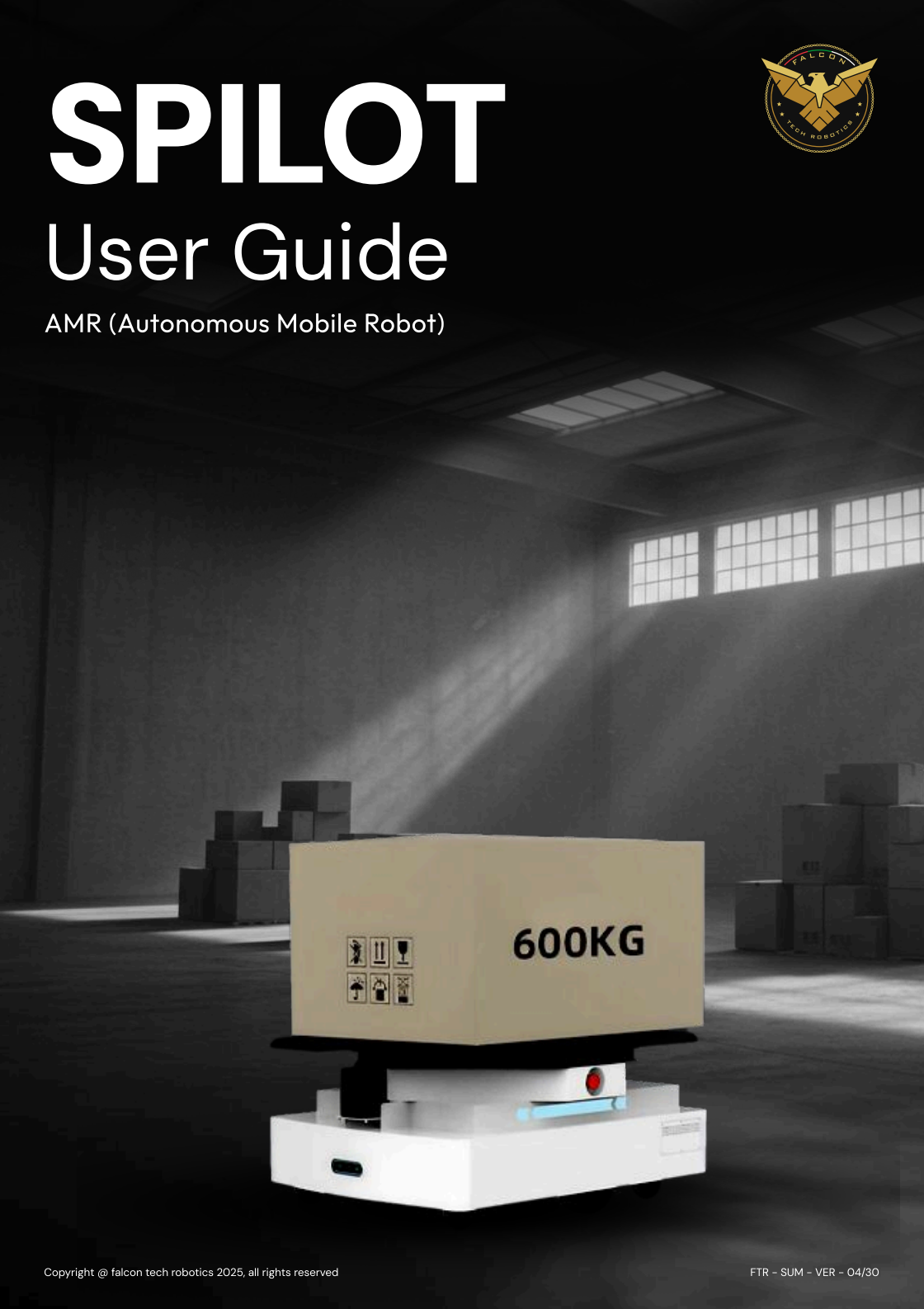
SPILOT

User Guide

AMR (Autonomous Mobile Robot)



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Product Introduction

Safety requirements for use

- Please wait a while before using the robot after a temperature change (for example, from a cold outdoor to a warm indoor room).
- Please do not use the robot in dusty, humid, rainy, dirty places or near magnetic fields.
- Please pay attention to whether there are objects on the ground such as power cords that may trip or entangle the robot. Please remove them before use.
- Please do not use the robot in an environment that is flammable, explosive, or near heat sources.
- Prolonged exposure to direct sunlight may damage the robot, please avoid this situation.
- The ground on which the robot operates should be solid and flat, and it is not recommended to use it on carpets, soft and grooved surfaces, outdoor areas, etc. to avoid the risk of robot performance degradation or falling.
- Please avoid moving near areas with a drop of more than 5cm, such as escalators, stairs, and steps, to prevent falling.
- When there is a fully transparent glass wall (such as a glass door and french window) in the environment where the robot is used, it may interfere with the laser radar reflection. It is recommended to paste opaque stickers on the glass between 22cm and 25cm (laser scanning height) from the ground.
- Do not apply excessive pressure to the screen or use sharp objects to touch the screen.
- To ensure the reliability and operational safety of this product, please make sure to use the exclusive accessories of this robot.
- The robot has the function of automatically identifying obstacles, but please do not suddenly appear in front of the robot while it's in motion, as it may cause safety hazards accidents.
- Do not disassemble the robot and its accessories on your own. Only authorized professionals can carry out the disassembly operation.

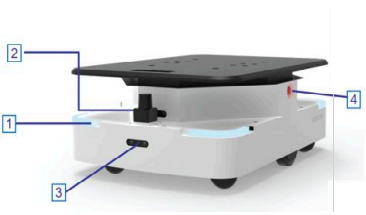
Charging precautions

- Please use the original DC charger of the robot to charge the robot to ensure its safety and efficiency, otherwise it may cause electric shock to personnel and damage to the robot.
- Personnel are prohibited from disassembling and assembling robots while charging.
- Do not drop or hit the charging station, as it may cause damage to the station.
- Do not touch the power cord with wet hands or unplug the charging station by pulling the power cord directly.
- The charging station should be placed in a dry area to avoid rain or liquid immersion.
- If the robot has not been used for a long time, please charge it once every 3 months to ensure that the battery is in optimal working condition.
- Do not use the battery for other devices.
- Do not attempt to touch the charging station or the charging port output end of the robot.
- The charging station layout area should be close to the wall and maintain an open environment within 2 meters ahead, without placing debris.

Special attention: Improper handling of batteries may lead to accidents such as battery explosion, fire, leakage and corrosion. Please be sure to comply with the above regulations.

Structural parameters

1. Overview of robot components



1. Decorative Lights
2. Lidar
3. Deep vision camera
4. Emergency stop switch

4. Emergency stop switch
5. 7-inch display
6. 6-inch wheel hub motor
7. 4-inch universal wheel

8. Infrared sensor
9. Micro USB port
10. Direct charging power port
11. Automatic charging contact spring
12. Power button

2. Specifications

Product Specifications

Operating System	Android 11.0 System
Robot Size	900mm(length)*650mm(width)*340mm(height)
Net weight	115kg
Maximum load	600Kg
Processor Type	RK3566

Memory LPDDDR3	2G
FLASH	16GB
Screen size	7 inches, IPS screen (16:9) resolution 1024 x 600
Android WiFi	Support dual-band 2.4 & 5 Ghz
Remote Function	Support remote navigation status monitoring and remote online update of navigation system
Environmental requirements	Operating temperature：0°C~50°C Ambient humidity：5% ~ 85% Storage temperature：-10°C~50°C

ROS navigation specifications

Operating System	Ubuntu
LiDAR	• Distance 40 meters • Wavelength 905 nm • Working area 260°
Gyroscope sensor	Single axis gyroscope sensor
Hard drive	128G high-speed solid-state drive
Motor drive	6 inch servo motor
512AN_HMW module Intel WIFI	Supports dual-band 2.4&5G WIFI 802.11b/g/n wireless LAN, 11ac 5.15GHz-5.825GHz
Movement Speed	0.3~1m/s
Navigation motherboard	Intel Core I5 Motherboard
Navigation method	Laser navigation+visual obstacle avoidance

Battery and battery life

Battery capacity	Lithium iron phosphate nominal 38.4V / 27.5Ah
No-load continuous motion	10h
Stand-by-power consumption	50W
Battery Life	Using lithium iron phosphate power battery, the cycle life reaches more than 2000 times

Charge

Charging station	Input: 100V~240V
Charging time	43.2V/6.5A (approximately hours)
Charging method	automatic recharge

3D camera

Depth vision camera	Horizontal angle of view 110°, Vertical angle of view 71°

Code reader (optional)

Lens focal length	3.37mm
Working distance	100mm ± 20mm
Field of view	60°*45°

Instructions for use

A. Get to know your robot

Power on

Press and hold the [power button] as shown in the image for about 1 to 2 seconds, the buzzer will make a short "beep" sound, and the internal light bar of the machine will light up, waiting for the robot to start up.

Power off

Press and hold the [power button] for about 3 seconds, and then the display will turn off and the motor will be powered off after a beep.

Charging

You need to insert the plug into a 110-220V voltage. At this time, the green light on the charging pile will light up, indicating that it is ready to charge.

1. **Manual charging**

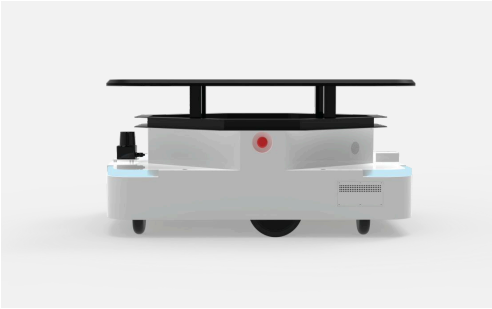
   Turn on the charging pile, then push the robot onto the charging pile, so that the charging plate behind the robot is in full contact with the charging plate on the charging pile. The charging pile indicator light turns red to indicate that the machine is charging.

2. **Automatic charging**

   Refer to the navigation deployment below, deploy the charging point locations, and open the [IronOx] application on the Android screen to customize the battery level that triggers automatic recharging

B. Lifting mode

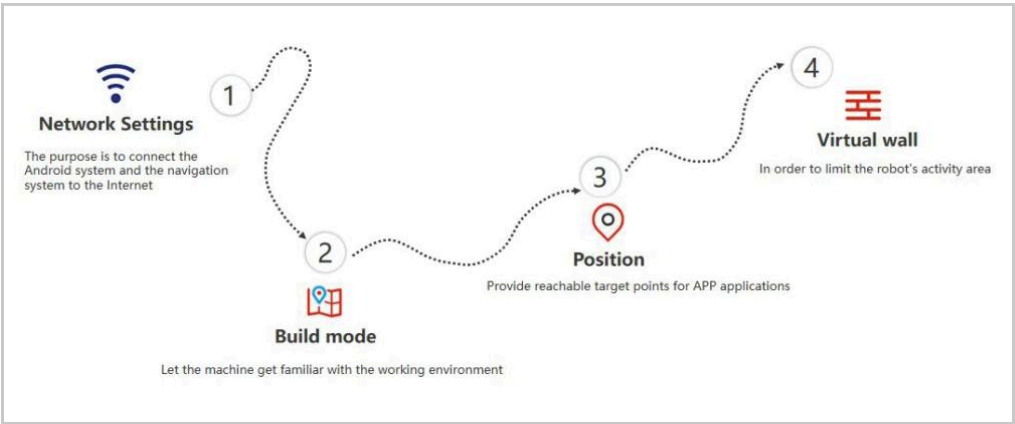
The robot lurks at the bottom of the cargo rack, lifts the cargo rack by 100mm, transports the cargo rack to the designated location, and uses the label code to accurately locate the cargo rack, thereby realizing the transportation of materials. Lifting view:



C. Navigation deployment

Explanation

The following content is an introduction to all the functions of the robot deployment backend. The necessary functions are shown in points 1, 2, 3, and 4 in the figure below. Other functions depend on specific scenarios and usage situations

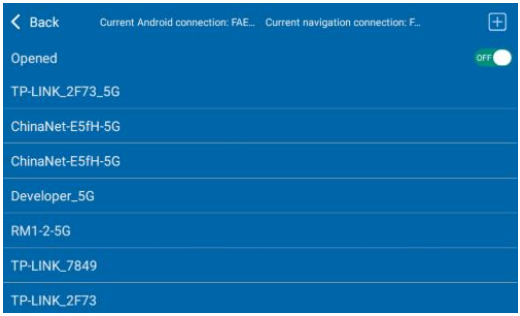


Step-1 (Network Settings)

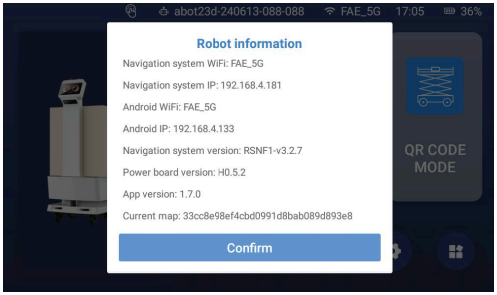
Note

The router network segment cannot be the 192.168.10.x network segment

1. Click on the application on the robot Android page to find the "**IronOx**" software. You need to connect to the Internet when you enter the software for the first time.



1. Check the Wi-Fi name you want to connect to
2. Enter Wi-Fi password
3. Send Wi-Fi information to the navigation system (click once, do not click repeatedly)
4. If the IP is displayed, the connection is successful (if the connection timeout is displayed, the connection fails)
5. After the WIFI connection is successful, you will enter the main interface of the software. Click the ⑤pattern on the main interface to view the robot's navigation system IP.



2. The scanning device needs to be connected to the same WIFI as the robot. Open the browser and enter the robot's Navigation system IP address (Chrome browser is recommended)

Note

If the Wi-Fi connection fails, you can reconnect to the network again. If it still fails, you can try another network to connect.

Step-2 （Build a map)

The purpose of building a map is to allow the robot to understand the working environment

Actual environment

The map scanned by the robot's laser

Robots need to scan the actual environment and build a "raw map", so that they can compare the real-time scanning with the original map and find their own location during the navigation process.

The viewing angle of LiDAR is 260 °, and the scanning range is the horizontal plane of the radar height; the scanning distance is 40m.

Please push the robot from behind to scan the map (this method requires pressing the emergency stop switch), or use the keyboard arrow keys to control the robot to move and scan (this method requires keeping the emergency stop switch in the non-pressed state).

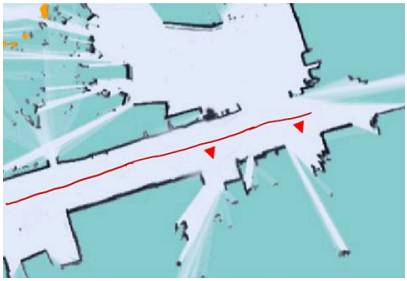
Note

This model recommends using the computer keyboard arrow keys to control the robot to scan.

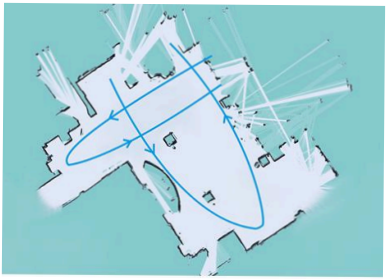
1. Please follow the sequence below to enter the map creation page

1. Make sure the computer and the robot are connected to the same WiFi, open the browser, enter the IP address displayed on the IronOx app in the address bar, and press Enter to connect to the robot.

2. After entering the [Build mode], first push the robot to rotate in place for a circle to scan the surrounding environment. Do not rotate too fast. After a circle, continue to push the robot to scan according to the actual situation of the environment. In narrow areas, you can walk in a straight line. When walking, you need to pay attention to the intersections. Slowly rotate the machine 90 degrees in place to face the gap to clear the feature points, and then slowly turn back to continue scanning; in open areas, you can follow a U-shaped route as follows.



Straight Line



U-shaped Route

3. When pushing the robot forward to scan the map, it is necessary to pay attention to check if the laser matches the actual terrain. If it does not match, stop and wait for a moment. Wait until the laser matches the actual terrain before continuing. As shown in the following figure: Yellow represents the real environment scanned by the laser, and black represents the generated map outline.

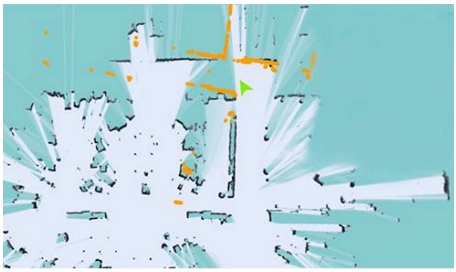


Figure 1

The laser does not match the terrain (when the laser does not match the terrain, stop and wait for the laser to match the terrain before continuing to push the robot to build a map)

Laser matching with terrain (some areas require the robot to turn around to scan clearly, such as wide terrain and inside a room)

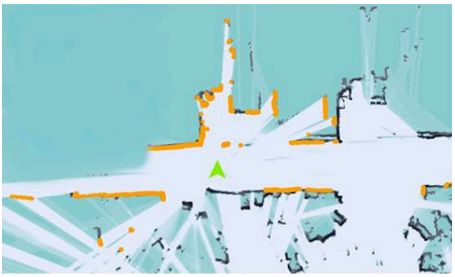


Figure 2

4. After determining the environment in which the robot needs to work after scanning, do not move the machine again. Just observe if the map is clean and free of ghosting, and matches the actual terrain. If there is no obvious misalignment, you can click 'Composition Complete'. If there is any misalignment, please wait for a period of time, and the algorithm will correct it. If the correction is not successful within 10 minutes, consider rebuilding the map.

Matters Needing Attention

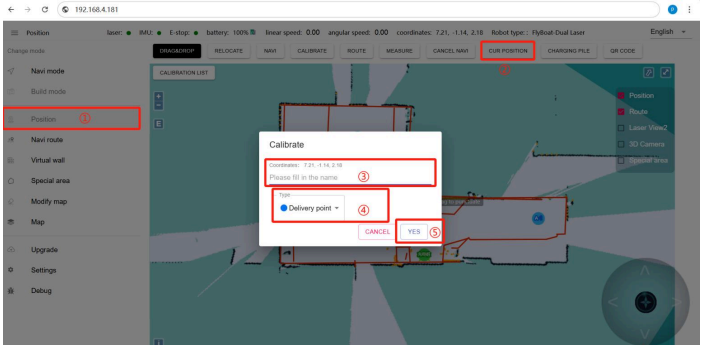
1. Select a place with obvious feature points and clean terrain as the starting and ending points for scanning, and slowly rotate in place at the beginning to scan the surrounding environment clearly.

2. When pushing or controlling the robot, it is necessary to walk slowly and constantly observe whether the laser matches the terrain. If a mismatch occurs, it is necessary to stop and wait for the laser to match the current terrain.

Step-3 (Calibration position)

Function: Set a coordinate point in the map as the specified name, facilitating the business layer to use the location name to guide the robot to the specified location.

1. Normal position calibration: Push the robot to the target point and adjust the direction of the robot, then click **CUR POSITION**, select the point type, give the point a name, and click OK. As shown in the figure

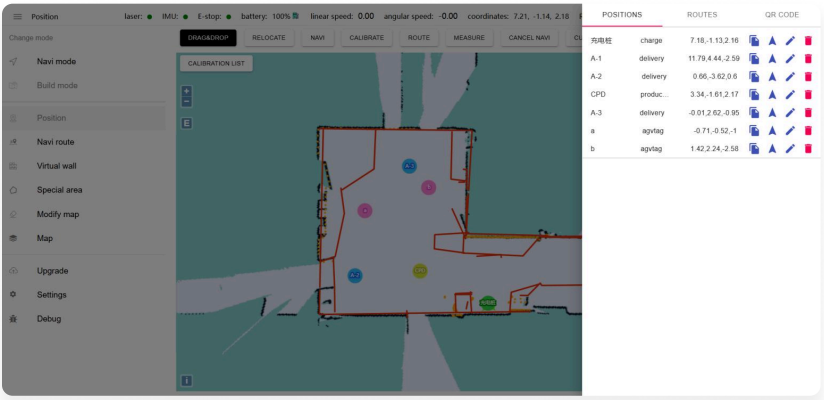


Reflective code calibration method:

To calibrate the reflective code point, push the machine to a position 80 cm away from the shelf, with the front of the machine facing the reflective code on the shelf (the length of the reflective code should be about 8cm), and the calibration point type is the distribution point type

2. Understand the function of each button in this mode

1. **DRAG&DROP:** Press and hold the left mouse button to drag the map up, down, left, and right
2. **Repositioning:** Find the actual location of the machine's environment on the map, click the left mouse button, and drag to generate a straight line that represents the direction of the machine. Release the mouse, and the machine will be positioned to the dragged position. At this point, the complete overlap of the yellow laser data and the black obstacle indicates that the machine is currently positioned correctly.
3. **NAVI:** Click the left mouse button on a blank area on the map and drag the mouse before releasing it.
4. **CALIBR ATE:** You can drag the map to get the coordinates of the specified location for calibration and select the required point type.
5. **MEASURE:** Click any two points on the map to get the length of the route.
6. **CANCEL NAVI:** Cancel the current navigation task.
7. **CUR POSITION:** Get the current position of the robot for location calibration
8. **CHARGING PILE:** Place the robot's charging spring against the spring of the charging pile, and then click "Charging Pile" to calibrate (Note: Make sure the current positioning of the machine is correct)
9. **CALIBRATION LIST:** After clicking, the "POSITIONS", "Routes" and "QR Code" will pop up on the right.

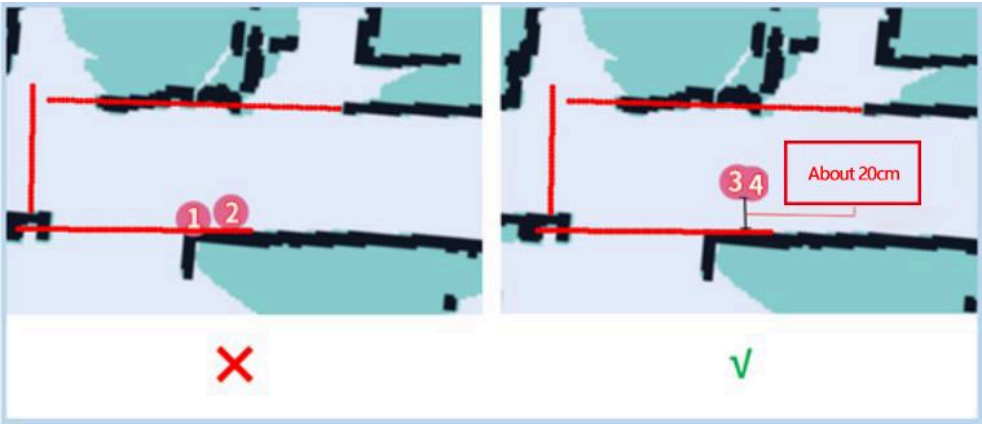


Special point: [Charging pile] Position calibration method diagram:

Firstly, move the robot so that the charging cartridge of the robot is connected to the charging cartridge of the charging station. Click the "Charging Station" button on the map menu bar and confirm in the pop-up box.

> **Note**
>
> The robot must be turned on in front of the charging station for subsequent use to ensure that the robot is positioned correctly.

Examples of ordinary point calibration are as follows



Matters Needing Attention

1. When calibrating the position, it is important to ensure that the current positioning status of the machine is correct.

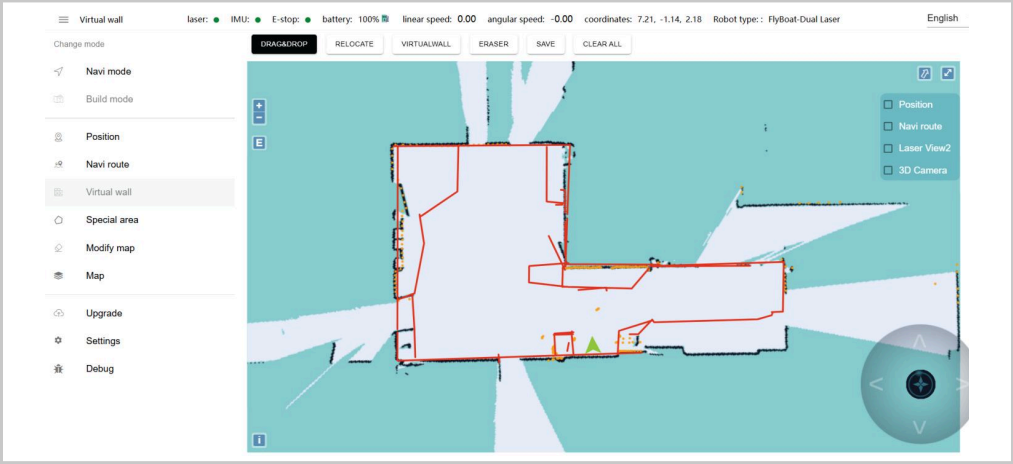
2. The calibrated position should be at least 20 centimeters away from surrounding obstacles and virtual walls.

3. It is recommended that there are no obstacles within 1.2 meters on the left and right sides of the charging station

Step-4 (Virtual Wall)

Function:

Limit the robot's activity area



DRAG & DROP

This mode allows you to zoom, pan and rotate the map. Press "ctrl+left mouse button" to select a rectangular area, and the virtual walls in the area will be cleared.

ERASER

Just circle the virtual wall you want to clear.

SAVE

Only click Save to save the drawn virtual wall.

VirtualWall

Click two locations to draw a straight line between the clicked locations. This is often used for regular terrain or rough drawing of an area.

CLEAR ALL

If you are not satisfied with the current virtual wall, click the Clear button to clear all virtual walls (you need to click Save to take effect)

Example: Glass wall

Attention

Laser can penetrate glass, so when drawing virtual walls, it is necessary to pay attention to placing them outside the walls.

Figure 1

Figure 2

Figure 3

Figure 4

Example: Table

Note

Laser can only scan one horizontal plane, so when drawing virtual walls, consider the protruding part of the desktop.

Figure 1

Figure 2

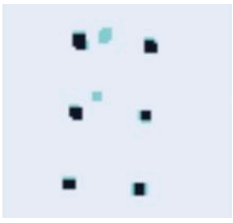


Figure 3

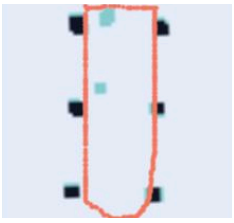
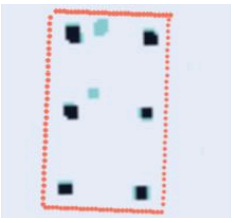


Figure 4



Matters Needing Attention

1. The minimum passing distance of the machine is 100cm, so attention should be paid when drawing virtual walls.
2. The main function of a virtual wall is to draw the activity space of the robot, separating the areas where the robot does not want to travel with virtual walls.
3. Please be sure to establish virtual walls in areas that do not require driving or areas that cannot be scanned by lasers (such as glass walls, tables and chairs, steps, and transparent and fragile items)

Explanation of other functions

A.【Navi route】

Functions:

Let the robot navigate and walk along a fixed route.

1. **Navigation Mode:** The robot distinguishes two navigation modes: free route navigation mode and fixed route navigation mode. The two different modes have different pages when punctuating. The two different modes have different pages when punctuating. Free route navigation is calibrated at the Position

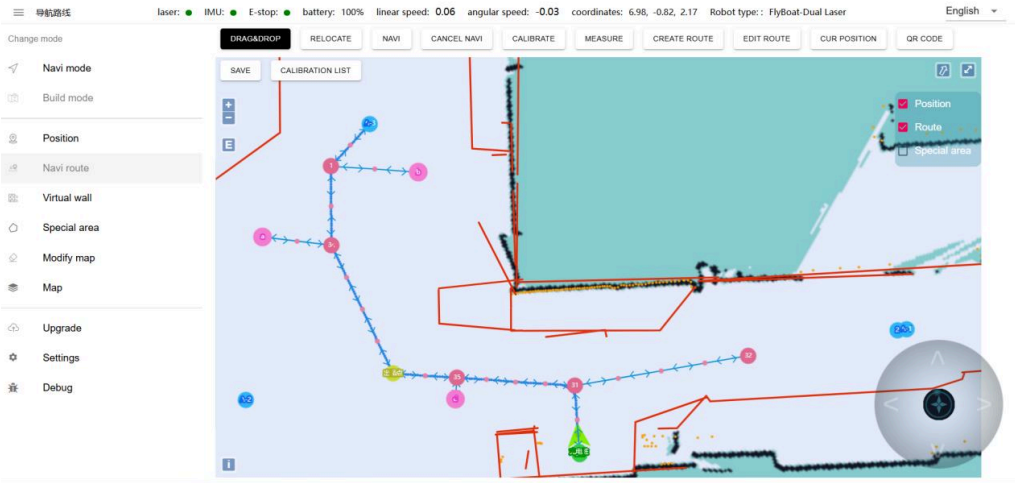
Fixed route navigation is marked under the Navi route

1.1. Free route navigation mode:

The point where this mode is effective is the point calibrated under the robot web page “Position”. When using free route navigation, the navigation algorithm will automatically generate the shortest route to the target point, as shown in the figure, the blue is the route to the target point.

1.2. Fixed route navigation mode

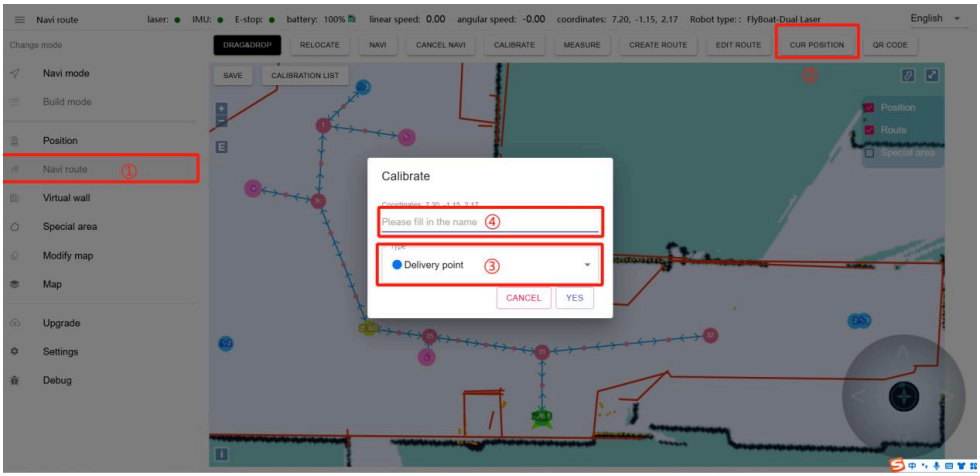
The points where this mode takes effect are the points marked under the Navi route on the robot web page. When using fixed route navigation, the robot will navigate along the existing route to a certain target point, as shown in the figure:



2. **Fixed route Calibration method:** After pressing the emergency stop button of the robot, push the robot to the corresponding point and click the current position,as shown in the figure:

2.1. Calibrate:

After pressing the emergency stop button of the robot, push the robot to the corresponding point and click the current position,as shown in the figure:

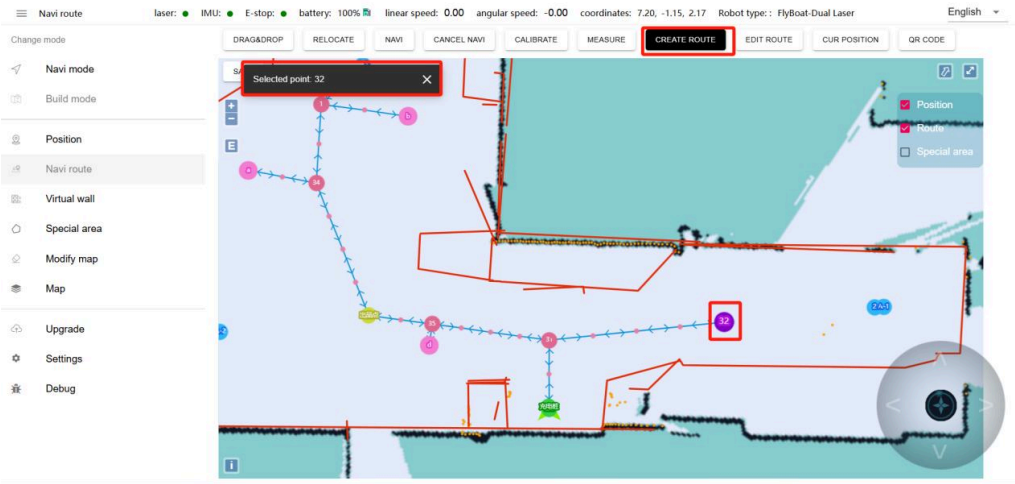


Note

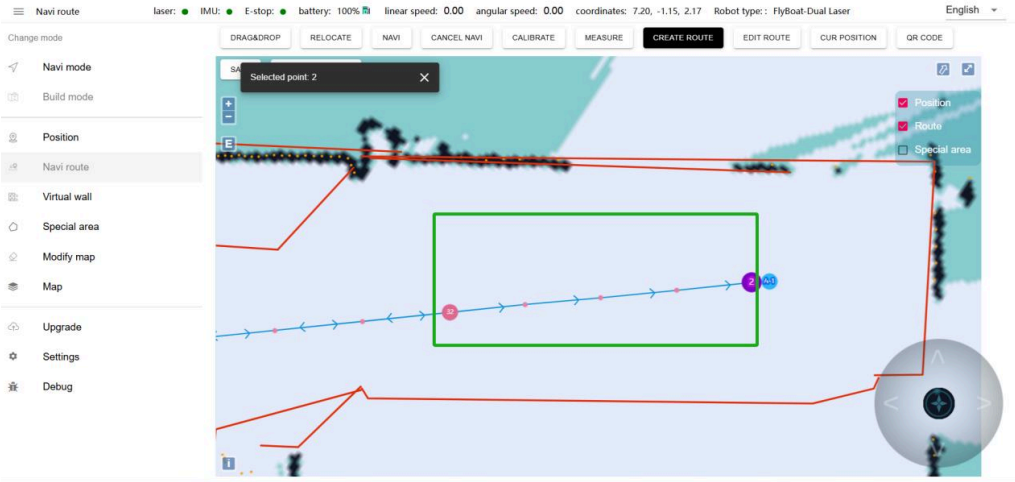
When selecting the point type, you need to select the corresponding type. For the charging point, select the charging point (only one can be calibrated), for the production point (the robot's standby point, only one can be calibrated), select the delivery point, and the delivery point is the target point that the robot needs to go to on a regular basis.

2.2. Draw the route:

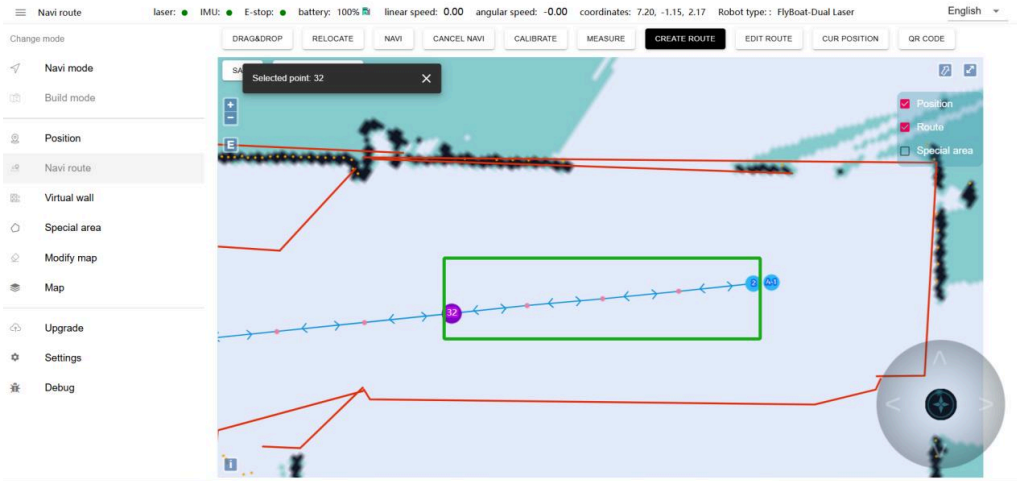
When all points are marked, click Create Route, place the mouse on a point and click to select the current point, as shown in the figure:



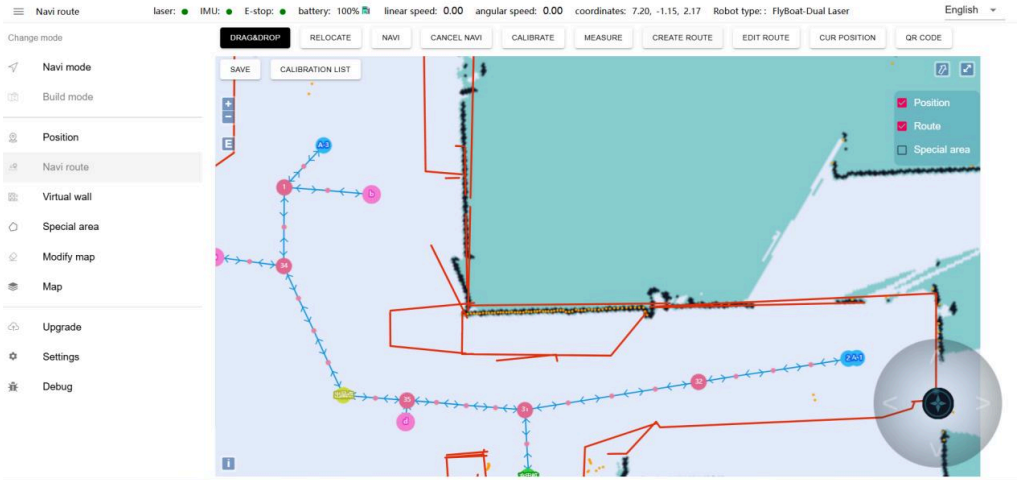
After selecting a point, click the mouse on another point. In this way, these two points will generate a **one-way route.** As shown in the figure, a route from 32 to 2 is generated:



As shown in the figure above, after the robot reaches point 2, if it wants to return to point 32, there is no route to return, because the above drawing is only a one-way route from 32 to 2. Therefore, it is generally recommended to draw the route as a two-way route. Create a new route, click 2, and then click 32. In this way, there is also a route from 2 to 32, as shown in the figure:



The map with all the points connected is as shown in the figure:

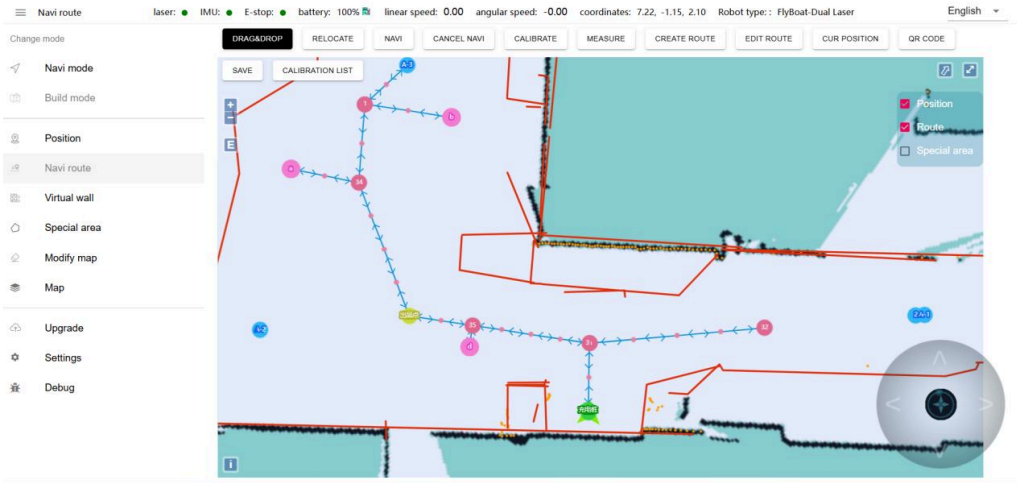


Note

You can select route points as the point type when marking points, but route points are not the final target points of the robot. They only play an auxiliary role. Therefore, if the scene is large, you need to add some route points between the target points, for example:

Note

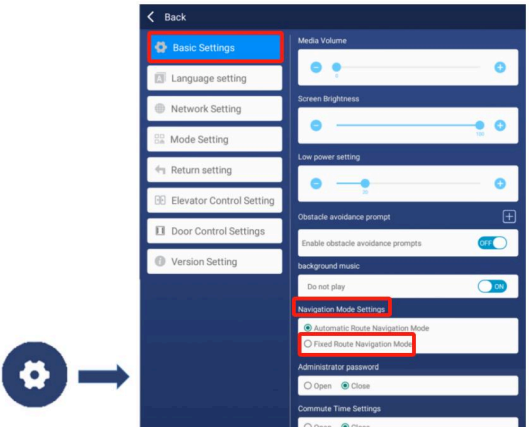
After the navigation route is calibrated, click the Position. You need to calibrate another charging pile point under the Position. The position should be consistent with the charging pile position under the Navi route, as shown in the figure:



3. **App switches to fixed route mode** After pressing the emergency stop button of the robot, push the robot to the corresponding point and click the current position, as shown in the figure:

3.1. Click Settings, as shown in Figure ④:

3.2. Find the navigation mode setting in the basic settings and click the fixed route navigation mode, as shown in the figure:



3.3. After switching, click on the upper left corner to return, click on normal mode, select the corresponding point, click on start, and the robot will reach the target point according to the route connected on the map

B. Special Area

Functions:

Draw an area to limit the robot's speed in a certain area

1. Navigation Mode: The robot distinguishes two navigation modes: free route navigation mode and fixed route navigation mode. The two different modes have different pages when punctuating. The two different modes have different pages when punctuating. Free route navigation is calibrated at the Position

1. New :

You can draw a polygon by clicking the left mouse button on the map. After you finish, a naming box will pop up to define the area and speed.

2. Modify :

To adjust the edited speed area, click the speed area to be edited. The area will change color (the line around the selected area will become thicker and red). You can adjust the area size by dragging the line.

3. Area List :

After clicking, the edited area list will pop up on the right side of the page. You can redefine the speed and name of the area in the area list and delete the area.

4. Save :

Save the edited special area.

5. Clear All :

Save the edited special area.

> **Note:**
>
> After editing, click Save to take effect.

C. Modify Map

The purpose of editing maps: to correct errors caused by scanning maps. Prerequisites for editing maps: If an obstacle is missed during scanning, or if the map changes after scanning, and the changes are minor, you can use the edit map function to edit the map appropriately. If the map is too different from the actual environment, it is recommended to rescan.

> **Note:**
>
> This function is rarely used. Try not to edit or modify the map

1. **Save :**

Click Save to apply changes to the map.

2. **Clear All :**

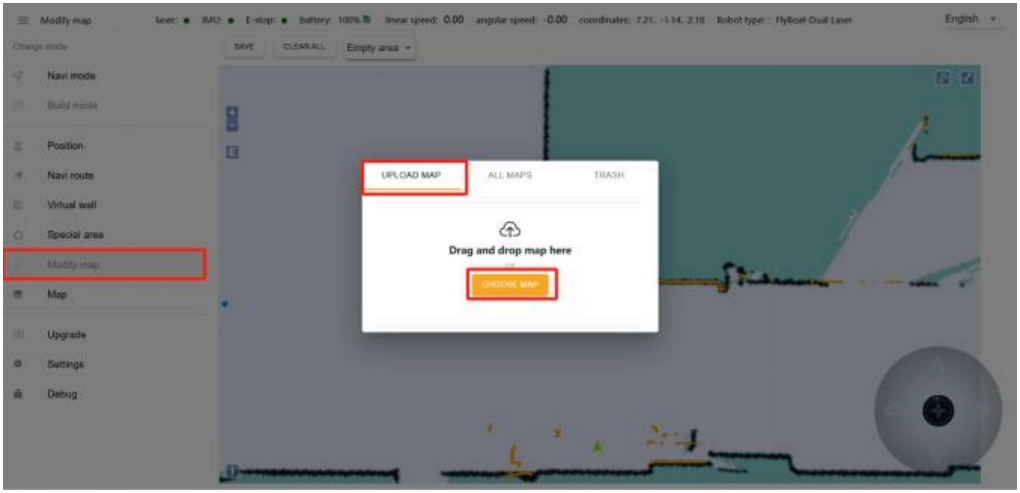
Clear the drawn polygon

3. **Empty Area :**

Remove noise points (such as noise points left by pedestrians walking on the map during map scanning, temporary obstacles, etc.). Do not remove real obstacles as noise points.

D. Map

1. Upload Map :

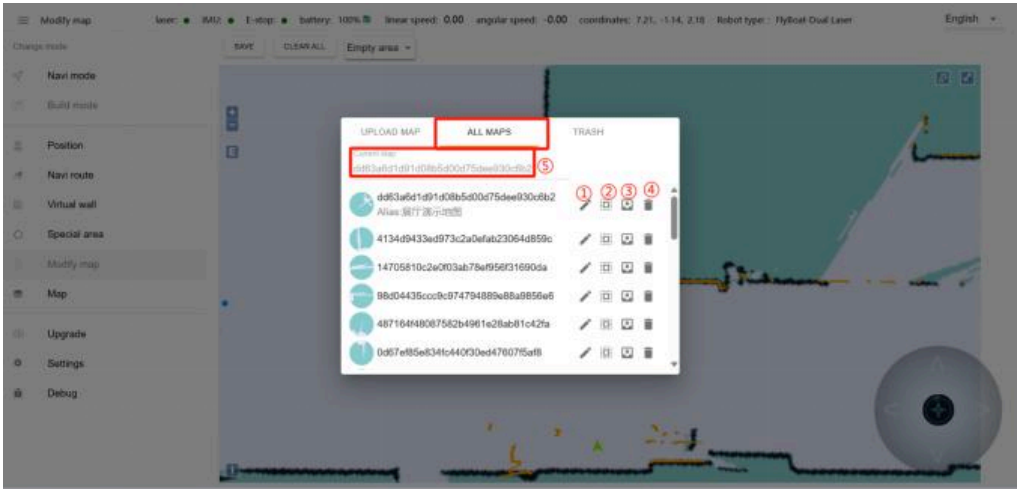


2. Choose Map :

You can upload maps exported from other robots in .png file format.

> **Note:**
>
> The map will not be applied immediately after it is uploaded. You need to find the map in [All Maps] and click the [Apply] icon.

3. All Maps :

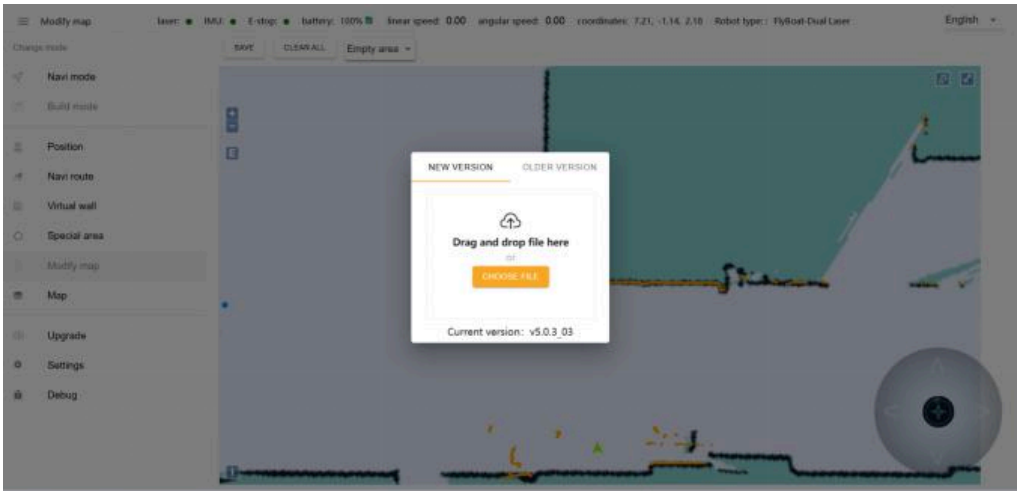


01	Name a map
02	Apply a map
03	Export a map
04	Delete a map
05	Displays the current map and the unique name of the current map

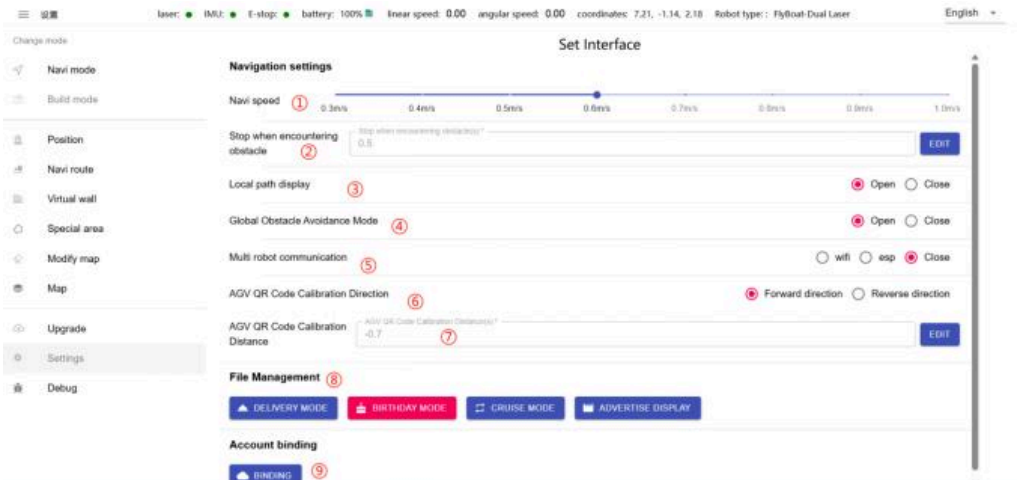
E. Upgrade

Tips :

We will upgrade the machine to the latest version before it leaves the factory, so this function is generally not needed.



F. Settings



1. **Navigation speed :**

adjust the robot's travel speed (unit: m/s)

2. **Stop when encountering obstacle :**

Can Adjust the time the machine stays when encountering an obstacle.

3. **Global Obstacle Avoidance Mode :**

When it is turned on, the robot will replan the global path when encountering an obstacle.

4. **AGV QR Code Calibration Direction :**

The direction of the machine when docking with the QR code.

5. **AGV QR Code Calibration Distance :**

The distance the machine withdraws from the small QR code.

6. **File Management :**

DELIVERY MODE: Upload the background music file. After uploading, you can set it in IronOx software. **(Quantity: 20 in total, 1G for each audio)**

7. **Binding :**

Bind the machine to the cloud platform management account

> **Note:**
>
> The cloud platform management account is provided by the manufacturer.

Precautions for daily use

1. Robot positioning lost

Overview :

Location loss refers to the mismatch between the map location of the robot and the actual environmental location.

Cause :

- Positioning loss caused by manually pressing the emergency stop switch to move the machine

- During the robot's movement, it will match the current map based on actual laser data. If the current environment is too different from the map, it will cause the robot to fail to match the map, resulting in localization loss. Localization loss will cause the robot to lose its path planning ability and be unable to move

- Someone is surrounding the machine in front, causing a loss of positioning. If too many people surround the machine, it will block the laser, and the matching degree between the laser and the terrain will become very low, leading to a loss of positioning

Resolvent :

- Move the machine to the location of the charging station and restart the machine within 2m of the charging station (note: the target point of the charging station should be marked on the map)
-
- Enter the map interface and manually issue relocation instructions

2. Robot does not navigate

Overview :

Robot non navigation refers to allowing the robot to navigate to a certain point without moving

Cause :

- Check if the emergency stop switch of the machine is turned on. Only when the machine is turned on can it navigate autonomously (turning the emergency stop switch to the right indicates opening, pressing it indicates closing)

- Check if the machine has lost its positioning (if the orange laser and black obstacles on the map do not completely overlap, it indicates a loss of positioning)

- Check if the machine is close to obstacles or virtual walls (approaching obstacles or virtual walls can cause the machine to be unable to navigate)

- Check if the target point is close to obstacles or virtual walls

Resolvent :

- Move the machine to the location of the charging station and restart the machine within 2m of the charging station (note: the target point of the charging station should be marked on the map)

- Enter the map interface and manually issue relocation instructions

3. Robot navigation charging did not respond

Overview :

Sending navigation charging commands to the machine, the robot has not started navigation

Cause :

- Check if the calibration of the charging station point is done by using the charging station button after the machine is connected to the charging station
- Check if the charging station target is close to obstacles or virtual walls

Resolvent :

- Please refer to the calibration method for the charging station in the 'Calibration Location' section
- It is best not to have any obstacles within 1.5m on the left and right sides of the charging station

4. Repositioning

Overview :

Recalibrating the incorrect position of the machine

Cause :

- The on-site environment and map scanning have significant changes
- During machine operation, manually press the emergency stop switch to move the machine to an area that has not been scanned before moving it back
- Not turning on at the charging station position

Resolvent :

- Please refer to the calibration method for the charging station in the 'Calibration Location' section

- It is best not to have any obstacles within 1.5m on the left and right sides of the charging station

Be careful :

When the machine loses its positioning (i.e. the laser does not match the current terrain, as shown in Figure 1), it needs to be repositioned. The repositioning operation method is shown in Figure 1, and Figure 2 has successfully repositioned. If the repositioning is not successful, try again using this method.

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