



# 用户手册

视觉导航机器人配送版本



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# Table of Contents

Introduction	1.1
1. Install Software	1.2
2. Use Remote Control	1.3
3. Vision Navigation	1.4
4. Audio Editing Tool	1.5
5. The Calibration of Robot	1.6
6. Robot Setting	1.7
7. I/O Control	1.8
8. Remote Control with 4G	1.9
9. FAQ	1.10

- [Introduction](#)

## **Introduction**

Galileo vision navigation system is a robot positioning and motion control system that integrates multiple sensors and takes visual navigation as the leading role. Suitable for indoor environment and open outdoor environment. Our system has different usage methods for different application scenarios. This manual describes how to use the Galileo vision navigation system in the delivery robot application scenario.

For the delivery robot application scenario, we have developed many useful functions.

[The Android app of Food Delivered Robot](#)

- [Chapter1 Install Software](#)
  - [1.1 How to install software](#)

## Chapter1 Install Software

### 1.1 How to install software

1. Download it from [there](#), then double click it to install
2. After successful installation, you can see a icon on the desktop as the picture below shows, then double click it to run software



1. The software is developed based on .NET technology and requires .NET Framework 4.6.1 . Windows 10 comes with this operating environment. For other Windows operating systems, please install .NET Framework 4.6.1 by yourself.

- [Chapter2 Ues Remote Control](#)
  - [2.1 Connect to the network](#)
  - [2.2 Introduction of UI](#)
    - [2.2.1 Start to use](#)
    - [2.2.2 How to close the software](#)

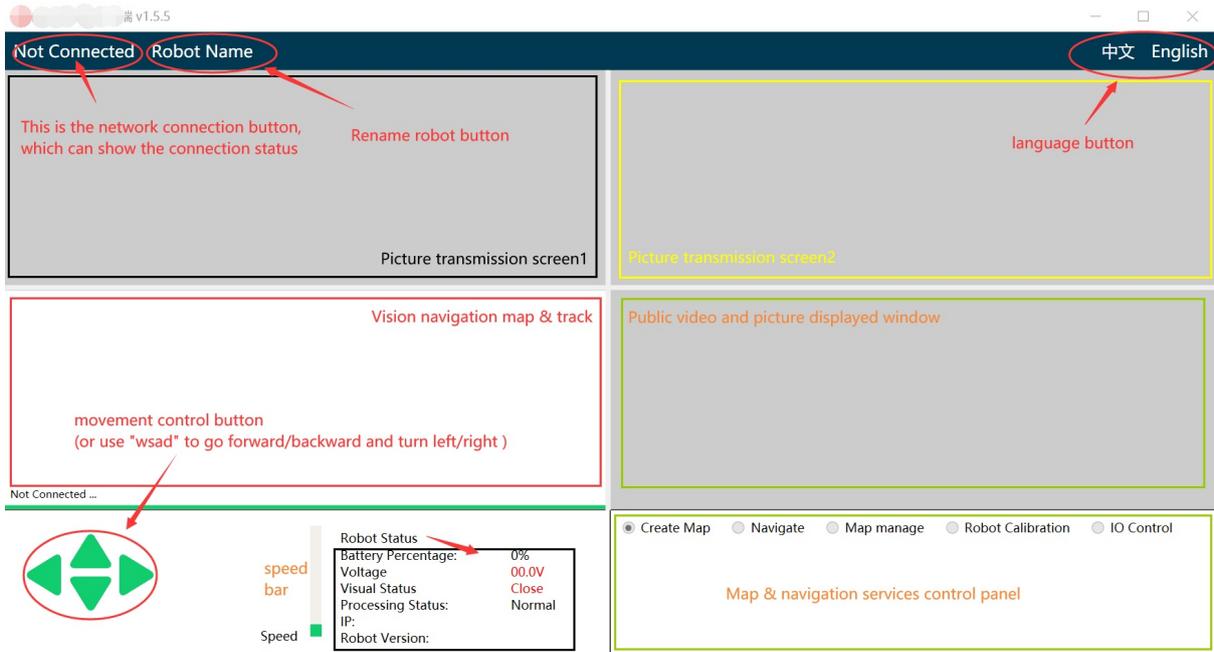
## Chapter2 Ues Remote Control

### 2.1 Connect to the network

The computer with installed software needs to be in the same wireless network as the robot. Please refer to Chapter 1 to install the software. As for the robot with router, you can connect your pc to the router of robot.



### 2.2 Introduction of UI

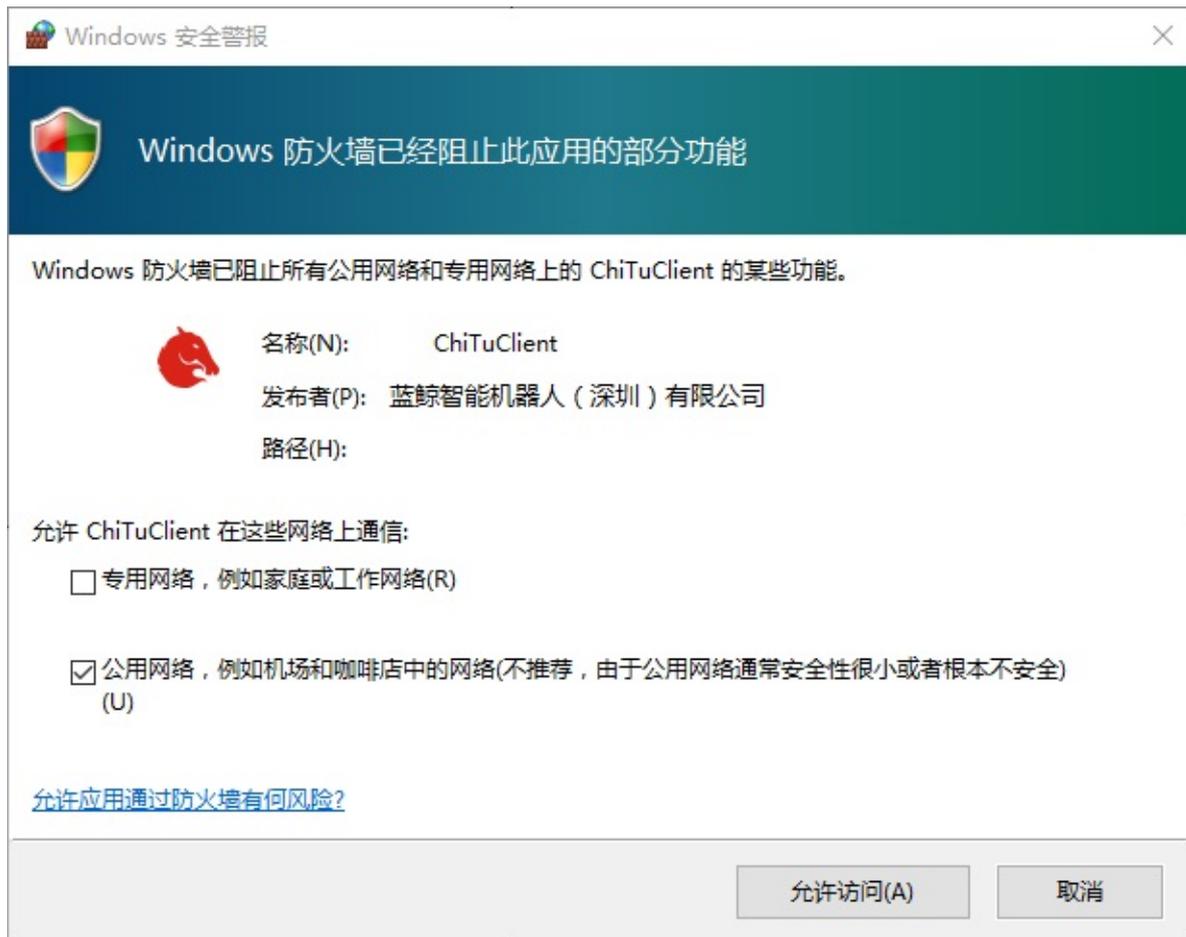


### 2.2.1 Start to use

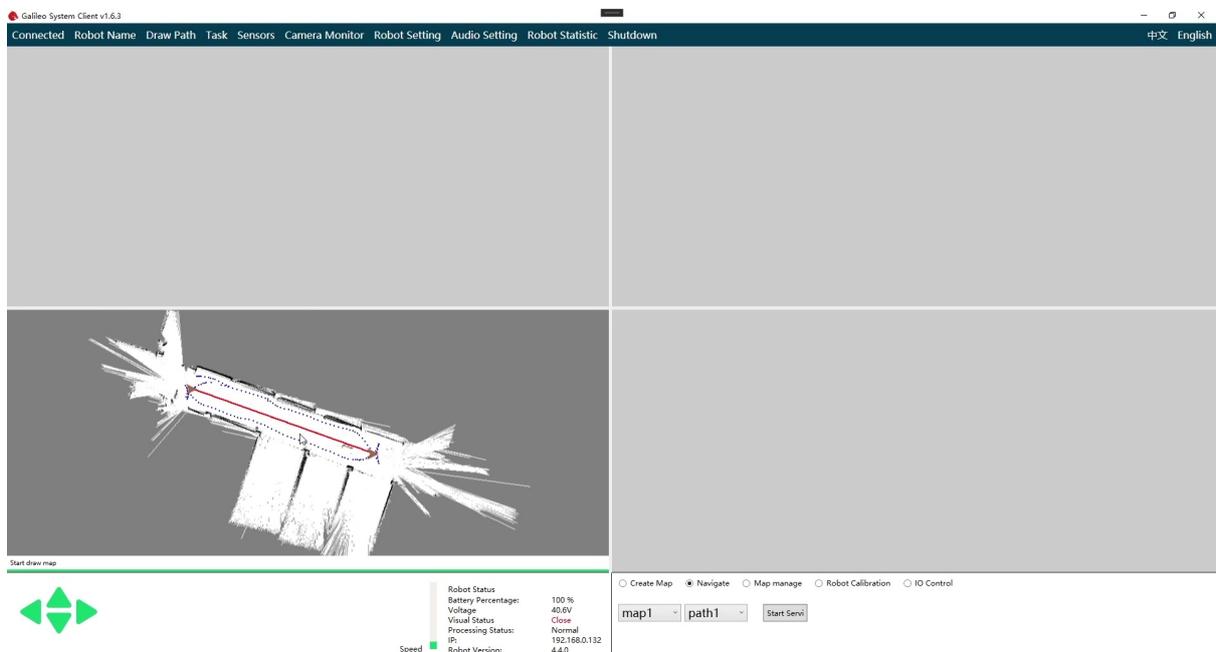
Demo Video :



CLIKK the Not Connected button to connect robot. Firewall warning will pop up in the first run, please select "Allow access". If this window does not pop up, or the client cannot connect to the robot WIFI, you need to manually add the "ChiTuClient.exe" to the firewall rules.

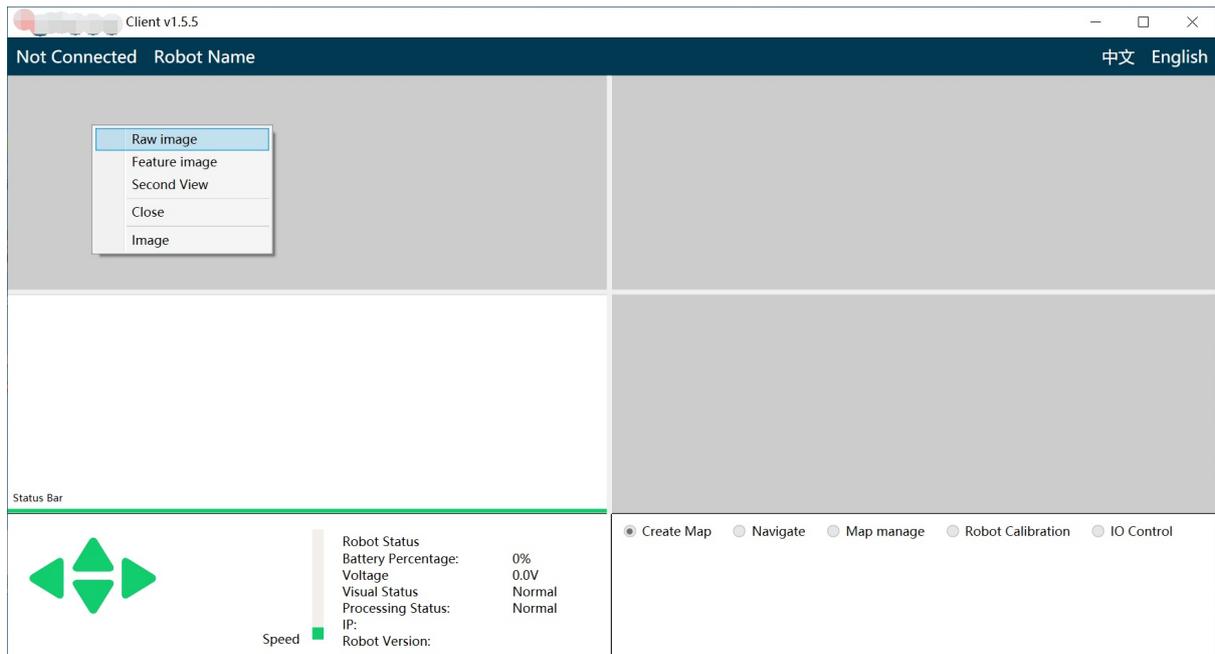


After connecting successfully, UI changes as below. Now we can control robot.

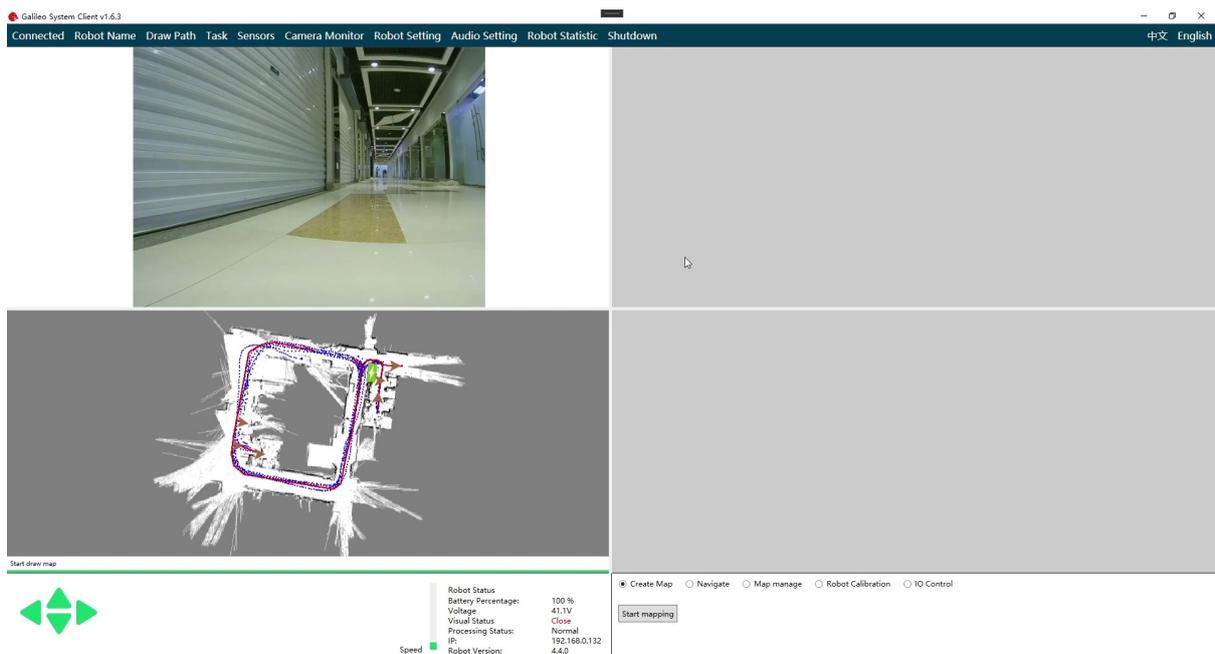


Chassis motion control support keyboard manipulation, WSAD controls front and back, left and right, and up and down arrows control the speed gear.

Right click the screen1



And then choose "Raw image", now we can see the image from the front camera, the transmission of image already start.



Click "close" in the right-click-menu can end the transmission

### 2.2.2 How to close the software

Just click **x** in the upper right corner. If you want to turn off the robot, you must first click the "Shutdown" button on the main interface to turn off the robot host, and then turn off the robot power switch.



- Chapter3 Mapping and Navigation
  - 3.1 System introduction
  - 3.2 Buliding map
  - 3.3 Draw mavigation path & Set target point
    - 3.3.a Draw navigation path
    - 3.3.b Set target point
    - 3.3.c Save and upload the navigation path file
  - 3.4 Start & Stop navigation service
  - 3.5 Navigation map management & update
    - 3.5.1 Update
    - 3.5.2 Deletion

## Chapter3 Mapping and Navigation

### 3.1 System introduction

Navigation Workflow:

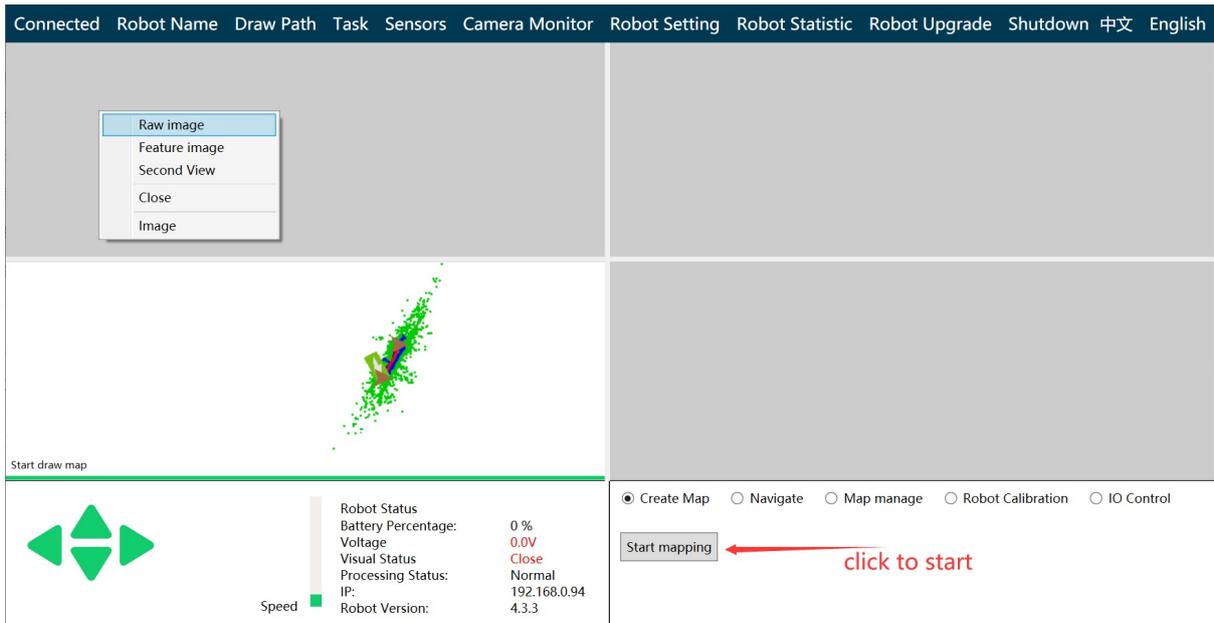
1. In mapping mode, you can bulid a map for the robot by controlling the robot to walk around in the target area.
2. Using our client to draw navigation paths manually and set target points in the map we build in the step one.
3. Start navigation after path and target point are set. Select target point and click start button, then the robot will move automaticly to the target point along the trajectory we drew in step 2.

Full demo video:

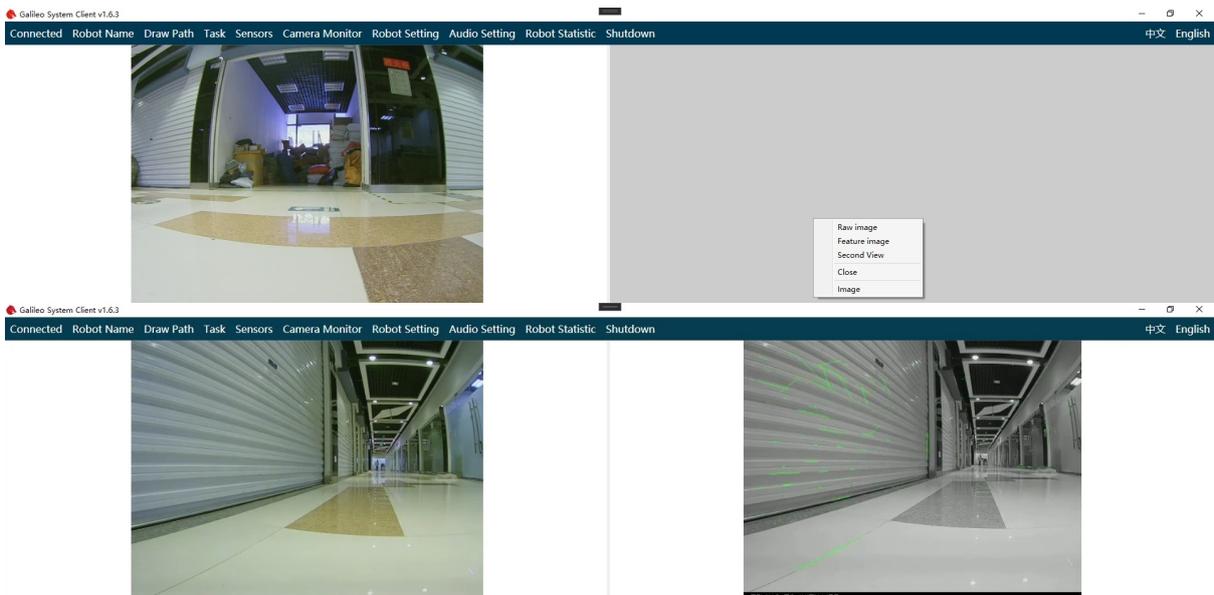


### 3.2 Buliding map

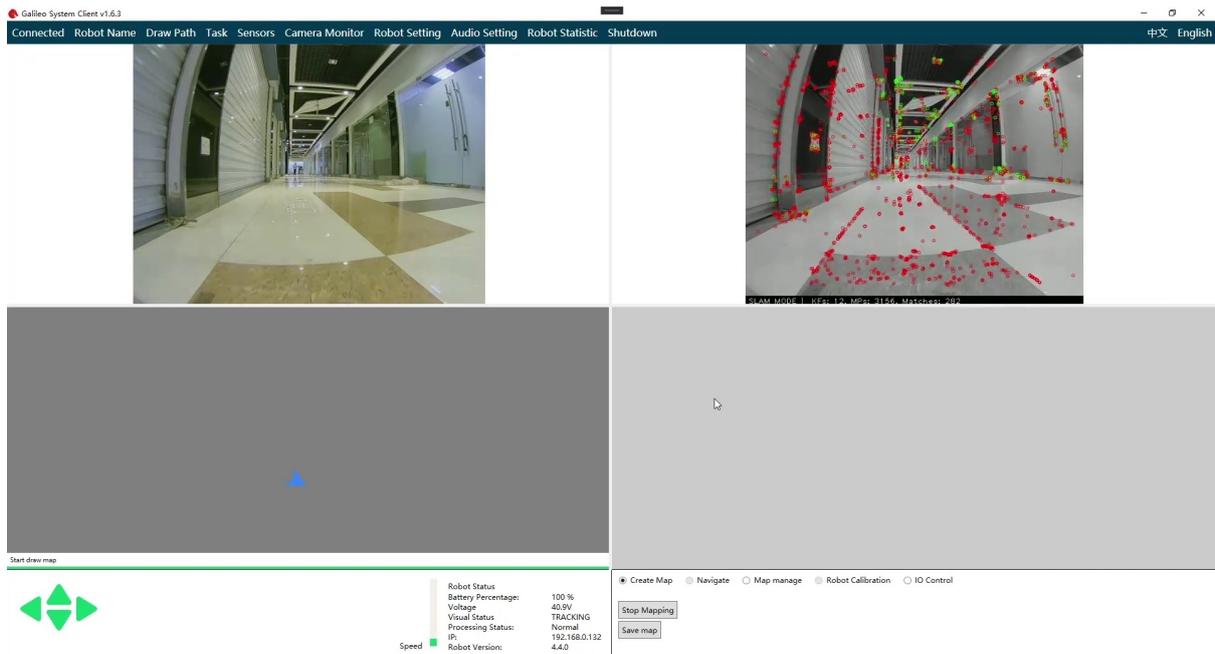
First, you need to click “Start mapping” button and wait a moment.



Right click on the screen2 and choose Feature image in the right-click-menu



Control the robot to go forward until visual system starts successfully

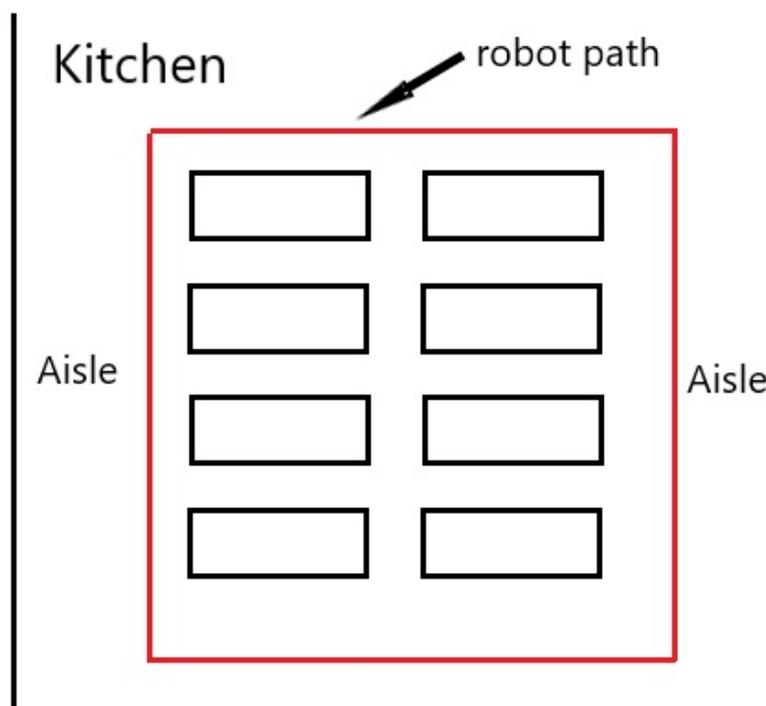


Now control your robot move around the target area. Please do not turn left/right without pressing front key or back key, it will make the visual system lost target.

Please ensure Visual Status is **TRACKING** . Once it becomes **LOST** with red color, you must control the robot to go backward just by pressing back key until the status turns to **TRACKING** .

Please do not move the robot when the status turns to **Loop Closing** . When the robot walks a circle, the robot automatically optimizes the previously created map, which greatly improves the quality of the map. As a result, the remote-controlled robot can walk the closed path multiple times during mapping, which will create a more accurate map. The quality of the map will greatly affect the effect of navigation later.

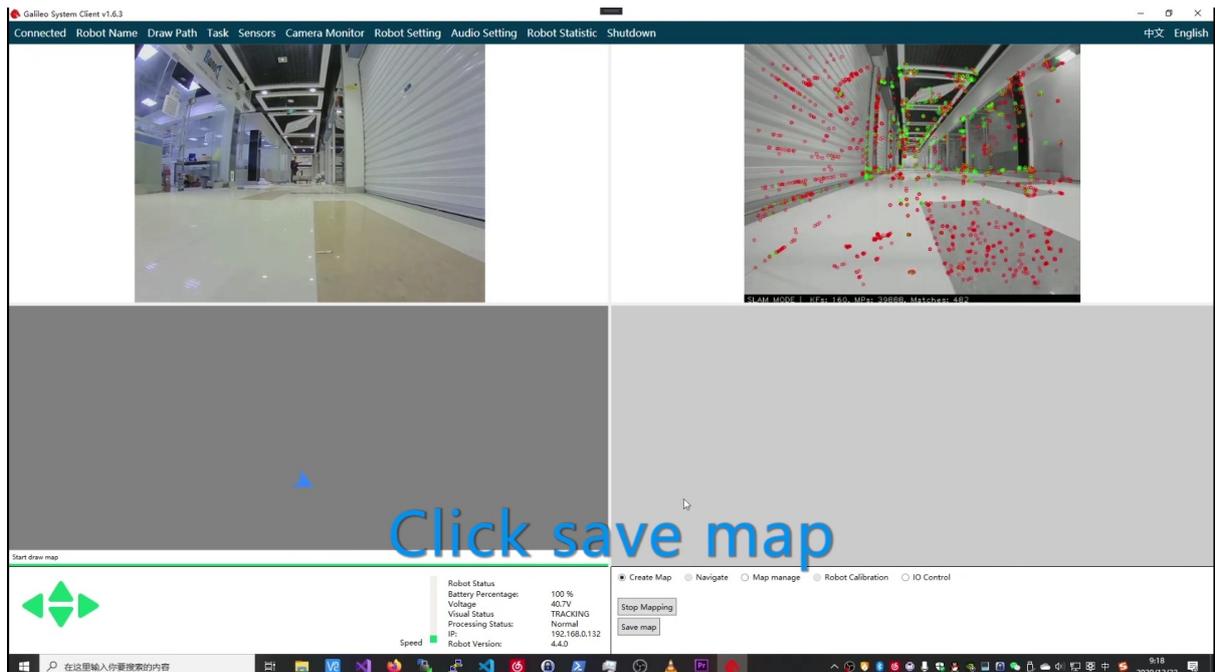
Buliding map example:



There are aisles on either side and tables in the middle. We can remotely control the robot to follow the red route first clockwise. Turn counterclockwise after the client prompts "Closed Loop Optimization Complete". Closed-loop optimization is also required. In this way, we can get a better map.

The quality of map will effect navigation greatly.

Stop moving after going around the target area, clicks the "Save Map" button on the main interface, and waits for the save dialog box to pop up. Enter "Map Name" in the dialog, and then click OK. Wait for the map to load.



After loading-map complete, you can see the map on the screen. If you think it's ok, you can click stop mapping and now mapping is completed.

## 3.3 Draw mavigation path & Set target point

Full demo video:

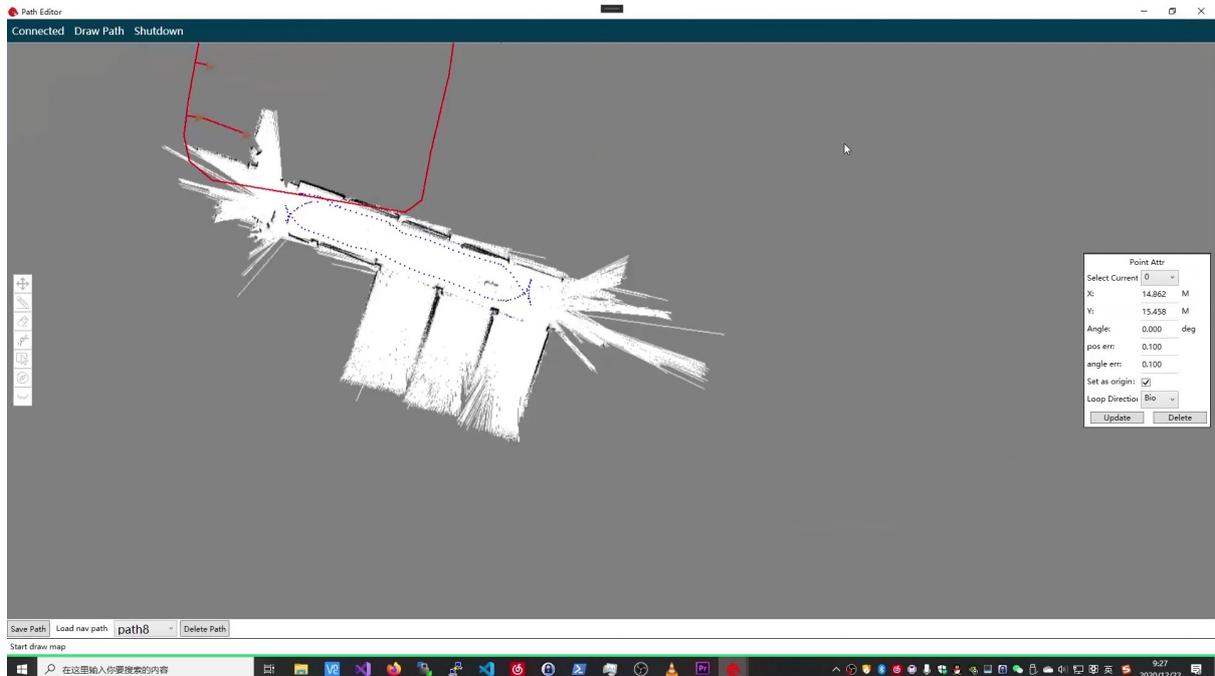


Warning: Please be patient and waiting for the update of UI, because it will take a long time to exchange data between the robot and software while we run the operation of section3.3.

After connecting to the robot successfully, click the "Draw Path" button on the upper menu bar of the main interface to open the navigation path editing interface.



UI just like the image below.



### 3.3.a Draw navigation path

The navigation path is the path you want the robot to go. Click "start navigation" on the main interface, the robot will move according to the path you draw. Here's how to use the path drawing tool.

-  1. Basic operation

Basic operations include pan and zoom. Drag the map with the left mouse button to pan the map. Scrolling the mouse wheel forward and backward can zoom the map, which is very useful in drawing the path. For the places where the movement requirements are more detailed, you can zoom in and draw.

-  2. Pencil tool

Click the pencil-like icon in the toolbar on the left. This is the linear tool. Use the left mouse button to click a point on the graph as the starting point, and then move the mouse, a red line will appear, move the mouse to the desired end position, click the left mouse button again, a line will be drawn. If you want to draw a polyline, you can click twice in a row at the turning point.

-  3. Eraser tool

Click the eraser tool in the left toolbar, and then drag with the left mouse button to erase the previously drawn points. The erasing range of the eraser is very small, the delete operation is recommended to use the following delete tool.

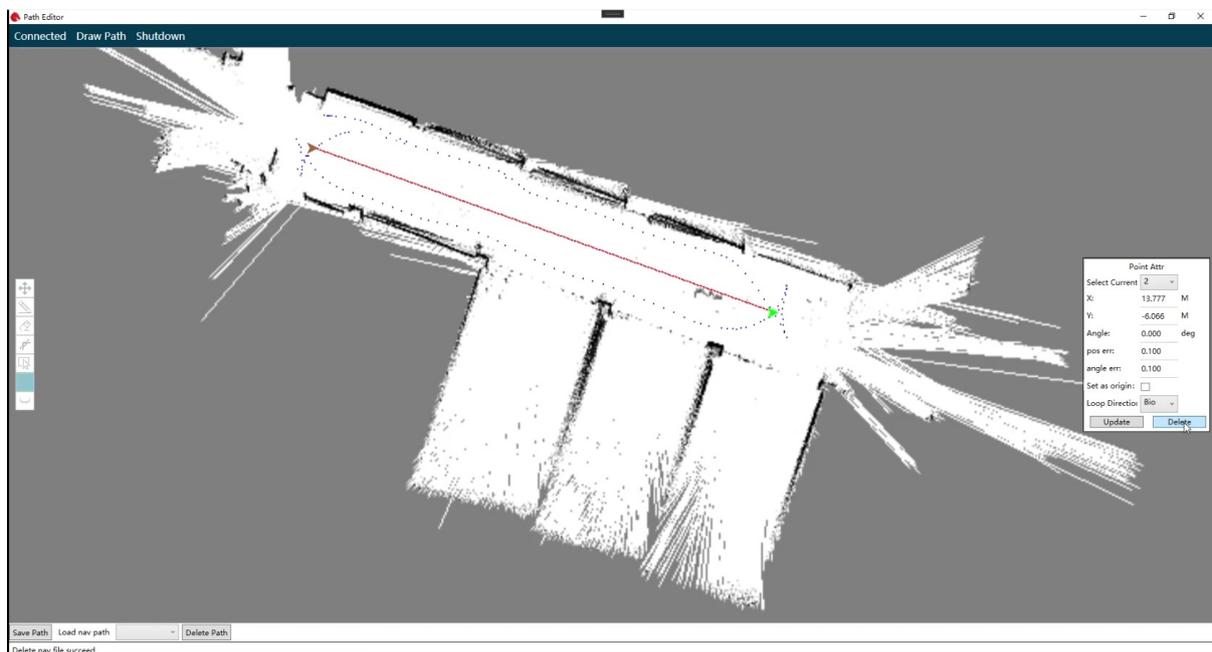
-  4. Curve tool

Click the left curve tool, click the left mouse button at the starting point of the curve, then click the left mouse button again in the middle of the curve, and finally click the left mouse button at the end point of the curve. Such a curve is drawn. Note that if you want the robot to walk closer to the planned route or smooth walking, it is recommended to use this tool to adjust the turning radius of the corner.

-  5. Deletion tool

If you want to delete the previously drawn points on a large scale, you can use this deletion tool. Click the delete tool on the left and then click the starting point of the deletion with the left mouse button. You can see that a rectangle has been following during the movement of the mouse. Click the left mouse button again to delete the selected area of the rectangle.

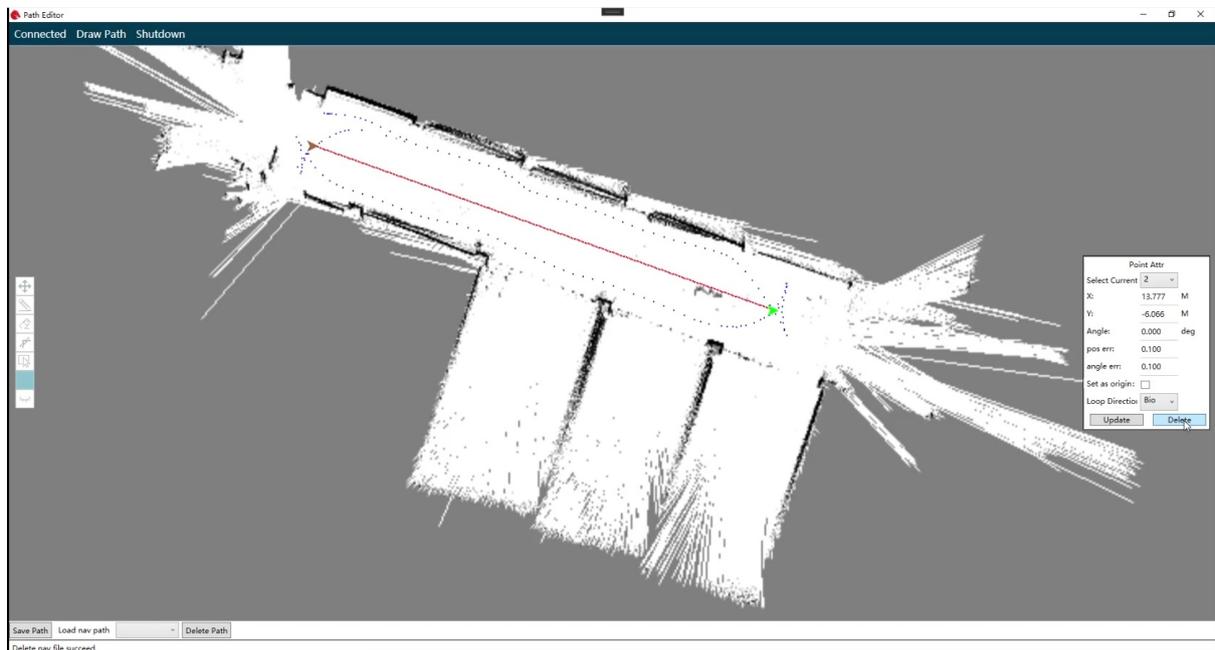
Using these tools, you can draw the robot's navigation route. Pay attention to try to follow the original trajectory (blue dots) to draw the line, so as to ensure that the robot can move smoothly in the planned route. There are dense black spots around the map that are the boundaries of the area or the outline of obstacles. These points can roughly reflect the surrounding state. For the service robot, the drawn paths must be connected.



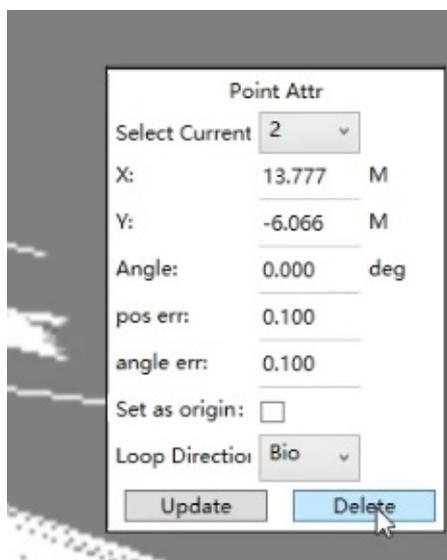
### 3.3.b Set target point

For robot application scenarios, the robot needs to move back and forth between several fixed positions. For example, walk from the kitchen to table one, and then return to the kitchen to table two and so on. The following work is to mark the location of each target point on the path drawn above. After that, we can send the corresponding target point to the robot, and then let the robot automatically go to the target point.

Click  to activate the navigation target point insertion tool, and click on the navigation route in turn to insert the navigation target point. You can also use the eraser and delete tools to delete the navigation target point.



The selected target point is green, and its information will be displayed in the point attribute panel on the right.  
**ATTENTION: Point 0 means the kitchen in food-delivery scenario.**



Point attribute description:

- (1) To switch points, you need to use the point switch button on the upper side of the site properties window to switch.
- (2) To accurately adjust the position of the point, the position of the point can be changed by modifying the "X axis" and "Y axis" under the point properties.

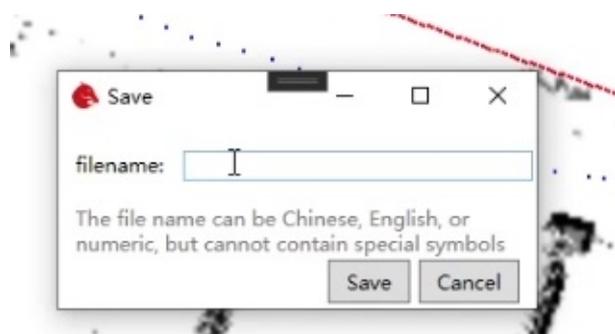
(3) Modify the direction of point by modifying the "angle". The direction of the arrow is the direction of the robot after driving to the destination (the robot must turn to this direction to confirm its arrival at the destination).

(4) The "radius difference" and "angle difference" are the allowable position error and the allowable angle error when the robot reaches the target point.

(5) The circulation direction is to adjust the circulation direction, and the default is bidirectional.

### 3.3.c Save and upload the navigation path file

On the editing interface, click the "Save Path" button and a save dialog box will pop up to enter the file name, and click "Save".



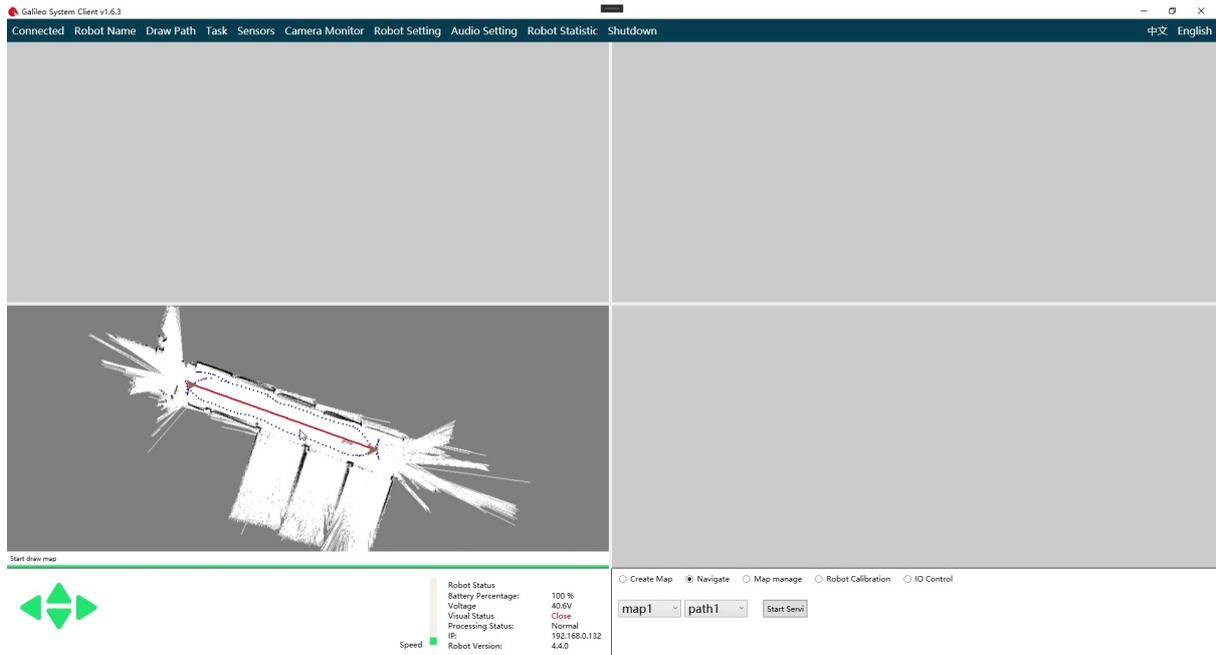
## 3.4 Start & Stop navigation service

Full demo video:



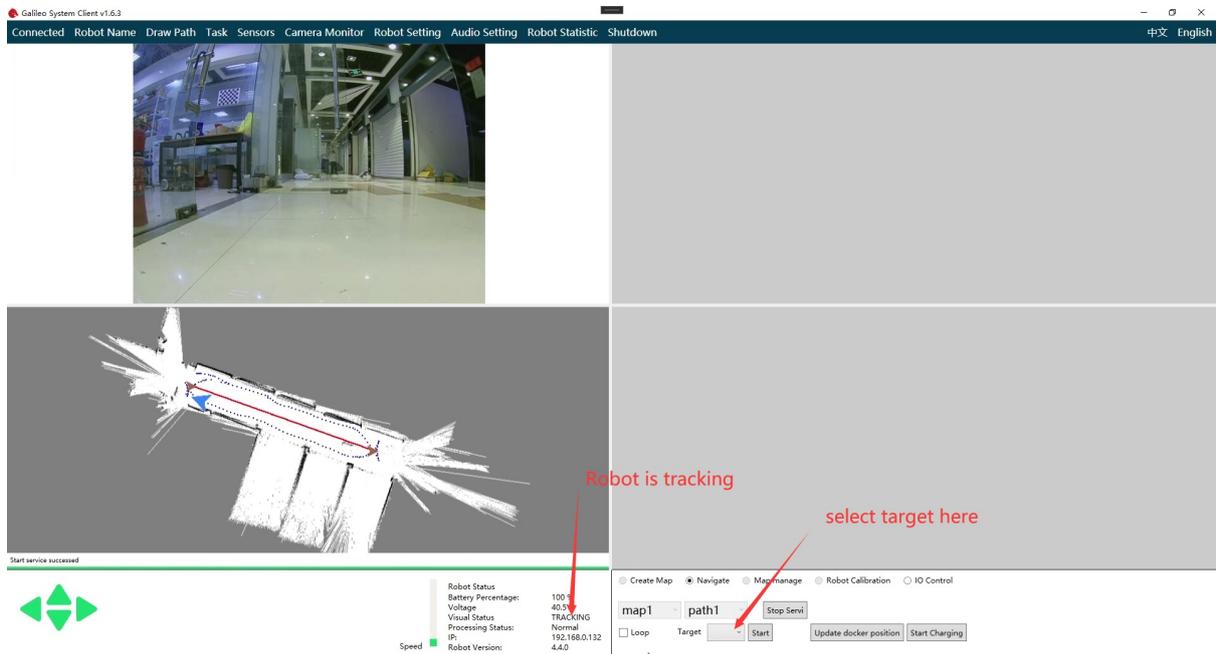
After connecting to the robot and loading map successful, the client can load path and point we drew and set automatically.

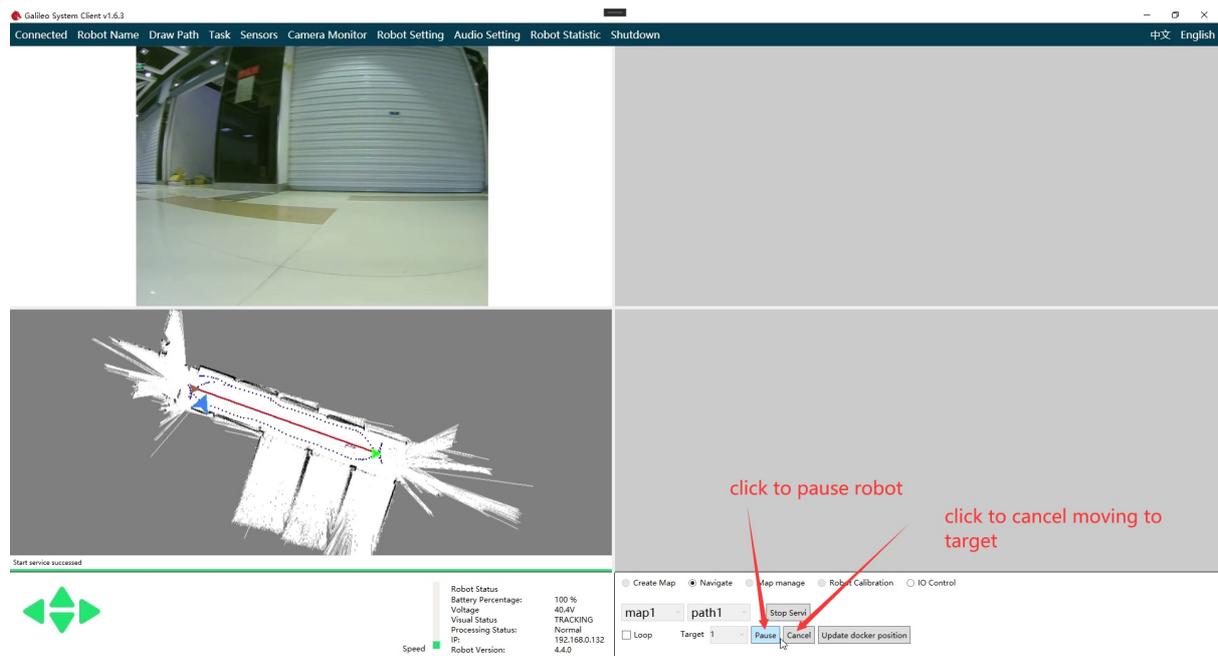
### 3. Vision Navigation



Control the robot move to the position that can be tracked, the robot must be on the navigation path, and the orientation of the robot must be consistent with the orientation of the mapping.

Select "navigation" and click the "Start Service" button to start the navigation service. After loading the program, the robot starts to move autonomously. At the same time, the blue block indicating the robot's position in the interface starts to update synchronously.





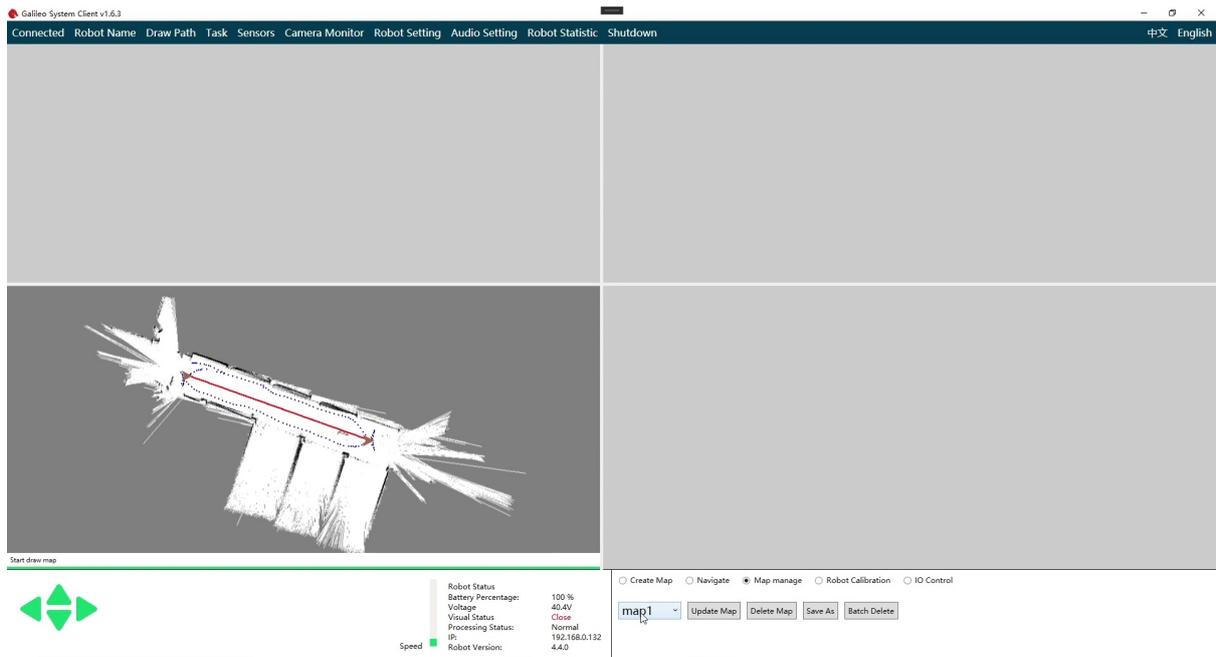
If you want to stop the navigation service, click the "stop service" button directly; If the robot suddenly stops moving during navigation, the visual state becomes "lost", which means that the visual system loses its target. There are two reasons: Reason 1: The initial movement direction of the robot is opposite to the movement direction when the map is established; Reason 2: Great changes in light intensity or environment. Solution 1 method: turn the robot around and start over; solution 2 needs to re-establish the map and plan the route. In case of emergency and uncontrollable, manually press the red emergency stop button on the back of the robot or touch the black anti-collision edge of the robot to stop its operation.

ATTENTION: Please press the red emergency stop switch on the robot under emergency.

## 3.5 Navigation map management & update

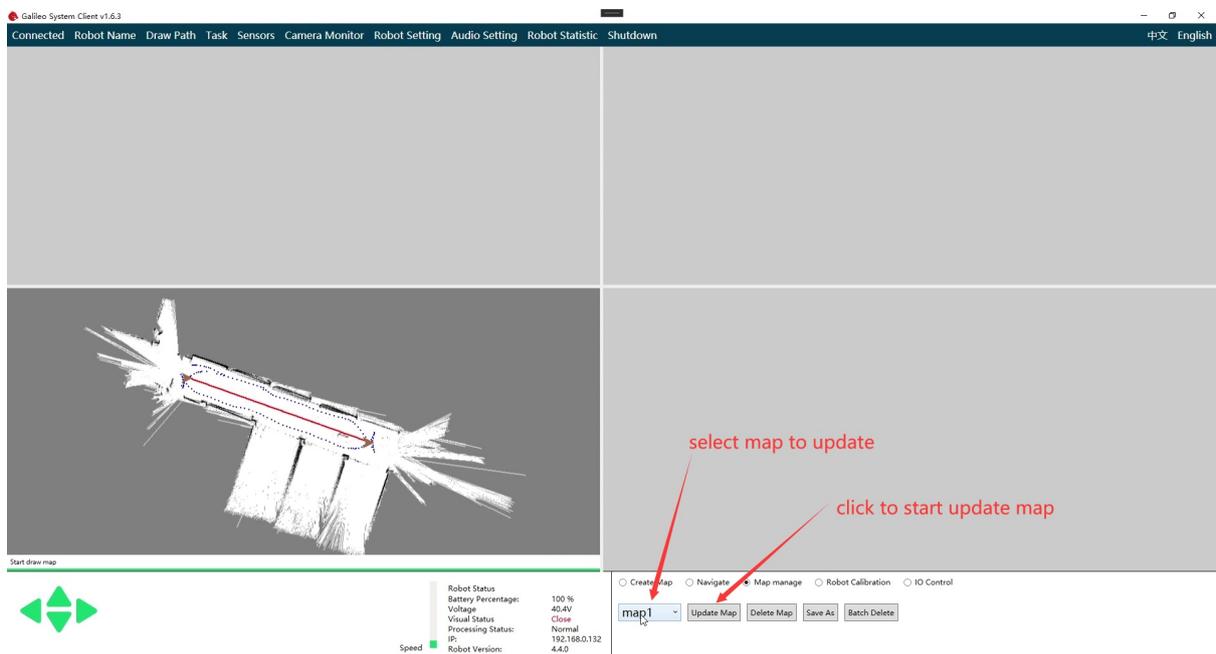


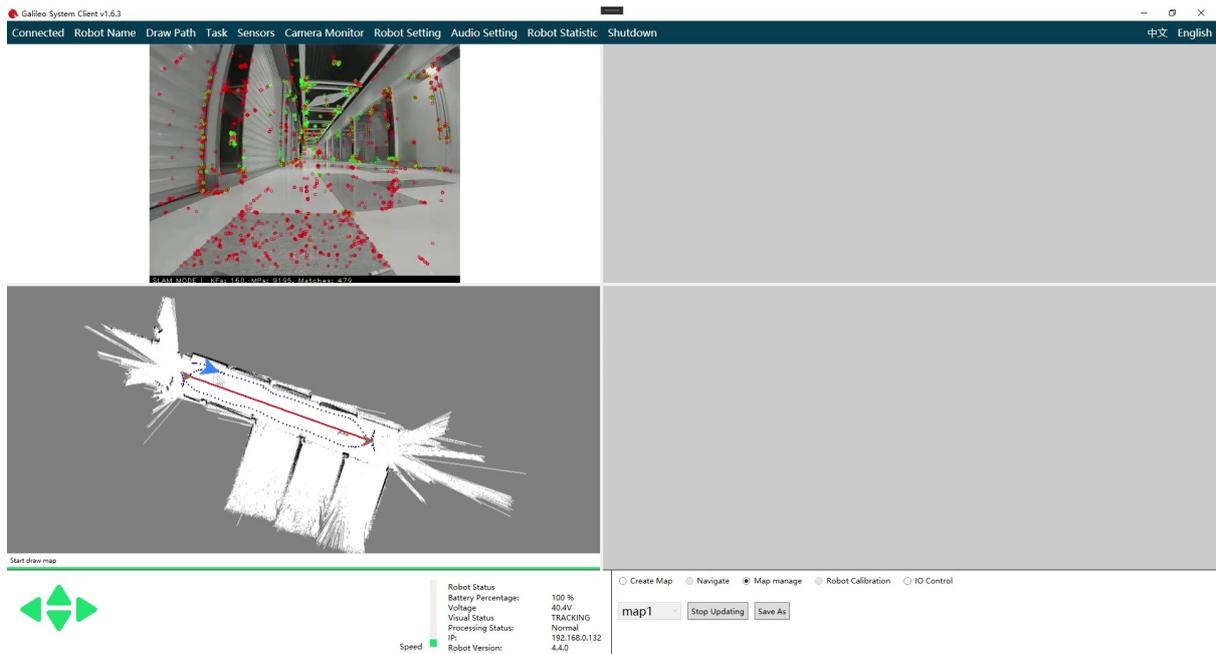
The map management control panel provides map management functions, including "map deletion", "update", and "save as" .



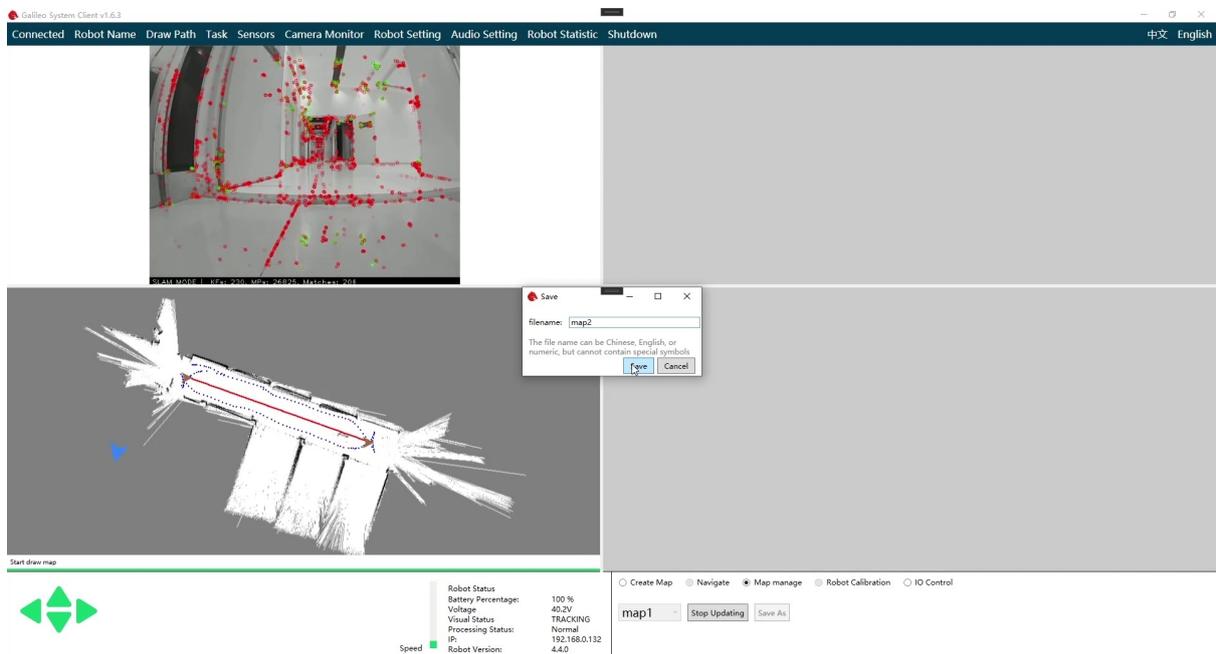
## 3.5.1 Update

In actual use, the environment may change a lot, which makes the previously built map unable to continue tracking and use. At this time, the map needs to be updated. First, select the map to be updated in the left menu and click the update map button.





The robot may not be able to track when the update is turned on. At this time, the robot can be remotely controlled to a place where the environment does not change much, so that the robot can track the environment. The operation after that is the same as the process of mapping. When saving, enter the name of the map and wait for the save to complete (if the name is the same, the previous map will be overwritten). If you feel that the quality of the new map is good, you can click stop updating button to stop the map update process. You can see the newly updated map in the map drop-down menu. You can then use the new map to navigate.



### 3.5.2 Deletion

Find the drop-down menu in map management and select the name of the map you want to delete. Click the delete button on the right to delete the map.



- [Chapter4 Audio Editing Tool](#)
  - [4.1 Function](#)
  - [4.2 Instructions](#)
  - [4.3 How to speak other languages](#)
  - [4.4 Custom audio](#)

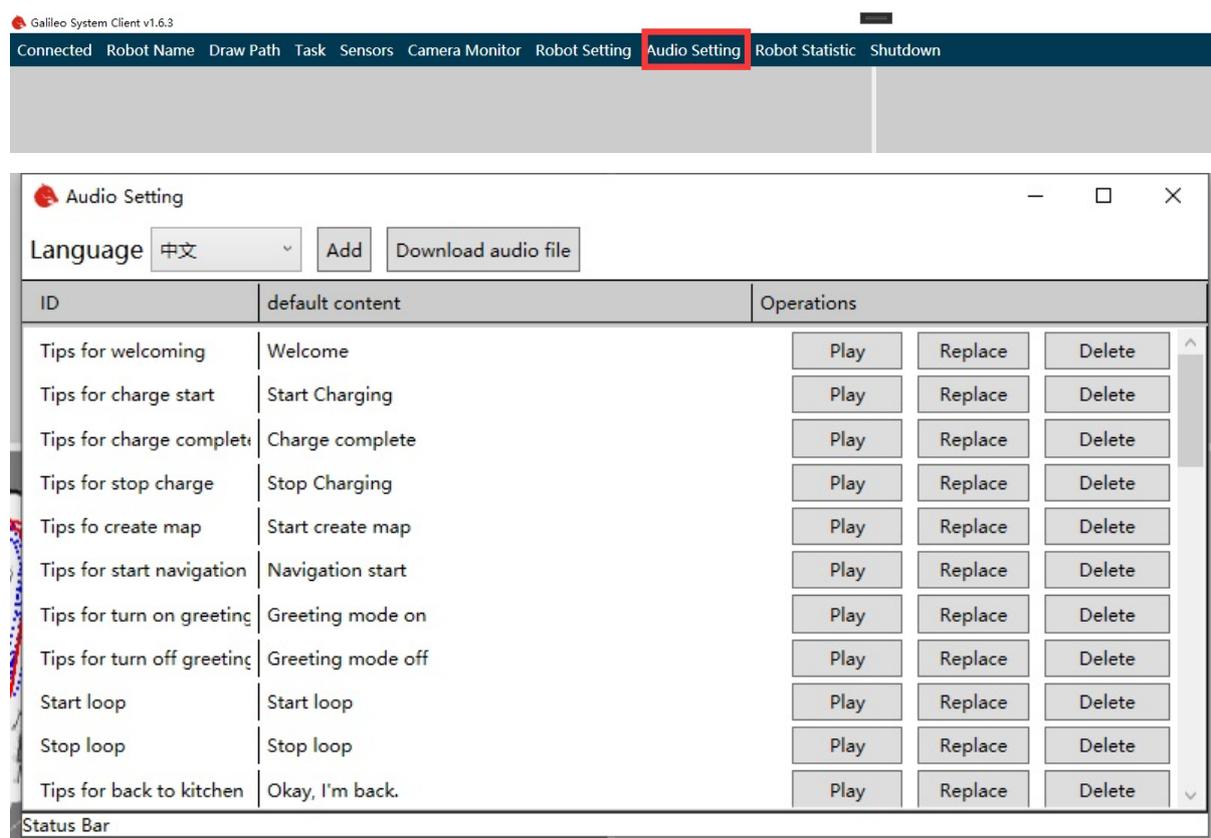
## Chapter4 Audio Editing Tool

### 4.1 Function

Customers can use this software to modify the robot's default audio. It can achieve audio customization, translation, publicity and other effects.

### 4.2 Instructions

Open the software and the UI shows as below.

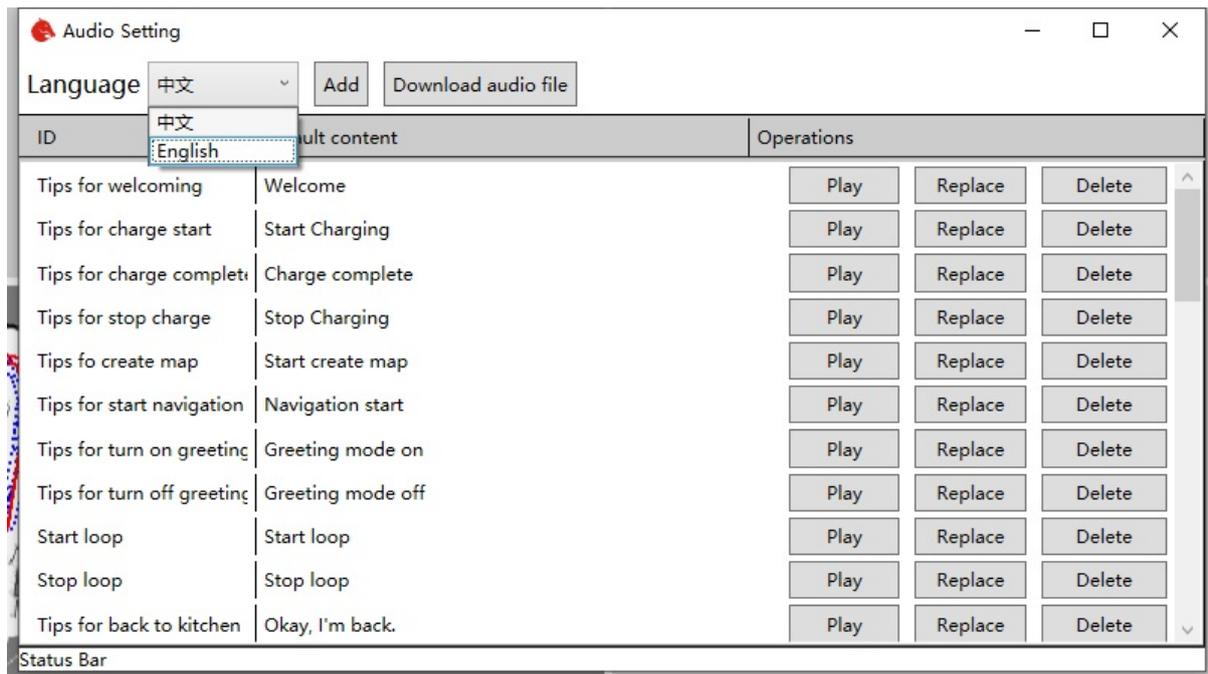


Click the play button of the corresponding audio to hear the robot say the corresponding words. If you want to modify the default audio, click the replace button, and then select your own audio file. Now only wav and MP3 are supported.

If you want to restore the default audio, you can click the delete button. At this time, the software will delete the user-defined audio and download the default audio from the Internet. So make sure the robot can access the internet.

## 4.3 How to speak other languages

Click languages list, and then we can see languages can be chosen. For example, we want robot to speak English.

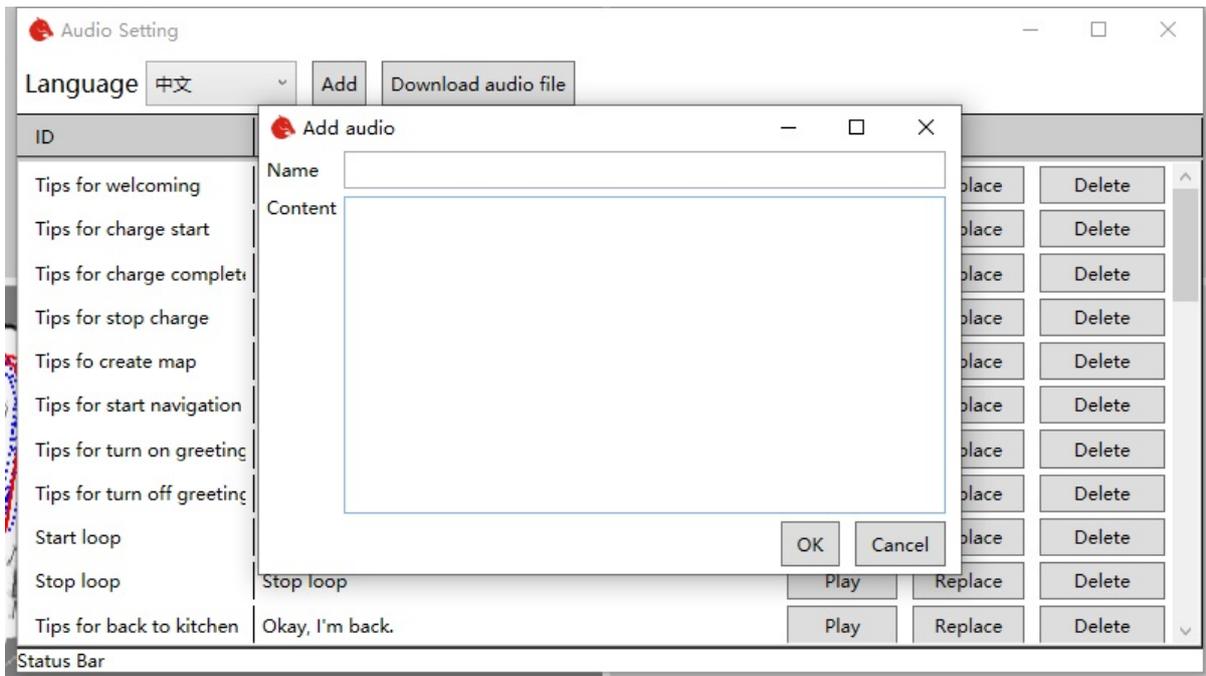
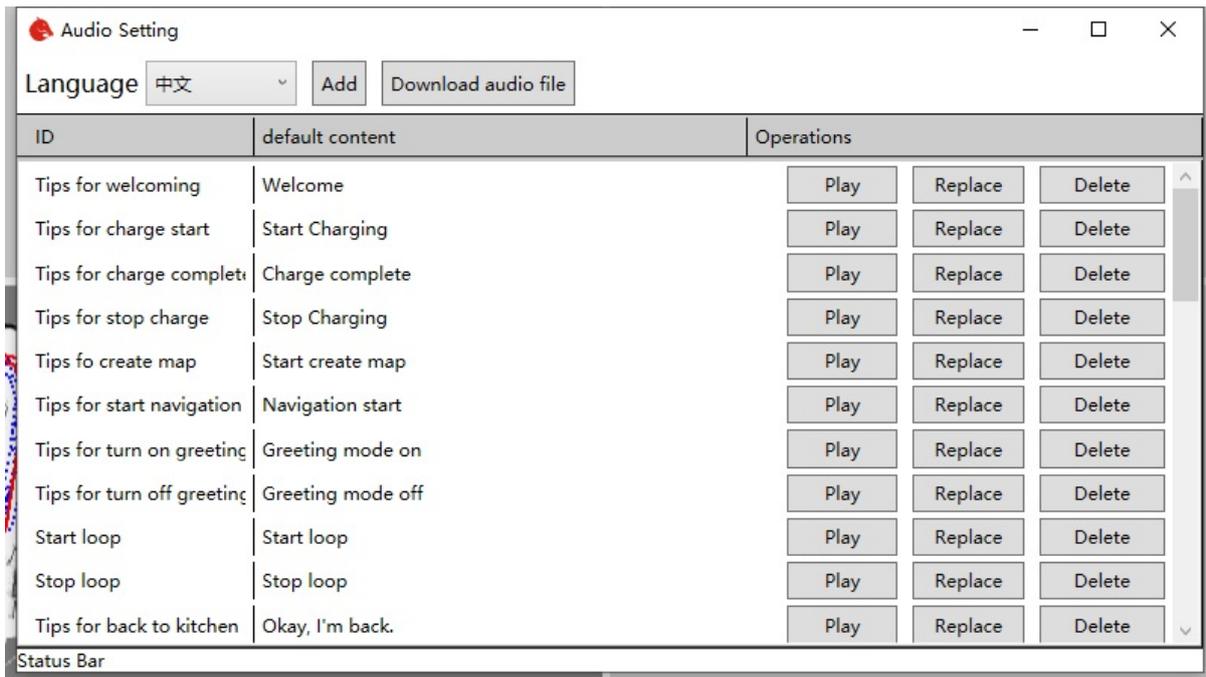


After that, according to the previous method to replace the corresponding audio with the English audio file.

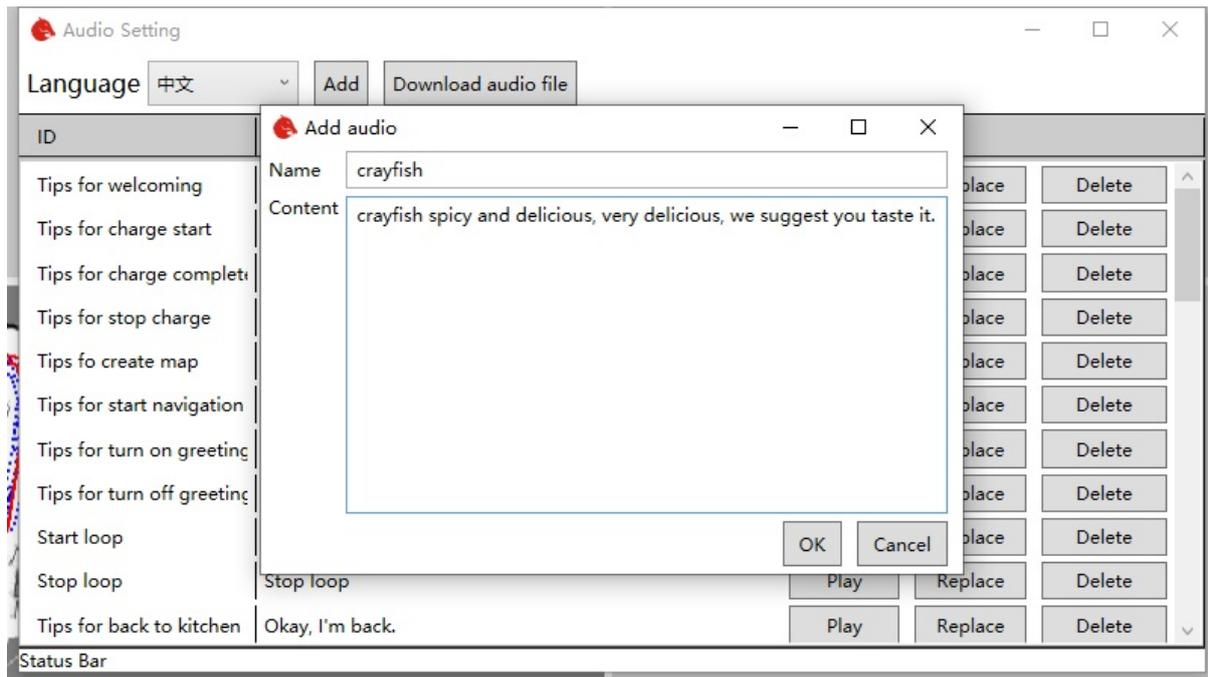
## 4.4 Custom audio

Sometimes we want robots to help us promote products through audio. This function can also be implemented by this software.

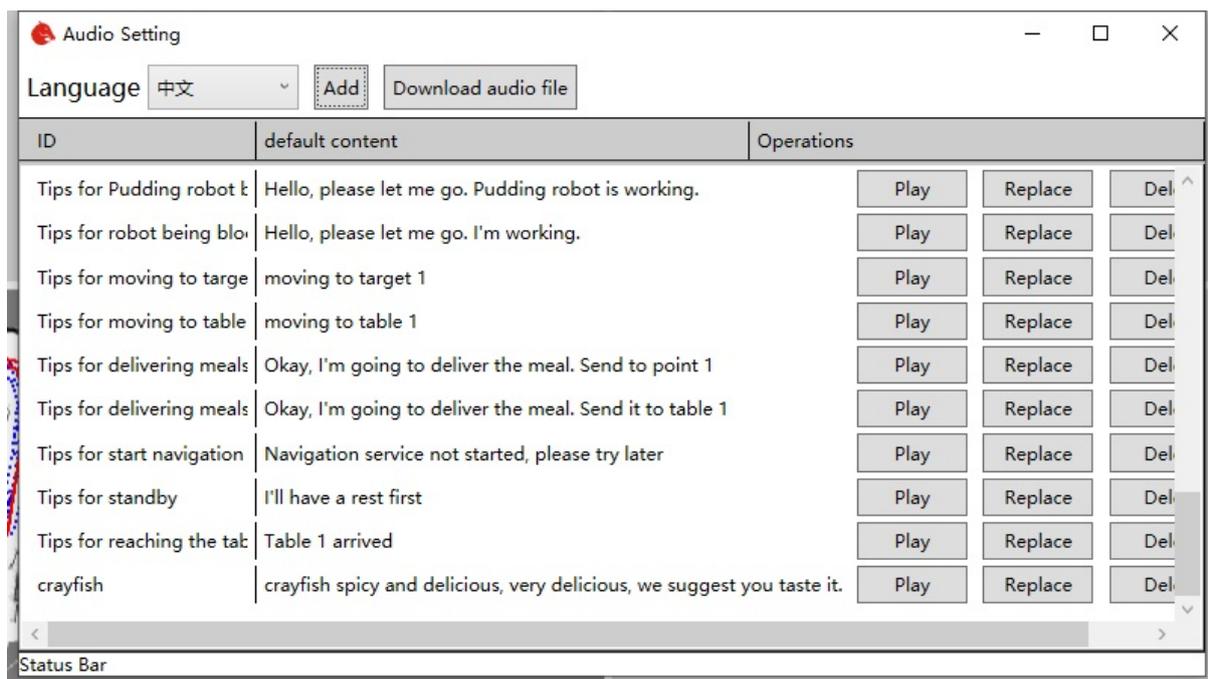
First, click the Add button in the upper right corner of the main interface to open the add audio dialog box.



Enter what you want the robot to say, like we use it in a restaurant. I want a robot to introduce crayfish to us. You can enter "crayfish" in the name, and then enter the content "crayfish spicy and delicious, very delicious, we suggest you taste it."



In this way, we can see the newly added crayfish audio at the bottom of the main interface.



Click play to hear the audio introduction. If you are not satisfied with the automatically generated audio, you can also replace it with your own prepared audio file by using the replacement method described earlier.

The added audio can be used in the robot app, which can control the robot to play the corresponding audio circularly. In this way, robots can sell products for you.

The audio settings in app can be referred to [click there](#)



- Chapter5 The Calibration of Robot
  - 5.1 IMU calibration
  - 5.2 Camera calibration

## Chapter5 The Calibration of Robot

In the process of using the robot, due to the robot assembly error. The built-in parameters of the robot and navigation will lead to errors in the actual positioning and positioning of the robot. The robot parameters can be calibrated by using the robot calibration tool, which can reduce the error and improve the positioning and navigation accuracy of the robot.

The calibration of robot consists of two parts. One is IMU calibration, the other is camera calibration.

Demo video

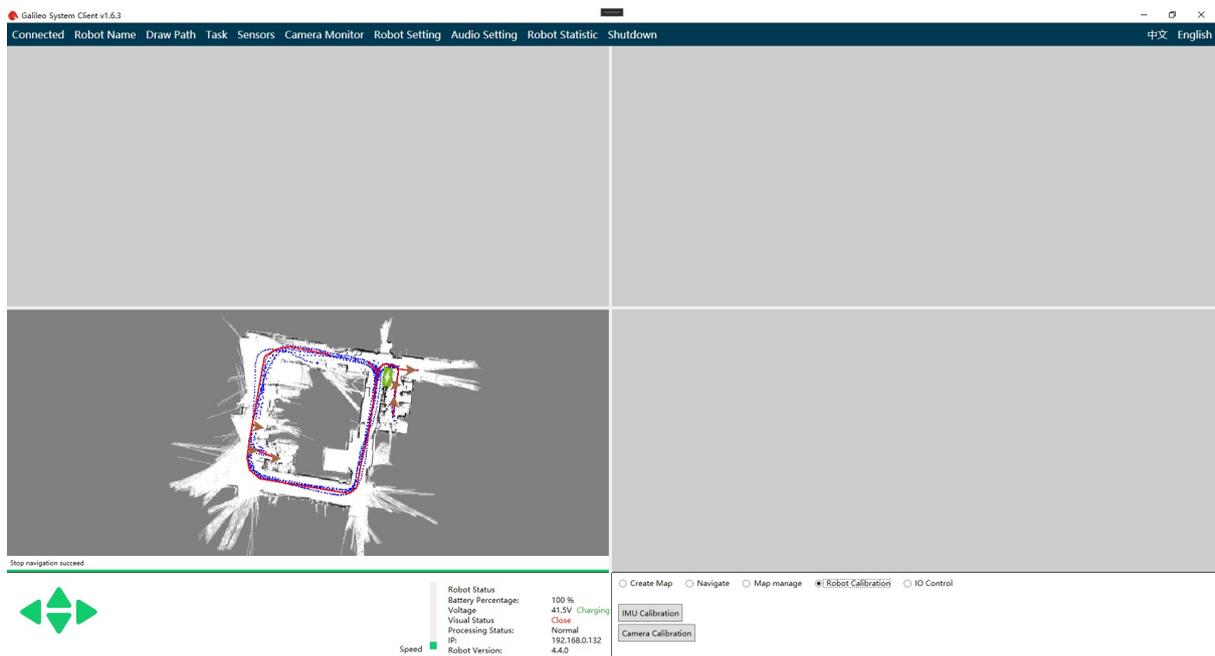


### 5.1 IMU calibration

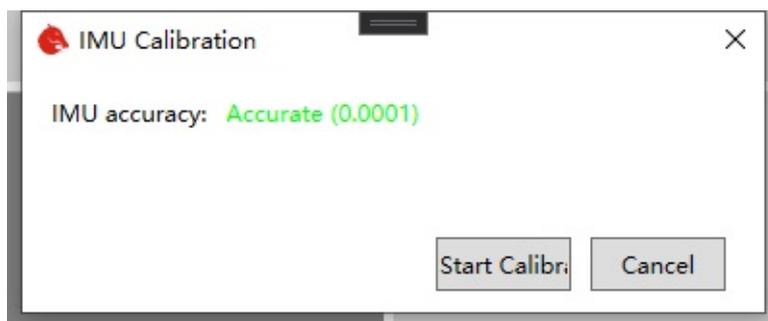
IMU is a kind of equipment used by robot to locate in short distance. First open the client and connect the robot.



Click "Robot Calibration"



Then click IMU Calibration



The IMU calibration window will pop up. The IMU data will be displayed in the window. The smaller the value is, the more accurate IMU is.

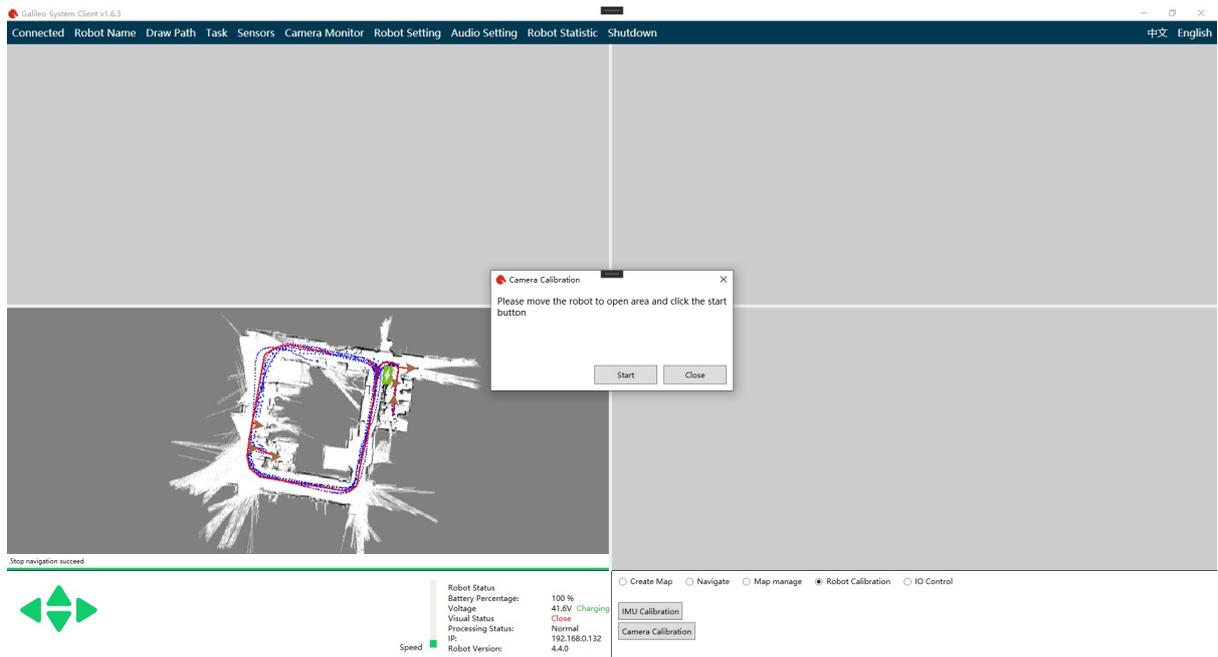
Click "Start Calibration" to calibrate. Pay attention not to touch the robot during calibration. This will lead to a large error in calibration. The whole calibration process may take two minutes. Please be patient.

After the calibration is completed, you can close IMU calibration window.

## 5.2 Camera calibration

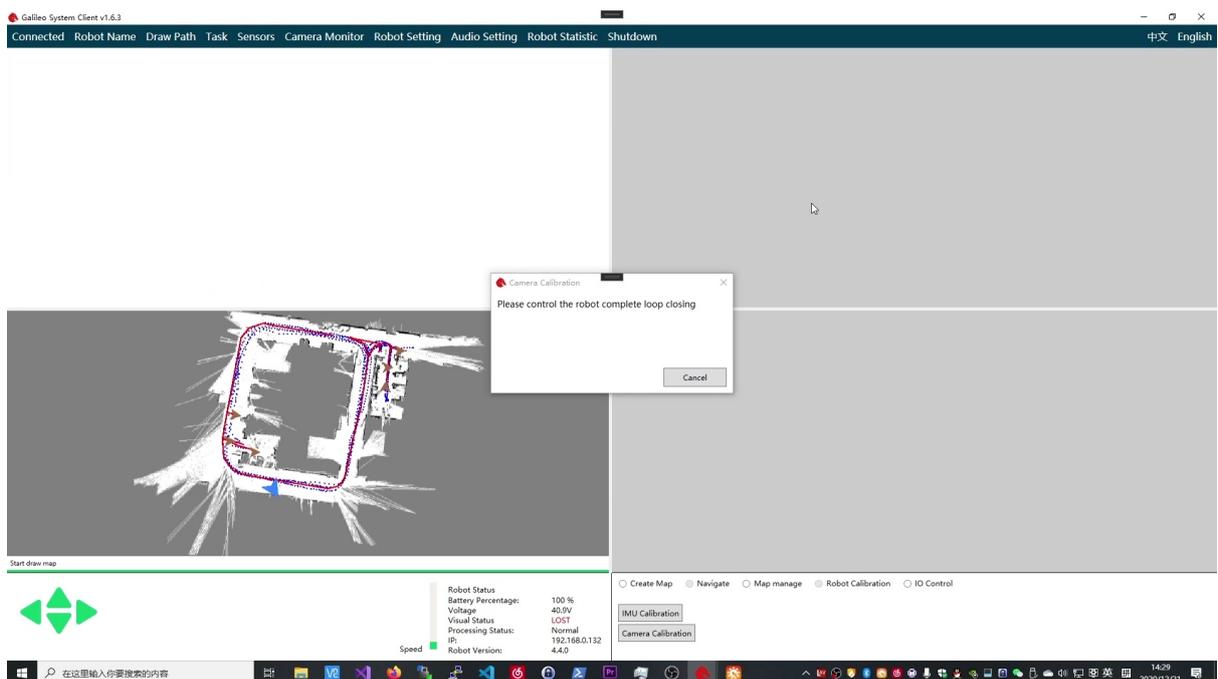
The camera calibration process requires the remote robot to move around in the environment, so please ensure that there is enough space for the robot to move before starting the calibration.

Click "camera calibration" button in the lower right corner. The camera calibration window will pop up. Then according to your robot, you need to choose the correct button to calibrate the front/back camera or just a single camera.

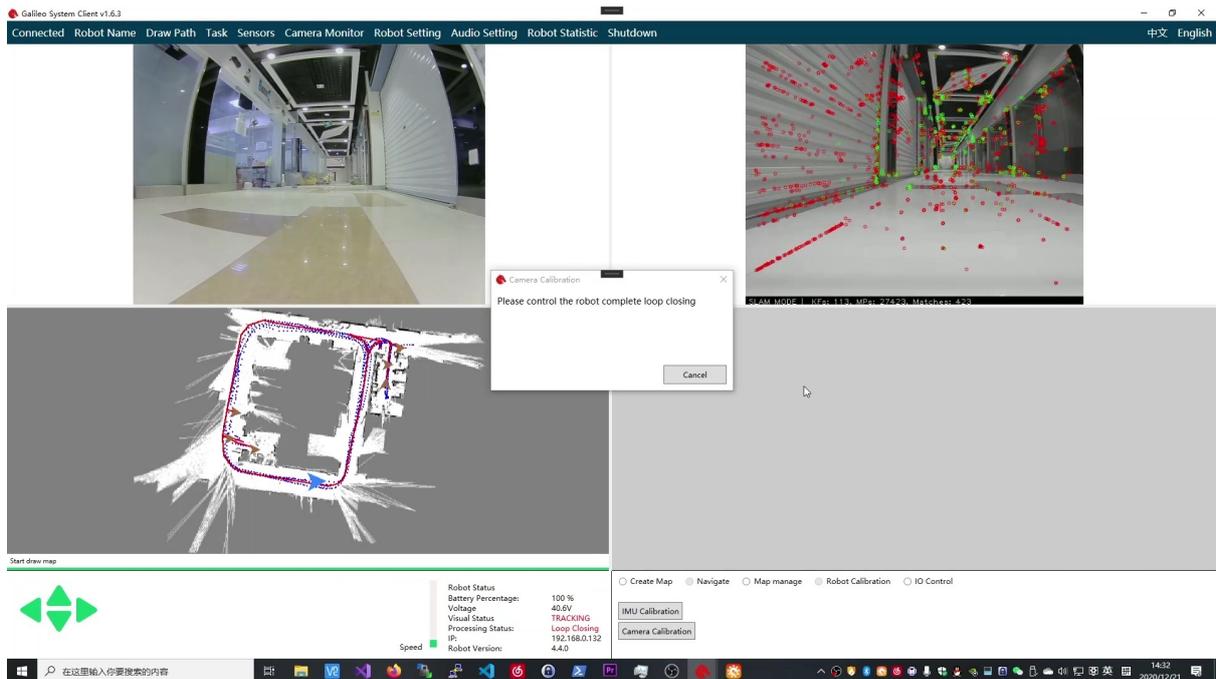


According to the prompt, remote control the robot to a more open position. Then click the start button.

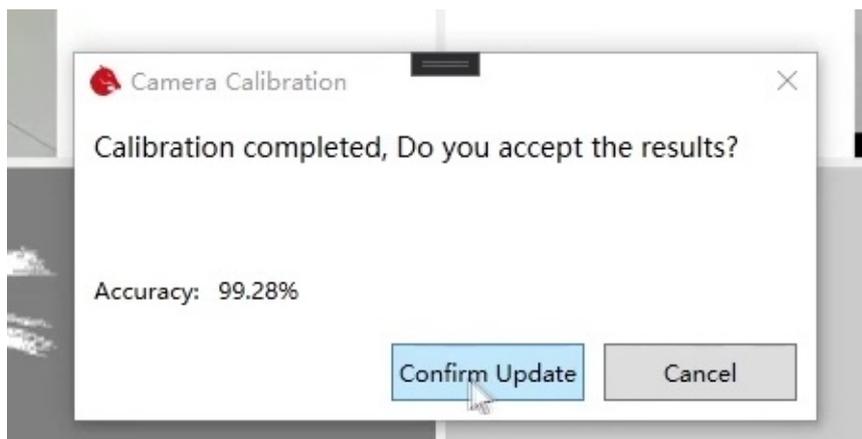
At this time, the robot will enter the building-map status.



According to the window prompt, move your robot forms a closed-loop.



Wait for the closed-loop to complete, and then continue to move forward for a distance. At this time, the robot will automatically calculate the calibration parameters and errors.



Better results can reach more than 99%. Whether you can accept the calibration depends on the accuracy of the results. If you accept the results, click the confirm Update button.

Now calibration is done.

- [Chapter6 Robot Setting](#)
  - [6.1 Main parameters](#)

## Chapter6 Robot Setting

According to different application environment, the performance of robots will be different. For example, some scenes need robots to move faster, while others need robots to move more smoothly. The performance of the robot is determined by the corresponding parameters. Through the robot parameter modification interface, we can easily modify the parameters of the robot, so as to make the robot more suitable for our application scenarios.

After connecting the robot, click the setting button in the navigation bar above to open the robot setting interface.



If there is no button in the navigation bar, the robot does not support setting parameters. You can try again after updating the robot.

The setting interface is as follows

Robot Motion Params		
Max control speed	1.2	reset default
Max control angle speed	Default	reset default
Navigation Speed	0.6	reset default
Max angle speed	Default	reset default
PID (K2)	Default	reset default
PID (Kp)	Default	reset default
PID (Ki)	Default	reset default
PID (Kd)	Default	reset default
Look ahead distance	0.4	reset default

Barrier Avoidance Settings		
Get around	<input type="checkbox"/>	reset default
Get around radius	Default	reset default
Robot width	Default	reset default
Robot rotate width	0.6	reset default
Back time	Default	reset default
Avoid distance	0.8	reset default

Map Setting

OK Cancel

Modify the parameters that need to be changed, and then click OK to update the robot parameters.

If the confirm button is disabled, it indicates that the robot program does not support parameter modification function, and it needs to be modified again after upgrading the robot program.

## 6.1 Main parameters

### Robot Motion Params

- Navigation Speed

The navigation speed is the target speed when the robot navigates, and it is also the maximum speed. The unit is meters per second. If the navigation speed changes little from the default value, it can be modified directly. If there are large changes, the following PID control parameters need to be modified at the same time. Otherwise, the robot may have the problem of unstable navigation.

- Max angel speed

Unit: radian / second. Set the maximum rotation speed during navigation.

- PID parameters

The motion control of robot adopts PID algorithm, and K2, KP, Ki, KD are related control parameters. If you are familiar with PID control algorithm, you can adjust it according to the general PID parameter calibration method. If you are not familiar with it, you'd better not change it.

- 

- PID(K2)

Unit: dimensionless. The larger the value, the smaller the forward speed when turning. The recommended range is 0.3 to 2.0. If the value is too small, the turning speed will be too high to rush out of the path.

- 

- PID(Kp)

Unit: dimensionless. The PID proportional control factor when deviating from the path. The recommended range is 0.3 to 2.0. The larger the value is, the greater the angular velocity of the regression path will be. If the value is too large, it will cause oscillation and make the car swing left and right. If the value is too small, it will cause the car to deviate from the path.

- 

- PID(Ki)

Unit: dimensionless. The PID integral control factor when deviating from the path. In most cases, you don't need to change value.

- 

- PID(Kd)

Unit: dimensionless. The PID differential control factor of deviation path. The recommended value range is - 1.0 to 2.0. This value is used to eliminate the phenomenon of angular velocity oscillation, and when the value is appropriate, it can eliminate the left and right swing when the vehicle is running in a straight line. When the value is not suitable and too high, the oscillation phenomenon of left-right oscillation will be strengthened.

- 

- Look ahead distance

Unit: meter. The higher the value of the motion control parameter forward direction aiming distance is, the worse the fitting effect of the path is (when the mode is not bypassed, the traffic efficiency will be affected), but the speed will be smoother and the swing range will be smaller.

- Get around

If checked, it means to select the mode of detouring when encountering obstacles (if it can't be bypassed, it will stop moving until the obstacle disappears), and canceling the check means to select the mode of stopping moving when encountering obstacles (the task will continue automatically after the obstacle disappears).

- Get around radius

Unit: meter. Only works in bypass mode. It corresponds to the "distance between the obstacle and the detour" in the above figure, and also represents half the width of the minimum passable path (for example, setting it to 0.5 m means that the minimum passing width is 1 m). This value cannot be less than half the actual width of the car.

- Robot width

Unit: meter. It corresponds to "left obstacle avoidance distance" + "right obstacle avoidance distance" in the above figure. It is generally set as the actual width of the car.

- Robot rotate width

Unit: meter. Represents the diagonal length of the car. When the distance between the obstacles is less than half of the set value, it cannot rotate and the angular velocity is forced to zero.

- Back time

Unit: second. Only works in bypass mode. Indicates the maximum continuous backward time in case of no forward. It is better to set it to a small value greater than zero, otherwise the passable effect will be affected.

- Avoid distance

Unit: meter. It corresponds to "obstacle distance ahead" in the figure above. When the safe distance between the vehicle and the obstacle is less than this value, the car cannot move forward, but it is allowed to rotate in place.

### Map Setting

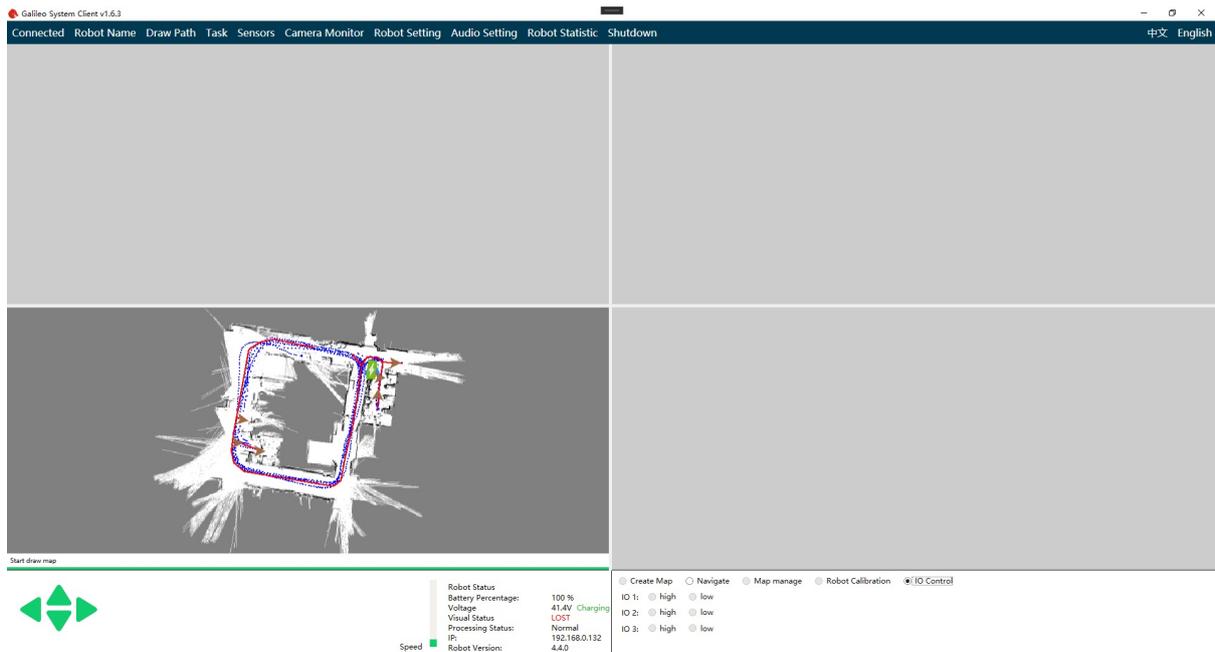
The robot's default navigation map and corresponding navigation path settings. When the automatic map switching function is turned on, the robot will automatically load the path corresponding to the relevant map according to the settings here. It can be used to realize the scene switching of robot automatic navigation, such as automatic switching from No.1 warehouse to No.2 warehouse. Automatically switch from the first level scene to the second level scene.

- Chapter7 I/O Control

## Chapter7 I/O Control

For some robot scenarios, it is necessary to control the IO of the robot, which can be easily operated through the IO control panel.

After connecting the robot, click the IO control panel in the lower right corner.



As you can see, there are three IO's marked with high level and low level options.

If the robot program does not support the IO control function, the corresponding IO button is disabled. If the robot supports IO control function, the IO control panel will display the current level state of IO corresponding to the robot. If you click the corresponding level option, the program will set the corresponding io of the robot to the level you set.

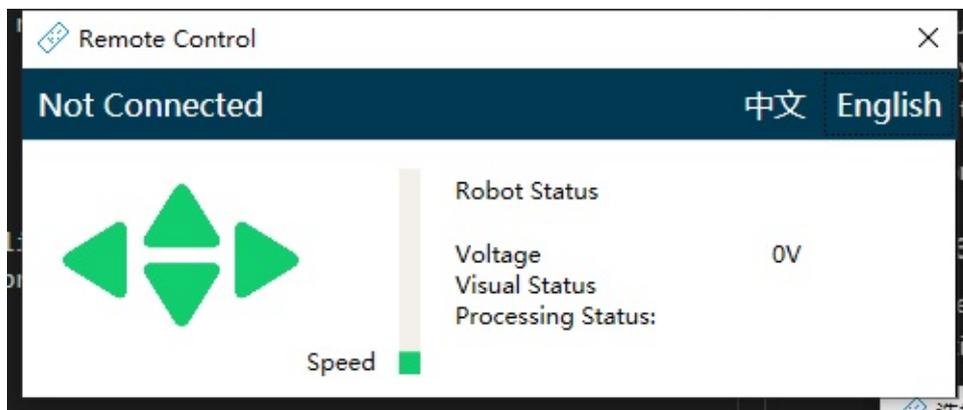
- [Chapter8 Remote Control with 4G and Image](#)
  - [8.1 Install](#)
  - [8.2 Configuration](#)
  - [8.3 Remote](#)

## Chapter8 Remote Control with 4G and Image

Galileo navigation system with Internet of things system, users can remote control the robot through 4G network.

### 8.1 Install

[Download](#) remote control package and install. After installation, the interface is shown in the figure below.



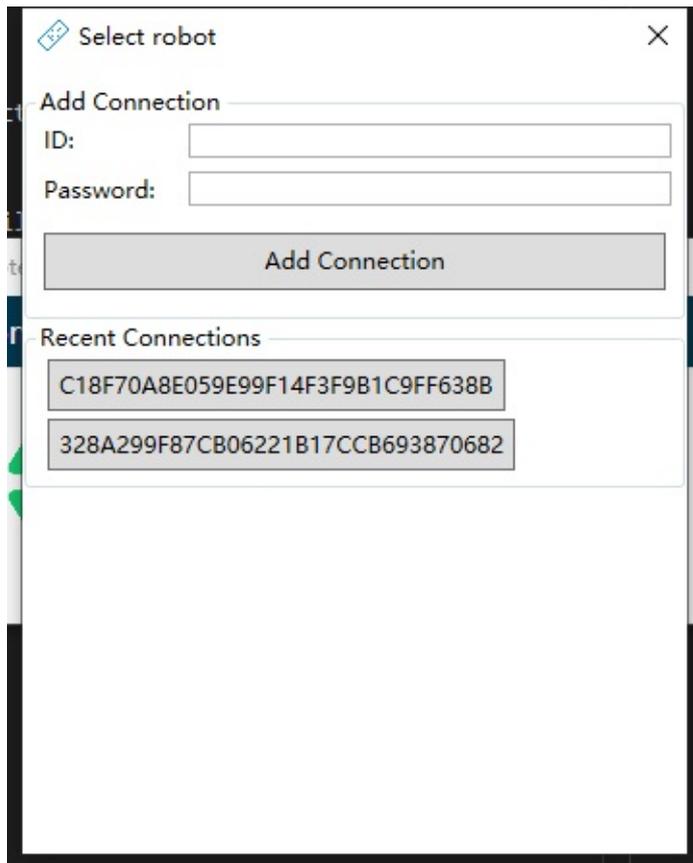
### 8.2 Configuration

By default, the networking function of robots and people is turned off by default and needs to be turned on manually (for a few models, please consult the robot sales department for details). Developers can use the [doc](#) to turn on the function. General users are not recommended to open it.

After configuration, pay attention to modify the remote connection password of the robot `IOT_PASSWORD`.

### 8.3 Remote

After the robot side ensures normal operation, click the unconnected button of the client. Enter the ID and remote connection password of the robot in the pop-up window.



After the input is completed, click the Add Connection button. Under normal circumstances, the client can remotely control the robot.

After successful connection, the connection information will be automatically displayed in the recent connections list below. Next time, you can directly click the corresponding button to connect directly, no longer need to input connection information.

The client will show in the figure as the picture below after successful connection



The speed is controlled by WSAD key on the keyboard, and the speed of robot is controlled by up and down arrow keys.



- [Chapter9 FAQ](#)
  - [4.1 Image transmission picture freeze, delay](#)
  - [4.2 The visual status shows "missing" during the construction process, and no green feature points appear in the black and white image transmission screen](#)
  - [4.3 After starting the service, the visual status always shows "lost" and the robot swings in place](#)
  - [4.4 Unable to turn off navigation service](#)
  - [4.5 When planning the path, the loaded map shows a mess of gray dots, and the blue trajectory point of the robot is not like the remote control path when the map is scanned.](#)
  - [4.6 The client cannot connect to the robot](#)

## Chapter9 FAQ

### 4.1 Image transmission picture freeze, delay

Right-click to close the image transmission, and then reopen the image transmission, if the problem still exists, please wait for the robot to drive away from this signal blocking area before trying again.

### 4.2 The visual status shows "missing" during the construction process, and no green feature points appear in the black and white image transmission screen

There are two cases as follows:

- a. After turning on the vision, the visual state has not been "tracking";
- b. "Tracking" appeared before the visual state, and suddenly became "lost" during the remote-control drawing process.

SOLUTION:

- a. Try to ensure that the robot moves in a straight line, move forward for a period of time and then back for a period of time, and repeat the action until the visual state becomes "tracking";
- b. Return the robot (ensure that the orientation of the robot remains unchanged) to the closest position where the visual state is "tracking", so that the robot vision system is locked again;
- c. After trying both methods for many times, if it still shows "missing", please turn off the vision and then turn on the vision again, and scan the image from the beginning.

### 4.3 After starting the service, the visual status always shows "lost" and the robot swings in place

This situation indicates that the robot cannot recognize the current position, and there are two possibilities:

- a. The current position has not been recorded during the construction scan, please remote control the robot to the scanned position to ensure that the orientation of the robot is the same as the orientation during the construction, and then restart the autonomous inspection;
- b. The light intensity or item distribution at the current location has changed significantly, and the environment needs to be rescanned for construction, and the inspection paths and stations also need to be redrawn.

## **4.4 Unable to turn off navigation service**

- a. It may be that the network connection is not available, you can try to make the control terminal close to the robot, and then turn off the navigation service;
- b. The system processing information has not yet reacted, just a moment later;
- c. When it is found that it still cannot be turned off normally, you can manually turn off the robot power switch.

## **4.5 When planning the path, the loaded map shows a mess of gray dots, and the blue trajectory point of the robot is not like the remote control path when the map is scanned.**

This means that the creation of this map has failed. Please rescan the map and try again.

## **4.6 The client cannot connect to the robot**

Please check your network to make sure that both computer and robot already connect to the network.