SFL-CPD15-T
User Guide

Revision History

Version	Date of Issue	Description
V1.0	2021.01	First Version
V1.1	2021.04	Deleted relevant content of Moxa
V1.2	2021.05	Revised the environmental safety
V1.3	2021.09	Replacement of rear obstacle avoidance laser, selection & replacement of PERCIPIO camera, and replacement of nameplates

For More Information

Please visit https://www.seer-group.com/

Thanks for your purchase.

Only those who have received training and qualified correspondingly are allowed to use this product.

This document includes precautions that shall be followed to ensure personal safety and protect this product.

Disclaimer

All contents of this document have been verified and confirmed to be as accurate, reliable and complete as possible, but there is no guarantee that all contents are consistent with the product.

Technical data may be changed without further notice.

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Contents

1. Foreword

1.1 Reading Tips

CPD, robot and forklift that appear separately in this document are abbreviations of SFL-CPD15-T.

Before using the robot, always read the User Guide carefully.

Do not disassemble or assemble the CPD without authorization.

Please pay attention to the safety warnings involved in the User Guide.

If there is any abnormal problem with the robot, please contact the manufacturer promptly.

If you smell an abnormal odor when using the robot, stop it immediately, turn it off and remove the batteries.

The User Guide is not a substitute for the Technical Agreement.

1.2 Use Prohibitions

- It is prohibited to use it in an outdoor environment.

- It is prohibited to use it in an environment that strongly interferes with navigation equipment.

- It is prohibited to use it in an environment full of dust, powder, and other explosive hazards.

- It is prohibited to use it in an environment with high salt content (marine climate).

- It is prohibited to use it in extremely bad environments (extreme weather, cold storage, and strong magnetic fields etc.).

- It is prohibited to carry inflammable and explosive materials.

- It is prohibited to carry liquid objects.

- It is prohibited to run on uneven, obstructed or stepped ground.

- It is prohibited to turn in place on the ramp.

- It is prohibited to carry people.

- It is prohibited to run it with the load on the shell.

- It is prohibited to run on the ground with oil and water.

2. Safety

Please read this section before starting and running CPD.

⊙	**Notice** • We will not responsible for any problems caused by damage, replacement or modification of CPD or its accessories in any way. • We will not responsible for any damages to CPD, accessories or any other equipment due to programming errors or faults.

2.1 Types of Safety Information

This document contains the following types of safety information.

⚠	**Warning** • Indicates a potentially dangerous situation that may cause death or serious injury. • Appropriate preventive measures shall be taken to avoid damage or injury.
⚠	**Caution** • Indicates a potentially dangerous situation that may cause minor or moderate personal injury, or a prompt to avoid unsafe behavior. • Appropriate preventive measures shall be taken to avoid damage or injury.
⊙	**Notice** • Indicates important information, including conditions that may cause damage to equipment or property.

2.2 General Safety Precautions

This chapter contains the general safety precautions.

⚠	**Precautions for Robot Rolling Over** • If the load is not placed or secured correctly, the load may drop out or the robot may roll over. • Ensure that the load is placed and secured correctly according to the specifications. Please refer to the 10. Effective Load Specifications.
⚠	**Precautions for Personal Injury by Machine** • The high-speed slewing part of the robot body, such as universal wheels and driving wheels, may cause personal injuries. • Do not rely too much on the robot's autonomous avoidance function. Please take the initiative to avoid the robot.
⚠	**Running Precautions** • The robot can't observe the descending stairs and potholes on the floor. • Please mark the stairs and potholes as prohibited areas on the map. • Please update the map in time.

2.3 Safety Instructions

2.3.1 Qualification Requirements for Personnel

CPD shall be installed, debugged, operated and maintained only by qualified safety personnel.

Mechanical Installation and Debugging

The personnel responsible for the mechanical installation and debugging shall have professional knowledge and experience in related fields, and have sufficient experience to assess whether the machine is in a safe running state after using protective equipment

Electrical Installation and Debugging

The personnel responsible for the electrical installation and debugging shall have professional knowledge and experience in related fields and have sufficient experience to assess whether the machine is in a safe running state after using protective equipment

Operation and Maintenance

The personnel responsible for the operation and maintenance shall have professional knowledge and experience in related fields, be familiar with the application of protective equipment on the machine and be guided by the machine user.

2.3.2 Running Safety

2.3.2.1 Safety of Running Environment

- The ground shall be smooth, and free from any grooves, breakage, cavities, water stains, oil, glue or other contaminants.

- There shall be no foreign objects on the floor, such as screws, rags, gloves, and thread cables that are easy to jam and entangle the wheels.

- It shall run in excessively open areas (beyond the laser sensing distance), such as long corridors.

- A fully-loaded robot can only cross steps not higher than 0.5cm at low speed.

- To pass through a narrow passage, a 10cm gap must be maintained between the outermost side of the robot and the passage.

- The sections of the work area shall be protected or marked with warning signs to remind other personnel that robots are coming in and going out.

2.3.2.2 Running Inspection

The operator shall inspect the condition of the robot before starting to ensure safe use. The inspection items shall 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 bent, cracked or worn).

- Whether the warning device is normal.

- Whether the tricolor light is normal.

- Whether the HMI display screen is normal.

- Whether the function of the laser sensor is normal.

- Whether the battery level is normal.

- Whether the charging function is normal.

- Whether the handle and pedal are normal.

- Whether the hydraulic oil, electrolyte and brake fluid are leaking out.

- Whether the mast lifting, tilting, forklift steering and braking are normal.

2.3.2.3 Running on Ramp

- It is only allowed to run on ramps that meet the performance parameters; please refer to 3.8 Technical Parameters.

- The upper and lower ends of the ramp shall be flat to prevent the load or robot from touching the ground.

- It is prohibited to turn around, run diagonally or stop on the ramp.

- When the tractor is towing a trailer without a brake, the emergency braking shall not be applied.

2.3.2.4 Running in Elevator or Lifter

- Ensure that the elevator or lifter can bear the full weight of the robot and its load.

- Ensure that no part of the robot is in contact with the car wall of the elevator or lifter.

- Ensure that the robot would not move unexpectedly.

- Ensure that the elevator meets the standard GB 7588-2003.

2.3.3 Safety Rules for Manual Operations

- Dress neatly before driving and always wear work clothes.

- Always pay attention to the height of area where the forklift is working.

- Drive forward when going uphill and drive backward when going downhill.

- Do not expose your arms and body outside the roof rack during work.

- Avoid driving on soft or unprepared surfaces.

- Avoid eccentric loading.

- Inspect the position of the locating pins on the fork.

- Try not to drive on smooth or slippery ground.

- Pay attention to the lateral driving stability of the forklift when it is unloaded.

- Do not chase each other when driving.

- If the load is too high and blocks the view, drive backward or arrange a guide person.

- Do not make turns on slopes.

- Sound the horn when there are people or objects on the road.

- Pay attention to the change in the forklift's rated lifting capacity.

- Please try to slow down when loading.

- No one is allowed to walk or stand under the raised forks.

- Try to avoid the load exceeding the height of the shelving.

- Special safety equipment must be provided in order to carry people to work at heights.

- Do not lift the load at angle.

- Do not load or unload when the forklift is not in a horizontal position.

- When driving, the distance between the forks and the ground shall not exceed 300mm.

- Do not make fast or sharp turns whether it is loaded or unloaded.

- Do not jump off if the forklift tips over.

- Staying on the forklift during a tip-over will protect you better than jumping off. If the forklift starts to tip over:

1. Step on the pedal tightly and hold the operating handle firmly.

2. Do not jump off.

3. Bend and lean your body in the opposite direction of the tip-over.

4. Lean your body forward.

2.3.4   Load Safety

- CPD and its load shall not exceed the allowable range of the road surface.

- The load carried must be reliably secured.

- The load carried must be placed in the load center with certain anti-skid measures. Please refer to 10. Effective Load Specifications.

- The load weight carried on the upper mechanism must be distributed evenly without partial load.

2.3.5   Parking Safety

- When the robot stops running, shut down and cut off the power supply.

- Do not park on the ramp.

- Do not park near heat sources or fire sources.

- Do not park in open pits, underground passages, elevator shafts or other similar areas.

- Do not park in the fire paths, stair openings and areas obstructing the passage of firefighting equipment.

- Under special circumstances, take safety measures for the robot, such as using wedges.

2.3.6   Safe Avoidance Range

The slewing radius of the robot is 3020mm. Keep away from this range.
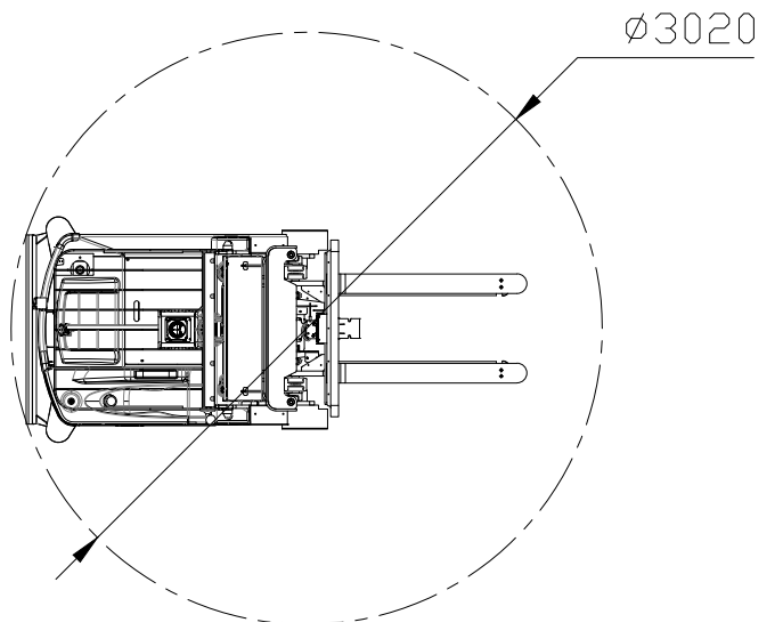
2.4   Battery Safety Warning

- For your safety, please do not open or disassemble the battery without permission.

- The battery must be maintained and replaced by professionals. If necessary, please call our service hotline.

- To replace the battery, please choose lithium battery for forklift of same type and model, or consult us first. The lithium batteries of different sizes from different manufacturers shall not be mixed.

- Please use the special charger provided by us to charge the battery. Do not charge the battery with charges of other specifications or from other companies.

- When installing the battery system, reserve a safe distance around it.

- It is strictly prohibited to discharge the battery excessively!

- Please take care to avoid using this system in the following environments:

- High/low-temperature and humid places that exceed the technical specifications;

- Places where metal dust, corrosive substances, salt and flammable gases are present;

- Places where the air cleanliness is low.

2.5   Risk Assessment

The risk assessment is an important step for the Integrator to realize safe installation. The on-site commissioning personnel are usually responsible for the risk assessment.

The risk assessment does not only involve CPD chassis, but also consider path planning, work environment etc.

It is recommended to carry out the risk assessment with reference to the guidelines in ISO 12100, ISO 3691-4, ANSI B56.5 or other relevant standards, including but not limited to:

- It shall be demonstrated in the robot installation, development and use process.

- The robot equipment shall be working normally.

In paragraph 4 of ISO 3691-4, the major hazards, dangerous situations and events that need to be paid attention to shall be listed.

The risk assessment items shall be listed in the technical agreement.

2.6 Residual Risk

The following lists the potential major hazards. Please operate the robot carefully.

- The robot can be set with a route for moving backwards, but there is a risk of collision if entering the running route of the robot when it moves backwards.

- If the user accidentally touches the moving parts of the robot, there is a risk of being pinched or collided.

- There is a risk of being impacted and jammed when transporting the load.

2.7 Environmental Safety

2.7.1 Noise

The noise level of the CPD in normal use complies with the international standard EN 12053.

2.7.2 Scrap Disposition

CPD contains the following materials that affect environmental factors:

- Plastic

- Battery

- Hydraulic oil

Disposal requirements: CPD shall be disposed of by the user and the final scrap processor in accordance with the Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution.

3. Product Introduction

3.1 Overview

SFL-CPD15-T (Seer Forklift) is a laser SLAM Counter balanced stacking automatic forklift. It is internally equipped with SRC core controller to provide the core map building, localization and navigation functions, and I/O, CAN, RS485 and other interfaces are reserved for helping users to quickly realize various applications of the automatic forklift.

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3.2 Product Dimensions

3.2.1 Dimensions of Robot

S/N	Definition	SFL-CPD15-T (mm)
h3	Standard lifting height	3300
h2	Free lifting height	0
s/e/l	Standard fork size (length/thickness/width)	110x40x950
b3	Fork spacing (max/min)	750/215 (including 560/600)
L1	Total length (Tail to fork point)	2555
L2	Body length (tail to front end of fork)	1605
b1	Total width	1150
h1	Mast retracted height	2160
h4	Mast expansion height	4208
h5	Overhead height (including navigation laser)	2326
c	Axle center to fork face (fork raised/lowered)	173
Wa	Minimum turning radius	1510+200
Ast	Aisle width, 1000x1000mm pallet crosswise	2740+200
	Min right angle aisle width	1870+200

3.2.2 Coordinate System of Gyroscope

The data of gyroscope in the coordinate system of the robot can be used to detect slippage.
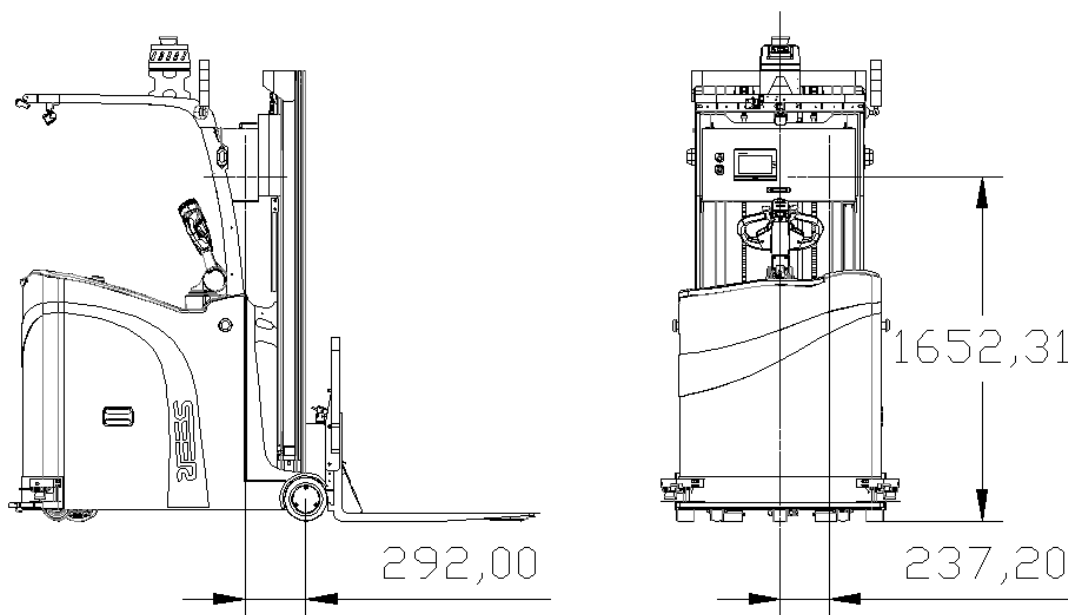
S/N	Definition	SFL-CDD15-T
x	Refers to the offset of the position where the controller is installed in the x axis of the coordinate system	292mm
y	Refers to the offset of the position where the controller is installed in the y axis of the coordinate system	237.20mm
z	Refers to the offset of the position where the controller is installed in the z axis of the coordinate system	1652.31mm
yaw	Refers to the degree of yaw where the controller is installed relative to the coordinate system of the forklift	-90°
qx	Refers to the x component of the quaternion (reserved, no need to be filled in)	/
qy	Refers to the y component of the quaternion (reserved, no need to be filled in)	/
qz	Refers to the z component of the quaternion (reserved, no need to be filled in)	/
qw	Refers to the w component of the quaternion (reserved, no need to be filled in)	/
faceUP	Refers to the orientation of the controller	2

3.3 Main Labels

3.3.1   Precautions

> ⚠ **Notice**
>
> 1. Learn about AGV
> Users shall operate AGVs without professional training, and must read the vehicle safety instructions carefully before operation
> 2. Inspect the AGV
> Inspect the AGV before usage. If finding any damages, stop immediately and paste a "Prohibited to use" label and contact a professional for treatment.
> 3. Protect yourself and the people around you
> Do not carry passenger on the AGV. No one is allowed to sit on AGV, its battery or cargo.
> 4. Learn about your working area
> When using AGV, it is necessary to ensure that the working environment is neat and normative. No one should stay or no cargo should be placed temporarily on the running route of AGV. The working staff should avoid immediately when listening or seeing AGV passing by.
> 5. Learn about your load
> Do not overload the AGV. Carry cargo within the specified load range. Do not carry loose cargo or cargo that exceeds the length, height and width limits.
> 6. Avoid sudden starting
> Before starting the AGV, keep the irrelevant personnel away to avoid unexpected start of AGV.
> 7. Charging Precautions
> Charge it always with the original charger and within the specified area. When charging, keep good ventilation, prevent the vents being blocked, and prevent sparks developing into open flame. Before repairing, disconnect the battery.
> 8. Do not allow any non-professionals to remove the AGV.
> 9.   The battery should not be under voltage. Refer to the instructions or a professional for treatment.

3.3.2 Nameplate

产品名称 Product name	激光SLAM平衡重式自动叉车
产品型号 Model	SFL-CPD15-T
文件号 File number	0300502007
自重（含电池）Weight（with battery）	2325kg
锂电池重量 Battery weight	230kg
电池规格 Battery specifications	24V/270Ah
额定起重量 Load capacity	1500kg
载荷中心距 Load center	500mm
起升高度 Lifting height	3300mm
货叉尺寸 Fork dimensions	950/110/40mm
货叉外宽 Width of fork carriage	460-750mm
叉齿面离地高度 Fork ground clearance	45±5mm
制造日期 Manufacture date	
序列号 Serial number	

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CE RoHS

3.4 Body configuration

S/N	Name	S/N	Name
1	Navigation laser	12	Photoelectric sensor
2	Searchlight	13	Electric control cabinet
3	Data recorder	14	SRC switch
4	Tri-color light	15	Manual/automatic switching
5	Turn light	16	HMI display screen
6	Emergency stop button	17	Manual control handle
7	Obstacle avoidance laser	18	Display list
8	3D pallet recognition	19	Key switch
9	Draw wire encoder	20	Main power switch
10	In-place switch	21	Hydraulic oil filler
11	Obstacle avoidance laser		

3.5 Operation Panel

SCR switch
Manual/automatic switching

Emergency stop button

Tri-color light

HMI display screen

Manual control handle

Display list

Main power switch
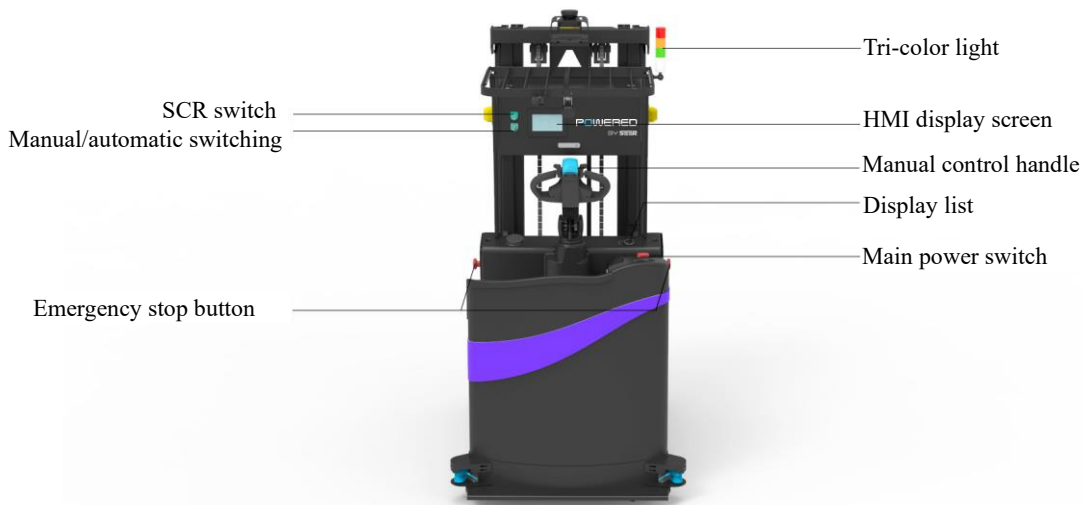
Emergency stop button

- The emergency stop button is only used under emergency, and shall not be used to stop the robot when it is running normally.

- After the emergency stop button is pressed, the robot will immediately stop all movement.

- The emergency stop button can be pulled up only when the cause of the fault is identified and the fault is eliminated.

⚠️ **Precautions for Emergency Stop of Robot**

- When using our dispatching system, it is strictly prohibition to move the robot by moving after pressing the emergency stop button; otherwise, it will cause the robot task to go wrong.

Main power switch

- The default of the main power switch is to power off the forklift. Press it to disconnect all power supplies, and pull it up to power on the forklift.

- The line can also be changed to driver disconnection. Press it to disconnect the driver, and pull it up to clear the driver error.

Manual - Automatic - Reset toggle switch

- Manual (Manual): Specifically, when the robot is controlled by an external device such as a handle or communicator (usually found in large robots such as forklift), the criterion is whether the SRC is in external control mode.

- Automatic (Auto): When the SRC is not externally controlled, it is deemed to be in automatic mode.

    a. Automatic Navigation: Any case where navigation instructions are sent through the API (including Roboshop, dispatching API, or other upper computer).

b. Remote Control via Upper Computer: Any cases where control is implemented via API 2010 (includes Roboshop WASD, open-loop instructions by customer etc., i.e., what was usually known as manual control).

- Reset (Rest): After the emergency stop button is pulled up or the fault signal is released, the reset button must be pressed before the system resumes operation.

3.6 HMI display screen

HMI display screen consists of display screen, PWR indicator light, CPU indicator light and COM indicator light. The specific information is shown in the following figure

HMI display screen is divided into four parts: general information, basic information, control and alarm frame.

3.6.1 Main interface

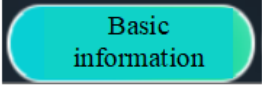After the display screen is turned on and connected to communication, the main interface can be displayed.

If the communication is not connected, the PLC communication does not respond.

3.6.2 General Information Display

General message function description

Type	Icon	Definition
Basic information	Basic information	Click it to switch to the basic information interface
Control	Control	Click it to switch to the control interface
IP	192·168· 3 · 66	Real-time display of current IP value
Battery current	Current(A) 0.000	Display the current charging/discharging information of the robot (positive in case of charging and negative in case of discharging)
Logo	SEER	Display the company logo
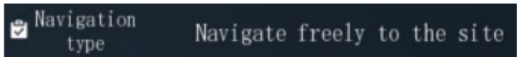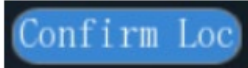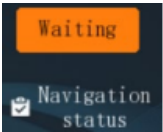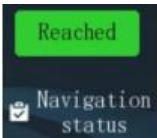
UI Version	UI Version: 20201019001	Display the current version of interface in real time
RBK Version	RoboKit: 1.2.3.4	Display the current version of RBK in real time
Chinese-English Switching	In Chinese	Click it to switch between Chinese and English

3.6.3 Basic information page
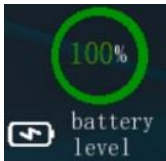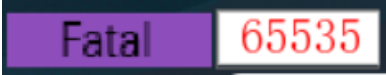
Basic information Function description

Type	Icon	Definition
Navigation modes	Navigation type None	Indicate that the robot is not executing any task
	Navigation type Navigate freely to coordinate points	Indicate that the robot is navigating to the coordinate point

		freely
	Navigation type Navigate freely to the site	Indicate that the robot is navigating to the site freely.
	Ɫʎbɇ Nɐʌıƃɐʇıou Ԁɐʇɥ Nɐʌıƃɐʇıou	Indicate that the robot is navigating to the site by the path
Confirm localization	Confirm Loc	Click it to confirm the current localization of the robot
RESET	RESET	Click it to clear the fork status of the robot
Operating mode	Auto	Indicate that the robot is currently in the automatic operating mode
	Manual	Indicate that the robot is currently in the manual operating mode
Navigation status	Null Navigation status	Indicate that the robot is currently in the "Null" navigation status
	Waiting Navigation status	Indicate that the robot is currently in the "Ready" navigation status
	Paused Navigation status	Indicate that the robot is currently in the "Suspended" navigation status
	Reached Navigation status	Indicate that the robot is currently in the "Arrived" navigation status

	Failed ☑ Navigation status	Indicate that the robot is currently in the "Failed" navigation status
	Cancelled ☑ Navigation status	Indicate that the robot is currently in the "Canceled" navigation status
	Timeout ☑ Navigation status	Indicate that the robot is currently in the "Timeout" navigation status
Fork height	0.000 🔋 Fork height	Indicate that the current fork height of the robot is 1.560m. Click it to set the fork height.
Driving velocity	0.000 🚗 Driving speed m/s	Indicate the current driving velocity of the robot
Angular velocity	0.000 🕐 Angular velocity rad/s	Indicate the current angular velocity of the robot
Target site	Null ◎ Current target	Indicate that the current target site of the robot is null; click the icon to input the site for navigation
Current site	1 📍 Current point	Indicate that the robot is currently in the site 1
Confidence coefficient	1.00 📶Confidence	Confidence coefficient ∈ [0.00, 1.00]

Battery level		Battery level (%)∈[0，100]
Emergency stop status		No emergency stop
		Under emergency stop
Blockage status		No blockage
		Blocked
Error Code		If there is a Warning, the corresponding warning code will be displayed on the right (subject to the actual warning code)
		If there is an Error, the corresponding warning code will be displayed on the right (subject to the actual warning code)
		If there is an Fatal, the corresponding warning code will be displayed on the right (subject to the actual warning code)

3.6.4 Control Interface

Introduction to control interface functions

Type	Icon	Definition
Control power	Require	Click it to recover the control right over the robot.
	Release	Click it to release the control right over the robot.
Robot status		They are emergency stop status, blockage status, warning code, error code and fatal code from the left to the right.
		When the status is triggered, the corresponding icon will change to the style as shown in the figure below and will keep flashing.
DI		Not triggered
		Triggered

DO		Not activated; click the button to activate it
		Activated; click the button to deactivate it

3.6.5 Alarm box interface

Alarm box function description

Type	Icon	Definition
Any of the following messages except for the charging message will trigger an alarm frame, and corresponding alarm message will be displayed.		
Robot status		Indicate that the robot has been blocked when this message pops up
		Indicate that the robot is charging (during which it will not pop up)

Error or Warnning!	Indicate that the robot has an error or warning when this message pops up
E-Stop!	Indicate that the robot is in the emergency stop status when this message pops up

3.7 Sound and light system

3.7.1 Tri-color light

In automatic mode:

- The tri-color light will turn yellow when the forklift is in the standby status.

- The tri-color light will turn green when the forklift is executing a task.

- The tri-color light will turn red when an error occurs in the forklift.

3.7.2 Turn light

In automatic mode:

- The left turn light will be lit if the forklift makes a left turn when executing a task.

- The right turn light will be lit if the forklift makes a right turn when executing a task.

3.7.3 Searchlight

SFL-CPD15-T is equipped with a searchlight. When the forklift is in the automatic mode, the search-light will be normally on.

3.8 Technical Parameters

Model Parameters	SFL-CPD15-T
Number of navigation lasers	1（P+F R2000）
Number of obstacle avoidance lasers	2 (OLE LR-1BS2, head) +1 (OLE LR-1BS2, tail)
Driving form	Single-steering wheel
Dimensions	
L * W * H	2555mm*1150mm*2326mm
Weight (including battery)	2325kg
Color	
Shell color	Blue + black/customized color
Network Interface	

Wireless network	Wi-Fi 802.11 a/b/g/n/ac
Battery	
Battery capacity	24/270V/AH (lithium battery)
Battery life	10h
Charging time	10-80%：2h
Charging method	Manual/automatic (requiring automatic charging pile)
Battery charge and discharge cycles	＞2000 times
Operation Panel	
HMI display screen	√
Emergency stop button	√
Buzzer	○
Power indicator	√
Audio and mood light	
Speaker	√
Tri-color light	√
Searchlight	√
Performance Parameters	
Maximum load	1500kg
Driving velocity	With/without load: 1.2/1.5m/s
Rising velocity	With/without load: 95/120mm/s
Dropping velocity	With/without load: 120/85mm/s
Maximum climbing ability [1]	5%
Localization accuracy [2]	±10mm，±0.5°
Map area (single frame)	≤400000m²
Functions	
Basic functions [3]	√
Wifi roaming	√
Automatic charging [4]	○
Pallet recognition [5]	○

Laser reflector navigation	〇
3D obstacle avoidance[5]	〇
Environment	
Ambient temperature and humidity range	0℃-50℃ (humidity 10-90%, without compression condensation)
IP rating [6]	IP20

√	Supported
×	Not supported
〇	Optional

1. The road surface should be smooth, clean and free of obvious ups and downs. Slope 5% = arctan(0.05) ≈ 2.8°。 The robot must not stop or turn at the ramps, steps, or gaps, but can pass quickly perpendicular to them.

2. The localization accuracy usually refers to the repeatability of the robot navigating to the target site. When the environment scanned by the robot's laser radar is relatively stable, the repeatability of the robot navigating from a fixed direction to the target site can reach the expected value. The robot will try to fit the path but could not ensure its repeatability when it runs along the planned path. That is, the robot can guarantee the accuracy of the point, but not the fitting accuracy of the path. The minimum site spacing supported by CPD is 1cm. Therefore, the robot should not be used as a linear guide.

3. The basic functions include map editing, model editing, localization module, navigation module, basic motion model (differential), and API interface etc.

4. Need to be used with a dedicated automatic charging pile of SEER.

5. A 3D camera must be installed in the peripheral extension to enable this function.

6. CPD is designed for indoor transportation only and is not recommended for outdoor use.

3.9 Software Functions

- Map editing

- Model editing

- Localization module

- Navigation module

- API interface

- Visible operation

- Multi-robot dispatching

- Wi-Fi roaming

- Automatic charging

- Laser reflector navigation

- 3D obstacle avoidance

- Pallet recognition

3.10 Network Requirements and Configuration

Network Requirements

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

Broadband speed: ≥100Mbits

Signal intensity: ≥-60dBm

Network delay: Average delay time ≤100ms

4. Start to Operation

4.1　Accompanied Articles

- CPD robot body

- Manual charger/ automatic charging pile (Single piece or two pieces optional)

4.2　Startup of Robot

1. Pull up the red main switch of power supply.

2. Turn on the driver switch clockwise.

3. Press the SRC switch until the green power indicator is normally on, and then release the power-on switch to finish the power-on process. In this process, the tri-color light, searchlight and laser are on.

4.3 Manual driving (from the Operation and Maintenance Instructions for RE-BOT Battery-powered Counter Balanced Forklift)

4.3.1 Introduction to Cab
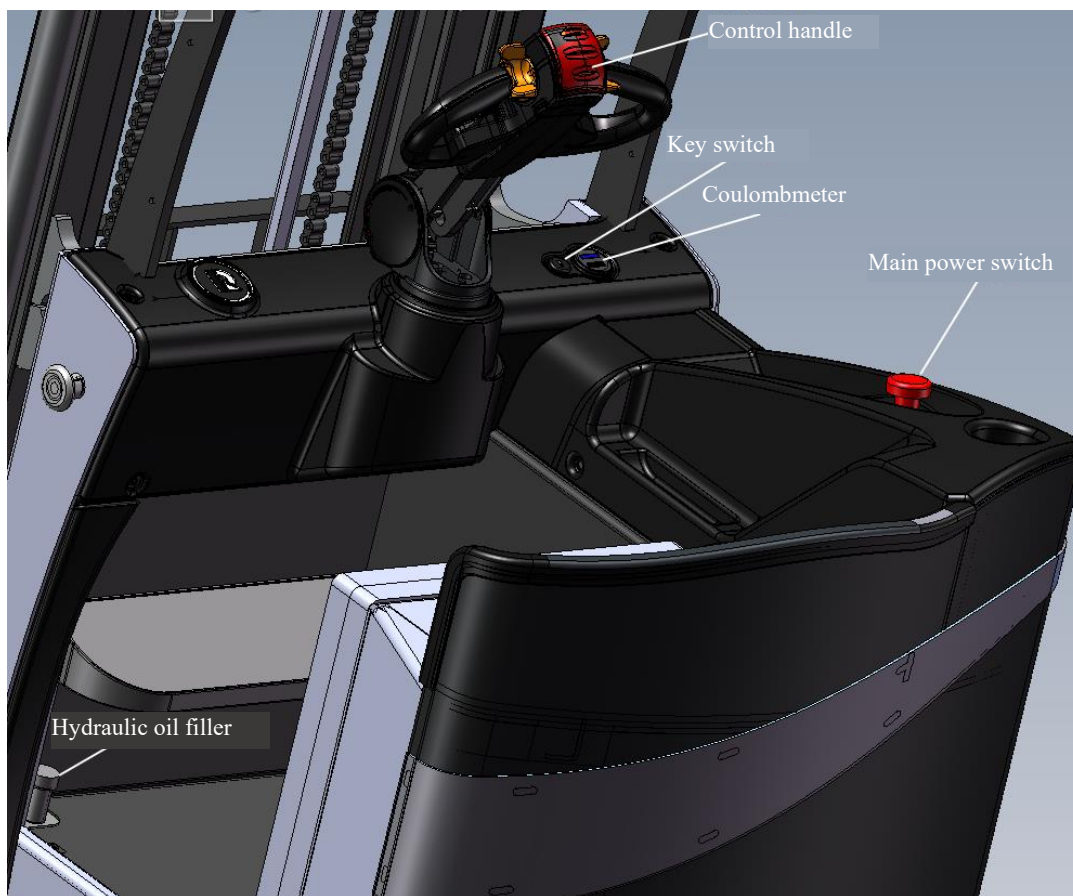
4.3.2 Introduction to Manual Control Handle

- **Direction Control:**

    When operating, the driver sits in the middle of the forklift and operates the handle in his front with both hands. When the forklift runs forward, it will make a right turn if the operating handle is turned to the left, and will make a left turn if the operating handle is turned to the right. When the forklift runs backward, turn the operating handle to the left.

- **Driving Direction and Speed Control:**

    CPD15-T forklift is controlled with a control handle. Before driving, press the steering handle until the brake is released, or turn the red knob slowly forward or backward to drive the forklift forward or backward. The driving velocity is controlled with the rotation angle of the red knob. The operator can determine the driving velocity according to the specific situation.

- **Control of Lifting Mechanism:**

    The forks of CPD15-T forklift are controlled to lift or rise respectively with the rising toggle button on the right and the dropping toggle button on the left of the control handle.

Dropping switch button

Rising switch button

Acceleration knob

Horn button

Acceleration knob
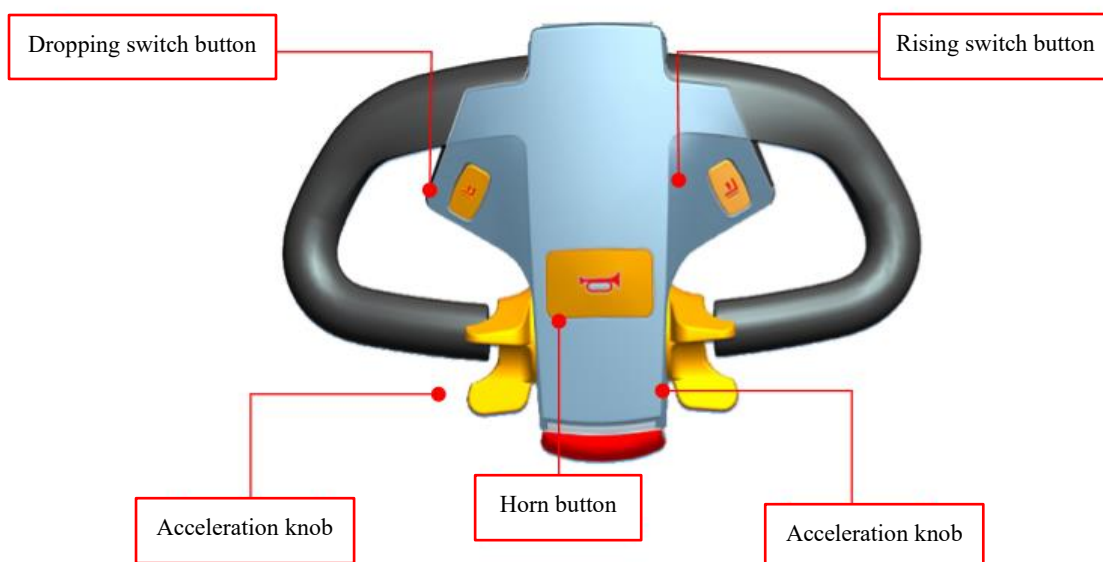
Function Diagram of CPD15-T Control Handle

4.3.3 Safety Features of Forklift

The forklift is equipped with sufficient safety devices to reduce the potential of accidents.

- When the fork is raised to the highest point, this forklift is equipped with dual safety protection of mechanical limit and electrical limit.

- When the steering angle is more than ±20°, the driving velocity will be lowered automatically.

- When any error occurs in the electrical system, the forklift will stop running automatically.

- The forklift will run only after the control handle is pressed to the set range.

- The forklift will not run if any control button is active before the power is on (power key switch turned to the position ON) (e.g. control handle is pressed early). (tilting toggle button, lifting toggle button, acceleration knob, horn button, dropping toggle button and rising toggle button etc.)

- When the forklift is out of control or under emergency, press the red emergency power-off switch to cut off the main power of forklift.

- Release the acceleration knob, or press the operating handle; the forklift will apply braking.

4.3.4 How to drive a manually operated forklift

Before driving or handling cargoes, the operator must ensure that the surrounding area is in a safe condition.

- Enter the cab and turn the power key switch to the position ON.

- If any of the control knobs are active before the power is on (power key switch turned to the position ON), the forklift will activate the safety protection function to prevent the forklift from traveling after powering on.

- Hold the operating handle with both hands.

- It is prohibited to operate the forklift with a single hand.

- The function of acceleration knobs on both left and right sides is the same. When the driver rotates the acceleration knob with index finger forward, the forklift will drive forward and the driving velocity will increase with the increase in rotation angle.

- When the driver rotates the acceleration knob backward, the forklift will drive backward, and the driving velocity will increase with the increase in rotation angle. Start and accelerate the forklift gently but do not start or accelerate suddenly.

- When driving on the slope, the cargo on the forks must face uphill.

- Generally drive in the direction of facing the cargo as far as possible; when the cargo is blocking the line of sight, it is necessary to drive backward to ensure a good view and maneuverability.

There are three ways to apply braking:

- Press the emergency stop button.

- Emergency braking: Quickly press on the control handle.

- Press the emergency power-off switch.

4.4 Shutdown of Robot

1. Make sure that the robot currently has no tasks and is in a stopped state.

2. Press on the SRC on/off button for 2-3s, and then release it; the power indicator will go out in seconds.

3. Turn it off by turning the driver switch to the left.

4. Press the main power switch to complete the shutdown.

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

5. Battery and Charging

5.1 Manual charging of the robot

The CPD battery supplied along with the robot can be used for 4-5h, after which it needs to be charged. Please use the original charger. The specific charging steps are as follows:

1. Remove the switch baffle from the side of the seat.

2. Pull up the red handle.

3. Open the rear cover of the forklift
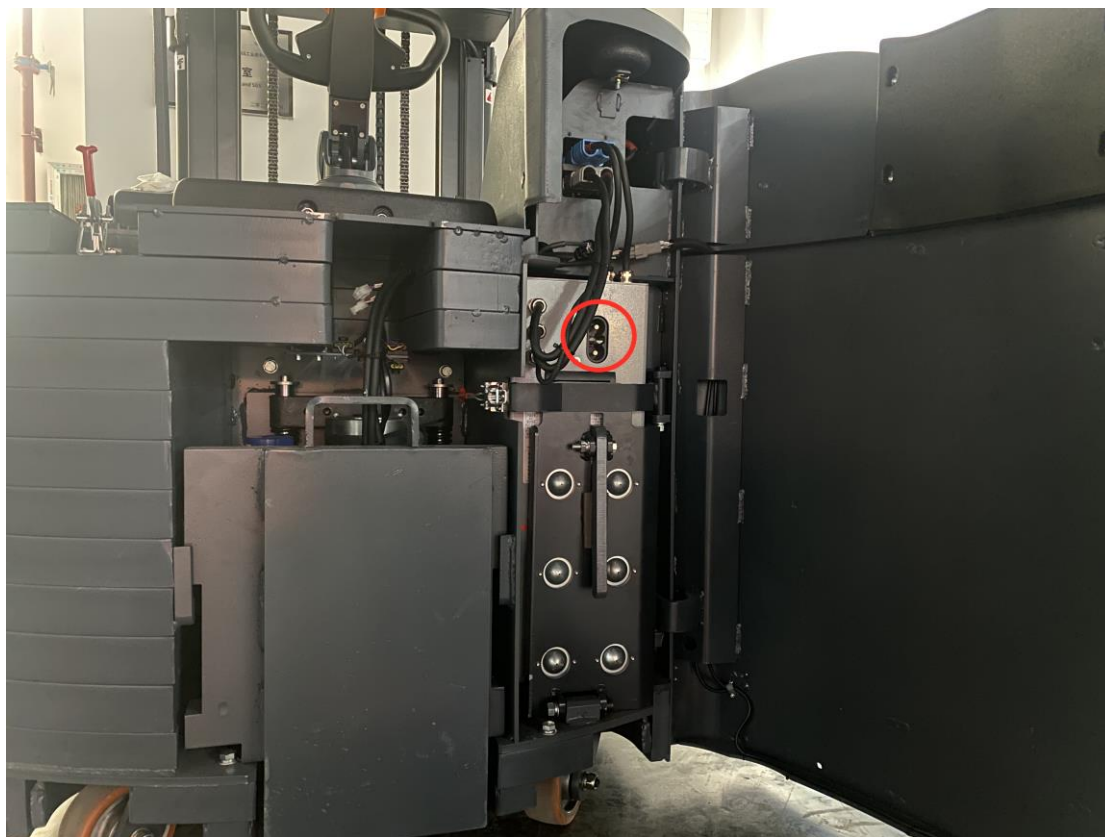
4. Insert the manual charger into the charging hole.

5. Power on the manual charger, turn on the charger switch, and the charging information lights up.
   Note: The socket should be of national standard 16A and be grounded.

6. Observe the HMI display screen; when the charging icon is displayed, it indicates that the robot is charging.

> ⚠ **Notice**
>
> - It is recommended to turn off the robot when charging with a charger.
>
> - If you use the same charger to charge two robots sequentially, please wait one minute after the first robot is fully charged, and then charge the second robot to ensure that the charger can correctly identify the second robot.
>
> - Please use the original charger.

5.2 Automatic charging of the robot

Automatic charging interface

2330
1081,00
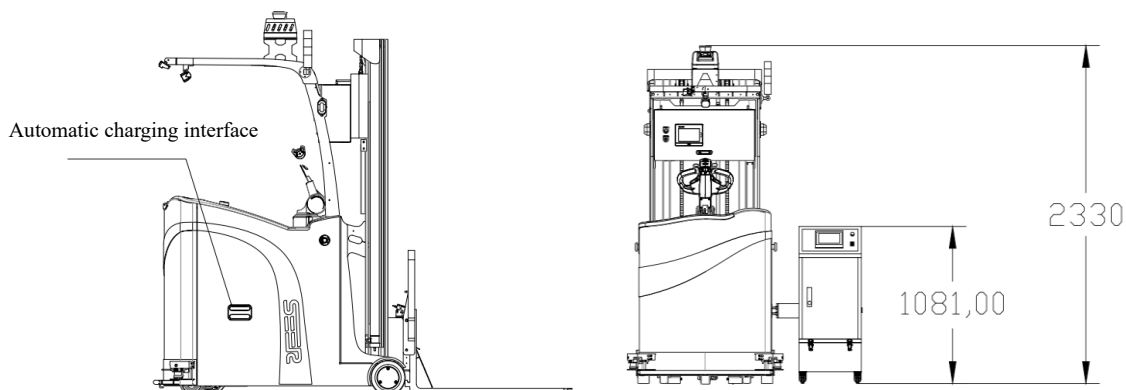
Note: Please refer to the User Guide for SFL Charging Pile for the usage and configuration of the charging pile

5.3 Battery Product Performance Curve

5.3.1 Discharging curves of different ratios

LF90 Ratio Discharging Curve

0.33C Discharging
0.5C Discharging
1.0C Discharging
1.C Discharging
2.0C Discharging
3.0C Discharging
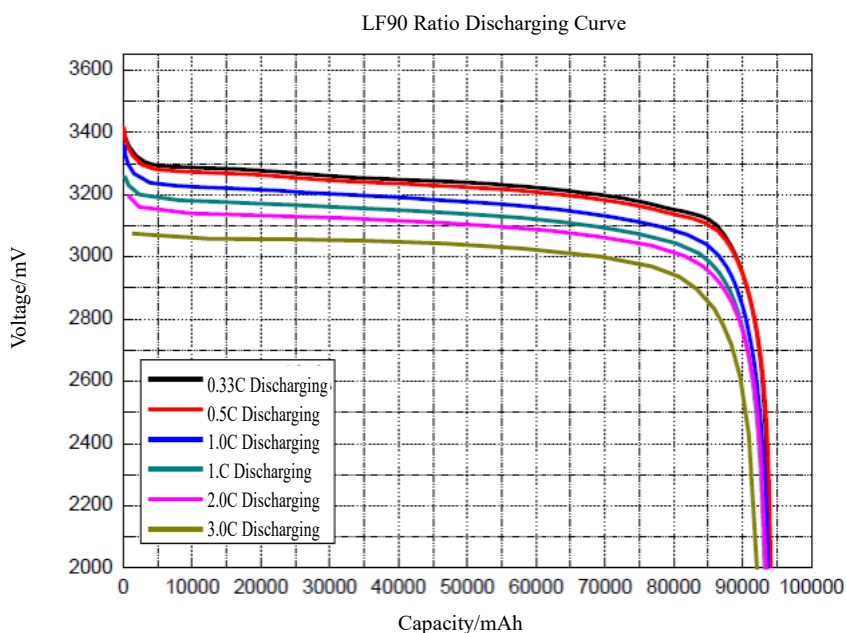
5.3.2 Discharging curve of different temperatures

LF90 Discharging Curve at Different Temperatures
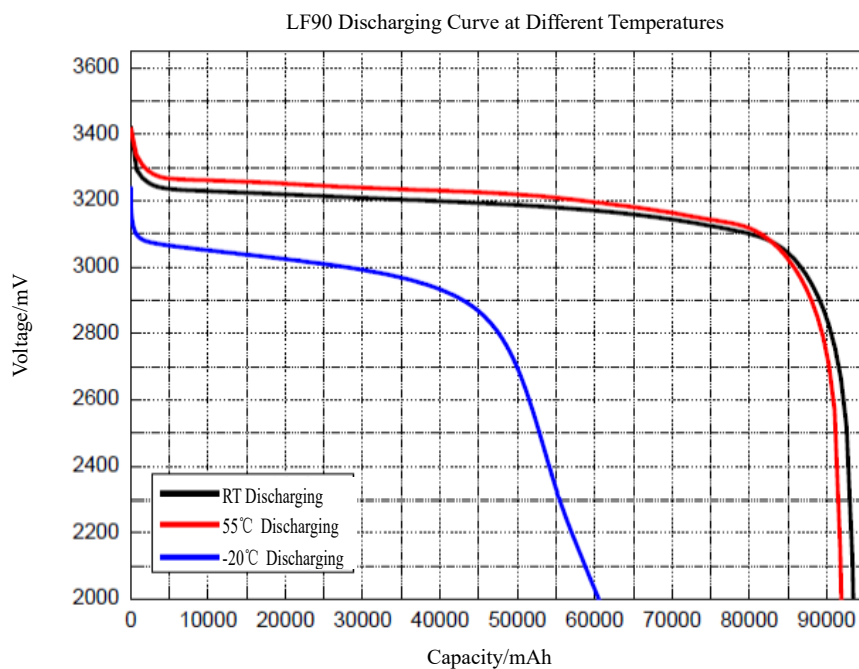
5.3.3 Cycle Performance (1.0C/1.0C Charging/Discharging) Curve

LF90 cell cycle: 3,500 cycles
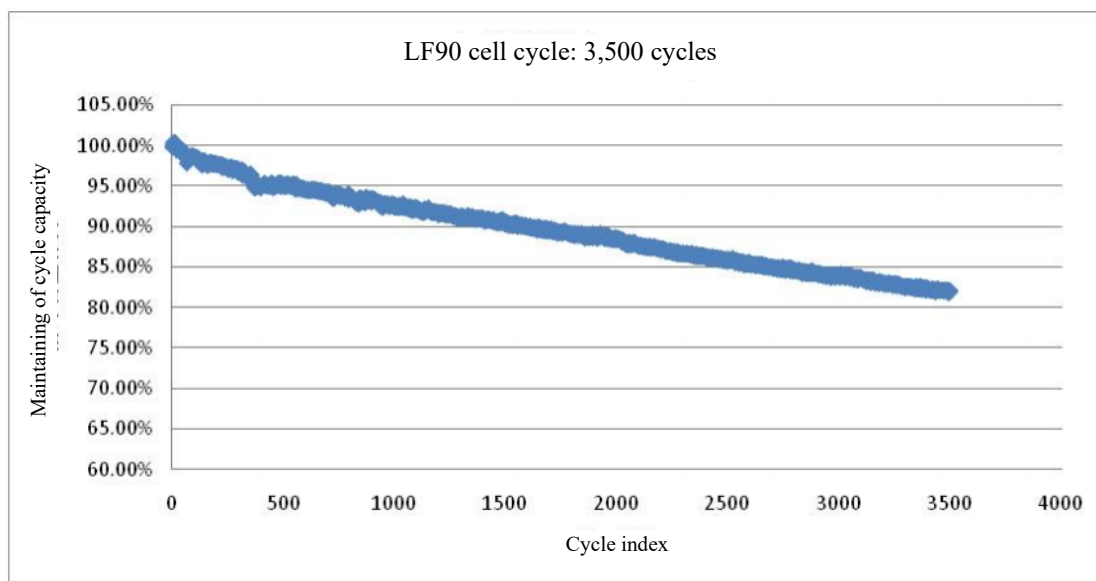
5.4 Battery system parameters

This product selects safe and high-quality lithium iron phosphate lithium-ion battery cores, adopts modular integration technology and is fitted with a special battery management system for lean manufacturing and comprehensive control to ensure product safety and long service life.

S/N	Item		Indexes	Remarks
Battery Cell Parameters:				
1	Cell type		Power type square cell	
2	Material system		Lithium iron phosphate battery	
3	Nominal voltage		3.20V	
4	Discharge cut-off voltage		3.65V	
5	Discharge end voltage		2.5V	
6	Maximum operating temperature range	Charge	0℃~55℃	
		Discharge	-20℃~60℃	
7	Optimal operating temperature range	Charge	15℃~35℃	
		Discharge	15℃~35℃	
8	Storage temperature	Within 1 month	-40℃~45℃	
		Within 6 months	-20℃~35℃	
Battery pack system parameters				
S/N	Item		Value	Remarks
1	Recommended state of charge (SOC)		10%-95%	
2	Charging temperature range		0℃~+55℃	
3	Discharge temperature range		-20℃~+55℃	Natural cooling, temperature ≤ 10℃
4	Cycle life		2,500 times or 5 years (whichever comes first)	Standard cycle

5.5 Battery management system parameters

S/N	Item	Value	Description
1	Operating power supply	12V	DC/DC power supply in the battery box
2	Operating energy consumption	<3W	Power consumption without relay
3	Operating temperature	-40℃~85℃	
4	Protection rating	IP20	Guaranteed protection rating of battery box
5	CAN communication	External with two circuits	One for main control and one for charging
6	CAN baud rate	250K	
7	485 communication	1-circuit	External display screen
8	Cell voltage sampling	Accuracy ±5mv, range 2-5V	
9	Current sampling	-750A~+750A	
10	Temperature sampling	-40℃~85℃	
11	SOC estimation accuracy	Refer to QC/T 897-2011	
12	Safety management of battery pack	Two-level warning, one-level shutoff	Two-level warning strategy
13	Thermal management of battery pack	Supported	
14	Contactor control	With	
15	Charge control	With	

5.6 Battery safety performance

S/N	Item	Standard	Test methods
1	Penetration performance	No explosion No fire	After charging the battery, set aside for 1h at 20℃±5℃. Rapidly penetrate with a 3mm-8mm steel nail perpendicular to the battery pole plate (with the steel nail staying in the battery).
2	Crushing test	No explosion No fire	After charging the battery, set aside for 1h at 20℃±5℃. Carry out the test under the following conditions. The test shall be carried out under conditions with adequate environmental protection: a) Crushing direction: Apply pressure perpendicular to the battery pole plate. b) Crushing area: Outer surface perpendicular to the pressure application direction. c) Degree of crushing: Crush until the battery shell is ruptured or internally short-circuited.
3	Heating test	No explosion No fire	After charging the battery, set aside for 1h at 20℃±5℃. Set aside for 120min at 85℃±2℃.
4	Short-circuit Performance	No explosion No fire	After charging the battery, set aside for 1h at 20℃±5℃. When the battery is short-circuited externally for 10min, the resistance of external line shall be less than 10mΩ.
5	Over-charging Performance	No explosion No fire	After charging, set the battery aside at 20℃±5℃ for 1h. Then, charge the battery at the same temperature with either of following two charging methods: （1） Charge with 150A current until the battery voltage reaches 5V or for 90min (stop the test under either of the above conditions). （2） Stop the test when the voltage reaches 10V with 9I3 (A) current.
6	Over-discharging Performance	No explosion No fire	Discharge the battery with 100(A) current at 20℃±5℃ until the voltage is 0V.

5.7 Battery Storage

- In case of long-term storage, the battery assembly shall be kept in a shaded and ventilated place which is away from flammables, explosives or hazardous substances, and shall be protected from exposure to direct sunlight to prevent the high-temperature protection of battery being triggered.

- To store for more than 3 months, it is recommended to charge to 50% SOC with AC current, and then store it in a dry warehouse at room temperature; moisture, water and dust prevention measures shall be taken for the contact positions of battery assembly to avoid corrosion and short-circuit.

6. Navigation and Control System

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

6.1　System Overview

The navigation and control system controls the robot to navigate to another destination in the constructed 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. The following figure shows the structure of the navigation and control system. The modules designed in the navigation and control system are as follows:

- Global Path Planning

According to the planning of destination point and map file, generate the shortest path to the destination point, and disassemble the total task into sub-tasks of each section of the path.

- Task Planning

The task planner generates a task queue based on the subtask instructions of current path, and then the model file information. Then, it calls the path navigation module or the action execution module.

- Local Path Planning

Based on the nature, localization, and sensors of the current path, the robot is controlled to travel on the current path. If an obstacle is encountered, the robot will report a blockage error.

- Action Planning

Based on the action instruction and sensor information, the robot mechanism is controlled to perform a specified action.

- Localization

The localization module provides the robot with real-time accurate location information in different environments based on laser SLAM navigation, or QR code navigation, or odometer navigation, or magnetic stripe.

- Sensors

Various sensors (Accelerometer, encoder, 3D camera, infrared sensor, and DI signal sensor etc.) provide real-time status query for the robot. This information can be used for arrival judgment, obstacle judgment, and deceleration judgment etc.

- Actuators

The actuators include motors, audio, DO, and the robot's own state, etc., and finally realize the robot's response to task instructions.

System Structure Diagram of Robot Navigation and Control

The user sends a task instruction to the robot somewhere through the network. The robot will automatically generate a path to the destination point based on the configurable content, localization and sensors, and use the actuators to complete the corresponding task action.

6.2 User Input Information

To enable the robot to navigate automatically, the user must provide the following information:

- On the map where the robot is located, you need to scan the robot map through RoboShop software, and set the working point location and path on the map

- Configure the robot model files

- Determine the current location of the robot

- Send the destination point location of the robot.

On the map, the robot is expressed as a semi-transparent rectangle, and the point location and path are also displayed on the map. The robot model file defines the properties of various mechanisms such as laser and motor. After the robot has the map, point location, path, model file, and current location, it can plan a path to the destination point.

When the robot receives the map, model file, current location and destination point location, the robot will plan a path from the current location to the destination point as short as possible.

6.3 Global Path Planning

The global path planning means that the robot generates a path to the destination point. The global

path planning is performed only at the beginning of the task. During the global path planning, the obstacles on the path will not be considered, but the deviation distance of the robot from the path will be taken into account.
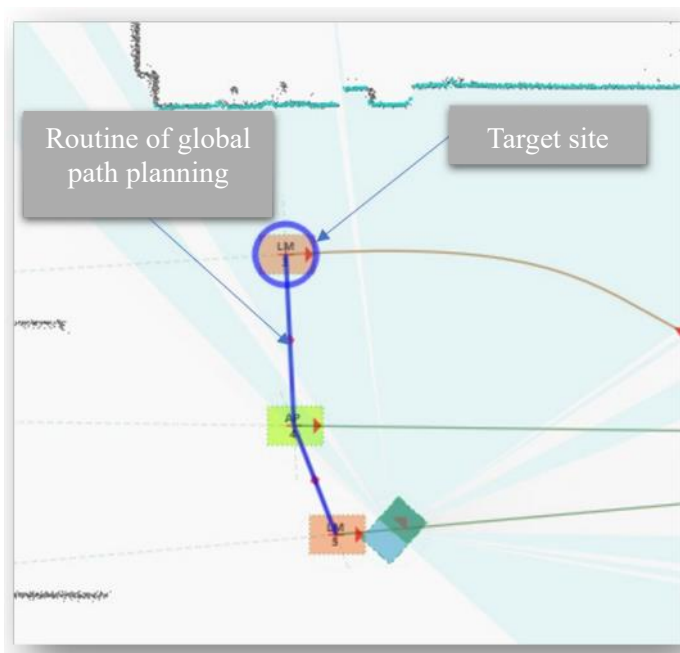
The blue circle is the destination point, and the blue line is the path planned by the robot.

6.4 Local Path Planning

The robot will conduct real-time local path navigation while running. When encountering obstacles, the robot will avoid obstacles. For the local path navigation, the speed of the robot will also be planned to ensure smooth speed during the operation of the robot. When the robot is off the path, it will display that the navigation fails and the robot is not in the set path.
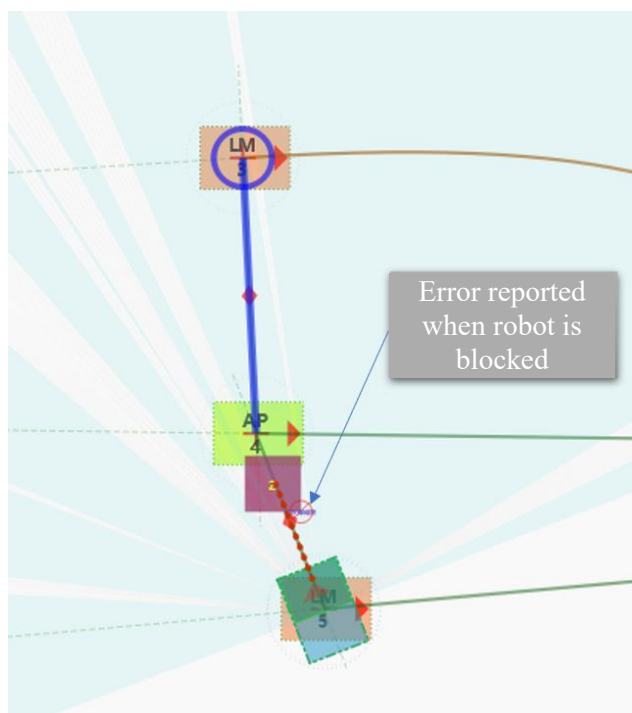
When it detects a virtual obstacle on the path, the robot will navigate the local path to avoid obstacles and stop.

6.5 Task Planning and Action Planning

When the robot receives a task instruction, it will split the instruction into a sequence of actions. For example, the task of recognizing and picking up the cargo is issued to the jacking cart, the instruction issued will be decomposed into three parts during the task planning: 1. Recognize the location of the cargo; 2. Navigate to the location of the cargo; 3. Perform the pickup action. Only after each action is successfully actuated, the task instruction is considered to be complete.

The action planning is to plan the robot's own equipment to perform each action. For example, 1. To recognize the location of the cargo, the action planning will call the camera to recognize the location of the cargo based on the appropriate recognition files. 2. To navigate to the location of the cargo, the action planning will call the local path navigation to make the robot move to the destination. 3. To perform the pickup action, the robot will rotate the pickup motor to load the cargo.

Under the control of RoboShop, each navigation instruction can be accompanied by a task instruction. In the dispatching mode of the robot, each path can be accompanied by a task instruction.
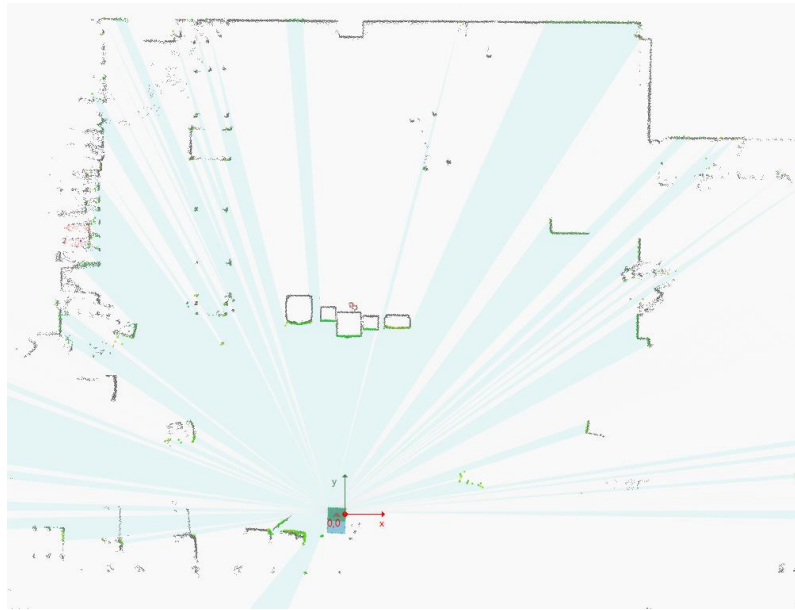
6.6 Obstacle Detection

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

• Laser

• Obstacle avoidance laser
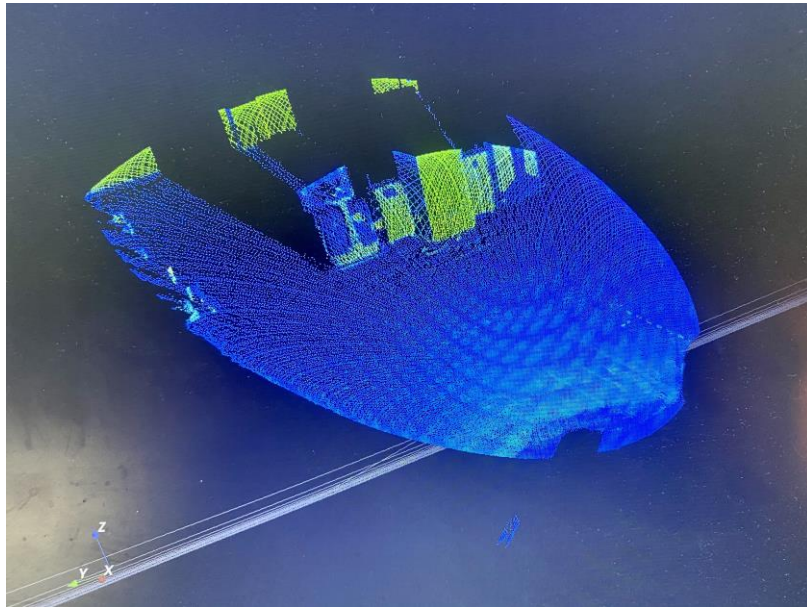
• 3D laser (optional)

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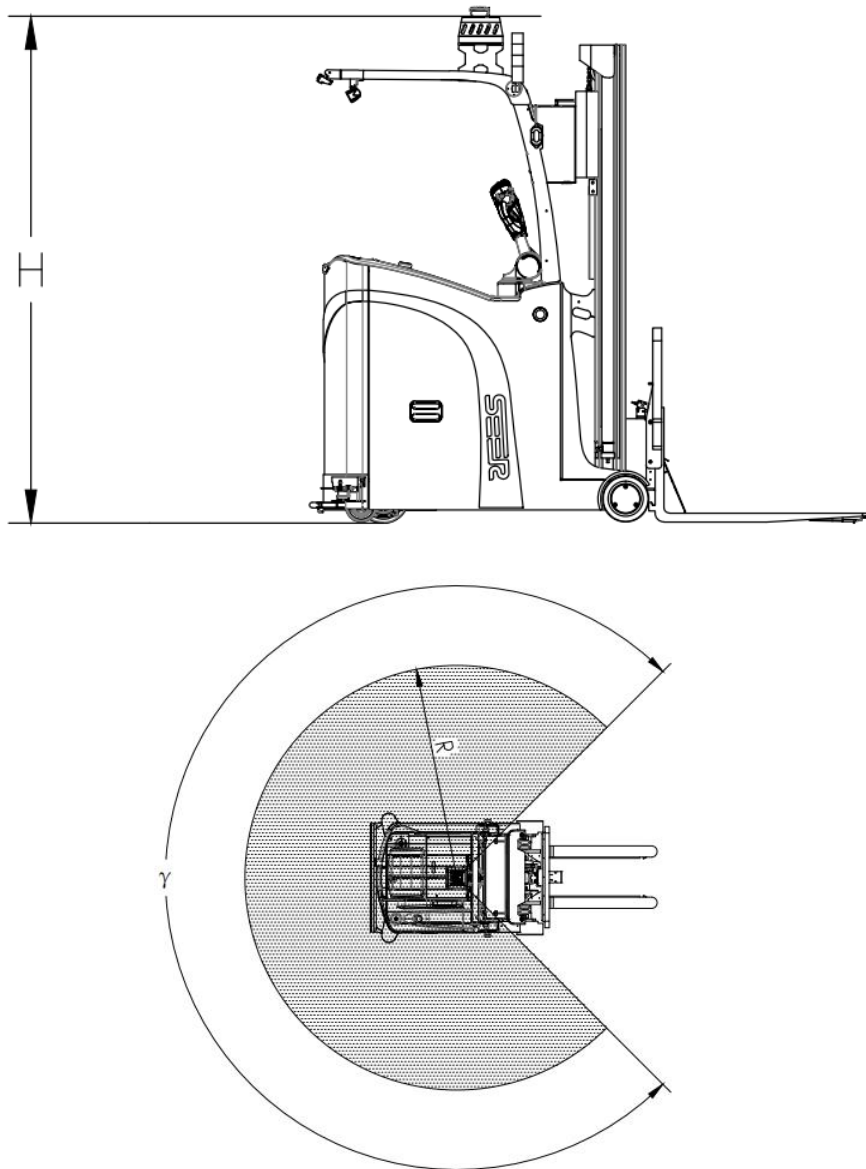

Human Vision

Laser Vision

3D laser vision

6.6.1   Navigation Laser

SFL-CPD15-T is equipped with a SICK nanoScan3 Core; the main functions are as follows:

• Map scanning

• Localization and navigation

• Obstacle recognition

6.6.1.1 Detection Range

Model	S/N	Definition	Parameter
SFL-CPD15-T	R	Detection distance	40m
	Y	Scanning angle	275°
	H	Detection height	2296mm

6.6.1.2 Non-detection Zone

Due to the characteristics of the navigation laser sensor, the objects lower or higher than its detection height can't be detected.

6.6.1.3 Actions after Detecting the Obstacles

When CPD is delivered, the default deceleration (ObsDecDist) and stop (ObsStopDist) districts have been set.

- In the deceleration district (default value 3m), the robot will decelerate when the laser detects an obstacle.

- In the stop district (default value 1m), the robot will stop when the laser detects an obstacle.

- In Roboshop parameter configuration, you can modify this parameter by yourself.

	类别	参数名	插件名	值	默认值	最小值	最大值	参数描述
1	安全性	☐ 3DCameraObsta...	MoveFact...	true	true	——	——	导航是否使用3D相机检测凸起障碍物
2	安全性	☐ DynamicObsDist	MoveFact...	0.10000	0.1	0.01	1	判别是否是动态障碍物的距离阈值
3	安全性	☐ Load_ObsDecDist	MoveFact...	5.00000	5	0	10	Load减速预测的距离(m)
4	安全性	☐ Load_ObsExpan...	MoveFact...	0.15000	0.15	0	0.5	Load碰撞预测的机器人扩展宽度(m)
5	安全性	☐ Load_ObsStopD...	MoveFact...	1.00000	1	0	10	Load碰撞预测的距离(m)
6	安全性	☐ ObsDecDist	MoveFact...	3.00000	3	0	10	减速预测的距离(m)
7	安全性	☐ ObsDecSpeed	MoveFact...	0.20000	0.2	0	2	减速速度(m/s)
8	安全性	☐ ObsExpansion	MoveFact...	0.10000	0.1	0	0.5	碰撞预测的机器人扩展宽度(m)
9	安全性	☐ ObsStopDist	MoveFact...	1.00000	1	0	10	碰撞预测的距离(m)
10	安全性	☐ TargetObsDete...	MoveFact...	0.00000	0	0	1	终点处障碍物检测距离(m)
11	差动机器人	☐ MS_SgpGlobalP...	MoveFact...	0.50000	0.5	0	10	绕障: 全局路径对障碍物的容忍(m), 即安全距离减去障碍物离机器人的距离
12	差动机器人	☐ SgpGlobalPath...	MoveFact...	0.50000	0.5	0	10	绕障: 全局路径对障碍物的容忍(m), 即安全距离减去障碍物离机器人的距离

> ⚠️ **Precautions for Parameter Configuration of Robot**
> - The collision detection will be turned off when ObsStopDist is set as 0. A collision may occur at this time. Be careful!

6.6.1.4 Characteristics and Operation Restrictions of Navigation Laser

Noise

The noise of the laser is caused by the principle of laser measurement. During laser ranging, a light spot is emitted, which usually has a fixed divergence angle. Therefore, the longer the measurement distance is, the larger the spot formed in the distance will be. If a light spot is emitted while half illuminating the object in front and half of the object behind, and the energy returned will be high, the distance measured here will be problematic, and the laser noise will be generated generally.

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 likely to be generated at the edge of the foreground object as shown in the figure below:
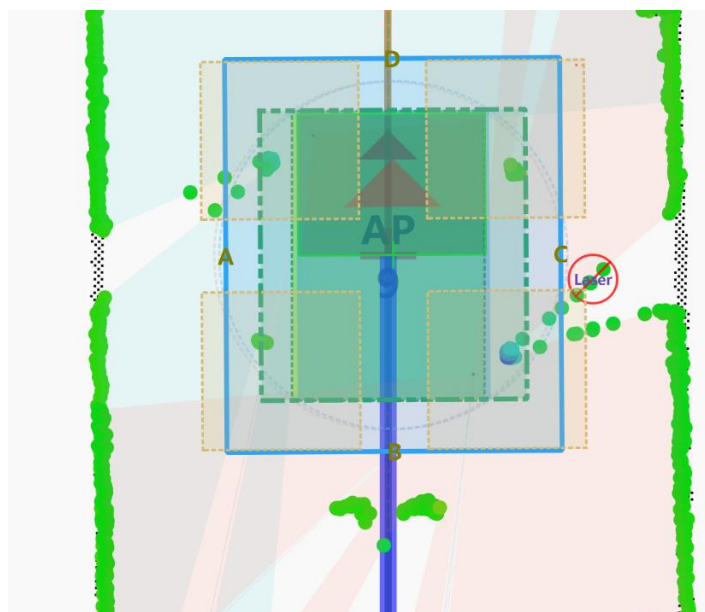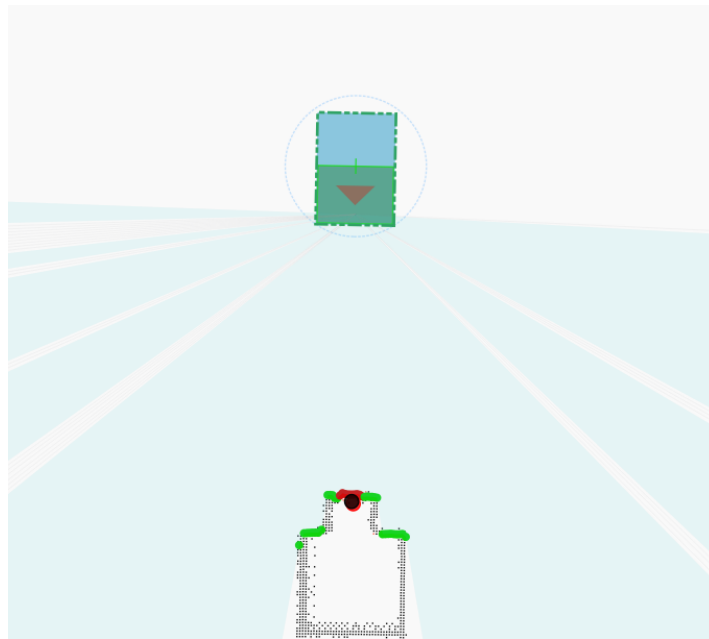
Effective Distance

The effective distance of the Pepperl + Fuchs laser is 0.1m-40m during normal running, so when the laser is very close to the object, the laser data may be inaccurate. Therefore, the laser shall not be particularly close to the wall or other objects when using it (at least 10cm space should be reserved).

Reflectivity

The reflectivity of the laser is usually related to the intensity of the energy returned by the laser, so objects with high reflectivity (reflectors) will have a higher reflectivity, and ordinary objects will have a lower reflectivity. Usually, we normalize the reflectivity to 0-255, where 0 is the lowest reflectivity, and 255 is the highest reflectivity. The reflectivity of general objects is less than 150, and the reflectivity of special diamond reflectors is more than 200. You can know the reflectivity of a laser point through the laser point color on Roboshop, as shown in the figure below:

Therefore, if the environment is full of objects with high reflectivity, it may affect the related applications that need to recognize the reflector.

Black Object

For a black object with a reflectivity of 10%, the effective measurement distance of the laser is 0.1m-10m. For black objects with lower reflectivity, the laser may not be able to recognize or the distance measured may be inaccurate. Therefore, if the environment is full of black objects with low reflectivity, the robot may not be able to build an accurate map of the environment, and thus can't navigate stably and accurately.

Objects with Specular Reflection

For the purpose of laser measurement, the distance is calculated based on the reflected laser received, so the objects of different materials will have different effects on the laser measurement. For the surface of natural object that produces uniform diffuse reflection, the noise will be relatively low after the laser irradiates onto it, and thus the measurement accuracy will be relatively high. For the smooth surface that produces specular reflection, the measurement noise will be relatively high, and thus the measurement accuracy will be relatively low. For this reason, the robot will be unable to draw an accurate environmental map if there are too many objects with specular reflection in the environment, so that it can't navigate stably and accurately.

Jamming between Lasers

Generally, the lasers are designed to protect against the jamming between multiple lasers to avoid mutual jamming. However, the laser manufacturers recommend using the following installation method to completely avoid mutual jamming between them when using multiple lasers. The jamming between lasers is eliminated by increasing the tilt angle of the laser installation. For laser SLAM applications, the tilt angle shall be upward instead of downward.
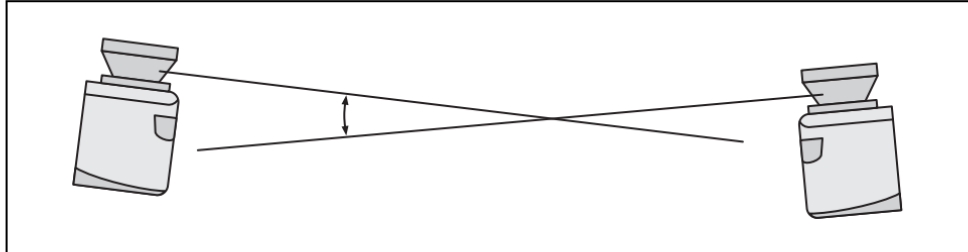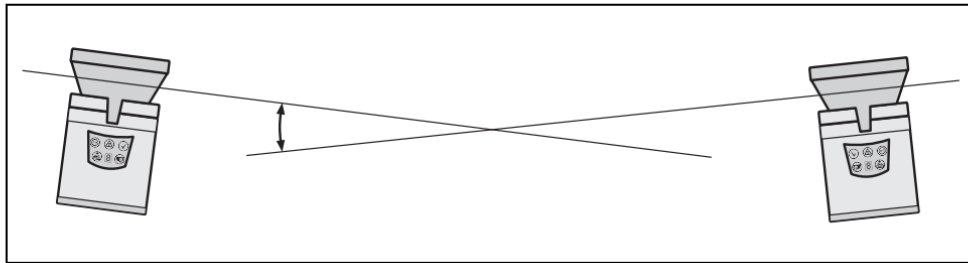

Fig. 38:   Placement of two LMS1xx opposed to each other

Influence of Strong Light
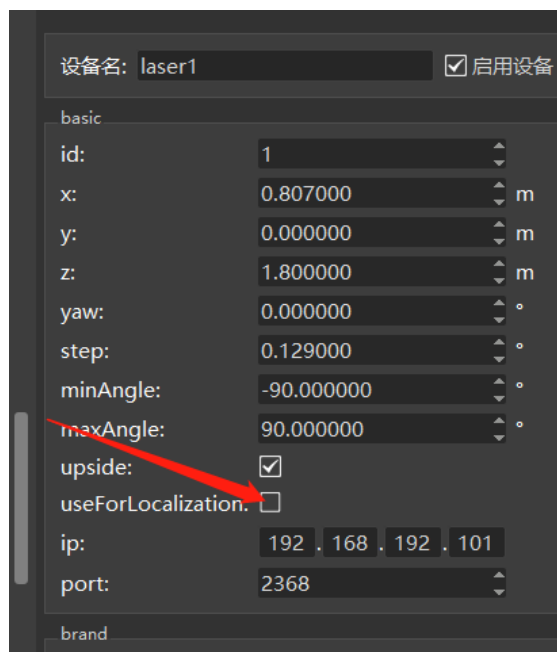
Generally, the ambient light immunity of the indoor laser is about 40klux-80klux, and the indoor light intensity is usually less than this value. Therefore, the indoor light will not influence the laser, but it is necessary to avoid direct sunlight as much as possible. For outdoor applications, please use an outdoor dedicated laser, such as Sick LMS 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 contour of the environment with the laser radar, and then perform localization and navigation by matching the built point cloud map with the real-time point cloud scanned with the laser. Therefore, if the contour of the environment changes significantly (>30%) after map building, the robot may not achieve the expected high accuracy. If the contour of the environment changes more significantly (>60%), the robot may deviate from the path or even lose its localization. Therefore, for the use of laser SLAM in scenes where the environment often changes significantly, please consider adding other auxiliary measures, such as enabling online SLAM, deploying reflectors or QR codes.

6.6.2   Obstacle avoidance laser

CPD is equipped with two OLE LR-1BS2Ls on the head (the Model can be changed according to demand) and one OLE LR-1BS2L at the tail as obstacle avoidance lasers, so that the robot will slow down and stop accordingly when meeting obstacles at the mounting plane of the obstacle avoidance lasers, improving the safety of the robot in the moving process. **Note: OLE laser should not be used for localization, and thus the useForLocalization in the robot model file shall be checked off.**

6.6.2.1　Detection Range
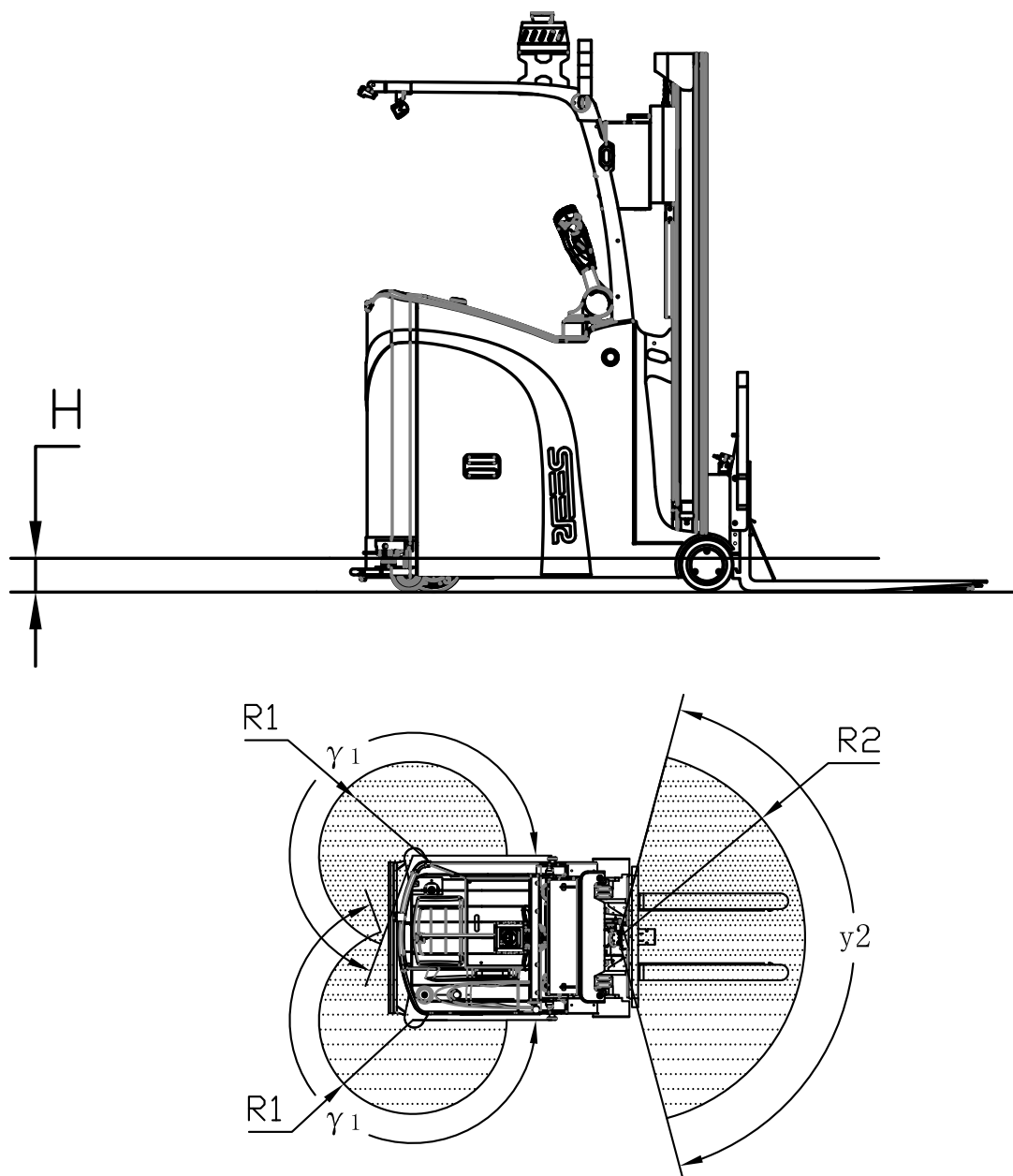
Model	S/N	Definition	Parameter
SFL-CPD15-T	R1	Detection distance	10m
	R2		
	γ1	Scanning angle	270°
	y2		150°
	H	Detection height	136mm

6.6.2.2　Non-detection Zone

Due to the characteristics of the navigation laser sensor, the objects lower or higher than its detection height can't be detected.

6.6.2.3 Actions after Detecting the Obstacles

When CPD is delivered, the default deceleration (ObsDecDist) and stop (ObsStopDist) districts have been set.

- In the deceleration district (default value 3m), the robot will decelerate when the laser detects an obstacle.

- In the stop district (default value 1m), the robot will stop when the laser detects an obstacle.

- In Roboshop parameter configuration, you can modify this parameter by yourself.

	类别	参数名	插件名	值	默认值	最小值	最大值	参数描述
1	安全性	☐ 3DCameraObsta...	MoveFact...	true	true	——	——	导航是否使用3D相机检测凸起障碍物
2	安全性	☐ DynamicObsDist	MoveFact...	0.10000	0.1	0.01	1	判别是否是动态障碍物的距离阈值
3	安全性	☐ Load_ObsDecDist	MoveFact...	5.00000	5	0	10	Load减速预测的距离(m)
4	安全性	☐ Load_ObsExpan...	MoveFact...	0.15000	0.15	0	0.5	Load碰撞预测的机器人扩展宽度(m)
5	安全性	☐ Load_ObsStopD...	MoveFact...	1.00000	1	0	10	Load碰撞预测的距离(m)
6	安全性	☐ ObsDecDist	MoveFact...	3.00000	3	0	10	减速预测的距离(m)
7	安全性	☐ ObsDecSpeed	MoveFact...	0.20000	0.2	0	2	减速速度(m/s)
8	安全性	☐ ObsExpansion	MoveFact...	0.10000	0.1	0	0.5	碰撞预测的机器人扩展宽度(m)
9	安全性	☐ ObsStopDist	MoveFact...	1.00000	1	0	10	碰撞预测的距离(m)
10	安全性	☐ TargetObsDete...	MoveFact...	0.00000	0	0	1	终点处障碍物检测距离(m)
11	差动机器人	☐ MS_SgpGlobalP...	MoveFact...	0.50000	0.5	0	10	绕障: 全局路径对障碍物的容忍(m), 即安全距离减去障碍物离机器人的距离
12	差动机器人	☐ SgpGlobalPath...	MoveFact...	0.50000	0.5	0	10	绕障: 全局路径对障碍物的容忍(m), 即安全距离减去障碍物离机器人的距离

> ⚠️ **Precautions for Parameter Configuration of Robot**
>
> - The collision detection will be turned off when ObsStopDist is set as 0. A collision may occur at this time. Be careful!

6.7 Localization

The purpose of the localization process is to determine the current location of the robot. The robot has 3 input items to determine its current location:

- The initial location of the robot is used as a reference point for localization.

- IMU and encoder data are used to determine the distance and speed of the robot from the initial location.

- The laser scanning data is used to determine the approximate location of the robot by comparing the location data of the wall on the map.

The particle filter uses the above data to determine the approximate location of the robot on the map.

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 location. The combined use of these two sets of data results in a more accurate position.

Laser and Particle Filtering

The robot controller uses a 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 is only compared the robot's estimated position based on the IMU and encoder data, it is necessary to confirm the initial location.

To ensure that the robot can be accurately positioned through particle filtering, we need to confirm when building the map:

- The map must have unique, recognizable static landmarks which are easily identifiable. The landmark should be a permanent structure that the robot can use to determine its own direction, such as corners, doorways, pillars and shelves.

- The robot must be able to detect static landmarks marked on the map in order to approach its current location.

- Make sure that the current location of the robot is correct.

6.8 Driver and Motor

The robot constantly adjusts the output of the motor on the basis of the information collected by the sensor. So the robot can correct its speed when climbing hills or carrying weights.

7. Debugging

7.1 Connection of Robot

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

1. Connect the computer to the lower network interface of the robot with an internet cable.

2. Set the computer's Ethernet IP to the network segment 192.168.192.xxx (xxx must be more than 200), and the subnet mask as 255.255.255.0; the gateway can be omitted.

3. Open Roboshop and click the [Refresh] button on the [Homepage] or manually [Enter the IP] address as [192.168.192.5] to add the robot.
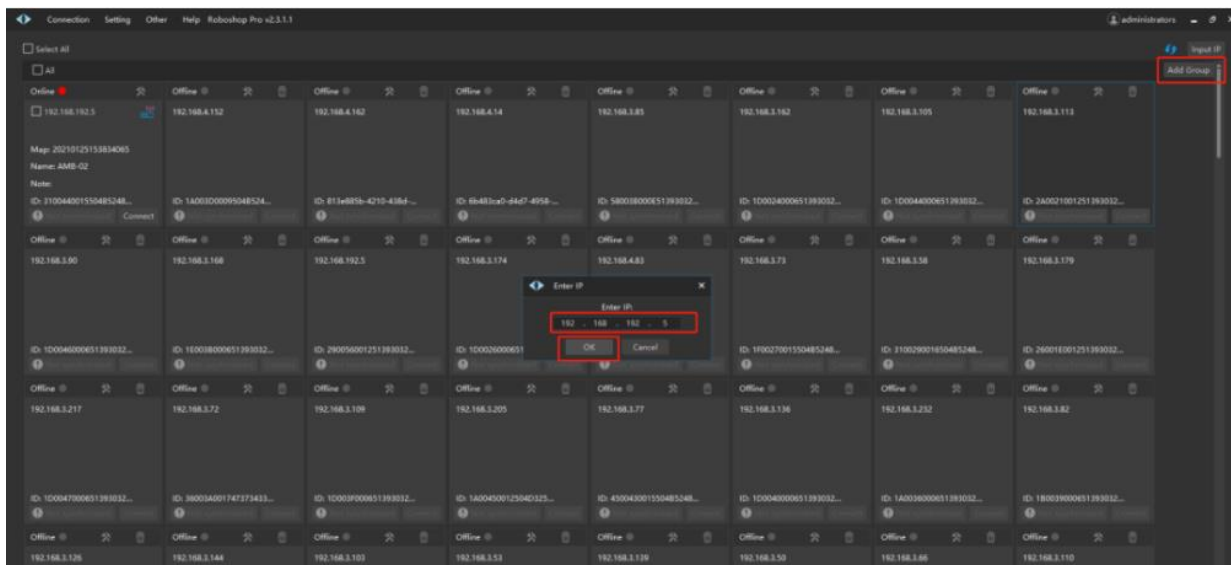
4. Find the robot with the IP address [192.168.192.5] in the robot list on the [Homepage] and click the button [Start Connecting].
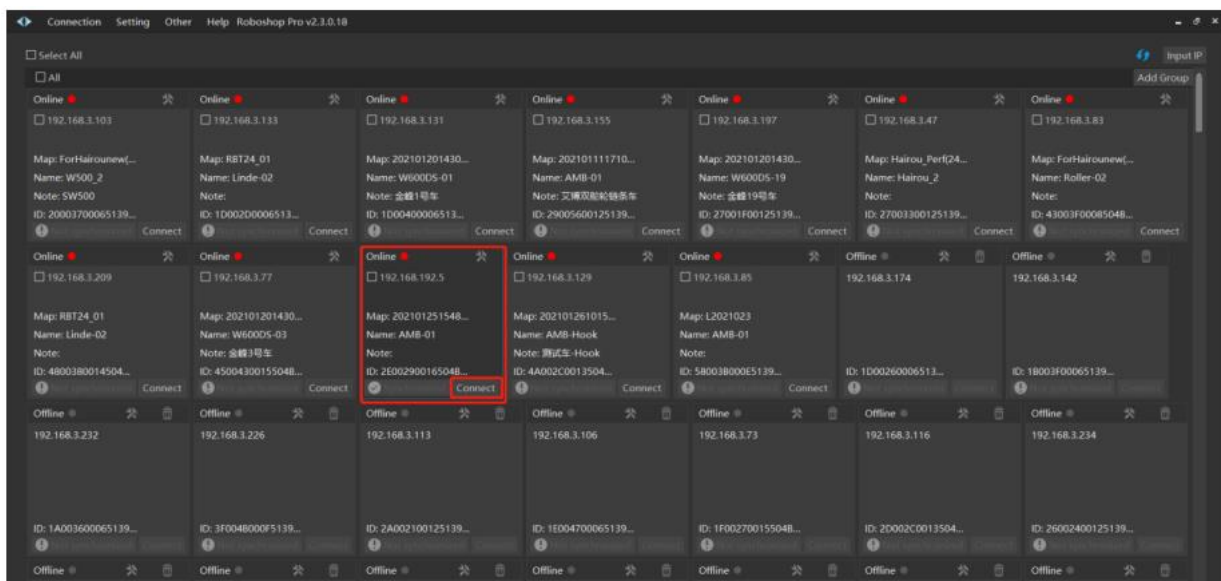
5. It indicates that it has been connected successfully when "Confidence", "Network Delay", "Map", "Name", "Remarks (if Any)" and other information of the robot are displayed on the robot tab.
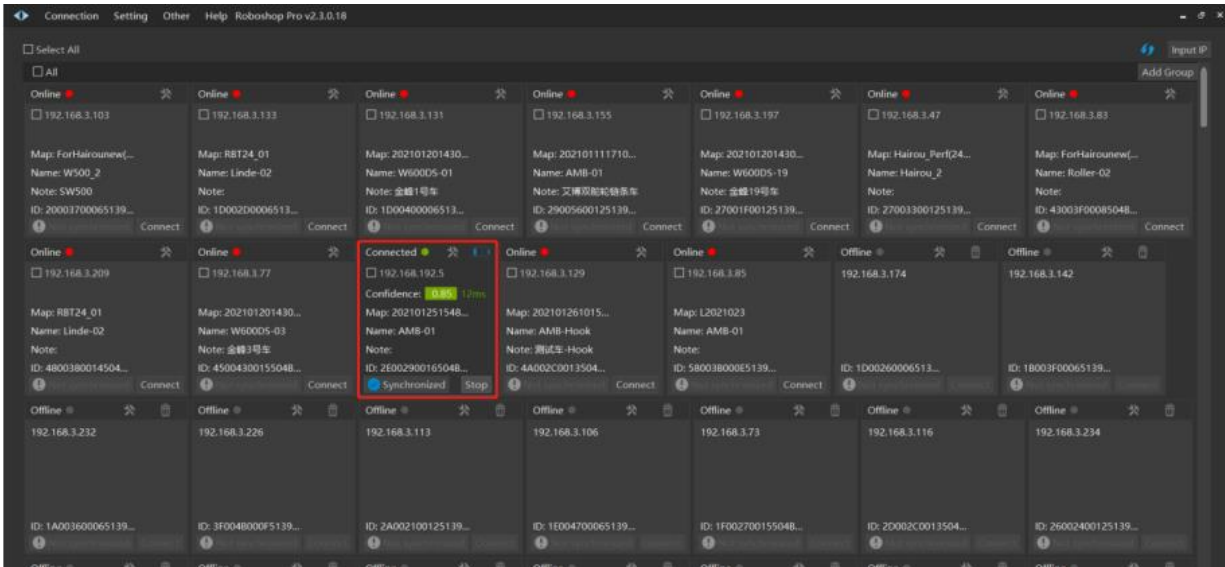
7.2 Map Building and Editing

Precondition: The robot is connected, and the robot model has been successfully configured and synchronized.

1. Map Building

a. Open Roboshop Pro, and double-click the robot to enter the [Map and Control] interface after successfully connecting the robot.

Click [Map Building] in the module toolbar, and all methods for [Map Building] will pop up.
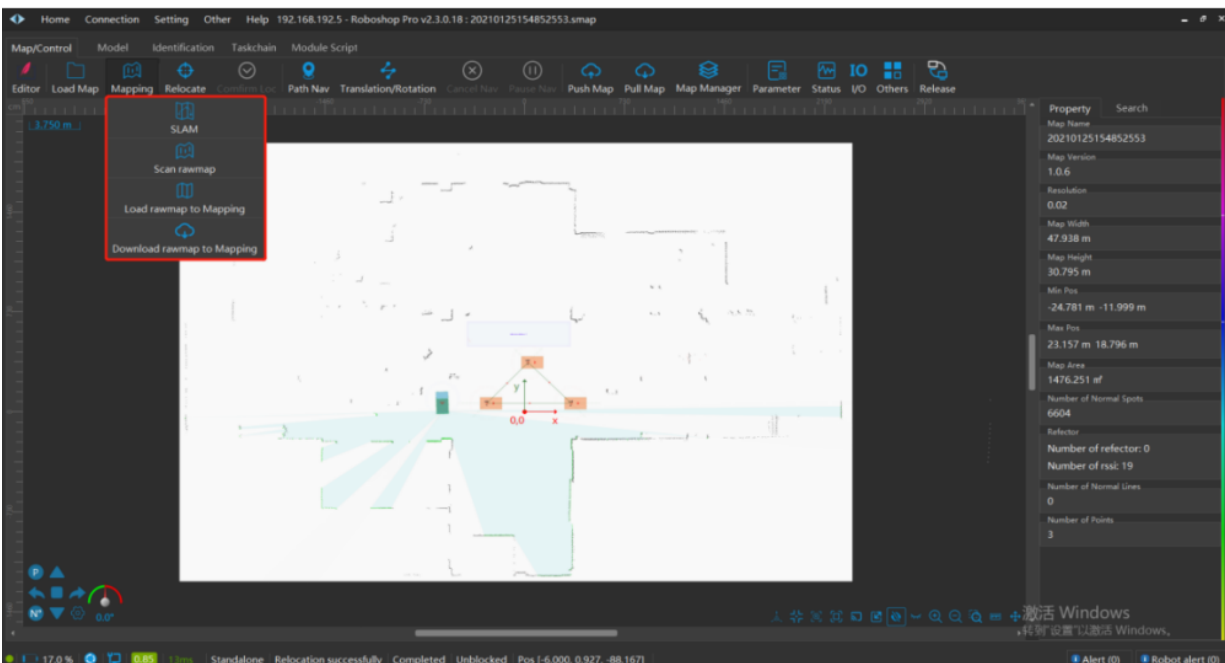
b. Click [Map Building] --> [SLAM], do not modify any parameters in the pop-up interface (generally, there is no need to modify the parameters of this interface), and click the [OK] button.
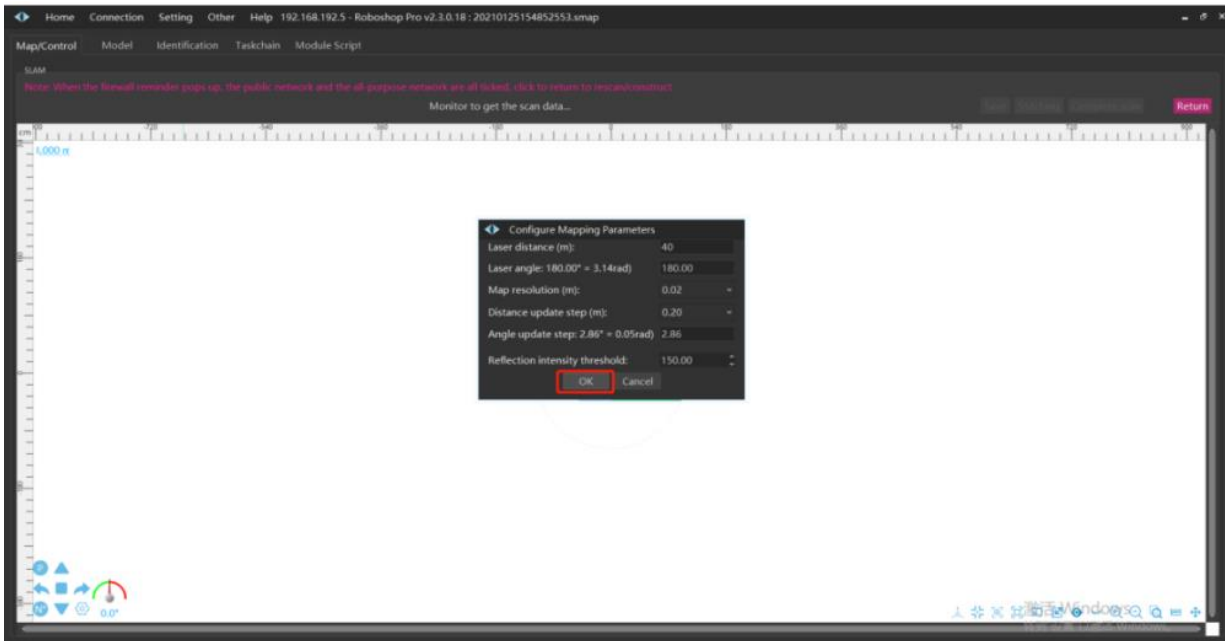

c. Use the keys W (Forward), A (Left turn), S (Reverse), D (Right turn) on the keyboard for robot control to make the robot move in the scene, and click the [Finish Map Scanning] button in the upper right corner when you finish scanning the map.
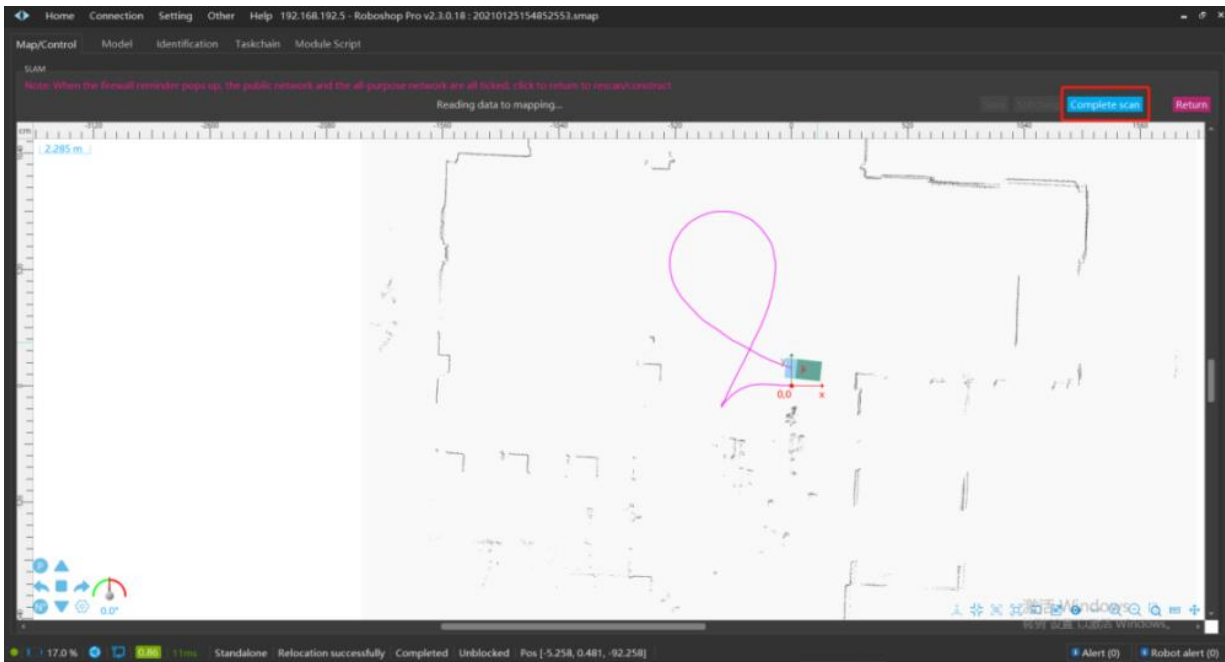

d. Wait for the completion of the map building, and then click the [Save] button in the upper right corner.
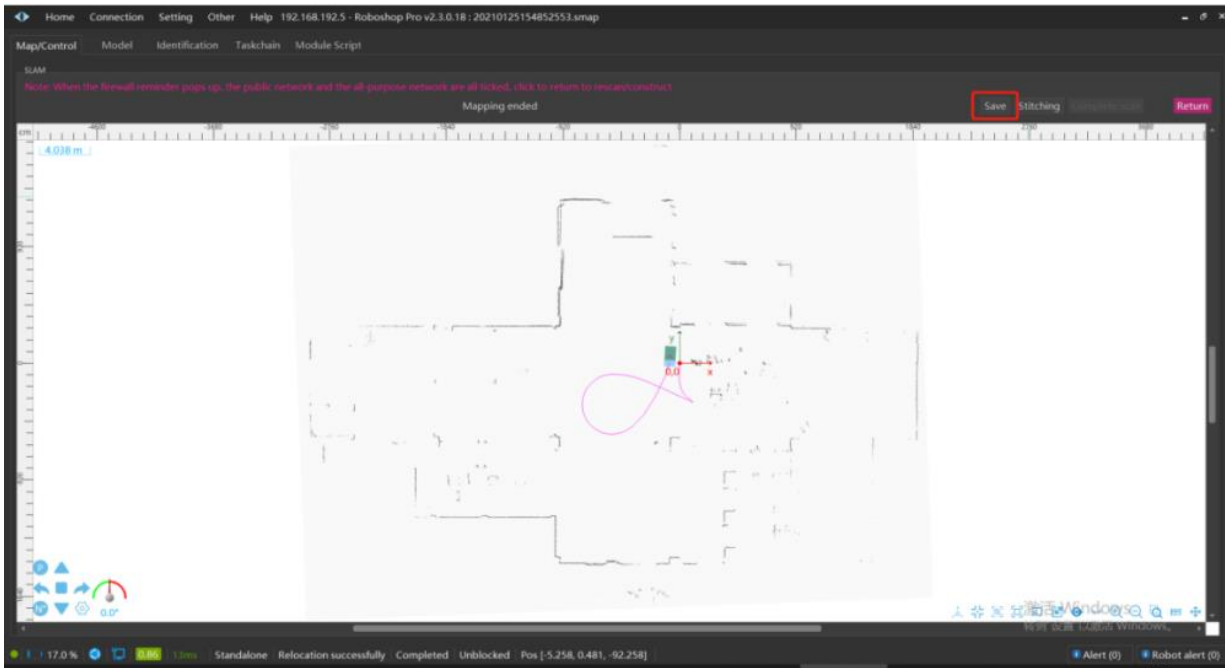
e. Select the desired path and enter the desired name in the pop-up interface to save the map.
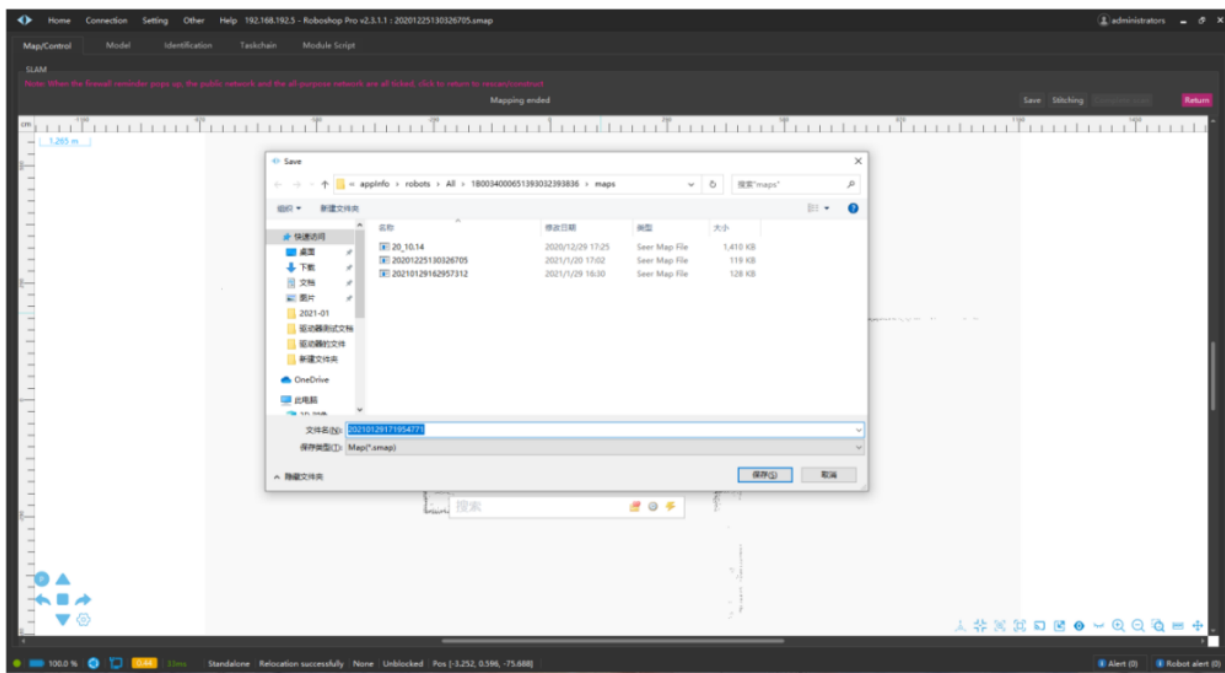
f. After it is saved successfully, a dialog box will pop up to ask whether to open it. Select [Push the Map and Open it] to open the map just built and synchronize the map, which can be used directly. At this point, the map building part has been completed.
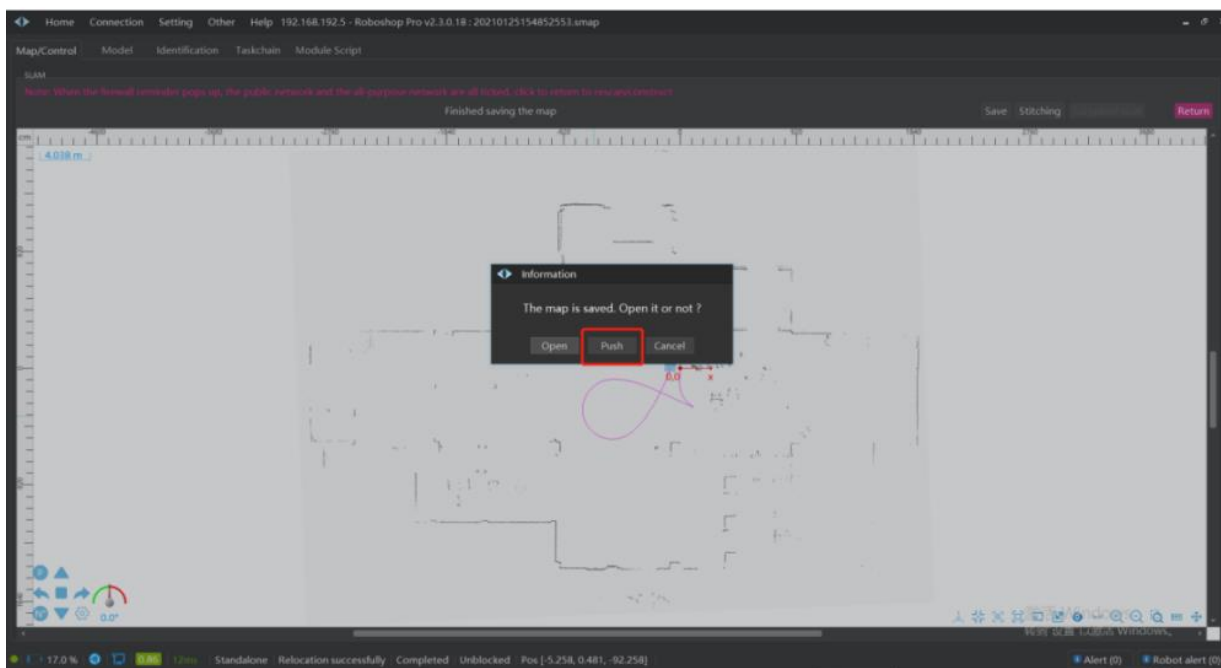
Description: If you select [Open], the map just built will be opened, and a dialog box with inconsistent map data will pop up. Select [Push the Map], [Pull the Map] or [Cancel] according to your needs.

7.3 Path Navigation and Obstacle Verification

Precondition: There are at least two sites on the map which are connected by a Bezier curve.

The robot conducts path navigation on the path: Click [Path Navigation] in the module toolbar, and then click a site, such as clicking the point LM2; the robot will perform path navigation along the path to the destination point (point LM2), and the robot will reach the site; the direction of the robot to the point is consistent with the direction of the site, as shown in the figure below.
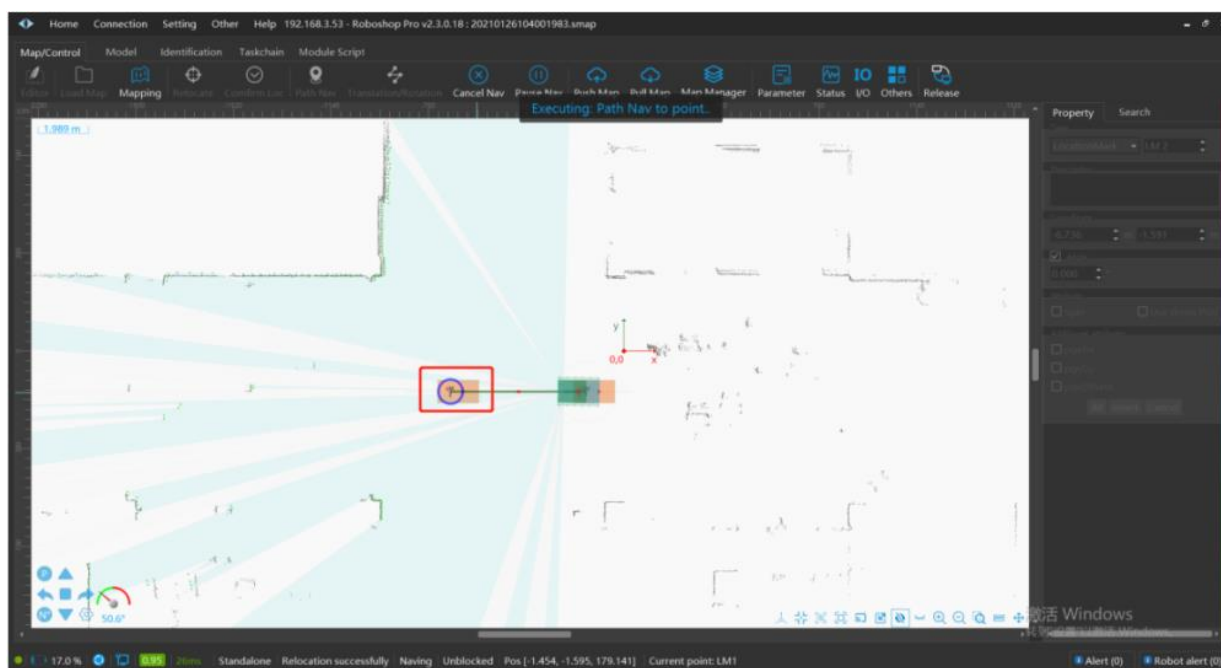
Description: If there is an obstacle on the path, the robot will stop in front of the obstacle in the navigation process, and will not run further until the obstacle disappears. The blocking reason will be displayed in the status bar.
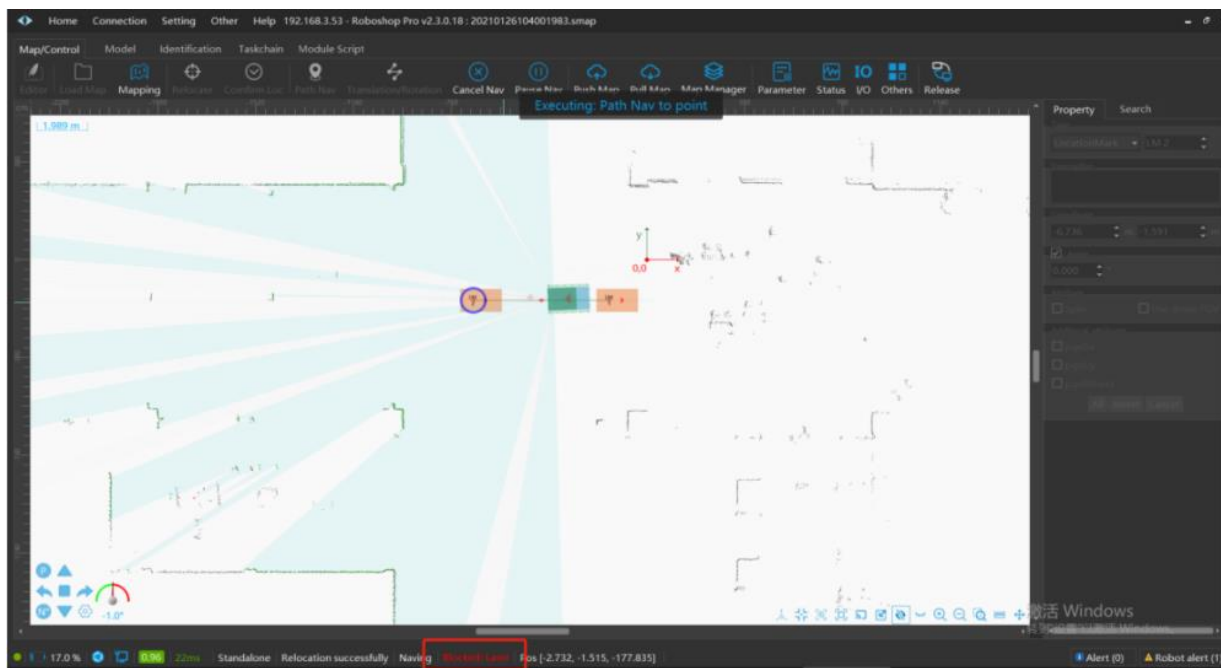
## 7.4   Setup and configuration of fork action AP workstation

a.   Use the robot to build a map in the area where the robot needs to work.

b.   Establish the AP point on the shelf and place it in the daily work position.

c.   Configuration of workstation

7.4.1　Workstation (AP)
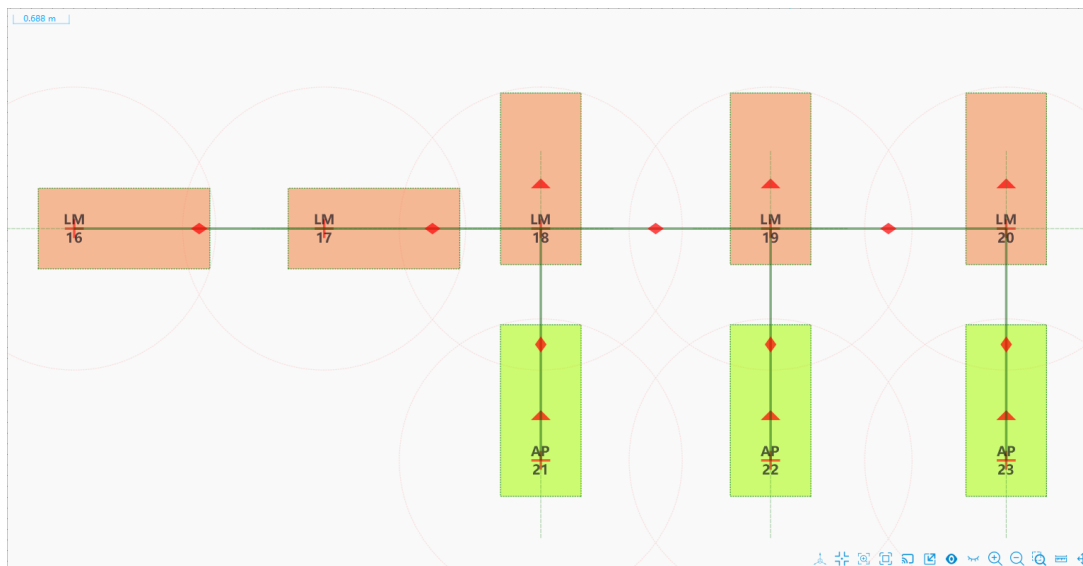
AP point is a workstation where the forklift works, such as picking, unloading or recognizing and picking pallet etc. since the forklift fork is at its tail, the forklift runs in the following path when picking and unloading: Backward LM→AP or forward AP→LM.

7.4.2　Special workstation (charging point (CP))
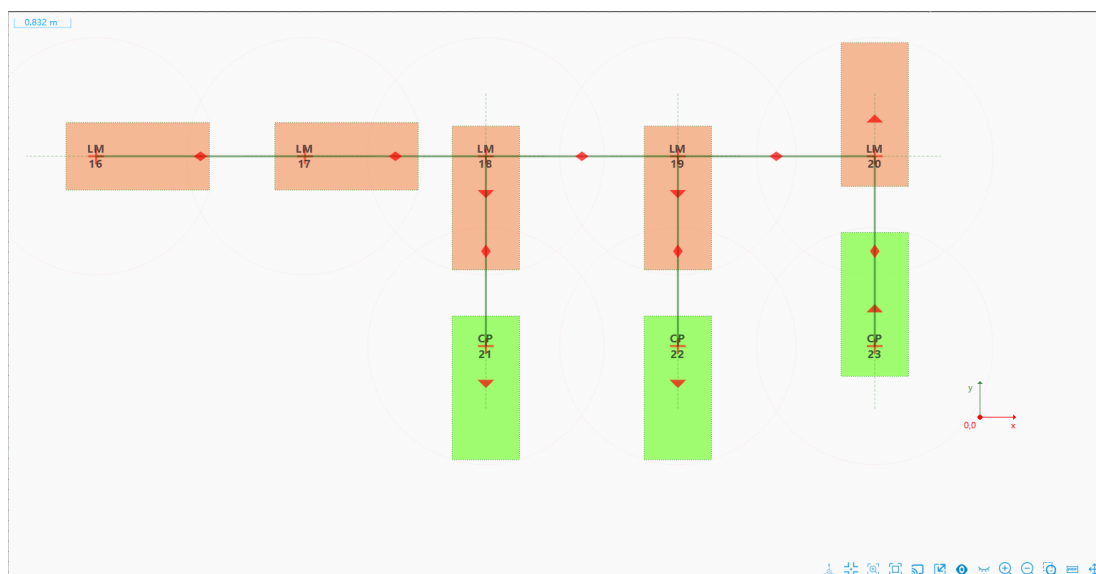
CP point is for forklift to charge the battery. The forklift is controlled via roboshop or dispatching system for charging. The forklift shall be driven into and out of the charging point directly, but shall not change direction at the charging point.

Notice: The points on the main path should not be directional, but the start points may be set between AP point and main path if the distance between the main path and the warehouse location when the warehouse location (which refers to the AP point with action recognized) or charging point is near the main path and the robot needs to enter the warehouse location directly from the main path; otherwise, the start point should be placed on the main path.

7.4.3 Work Route

Notice: The properties on the route when entering and leaving the AP point shall be set to LM→AP backward, AP→LM forward, and inspect carefully after the drawing is completed to prevent accidents in use.

The forklift has two working modes - recognition mode and non-recognition mode. According to working modes of the forklift and the size of the site space, the corresponding route also has the difference as shown in the following example:

7.4.3.1 With recognition and rich site space

When the forklift is in the working mode with recognition and rich site space, the route of forklift shall be drawn into "dead end highway", i.e. the forklift enters and leaves along two separate routes and runs unilaterally (pay attention to the gap between the cargo and the shelf to avoid collision when running in arc route).

The specific operations are as shown in the figure below:
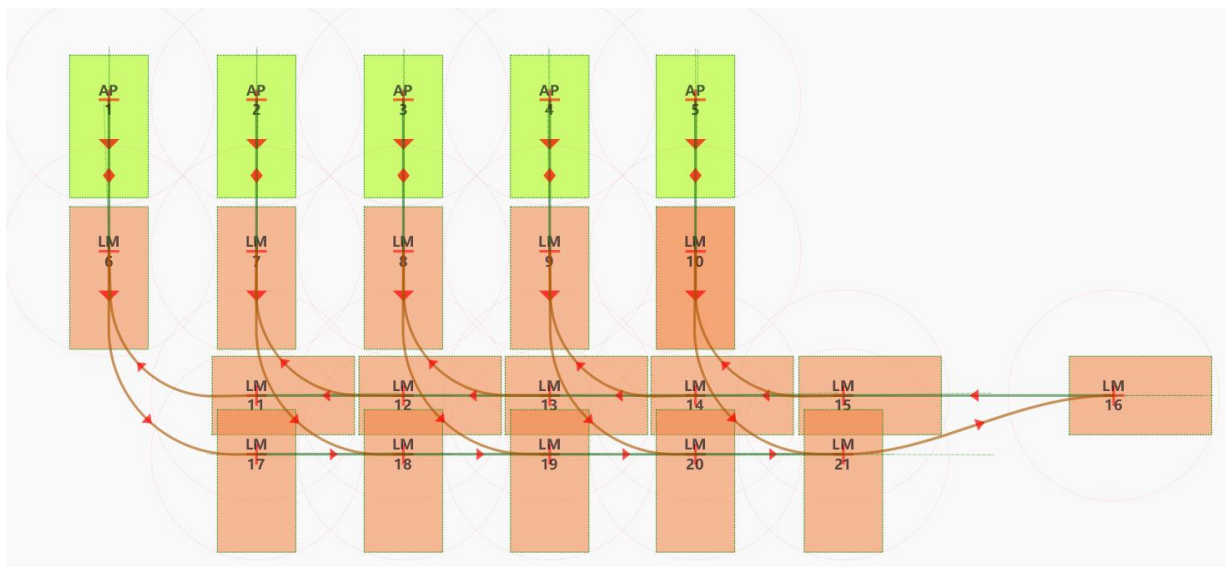
The route for the forklift to enter the warehouse location shall be set into unilateral route, so that the forklift has to drive out of the warehouse location from another route. The sites shall be adjusted according to the actual locations. The sites and routes can be coincided, and the connecting lines between the sites should be distinguished clearly. Special attention should be paid when drawing to avoid accidents.

7.4.3.2 Without recognition but with rich site space

When the forklift is in the working mode without recognition but with rich site space, it can drive in and out of the warehouse location in an arc route.
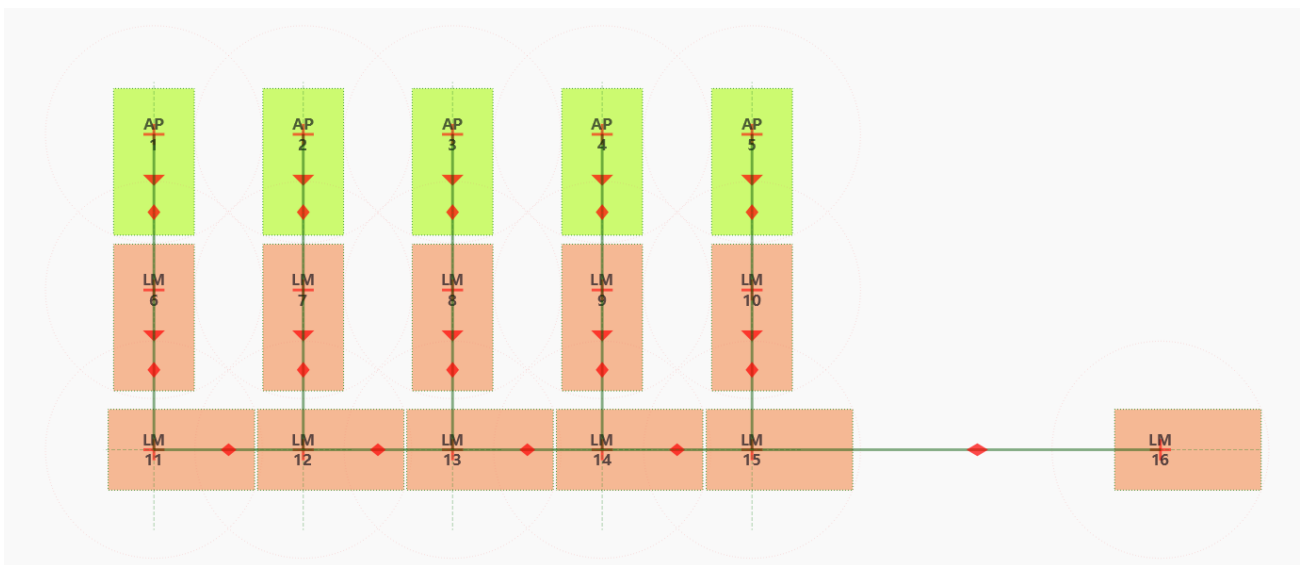
As shown in the figure below:
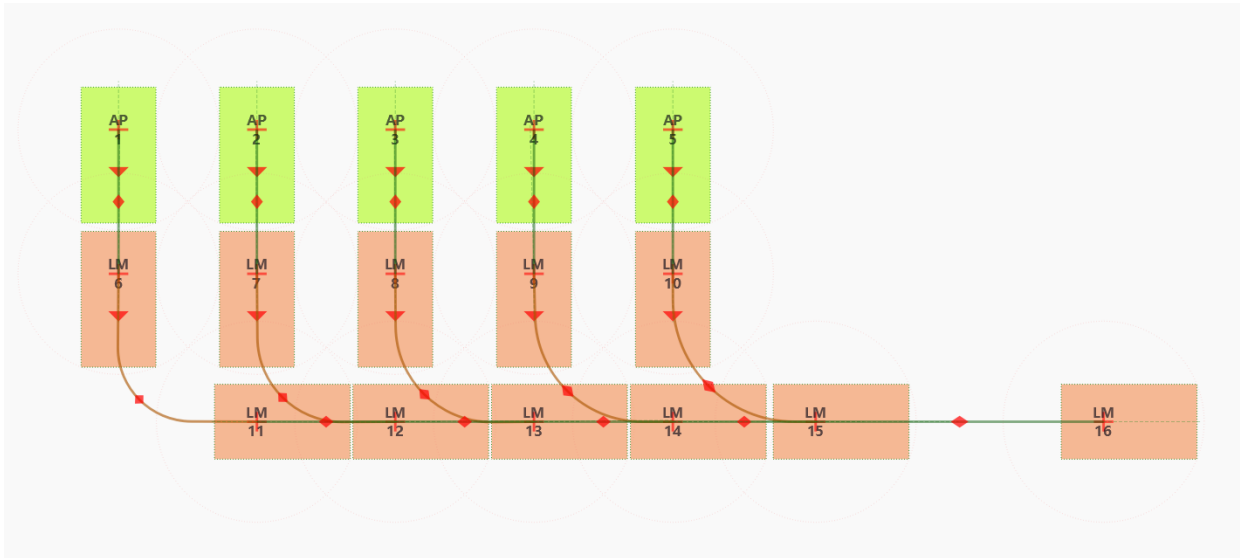
7.4.3.3 Small site space (with or without recognition)

When the site space is small and the distance between the warehouse locations does not allow driving of forklift in an arc route, the route should be drawn into an angle.

As shown in the figure below:

## 7.5 Navigate the Path to Specified Point and Execute the Corresponding Action

The forklift picks up in two modes: recognition mode and non-recognition mode.

- Recognition Mode: It refers to the mode in which 3D recognition camera is used to recognize the location and height of the shelf for picking up the cargo; it is necessary to set a start point in front of the shelf for the AP point on the map, but it is unnecessary to set AP points precisely. Note: Refer to 7.7 Recognition for detail.

- Non-recognition Mode: It refers to the mode for the robot to pick up cargo along the route preset on the map; AP point is the position for the robot to pick up cargo. It is necessary to determine a start point for setting entering height and set AP points precisely.

- Precondition: Confirm that the localization status of the robot is normal, and the path between the destination point and the current location of the robot is unobstructed.
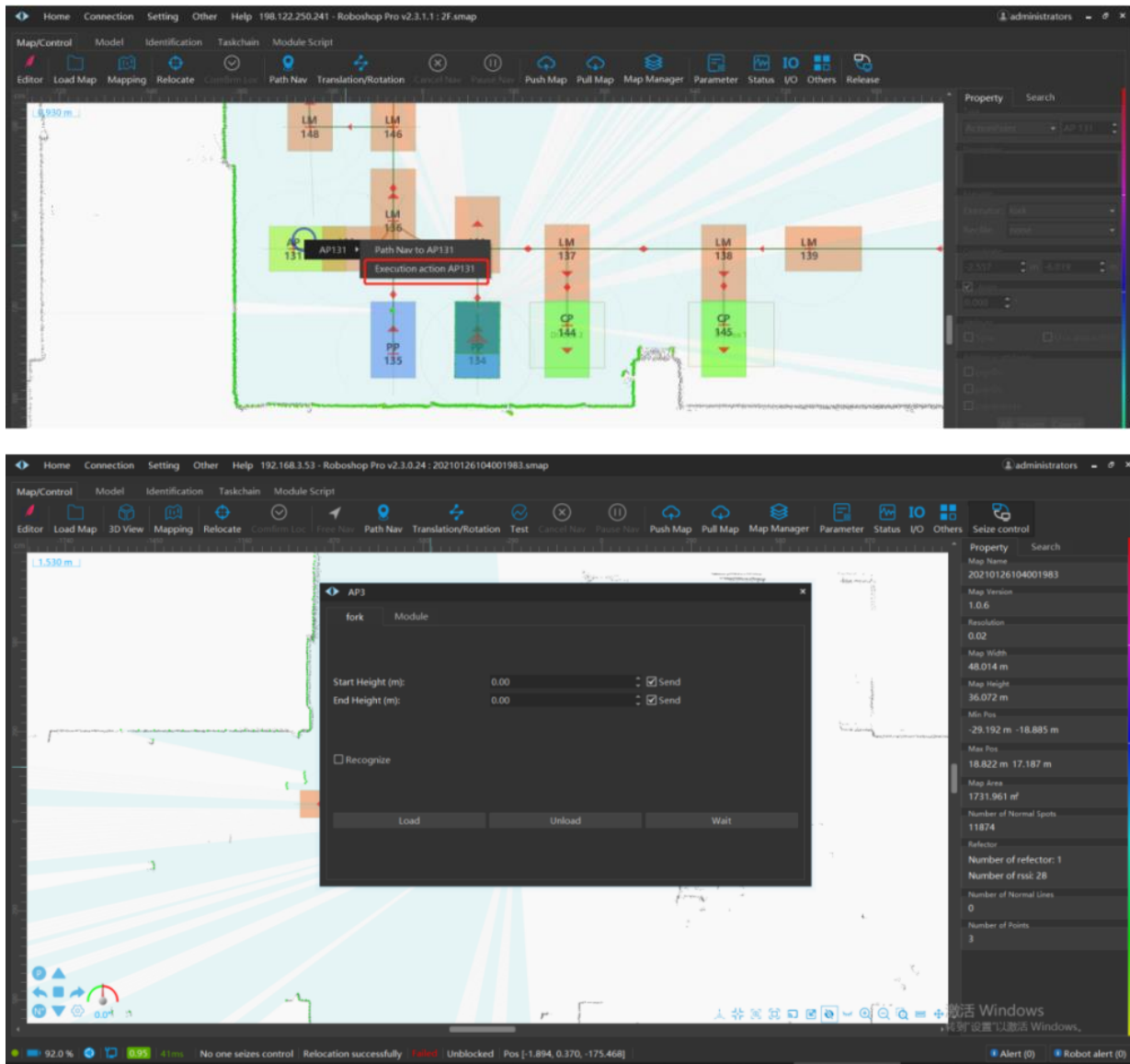
a. Load/Unload in Non-recognition Mode: Click [Path Navigation] in the module toolbar, click the target site with the left button, select [Execute Action AP35] in the popup dialog box, check off the option [Recgnize] in the dialog box, input Start Height and End Height in the dialog box and then select the option "Load/Unload"; the robot will execute the action of Start Height at the start point of AP35, execute the action of End Height and then perform the corresponding action of Load/Unload;

b. Load/Unload in Recognition Mode: Click [Path Navigation] in the module toolbar, click the target site with the left button,select [Execute Action AP35] in the popup dialog box, and check the option [Recgnize] in the dialog box;the robot will reach the start point of AP35 automatically for recognition and then rise the fork to the shelf height for lifting;

7.6 Upper computer controls the rising/dropping of forklift
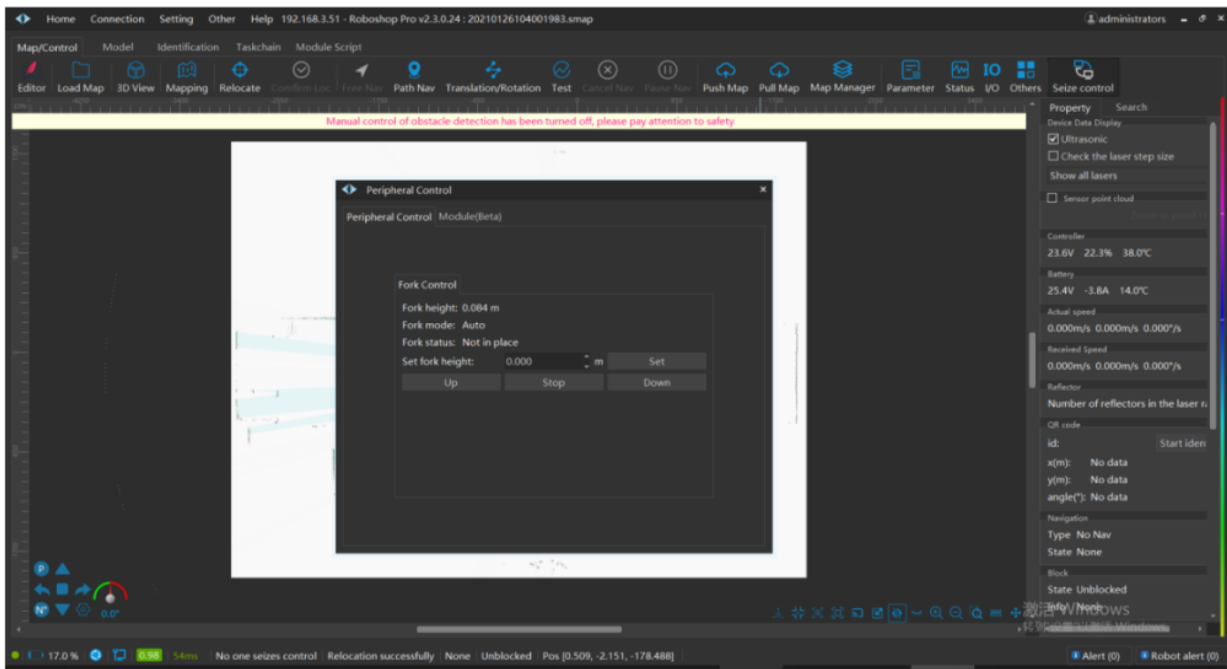
Upper computer controls the rising/dropping of forks: After confirming that the robot is in normal re-localization status, click the button P on the right bottom corner of Roboshop.

a. If clicking [Rise forks], the robot forks will rise to the maximum height from the present position;

b. If clicking [Drop forks], the robot forks will drop to the minimum height from the present position;

c. If clicking [Stop], the robot will stop the forks in motion (rising or dropping);

d. If inputting designated height (e.g. 1m) in [Set fork height], the forks will rise to 1m;

7.7 Recognition

If the forklift is fitted with 3D camera, it can recognize before forking the cargo, so as to implement more precise operations by adjusting the relative position between the fork tooth and the cargo. The following presents two recognition modes - pallet recognition and material cage recognition with PERCIPIO camera as an example:
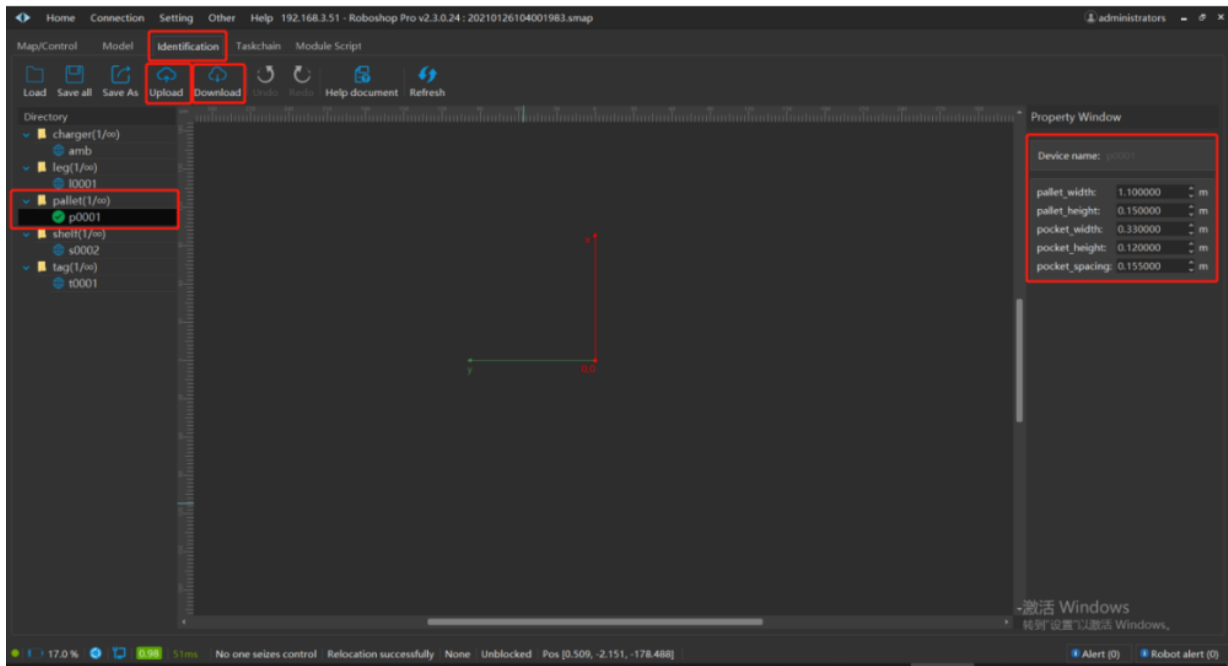
7.7.1 Pallet Recognition

Specific Operations and Parameter Setting

Refer to

https://seer-group.yuque.com/ui8dn8/chc43y/hn2dmc

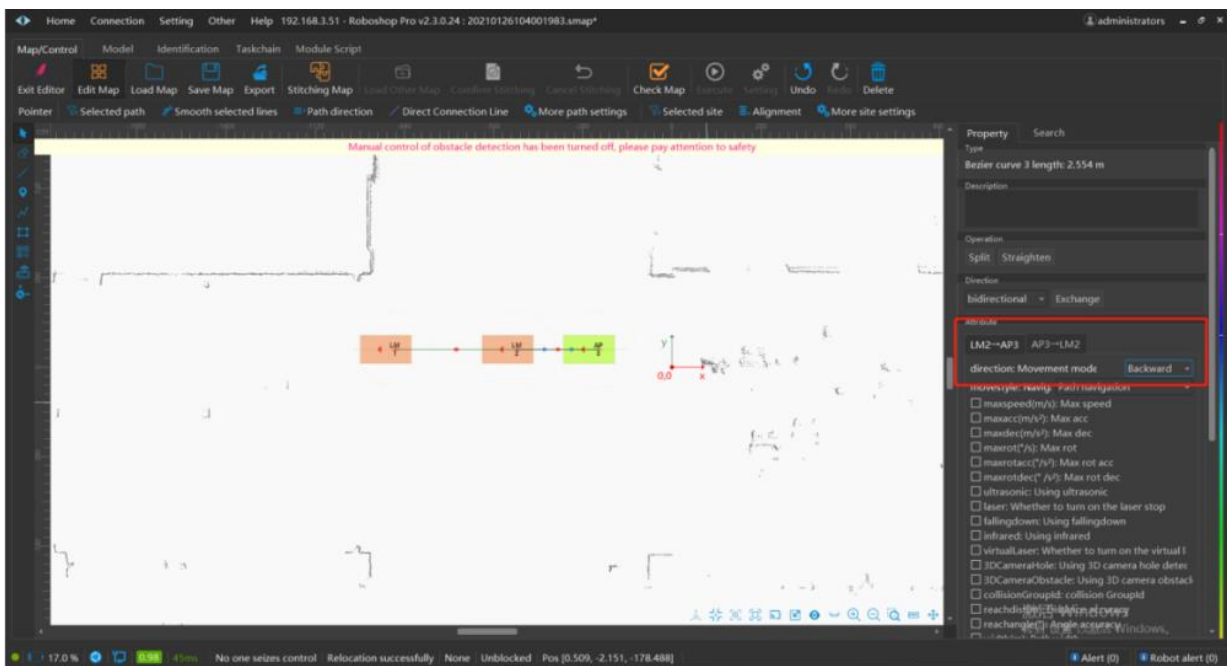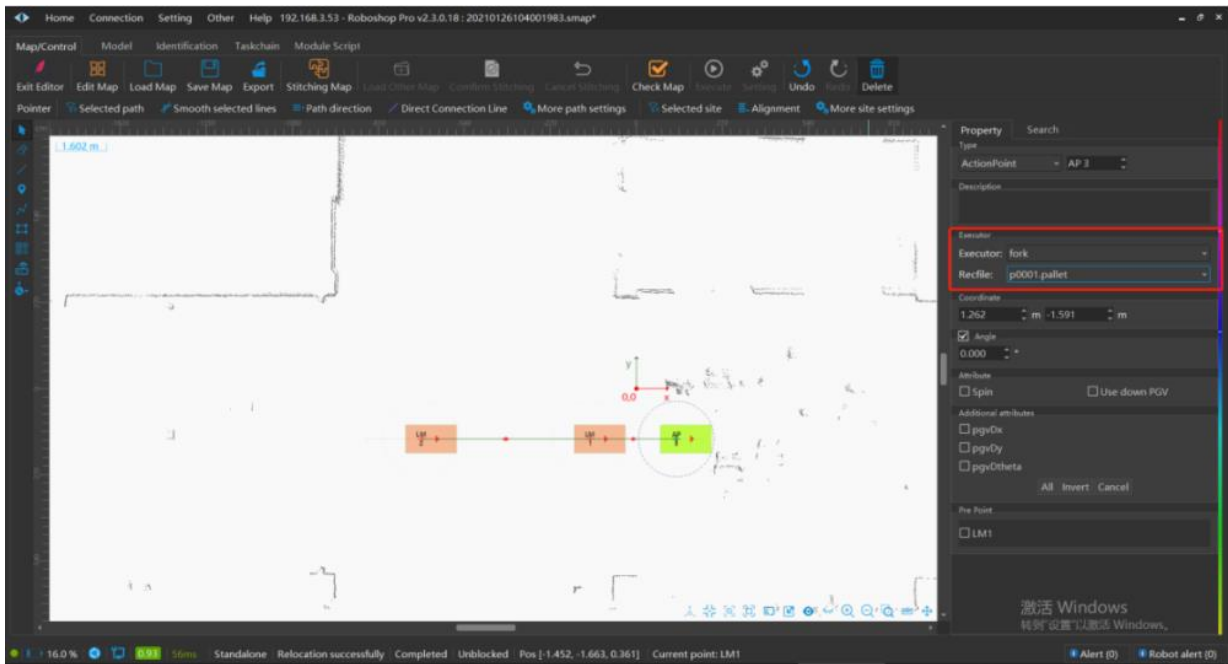https://seer-group.yuque.com/ui8dn8/ult9ds/snr17b

1. Before the forklift recognizes the pallet, the pallet data should be preset as follows: In [recognize file]--[pull out all], check [p001] in [pallet] on the left to change parameters or right click "Copy and add" to create a new pallet, change the pallet parameters and click [push all] to push the changed pallet recognition file to the robot.

2. Set three sites on the map: LM1, LM2 and AP3. Connect them successively, set LM2→AP3 as driving backward, click AP3 to change the [Execution object] into "fork", change [recognize model file] into "p001.pallet" (the specific file should be selected according to the actual situation), save it and push to the map.

3. Click [path navigation], move to AP3, click it with left button, select to execute the action AP3, check [Recognize] in the operation box and click [Load] to send the instruction.

7.7.2　Material Cage Recognition

Specific Operations and Parameter Setting

Refer to

https://seer-group.yuque.com/ui8dn8/chc43y/rodr31

https://seer-group.yuque.com/ui8dn8/ult9ds/snr17b

1. Before the forklift recognizes the material cage, the material cage data should be preset as follows: In [recognize file]--[pull out all], check [t001] in [tag] on the left to change parameters or right click "Copy and add" to create a new material cage, change the material cage parameters and click [push all] to push the changed material cage recognition file to the robot.
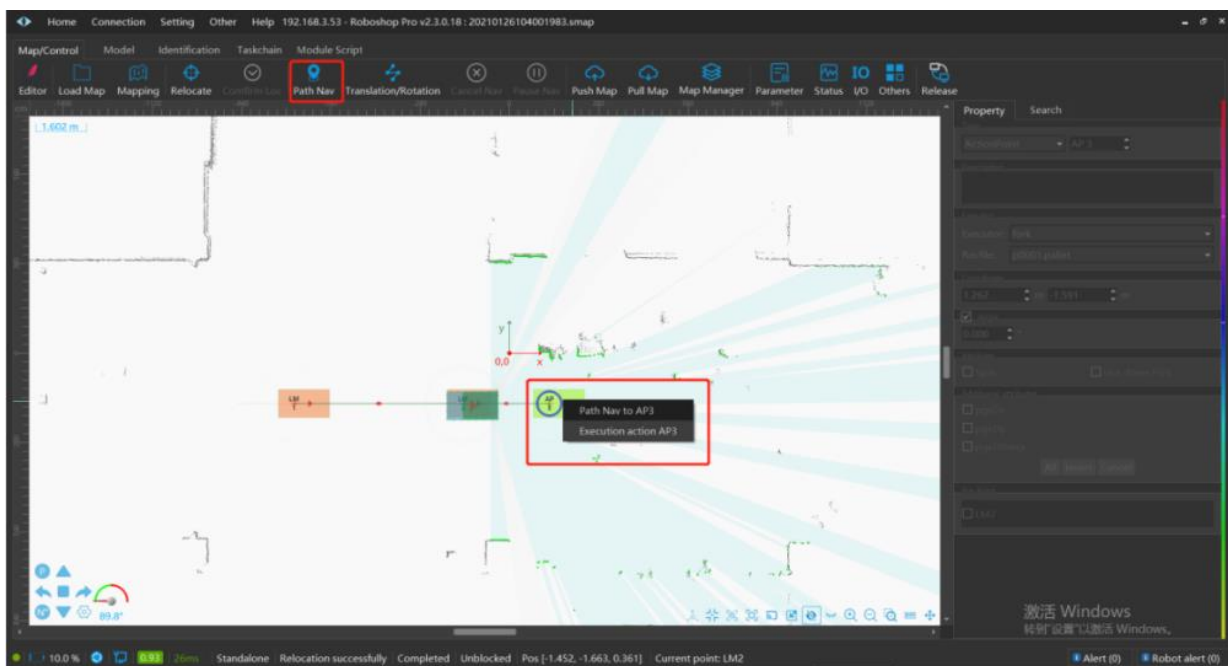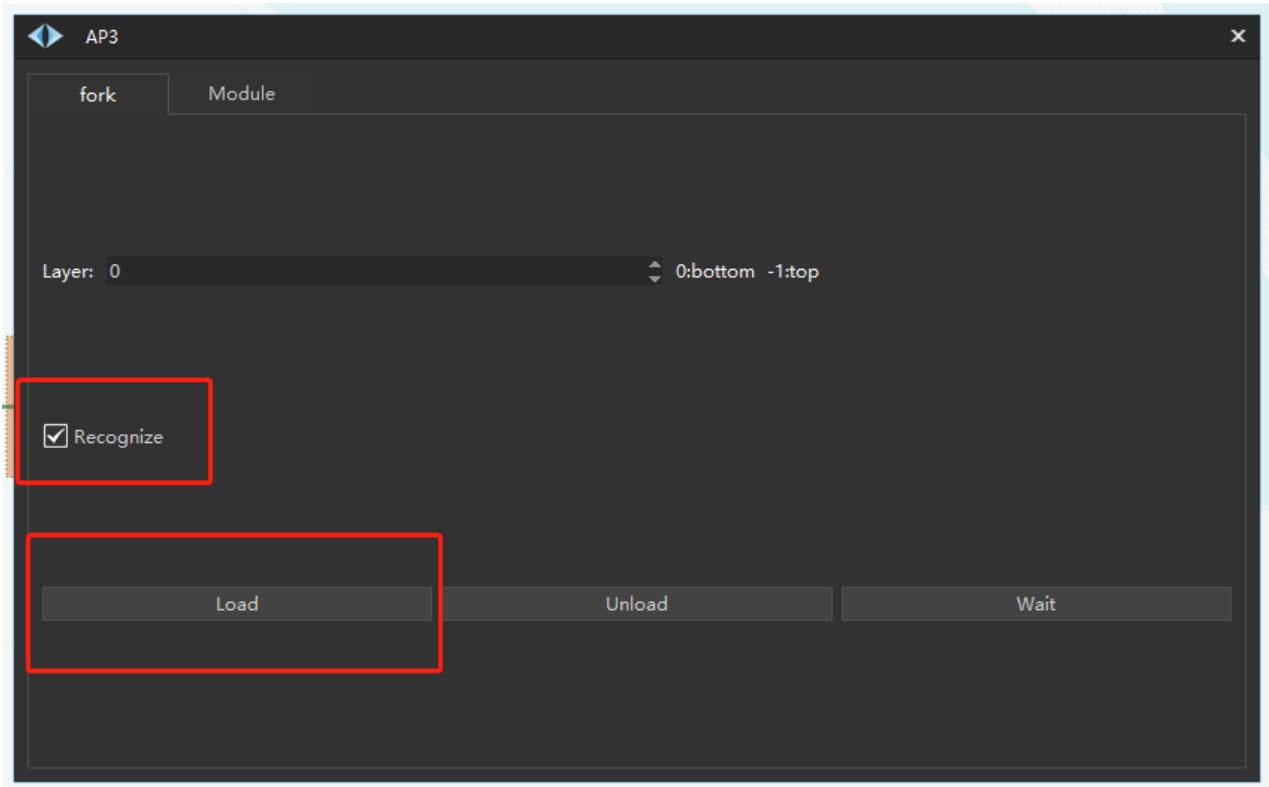
2. Set three sites on the map: LM1, LM2 and AP3. Connect them successively, set LM2→AP3 as driving backward, click AP3 to change the [Execution object] into "fork", change [recognize model file] into "p001.pallet" (the specific file should be selected according to the actual situation), save it and push to the map.

3   Click [path navigation], move to AP3, click it with left button, select to execute the action AP3, check [Recognize] in the operation box and click [Load] to send the instruction.
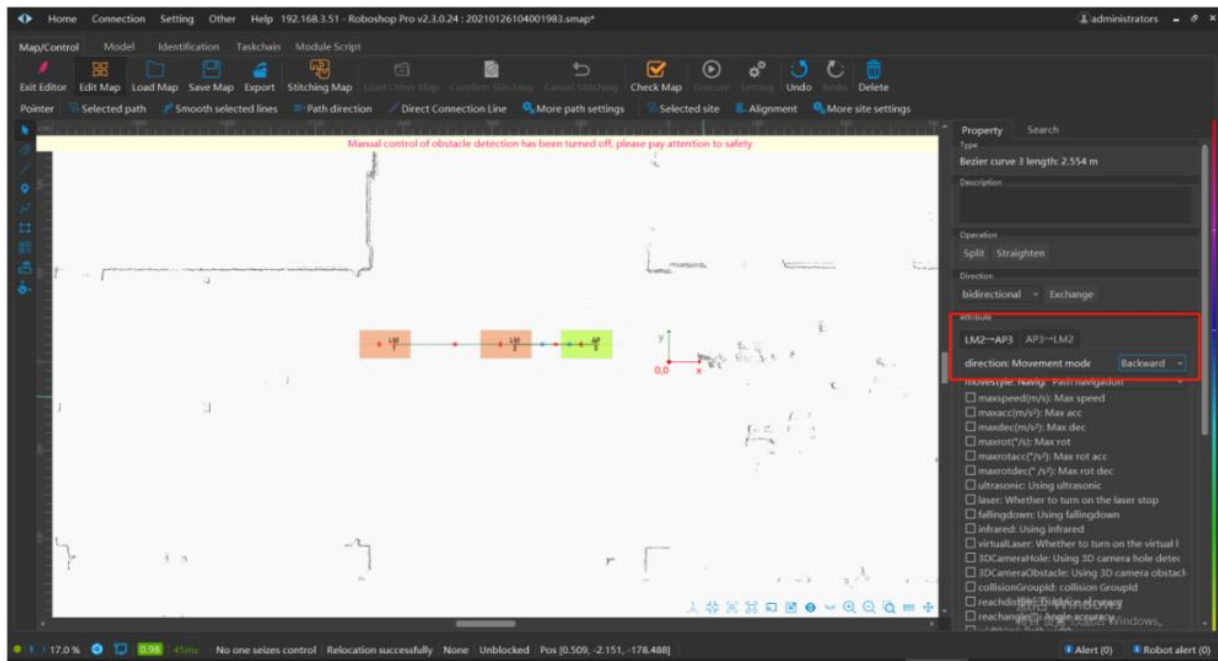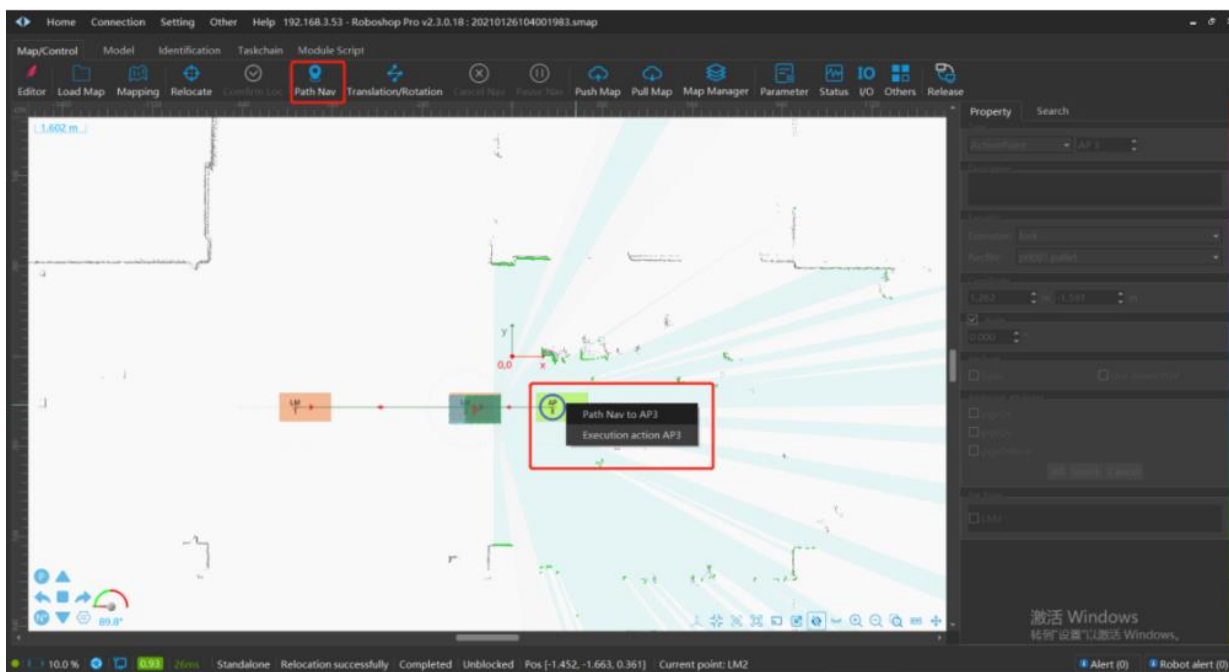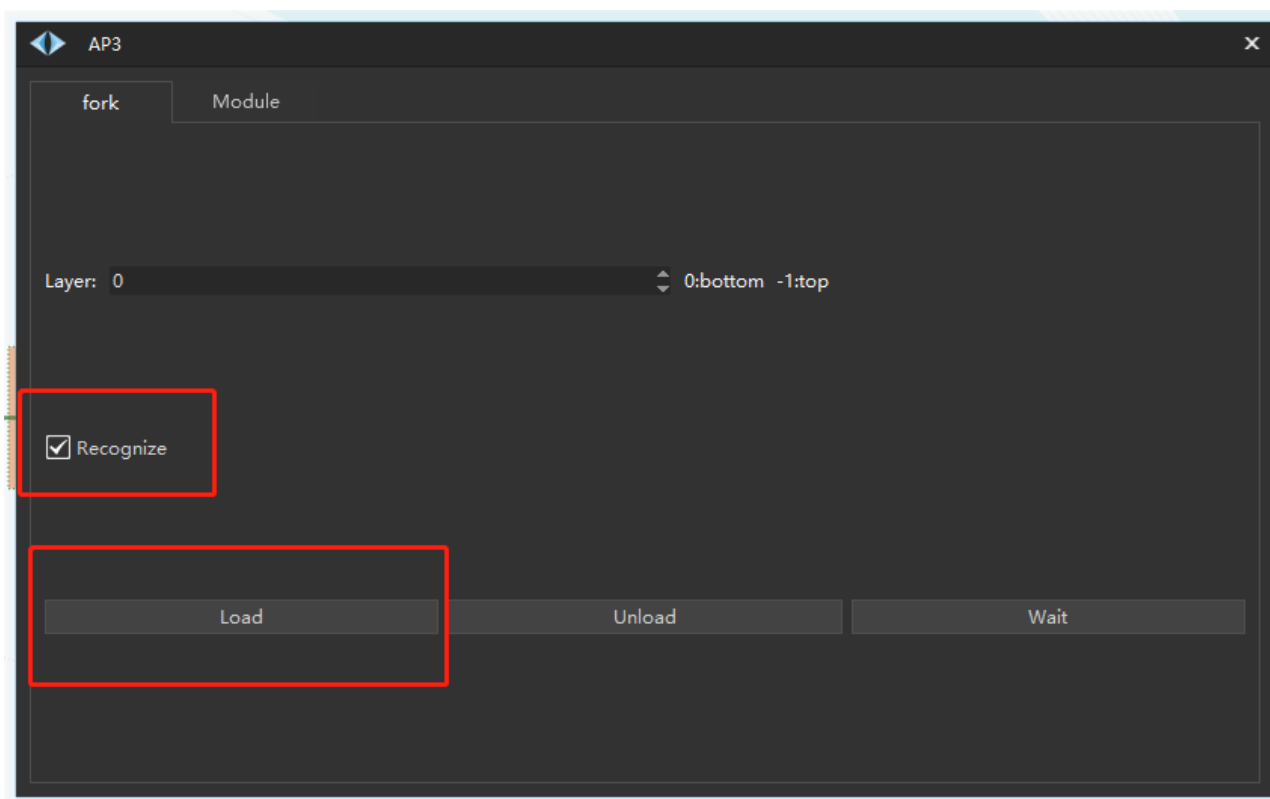
7.8 Error Code

When an error is reported in the robot, the corresponding causes can be ascertained in the document according to the error code in the Roboshop.

https://seer-group.yuque.com/ui8dn8/xwnsrg/append-b_gapm1u
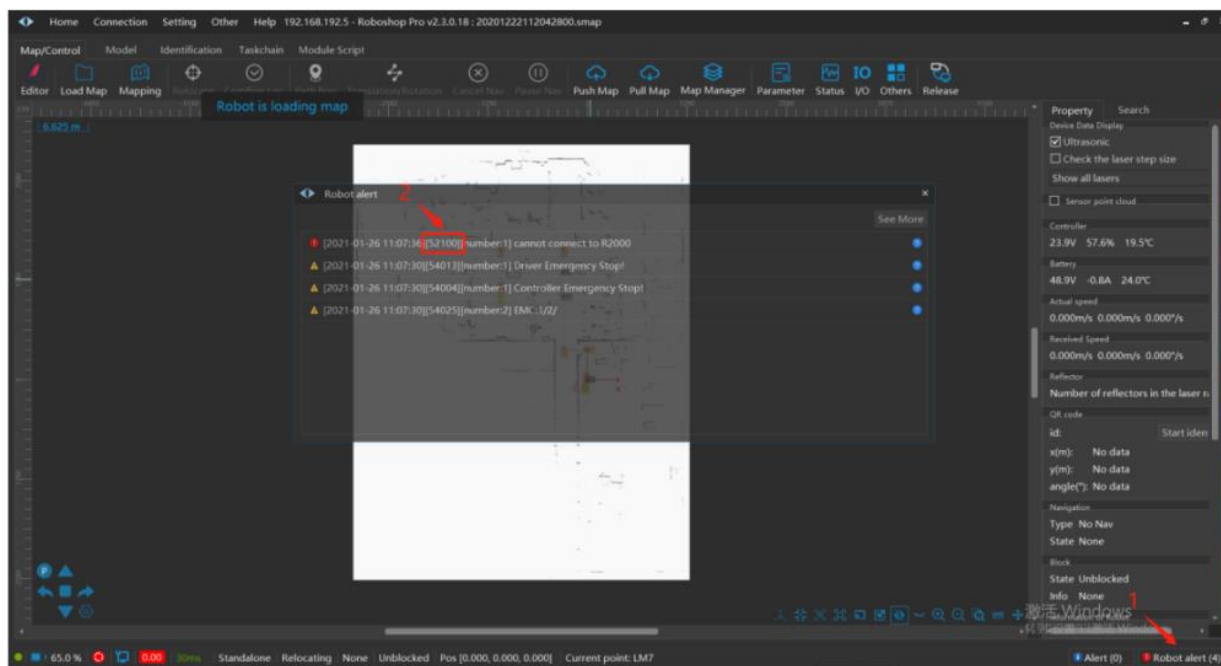
8. Application

8.1 Optional Parts for External Module

Name of Optional Parts	Model	Location	Purpose
3D laser vision (Obstacle avoidance)	DJI Livox Mid-70	Front middle position of forklift, designated height range area, installation orientation: Ground	To detect the obstacles on non-laser scanning surfaces in the driving direction of the forklift.
3D camera (pallet recognition)	PERCIPIO FM851-E2	Rear position of forklift, Installation orientation: fork tooth direction	Recognize the pallet to ensure accurate connection of forklift
3D camera (QR code recognition)		Rear position of forklift, Installation orientation: QR code area	To carry out secondary localization by recognizing the QR code to ensure accurate connection of forklift
Obstacle avoidance laser	HOKUYO UST-05LN	Left and right obstacle avoidance lasers on front part of forklift	To detect the obstacles for obstacle avoidance
	Hinson CNS-LS05I		

9. Product Maintenance

9.1 Maintenance Instructions

Before performing any maintenance or troubleshooting activities, please read the content of this chapter, this manual and other related manual carefully to understand 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 and training on maintenance organized by the manufacturers, distributors, and local importers.

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

⚠	**Operation Precautions for Robot Parts** • Only approved parts can be used. • If unapproved parts are used without authorization, we will not bear any responsibility. We will not responsible for any damage to the robot, accessories or any other equipment caused by the use of unapproved parts.
⚠	**Maintenance Precautions for Robot** • Perform maintenance in strict accordance with the description in this manual. Do not dismantle or change any parts not described in this manual without authorization. Wrong dismantling, changing parts, or wrong maintenance may cause the robot system to work abnormally and cause serious safety problems. • When you need to enter the working area of the robot under emergency, stop the system. • Please 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 instructions.

9.2 Regular Maintenance

9.2.1 Regular Replacement of Critical Safety Parts

• It is difficult to identify damage or breakage for some parts through regular maintenance. To further improve safety, users shall replace the parts given in the table below on a regular basis.

• If those parts become abnormal before the replacement interval expires, they shall be replaced immediately.

S/N	Name of Critical Safety Parts	Service life (years)
1	Hydraulic hoses for lifting system	1～2
2	Lifting chain	2～4
3	High-pressure rubber hoses and hoses for hydraulic system	2
4	Internal seals and rubber parts for hydraulic system	2

9.2.2 List of Forklift Oils

S/N	Name	Designation/ code		Capacity (L)	Remarks
1	Gear oil	80W/90		1.15	Gearbox
2	Industrial Vaseline	2#		On demand	Battery posts
3	Each bearing of front wheel and balancing wheel	GB491-65ZG-2 calcium-based grease		On demand	480h
4	Other moving fitting surfaces	GB491-65ZG-2 calcium-based grease		On demand	480h
5	Hydraulic oil	L—HM32	Winter	On demand	Hydraulic oil tank
		L—HM46	Summer		

9.2.3 Maintenance List

Operate according to the maintenance list below and follow the respective intervals, which are detailed below:

W1 = Every 50h of operation, but at least once a week.

M3 = Every 500h of operation, but at least once every 3 months.

M6 = Every 1,000h of operation, but at least once every 6 months.

M12 = Every 2,000h of operation, but at least once every 12 months.

Maintenance intervals							
Standard = ● Cold Storage = #							
Component	S/N	Maintenance Method	W1	M3	M6	M12
Body and working devices	1.1	Inspect all load-bearing parts for damage		●		
	1.2	Inspect all bolt connections for looseness		●		
Drive Part	2.1	Inspect the transmission system for noise and leakage		●		

Maintenance intervals						
Standard = ● Cold Storage = #						
Component	**S/N**	**Maintenance Method**	**W1**	**M3**	**M6**	**M12**
	2.2	Inspect the level of gear oil in the transmission system		●		
	2.3	Replace gear oil			#	●
Wheel Part	3.1	Inspect for wear and damage	●			
	3.2	Inspect the bearings in the wheels and ensure a tight fit with the wheels		●		
Steering System	4.1	Inspect the movement of steering control		●		
Braking System	5.1	Inspect the performance and adjustment of the foot brakes	●			
	5.2	Inspect the wear of the drive wheel brake discs		●		
	5.3	Inspect the brake coupling, and adjust if necessary		●		
Lifting Device	6.1	Inspect its performance and wear pattern, and adjust		●		
	6.2	Visually inspect rollers for jamming		●		
	6.3	Inspect the fork head and slide frame for wear and damage	#	●		
Hydraulic System	7.1	Performance Inspection	#	●		
	7.2	Inspect all connection parts for leakage and damage b)	#	●		
	7.3	Inspect whether there is leakage and damage to the hydraulic cylinder and whether the accessories are safe and reliable	#	●		
	7.4	Inspect the oil volume	#	●		
	7.5	Replace hydraulic oil and filter element c)			#	●
	7.6	Inspect whether each cylinder is normal			#	●
Electrical system	8.1	Performance Inspection		●		
	8.2	Inspect whether all wire connections are safe and reliable, and where there is any damage		●		
	8.3	Inspect whether the fuse amperage is appropriate				

		Maintenance intervals				
		Standard = ● Cold Storage = #				
Component	**S/N**	**Maintenance Method**	**W1**	**M3**	**M6**	**M12**
	8.4	Inspect whether the switches and steering devices are safe and reliable, and whether they function properly		●		
	8.5	Inspect the forward and reverse switches and acceleration knob		●		
	8.6	Inspect whether the function of warning device is correct	#	●		
Motor	9.1	Inspect the wear of carbon brush and commutator (pump station motor)			●	
	9.2	Inspect the safety of motor attachments		●		
	9.3	Clean the dust on the motor with vacuum cleaner			●	
Battery	10.1	Inspect the electrolyte density, capacity and battery voltage	#	●		
	10.2	Inspect the safety devices and grease suitability of terminals	#	●		
	10.3	Clean the battery connectors and inspect the fit tightness	#	●		
	10.4	Inspect battery cables for damage and replace if necessary		●		
Lubricating Oil	11.1	Grease the forklift according to the lubrication schedule	#	●		
General Measurement	12.1	Inspect the grounding of electrical system for errors				●
	12.2	Inspect the driving velocity and braking distance				●
	12.3	Inspect the rising/dropping velocity, forward/reverse tilting and side shift				●
	12.4	Inspect the safety devices and safety functions		●		
Demonstration	13.1	Perform test runs under rated load		●		
	13.2	After completing the above maintenance operations, prove that the forklift is reliable for personnel	#	●		

- Inspect the tightness of the nuts on the wheels approximately after first 100h of operation; tighten them if necessary.

- Inspect hydraulic system connections for leakage approximately after first 100h of operation;

tighten them if necessary.

• After the first 500h of operation.

9.3 List of Wearing Parts and Major Components

S/N	Name	S/N	Name
1	Load-carrying wheel	15	(Steering) proximity switch
2	Bearing of load-carrying wheel	16	Oil-free bearings
3	Balancing wheel	17	Handle nitrogen spring
4	Bearings of balance wheel	18	Key switch
5	Carbon brush of steering motor	19	Emergency stop switch
6	Drive wheel	20	Rising contactor
7	Phenolic bushings	21	Control handle assembly
8	Handle microswitch	22	Mast bearing
9	(Mast) proximity switch	23	Horn

9.4 Forklift Repair

9.4.1 Diagnosis

Phenomenon	Troubleshooting
1. Tremble when lifting	a. There is air trapped in the lifting cylinder. The air can be bleed off by lifting/lowering under load for several times. b. The oil level in hydraulic system is low. It is necessary to add hydraulic oil.
2. Drop automatically under load.	a．The oil leaks from pipeline or oil circuit joints. Tighten or replace the seals. b．The solenoid directional valve, one-way valve and overflow valve get stuck by dirt inside or the seal ring gets worn, resulting in internal leakage. Clean the valves and replace the seals.
3. The rising velocity is too low or it cannot rise.	a．The oil level in oil tank is low. Add hydraulic oil or replace the oil. b．The oil filter is blocked. Clean it with kerosene or replace it. c．The pressure of safety valve is insufficient. Re-adjust it. d．The excessive wear of oil pump causes internal leakage. Replace the oil pump. e．The solenoid directional valve, one-way valve and safety valve are worn or the seals are worn or aged. Replace them. f．The pipeline is blocked or leaks oil. Clean the oil pipeline or replace the

Phenomenon	Troubleshooting
	seals.
	g．The hydraulic oil is deteriorated or the viscosity declines, resulting in leakage. Replace the hydraulic oil.
4. Abnormal rattling sound is emitted from the driving wheel.	a．Hard debris is mixed in the lubricating oil. Replace the lubricating oil. b．The bearing is excessively worn or damaged. Replace it.
5. The electro-magnetic brake fails	a．The control circuit is not disconnected. Inspect the control system. b．The brake friction pad is worn. Replace it.
6. It does not work at all.	a．Inspect whether the key switch and emergency stop switch are turned on or damaged. b．Inspect whether the battery is charged. If the battery level is low, it is necessary to recharge it. c．Inspect whether the power socket is plugged in tightly, whether the emergency switch is disconnected, and whether the fuse is blown.
7. It cannot rise or drop.	a．The microswitch in the control switch is loose or fails, or the spring of reset switch is loose. Tighten the screw. b．The hydraulic valve pipeline is blocked. Clean the pipeline. c．The DC contactor connection for rising/dropping is loose or fails.
8. The dropping velocity is too high.	a．The flow rate of overflow valve is too high. Adjust the overflow valve accordingly.
9. The load cannot be lifted.	a．The battery level is low. Recharge the battery. b．Adjust the overflow pressure of the hydraulic station. c．The hydraulic oil pipeline leaks oil. Inspect the hydraulic oil pipeline. d．It is overloaded. Reduce the load. e．The oil pipeline of hydraulic valve is blocked. Dredge the hydraulic oil pipeline. f．The hydraulic lifting motor is faulty. Repair it.
10. It rises auto-matically.	a．The DC contactor switch fails. Repair or replace it.
11. It cannot drive forward or backward.	a．The battery level is low. Recharge the battery. b．The driving control microswitch is loose. Tighten the screw. c．The DC contactor fails. Repair or replace. d．The electric control panel is damaged. Repair or replace it.

Phenomenon	Troubleshooting
	e． The driving motor is faulty. Inspect and repair it. f． The wheel gets locked. Adjust the spacing between brake pads of driving wheel.
12. The forklift always drives forward.	a． The red brake pedal on the control handle gets stuck. Inspect and adjust its position, or replace the spring.
13. The battery life is short.	a． The battery electrolyte level is low. Replenish distilled water or plumbic acid. b． The battery is over-discharged and has not been recharged timely. It is necessary to repair and recharge the batter pack timely according to the operation and maintenance instructions for battery, so as to resume the dead battery. c． The battery is aged. Replace the battery.
14. The battery cannot be recharged.	a． The power socket is in poor contact. Repair the contact surface. b． The battery is serious under voltage. Replace the battery. c． The charger is damaged. Replace the charger.
15. The charger does not work.	a． There is no display on the charger. The fuse is blown. b． The power indicator of charger is lit, the internal fuse is open-circuited or the fuse is open-circuited or the rectifier tube is damaged. c． Inspect whether the battery is not connected properly, is short-circuited or is not connected at all, whether the over-temperature protection is triggered and whether the charging voltage meets the battery specification.

9.4.2　Preparation before Repair

To avoid accidents in the repair and maintenance process, the following preparation must be done:

• Park the forklift safely.

• Press the emergency stop switch and disconnect the battery connector.

• When the forks are to be lifted or the forklift is to be lifted before operation, measures must be taken to prevent the forks or forklift from tipping or slipping or falling suddenly.

9.4.3　Inspect the hydraulic oil level

• Prepare the forklift for repair and maintenance.

• Lift the pedal pad hole and the filler cover plate hole on the front floor.

• Inspect the hydraulic oil level in the tank.

• When inspecting the hydraulic oil level, the forks and fork CARR must be lowered to the lowest position.

9.4.4 Inspect the brake fluid level.

- Inspect the amount of brake fluid in the container on the left side of the body. If the brake fluid is insufficient, it shall be added in time.

9.4.5 Preparation before usage after maintenance:

Use the forklift again only after the following operations have been completed.

- Clean the forklift.

- Inspect whether the safety frame, tyres and mast are mounted firmly.

- Inspect whether the brake function is normal.

- Inspect whether the function of the emergency stop switch is normal.

- Inspect whether the function of the horn is normal.

9.5 Cleaning

9.5.1 Floor Cleaning

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

Epoxy Floor - Serious Traces
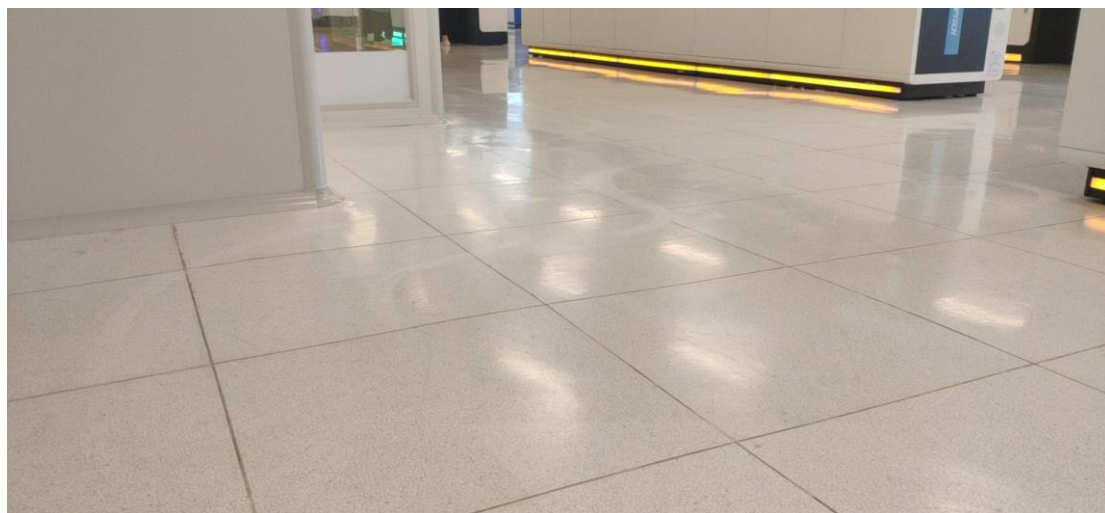
Anti-electrostatic Floor - Slight Traces

Ground Cleaning Requirements:

- Inspect the floor every day, and clean the dust, foreign matter and liquid contaminant timely for the purpose of preventing the robot sliding.

- Clean up the traces of the universal wheel on the floor timely for the purpose of avoiding 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.

9.5.2 Robot Cleaning

Before cleaning, please shut down the robot as follows:

- Park the forklift at the specified position.

- Press the emergency stop switch.

- Turn off the key switch and remove the key.

- Unplug the battery.

9.5.2.1 Clean the forklift surface.

- Do not use flammable liquids to clean the forklift; take safety measures to prevent short-circuit.

- Clean the forklift with water and soluble detergent.

- Carefully clean the oil filler and the surrounding area of the lubrication nozzle.

- If forklift is cleaned frequently, please lubricate it in time.

9.5.2.2 Clean the chain.

- Do not use corrosive liquids such as chemical detergents and acidic liquids to clean the chain.

- Place a container under the mast.

- Use petrochemical derivatives such as gasoline to clean the chain.

- Do not add any additives when cleaning with steam nozzle.

- Dry the water stains on the chain pins and chain surface immediately after cleaning.

9.5.2.3 Cleaning of Electrical System

- Do not clean the pump control and various connectors with water to avoid damage to the electrical system.

- Use a non-metallic brush or a low-powered hair dryer to clean the electrical system according to the manufacturer's instructions but do not move the protective cover.

9.5.2.4 After cleaning

- Thoroughly dry the water stains on the forklift (e.g. using compressed air).

- Start the forklift according to the procedure.

- If moisture penetrates the motor, it must be removed first to prevent short-circuit.

- Moisture will reduce brake performance. Apply braking for the forklift briefly and repeatedly to dry the brakes.

9.5.3　Laser Cleaning

⚠️	**Precautions for Laser Cleaning**
	• If the laser is not cleaned or is cleaned improperly, it may cause the following problems:
	1) The robot can't detect the sign/pallet rack.
	2) The robot enters the emergency stop state without clear reasons.

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

- Keep the laser lens surface clean, and clean up the dust regularly.

- Please use a special cleaning cloth.

- Do not dry-wipe the laser lens surface. Please use a dampened soft cloth to clean, and add a little detergent if necessary.

- Do not use corrosive solvent-based detergent, such as acetone.

9.6　Storage

9.6.1　Storage of Robot

- If it is to be stored for more than 2 months, the robot must be parked in a freezeproof and dry place, with the required protective measures taken before storage.

- If it is to be stored for more than 6 months, please refer to the manufacturer's service department for some additional protective measures.

- During storage, it is recommended that the forklift be jacked up to ensure that the wheels are completely off the ground to protect the wheels and bearings from being damaged.

9.6.1.1　Operations to be completed before storage

- Clean this forklift thoroughly.

- Inspect whether the braking function is correct.

- Inspect the hydraulic oil level. Fill up the oil tank if necessary.

- Apply oil or grease to all parts for protection.

- Lubricate this forklift with grease against the detailed lubrication table.

- Recharge the battery.

- Disconnect and clean the battery and apply electrode grease to the electrodes of the battery.

In addition, some special requirements in the battery's instruction manual must also be observed.

9.6.1.2 Measures to be taken during storage

- The battery must be recharged every 2 months.

- It is very important to charge the battery regularly. Otherwise, the battery can be completely self-discharged. Due to sulphation, the battery will be completely destroyed.

9.6.1.3 Carry out test run again.

- After the forklift has been parked for a long time, it should be tested again before usage again to make sure that all parts of the forklift are intact and all functions are running properly to ensure that the forklift can be used safely.

- Clean the forklift thoroughly.

- Lubricate the forklift according to the lubrication table.

- Clean the battery, apply electrode grease to the electrode bolts and reconnect the connectors.

- Recharge the battery.

- Inspect the gearbox oil of the driving wheels for moisture and replace it if necessary.

- Inspect the hydraulic oil for moisture and replace it if necessary.

- If the switches of the electrical system are in poor contact, spray all exposed electrical connectors with contact cleaner to remove the oxide layer from these connections.

9.6.2 Charger Storage

- When the charger is not in use, it shall be placed in the packaging box.

- The limit temperature of the warehouse shall be -20 to 70℃, the normal temperature shall be -20 to 50℃, the relative humidity shall be 5-90%, and there shall be no harmful gas, flammable, explosive, corrosive and other chemicals in the warehouse, or strong mechanical vibration, shock and magnetic field influence.

- 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, and it must be tested again after two years.

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

# 10. Specification of Effective Loads

The following diagram illustrates the center-of-mass specifications for safe operation under full load (1,500KG). (c refers to the load center which is 500mm)
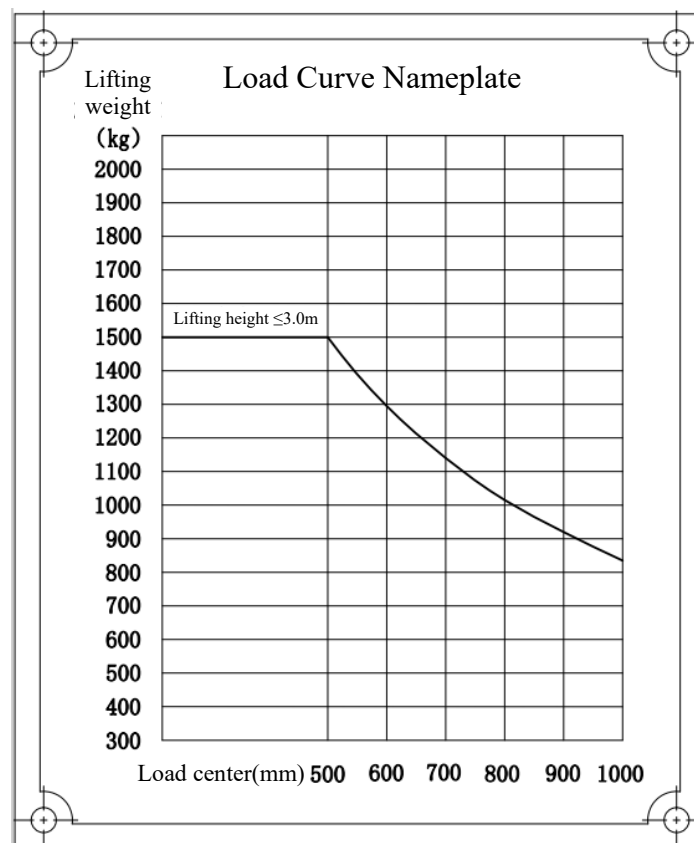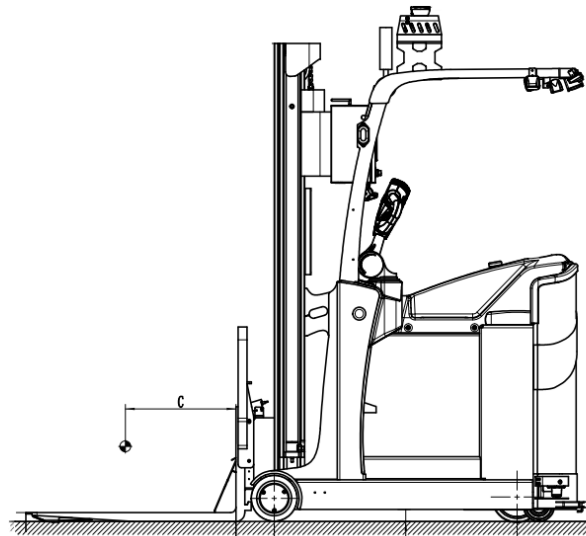
11. Software Update

Follow these steps to update the robot software:

1. Obtain necessary software update packages through our distributors or after-sales channels.

2. Connect the prepared computer and the robot to the same network (both wired and wireless, please set the appropriate IP address to ensure the normal connection between the computer and the robot).

3. Open the browser (we recommend that you use Chrome to ensure compatibility) and enter the robot IP address (the wired connection is 192.168.192.5, please determine the corresponding IP address for wireless connection) to access the robot upgrade interface.
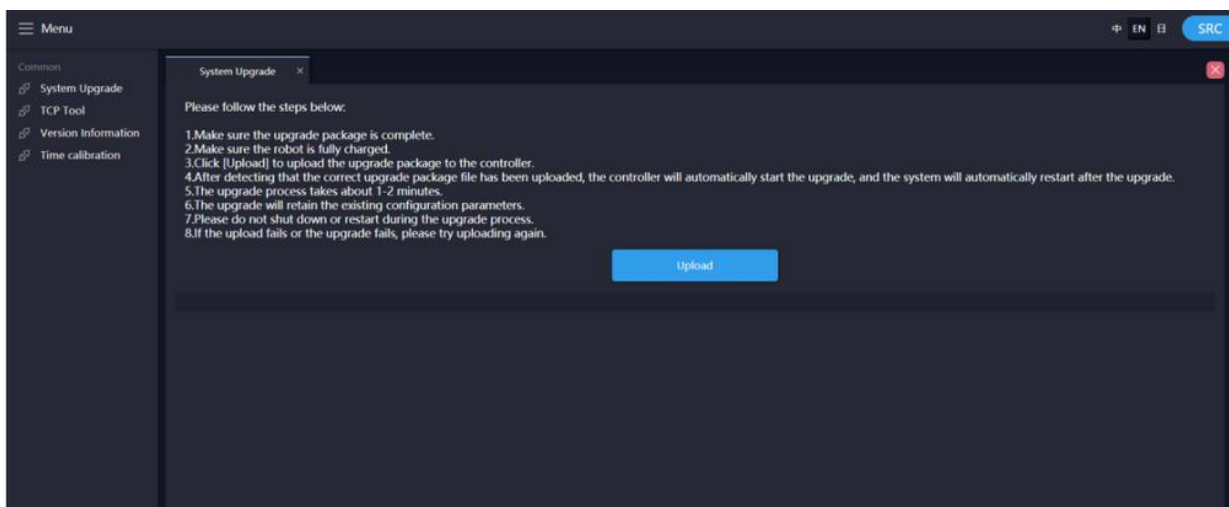
4. Select system upgrade and read the system upgrade steps carefully.
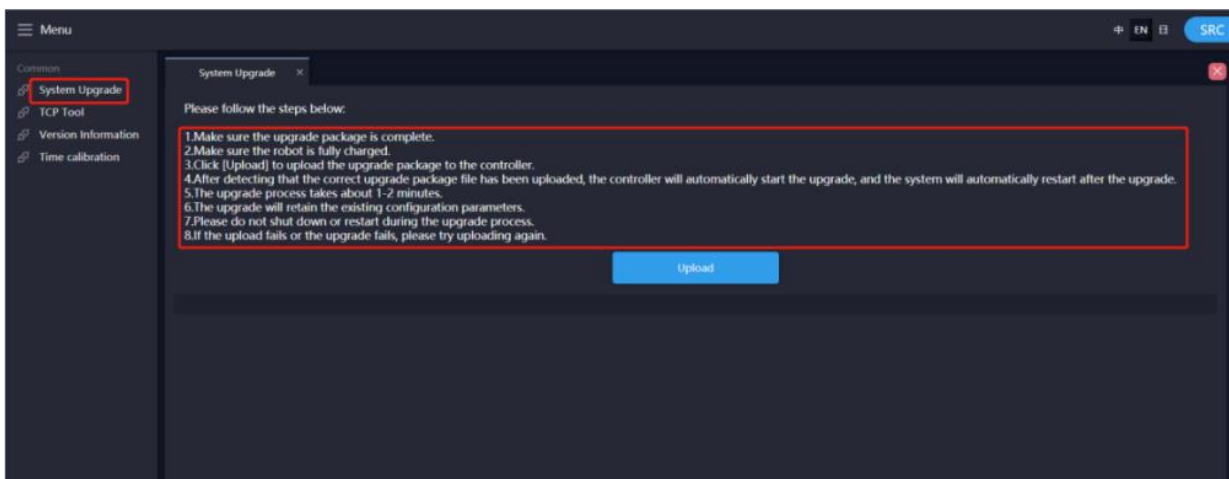
5. Click upload. Find and select the obtained software package.
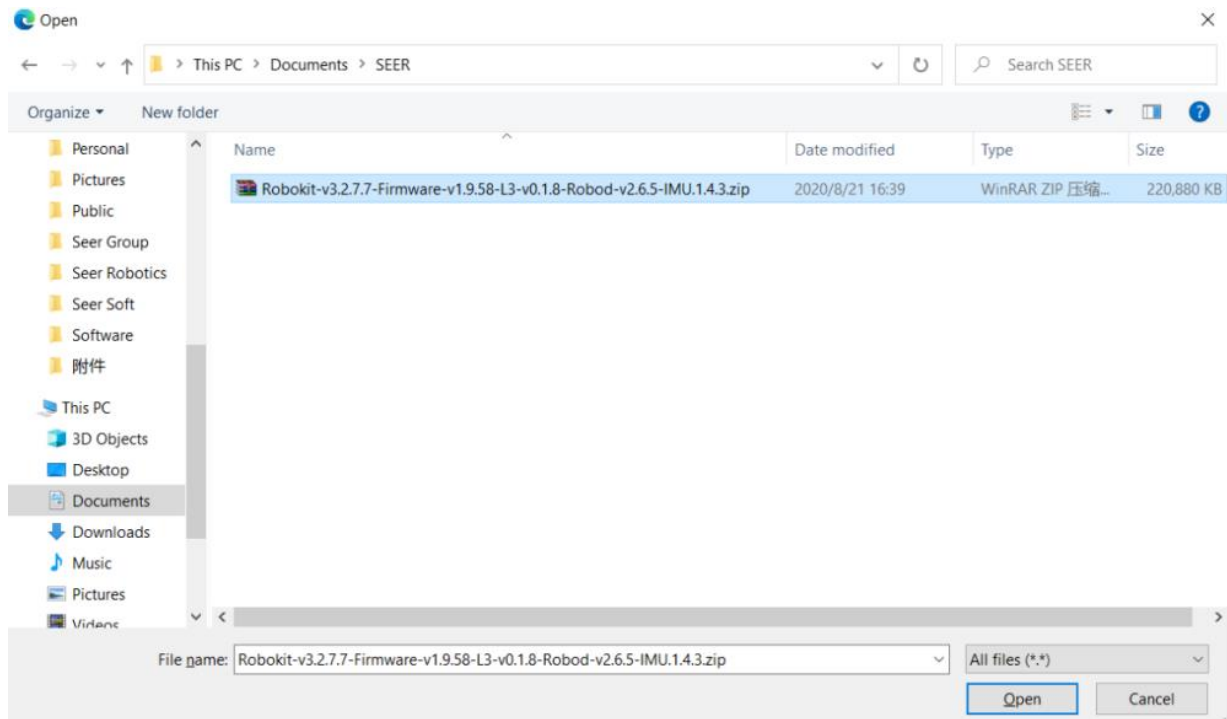
Generally, the package name starts with Robokit. Upload the zip package directly. Do not decompress the package.

6. Wait until the software package is uploaded, as shown in the following figure:
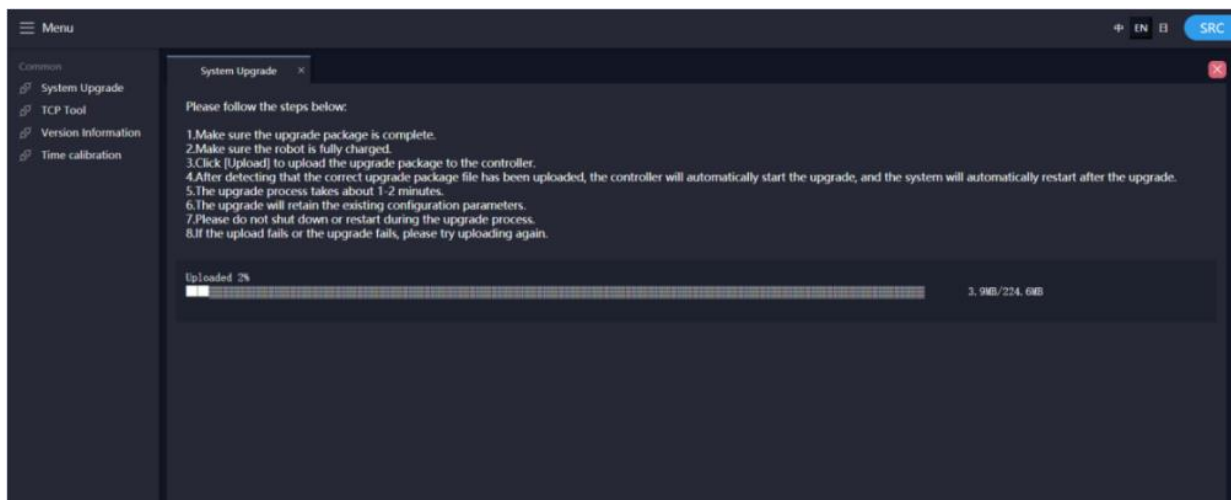
It may take several minutes for the software package to be uploaded. Make sure the network connection is stable.

7. The entire upgrade process may take several minutes. Please wait patiently. Do not perform any operations on the robot during the upgrade. The following prompts indicate that the upgrade is complete:
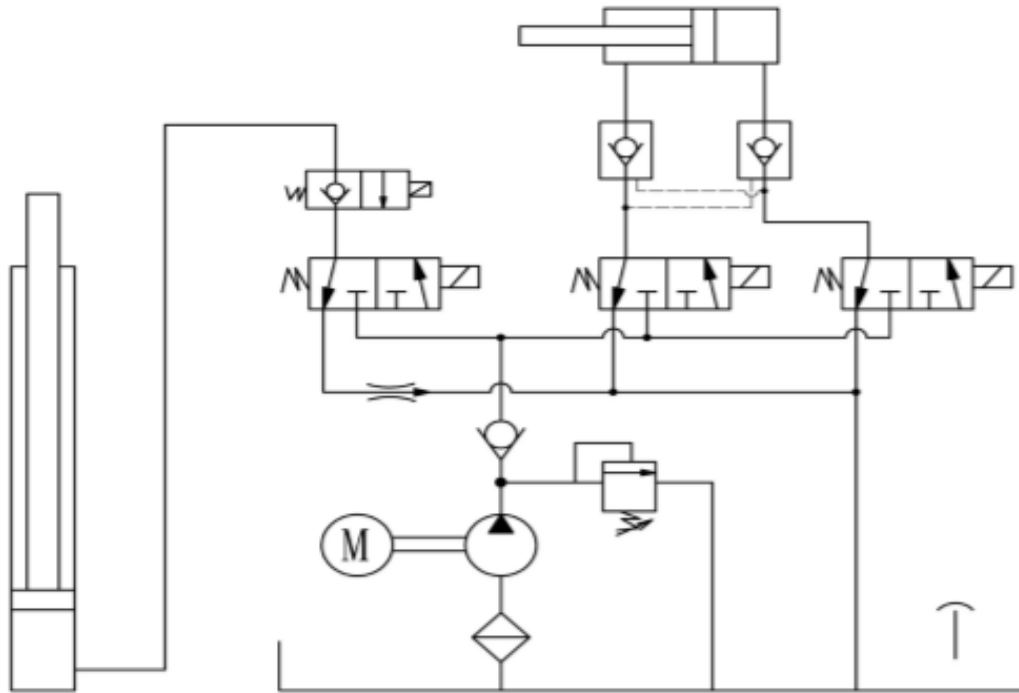
8. After the upgrade is completed, the robot automatically restarts for the update to take effect.

9. Click version information to view the software version of the robot, as shown in the following figure:
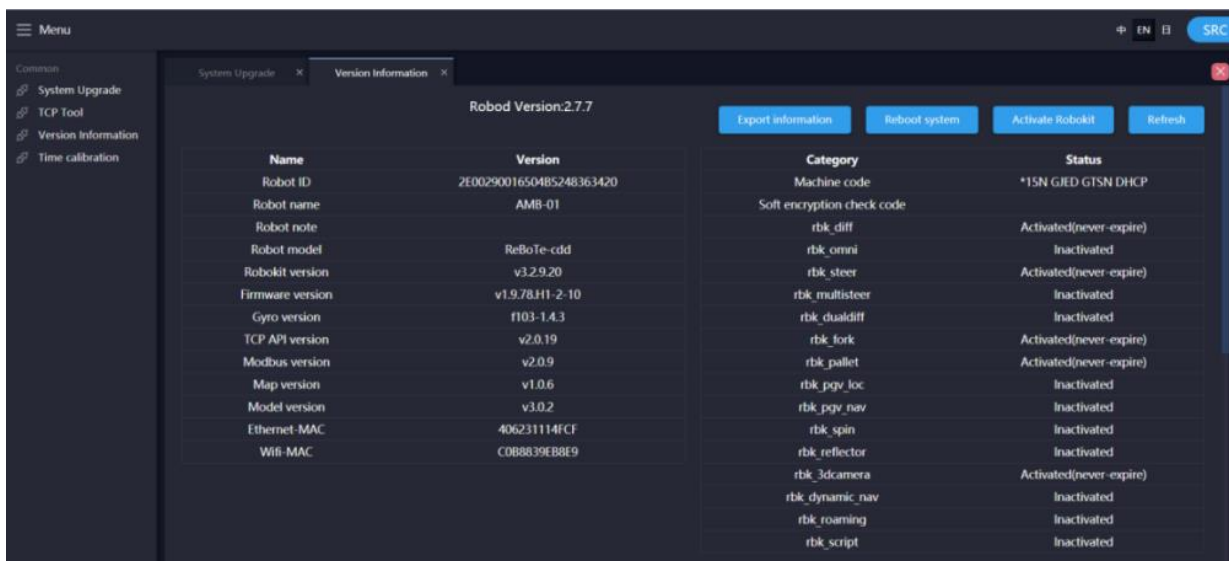
Note: If the upgrade fails, please try to upload it again or contact our after-sales service.

Appendix I Schematic Diagram of SFL-CPD15-T Hydraulic System

Wechat Service   Wechat Subscription

Telephone：400-762-9969

Website：www.seer-group.com   AMR.AI

Address: 1st Floor, Building 1, No. 151 Daxiu Road, Tang Town, Pudong New District, Shanghai

NO.SFL(CPD15-T)02V04-2109-EN