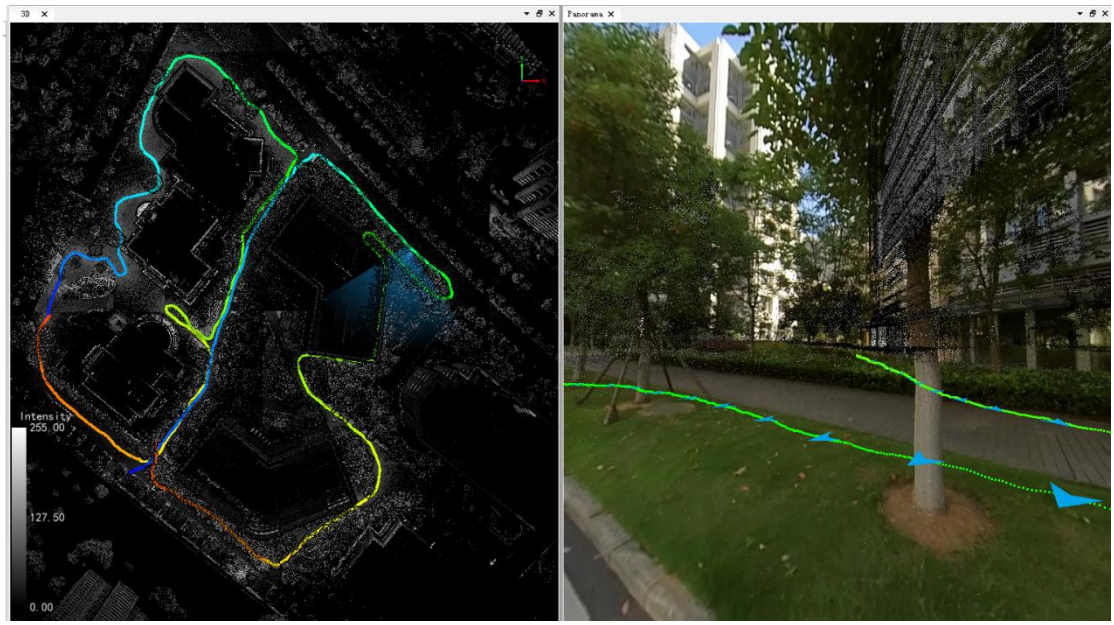


Figure 8-21 Stitching completed

8.4 Quality assessment

View the layering of point clouds, the layering of common areas between multiple sorties.

For other accuracy measures, see Section 7.5, "Data Quality Judgment".

8.5 Re-Output

Finally, click Project Settings -> Output -> check the filter option, and then re-output.

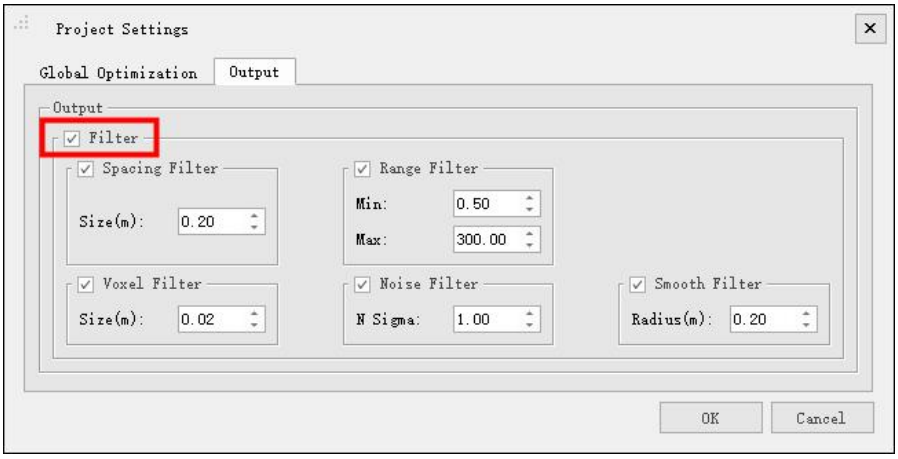


Figure 8-22 Re-output