LiMobile

Vehicle-borne Mobile Mapping System

User Guide V1.1

GreenValley International

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Copyright

1. Safety Warning

Please read this user guide carefully before you use the product and follow all operating and use instructions. The manual will be updated from time to time as the product upgrades. To access the latest user guides for LiMobile, please visit our website or contact GVI Tech Support Specialist.

LiMobile is an extremely high-precision device and is sensitive to jolts and excessive vibration. Please be careful when using the product. Please secure it in its protective case when carrying the scanner.

> Note:
>
> - If the scanner is not used for an extended period, please remove the battery from it.
>
> - The HDMI port on the LiMobile main body is a debugging interface for troubleshooting whenever a malfunction occurs. Under normal use of the device, please do not connect an external screen to do any operation. If any malfunction occurs, please contact the GVI Support team for assistance.

Please also note that the warranty will become invalid if you dismantle and/or reassemble any LiMobile devices without instructions from our official support team. This product should be serviced by a qualified licensed technician, electrician or electrical maintenance personnel familiar with its operation and the hazards involved.

2. Introduction

LiMobile is a mobile LiDAR 3D mapping system to collect indoor and outdoor point cloud and panoramic photography with high precision. It is a vehicle-borne lidar that integrates high-speed laser scanning technology with IMU, GPS and industrial camera. With its control system developed by GVI independently, LiMobile capture and produce real-time 3D point cloud data and synchronizing imagery that can be used in a variety of fields, from high-precision mapping, road reconstruction and expansion measurement, to 3D city modelling, and road asset inventory. What's more, GVI also provides complete mobile mapping solutions that include mobile & UAV LiDAR acquisition hardware, post-processing software, consulting and services.

2.1 Product Name and Components

Product Name: LiMobile Vehicle-borne Mobile Mapping System

Components: LiMobile is made of four major subsystems, namely, laser scanner, combined navigation system, industrial camera, and storage and control system. Its components are listed as follows:

(1) Global Navigation Satellite System (GNSS): it provides globally referenced localization supported by lidar;

(2) Inertial Navigation System: it measures the attitude parameters of the optical axis of the scanner;

(3) Laser Scanner: it measures the distance between the sensor and surface object;

(4) Camera: it acquires imagery of ground feature

(5) Storage and Control System: it controls LiMobile, receiving signals sent to the device from the computer and managing the parameters and data acquisition.

2.2 Major Technical Parameters

Performance Indicators	Parameters
Laser Sensor	XT-32
Laser Classification	Class 1 Eye-Safe
Range Accuracy	±1cm
Sys. Relative Accuracy	3cm
Sys. Absolute Accuracy	15cm
Weight	4.7kg
Main Dimensions	265*270*230mm
Max Range	100m
Wavelength	903nm
Scan Rate	640000pts/s
Horizontal FOV	0°~360°
Vertical FOV	-16°~15°
POS System	LiPos System
Point Cloud Data Format	.las,.laz,.ply,.LiData
Storage Space	512GB
Ports Available	HDMI,USB,Ethernet
Battery Capacity	5700mAh*6
Operating Time	≥6h
Operating Temperature	-10℃~40℃
Max.Ground Speed	100km/h
Camera Type	Monocular

Pixel	8.9 mega
Frame Rate	≥3fps
Control and Display	UI on mobile devices via WiFi (smartphones and tablets); data transmission over Ethernet cable (tablet)

3. Product Components

Components of LiMobile

1. Protection for laser scanner
2. Battery charger and power cable
3. Battery (not included)
4. LiMobile main body
5. Push pull bracket
6. Surface tablet and accessories
7. GNSS antenna
8. Ethernet cable (with USB adaptor)
9. GNSS feeder cable
10. Battery compartment
11. Power supply cable

LiMobile Details

Laser Scaner / Camera / Push pull bracket / Various interfaces / GNSS Antenna
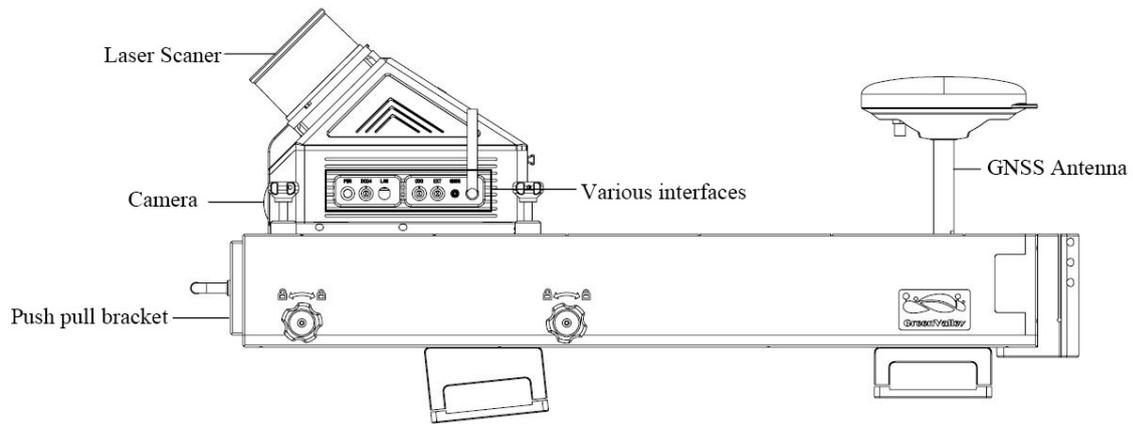
3.1 Laser Scanner

Laser Scanner	Hesai
Max Range	120m
Scan Rate	640000pts/s
Horizontal FOV	360°
Vertical FOV	－16°—15°
Range Accuracy	±1cm
Operating Temperature	-20℃~65℃

3.2 Camera

Camera Type	Industrial Camera
Camera Resolution	4096*2160
Frame Rate	3fps

3.3 Combined Satellite Positioning System

Signals	GPS: L1 C/A, L1C, L2C, L2P, L5 GLONASS: L1 C/A, L2C, L2P, L3,L5 BeiDou: B1,B2
Positioning Accuracy	1cm+1ppm
Navigation Accuracy	0.04°
Attitude Accuracy	0.015°

3.4 PC

- Operating Voltage: 19V
- Hard Disk Storage Space: 512GB SSD
- CPU: quad core 8 threads

3.5 Wifi Information

- Frequency range: 2.4 GHz

- Protocol: IEEE 802.11n
- Security: WPA2-Personal
- Gateway address: 192.168.12.1
- Connections allowe: 1 device
- Connection range: 5m
- Wifi SSID: LiMobile(default password：greenvalley)
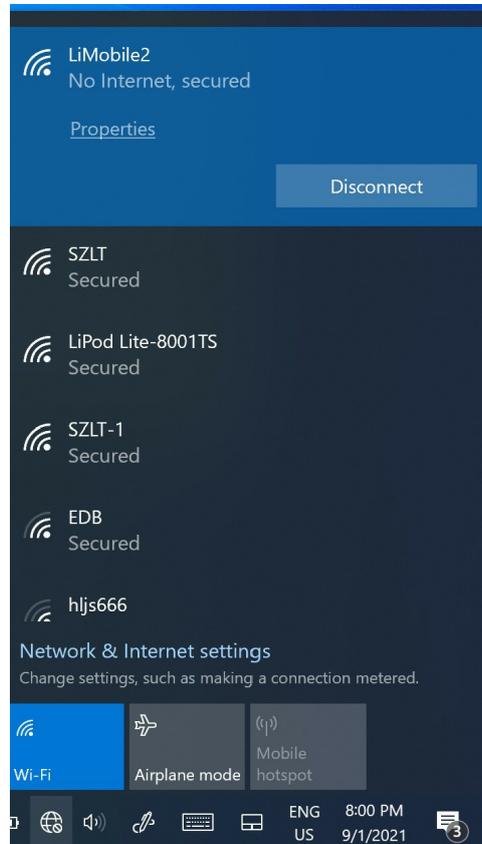
LiMobile Wifi information

4. Installation

LiMobile supports vehicle-borne scanning

1.Fix the push pull bracket on luggage rack.
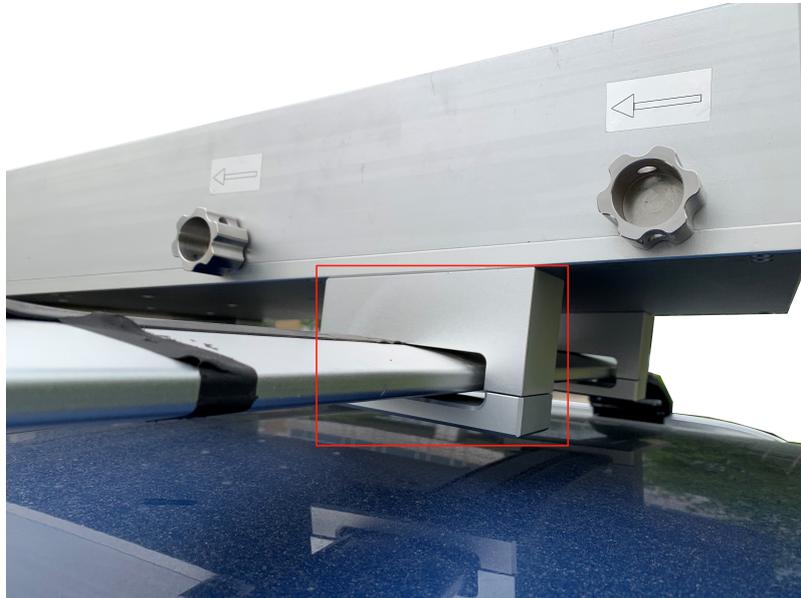
Fasten the screws under the push pull bracket to fix it on the luggage rack firmly.

2.Fix the luggage rack and the push pull bracket to the roof.

Use hexagonal screwdriver to lock the luggage rack in position.

3.After fixing, try to shake the luggage rack to confirm the stability.

shake the luggage rack to confirm its stability

4.Loosen the fixing bolts according to the arrow mark, pull out the bracket, and then tighten the bolts.
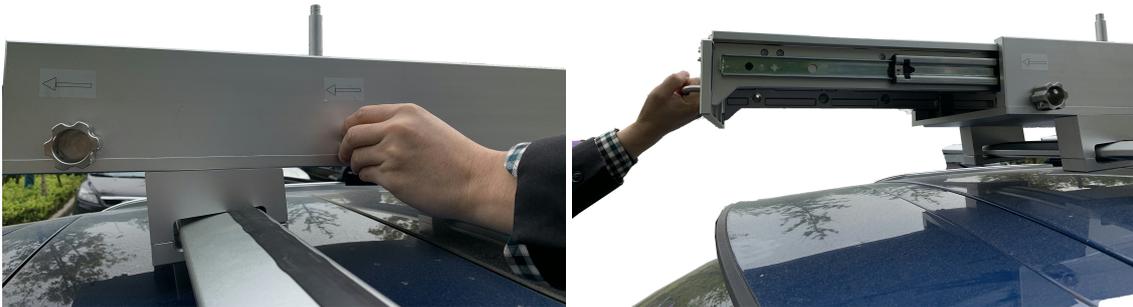
LEMO connector

5.Place the main body of the device on the base of the bracket and tighten the 4 thumb bolts.

fix the thumb bolts.

Note: After tightening, try to shake the device to ensure it is placed securely.

6.Install GNSS antenna and connect GNSS feeder cable.

Install GNSS antenna and connect GNSS feeder cable

7.Connect the power supply cable, connect the multi-function battery compartment and the main body.

LEMO connector

8.Overall view after installation

Overall view

5. Workflow

Please follow this guide to ensure the proper functioning of the device

5.1 Base Station Setup

1. Install GPS antenna and power on the base station as follows
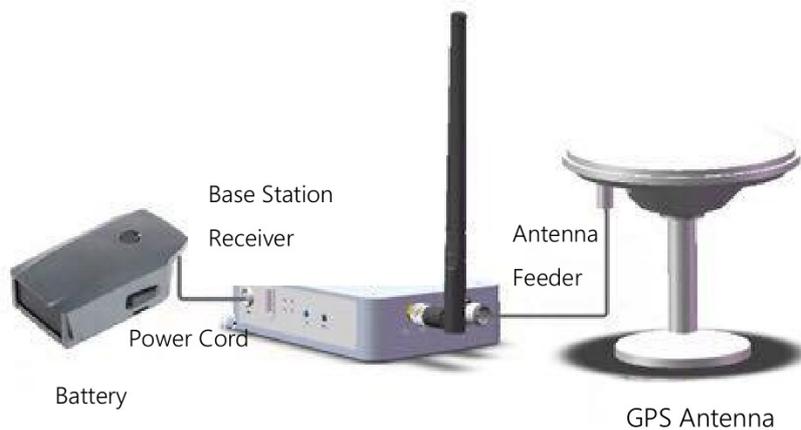
GPS antenna installation

Note: The red dot on the power cable must be properly aligned with the interface before connecting the base station

Alignment

2. Setting base station. Secure the base station in a location on the jobsite that has a clear line of the sight to the sky in all directions. Make sure the base station is not being subject to vibration or signal interference. For higher accuracy, users can fix the base station on a tripod on the known ground control point (GCP) with high absolute accuracy.

3. Connect the power cable and the indicators ▭ 、 ((•)) will stay on. Wait for the orange signal light ✶ of the GPS satellite to stay on (indicating the GPS signal is stable). Press and hold **Save** button (more than 2 seconds) to record data. Release the button as the indicator light becomes solid to start recording data.

Indicators and Button of the Base Station

4. Measure the oblique distance from antenna bottom edge to the ground for more than three times, take the mean value as H. Instrument Height (H) = The height from the center of jobsite where the base station was set to the lower edge of the GPS protector foils.

the lower edge of the GPS protective rim

Base Station Antenna

Antenna Height = $(0.05-0.046)+\sqrt{(H)^2-(0.1515/2)^2}$

Calculate Antenna Height

5.2 Device Initialization

The Battery Compartment is designed to accommodate up to 6 batteries for longer battery life. During operation, you can decide how many batteries you want to turn on.

Press and release the round button in the middle of the battery. Press and hold it again for 2 seconds until the red indicator on the button illuminates. Now both the battery and the main body start to work, the power supply indicator will be on. The battery can be turned off the same way and the device would be off in the meantime.

Turn on the Battery

Indicators Stay On

> Note: In general, in 1 minute after powering on the LiMobile system, Wi-Fi hotspot signal should be available. You can connect a mobile device (smartphones or IPad) to the device through Wi-Fi or cable.

- Connecting to the LiMobile User Interface via Wi-Fi: From the list of networks available to your device select the network named "LiMobile". When prompted to do so, enter the password "greenvalley". Navigate to **192.168.12.1:8090** and load the LiMobile User Interface. If the User Interface fails to load, please go check whether Wifi is connected to LiMobile.

- Connecting to the LiMobile User Interface via Ethernet Network: Attach the LEMO connector of the Network Cable to the LAN port on LiMibile and the opposite end of the Network Cable to the Ground Control Computer's Ethernet port. Set the IP address and Subnet mask to the following values Launch Google Chrome and navigate to **http://192.168.1.200:8090** to load the LiMobile User Interface.

Tablet Setting
IP address：192.168.1.99
Subnet mask：255.255.255.0

If the connection is successful, the main screen is displayed as shown. Four icons would appear on the upper right corners, indicating that the device is only powered on and not yet working.

Main Screen

5.3 Data Acquisition

1、Click on **Start** button and a countdown would display, indicating that LiMobile shall not be moved or disturbed for at least 5 minutes. Now would display on the GNSS and IMU icons, which indicates the GNSS starts to work.
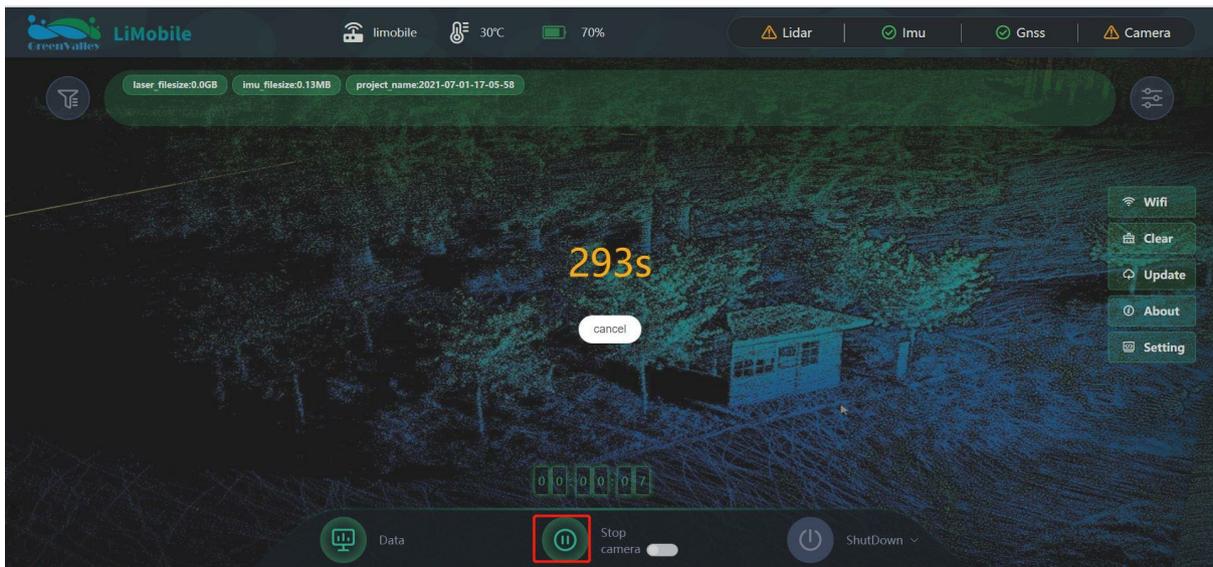
2、IMU Initialization: Start the car and accelerate to ensure the convergence of IMU precision. Please follow the procedures: Accelerate forward to 40km/h and slow down to 10km/h. Then accelerate forward to 40km/h, and slow down to 10km/h. Turn the car around and repeat the above process.

3、Turn on the camera/laser: after the acceleration and deceleration, click on the slide button next to **camera**. When the user interface prompts "Turn on the camera and laser?", click "OK" to turn them on. At this point, you can start acquiring point cloud data and image data.
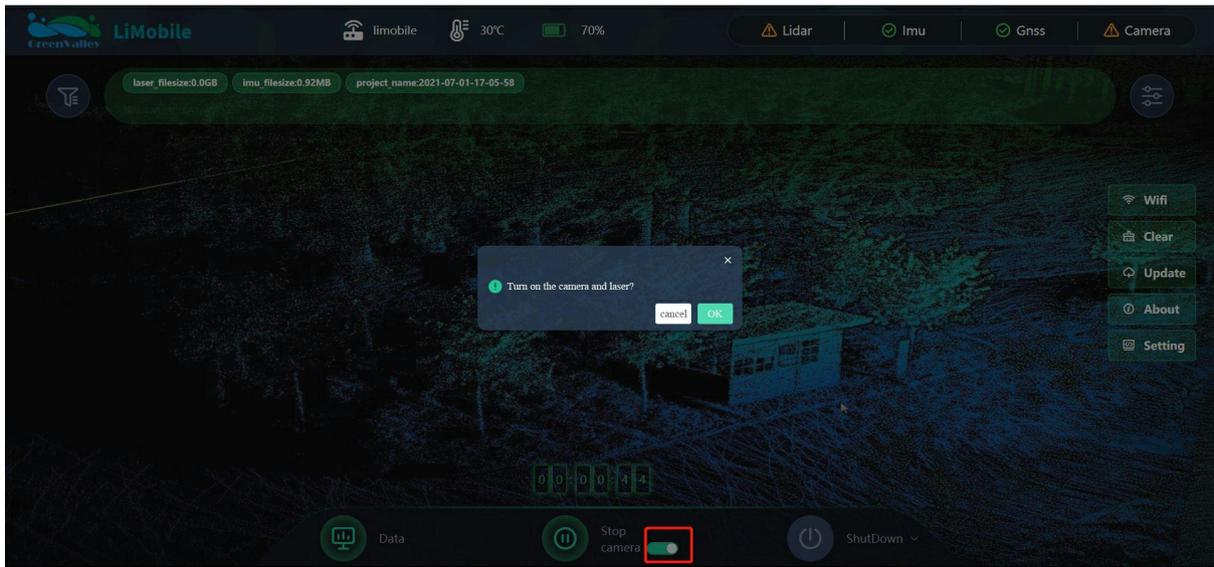
Turn on Camera/Laser

4、Acquisition in Process: During data acquisition, would display on the four icons in the upper right corner of the user interface.

Acquisition in Process

5、Turn off Camera/Laser: Once the data acquisition is completed in accordance with the planned route, click the slide button next to the **camera**. The user interface would prompt "Turn off the camera and laser?" and click "OK" to turn them off.
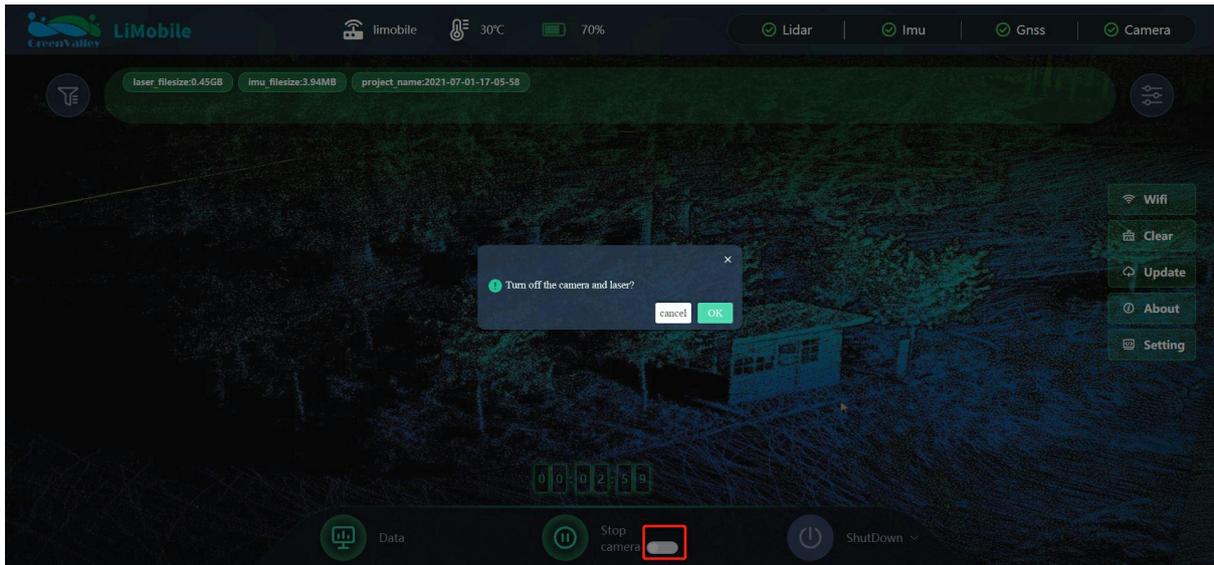
Turn off Camera/Laser

Now the "Lidar" and "Camera" in the upper right corner of the user interface would change to , indicating that the laser and camera have been turned off and that data acquisition is completed

Turn off Camera/Laser

6、Click on **Stop** button and a countdown would display, indicating that LiMobile shall not be moved or disturbed for at least 5 minutes.
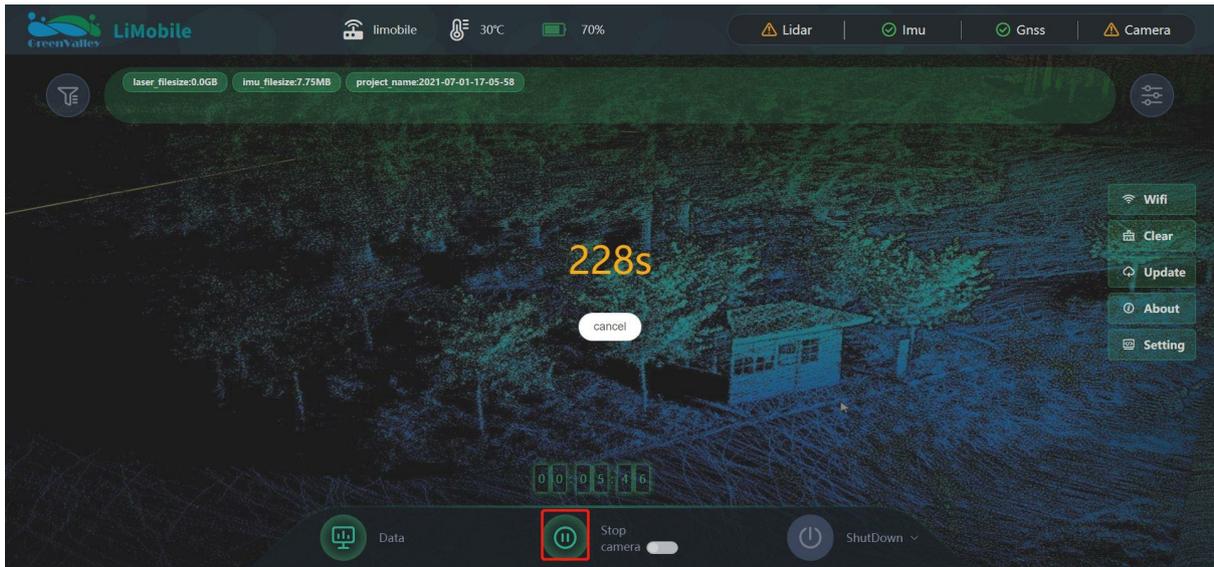
Shut down

Now data acquisition by LiMobile is complete, and the user interface would display the same as the initialization session. If you need to acquire data again, repeat the above steps. If data acquisition is complete, you can power off.
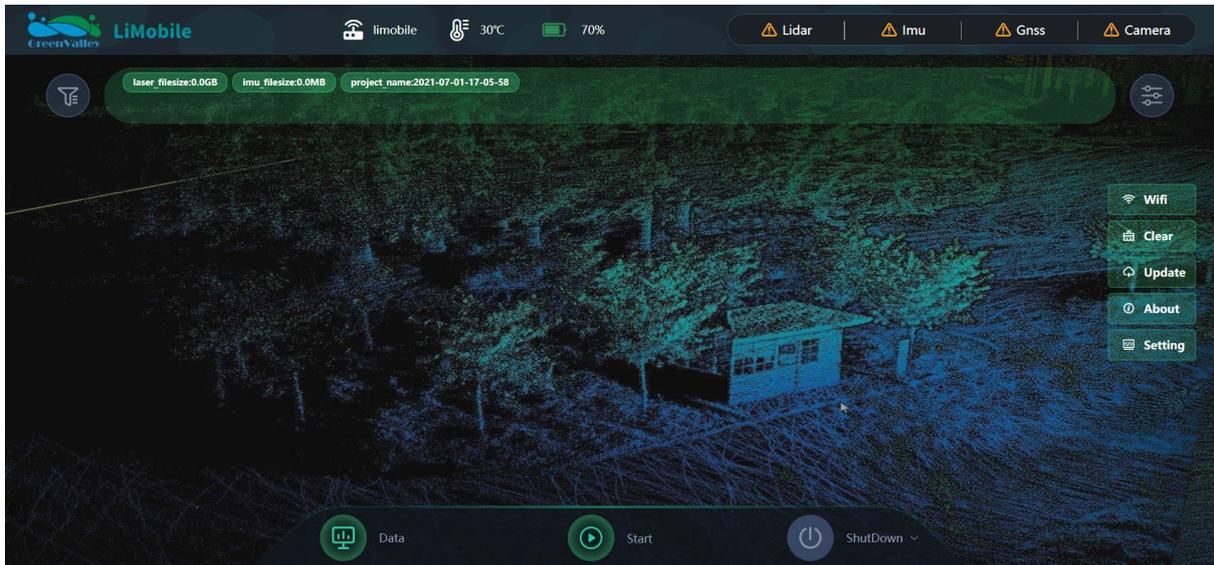
Data Acquisition Completed

Note: You can press Reboot button at the bottom of the window to restart your computer, or click on Shut Down button to turn it off. After each use, please click on the shutdown button on the web page instead of directly cutting off the power. An abnormal shutdown may cause unpredictable failures. If a restart is necessary, please click on the shutdown button and wait for 60 seconds to power on again.
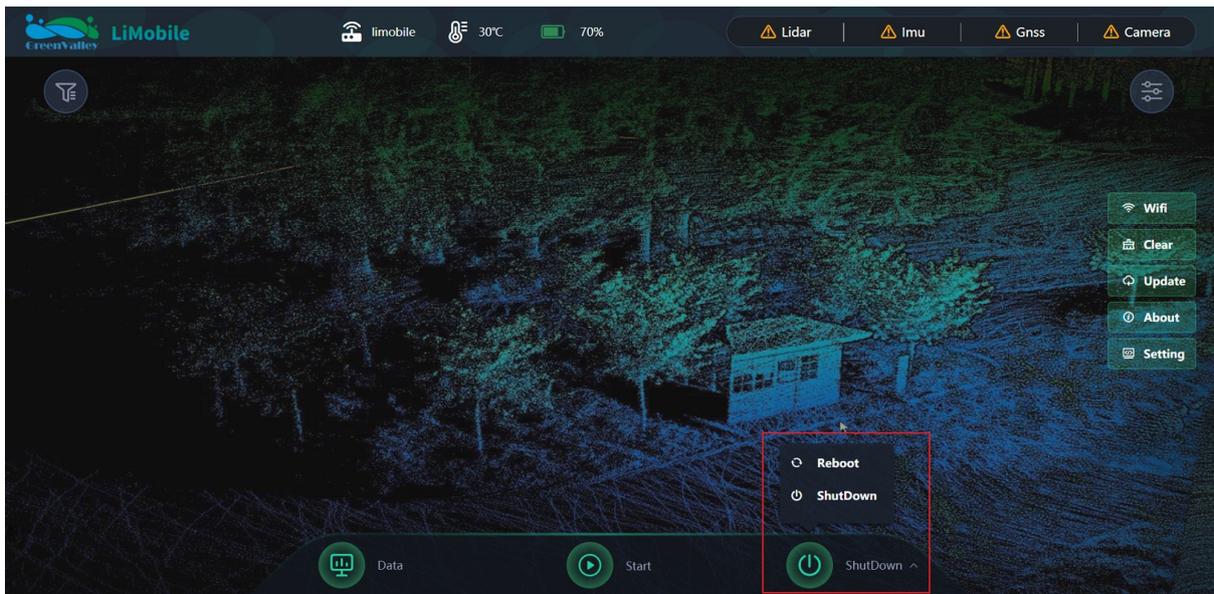
Reboot and Shut Down

5.4 Data Transfer

All data collected by LiMobile will be stored under the engineering catalog after acquisition. Data can be transmitted via WiFi or Ethernet Cable. - Download via WiFi: Click on the **Data** button on the main screen to select the files you want to copy in the pop-up window.
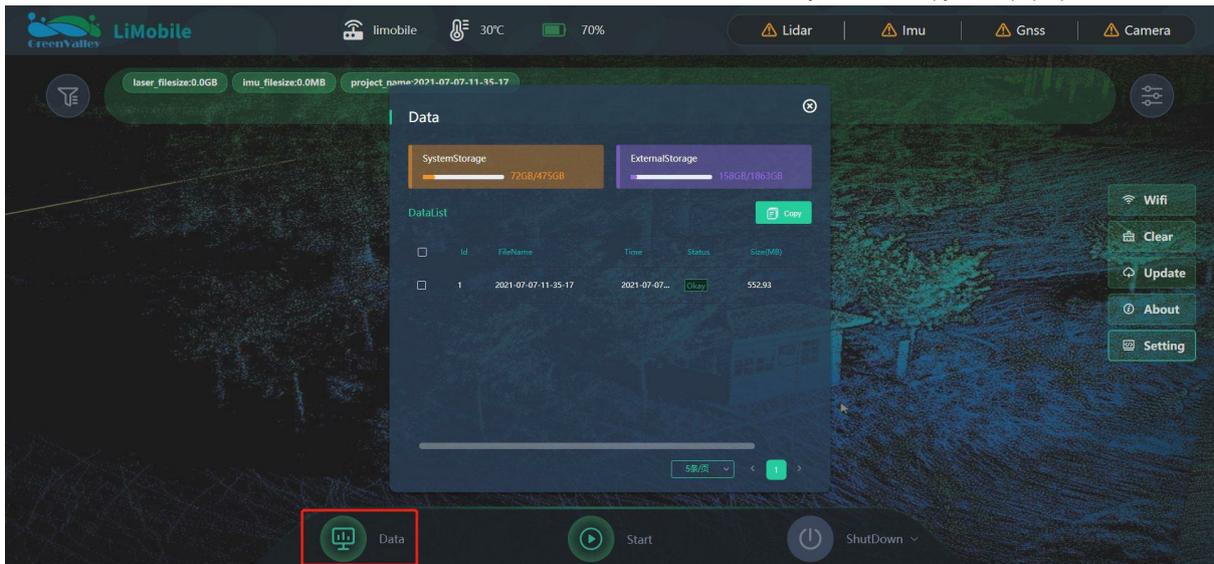
Copy Data
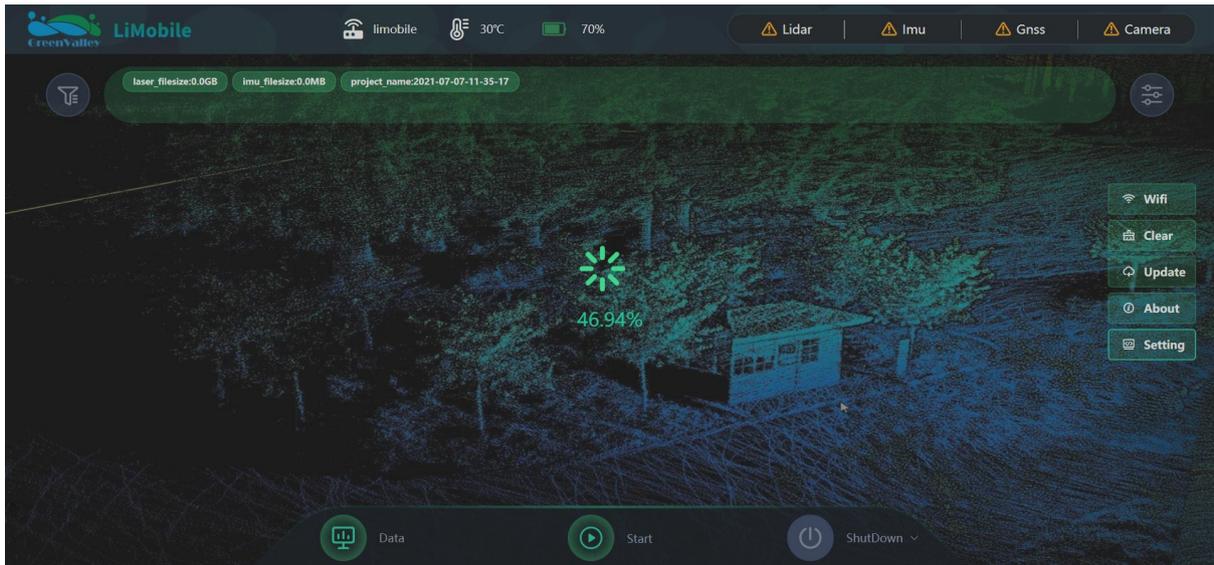
Data Downloading in Process

- Download via Ethernet Cable: Connect the external computer to LiMobile using the provided LEMO to Ethernet Network Cable. Set the IP address and Subnet mask to the following values: IP address: 192.168.1.99 Subnet mask: 255.255.255.0" Launch Windows File Explorer, and enter\\192.168.1.200 to see Projects saved to the LiMobile's internal storage. Open **data** folder and find the file in accordance with the time of acquisition. Copy the Project folders to the computer's internal or external data storage device.
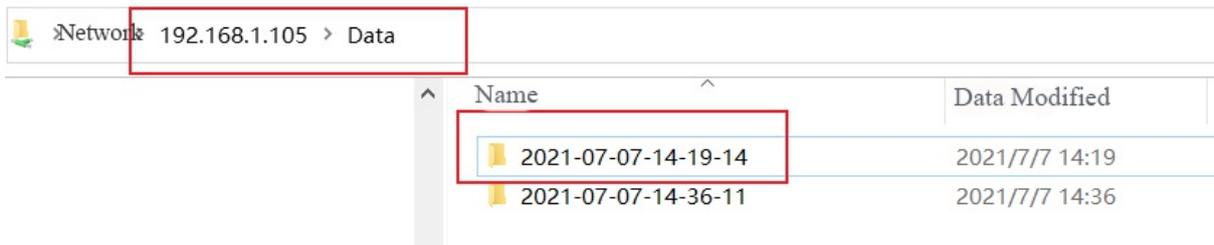
Download Data via Ethernet Cable

> Note: Do not insert the USB flash drive to copy data until LiMobile is turned on.

- The raw point cloud data captured by the scanner (.pcap file) will be saved in the LaserRaw folder in the Project directory.
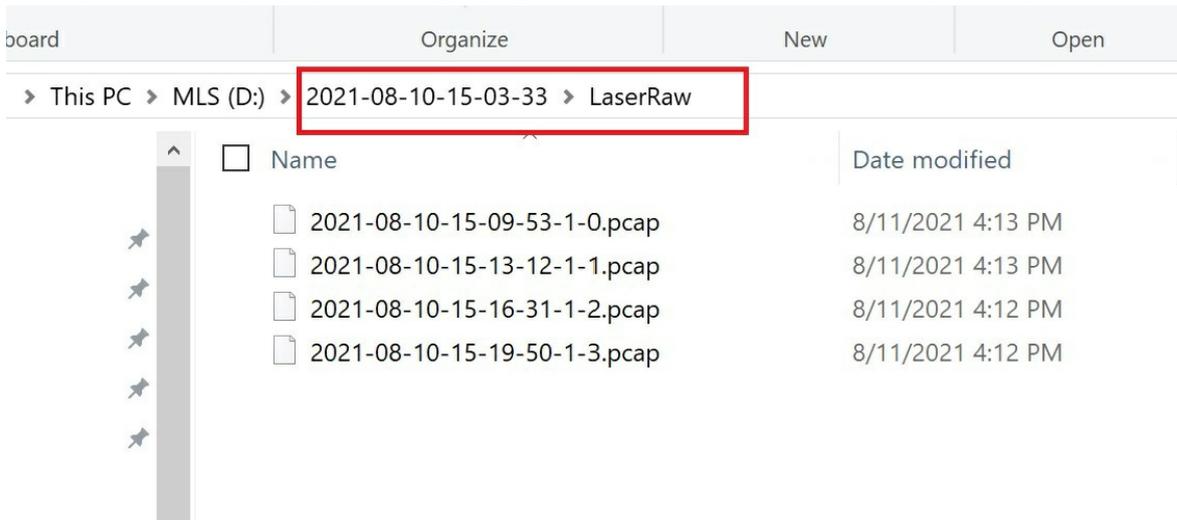
Raw Point Cloud Files

- INSTraj-IMU folder is used to store data collected by the combined navigation system including gps .log files, imu .log files, and *.imr files.
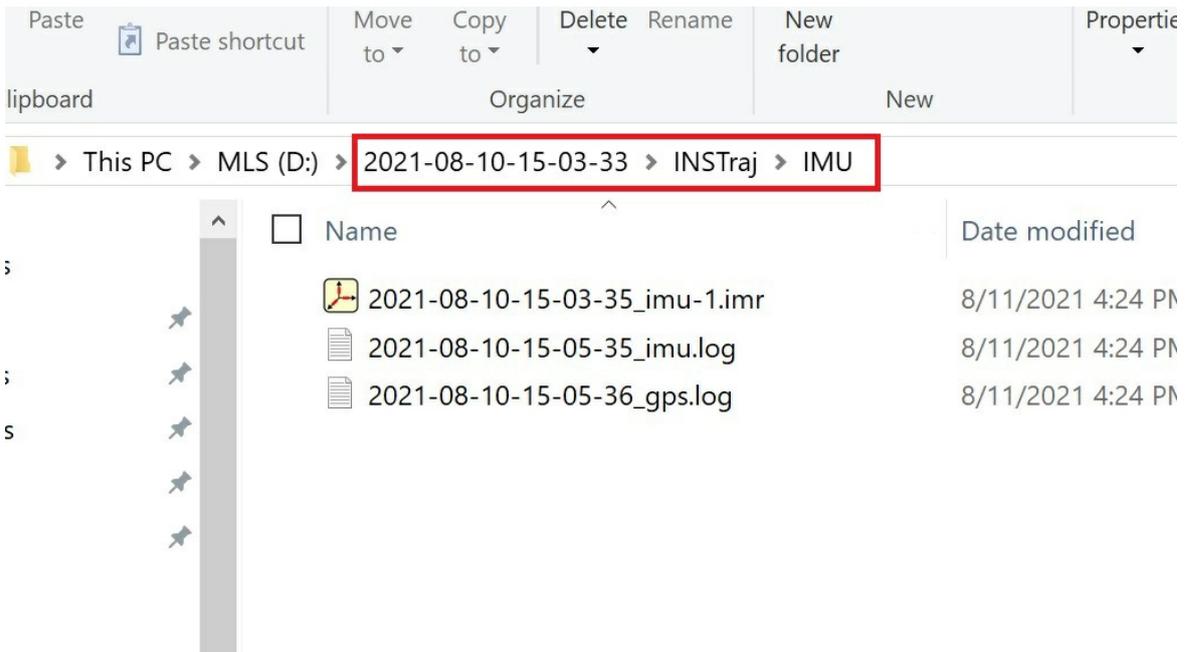
Raw IMU Files

- Cam-Cache folder in the Project folder is used to store the raw imagery captured by the camera (*.jpg).
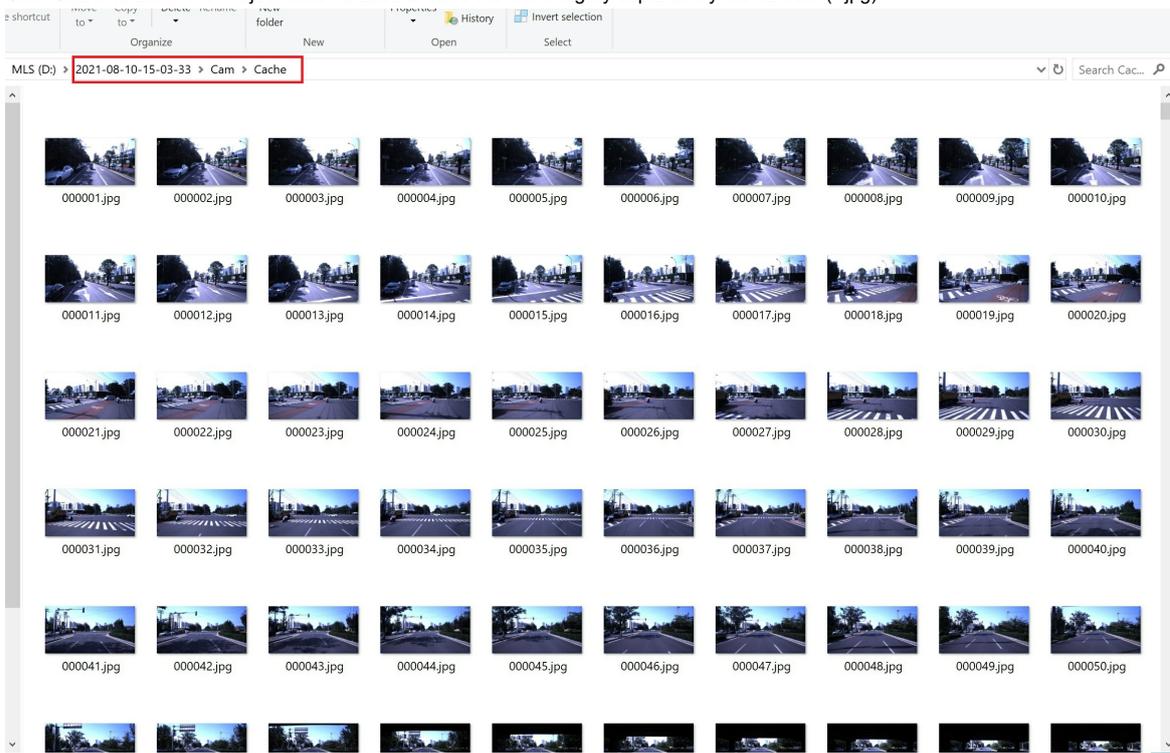
Raw Imagery Files

5.5 Data Processing

There are two sections in data processing for LiMobile:

1、Trajectory processing: use IE software for trajectory solution (For more information, introduction of IE processing is detailed in IE User Handbook and inertial navigation file configuration instructions .)

2、Data Processing: LiGeoreference is a LiDAR point cloud georeferencing software developed by GreenValley which allows users to complete point cloud data pre-processing and coloring. (For more information, introduction of processing point cloud data is detailed in LiGeoreference User Handbook. This user guide will only illustrate the differences in LiMobile processing.)

- As the trajectory is processed externally by IE software, you will be asked to add a trajectory file when you open the project folder

(automatically created under the project directory and named "Time.live"). add the processed trajectory results as required.
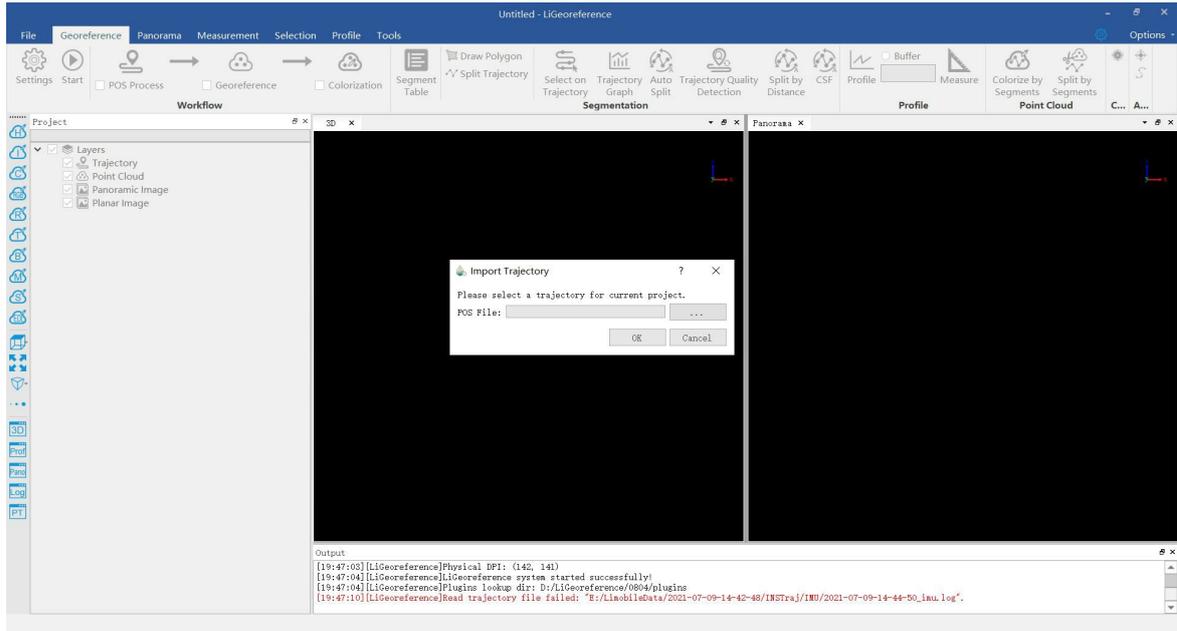
Add External Trajectory File

- For different types of cars, it is inevitable that the laser scanner would capture image noise from the rear of the car. To reduce the noise in the resolution process, it is advisable to add filter by distance to eliminate it.
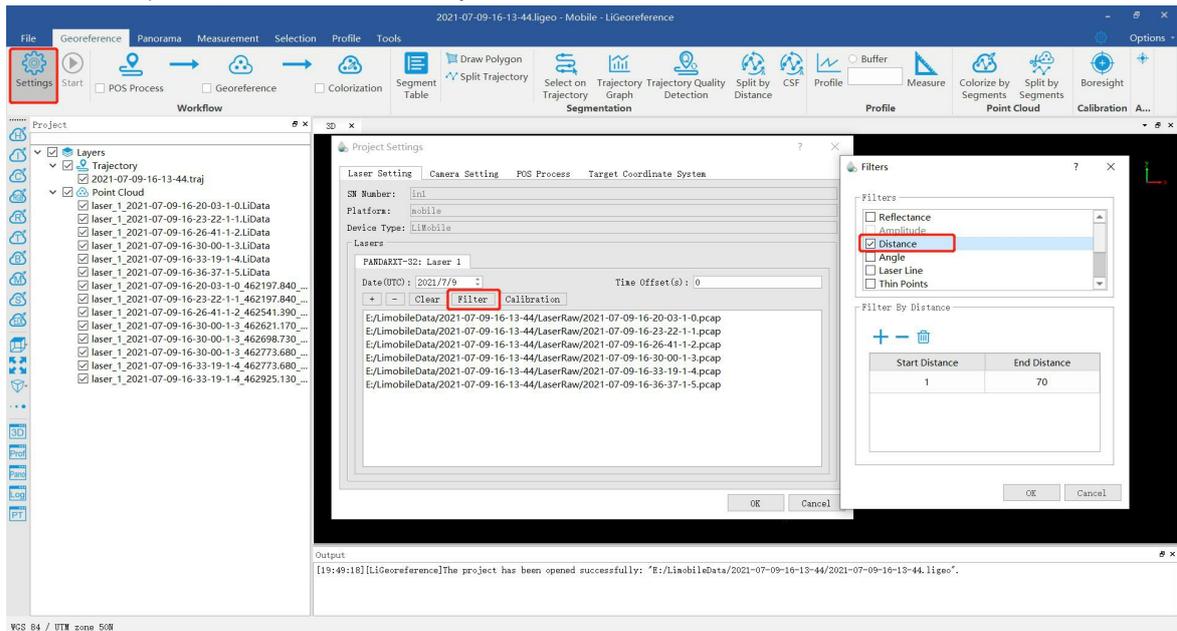
Filter by distance

- Check Solution and Coloring in the workflow, click on the **Start** button and you will have the point cloud data in .LiData format.

5.6 System settings

5.6.1 Main Interface Display Settings

Click the ⬚ button in the upper left to select the information that will be displayed in the main interface.

Lidar interface: You can choose to display the laser scanner's model, scan rate, and file size of the raw point cloud in the main interface

Interface Settings-Lidar

IMU interface: You can choose to display the accuracy and file size of IMU in the main interface.

- accx, accy, accz: acceleration of the accrometer;

- gryx, gryy, gryz: angular velocity of the accelerometer.
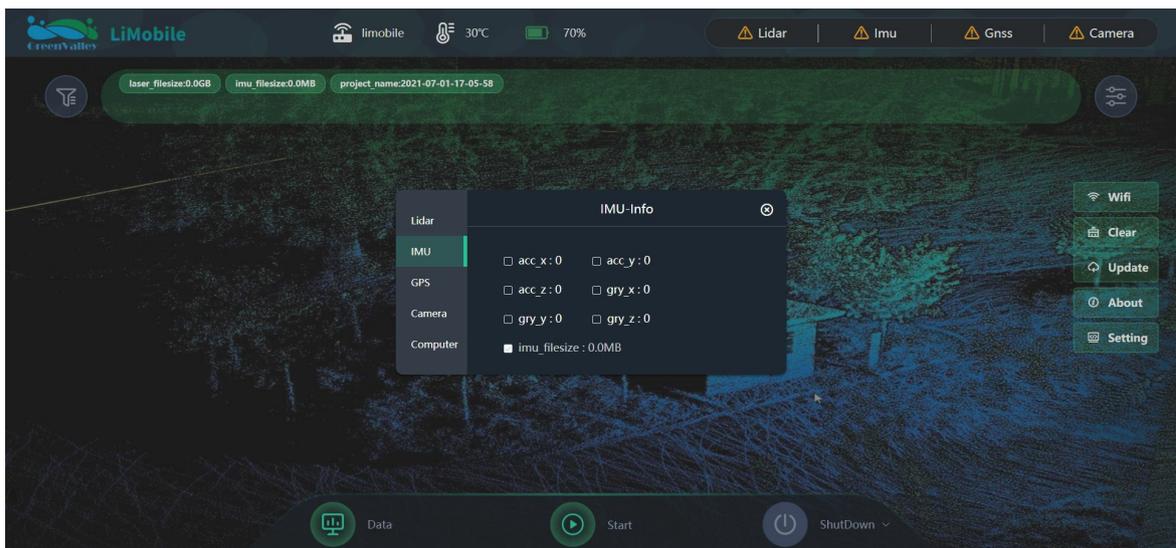
Interface Settings-IMU

GPS Interface: You can view the number of satellites searched
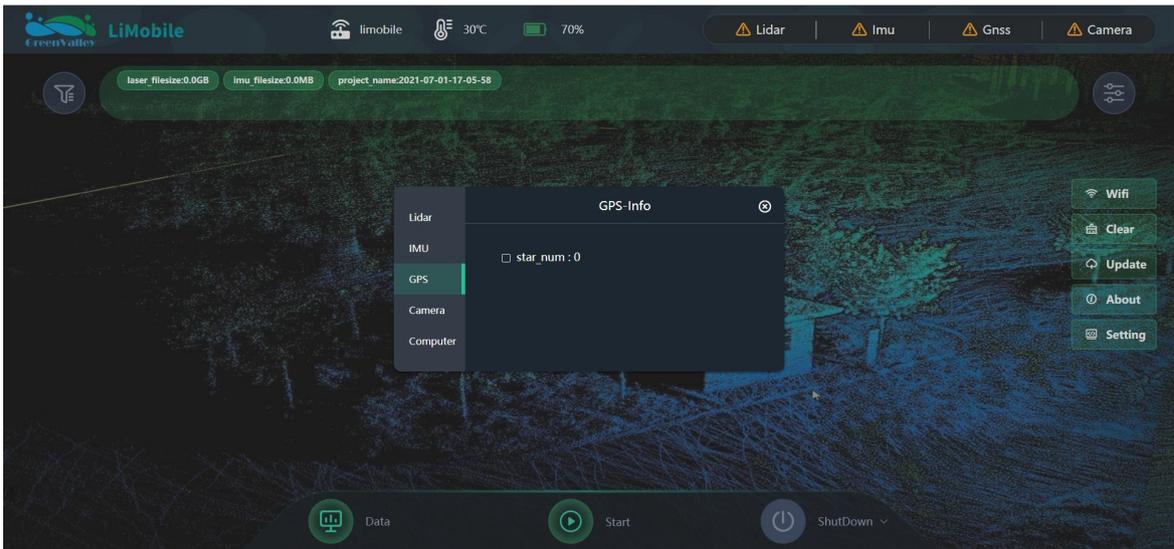
Interface Settings-GPS

Camera interface: You can view the camera's frame rate, camera exposure, and the number of lost frames.
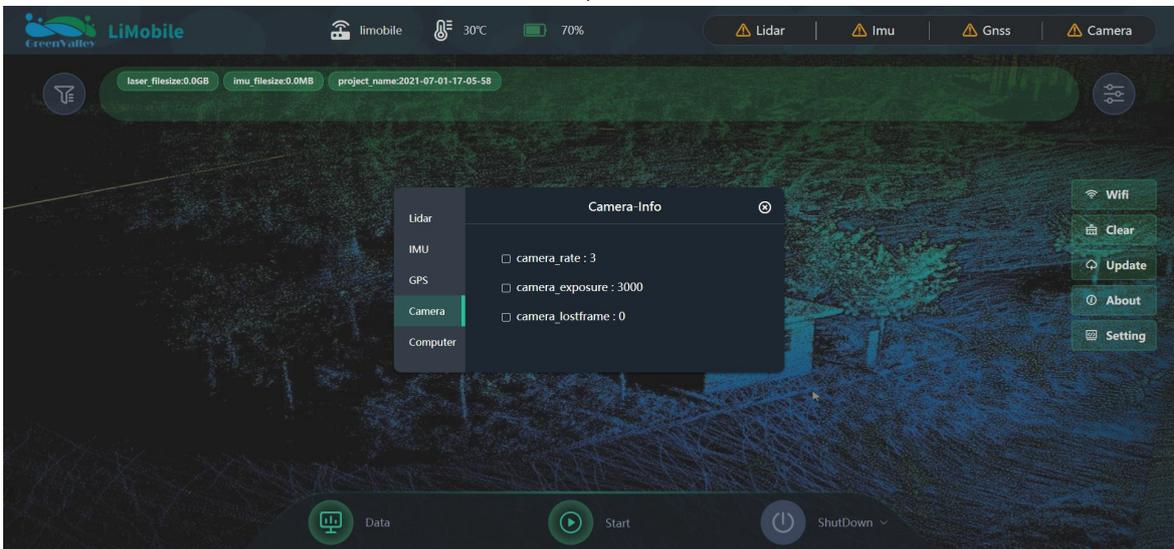
Interface Settings-Camera

Computer interface: You can view the project file name and the storage available of the main body.
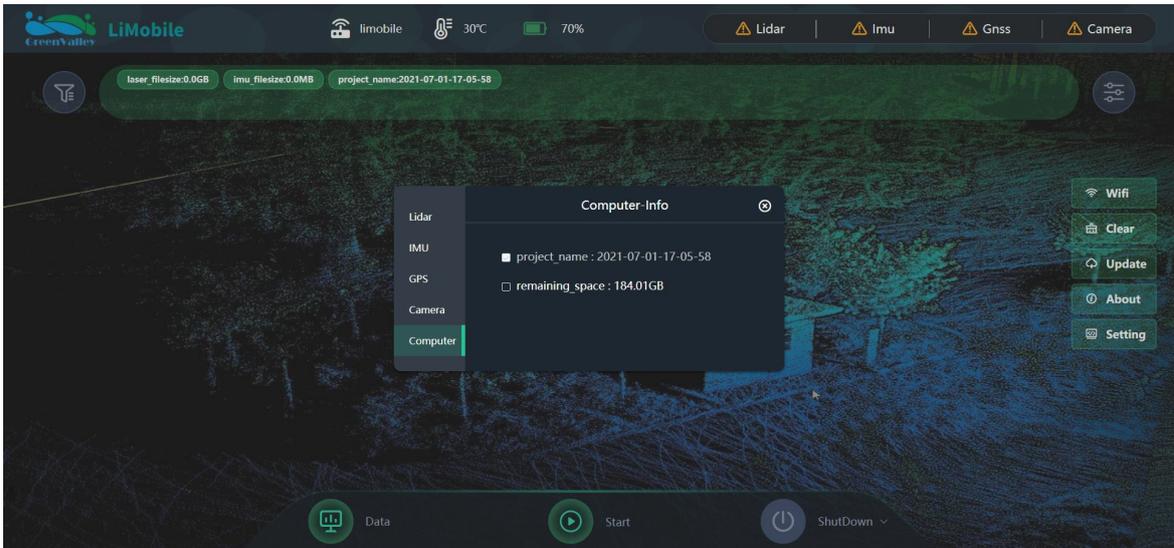
Interface Settings-Computer

5.6.2 Wifi Settings

When not collecting data, you can set Wi-Fi name and password by clicking the Wi-Fi Button on the right side of the interface.

- **Wifi Name**: The default Wi-Fi name is LiMobile, and you can add it with a suffix.
- **Password**: The default password is greenvalley.
  Note: the password will be reset to the default after system update.
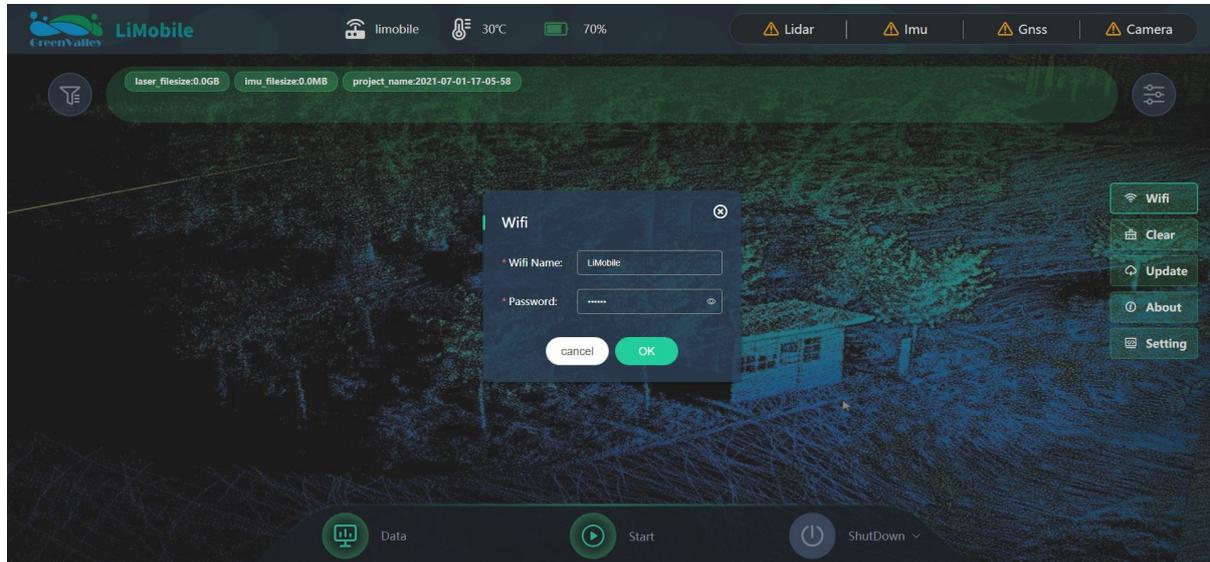
Wifi Settings

5.6.3 Clear System Storage

It is advisable to check the storage available in the display settings of the main interface before data acquisition. When system storage space is inadequate (shows in the Copy interface), you may tap on the **Clear** button to clear data from the system.

Note: This operation will permanently delete all data from storage. Please backup important files in advance.
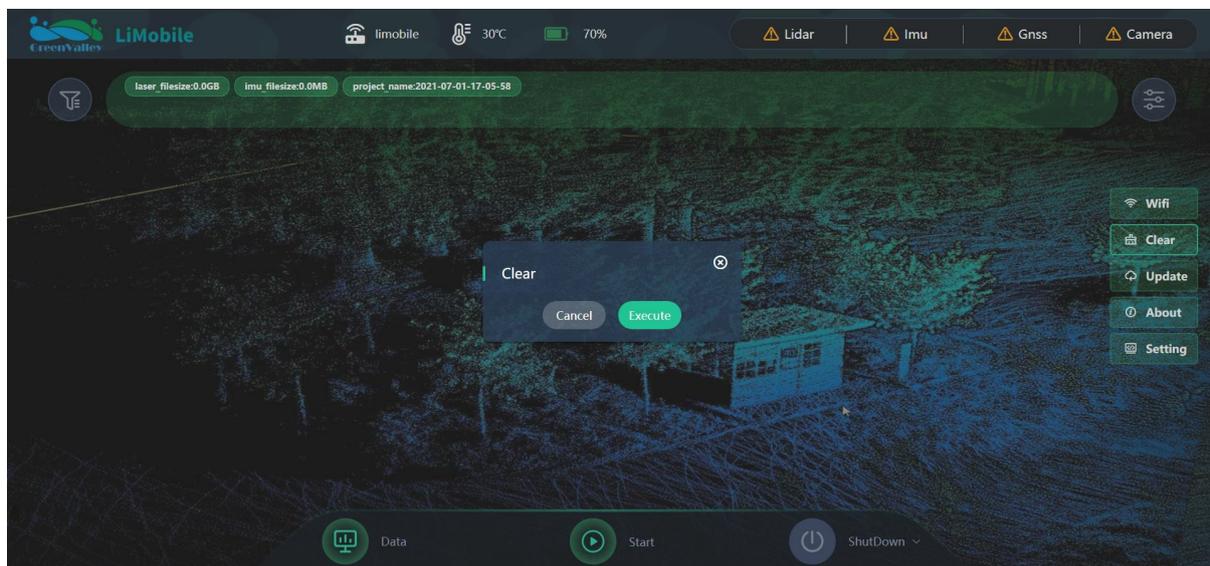
Clear System Storage

5.6.4 System Firmware Upgrade

Firmware upgrades can be realized by USB drive installation. Users can acquire upgrade packages from GVI and place them in the root folder of a USB drive. Tap on the **Update** button. The following interface will tell you about current version.
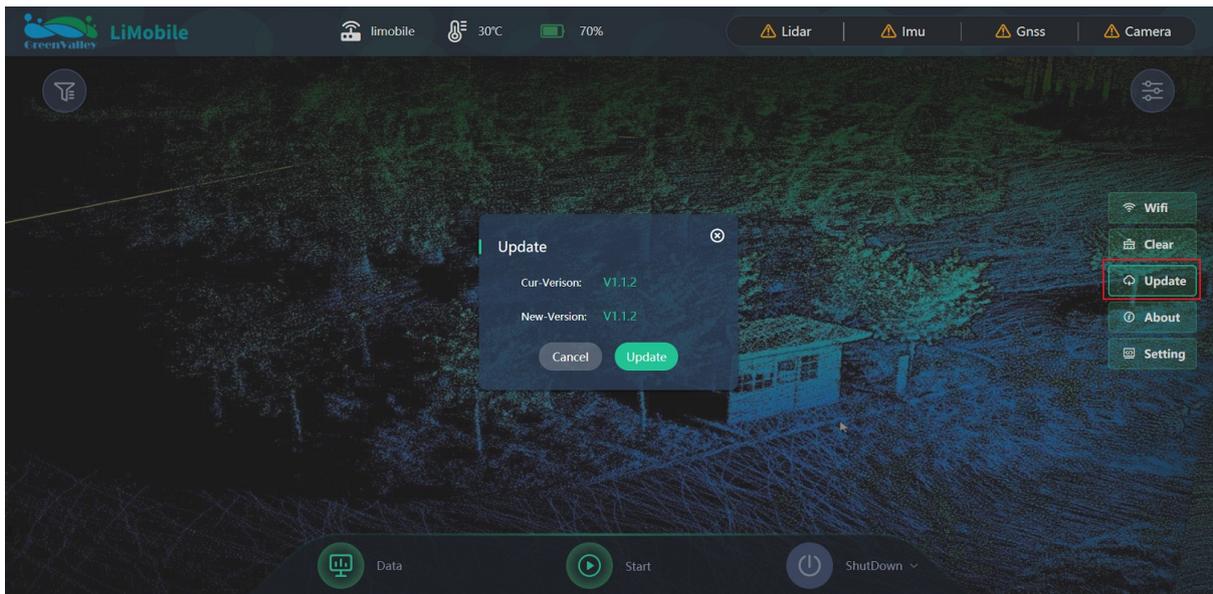
System Update

> Note: If the package is non-existent, placed wrong, or renamed, then the system will not detect and proceed.

5.6.5 System Version Information

Tap on About button to check the current firmware version and GVI contact information.
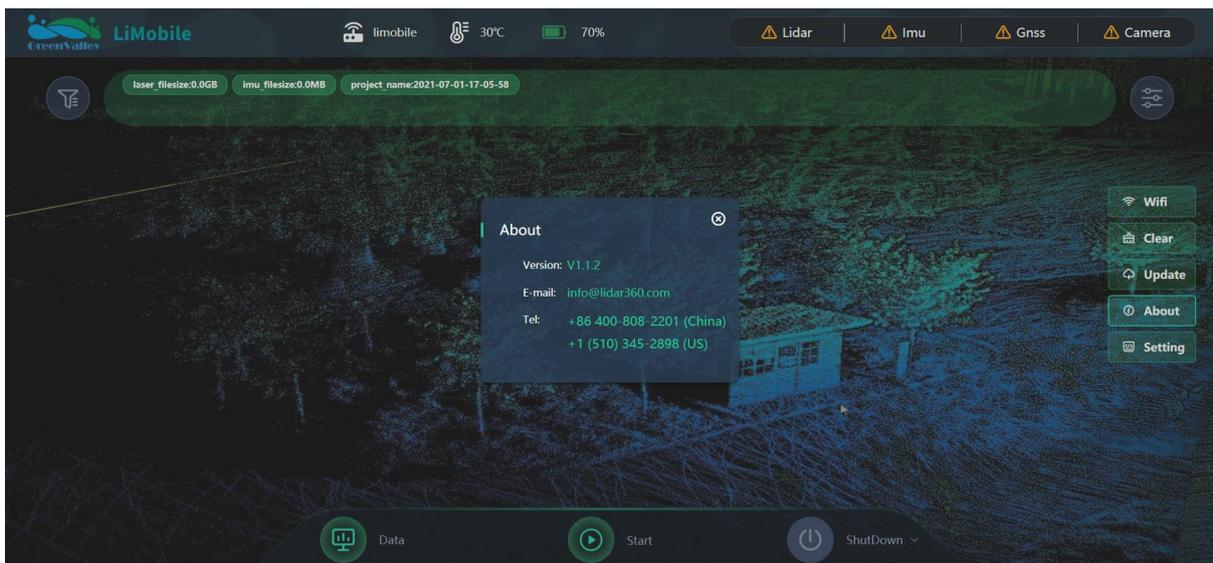
System Version Information

5.6.6 Camera Setting

Tap on **Setting** button to configure the camera.

- **CameraRate**: This is the frequency at which a complete image is captured by the sensor, usually expressed in frames per second (fps).
- **CameraExposure**: This the amount of time in which light is allowed to reach the sensor, usually expressed in microsecond (μs).
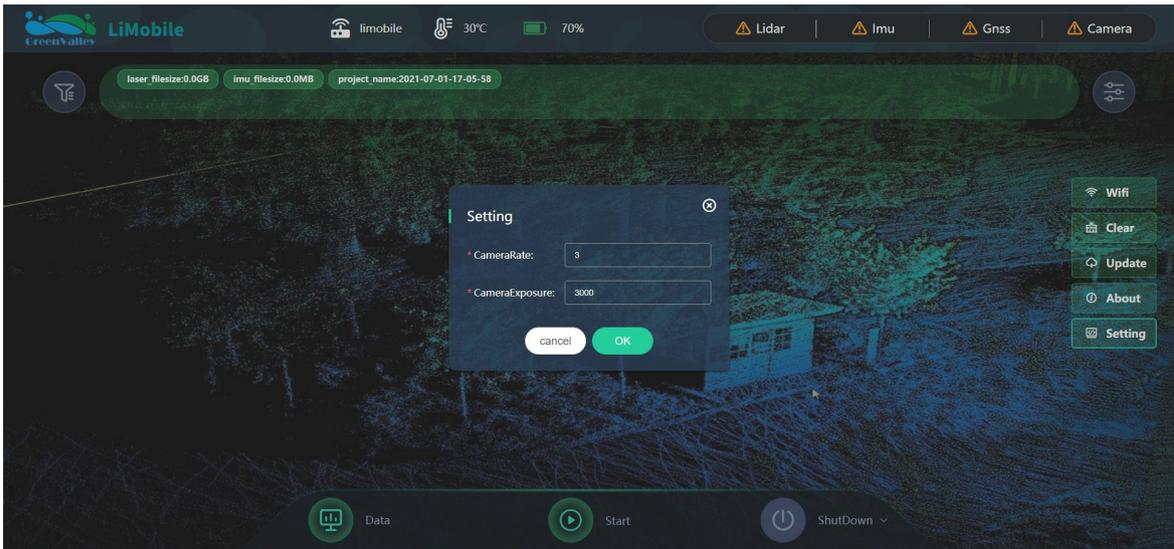
Camera Settings

6.FAQ

What should I do if I cannot find the LiMobile connection after powering on the system?

In general, in 1 minute after powering on the LiMobile system, a Wi-Fi connection called 'LiMobile' should be available. If not, try refreshing your phone or tablet. If the problem is not resolved after 5 minutes, please power off the system, reboot the computer, and then search for the Wi-Fi connection again.

Why do not the laser scanner and the computer start after powering on the LiMobile system?

- Please check: (1) if the battery percentage is low (2) if the battery is correctly connected.
- Please avoid over-discharge which can cause damage to the battery.
- It is recommended that the battery is charged or changed when the battery percentage is lower than 30% and that the power cable is disconnected when the scanner is off.

What should I do when LiMobile Wi-Fi is found but the UI device cannot connect to it?

It is recommended that the Microsoft Surface Pro tablet included with the LiMobile system at the time of purchase is used for data collection.

- If the device is an iPad or iPhone, please refer to Apple's instructions for resetting the network settings, or follow these steps (Settings->General->Reset->Reset Network Settings):
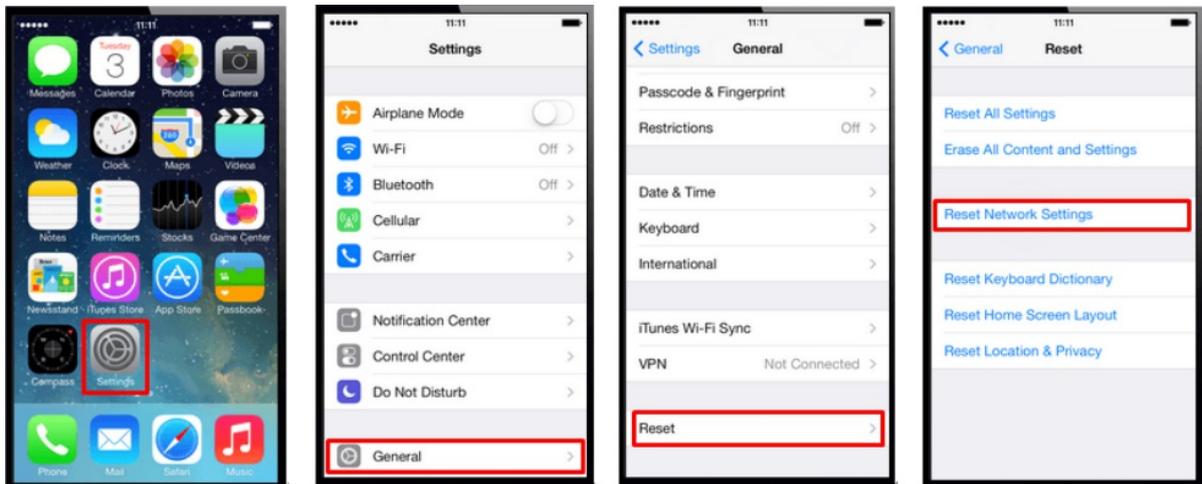
- If the device used is an Android device, please follow these steps to reset and reconnect to the LiMobile Wi-Fi (Settings->System->Reset->Network settings reset; steps may vary with make and model):
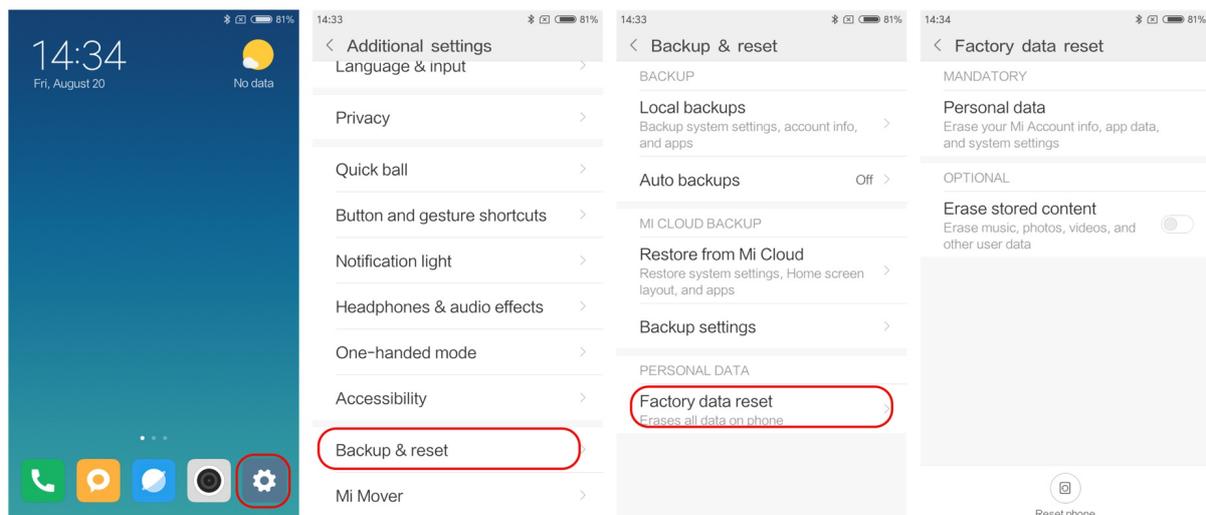
What should I do when I cannot open the copied data?

Please ensure that:The drive was not unplugged until the process bar reaches 100% and the notice to unplug the drive appears on the display.

What should I do when the copy process bar remains at 99% for a long time?

This is likely to occur when large quantities of data are being copied. You should wait for the message that file transfer is completed before removing the USB drive or shutting down the system to avoid data loss and/or damage to the drive.

Does LiMobile come with a point cloud post-processing tool?

We recommend using LiDAR360, a comprehensive point cloud post-processing suite developed by GreenValley International. LiDAR360 provides comprehensive toolsets for point cloud visualization, processing, analysis, and other tasks.

Is the output point cloud calibrated to be vertical to the ground?

Yes, LiMobile point cloud processing will adjust the tilt angle of the scanner based on analysis of the IMU data. The tilt angle accuracy is in a 1–3° range.
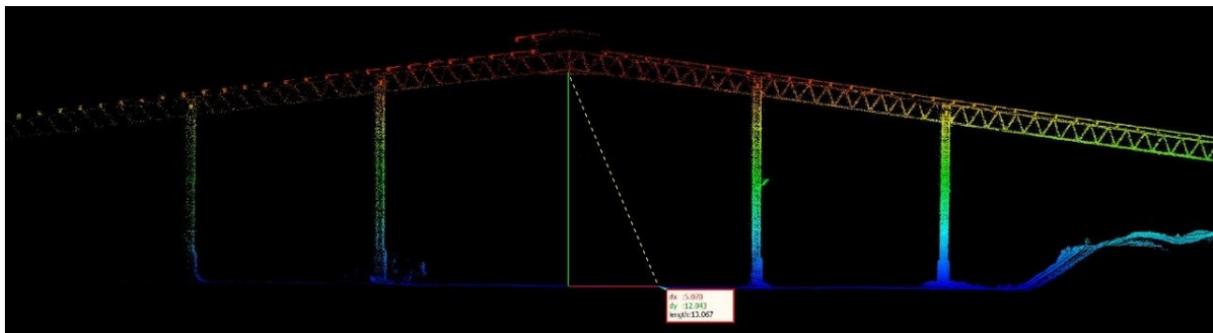
How long can I scan with LiMobile on one battery charge?

LiMobile can operate for 6 hours with one fully charged DJI TB47S Intelligent Flight battery.

What are the recommended operation environment and conditions for LiMobile?

Operation of the system should be carried out when ambient temperatures are within the −20° to 65°C range. You should avoid operating the LiMobile outdoors on wet-weather conditions.

What is the ANSI Laser Safety Standard rating of LiMobile's LiDAR sensor?

ANSI Laser Safety Standard rating of LiMobile is Class-1 (eye-safe).

Is my data collected with LiMobile secure?

All data collected with the LiMobile system is securely stored local on the system drive and not uploaded to any network. The data can later be transferred out to USB devices or deleted from the UI. If you encounter any difficulties with real-time data processing, please contact us at info@lidar360.com and send us the data with its documentations. We will post-process your data to produce high accuracy point cloud.

When can I unplug the flash drive?

It is possible to hot swap the drive if data copying is not in progress. DO NOT unplug the drive if data copying is in progress. Wait until the process is completed and a notice to unplug the drive is displayed.

Why is the point cloud layered in repeated scans?

The layering of point cloud data may be affected by many factors. First, check the parameters such as lever arm value, and then check the trajectory accuracy of multiple scans at the layered location. If there are small number of satellites, the trajectory accuracy is low, it may affect point cloud data quality.

7. Appendix

LiMobile Data Product Examples:

Currently, LiMobile is mainly applied in outdoor scenes (e.g. roads) to provide raw point cloud data for high-precision mapping. All data are displayed in LiDAR360, GVI's all-in-one software that provides comprehensive LiDAR solutions. LiDAR360 supports regular point cloud display modes by height, intensity, classification, return, etc., along with EDL and GLASS special filters for the best data display effects.

Road True-color View
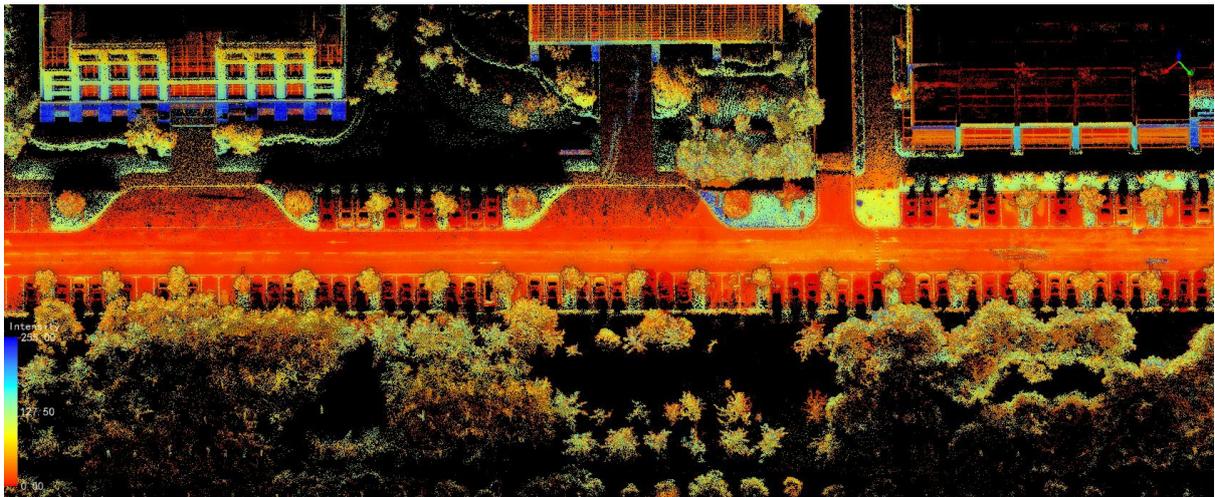
Road Elevation View
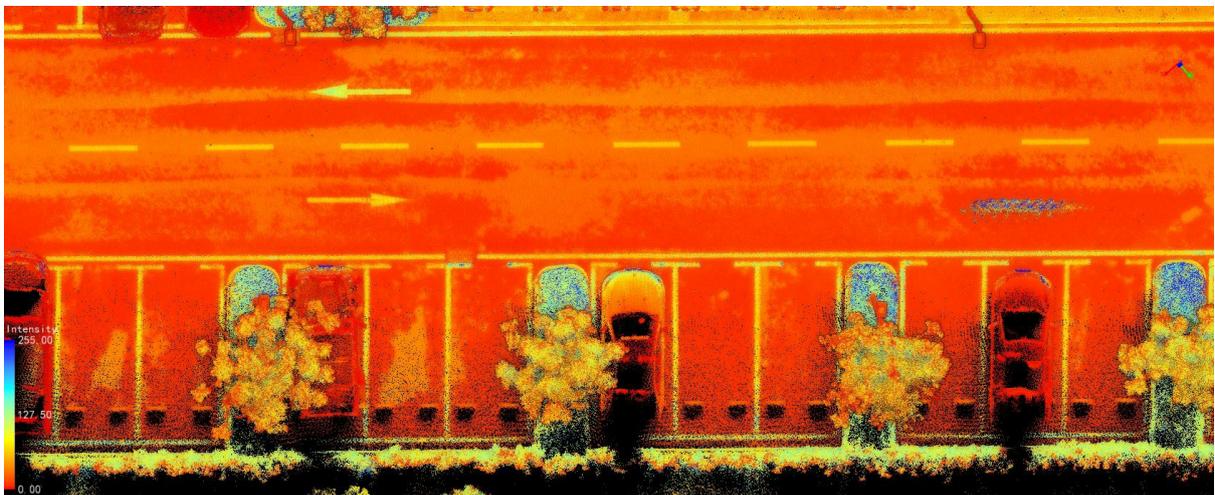
Road Sign Elevation+Black-and-White View

Cross-Roads True-color View
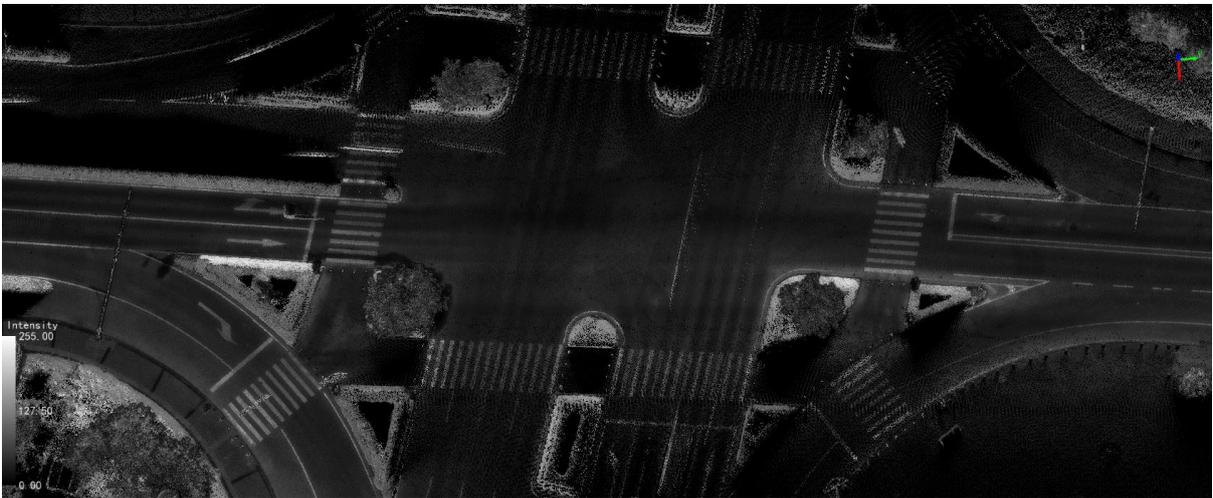
Cross-Roads Black-and-White View
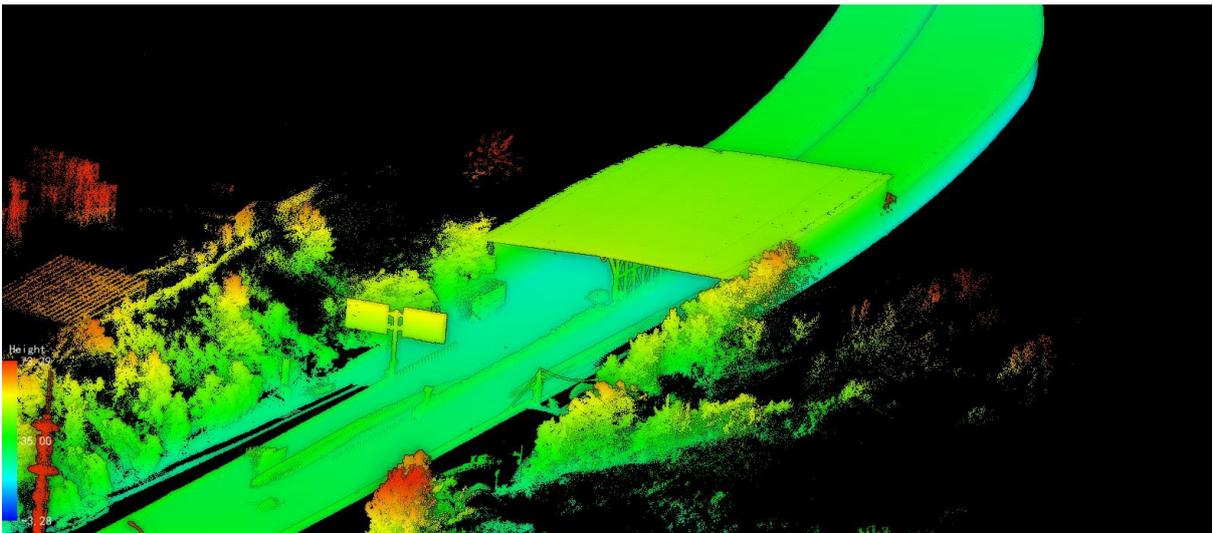
Tunnel Elevation View
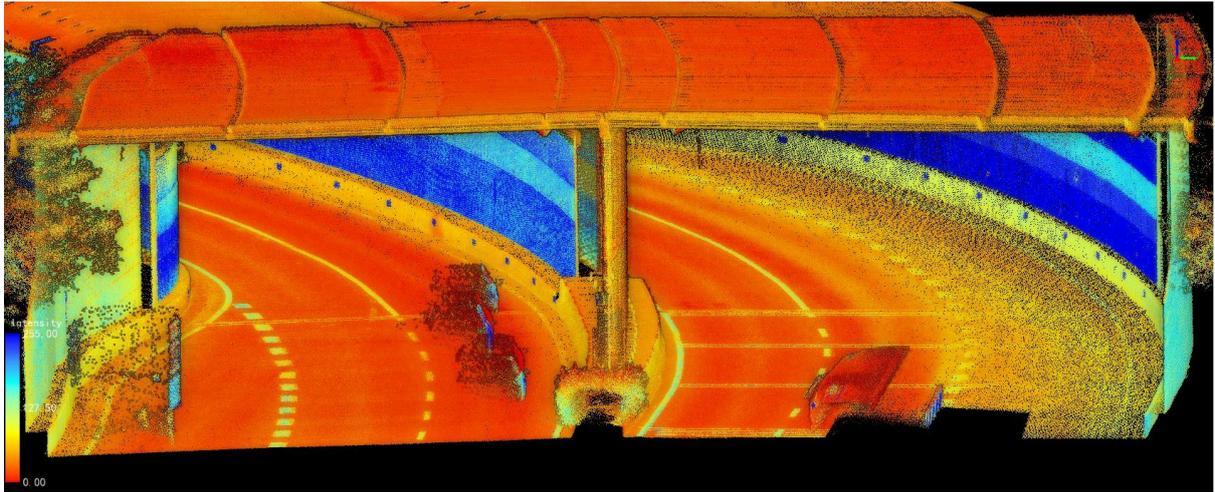
Tunnel Elevation+Black-and-White View

High-precision map with the data collected by LiMobile
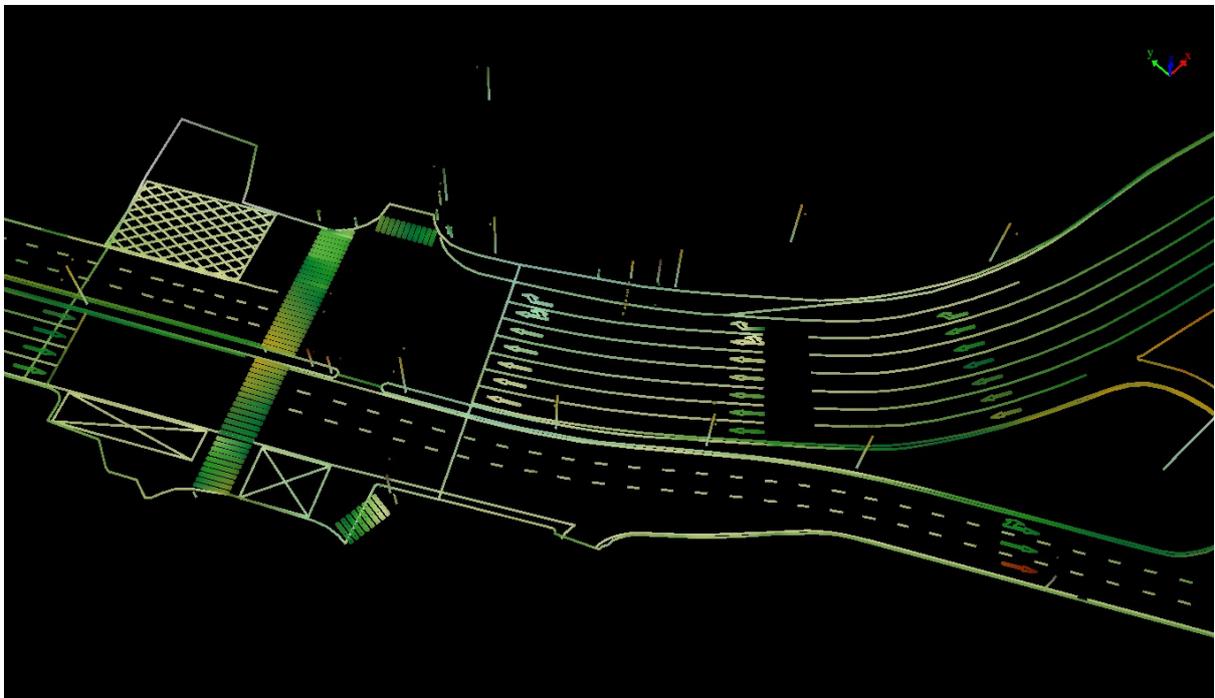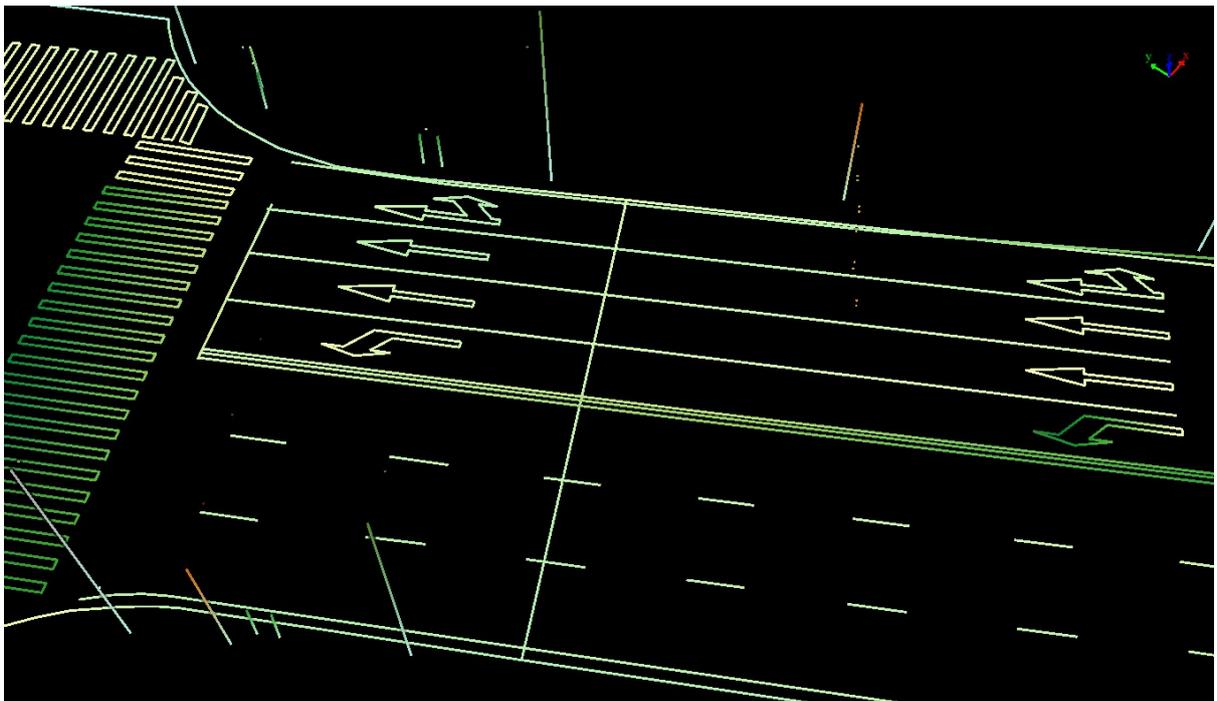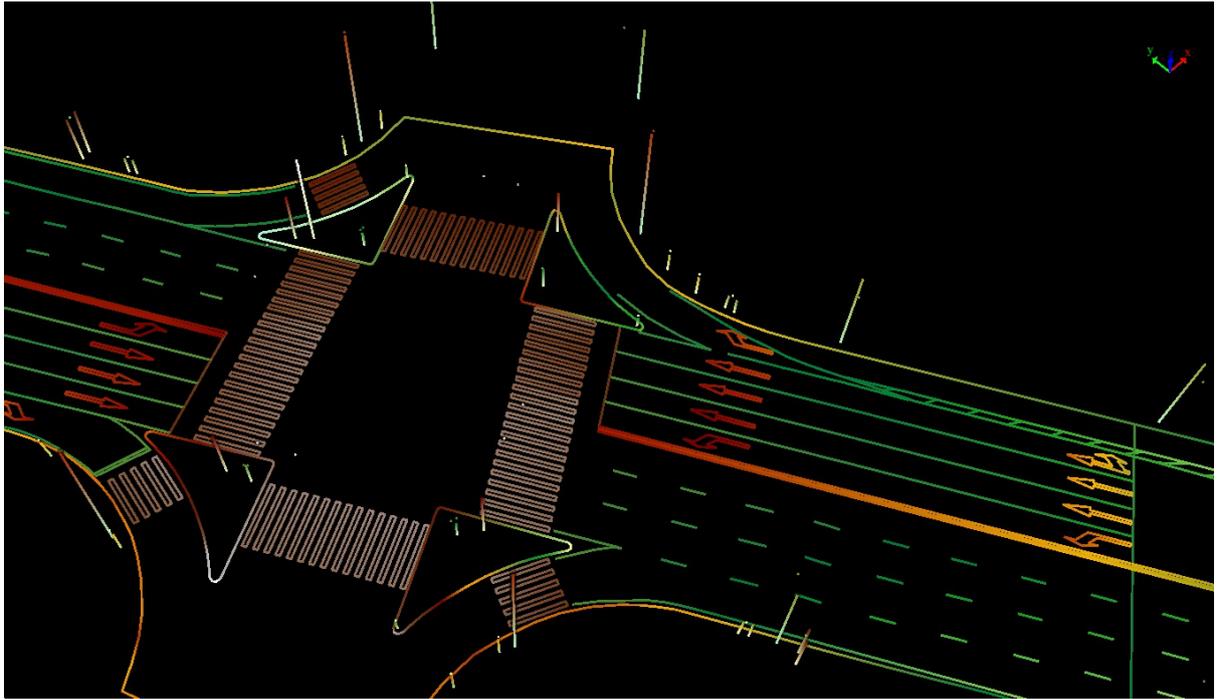
High-precision 3D vector map