Record

Version	Issue date	Description
V1.0	2023.05	First version
V1.1	2023.08	Replace nameplate
V1.2	2023.09	Update logo and protect area

- ## Request more Info

For more information, please log in: https://www.seer-group.com/

Thank you for your purchase.

Only qualified personnel who have received corresponding operation training and obtained qualifications are allowed to use this product.

This document includes precautions to ensure personal safety and protect this product.

Disclaimer

All contents of this document have been verified and confirmed and are as accurate, reliable and complete as possible, but all contents cannot be guaranteed to be consistent with the product.

Technical data are subject to change without prior notice.

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Content

1 Preface

1.1 Reading Tips

the robot in this document are all abbreviations of AMB-1000JS. Read the user guide carefully before using the robot.

Without authorization, AMB-1000JS cannot be disassembled or assembled without authorization.

Please note the security warnings involved in the user guide.

If the robot has abnormal problems, please contact the manufacturer in time.

When using the robot, if you smell abnormal smell, please stop immediately, shut down and take out the battery.

The user guide cannot replace the technical agreement.

1.2 Prohibition of use

- It is forbidden to be used outdoors.
- It is forbidden to use in environments that have strong interference with navigation equipment.
- It is forbidden to use it in an environment full of dust, dust and other places with explosion risks.
- It is forbidden to be used in environments with high salt content (marine climate).
- It is forbidden to be used in extremely poor environments (extreme weather, frozenarehouses, strong magnetic fields, etc.).
- It is forbidden to carry inflammable and explosive articles.
- It is forbidden to carry liquid articles.
- It is forbidden to run on uneven, obstructed, or ladder.
- Do not rotate in situ on the slope.
- No loading personnel.
- The shell is forbidden to run under load.
- It is forbidden to operate on the ground with oil and water.

2 Security

Read this section before starting and running AMB-1000JS.

	Note: ● the company is not responsible for any problems caused by damage, replacement or modification of AMB-1000JS or it’ s accessories in anyway ● The company is not responsible for any damage to AMB-1000JS, accessories or any other equipment caused by customer programming errors or faults.

2.1 Security Message Types

This document contains the following security message types.

	Warn ● Indicates a potentially hazardous situation that could result in death or serious injury. ● Appropriate precautions should be taken to avoid damage or injury.
	Be Careful ● Indicates a potentially hazardous situation that could result in minor or moderate injury to a person. Reminder to avoid unsafe behaviour. ● Appropriate precautions should be taken to avoid damage or injury.
	Note ● Indicates important information, including situations that could result in damage to equipment or property.

2.2 General Safety Precautions

This chapter covers general safety precautions.

	Precautions for robot tilting ● if the load is not properly placed or fixed, it may cause the load to drop or the robot to tilt. ● Make sure that the load is properly fixed according to the specifications. See 10 . Effective load specifications .
	Precautions for machine injury ● the high-speed rotating part of the car body will cause personal injury, such as universal wheel and driving wheel. ● Do not rely too much on the self-avoidance function of the vehicle, please take the initiative to avoid the vehicle.

⚠	**Operational precautions** ● Robot cannot observe downstairs and holes in the floor. ● Mark stairs and holes as forbidden areas on the map. ● Please update the map in time.

2.3 Safety instructions

2.3.1 Personnel Qualification Requirement

only qualified security personnel are allowed to install, debug, operate, and maintain AMB-1000JS.

2.3.2 Mechanical installation and debugging

Installation and commissioning of machinery

personnel who carry out mechanical installation and debugging should master professional knowledge and experience in relevant fields, have sufficient experience, and be ableit is sufficient to evaluate whether the machine is in a safe operation State after using the protective equipment.

2.3.3 Electrical installation and commissioning

The person carrying out the electrical installation and commissioning should have specialist knowledge and experience in the relevant field and be sufficiently experienced to be able to assess whether the machine is in a safe operating condition after the use of protective equipment.

2.3.4 Operation and maintenance

The person carrying out the operation and maintenance should have expertise and experience in the relevant field, be familiar with the application of the protective equipment to the machine and be instructed by the machine user in its operation.

2.3.5 Operational safety

Safety of the operating environment

The ground is flat, with no grooves, no damage, no hollowing, no water stains, oil stains, glue and other pollutants.

The ground is free of screws, rag gloves, cable and other foreign matters that are easy to get stuck and twine the wheels.

Do not operate in excessively open areas (greater than laser sensing distance), such as long corridors.

Robots with full load and low speed can only cross steps not higher than 0.5cm.

Through the narrow channel, the outermost side of the robot needs to keep a 10cm gap with the channel.

The road sections in the work area should be protected or marked with warning signs to remind other personnel of robots entering and leaving.

Operational checks

The operator should check the condition of the robot prior to start-up to ensure safe use.

Inspections:

- Wheel fasteners are tight.
- Whether the power system is normal.
- Whether the emergency stop function is normal.
- The load handling device is not damaged (e.g. bent, cracked or worn).
- Warning devices are in order.
- The ambient light is working properly.
- The laser sensor is functioning correctly.
- The battery is charged properly.
- Whether the charging function is normal.

Operation Check

- The operator shall check the condition of the robot before enabling it to ensure safe use. Check items include:
- whether the wheel fasteners are tightened.
- Whether the power system is normal.
- Whether the emergency stop function is normal.
- Whether the load handling device is damaged (such as bending, crack or abrasion). Whether the warning device is normal.
- Check whether the enclosure light is normal.
- Whether the HMI display is normal.
- Whether the function of the laser sensor is normal.
- Whether the battery is normal.

Whether the charging function is normal.

Run on Ramp

- run only on ramps that meet performance parameters. For more information, see 3.8 technical parameters

- The upper and lower ends of the ramp should be flat to prevent the load or robot from touching the ground.
- It is forbidden to turn around, run diagonally or stop on the ramp.
- When the tractor runs downhill with a trailer without braking, it should not brake urgently.

Run in Elevator or Lift

- ensure that the elevator or lift can bear all the weight including the robot and its load.
- Make sure that any part of the robot is not in contact with the elevator or the car wall of the elevator.
- Make sure that the robot does not move unexpectedly.
- Make sure the elevator meets GB 7588-2003 standard.

2.3.6 Load safety

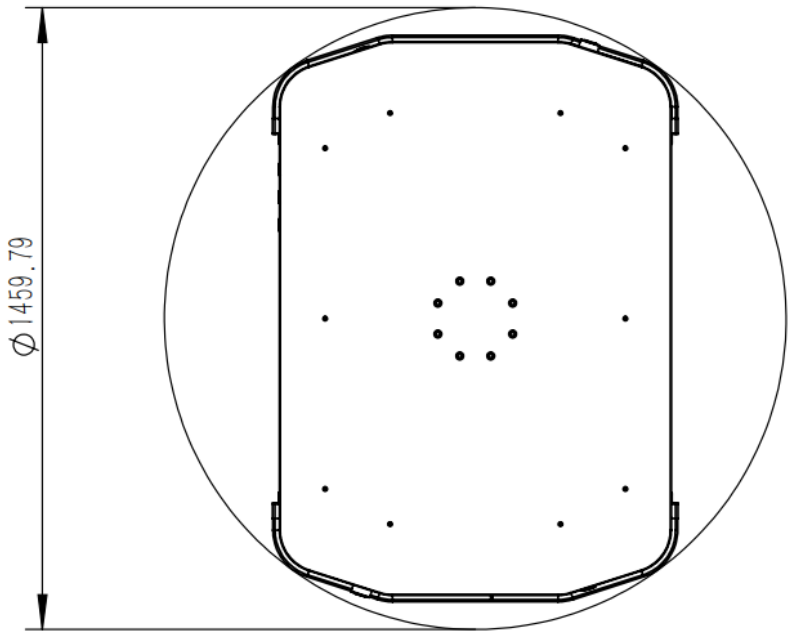
- AMB-1000JS and its load must not exceed the allowable range of the road surface.
- The goods carried must have reliable fixing measures.
- The goods carried must be placed in the load center with certain anti-skid measures. Please refer 10. Effective load specifications.
- The weight of the goods carried by the upper-layer mechanism must be evenly distributed and no partial load is allowed.

2.3.7 Parking Safety

- When the robot stops running, it should be turned off and the power supply should be cut off.
- Do not dock on the ramp.
- Do not stop at the heat source or next to the fire source.
- Do not park in open pit, underground passage, elevator shaft or other similar areas.
- Do not park in fire exits, stairway or areas that hinder the passage of fightion.
- Under special circumstances, safety measures should be taken for robots, such as wedges.

2.3.8 Safety avoidance Scope

The maximum swing diameter of the robot is 1460 mm. please avoid it.



2.3.9 Battery Safety Warning

⚠	**Precautions for the use of batteries** ● Lithium battery is a high-energy substance and must be used under certain technical conditions. If the use exceeds the limit, the buyer must notify the seller in written form, and the seller can confirm it before proceeding, otherwise the consequences will be borne by the negligent party. ● Please use the original charger. It is forbidden to mix chargers of other brands, otherwise it will cause irreversible damage to the battery.

- for your safety, please do not open or disassemble the battery privately.
- Battery maintenance and replacement must be carried out by professionals. If necessary, please call our service hotline.
- If you need to replace the battery, please select the same type and model of AMB-1000JS lithium battery, or consult us first. It is strictly prohibited to mix lithium batteries of different specifications from different manufacturers.
- Please use the special charger configured by our company to charge the battery, and do not replace the Charger of other specifications or other companies to charge.
- When placing the battery system, there should be a safe distance around.
- It is strictly prohibited to discharge the battery too low!
- Avoid using this system in the following environments:

1. high, low and humid places beyond the provisions of technical indicators;

2. places with metal dust, corrosive substances, salt and combustible gases;
3. places with low air cleanliness.

2.4 risk assessment

risk assessment is one of the important steps for integrators to implement secure installation. On-site debugging personnel are usually responsible for risk assessment.
Risk assessment involves not only AMB-1000JS chassis, and also consider peripheral modules, path planning, working environment, etc.
It is recommended to use the guidelines in ISO 12100, ISO 3691-4, ANSI B56.5 or other relevant standards for risk assessment. Including but not limited:

- in the process of robot installation, development and use, teach.
- The robot device works normally.

In article 4 of ISO 3691-4, major dangers, dangerous situations and events requiring attention are listed.
Risk assessment items shall be listed in the technical agreement.

2.5 Residual risks

Potential significant hazards are listed below, so please operate the robot with caution.

- The robot can be set to travel backwards, but if there are no sensors at the rear of the vehicle, there is a risk of being struck if it enters the robot's path when travelling backwards.
- Risk of pinching, crushing of feet or impact if the user inadvertently comes into contact with the robot's moving parts.
- There is a risk of impact and jamming when transporting loads.

2.6 Environmental safety

2.6.1 Noise

AMB-1000JS noise ⩽75 dB(A), in accordance with EN12053.

2.6.2 scrap disposal

AMB-1000JS contains the following materials that affect environmental factors.

- Plastics
- Batteries

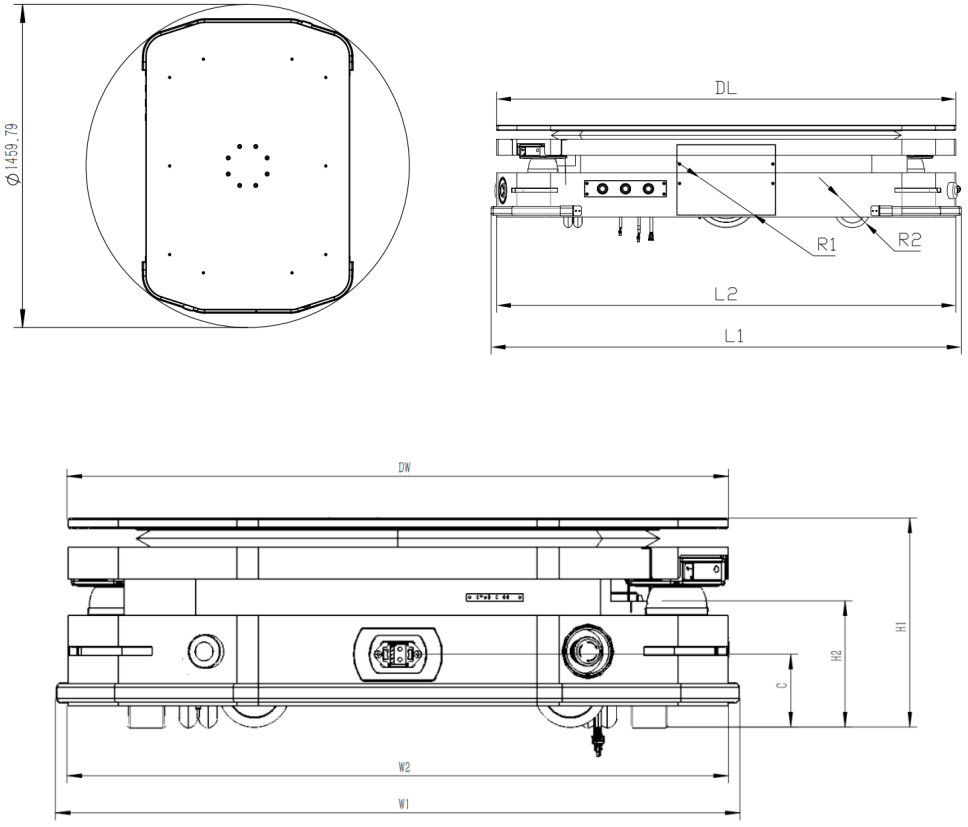
Handling requirements: AMB-1000JS shall be handled by users and final scrap disposers in accordance with *the law of the People's Republic of China* on the prevention and control of environmental pollution caused by solid waste.

3 Product introduction

3.1 Introduction

AMB-1000JS (Laser SLAM Safety Jacking Transfer Robot) is a laser SLAM security jacking robot with SRC core controller inside, providing core map construction and positioning navigation functions, and reserving abundant I/O, CAN, RS485 and other interfaces, thus helping users to quickly realize various applications of automatic robots.

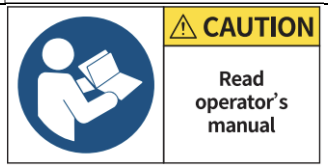
3.2 Product Size



No.	Definition	AMB-1000JS(mm)
L1	Body length (with bumper)	1330
L2	Body length (without bumper)	1300
W1	Body width (with bumper)	952
W2	Body width (without bumper)	920
DW	Width of top plate	920
DL	Length of top plate	1300
H1	Body height	290
F	Minimum diameter of in-situ rotation	1460
H2	Height of laser scanning area	175
C	Height of charging poles above ground	101
R1	Drive wheel radius	90
R2	Slave wheel radius	50

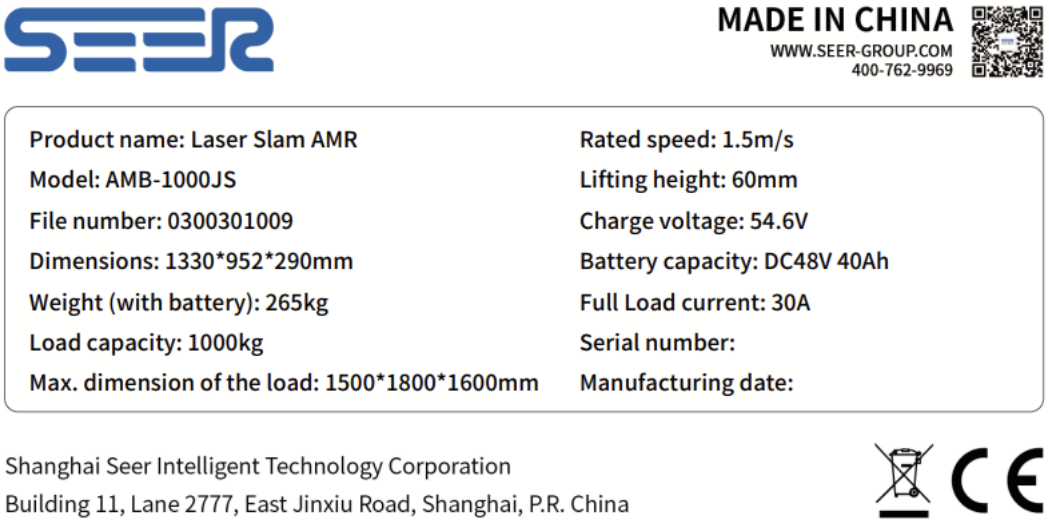
3.3 Primary Tag

3.3.1 Warning label

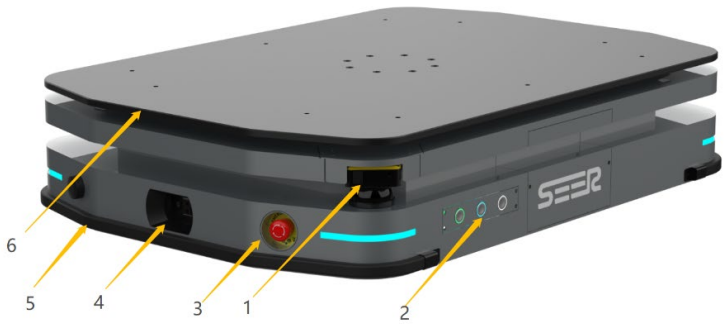
	LABEL	PLATE
1	RIDING ON THIS TRUCKS IS PROHIBITED	
2	CLASS 1 LASER PRODUCT	
3	Crush! Hazardous zone no entry	
4	Pinch points Watch your hands	
6	Read operators manual	

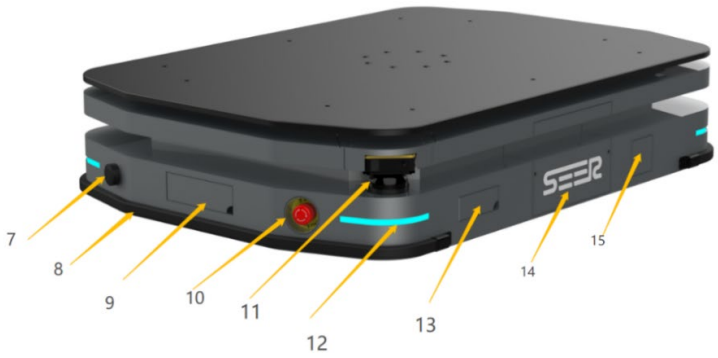
7	No step	
8	Hazardous voltage inside! Maintained by well trained staff only	

3.3.2 Nameplate



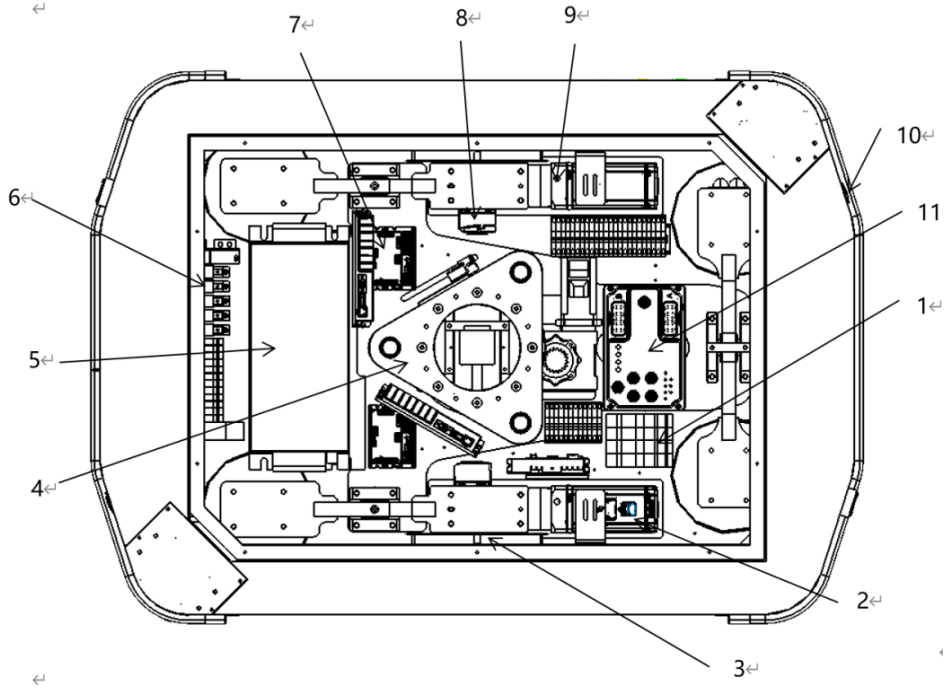
3.4 External parts





No.	Name	No.	Name
1/11	Safety Laser Scanner	7	Antenna
2	Power/Reset/Brake release Button	9	Air Switch/Automatic charging port/bms
3/10	Emergency stop button	12	Status light
4	Manual charging port	13	Debugging Interface
5/8	Bumper	14	Drive wheel
6	Top plate	15	Speaker

3.5 Internal parts

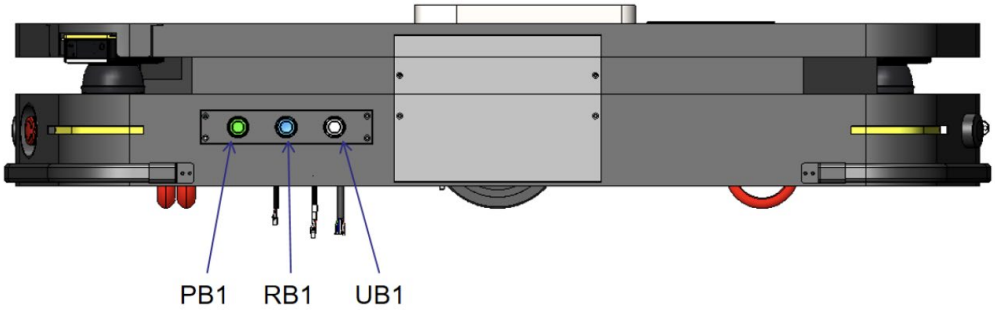


No.	Name	No.	Name
1	Relays	7	Drive
2	Motor	8	Encoder
3	Drive wheel	9	Gear reducer
4	Jacking module	10	Emergency stop button
5	Battery	11	SRC 3000FS
6	Fuse	12	

3.6 Operation panel

The AMB-1000JS operation panel on the left side of the front and an emergency stop button on the left front. The specific definition is shown in the following figure.

3.6.1 On/off button PB1



- Press to on/off button (PB1) for 3 seconds, green light of on/off button is on.
- Press to on/off button (PB1) for 5 seconds, wait for several seconds, button light and status light go out.

3.6.2 Reset Button RB1

After robot boot, status light become dark red blinking. Then press reset button to mark jack zero position and start using robot.

After the emergency stop is pulled up or the fault signal is relieved, the system must press the reset button to resume work.

3.6.3 Brake release button UB1

Keep air switch and key switch both on, press brake release button and emergency stop button to release motor brake for moving robot manual.

3.6.4 Emergency stop button

The AMB-1000JS is equipped with 2 emergency stop buttons with the following emergency stop behaviors.

- The emergency stop button is for emergency use only and must not be used to stop the robot.
- When the emergency stop button is pressed, the robot stops all movements immediately.
- The emergency stop can only be pulled up if the cause of the fault has been determined and the fault has been removed.
- When the emergency stop is pressed, the robot can be cleared of drive errors.
- When the emergency stop is pressed, the robot can be pushed.

⚠	**Robot emergency stop precautions** When using our scheduling system, it is strictly forbidden to push the robot after pressing the emergency stop, as this may cause robot tasks to errors.

3.7 Technical parameters

Product Model	AMB-1000JS
Basic parameters	
Navigation method	Laser SLAM
Driver form	Two wheel differential speed
Lasers	2（SICK nanoscan3 Core）
Maximum load	1000kg
Weight (with batteries)	265kg
Shell colour	Cool Gray
L*W*H	1330mm(L)*952mm(W)*290mm(H)
Rotation diameter	1460mm
Network interface	
Wired network	Two RJ45 Gigabit networks
Wireless network	Built-in Moxa AWK-1137C
Battery	
Capacity	48V 40Ah lithium iron phosphate battery
Comprehensive battery life	⩾7h
Charging time	⩽2h
Charging method	Manual / Automatic
Number of battery charge and discharge cycles	> 1500 cycle
Operating instructions	
Emergency stop button	√
Power indicator	√
Audio	
Speaker	√
Performance parameters	
Passability[1]	Slope < 5%, step < 0.5cm, gap < 1cm
Lifting time	9s±0.5s
Positioning accuracy [2]	± 5mm ±1°
Navigation speed	1.5m/s

Map area (single)	⩽ 400000m²
Functions	
Basic functions [3]	√
Wifi roaming function	√
Automatic charging function [4]	√
Shelf recognition function [5]	√
Environment	
Ambient temperature and humidity range	0°C to 50°C (humidity 10-90%, no compression condensation)
IP level [6]	IP20

√	Support
×	Not support
◯	Optional

1. The road surface is smooth and clean without obvious ups and downs. The inclination is not higher than 5% = arctan(0.05) ≈ 2.8°. Robots cannot stop or turn at ramps, steps, and gaps. They can only pass through the ramps, steps, and gaps vertically.

2. Positioning accuracy usually refers to the repeated accuracy of the robot navigating to the target site. Under the condition that the environment scanned by the robot laser radar is relatively stable, the repeated accuracy of the robot navigating from a fixed direction to the target site can reach the expected value. When the robot runs along the planned path, it fits the path as much as possible, but does not guarantee repeatability. That is, the robot can ensure the point accuracy, but not the path fitting accuracy. The minimum site spacing supported by AMB-1000JS is 1cm. Therefore, robots cannot be used as linear guides.

3. Basic functions include map editing, model editing, positioning module, navigation module, basic motion model (differential), support for peripheral extensions, API interface, etc.

4. Use it with the automatic charging pile of SEER.

5. The shelf identification function can only identify the shelf position, but not the shelf number or other information.

6. AMB-1000JS is designed for indoor transport only and is not recommended for outdoor environments.

3.8 Software Functions

- Map Editing
- Model Editing
- Positioning module
- Navigation module

- Peripheral extensions
- API interfaces
- Visualisation
- Multi-camera scheduling
- Wi-Fi roaming
- Automatic charging function
- Shelf recognition

3.9 Network requirements and configuration

Network requirements

Wireless network protocol: IEEE 802.11 a/b/g/n

Broadband speed value: ⩾ 100Mbits

Signal strength requirements: ⩾ -60dBm

Network delay requirements: average delay time ⩽ 100ms

Network Configuration

For network configuration, please refer to the Robotics Network Configuration.

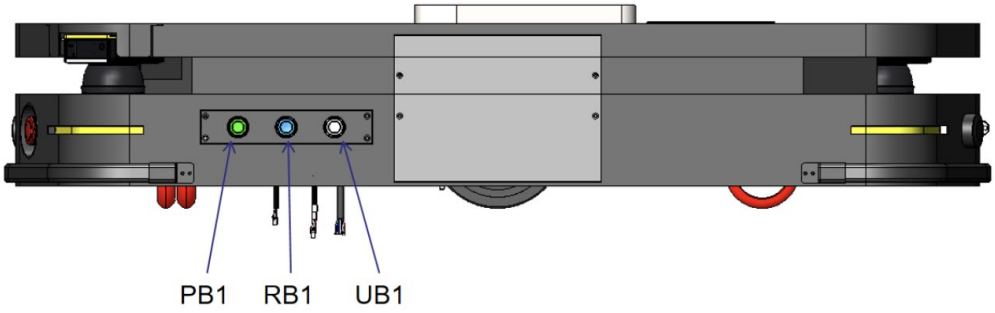
4 Start using

4.1 Article with box

- AMB-1000JS robot body
- Manual charger / automatic charging post (one pieces or two pieces)

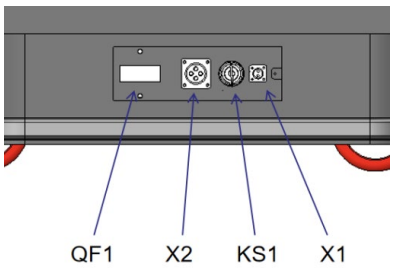
4.2 Robot boot

1. Press the on/off button (PB1) for 3 seconds, green power-on-light is on
2. Release the button and wait for several seconds and status light is on and become dark red blinking.
3. Press the reset button (RB1), the light of Ambient lamp become bluewavering, and the jack motor mark zero position.



4.3 Robot shutdown

1. Make sure that the robot has no tasks and is in the stopped state.
2. Press and release the On/Off button for 5 seconds and wait a few seconds for status light go out, completing the shutdown process.



Note: If the machine is shut down due to transportation, maintenance or repair, the robot battery switch must be turned off.

5 Battery and charging

Robots are powered by a fast-changing lithium ion battery, which can be divided into automatic charging and manual charging.

5.1 Battery System

Basic battery performance parameters:

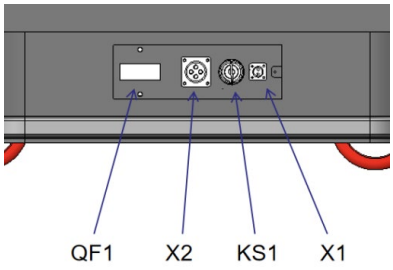
Nominal voltage		48V	
Nominal capacity		40AH	0.2CC/0.2CD@25°C
Charging parameters	Standard charging current	25A	0.6C
	Charging cut-off voltage	54.6V	
	Maximum continuous charging current	40A	
Discharge parameters	Standard discharge current	40A	1C
	Discharge cut-off voltage	35.7V	
	Max. continuous discharge current	50A	
Operating temperature	Charging temperature	0°C-45°C	
	Discharge temperature	-20°C-65°C	
Storage temperature		0°C-40°C	
Safety protection function		Overcharge, overdischarge, overcurrent, overtemperature, short circuit ,Balancing	See the battery manual for specific threshold settings Battery manual
Communication requirements		RS485	
Dimensions (mm)		4200mm*218mm*173mm	
Weight (Kg)		about 22KGS	Estimate, based on actual

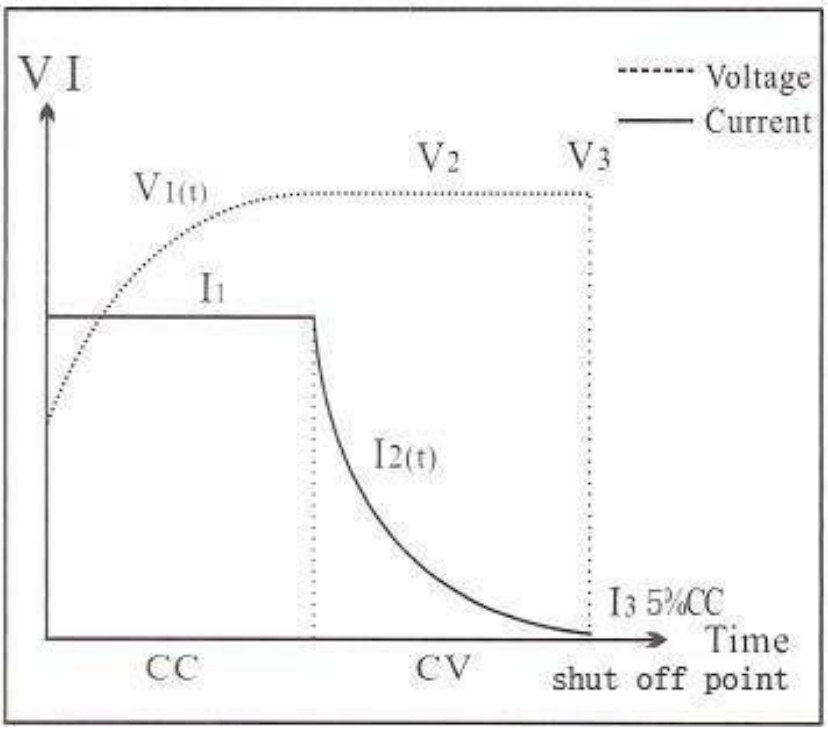
BMS Protection performance parameters

Overcharge protection	Overcharge voltage	4.25V（Single string）	Adjustable
	Overcharge protection delay time	3S	
	Overcharge release voltage	4.15V（Single string）	Adjustable
Over-discharge protection	Over Discharge Voltage	2.75V（Single string）	Adjustable
	Over-discharge protection delay	3S	
	Over-discharge release voltage	3.0V（Single string）	Adjustable
Overcurrent protection	Overcurrent detection current	110A@3S	
Over-temperature protection	Temperature protection	Charging：55°C； Discharging：65°C	
Short circuit	Short circuit protection	Disconnected load recovery	
Equalization	Equalization method	Passive balancing	

5.2 Charger Parameters

Pay attention to the automatic and manual charging interfaces of the robot.





Charging curve

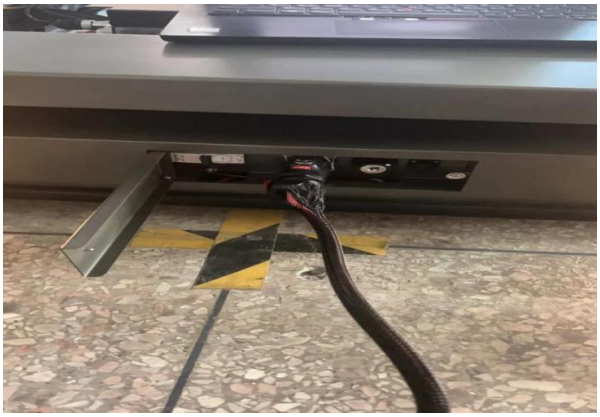
Note: For the use and configuration of charging piles, please refer to AMB-1000JS Charging Pile User Guide

5.3 Robot Charging

AMB-1000JS ex-factory battery can be used for 4-5 hours, after which it needs to be recharged. Please use the original charger. The specific charging steps are as follows:

1. Open the red cover of the manual charging port.

2. Connect the charger to the robot's manual charging port and to the power outlet. Turn the battery switch on, as shown in the figure.



3. Start charging.

4. It will take about 3 hours to complete the charge. Please restore the cover to the closed state after completion

5.4 Battery Storage

- The battery pack shall be stored at an ambient temperature of 0-40°C and a relative humidity of 10%-90% RH.
- The battery pack should avoid contact with corrosive substances or magnetic environment.
- The battery pack is stored in a clean, dry and ventilated environment, away from the fire source or heat source.
- When the battery pack is not used for a long time, it is recommended to charge and discharge the battery pack regularly (once a month).

6 Navigation and control systems

The navigation and control system enables robots to complete a series of tasks according to task instructions. This chapter introduces the process and main components of robot navigation and control system.

6.1 System overview

The navigation and control system controls the robot to navigate to another destination in the built map according to the task instructions issued by the user, or controls the motor, audio, DO or robot status according to the current status of the robot. Figure 1 shows the structure diagram of the navigation and control system. The modules designed in the navigation and control system are as follows:

- **Global path planning**

Generate the shortest path to the target point based on the planning of the target point and map file, and split the total task into subtasks of each line.

- **Task planning**

The task planner generates a task queue based on the current route subtask instructions and then on the model file information. The path navigation module or the action execution module is then invoked for execution.

- **Local path planning**

Based on the properties of the current path, positioning, and sensors, control the robot to walk according to the current path. If an obstacle is encountered, the robot blocks the error.

- **Action Planning**

Based on action instructions and sensor information, the robot mechanism is controlled to perform specified actions

- **Positioning**

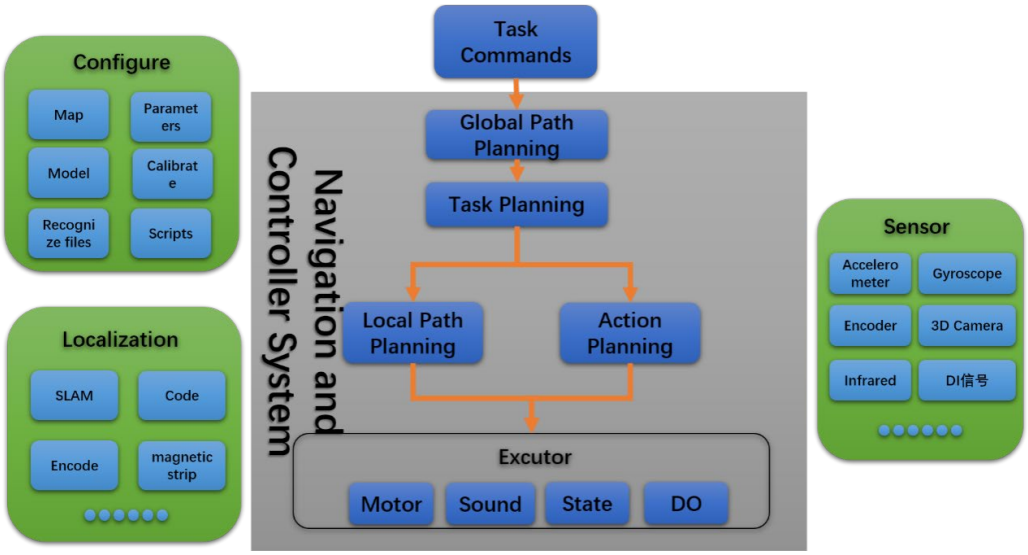
The positioning module is based on laser SLAM navigation, two-dimensional code navigation, odometer navigation, or magnetic stripe, to provide real-time accurate location information for robots in different environments.

- **Sensors**

A variety of sensors (accelerometers, gyroscopes, encoders, 3D cameras, infrared, DI signals, etc.) provide real-time status queries for the robot. This information can be used to determine arrival points, obstacles, deceleration, etc.

- **Executor**

The actuators include motors, audio, DO, and the robot's own state, which ultimately enables the robot to respond to task instructions.



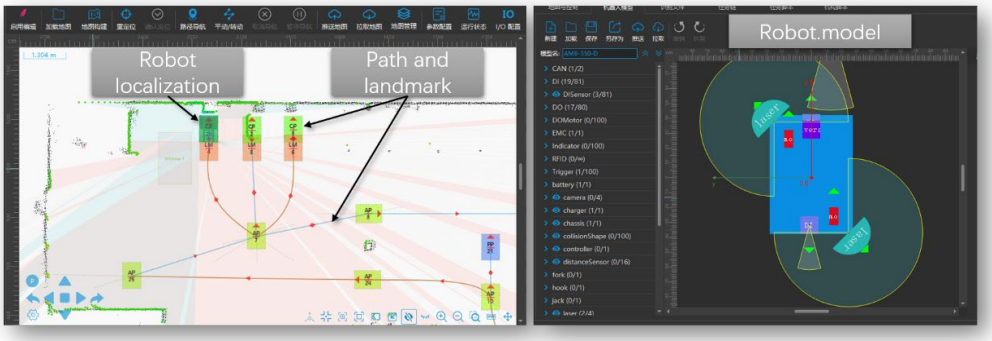
System structure diagram of robot navigation and control

The user sends a task instruction to the robot through the network. The robot will automatically generate a path to the target point according to the configurable content, and use the actuator to complete the corresponding task action.

6.2 User Input Information

In order for the robot to automatically navigate, the user must provide the following information:

- The map where the robot is located needs to be scanned by RoboShop software, and the working points and lines should be set on the map.
- Configure the robot model file.
- Determine the current position of the robot.
- Deliver robot target points.



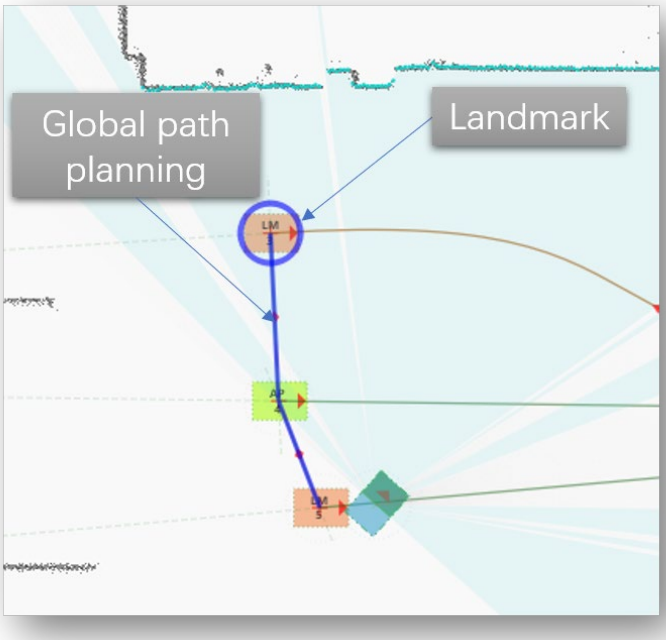
On the map, the robot is represented by a translucent rectangular frame, and the points and lines are also displayed on the map. The robot model file defines the mechanism properties such as laser and motor. After the robot has a map, a point location, a route, a

model file, and a current location, it can plan a route to the target point.

When the robot receives the map, model file, current position and target point position, the robot plans a route as short as possible from the current position to the target point.

6.3 Global path planning

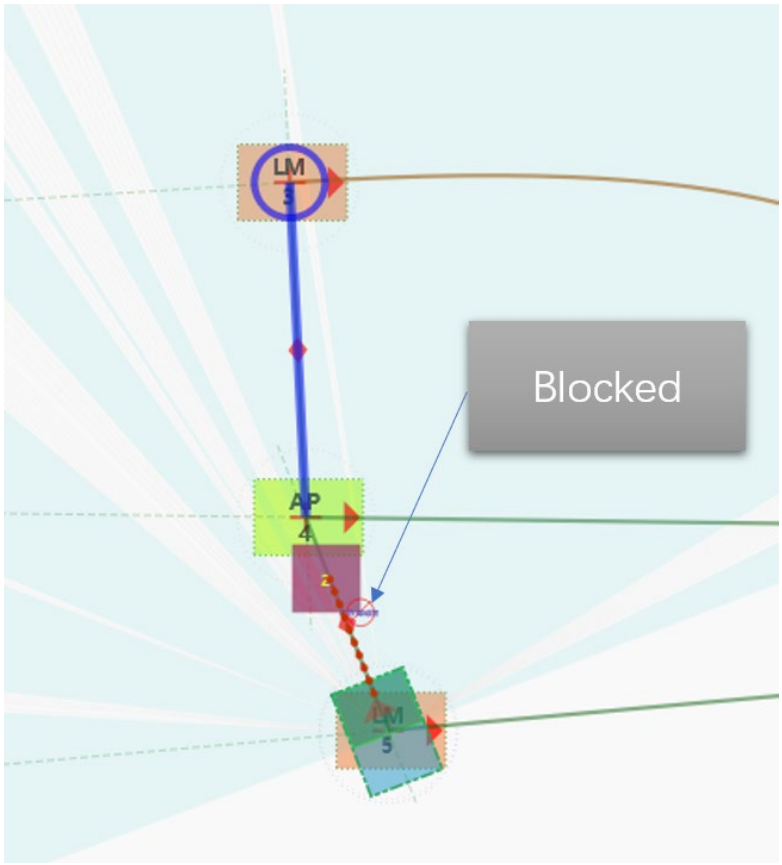
Global path planning refers to the robot generating a path to the target point. Global path planning is only planned at the beginning of the task. Global path planning does not consider obstacles on the line, but considers the deviation distance of the robot's offline path.



The blue circle is the target point, and the blue line is the line planned by the robot.

6.4 Local path planning

the robot will conduct local path navigation in real time during driving. When encountering obstacles, robots can avoid obstacles. Local path navigation also plans the running speed of the robot to ensure smooth running speed of the robot. When the robot is outside the line, the navigation fails and the robot is not in the path.



The robot detects virtual obstacles on the line, and local route navigation avoids obstacles and stops.

6.5 Task planning and action planning

When a robot receives a task instruction, it splits the instruction into an action sequence. For example, if the task assigned to the jacking vehicle is to identify and pick up the goods, the task planning will divide the issued instructions into three parts: 1. Identify the position of the goods; 2. Navigate to the position of the goods; 3. Perform the pick-up action. This task instruction is executed only after each action is executed successfully.

Action planning is to plan the robot's own equipment to perform each action. For example, 1. Identify the location of the goods. The action planning will call the camera to identify the location of the goods based on appropriate identification files. 2. Navigate to the cargo location, and the action planning will call local path navigation to let the robot move to the destination. 3. When the pickup action is performed, the robot will rotate the pickup motor to load the goods.

Under the control of RoboShop, each navigation instruction of the robot can be attached with a task instruction. In the scheduling mode, the robot can attach a task instruction to each line.

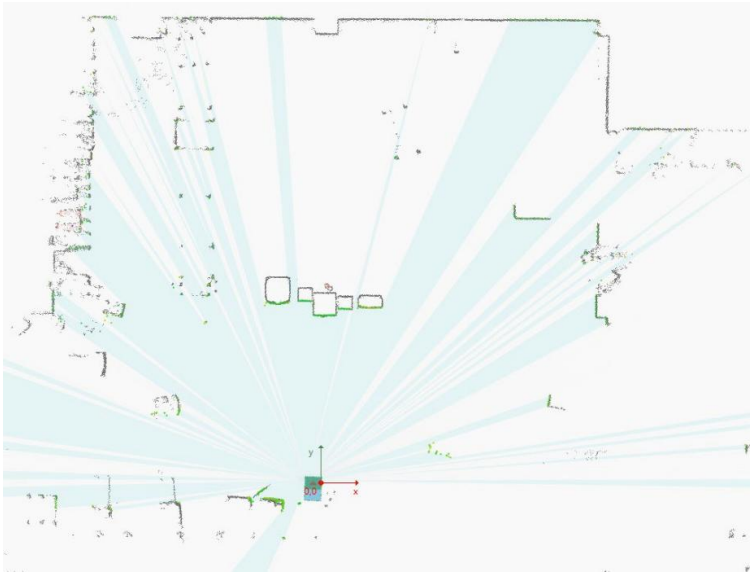
6.6 Obstacle Detection

The obstacle detection function of the robot is realized by the following sensors:

- Navigation laser

The following figure shows how the robot sees the environment and how it performs in the robot system.

Human Vision



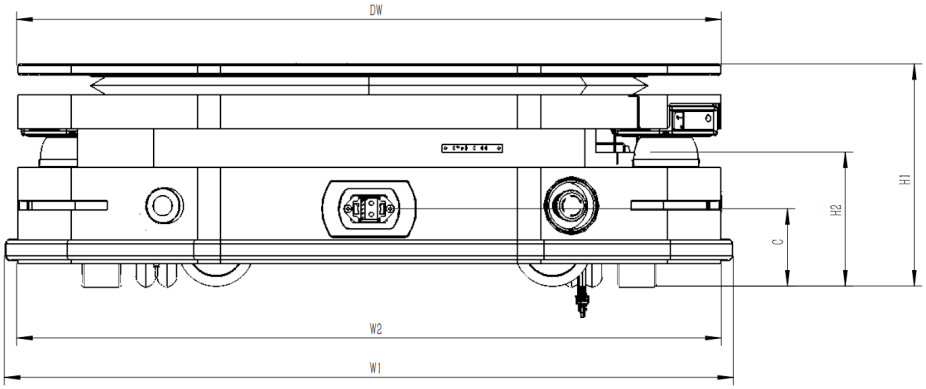
Laser Vision Navigation laser

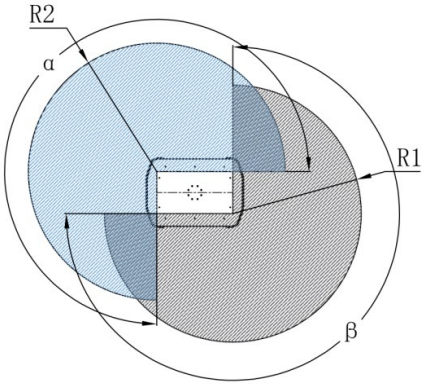
⚠	Precautions for laser use ● Do not open the top cover of the laser, otherwise the laser may be damaged or become invalid.

The AMB-1000JS is equipped with 2 SICK nanoscan3 Core lasers. The main functions are as following:

- Scan map
- Positioning and navigation
- Identify obstacles

6.6.1 Detection range





Model	No	Definition	Parameter
AMB-1000JS	R1/R2	Detection distance	40m
	α/β	Detection angle	270°
	H2	Detection height	175mm

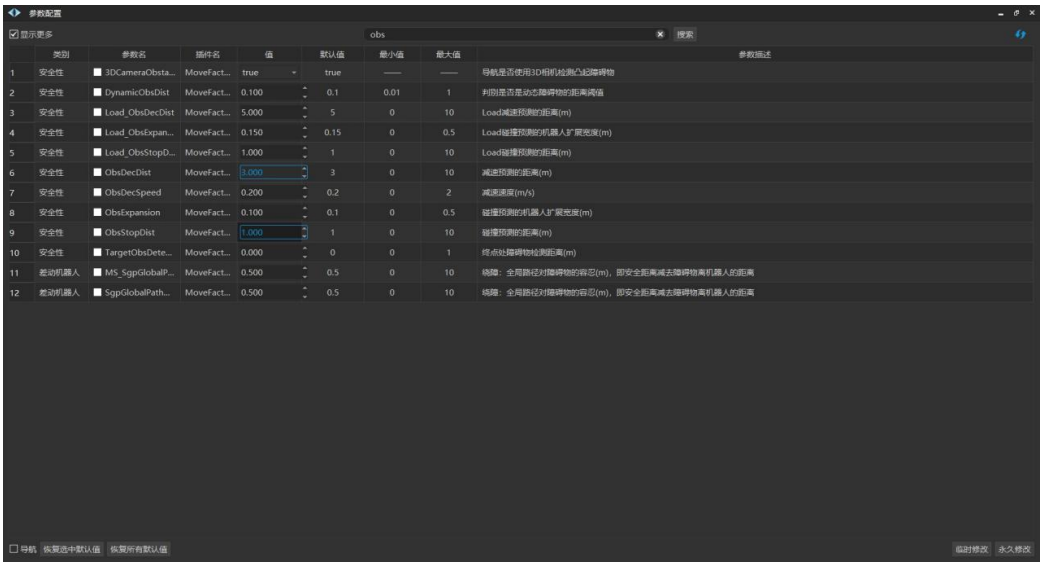
6.6.2 Blind detection zones

Due to the nature of the laser sensor, objects below or above the laser detection height are not detected.

6.6.3 Action after detection of an obstacle

When AMB leaves the factory, the default slowing down (ObsDecDist) and stop (ObsStopDist) areas have been set.

- In the slowing down area (default value: 3m), the laser detects obstacles and the robot decelerates.
- In the stop area (default value: 1m), the laser detects obstacles and the robot stops.
- In the Roboshop parameter configuration, you can modify this parameter.



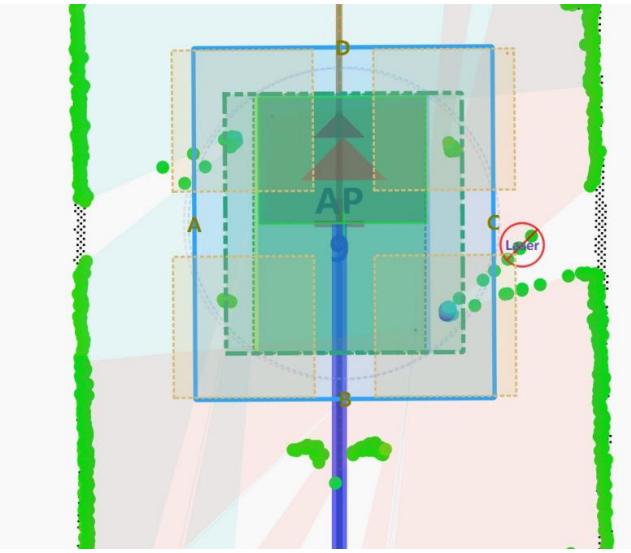
⚠	**Notes on the configuration of the robot parameters** ● Set ObsStopDist to 0 to turn off collision detection. Please be careful!

6.6.4 Laser Characteristics and limits

Noise

The noise of laser is caused by the principle of laser measurement. During laser ranging, a light spot is emitted, and the light spot is usually fixed at the divergence angle. Therefore, the farther the measuring distance is, the larger the light spot is formed in the distance. If a light spot is emitted and at the same time half of it shines on the object in front and half of it shines on the object behind, and the returned energy is very high, the distance measured here will be problematic, and the normal laser noise will be generated.

Therefore, usually when the reflectivity of the background object is relatively high and the foreground object is close to the background object, laser noise is easily generated at the edge of the foreground object. As shown in the following figure:

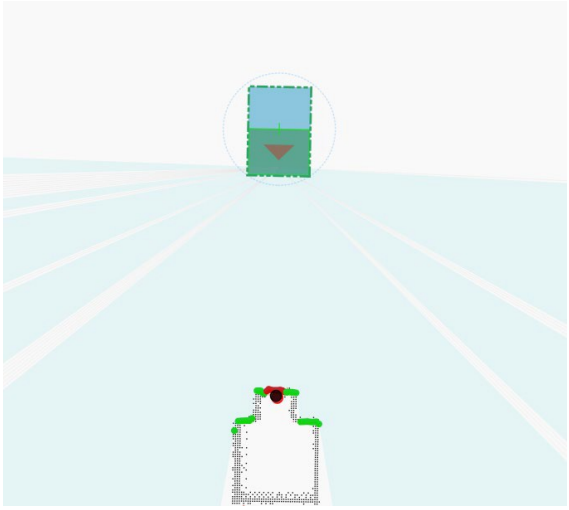


Valid distance

The effective distance of laser in normal operation is 0.1M ~ 40m, so when the laser is very close to the object, the data of the laser may not be accurate, so the laser should not be particularly close to the wall or other objects when in use (at least 10cm space needs to be reserved).

Reflectivity

The reflectivity of laser is usually related to the energy intensity returned by laser, so for objects with high reflectivity (reflector), there will be higher reflectivity, and for ordinary objects, the reflectivity is relatively low. Generally, we normalize the reflectivity to 0~255.0 is the lowest reflectivity and 255 is the highest reflectivity. The reflectivity of general objects is less than 150, and that of special diamond-grade reflector is more than 200. The reflectivity of a certain laser point can be known through the color of the laser point on the Roboshop, as shown in the following figure:



Therefore, if the environment is filled with objects with high reflectivity, it may affect the

relevant applications that need to identify the reflector.

Black objects

For black objects with reflectivity of 10%, the effective measurement distance of laser is 0.1M ~ 10m. For black objects with lower reflectivity, the laser may not recognize or the measured distance is inaccurate. Therefore, if the environment is full of black objects with low reflectivity, robots may not be able to build accurate environmental maps, thus failing to navigate stably and accurately.

Specular reflective objects

Since laser measurement is to calculate the distance according to the received and reflected laser, various objects of different materials will have different effects on laser measurement. For the surface of natural objects, as long as the diffuse reflection is uniform, the noise that laser shines on the surface of the object is relatively small and the measurement accuracy is relatively high. If the surface is smooth, mainly the specular reflection object, the measurement noise will be relatively large and the measurement accuracy will decrease. Therefore, if the environment is full of specular reflection objects, robots may not be able to build accurate environment maps, thus failing to navigate stably and accurately.

Interference between lasers

Generally, multiple laser interferences are usually protected during laser design to avoid mutual interference. However, laser manufacturers recommend using the following installation method to completely avoid mutual interference between them when using multiple lasers. By increasing the inclination angle of laser installation to eliminate the interference between laser, for the application of laser SLAM, the inclination angle should be upward rather than downward.

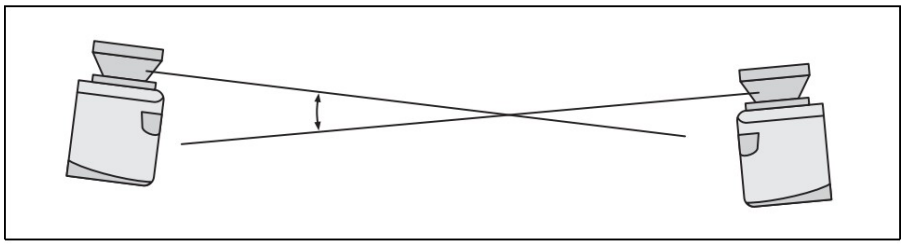
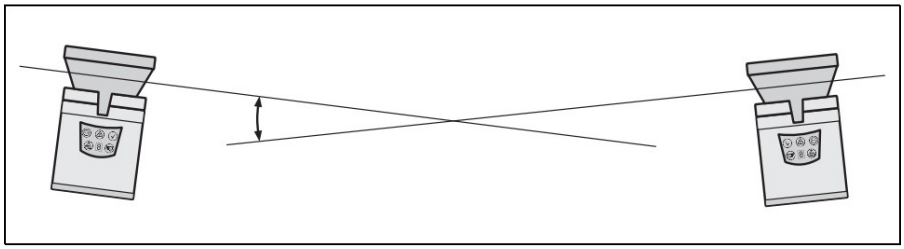


Fig. 38: Placement of two LMS1xx opposed to each other



Influence of strong light

Generally, the ambient light immunity of indoor laser is about 40klux ~ 80klux. Generally, the indoor light intensity is less than this value, so the indoor light will not affect the laser, but it is necessary to avoid direct sunlight as much as possible. For outdoor applications, please select outdoor dedicated laser, such as the Sike fairy series.

Influence of environmental changes on laser SLAM

the principle of laser SLAM is to build a point cloud map of the environment by scanning the outline of the environment by laser radar, and then to conduct positioning and navigation according to the matching between the constructed point cloud map and the real-time point cloud scanned by laser. Therefore, if the environment contour changes greatly (>30%) after the map is built, the robot may not be able to achieve the expected high precision. If the environment contour changes greatly (>60%), the robot may deviate from the path or even lose its location. Therefore, for scenarios where the environment often changes greatly, consider adding other auxiliary measures, such as enabling online SLAM, deploying reflector or twodimensional code, etc.

6.7 Position

The purpose of the positioning process is to determine the current position of the robot. The robot has three inputs to determine its current position:

- The initial position of the robot, which serves as the positioning reference point.
- IMU and encoder data, used to determine the distance and speed of the robot starting from the initial position.
- Laser scanning data, by comparing the position data of the wall on the map to determine the

Approximate position of the robot Particle filter to determine the approximate position of the robot on the map by using the above data.

6.7.1 IMU and encoder

The data of inertial measurement unit (IMU) and motor encoder can be used to calculate the distance and speed of the robot from the initial position. The two sets of data are combined to obtain a more accurate position.

6.7.2 Laser and particle filtering

The robot controller uses particle filter algorithm to confirm the best match by comparing the laser input data with the wall on the map. Since the laser input data only compares the estimated position obtained by the robot based on IMU and encoder data, the initial position needs to be confirmed.

To ensure that robots can accurately locate by particle filter, we need to confirm when building a map:

- The map must have unique and identifiable static landmarks and be easy to identify. Landmarks need a permanent structure, and robots can use it to determine their own direction, such as corners, doors, pillars and shelves.
- The robot must be able to detect static landmarks marked on the map so that it can approach its current position.
- Make sure the current position of the robot is correct.

6.8 Drivers and Motors

The robot continuously adjusts the output of the motors according to the information collected by the sensors. The robot can therefore correct its speed when climbing hills or carrying loads and can change its direction of travel to avoid moving obstacles.

6.9 Audio

The robot can broadcast its status through speaker, mainly including motion working status and robot abnormal status.

- Working status: The Robot indicate the current working status, including “navigation”, “astern”, “turnleft”, “turnright”, “moveleft” and “moveright” by speaker.
- Robot abnormal status: The Robot indicate the current working status, including “bloc”, “low battery”, “error” and “collision” by speaker.

7 Safety System

The robot has a series of built-in security-related functions. When there is a risk of casualties, the safety system can control the robot to slow down or stop.

All safety functions are designed in accordance with ISO 13849-1 standard to comply with EN 1525 and ISO 3691-4.

The robot is certified by CE-MD, CE-EMC, CE-RED instructions.

7.1 System Overview

The safety system is mainly controlled by the safety controller. The controller adjusts the input and output of safety-related functions to ensure the safety of workers near the robot.

Robot stop type

- Protection stopped

To ensure the safety of nearby personnel, robots can automatically enter the protection stop. When the protection stops, the robot motor holds the brake and can hear the sound of switching the safety relay.

- Emergency stop

When the emergency stop button is pressed, the robot enters the emergency stop. In case of emergency stop, the robot holds the brake and can hear the sound of safety relay switching.

Security related features

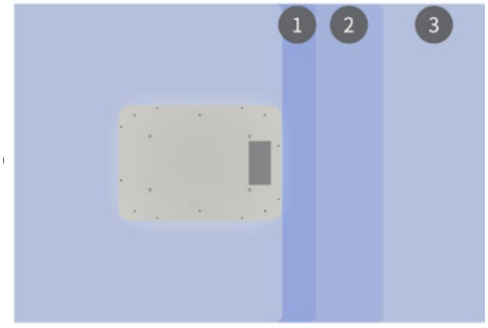
- Safety laser (safe area)
- Safety speed monitor
- Stability
- Driver (STO)

7.2 Safety Personnel detection (safe laser area)

Protected Area

The protected area is a function of the robot's personnel detection device. The protected area consists of independently configurable profiles. The system automatically selects the active protection area according to the running speed of the robot. When people or objects appear in the activity protection area, the robot will enter the protection stop state, and

will not continue to operate until the protection area becomes unblocked.



Driving direction front protection area

Security Zone	Speed Range	Region size
Security Zone 1	0 - 0.3 m/s	30 cm
Security Zone 2	0.3 – 1 m/s	100 cm
Security Zone 3	1.0 - 1.50 m/s	＞100 cm

Rear protection area of driving direction

Security Zone	Speed Range	Region size
Protected Area	All speed	30cm

7.3 Safety speed monitor

When robots hardware error, safety encoder can monitor the abnormal immediately, and report the error to prevent the robot from driving.

When robot driving speed exceeds the preset safety limit, it will immediately enter a protective stop. This ensures that the robot cannot be driven when the speed cannot be controlled.

7.4 Stability

When one wheel of the robot loses traction, once the motor encoder measures the difference of rotation speed of each wheel beyond the preset safety range, the stability function can immediately prevent the robot from driving.

When the robot detects instability, it immediately enters the protection stop state. This ensures that the robot cannot be driven when it loses control over the speed of each drive wheel.

7.5 Driver (STO)

Once the security function is triggered, the driver uses STO (Safe Torque Off safe Torque Off) function makes the robot stop at Level 0 (Category 0 stop: according to IEC 60204-1,

"cut off the power supply immediately" to stop), and then use SS1(Safe Stop l) function to carry out controlled braking. This is called enabling the robot to enter an emergency stop or protective stop, depending on the function see stop type.

7.6 Safety SRC-3000FS

SRC-3000FS is designed with a safety integrity level of SIL2, and construct robot safety control through OSSD signal or sin/cos signal with safety lasers, safety encoders, diver or emergency buttons.

In addition, SRC indicates the current running status of the robot by changing the color and shape of the status light.

7.7 Status light

The robot indicates the current running status by changing the color and shape of the enclosure lights.

Indication	State
Red wavering	Error
Dark red blinking	Emergency stop
Pink Purple trotting horse lamp	Blocked
Orange blinking	Turning[Note1]
Bluewavering	Going straight
Orange wavering	Charging
Dark red trotting horse lamp	Low battery[Note2]
Green-Dark red gradient	Stationary state[Note3]
Rainbow colors	Battery abnormal[Note4]

Note 1: configure according to actual needs (quantity, direction); When rotating in situ, all configured lights flicker synchronously.

Note 2: The electric quantity is lower than the maximum value of warning Percentage, errorPercentage and shutdownPercentage configured in the battery equipment (When the maximum value is -1, this effect is not displayed).

Note 3: The gradient color in the static state shows the electric quantity. Red: full grayscale 255 *(1-power percentage), green: full grayscale 255 * Power percentage.

Note 4: When the robot is still, the battery type is not configured or the battery communication is wrong.

Note5: the above order is the priority of the display of the headlights, that is, the error alarm

Note: the above order is the priority of the display of the headlights, that is, the error alarm takes precedence over the emergency stop display. When the condition of high priority is

met, the corresponding enclosure lamp effect is displayed, and the condition of low priority is no longer judged. The interval for each update is about 300ms.

8 Debugging

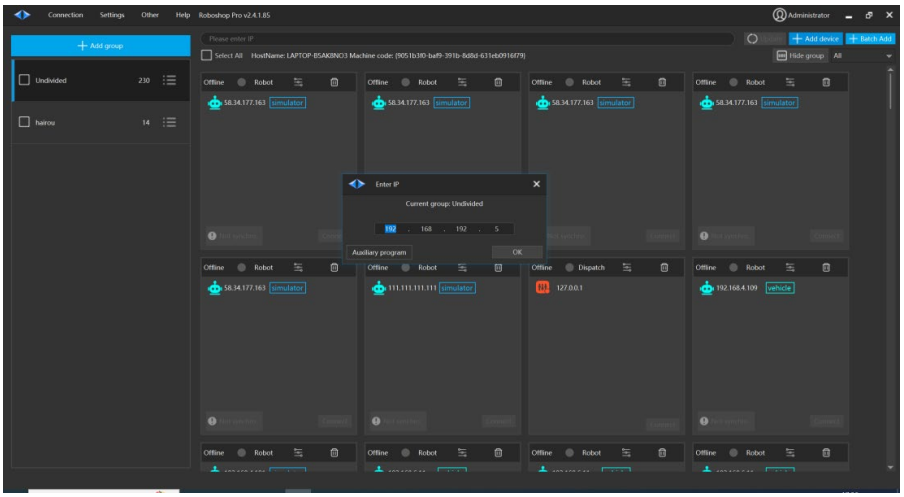
8.1 Connect robot

To operate a robot, you need to use the latest version Roboshop

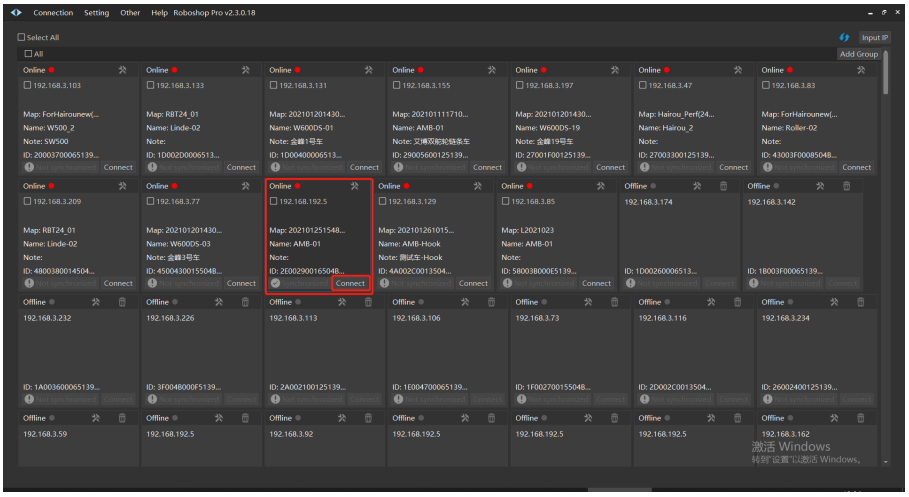
1. Use a network cable to connect the computer to the network port of the robot.

2. Set the Ethernet IP of the computer to 192.168.192.xxx(xxx must be greater than 200) CIDR block, subnet mask 255.255.255.0, and the gateway can be omitted.

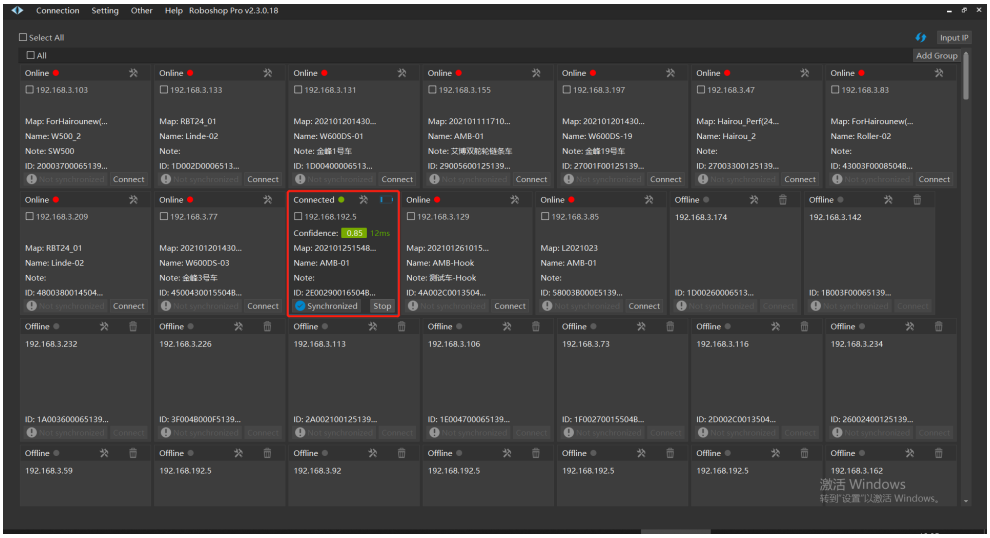
3. Open the Roboshop and click refresh on the home page or manually enter IP address192.168.192.5 to add the robot.



4. Find the robot whose IP address is 192.168.192.5 in the robot list on the [Home Page] and click the [start connection] button to connect.



5. When the robot's "confidence", "network delay", "map", "name", "remarks (if any)" information is displayed on the robot tab, the connection is successful.



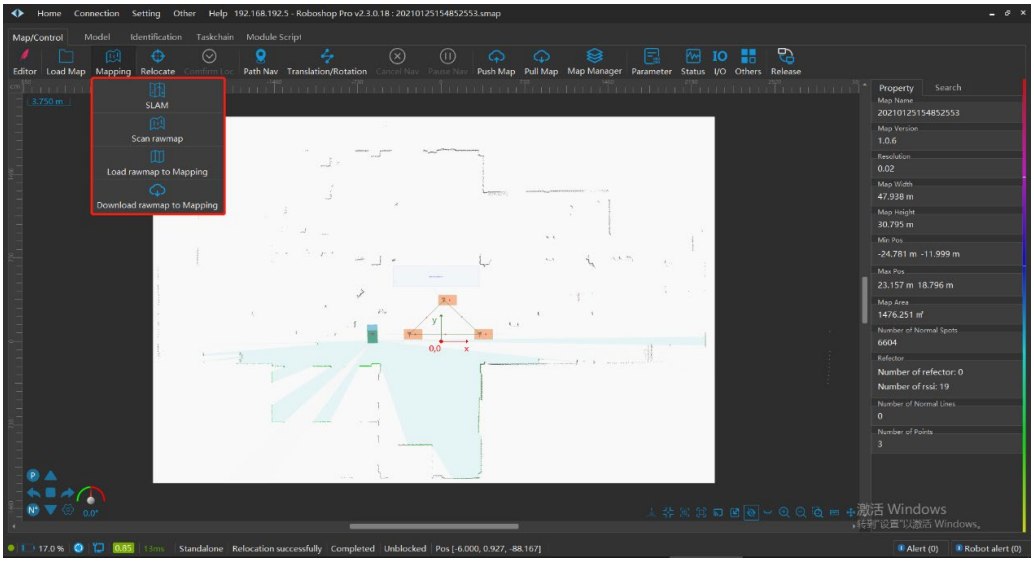
8.2 Map construction and editing

Preset conditions: robot is connected, robot model is configured and synchronized.

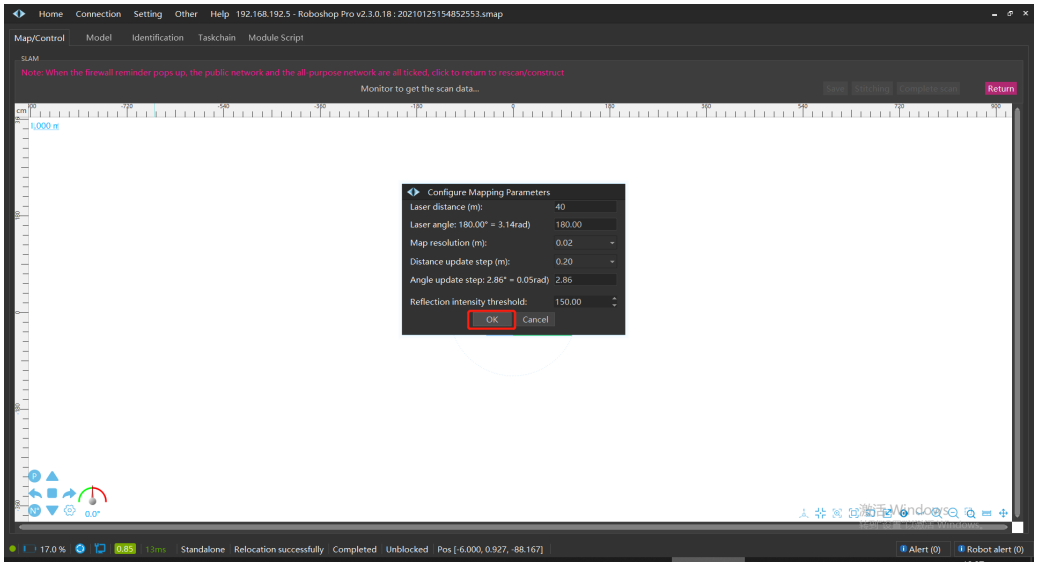
1. Map construction

a. Open the Roboshop Pro, connect the robot successfully, and double-click the robot to enter the map and control interface.

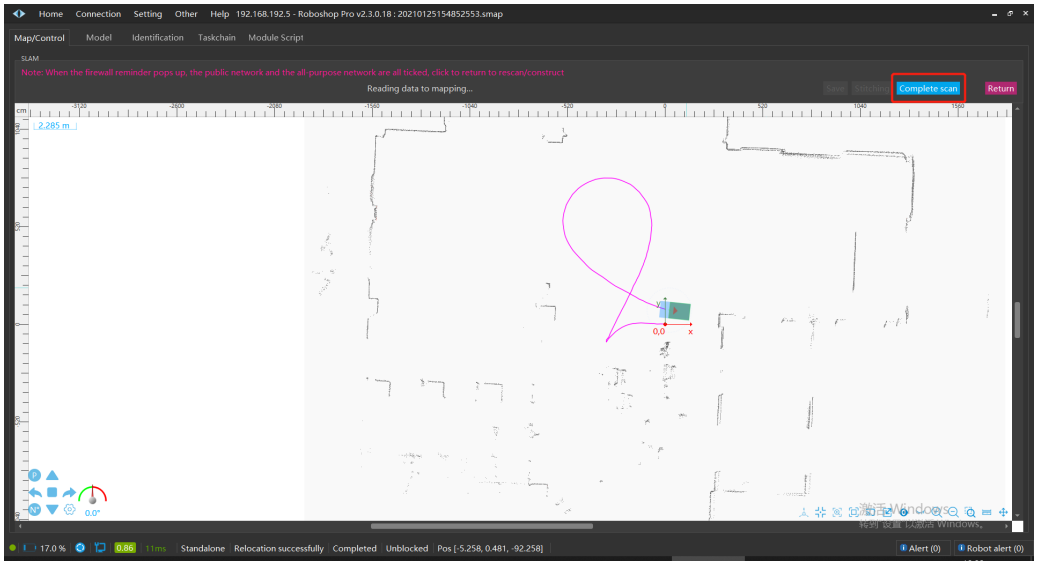
b. Click [map build] in the toolbar of the module, and all methods of [map build] will pop up.



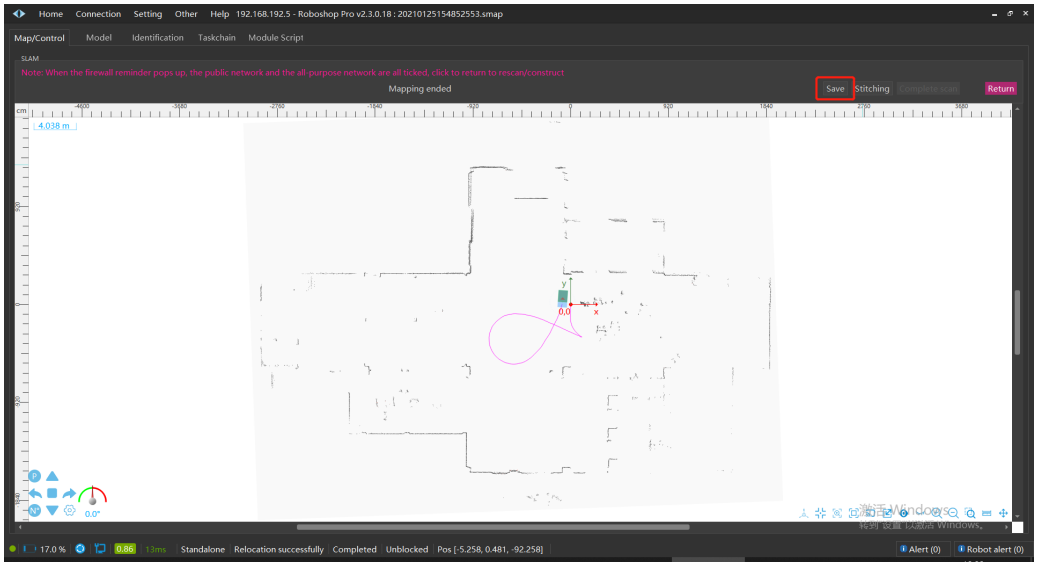
c. Click [map construction] --> [SLAM], do not modify any parameters in the pop-up Interface (generally, you do not need to modify the parameters of the interface), and click [OK].



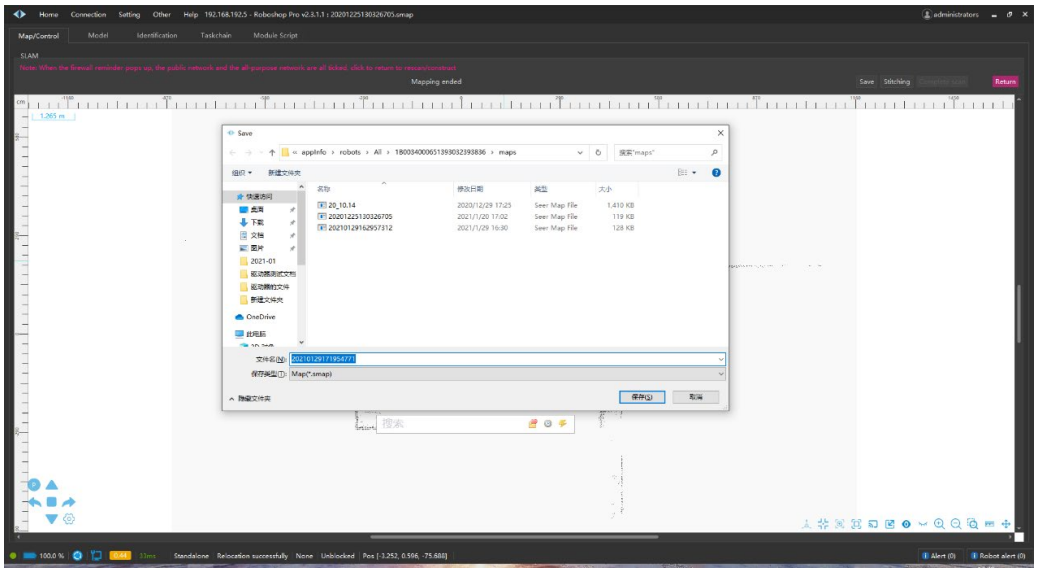
d. Use the keyboard buttons W (forward), A (left turn), S (backward), D (right turn) to control the robot, so that the robot can move in the scene. After finishing the scan, click the [finish scan] button in the upper right corner.



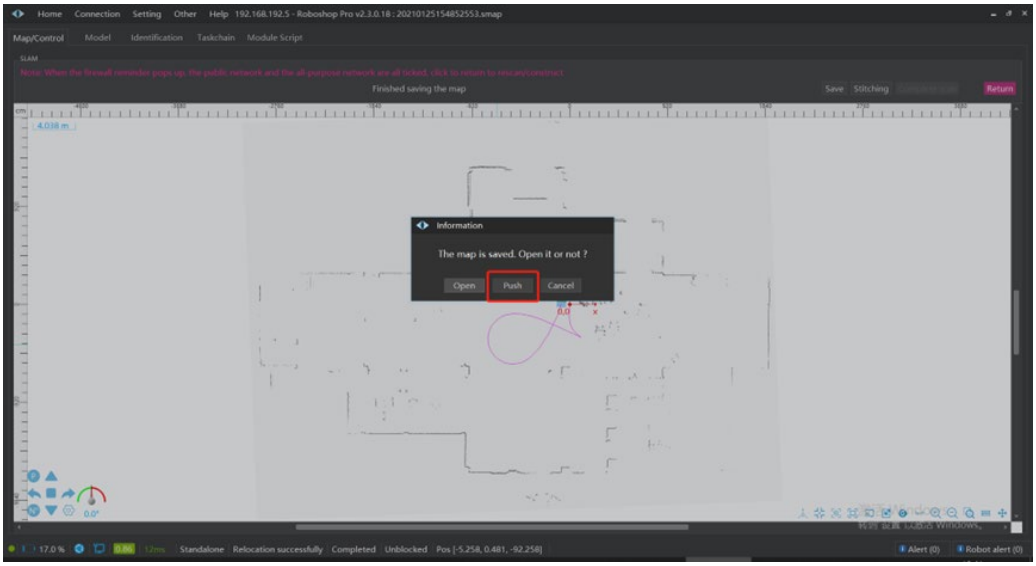
e. Wait until the drawing is completed, and then click save in the upper-right corner.



f. Select the desired path and enter the desired name in the pop-up interface to save the map.



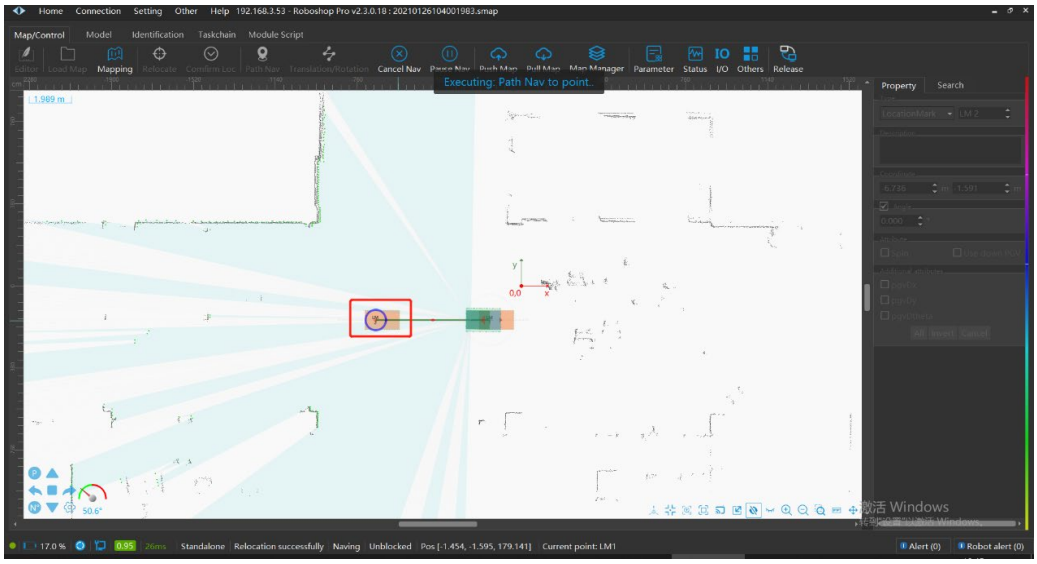
g. After saving, a dialog box will pop up asking whether to open it. Select [push map and open] to open the map youjust built and synchronize the map. You can use it directly. The map construction is completed.



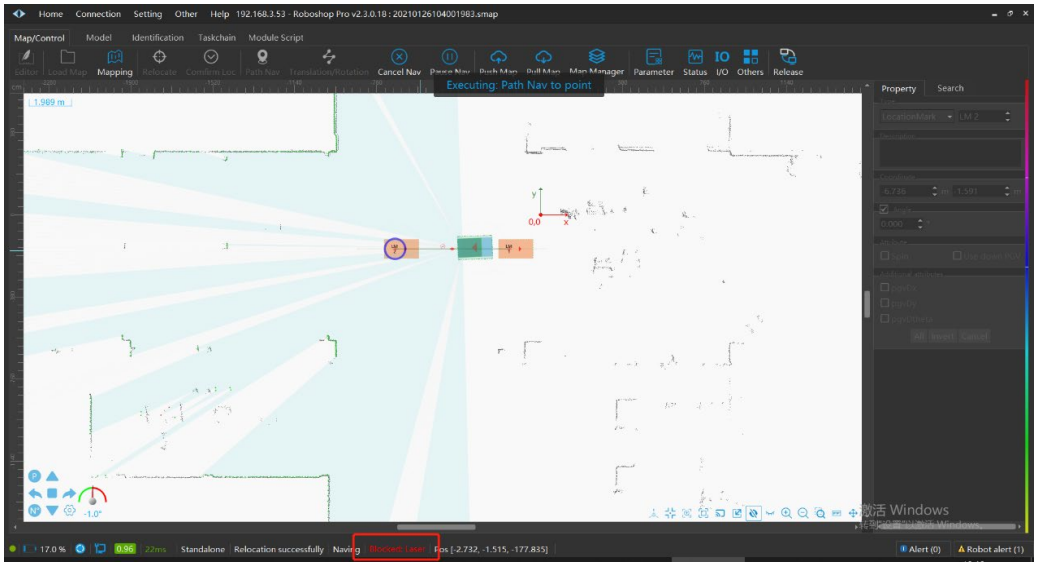
Note: If you select [open], the newly built map will be opened, and a dialog box with inconsistent map data will pop up. Select [push map], [pull map], or [cancel] as needed].

8.3 path navigation and obstacle stopping verification

Preset condition: at least two sites exist on the map and are connected through the Bessel curve. Robot route navigation: click path navigation in the module toolbar, and then click a site. For example, click LM2, the robot will route navigation to the target point (LM2) along the route, and the direction of the robot to the point is the same as that of the site, as shown in the following figure.



Note: If there are obstacles in the route, the robot will stop in front of the obstacles during navigation, and will not continue to run until the obstacles disappear, and the blocking reason will be displayed in the status bar.



8.4 Establishment and configuration for Jacking action AP workstation

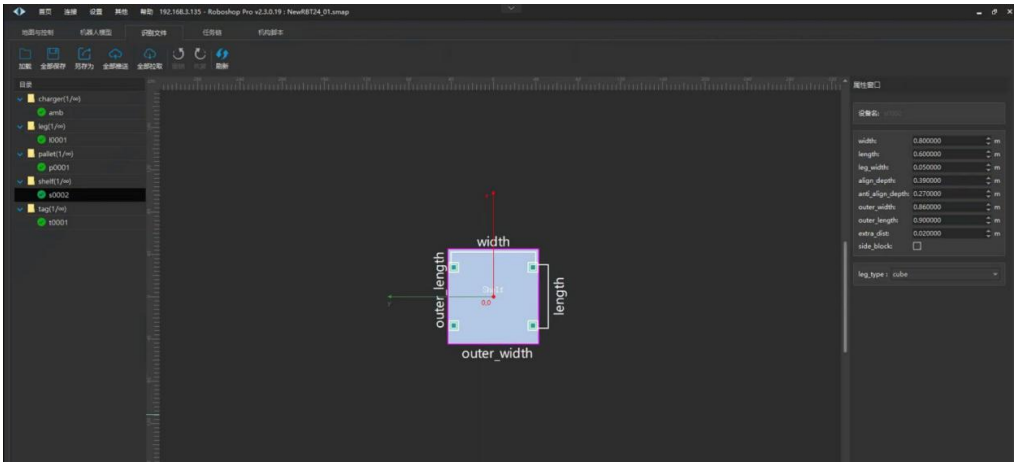
a. Use robots to build maps in areas where robots need to work.

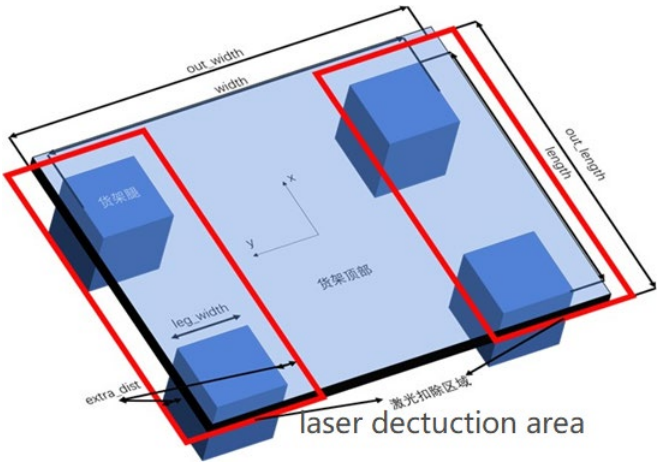
b. Set up the AP points shelves and place in the daily work position.

c. Configure the workstation.

Item	Description
Type	ActionPoint (AP point)
Operation Object	Jack (jacking mechanism)
Recognition profile	S0002.shelf, refer to the following steps for details
Attribute-Use Face down PGV	Information will be obtained through the face- down PGV at this AP point after it is selected.
Preceding point.	Pre-positioned point will be enabled after it is selected (see details below)

d. According to the actual shelf dimensions, accurately configure the shelf recognition file.





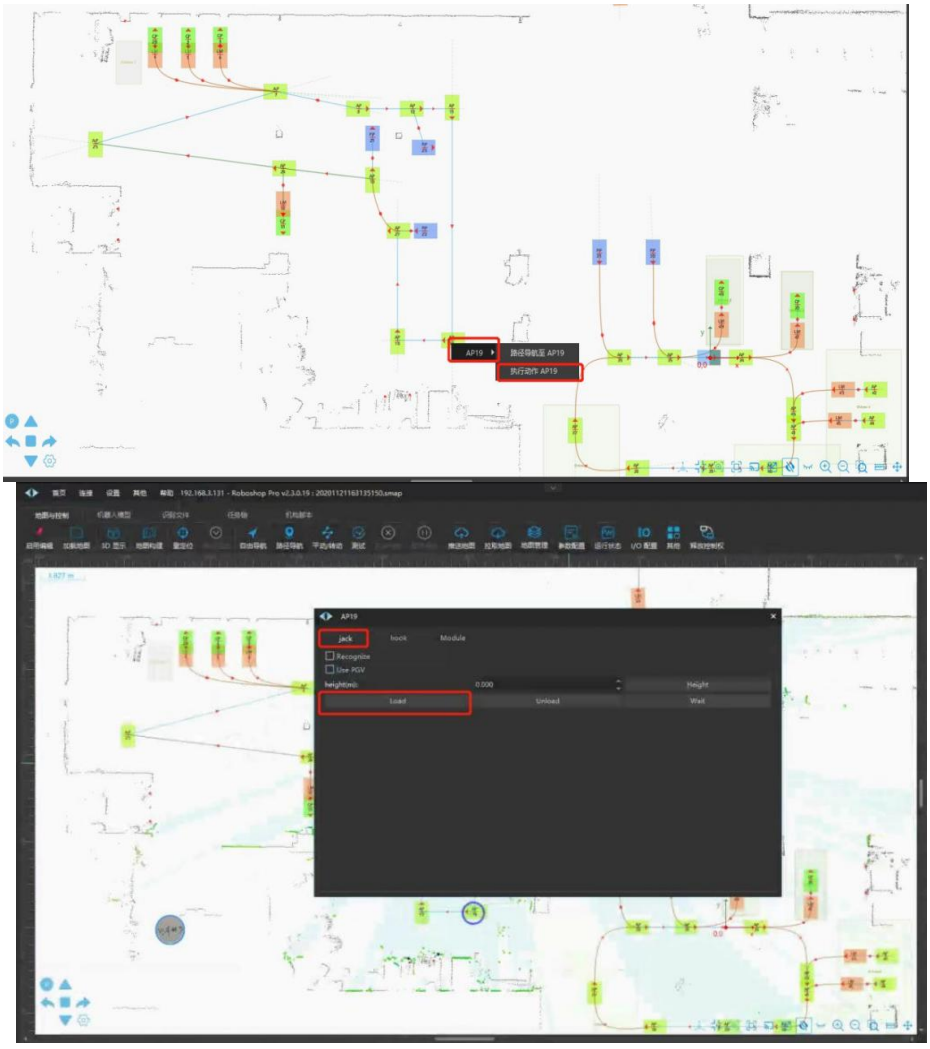
Parameter	Description
width	The outer width of the two shelf legs (after transformation, the outermost width of the two reflective strips) perpendicular to the drilling direction after transformation.
length	The outermost width of the two shelf legs parallel to the drilling direction.
leg_width	The width of the reflective strip; it is 0.05m when the standard 3M reflective sticker is selected.
align_depth	0.39, the depth at the bottom of the shelf to which the robot travels backwards when automatic recognition and drilling into the shelf is issued.
anti_align_depth	The depth at the bottom of the shelf to which the robot travels forwards when automatic recognition and drilling into the shelf is issued
outer_width	Used to configure the biggest width of the shelf in the situation where the top rectangle of the shelf is larger than the rectangle formed by the four shelf legs
outer_length	Used to configure the biggest length of the shelf in the situation where the top rectangle of the shelf is larger than the rectangle formed by the four shelf legs
extra_dist	Outline dimension expanded outward based on outer_width and outer_ length.
Side_block	If there is a baffle plate around the shelf, select this option to deduct the baffle plate around the shelf using the laser
leg_type	"cube", used to configure the shape of the shelf legs; since the reflective sticker is rectangular, it is generally configured as cube (square)

8.5 Navigate to Specified Point (by Path Navigation) an Execute the Corresponding Action

The drilling of robot under the shelf is divided into two modes: recognition mode and non-recognition mode.

- Recognition mode: It refers to the mode in which the laser sensor is used to recognize the shelf in the environment to realize the function of drilling under the shelf; the AP on the map can be set inside the bottom of the shelf, and there is no need to set the AP accurately.
- Non-recognition mode: It refers to the mode in which the function of drilling under the shelf is realized along the preset path in the map; the AP on the map is the position where the robot stops and jacks up, and the AP position must be set accurately.

Prerequisites: Confirm that the localization status of the robot is normal, and the path between the destination and the current location of the robot is unobstructed.



a. Load/ Unload in non- recognition mode: Click [Path Navigation] in the module toolbar, click the left mouse button on the destination point, select [Execute Action AP19] in the pop- up dialog box, and select the [Load/ Unload] in the pop- up dialog box; the robot will travel to AP1 9 and carry out corresponding Load/Unload actions;

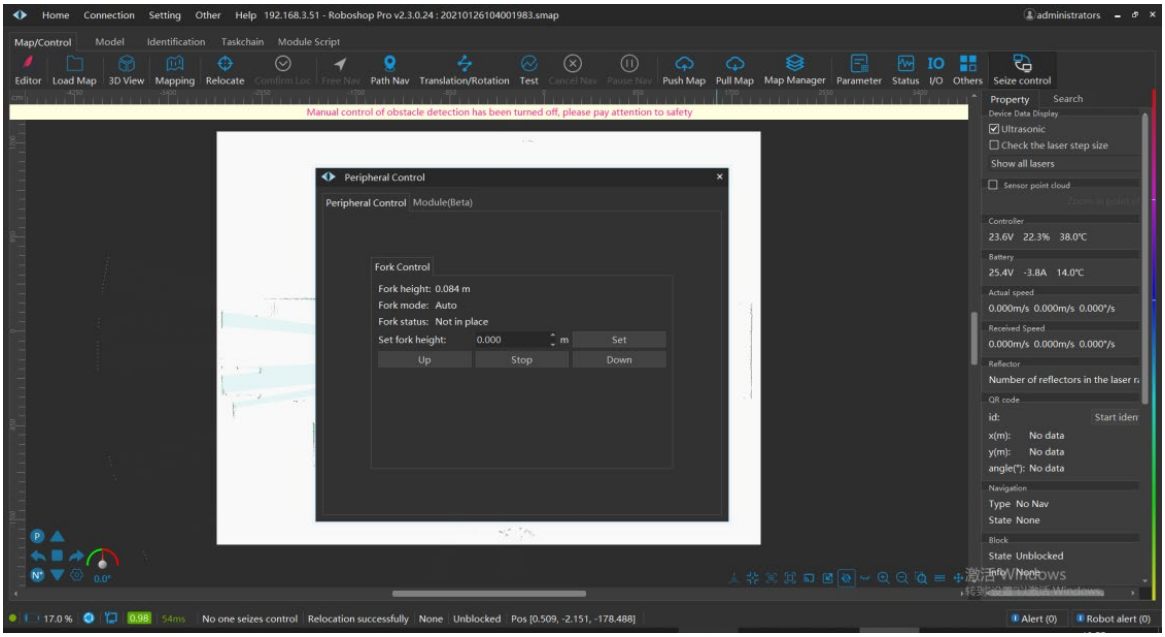
b. Load/ Unload in recognition mode: Click [Path Navigation] in the module toolbar, click the left button on the destination point, select [Execute Action AP19] in the pop- up dialog box, and select the [recognize] option; the robot will travel to the pre-positioned point of AP1 9 automatically, drill under the bottom of the shelf after recognition and jack it up;

Caution:

1. The recognition file shall be configured for the AP for the purpose of recognizing the shelf.
2. When "use Reflector for detecting shelf" is set as "True" in the parameter configuration, it is necessary to stick the reflective stripes on the shelf legs.
3. When "use Reflector for detecting shelf" is set as "False" in the parameter configuration, don't stick the reflective stripes on the shelf legs.

8.6 Lifting/Lowering of Shelf via Remote Control on Upper Computer

Prerequisites: The robot has been localized properly;



Manually control the robot to lift and lower: Confirm that the robot has been re-localized properly, and click the button P on the right bottom corner of Roboshop.

a. The jacking mechanism of the robot will lift to the maximum height from the current position if [Lifting of jacking mechanism] is clicked;

b. The jacking mechanism of the robot will lower to the minimum height from the current position if [Lowering of jacking mechanism] is clicked;

c. The robot will stop the moving jacking mechanism (lifting or lowering) if [stopping of jacking mechanism] is clicked;

d. The jacking mechanism will lift to 0.05m if a designated height such as 0.05 is entered in [jack to the designated height (m)];

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9 Application

Name of Optional Component	Model	Location	Purpose
QR code reader	PGV100R- F200-F200-R4-1/PGV100-F200A-R4-V19	The middle of the vehicle body, that is, the center of the drive wheel Orientation: Face-up or Face-down	Face-up: Recognize the shelf location Face-down: Recognize the bin location

10 Product maintenance

10.1 Maintenance instructions

Before performing any maintenance or troubleshooting activities, please read the content of this chapter, this manual and other related manuals carefully to comprehend the safe maintenance and troubleshooting procedures fully.

Only authorized personnel who have passed safety training and other related training can maintain the robot system. Other related training includes training on robot system as well as training on maintenance organized by the manufacturers, distributors, and local importers.

Operators shall participate in safety training in accordance with national regulations.

	**Precautions for Using Robot Parts** ● Only approved parts can be used. ● We declaim any or all liability if unapproved parts are used without authorization. We will not be held responsible for any damage to the robot, accessories or any other equipment caused by the use of unapproved parts.
	**Precautions for Robot Maintenance** ● Perform maintenance in strict accordance with this manual. Dismantling or changing of any parts not described in this manual is prohibited without permission. Improper dismantling, changing of parts, or wrong maintenance may result in robot system failure and cause serious safety problems. ● Shut down the system when you need to enter the working area of the robot under emergency. ● Carry out maintenance and repair activities in the designated maintenance area. Before performing any maintenance, always remove the robot from the system and turn off the power supply for the robot to prevent the robot from moving suddenly when it receives the system commands.

10.2 Periodic Maintenance

Parts	Maintenance method	Maintenance period
Shell	Inspect whether there is any crack. Inspect the installation conditions.	Once a month, and make the replacement when necessary.
Universal wheels	Inspect whether there is any crack. Inspect the installation conditions.	Once a month, and make the replacement when necessary.

Laser	Inspect the surface for any scratch or crack	Once a week, and make the replacement when necessary.
Emergency stop button	Inspect whether the labels are worn, and whether they are legible	Once every three months, and make the replacement when necessary.
Grounding chain	Check for damage or debris winding.	Check for damage or debris winding. Once a month, and make the replacement when necessary.

10.3 List of Spare Parts and Consumables

No	Name	Brand	Spec	Quantity	Replacement or cycle
1	Universal wheels	HERDAR	4 inch/93A red	4	One year or 8,000 kilometers
2	Drive wheels	HERDAR	180*50/93A red	2	One year or 8,000 kilometers
3	Battery	Topbang	48V 40Ah (customize)	1	1 year or 21000 charge cycles Test after 1 year or 21000 charge/discharge cycles

10.4 Replacement of Components

10.4.1 Replacement of Driving Wheel or Universal Wheel

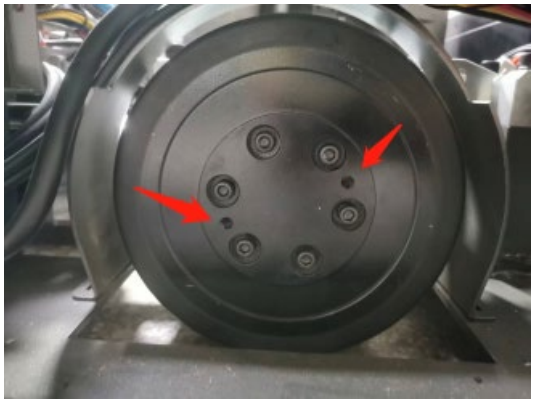
When the robot's drive wheels or gimbals become worn, please replace the wheel as follows.

1. Use thick foam pad bottom protection to keep the drive wheel suspended. Note: Do not press the emergency stop to trigger.

2. Using an Allen wrench, remove the housing m4 size screws. Steps: Remove the four screws in the figure in turn, and remove the cover to reveal the internal drive wheel.

3. Use an Allen wrench to remove the drive wheel m6 size screws. Steps: Remove the six screws in the figure in order to remove the drive wheel.

4. (Emergency measures: If the six screws have been removed, the drive wheel can not be removed, you can use two m6 screws into the hole shown to remove the drive wheel.)

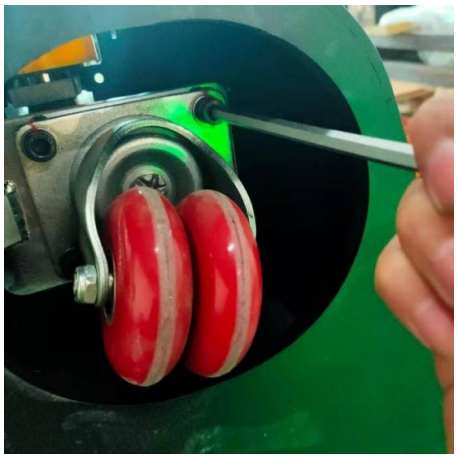


5. After replacing the drive wheel or gimbal as required, attach the side plate to complete the replacement procedure.

10.4.2 Replacement of universal wheel

1. Use thick foam padded bottom protection to turn the robot on its side. Note: Do not press the emergency stop to trigger.

2. Replace the universal wheel: use the hexagonal wrench, remove the universal wheel screws (a universal wheel four screws), replace the new universal wheel tightening screws can be.



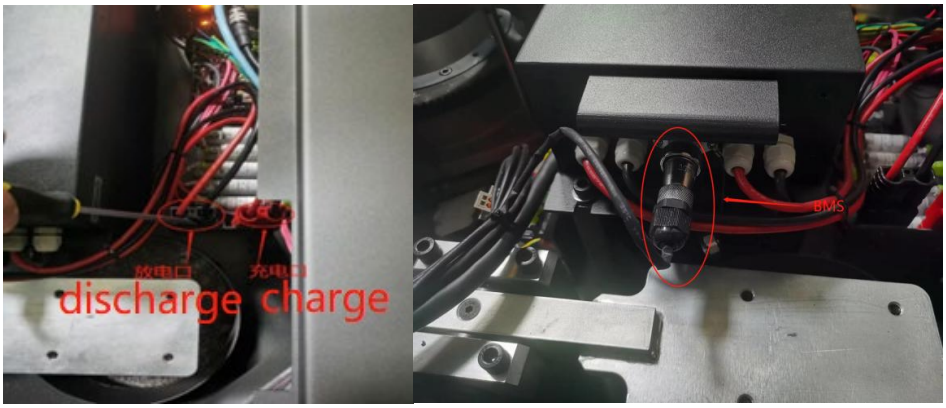
3. After replacing the gimbal as required, complete the replacement procedure.

10.4.3 Replacement of battery

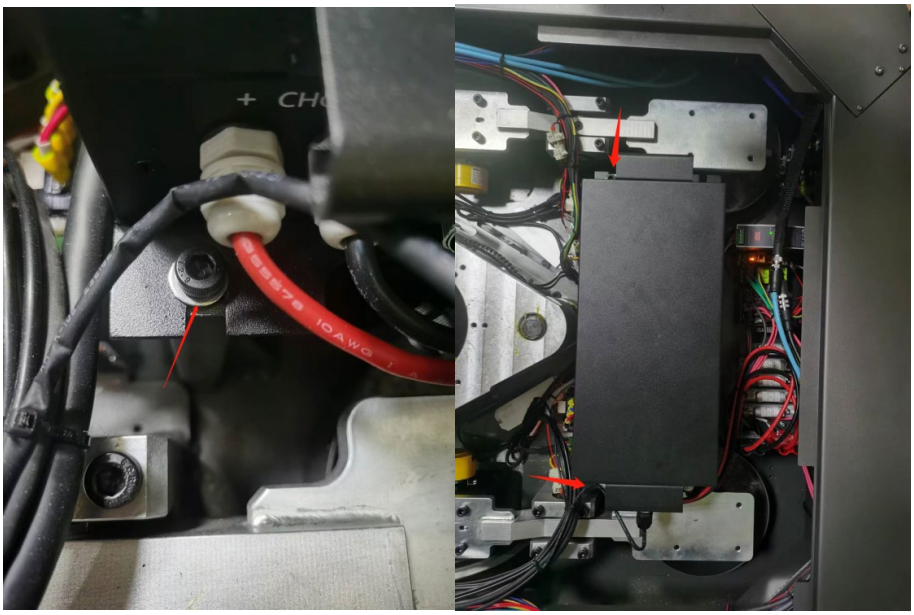
When the robot battery is damaged or has reached the specified life of the battery, please replace the battery as the following steps:

1. Switch the robot off. Disassemble the robot's top plate and housing in turn and cut off the ties.

2. Unplug the charge port, discharge port and BMS (BMS needs to loosen the nuts first).



3. Remove the 2 screws holding the battery and replace it with a new one. And restore the above disassembled parts in turn.



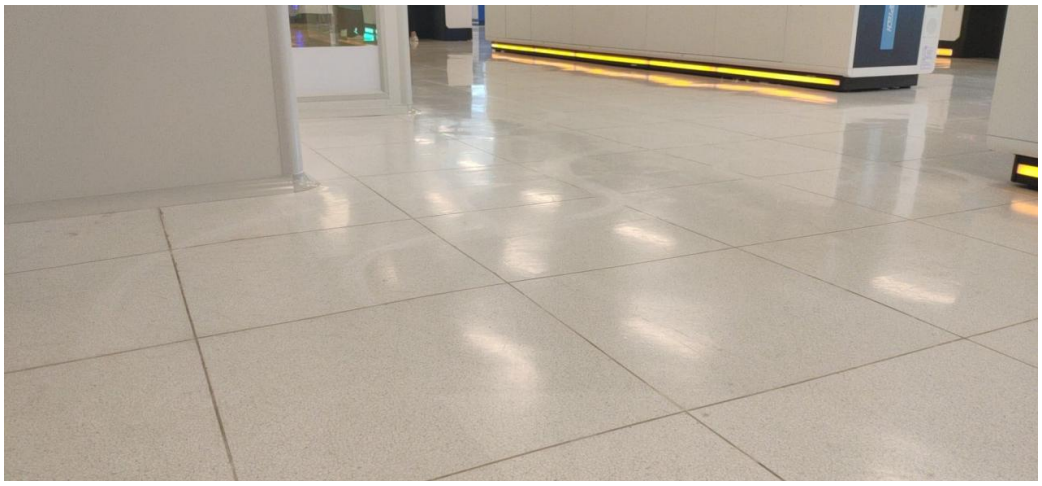
4. Install the robot's housing and top plate to complete the battery replacement.

10.5 Cleaning

10.5.1 Floor cleaning

Both the drive wheel and the omnidirectional wheel of the robot are made of polyurethane (PU), which will inevitably leave traces on the ground after long-term running.

Epoxy Floor - Severe Traces



Epoxy Floor - Severe Traces

Floor cleaning equirements:

- Inspect the floor every day, and clean the dust, foreign matters and liquid contaminant timely to prevent the robot slipping.
- Clean up the traces of the omnidirectional wheel on the floor timely to avoid serious traces.
- Do not wax the ground on the path of the robot; otherwise, it may cause the wheels of the robot to slip or become dirty.

10.5.2 Robot cleaning

1. Before assembling the body, use an air gun to clean the dust and sundries in the body, and inspect the body after cleaning; there shall be no defects such as residues and dirt on it.

2. After the vehicle body is assembled (except the shells), check whether there are any residues in the vehicle such as screws, copper wires, wire skins, etc. If any, it must be cleaned

up. No residues are allowed in the vehicle body.

3. Inspect whether the wiring within the body is neat, and make sure there is no dust or dirt on the wires. If any, wipe it with alcohol.

4. Install the shells and wipe them with a dry cloth.

5. If the shell is still dirty after cleaning, dip a little alcohol and clean the surface until it is completely clean.

10.5.3 Laser cleaning

⚠	**LiDAR cleaning precautions** ● Not cleaning or improperly cleaning the laser may cause the following problems.: 1) The robot fails to detect the sign/pallet rack. 2) The robot goes into an emergency stop without a clear reason.

Please clean the laser according to the following instructions; otherwise, it may cause damages to the laser lens or malfunction.

- Keep the laser lens clean, and clean up the dust regularly.
- Please use a special cleaning cloth.
- Do not dry-wipe the laser lens. Use a dampened soft cloth to clean, and add a little detergent if necessary.
- Do not use corrosive solvent-based detergent, such as acetone.

10.6 Storage

Storage of the robot

- Proper anti-corrosion measures must be taken when storing the out-of-service robots for a long time. Disconnect the battery from the AMB-1000JS, and ensure that the battery is recharged once a month.

Storage of the charger

- The charger shall be placed inside a packaging box when it is not used.
- The extreme temperature of the warehouse shall be -20 to 70°C, the normal temperature shall be -20 to 50°C; the relative humidity shall be 5-90%; there shall be no harmful gas, flammable, explosive, corrosive and other chemicals in the warehouse; and the warehouse shall be kept from strong mechanical vibration, shock and magnetic field.
- The packaging box must be placed at least 20cm high from the ground and 50cm away from the wall, heat source, and vent. The charger can be stored for two years under

this storage condition. After two years, it must be tested again.

- The charger must be powered on every three months, and the power-on period shall not be less than 0.5h.

11 Packaging and transportation

Transportation of Robot

- When transporting the robot, please use the original packaging materials.

ⓘ	**Precautions for Robot Packaging and Transportation** ● Please package and transport the robot in an upright posture. Packaging and transporting the robot in any other posture will invalidate the warranty.

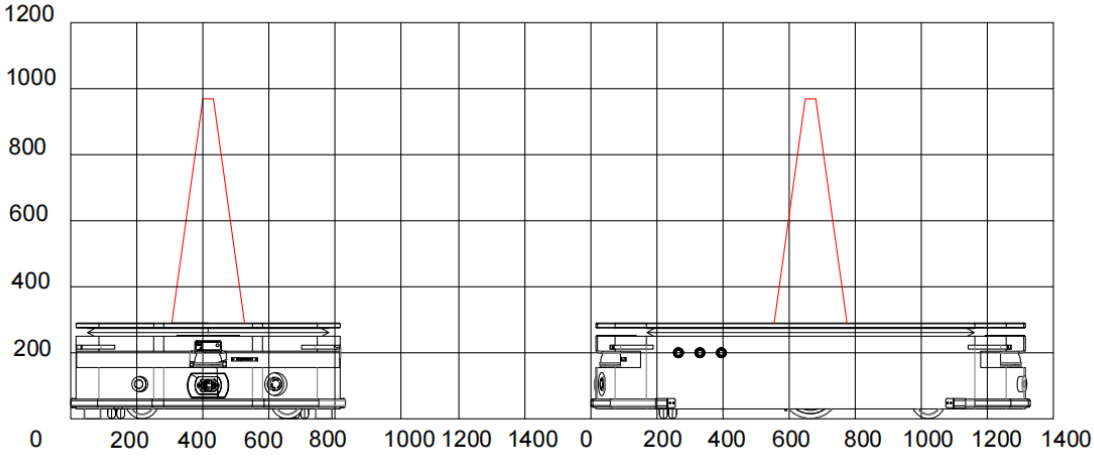
Transport of batteries

- The battery must be transported in accordance with relevant laws and regulations. The specific regulations may be slightly different depending on different methods of transportation (by land, sea or air).
- Be sure to follow the safety precautions and instructions in this section when transporting the battery.
- The battery should be packed in boxes when transported. During transportation, avoid severe vibration, impact or squeezing, and protect it from sun and rain.
- The battery used by AMB-500JS has been certified according to UN 38.3, please contact our company for more information.

⚠	**Notes on the transport of batteries** ● The transport of batteries is subject to special transport provisions in accordance with the United Nations Dangerous Goods Transport Regulations UN 3171. Compliance with such regulations requires special transport documentation and can affect transport times and costs。

12 Payload specification

The following diagram illustrates the mass center specifications for safe operation when the vehicle is fully loaded. Unit: mm



13 Software Update

Please follow the following steps to update the robot software:

1. Load the file: Select the upgrade package to upgrade, you can directly drag the file to the dotted box area with the mouse

2. Start upgrade: Start to update the version.

Note: Before the upgrade, the upgrade package needs to be loaded and whether it matches the current IP device