TSR20 Handheld LiDAR Scanner Users' Operation Manual

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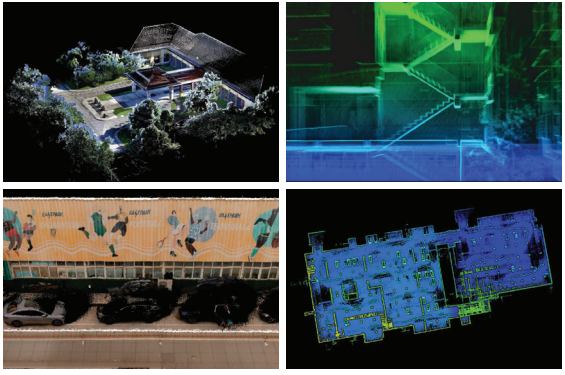
Contents

1. SLAM Concept

The full name of SLAM is Simultaneous Localization And Mapping, which is "simultaneous localization and map construction". It was first used for submarine positioning in military nuclear submarines. In recent years, due to the development of robots, drones, autonomous driving, AI, and VR and AR technologies, SLAM technology has gradually become well-known, because SLAM technology is the core point of navigation in these fields.

SLAM technology can be explained as a robot in an unfamiliar environment, it can perceive the surrounding environment through such as laser sensors; the robot constantly perceives the surrounding environment during the movement process, and matches the environment perceived at different times, so as to reverse the robot body Location and motion trajectory in the environment. SLAM technology is divided into visual SLAM and laser SLAM according to the type of sensor used.

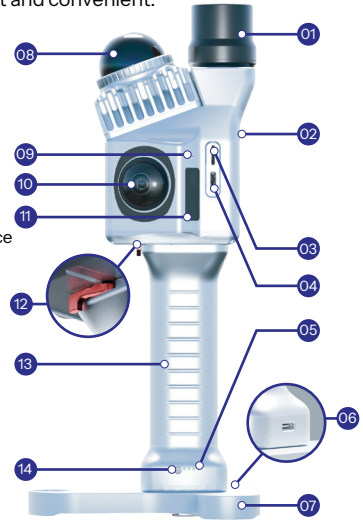


The TSR20 is a new handheld mobile LiDAR scanner launched by TOKNAV. Combined with industry leading SLAM algorithms, it can acquire high-precision, high-resolution 3D point cloud data of the surrounding environment without GPS or external illumination.

The TSR20 uses two 13-megapixel fisheye cameras that capture an ultra-wide field of view, acquire texture information under lighting conditions, and generate color point clouds and localized panoramic images.

The TSR20 features an integrated design with a built-in control and storage system and a replaceable handle battery. Operations are initiated via the app, and point clouds are displayed in real time during data collection, making data acquisition more efficient and convenient.

01. GNSS Antenna
02. Phone Holder
03. TF Card Slot
04. Type-C Interface
05. Power Indicator
06. Type-C Charger Interface
07. Base Plate
08. Laser sensor
09. Wi-Fi Indicator
10. Fisheye Camera
11. Wi-Fi Module
12. Latch
13. Handle (Built-in Battery)
14. Power Switch



1. 1 Device Composition

The TSR20 device consists of two parts: the Laser head unit and the handle battery. The handle supplies power and supports the main unit, while laser head unit is integrated with laser sensor, cameras, GNSS/INS unit, a storage module.

1.2.2 Device Charging

The TSR20 uses a Type-C charging interface. The power adapter should be a fast charger with a power output of 65W or higher. The device does not need to be attached to the handle during charging, and the handle battery can also be charged separately. There are four indicator lights on the handle battery, which flash during charging and remain solid when charging is complete.

1. 2 Device Installation

1.2.1 Positioning Base Installation

As shown in the figure below, first assemble the handle and the positioning plate. Ensure that the charging port on the handle faces backward and the cross-shaped positioning hole on the base faces forward. Align the screw holes on the bottom of the handle with those on the positioning plate, and tighten the screws clockwise. Finally, gently shake the assembly to confirm that the handle and positioning plate are securely installed.

1. 3 Data Collecting Operation Procedure

1.The Application

Since SLAM equipment does not depend on GNSS position, SLAM equipment are applied to various scenarios such as underground, indoor and outdoor, underground garages, and narrow passages between high-rise buildings. The use of SLAM equipment is also not affected by light, such as underground karst caves, coal mine tunnels, air raid shelters and other scenarios.

Because LiDAR can be affected by specular refraction and reflection, laser-based SLAM devices are notsuitable for the scenes with a large number of glass mirrors. Such as mirror mazes, transparent buildings,etc.

Because laser-based SLAM equipment needs to rely on the acquired 3D point cloud structure for matching, it is not easy to guarantee the accuracy of scenes with large areas of similar 3D structures. Such as long straight corridors with no geometric differences in walls, squares without any geometric structure, etc.

2. Surveying Area Classification

When use Handheld LiDAR unit, as long as it has enough power and storage space, and there is enough closed loop in the acquisition process in principle, the recommended acquisition time is within 30 minutes, to make sure the data quality is good enough. However, if the collected area is relatively large, the measurement area can be collected in blocks. When collecting in blocks, it should be divided by area, and there should be enough overlapping areas (at least 25%) between each area for the software to match, which is helpful for the splicing of later data.

Following picture, it is big area and collect the data in blocks, one color one collection.

3. Collection Route Planning

Review the survey area, to check whether it is indoor or outdoor. If data collecting indoor, a multi-route location should be selected as much as possible as the starting and ending points of data acquisition for handheld unit.

If data collecting outdoor, the object to be measured is within the effective range of the handheld unit. (determined according to the reflectivity of the object).

4. Route planning of the survey area

When planning indoor and outdoor routes, design a closed route as much as possible.

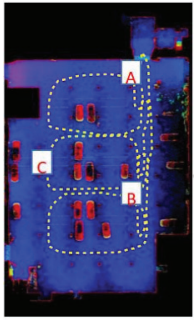
During the acquisition process, as many continuous closed trajectories occur as possible, which is beneficial to the accuracy requirements of data calculation.

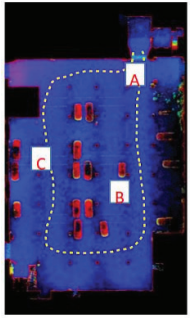
When planning, pay attention to the SLAM equipment' power and plan the route length reasonably.

5. Closed Loop and None Closed Loop

With the development of software improvement, it is not necessary to do a closed loop in open scenes. But the route of closed loop could improve the data quality and objects in detail in closed scenes.

When the walking distance continues to increase, errors will accumulate. The farther the distance is, the greater the error will be. In the closed loop of a single-storey building, there should be as many O-shaped closed loops as possible instead of linear closed loops, which may control the error to a minimum, as following





2.DataAcquisition

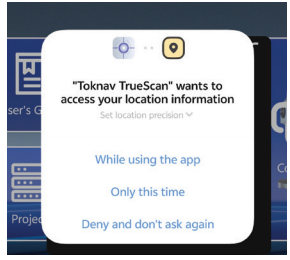
To begin scanning, you need to use the dedicated Toknav TrueScan app to control the device. The app allows you to start/stop scanning, connect to RTK, and perform other operations.

Before scanning, make sure that your phone is not connected to any nearby Wi-Fi networks. If it is, you must remove the Wi-Fi connection to prevent interference with the TSR20 scanner's Wi-Fi during data collection.

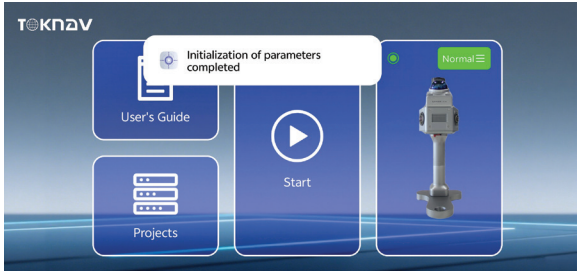
2.1 Power On & Connect to the App (android)

After installing the scanning device, place it on a stable surface and keep it stationary. Hold the power button for 3 seconds, then release. The power indicator is fixed(Green), and the device indicator (Wifi) will blinks.

Select the corresponding Wi-Fi name from the device list (last 3 number of your unit'series no.), then select the Precise location(First time to install this App).



Connection successful. Initialization of parameters completed.



RTK Connection Guide:

Tap the Settings button (top-right corner) to enter the RTK configuration interface.

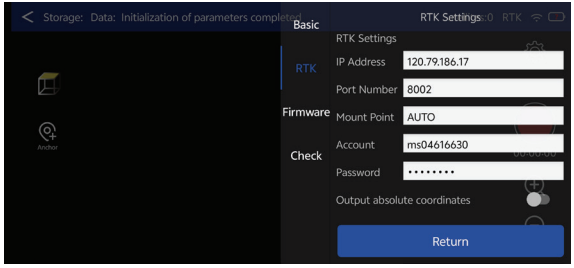
Ensure your phone has network connectivity before using RTK.

After configuring your account, tap "Connect" – a notification will confirm "RTK Service Connected Successfully."

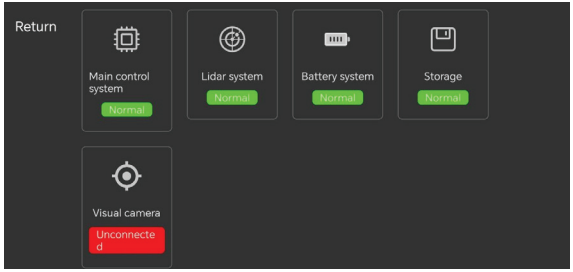
(Optional) To output absolute coordinates, enable the “output absolute Coordinates" option.

File Path for Absolute Coordinates:

Internal Storage /Documents /TOKNAV /mobile /project /[Project_Name]/RtkCoord



The self-check interface shows real-time status alerts (e.g., "TF Card Not Detected - Project creation disabled").



2.2 Create New Project

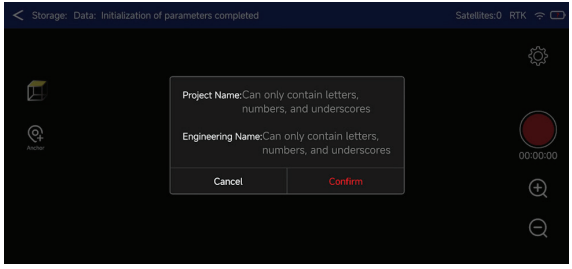
Hold the red button on the right to enter the New Project interface.

Enter the Project Name and Engineering Name.

Naming Rules: Only letters (A-Z/a-z), numbers (0-9), and underscores (_) are allowed.

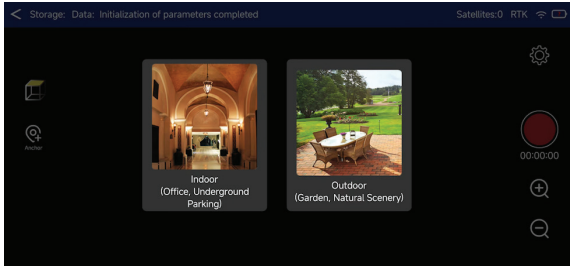
Special characters are NOT supported.

Note:The Project Name and Engineering Name fields are mandatory.

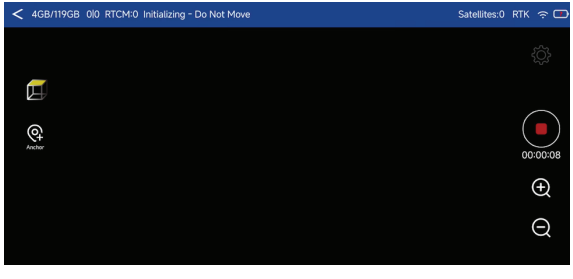


2.3 Mode Selection

After creating the project, click "Confirm" to enter the Mode Selection interface. Choose the appropriate mode based on your application scenario.

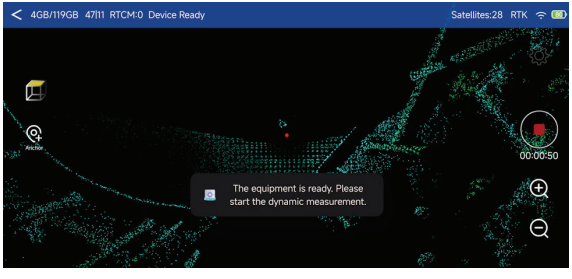


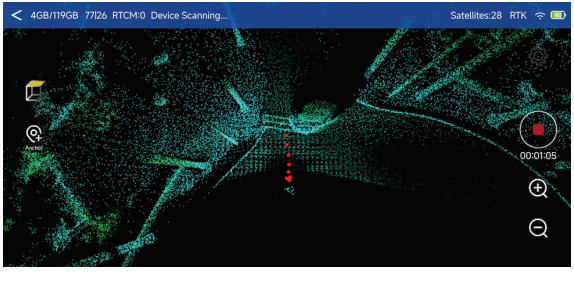
System will automatically send startup command after mode selection, with "Device Start" displayed on the top of the interface.



2.4 Real-time point cloud

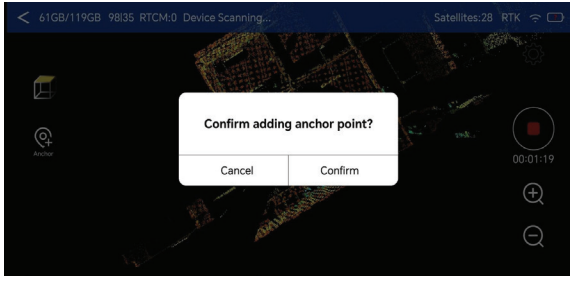
After starting, wait for about 40 seconds, the real-time point cloud appear. "Device Ready" then “Device Scanning" will pop up on the top of the interface. You can pick up the device to collect data when "The equipment is ready. Please start the dynamic measurement " pop up. When collecting data, the walking speed should not be too fast.





2.5 Control point Acquisition

When starting the operation, you can click the button “anchor" on the left side of the interface, click Confirm, then "Anchor point set successfully" pop up with a voice notified. The control point will be participated in the later data calculation, and will be explained in detail during the data solution.

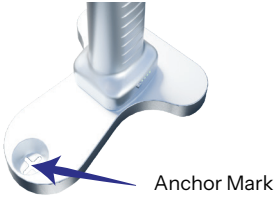


Control Point Acquisition Procedure:

Alignment Process: Precisely align the center of the base plate's control point acquisition area with the target control point center position.

Data Collection: Tap "Add Control Point" to initiate acquisition Maintain steady device position during the process

Verification: Wait for system confirmation: "Anchor Point Successfully Set". Do not move device until confirmation appears



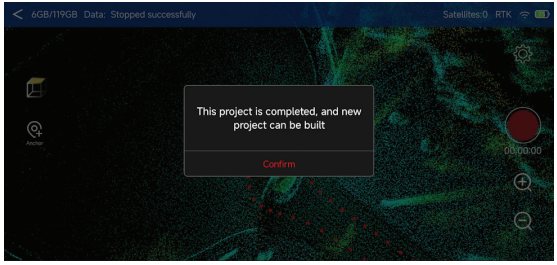
Anchor Mark

2.6 Zoom in and out of real-time point cloud

During the acquisition process, the real-time point cloud interface can be zoomed in and out by clicking the zoom in and zoom out buttons in the lower right corner. Random dragging and sliding are not supported. To switch views, click the cube button in the upper left corner. Currently, the front view and top view are supported.

2.7 Ending Data acquisition

To end the scan, hold the red button on the right, “Ths project is completed, and new projects can be built” pop up, the scan has been finished successfully. If you want to another data acquisition, you can leave the device on a stable surface without powering off, and hold the red button to create the project again. When finish all the data acquisition, hold the power button for 3 seconds and then release it (The Wifi indicator is off immediately and the power indicator is off 10 second late).



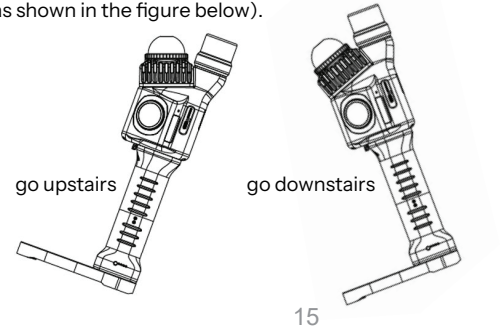
3. Precautions

3.1. Do not use unstable power supply or power supply that exceeds the voltage range.

3.2. The data collection process must be stable and avoid violent shaking.

3.3. The device should be handled carefully during usage to avoid damage to the laser sensor due to bumps or violent vibrations.

3.4. When encountering 90° angle places during the data collection, making a turn smoothly. when collecting stair scenes, let the laser head face to the ground (as shown in the figure below).



3.5. Keep the distance between the scanner and the object being measured > 0.4m, and avoid the laser head from scanning the wall at close range (< 0.4m).

3.6. Avoid moving objects. Since the SLAM matching needs to match static objects, try not to point towards the direction of a large range of moving objects or people. If a large range of moving objects are in a cover of collected data, it will cause the static objects to shift. When encountering such a situation, avoid it as much as possible. If it cannot be avoided, stop moving until the moving object leaves. Here are some common situations that need to be avoided.

3.6.1 Avoid facing moving crowds.

For example, when collecting data, avoid having accompanying personnel walking closely in front of the operator. The accompanying personnel should walk behind the operator or not follow the operator. Avoid collecting data in the crowd.

3.6.2 Avoid facing large moving objects.

For example, when collecting data in an open-pit mine, avoid having a mine car moving closely (within 10m) in front. Avoid collecting data near large vehicles such as buses and coaches.

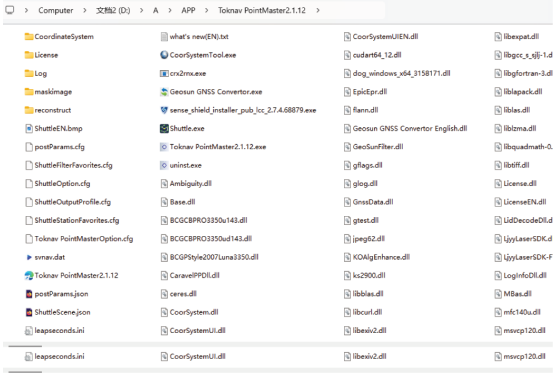
3.7 If you enter the indoor scene from the outdoor scene during collection, directly select the indoor mode when processing;

4. PointMaster

4.1 Software Installation

4.1.1 The following figure is the content of PointMaster software(2.1.12 version or above) after installation successfully.

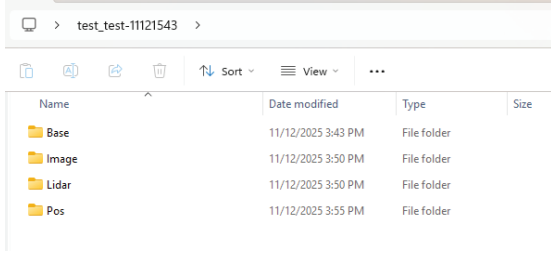
It is better not to install the software at system drive (C drive).



And make sure the license file is in the folder of License (See above example) before process the raw data.

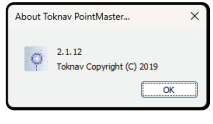
4.1.2 Before running the PointMaster software, please make sure the data of the four folder are collected (Image, Lidar, Pos) are ready.

The base folder is only for PPK process when use SLAM + PPK mode, the procedure is similar with Aerial application.



4.1.3 Start the PointMaster

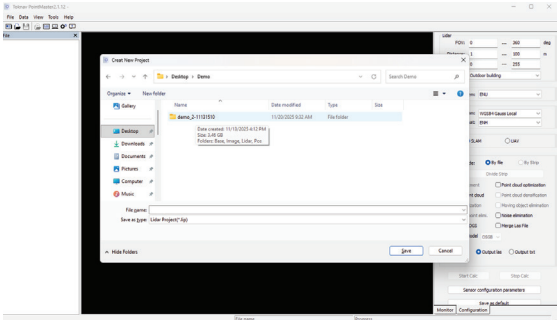
Double click the PointMaster icon on desktop, enter into the interface of PointMaster software, as following



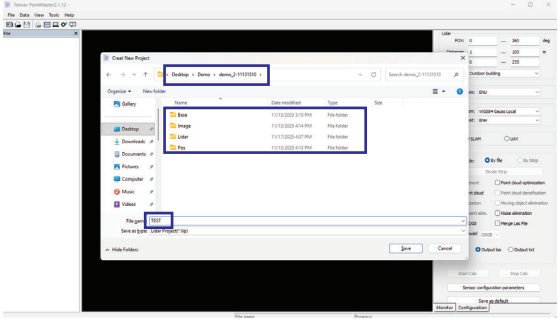
It is PointMaster software 2.0.32 version.

4.2 Create a New Project

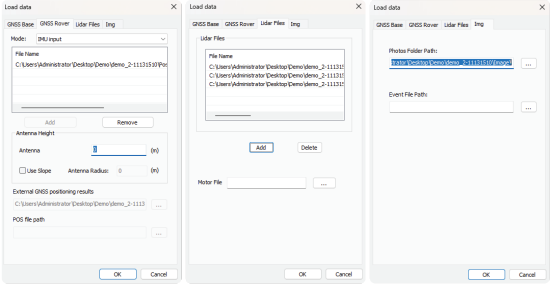
4.2.1 Click the File menu bar, select New Project, enter into Create New Project interface. Making sure the location of New Project is same as the folder of this flight, otherwise Reading Folder function automatically fail and pop up dialogue, please input the files manually, as following



Name the file as “TEST” (whatever you like) , then click the Save bar, the Reading Folder function automatically is active, as following

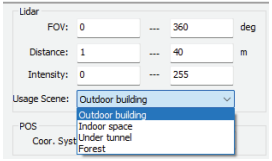


Four folder files are loaded automatically, as following



Click the OK bar.

4.3 Set the Parameter



FOV :0-360 degree

(The FOV of SLAM is 270°X360°)

Distance :

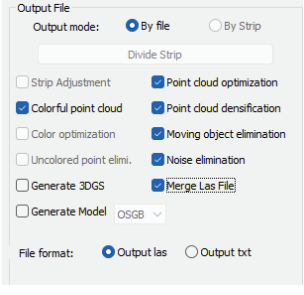
Outdoor Scanning Recommend 1 - 40m

Indoor Scanning Recommend 0.5 - 40m

Intensity: 0-255

Usage Scene
Divide the Usage Scene into 4 parts,
Outdoor Building: Apply for construction of outside of building.
Indoor Space: Apply for construction of engineering (Narrow space), such as the Stairs, Parking Lot Indoor, and the Small house Indoor.
Under Tunnel: Apply for tunnel, such as the Underground Mineral, the Cave, the Tunnel.
Forest: Apply for forestry. So please select the Usage Scene before process the raw data.

Output File
Output mode By file is available only (SLAM application)
File format By Output Las or Output txt
(According to the clients' requirement)



The definition of Checking Box
Strip Adjustment: Not Available
CloudPoint Optimize: Compress the thickness of pointcloud and optimize the structure in detail
Output Color Point Clouds: Output the color pointcloud
Noise Filter: Filter the noise pointcloud
Optimize Image Brightness: Balance the brightness of image.
Moving objects Remove: Remove the moving objects (noisy pointcloud) when scan

Eliminate Uncolored Pointcloud: Eliminate the pointclouds which are not colored.
Uniform Unsample Points: Added the pointcloud averagely (Good for surface of building)
Merge Las File: Combine all Las files into one file

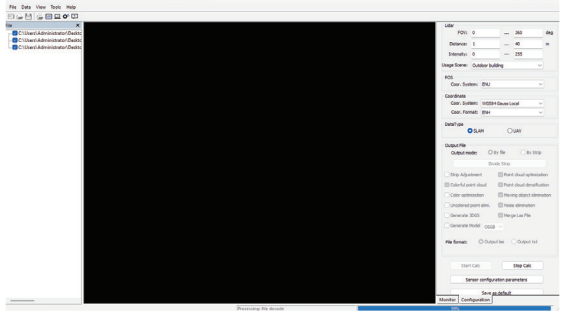
Once the **Output color point** clouds checking box is selected, the checking box of **optimize image brightness** and **Eliminate uncolored points** are available.

Once the **Cloudpoint Optimize** checking box is selected, the checking box of **Moving objects Remove** and **Uniform Unsample Points** are available.

This data is scanning the Parking Lot Indoor, so we select the Indoor Space scene.

4.4 Point Cloud Calculation

Click the Start Calc bar to start to process the data. The progress bar is movement. As following

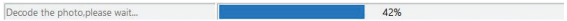


Processing (decode) the lid files,

Processing GNSS/INS(POS) integration,

Output Pos,

Decode the image,



Processing the lid files, wait for pointcloud

Wait for pointcloud output.

During these process, when the point cloud display(or click the R key to display point cloud), forward & backward the roller of mouse to zoom in/out.
Hold the mouse and move it, the point cloud turn around.
Hold the roller, drift the point cloud wherever you want.
It could stop when you click the Stop Cal if required.

Note

The Time takes between data collection and data processing
If choose the Outdoor Building Scene, the ratio of data collecting and data processing is 1:2 (Whatever you select the checking box or not, Mentioned page 6).
It means it takes 10 minutes to collect the data, and it takes 20 minutes to process the data.

If choose the Indoor space/Under tunnel/Forest Scene, the ratio of data collecting and data processing is 1:3
(Without any checking box, Mentioned page 6).
It means it takes 10 minutes to collect the data, and it takes 30 minutes to process the data. And it takes more than 30 minutes to process the data once select the checking box(Mentioned page 6).

The PC RAM takes when do data processing
It is recommended to do data collecting within 30 minutes, with 128 GB RAM high performance computer. Otherwise the PointMaster software crash or POS error pop up.

5.SPECIFICATION

SYSTEM SPECS	
Accuracy	≤3cm(Relative), ≤5cm(Absolute)
Voltage Range	12-20V
Dimensions	16.5*12.0*32.4cm
Weight	1.0kg (including battery)
Operating Temperature	-20°C-55°C
Power Supply Range	12V-16.8V
System Consumption	25W
Storage	64GB internal flash memory 128GB MicroSD Card
Carrying Platform	Handheld
WiFi Transmission Distance	Data reception is smooth within 5m

POS SPECS	
Model	Built-in GNSS positioning and orientation dual antenna
POS Update Rate	200Hz
GNSS System	GPS L1/L2/L5 GLONASS L1/L2 GAL E1/E5a/E5b BDS B1c/B1/B2/B2a/Bab/B3
Positioning Accuracy	Horizontal: ±0.02m Vertical: ±0.03m
Pitch Accuracy	0.015°
Heading Accuracy	0.040°
Roll Accuracy	0.015°

LASER SPECS	
Measuring Range	40m/10%
Horizontal FOV	360°
Vertical FOV	-7°-52°
Wavelength	1535mm
Data	Single echo, 200,000Points/Sec
Range Accuracy	≤2cm/10m, ≤3cm/0.2m
Scanning Mode	Non-repetitive Scanning

CAMERA SPECS	
Effective Pixel	2*20MP
Scanning Mode	Time-synchronized Scanning
FOV	Horizontal/Vertical FOV: 200°

MAPPING	
Mapping Mode	SLAM; RTK-SLAM; PPK-SLAM

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Manufacturers may update parameters at any time, please refer to the latest product information.

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