遨博（北京）智能科技有限公司
AUBO (Beijing) Robotics Technology Co., Ltd

User Manual

AUBO Mobile Collaborative Robot

The user manual version is detailed in the version information section of this manual. Please check the actual product version information carefully before use to ensure consistency.

The user manual will be checked and revised periodically, and the updated content will appear on the latest version.

The information in this manual is subject to change without notice and should not be regarded as a commitment by AUBO (Beijing) Robotics Technology Co., Ltd.

AUBO (Beijing) Robotics Technology Co., Ltd. assumes no responsibility for any errors or omissions in this document. AUBO (Beijing) Robotics Technology Co., Ltd. assumes no responsibility for incidental or consequential damages arising from use of this manual and products described herein.

Please read this manual before install or use.

Please keep this manual to read and as reference any time.

The pictures in this manual are for reference only, please refer to the actual product received.

Catalog

Preface

Figure 1 AUBO Mobile Collaborative Robot

Thank you for purchasing AUBO Mobile Collaborative Robot, which is researched and developed by AUBO (Beijing) Robotics Technology Co., Ltd. The user manual is intended to provide a guide for the user to use the mobile collaborative robot safely and effectively. Please read it carefully before using the robot. All pictures in this manual are for reference only, please refer to the actual product.

All safety information contained in this manual shall not be regarded as the guarantee of AUBO (Beijing) Robotics Technology Co., Ltd. Even if all the safety instructions are observed, the personnel injury or product damage caused by the operator may still occur.

AUBO (Beijing) Robotics Technology Co., Ltd. is committed to continuously improving the reliability and performance of the product. Therefore, we reserve the right to upgrade products without notice. AUBO (Beijing) Robotics Technology Co., Ltd strives to ensure the accuracy and reliability of the contents of this manual but is not responsible for any errors or omissions. AUBO is not responsible for personal injury or product damage caused by incorrect use of the robot according to the manual.

Intended Use

AUBO Mobile Collaborative Robot can flexibly control AUBO Manipulator, Automated Guided Vehicle (AGV), visual camera, gripper and other tools. The multi-in-one robot control system brings a simple and convenient, safe and reliable, extended flexibility, and efficient collaborative full-scene interactive experience. The robot can flexibly adapt to various working environments, eliminate complicated operations, and realize the sorting and transportation of items in mobile space. It can be used for the grabbing, assembling, transporting, loading and unloading of workpieces, and can also be rapidly deployed in automatic factories, warehouse sorting, automated supermarkets and many other scenarios to provide automatic and flexible operation for automatic workpiece transporting and sorting.

Product Components

The components of the robot are listed as below:

Table 1-1 robot components list

NO.	Product	Quantity	Note
1	AUBO Manipulator	1	Carton packaging
2	Automated Guided Vehicle (AGV)	1	Wooden box packaging
3	Teach Pendant	1	
4	Teach Pendant Cable	1	
5	Manipulator Cable	1	
6	Battery Charger	1	
7	Automatic Charging Station	1	Optional
8	Accompanying Documents	/	

More Information

If you need more information, please visit our official website at: www.aubo-robotics.cn

1. Safety

1.1 Introduction

This chapter introduces the safety principles and specifications that should be followed when operating a robot or robot systems. Integrators and users must read the relevant description in this manual carefully and fully understand and strictly adhere to the warning symbols in the contents. Because of the complexity and highly risks of the robot system, users need to fully understand the risks of operation, and strictly observe and implement the specifications and requirements in this manual. Both the integrators and users should have adequate safety awareness and comply with the Industrial Robots Safety Requirements ISO 10218.

1.2 Warning Symbols

The contents related to safety in this manual are explained with the following warning symbols. The descriptions of the warning symbols indicate important contents, which must be observed.

Symbol	Description
	This indicates an imminently hazardous situation that may cause personal death or serious injury if not avoided.
	This indicates a potentially hazardous electrical situation that may cause personal injury or major equipment damage if not avoided.
	This indicates a potentially hazardous situation that may cause personal injury or major equipment damage if not avoided. Marked with this symbol, depending on the circumstances, sometimes may have significant consequences.
	This indicates a situation that may cause personal injury or major equipment damage if not avoided. Marked with this symbol, depending on the circumstances, sometimes may have significant consequences.

1.3 Safety Precautions

1.3.1 General

This manual includes safety precautions for protecting the user and preventing damage to the machine. Users need to learn all the relevant descriptions and fully understand the safety precautions. In this manual, we try to describe all the various situation as much as possible. However, we cannot describe all the matters, which must not be done or which cannot be done, because there are so many possibilities.

1.3.2 Terms and Conditions

The following basic information needs to be understood and followed when using the robot or robot system for the first time. Other safety-related information will be introduced in other parts of this manual. However, it is impossible to cover everything. In practical applications, it is necessary to analyze specific issues.

1. Make sure to install the robot and all electrical equipment according to the manual requirements and specifications.
2. Make sure to conduct a preliminary test and have inspection for robots and its protection systems before using the robot or putting it into production for the first time.
3. Make sure to check the equipment and system for completion, operational safety, and any damage that can be detected before starting the system and equipment for the first time. The test needs to confirm whether it accords with valid safety production rules and regulations in country or region. All safety functions must be tested.

4. Make sure that all safety parameters and user programs are correct, and all safety functions are working normally. A qualified robotics operator is needed to check each safety function. Only pass the thorough, careful safety test and reach the safe level, we can power on the robot.
5. Installation and commissioning need to be performed by professionals in accordance with the installation standards.
6. When the robot is installed, a comprehensive risk assessment is necessary, and the test results need to be recorded in a report.
7. Set and modify the safety parameters by a qualified person. Use password or isolation measures to prevent unauthorized people from setting and modifying safety parameters. After a safety parameter is modified, the related safety functions need to be analyzed.

8. When the robot is in an accident or abnormal operation, the emergency stop switch needs to be pressed down to stop the movement.
9. The joint module of AUBO Manipulator has brakes inside, it will remain manipulator's pose when power outage occurred. Don't power on and power off frequently. It is recommended that the time interval of each switch should be more than 10s.
10. The robot generate heat during operation. Do not handle or touch the robot while the robot is working or just stop working.
11. To cool the robot down, power off the robot and wait for one hour.
12. Never stick fingers behind the internal cover of the control box.

1. Make sure the robot joints and tools are installed properly and safely.
2. Make sure that there is enough space for the manipulator to move freely.
3. Do not use the robot if it is damaged.
4. Do not connect any safety equipment to normal I/O. Use safety-related interfaces only.
5. Make sure to use the correct installation settings (e.g., the robot mounting angle, mass in TCP, TCP offset, safety configuration). Save and load the installations file along with the program.
6. Tools and barriers should not have sharp edges or pinch points. Make sure that all people keep their heads and faces outside the reach of the robot.
7. Be aware of robot movement when using the teach pendant.
8. Any strike would release a large amount of kinetic energy, which is much higher than the case of high speed and high payload.
9. The different mechanical linking may increase the risk or lead to new dangers. Make sure to perform a comprehensive risk assessment for entire installation. Always choose the highest-level performance when different safety and emergency shutdown performance level is needed. Make sure to read and understand all the devices manual used for installation.
10. Do not modify the robot. A modification may cause unpredictable danger to the integrator. All authorized reassembling shall be done according to the newest version of all relevant service manuals. If the robot is changed or altered in any way, AUBO (Beijing) Robotics Technology Co., Ltd refuses to assume all responsibilities.
11. User needs to check the insulation and protection measures before transportation.
12. Transporting robots must follow the transport requirements. Handing carefully and avoid t bumps.

1. When the robot is combined with or working with machines capable of damaging the robot, then it is highly recommended to test all the functions of the robot and the robot program separately. It is recommended to test the robot program using temporary waypoints outside the workspace of other machines.

2. AUBO (Beijing) Robotics Technology Co., Ltd cannot be held responsible for any damages caused to the robot or to other equipment due to programming errors or malfunctioning of the robot.

3. Do not expose the robot to a permanent magnetic field. Very strong magnetic fields can damage the robot.

4. Make sure that the load is placed and properly secured according to specifications. Failure to properly place or secure the load may cause the load to fall or the robot to tip over.

5. The robot cannot observe the stairs and holes on the floor. Please mark stairs and holes as prohibited areas on the map and update the map in time.

6. Please keep the integrity of the AGV surface. If the application development requires drilling, it may cause damage to the robot electrical equipment.

7. Do not hit the LIDAR of the robot to prevent the LIDAR from being worn or even damaged, which will cause the robot to lose its automatic driving ability.

8. Do not step on or place heavy objects on the robot shell to prevent damage to it.

9. Please use the matching key to open the lock of the robot. Do not use external force to damage the lock.

1.3.3 Operator Safety

In the operation of the robot, the first priority is to ensure the safety of the operators. The general precautions are listed below. Please take appropriate measures to ensure the safety of operators.

1. Each operator who uses the robotic system should be trained through a training course hosted by AUBO (Beijing) Robotics Technology Co., Ltd. Users need to make sure to fully grasp the safe and standardized operating procedures with the robot operating qualifications. Please inquire for training details, email: support@aubo-robotcs.cn

2. Do not wear loose clothing or jewelry when working with the robot. Make sure long hair is tied back when working with the robot.

3. When the robot is running, even if it seems to stop, it is possible that robot is waiting for the signal and in the upcoming action status. Even in such state, it should be considered as the robot is in action.

4. When using the operation panel or the teach pendant, make sure to take off the gloves in case of operational errors.

5. Pushing or pulling the manipulator, force the joint to move in the emergency or abnormal condition (like a person is caught in or surrounded by a robot). Manually move the manipulator without electric drive only for emergency, and it may damage the joints.

6. The high-speed rotating part of the robot (universal wheel or driving wheel) may cause personal injury.

7. Do not rely too much on the autonomous avoidance of the robot. Please actively avoid the running robot.

1.4 Responsibility and Standard

AUBO Mobile Collaborative Robot can be combined with other equipments to form a complete machine, and itself is not complete. The information in this manual does not cover how to design, install, and operate a complete robot, nor does it cover all peripheral equipments that can influence the safety of the complete system. The safety of installing a complete robot is determined by how it integrated.

Integrators must follow the standards and regulations and laws of the country where the robot is installed to perform a risk assessment for its system design and installation. Risk assessment is one of the most important things that integrators must done. Guidance on the risk assessment process may be found in the following standards.

- ISO 12100:2010 Safety of machinery - General principles for design - Risk assessment and risk reduction.
- ISO 3691-4 Industrial trucks — Safety requirements and verification — Part 4: Driverless industrial trucks and their systems
- RIA TR R15.306-2014 Technical Report for Industrial Robots and Robot Systems - Safety Requirements, Task-based Risk Assessment Methodology.
- ANSI B11.0-2010 Safety of Machinery; General Requirements & Risk Assessment.

AUBO robot integrators need to fulfill but not limited to the following responsibilities:

- Comprehensive risk assessment of complete robot system;
- Make sure the whole system design and installation is correct;
- Provide training to users and personnel;
- Create operational specifications for a complete system, specify instructions for process;
- Establish appropriate safety measures;
- Use appropriate methods to eliminate or minimize all hazards to acceptable level in the final installation;
- Convey the residual risk to the users;
- Mark the logo and contact information of the integrators on the robot;
- Archive technical file

Guidance on how to find and read applicable standards and laws is provided on: www.aubo-robotics.cn

1.5 Hazard Identification

Risk assessment should consider all potential contacts and foreseeable misuse between robot and operator. Operator's neck, face and head should not be exposed in case of collision. Without using peripheral safety devices, the robot needs to perform a risk assessment first to determine whether the risk is unacceptable, such as:

- The risk of using a sharp end-effector or tool connector.
- The risk of processing toxic or other hazardous substances.
- Fingers being caught by robot base or joint.
- The risk of being hit by manipulator.
- The danger due to incompletely fix of manipulator or connected tool.
- Danger due to impact between a heavy payload and a soild surface.

Integrators must measure these dangers and its associated risk level through a risk assessment. Identify and implement appropriate measures to reduce the risk to acceptable level. However, Integrators should be aware that specific robotic equipment may have other dangers.

Combine the inherent safety design which applied by AUBO robot with the safety specifications or risk assessment performed by integrators and users, risks that are associated with AUBO robot operation should be lower to reasonable and practicable level. Any residual risks before installing will be conveyed to integrators and users through this manual. If integrator's risk assessment shows that there may have unacceptable risks in specific applications, integrators must take appropriate risk reduction measures to eliminate or minimize these risks to acceptable level. It is not safe to use before taking appropriate risk reduction measures (If necessary).

If perform non-cooperative installation (for example, when using dangerous tools), risk assessment may infer that integrator need to connect additional security devices (such as a boot device) when it is programming to ensure the safety of personnel and equipment.

1.6 Emergency Situations

1.6.1 Emergency Stop Device

Pressing the emergency stop button will stop all robot movements. Emergency stop shall not be used as a risk reduction measure, but as a secondary protective device. If multiple emergency stop buttons are connected, it should be recorded in the risk assessment of the robot application. Emergency stop buttons should comply with IEC 60947-5-5.

Emergency stop button can be found on the teach pendant and AGV, as shown in Figure 1-1, the button must be pressed when a dangerous situation or emergency occurs. Control box is equipped with an external port for emergency stop button. Integrators and users can use it according to the actual situation.

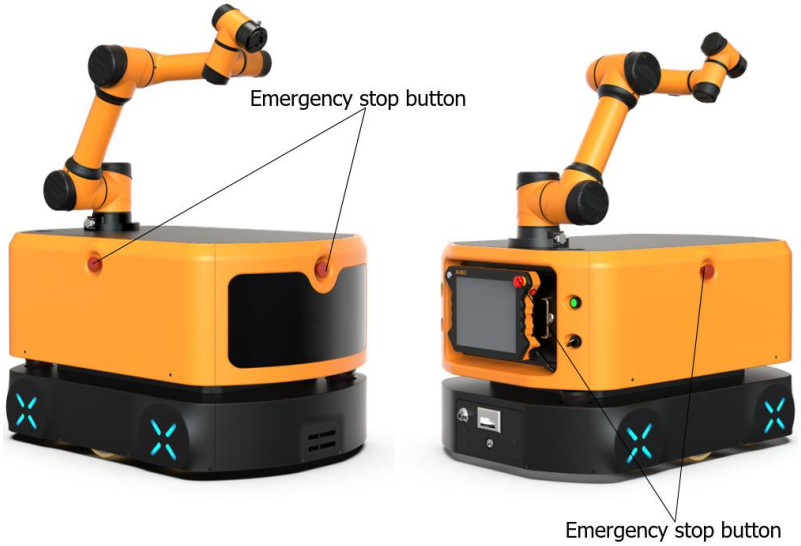

Figure 1-1 Emergency stop button

If the equipment or tools which connect to the end cause potential danger, it must integrate to the emergency stop circuit in system. It may result in death, serious injury or substantial property damage if failure to observe this warning.

1. The emergency stop button is only used for emergency and shall not be used to stop the robot operation.
2. When the emergency stop button is pressed, the robot immediately stops all movement.
3. When using the Dispatch System, do not push the robot after pressing the emergency stop button, otherwise it will cause problems in the Dispatch System.

1.6.2 Recovering from the Emergency Condition

All the button type emergency stop device has a "lock" function. This "lock" must be opened to end the emergency stop state.

Rotating emergency stop button can open the "lock".

Recovery from an emergency stop state is a simple but very important step. This step can only operate after making sure that the robot system is completely excluded from danger.

1.6.3 Emergency Move for Joint

In rare cases, it may be required to move one or more robot joints when the robot's power failure or in an emergency, which can force the robot to move by follow method:

Forced back-driving: Force a joint to move by pulling hard on the manipulator.

Forced to move the manipulator manually is limited to emergency situations and it may damage the joints.

1.6.4 Excessive Force Protection

Manipulator has excessive force protection. When manipulator is power-on and in stationary state, if impact force hit by operators or other objects mistakenly exceeds the safety threshold, manipulator will follow the direction of impact force to move passively. This function can reduce the damage when operators or other objects collide with manipulator.

This function can reduce the collision damage and required to perform risk assessment if other use is needed.

1.6.5 Collision protection

The Manipulator has collision protect function. During the operation of the manipulator, when the operator or other objects accidentally touch the manipulator and the collision force exceeds the safety range, the manipulator will enter **Type 2** stop state and enter the drag teaching mode. At this moment, the manipulator can be dragged to a relatively safe position and continue its operation by pressing buttons on the teach pendant. This function can ensure that when the operator or other objects collide with the manipulator, it reduces the damage to the person, to the objects and to the manipulator itself. At the same time, it saves the time of restarting the program and improves work efficiency. The safety range of the collision force can be changed by setting the collision level. For details, please refer to 10.5.1 Basic Configuration.

1.6.6 Safety System

The safety system of mobile cooperative robot includes two functions: Safety Emergency Stop and Safety Deceleration. The safety emergency stop means that the robot can immediately trigger the emergency stop action after detecting the presence of obstacles. The safety deceleration means that the robot can immediately trigger the deceleration action after detecting the presence of obstacles. Both safety emergency stop and safety deceleration are safety functions to protect personnel and on-site facilities. The difference between the two functions is reflected in the detection distance. The detection distance of the safety emergency stop is small, with a typical value of 0-20mm, and the detection distance of the safety deceleration is large, with a typical value of 20mm-1000mm.

The safety system acts on the manipulator and AGV at the same time. Once the safety emergency stop or safety deceleration is triggered, the manipulator and AGV will respond accordingly. When the safety emergency stop is triggered, the manipulator, AGV and all equipment of the robot system will stop working, and the online programming project of robot will enter the emergency stop state to ensure that all equipment will be stopped. When the safety deceleration is triggered, the manipulator and AGV will enter the half-speed motion state to protect the safety of nearby personnel and equipment.

The safety system uses the laser radar to sense the surrounding scene in real time. The mobile cooperative robot controller will analyze the environmental data sensed by the laser radar, extract the obstacle information, and judge whether the obstacle enters the detection distance of safe emergency stop or safe deceleration.

2. Robot Composition

2.1 Introduction

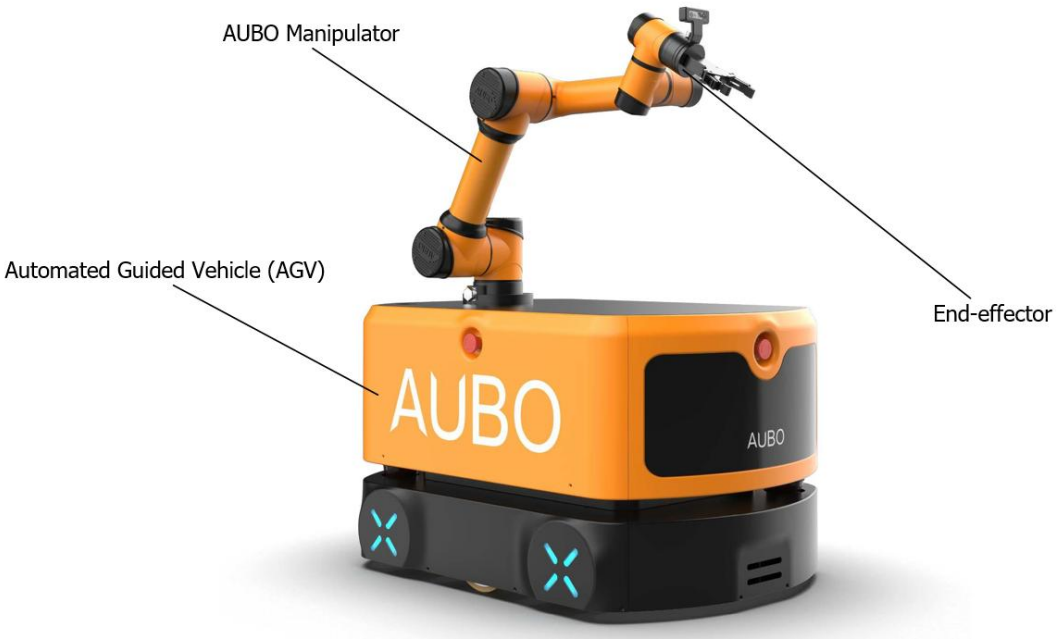

Figure 2-1 AUBO mobile collaborative robot

As shown in Figure 2-1, the mobile collaborative robot mainly consists of Automated Guided Vehicle (AGV), AUBO manipulator and end-effector (optional). The AUBO manipulator supports multiple model adaptations, such as AUBO-i5 and AUBO-i10. AUBO manipulator and AGV can be collaboratively controlled through the programmable interface of the teach pendant, or collaboratively managed through remote communication.

2.2 AGV

The Automated Guided Vehicle (AGV) is a mobile robot with the Automatic Map Building and Autonomous Navigation. Automatic Map Building is realized by the sensors carried by the robot. The typical sensor is LIDAR, and the typical scheme is two LIDARs arranged in the left front and right rear of the AGV, forming a diagonal arrangement structure to meet the requirement of 360-degree scanning and environment perception. Autonomous Navigation is realized by robot sensors and navigation algorithms. Typical sensors include LIDAR, inertial navigation chip and odometer, and the typical navigation algorithm is SLAM (simultaneous localization and mapping).

2.2.1 Basic Function

The Automated Guided Vehicle (AGV) has the following main functions:

1. Simultaneous localization and mapping (SLAM)
2. Establishing stations and path planning
3. Path navigation
4. Automatic charging
5. Safety emergency stop, safety deceleration
6. Provide a variety of buttons and components
7. Provide mechanical, hardware and software interfaces for development

2.2.2 Buttons and Components

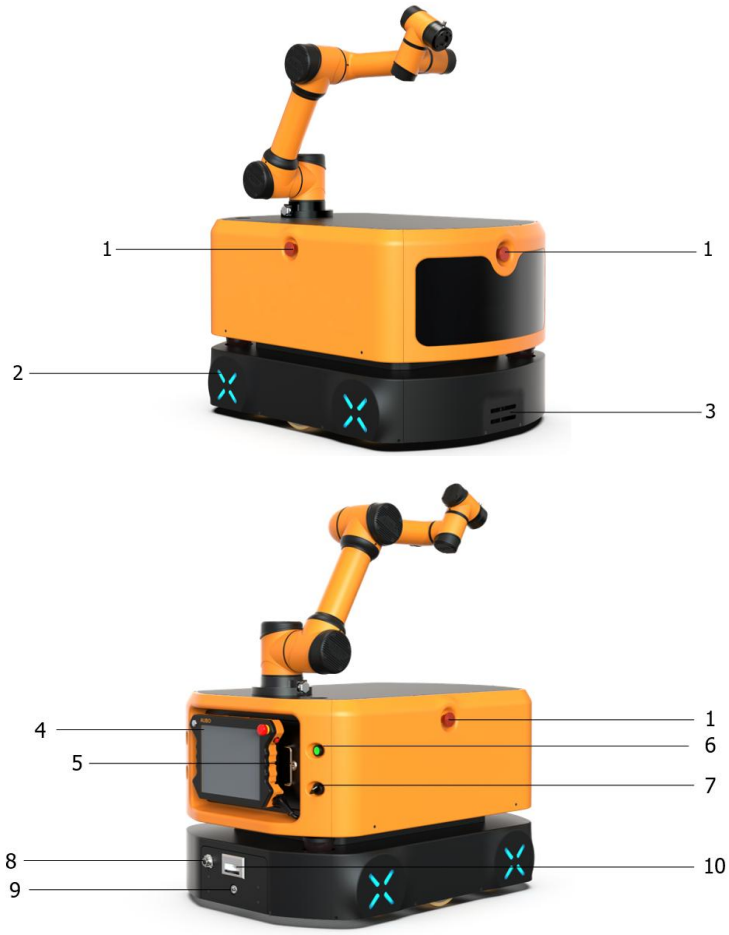

Figure 2- 2 Buttons and Components

NO.	Buttons / Components	Description
1	Emergency Stop Button	Press to stop the robot. Turn the button in the direction shown on it to return to normal mode.
2	Ambient Light	Display the current status of the robot and the battery level
3	Automatic Charging Port	Connect with the automatic charging station
4	Teach Pendant	Control and operate the robot
5	Hatch Keyhole	Lock or unlock the hatch of the AGV
6	Turn On/off Button	Press and hold the button to turn the robot on or off
7	Release Switch	After turning the Release Switch clockwise, the robot can be manually pushed
8	Manual Charging Port	Connect with the battery charger
9	Battery Compartment Keyhole	Release or lock the battery compartment
10	Battery Compartment Handle	For battery replacement

2.2.3 Ambient Light Status Display

The robot indicates the current operation status through the color and shape changes of the ambient light.

Ambient Light Display	Status Description	Note
Red Breathing Light	Robot error alarm	
Dark Red Light Flashing	Robot emergency stop	
Pink Purple LED Scroller	Robot encounters an obstacle	
Orange Light Flashing	Robot turning	
Blue Breathing Light	Robot moving straight	
Orange Breathing Light	Robot charging	
Dark Red LED Scroller	Robot low battery	
Green - Dark Red Light Gradient	Robot is at rest and display the battery level	Gradually from Green (100% power) to Dark Red (10% power)
Rainbow-Colored Light	Battery abnormal	When the robot is at rest, the battery type is not configured or the battery communication error

2.2.4 Teach Pendant

Figure 2-3 Teach Pendant

NO.	Buttons / Components	Description
1	Power Switch	Used to power on or off the teach pendant.
2	LCD Touch Screen	Display of robot operation and status information.
3	Emergency Stop Button	The emergency stop button on the teach pendant can be used to stop the robot. To reset the button, the user needs to rotate the button.
4	Force Control Switch	It is a three-position enabling switch that can realize the three-position action of avoiding dangerous OFF (opening) ⇒ ON ⇒ OFF (pressing). When the switch is in the ON state, the robot can be dragged to teach. When the switch is in the OFF state, the robot cannot be dragged to teach.
5	Teach Pendant Cable	Connection of the teach pendant to the TEACH PENDANT interface on the panel inside the AGV.

2.2.5 Technical Parameters

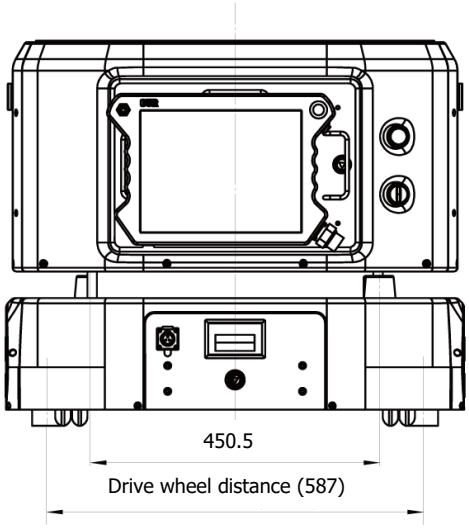

Figure 2-4 AGV Rear View

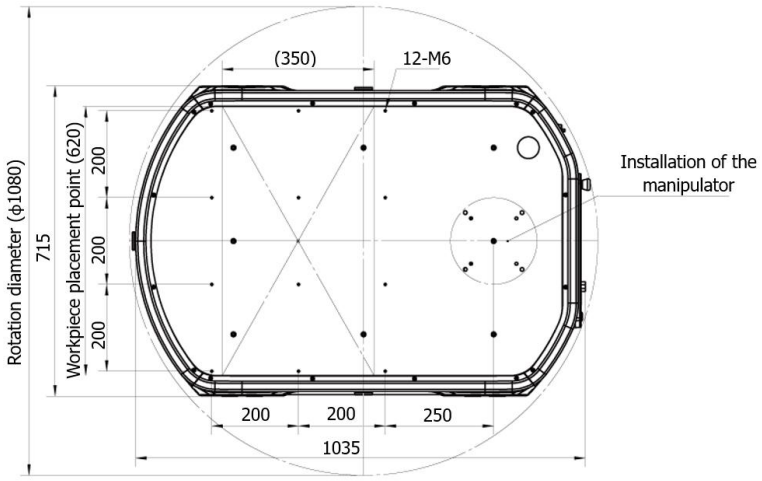

Figure 2-5 AGV Top View

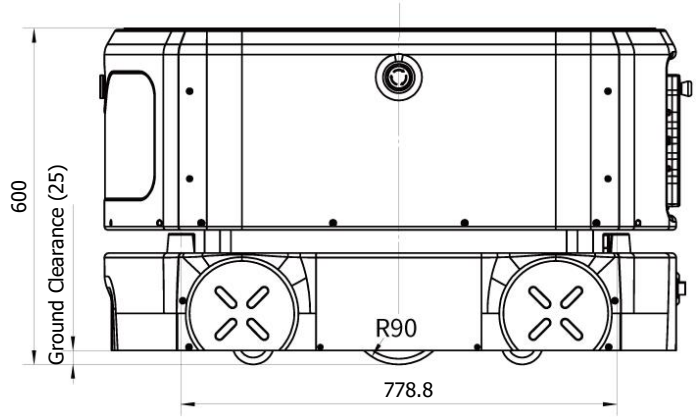

Figure 2-6 AGV Side View

BASIC PARAMETERS	
Product Model	AUBO-ARM300
Dimension (L×W×H)	1000×700×600mm (Height without manipulator) Tolerance: ±2mm
Load Surface Dimension (L×W)	650×620mm, Tolerance: ±2mm
Net Weight	250Kg (without manipulator)
Maximum Load	300Kg (manipulator and carrier included)
Drive Type	Dual wheel differential drive
Number Of Laser Sensors	2
MOVEMENT PARAMETERS	
Max. Speed	1.3m/s
Working Speed	Forward: 1.0m/s (Configurable), Backward: 1.0m/s (Configurable)
Turning Radius	0mm
Rotation Radius	550mm
Climbing Ability	6°
Surmountable Obstacle Height	10mm
Width of Passing Seam	30mm
Ground Clearance	25mm
Traveling Aisle Width	≥ 900mm
Turning Aisle Width	≥1300mm
Station Positioning Accuracy	±10mm
Ground Flatness	6mm
BATTERY PARAMETERS	
Battery Capacity	48V 52Ah, Lithium Battery
Charger Power Supply Parameters	220V 800-1000W
Endurance Time	6h (300Kg Fully loaded)
Battery Life	800 times (DOD 100%), Capacity Retention Rate 80%
Charging Method	Manually charged or automatically charged: Maximum charging current 15A
Charging Time	3h (Charge from 15% to 95%)

2.3 Interface Description

The mobile collaborative robot provides mechanical, electrical, and software interfaces for subsequent application development to meet the implementation of different functional contents. The mechanical and electrical interfaces are located on the upper table surface of the AGV and in the upper shell of the AGV, as shown in Figure 2-7.

Figure 2-7 Interface of mobile collaborative robot

2.3.1 Mechanical Interfaces

The mechanical interface of the mobile collaborative robot is the interface reserved for the user, including bolt holes, positioning pin holes, etc., which is used as the interface for equipment installation in user application development. The mechanical interface of the AGV is located on the upper table of the AGV, as shown in Figure 2-8 below.

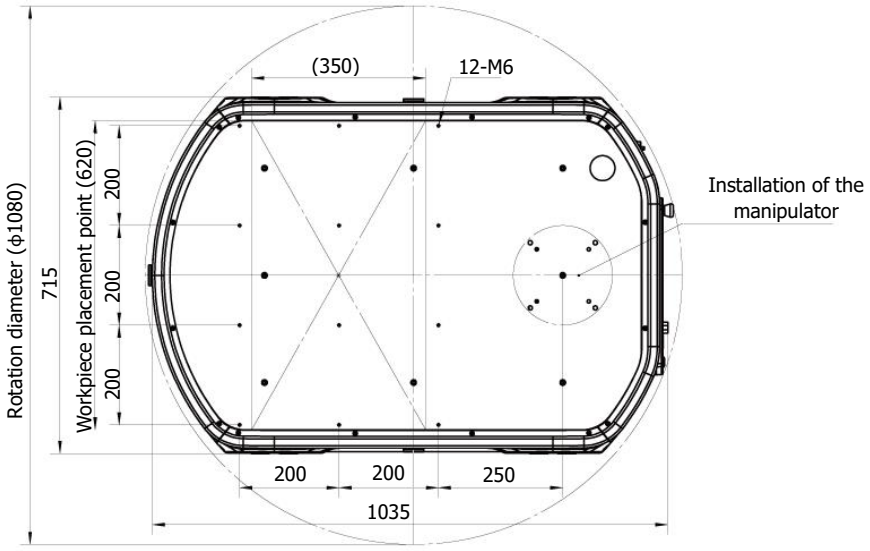

Figure 2-8 Mechanical interface of the mobile collaborative robot

2.3.2 Electrical Interfaces

The electrical interface of the mobile collaborative robot is located in the panel of the AGV. Including DC power interface, ROBOT interface, and TEACH PENDANT interface, etc., as shown in Figure 2-9. The DC power interface supports 12VDC and 24VDC output, the 12VDC interface provides three groups and supports up to 50W power output. The 24VDC interface provides three groups and supports up to 300W power output. Typical applications of DC power interface include power supply for visual camera, power supply for visual industrial controller, and power supply for Gripper.

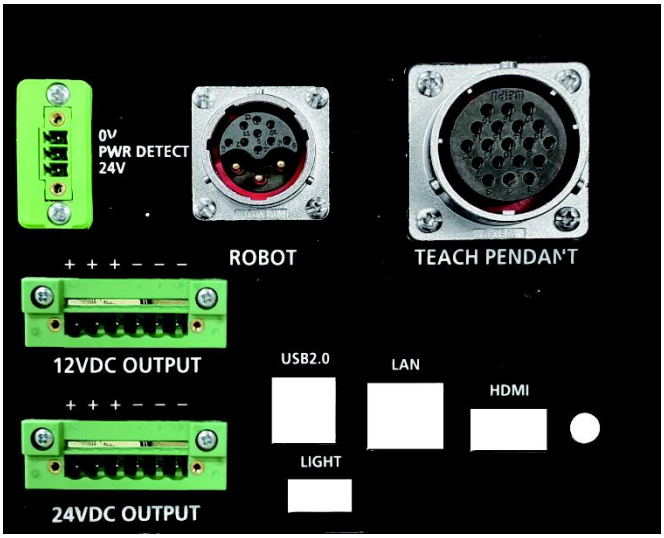

Figure 2-9 Electrical interface of the mobile collaborative robot

The Ethernet interface establishes network communication between users and the mobile collaborative robot, and it can be used for remote access and control. The USB interface provides the user with external device access, software upgrade and project file export. The external I/O interface is used to connect external devices. The enlarged diagram of external I/O interface is shown in Figure 2-11.

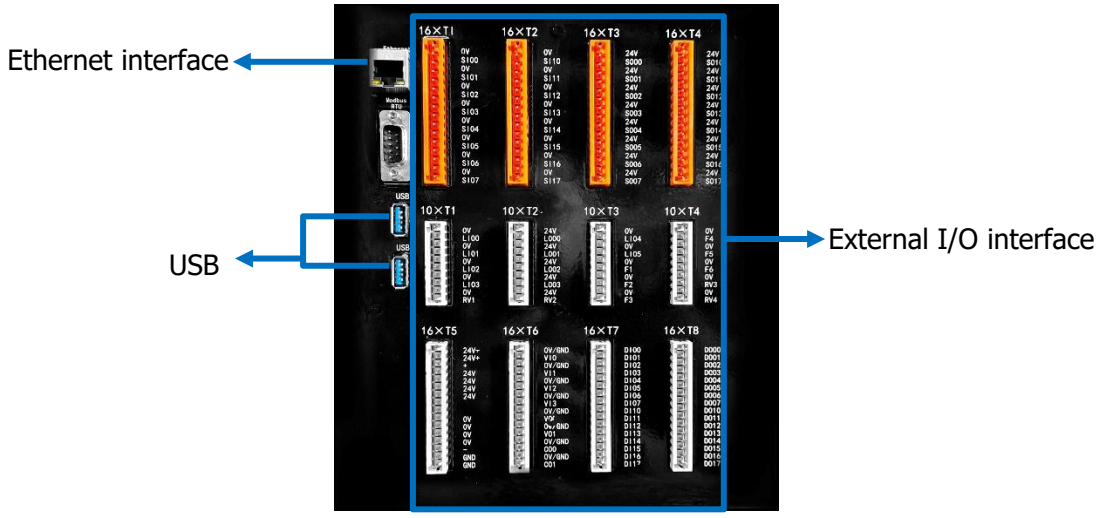

Figure 2-10 External I/O interface

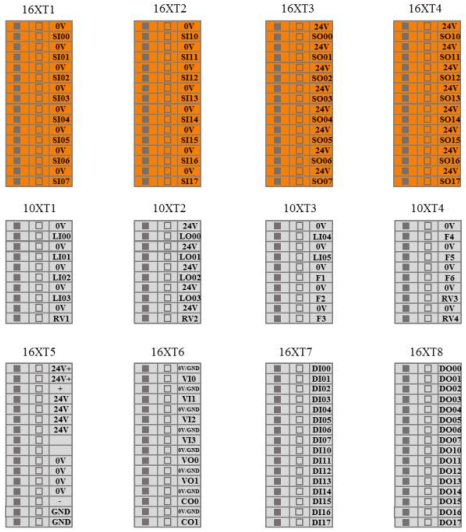

Figure 2- 11 The enlarged diagram of external I/O interface

1. All electrical interfaces must be wired with the robot powered down.

2. Do not connect the safety signal to the non-safety type PLC with an inappropriate safety level. Otherwise, serious injury or even death may occur due to the failure of a safety stop function.

3. All safety-type signals have dual-circuit safety channels (redundancy design). Keeping the two channels independent can ensure that the safety function will not be lost in the event of a single failure.

4. Be careful when installing interface cables to the robot I/O.

5. The robot electrical interface is fragile. Do not hit it during application development.

The robot has passed the tests specified in the international IEC standard of electromagnetic compatibility (EMC). Interference signals above the levels specified in the IEC standard will cause abnormal behavior of the robot. Extremely high signal level or excessive exposure will cause permanent damage to the robot. EMC problems usually occur during welding and are usually prompted by error messages in the log. AUBO (Beijing) Robotics Technology Co., Ltd cannot will not be responsible for any loss caused by EMC problems.

2.4 AUBO Manipulator

The mobile collaborative robot is equipped with the AUBO manipulator, which is characterized by lightness, high load ratio, safety, and high repeated positioning precision. And it can perform high-precision assembly and installation work. It is suitable for performing CNC lathe loading and unloading, equipment installation, and other work in industrial scenarios.

The mobile collaborative robot is adapted to a variety of AUBO manipulator models, typically such as AUBO-i5 (payload 5kg), AUBO-i10 (payload 10kg), as shown in Figure 2-12.

Figure 2-12 AUBO-i5 (left), AUBO-i10 (right)

The AUBO manipulator has six rotating joints, each representing one degree of freedom. The robot joints include the base (joint 1), shoulder (joint 2), elbow (joint 3), wrist 1 (joint 4), wrist 2 (joint 5) and wrist 3 (joint 6). The base is used to connect the manipulator and upper table of AGV. The tool end of the manipulator is used to connect with the end-effector. The manipulator tube is used to connect the shoulder and elbow as well as the elbow and wrist. The programmable interface of the Teach Pendant allows for real-time observation of the operating status and settings for the robot. The robot can perform complex work with the end-effector.

Note: More detailed information about AUBO manipulator can be obtained by consulting the AUBO i5 & CB-M User Manual or AUBO i10 & CB-M User Manual.

2.5 Optional Equipment

The end-effector is the device where the robot is in direct contact with materials, fixtures and equipment. Typical end-effectors include electric grippers, pneumatic grippers, electric suction cups, pneumatic suction cups and so on. The electric gripper is used more frequently on mobile collaborative robots because it is convenient to use and simple to debug without air sources.

In the industrial scenario, the typical end-effector work includes the gripping, sucking, and placing materials or fixtures. Materials include rough materials and finished materials. Fixtures refer to equipment used to fix materials.

Visual camera is a device for object identification and positioning from the environment, the components include visual camera, light source, visual industrial controller, etc. According to the principle of imaging and positioning, it can be divided into 2D visual camera, 2.5D visual camera and 3D visual camera. The visual camera is generally installed at the tool end of the manipulator, forming an eye-in-hand structure. And it forms the end-effector of the manipulator together with electric gripper and other equipment.

3. Use of the Robot

3.1 Important Safety Instructions

3.1.1 Working Environment Requirements

1. No corrosive gas or liquid; No oil mist, no salt mist, no dust or metal powder.

2. No mechanical shock/vibration, no electromagnetic noise, no radioactive materials, low humidity, and no flammable substances.

3. Ambient temperature: 0°C ~ 50°C; relative humidity: 90% RH (non-condensing); atmospheric pressure: 86kPa ~ 106kPa.

3.1.2 Ground Requirements

Parameter	**Value**
Surmountable Obstacle Height	10mm
Ground Flatness	6mm
Climbing Ability	6°
Width of Passing Seam	30mm
Ground Clearance	25mm

1. The ground is required to be flat, without grooves, without damage, without hollowing, without oil stain, without glue and other pollutants.

2. The ground shall be free of screws, rag gloves, thread cables and other foreign objects that are easy to jam and wind the wheels.

3. The working road shall be protected or marked with warning signs to remind other personnel of robot access.

3.1.3 Driving Passage Requirements

Parameter	**Value**
Turning Radius	0mm
Rotation Radius	550mm
Traveling Aisle Width	≥ 900mm
Turning Aisle Width	≥1300mm

3.2 Robot Installation

Take out the AGV and manipulator from the packaging box. The installation hole size of the AUBO-i5 manipulator base is shown in Figure 3-1. Using **Four** M8 bolts to fix the AUBO-i5 manipulator on the AGV upper table. The installation point shown in Figure 2-8 is the installation position of the manipulator. Install the manipulator with the socket facing the cable hole to prevent the cable from interfering with the robot movement. After the installation of the manipulator, insert one end of the connecting cable of the manipulator into the socket of the manipulator base, and the other end into the ROBOT socket shown in Figure 2-9.

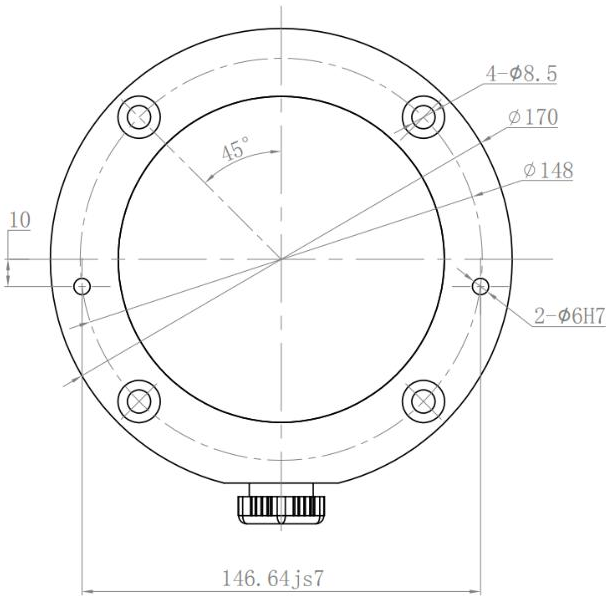

Figure 3-1 Mounting whole size of the manipulator base

3.3 Installation of End-effector

End-effector flange of the AUBO-i5/i10 manipulator has **Four** M6 threaded holes and a Φ6 positioning hole to fix the fixture on the end easily, as shown in Figure 3-2.

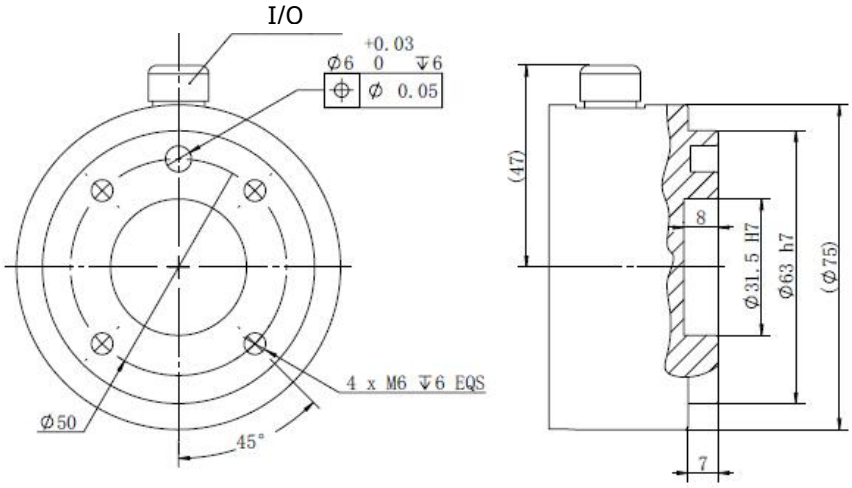

Figure 3-2 Mechanical dimensions of end-effector flange, unit: mm.

1. Make sure the tool is properly and safely bolted in place.
2. Make sure that the tool is constructed such that it cannot create a hazardous situation by dropping a part unexpectedly.

1. If additional components, such as cables, are not part of the AUBO supply and are integrated into the robot, the user is responsible for ensuring that these components have no impact at all and will not affect the safety function.
2. After installing the robot, safety assessment must be carried out and safety instructions must be strictly followed.

3.4 Turning on and off the Robot

1. **Turning on the robot**: Press and hold the Turn On/off Button of the AGV, and release it after the indicator light is always on. At this time, the LCD screen will light on. The ambient light will flash during startup. After startup, the ambient light will keep a certain color, which is related to the battery power (refer to Chapter 2.3.3 for details).

2. **Use:** The operator should check the condition of the robot before use to ensure safe. Check whether the wheel fasteners are tight. Whether the power system is normal. Whether the emergency stop function is normal. Whether the load handling device is damaged (such as bending, crack or wear). Whether the warning device is normal. Whether the ambient light is normal. Check whether the teach pendant LCD screen is normal. Whether the function of the laser sensor is normal. Check whether the battery power is normal. Check whether the charging function is normal. If there is no problem, the robot can be started normally.

3. **Shut down:** Ensure that the robot has no task and is in a stopped state. Shut down can be achieved in the following three ways:

1) Press and hold the Turn On/off Button of the AGV for 3s, and the shutdown is completed after releasing it;

2) Press and hold the power switch at the upper left corner of the teach pendant for about 3s, and then release it to complete the shutdown;

3) Press the software shutdown button  at the upper right corner of the teach pendant interface.

3.5 Robot Charging

When the battery needs to be charged, it can be charged using manual charging or automatic charging.

3.5.1 Manual Charging

1. Open the protective cover of the AGV manual charging port.
2. Then connect the charger to the manual charging port and 220V power socket.

3.5.2 Automatic Charging (Optional)

For the convenience of users, the robot provides automatic charging function, which can realize the automatic charging to the charging station when the robot is idle.

For the automatic charging operation of robots, please refer to the RoboshopPro User Manual of SEER.

1. Please use the original charger. It is forbidden to mix chargers of other brands; otherwise, irreversible damage will be caused to the battery.
2. The battery has fire, explosion and other risks. Do not decompose, crush, incinerate, heat or put the battery into fire.
3. Do not put the battery into water or wet it.
4. Do not contact the positive and negative electrodes of the battery with the metal shell at the same time.
5. Do not short-circuit, overcharge or over-discharge the battery.
6. Do not use or store batteries near heat sources (such as fire or heater).
7. Do not connect the positive and negative poles of the battery reversely.
8. Do not puncture the battery shell with nails or other sharp objects, and do not hammer or pedal the battery.
9. Do not disassemble or repair the battery in any way without authorization.
10. Do not hit, throw or make the battery subject to mechanical vibration and natural fall.
11. Do not mix batteries of different types and brands.
12. If the battery emits peculiar smell, heat, deformation, discoloration or any other abnormal phenomenon, it shall not be used, and the battery shall be removed from the use environment.
13. If the battery catches fire, use dry powder, foam extinguisher, sand, etc. to extinguish it and keep the battery away from the use environment.

4. Operation Interface

4.1 Introduction

The teach pendant provides a visual operation interface for the user. User can control the manipulator and AGV to move and perform programming through the teach pendant with a small amount of programming basis.

4.1.1 User Login

After the robot is installed and powered on, press the power switch of the teach pendant to start the software and enter the user disclaimer interface (tick the option to no longer prompt, and then run the software will no longer appear in this interface). After clicking Pass, the user login interface will pop up, as shown in Figure 4-1 below. The user needs to select an account and enter a password before logging in.

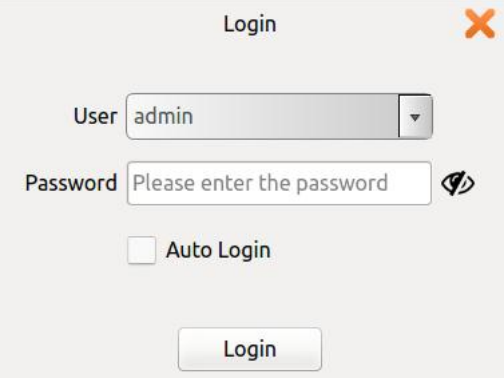

Figure 4-1 login interface

User name does not support customization, and can only be selected as shown in Table 4-1 below. The user needs to select an account, enters a password before login. After Auto Login is checked, the software will automatically enter the selected user interface after it is restarted. To cancel Auto Login or switch user login, you need to click the logout icon in the upper right corner of the interface. After confirming the logout, any running projects will stop running and switch to the user login interface.

Table 4-1 User Classification

User	Password	Permission limit
Admin (administrator)	Initial password: "1", modifiable	Highest authority, unlimited
Operator	Initial password: "1", modifiable	Safty settings (10.5) and update (10.6.6) are unavailable
Default (default user, cannot choose actively)	Default password: "1", unmodifiable	Safty Settings (10.5) and update (10.6.6) are unavailable

4.1.2 Initialization Interface

After successful login, the robot initialization interface will appear, as shown in Figure 4-2. In this interface, User can select the specified tool configurations. Click "**Save"** -> **"Start up"** button, then the robot starts initialization and powers up. Press and hold the blank at the upper left corner of the initialization interface (about 5 seconds) to directly enter the software.

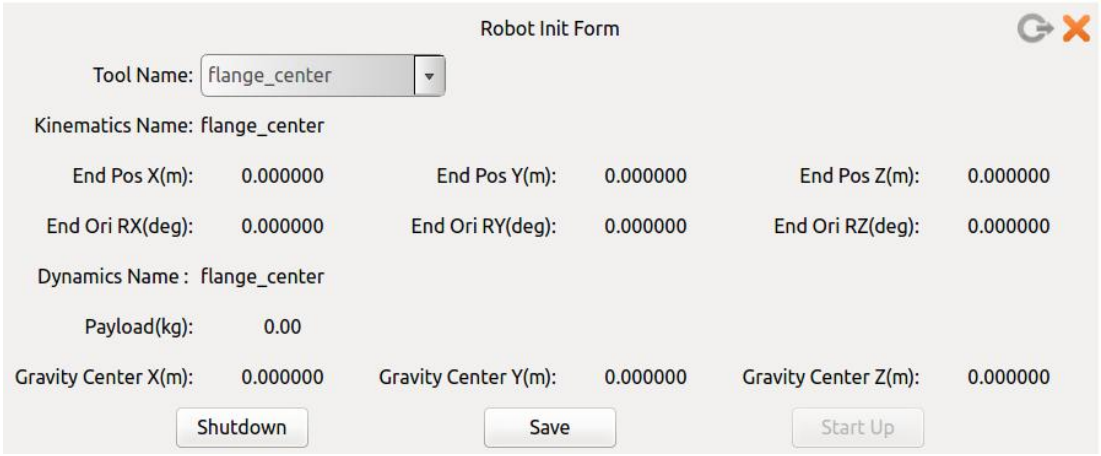

Figure 4-2 Initialization Interface

The Tool Name must be consistent with the load installed on the real manipulator. If it is inconsistent, the manipulator may be abnormal.

4.2 Manipulator Movement Control

Refer to the **AUBO i5 & CB-M User Manual or AUBO i10 & CB-M User Manual** for the operation of the manipulator movement, setting and programming.

4.3 AGV Movement Control

AGV can be controlled by the AGV plug-in interface of the teach pendant. The AGV plug-in interface path is: Extensions ->Peripheral ->AGV, as shown in Figure 4-3.

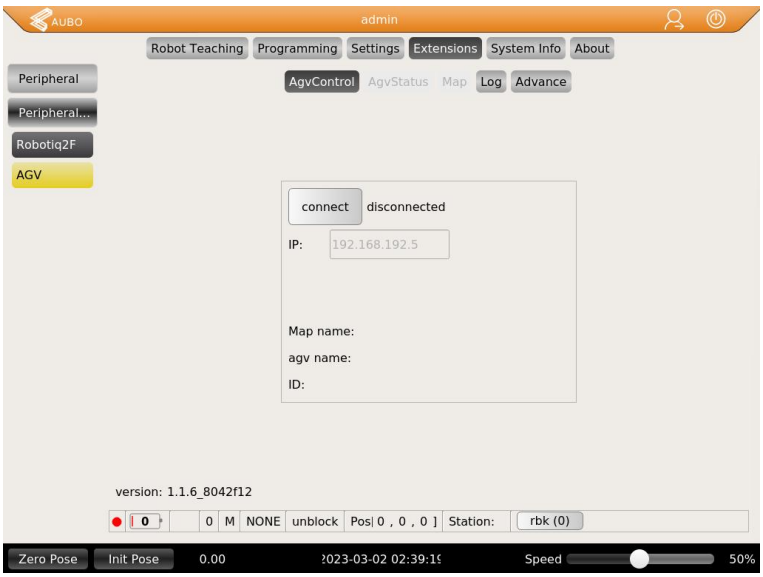

Figure 4-3 AGV Interface

The AGV plug-in interface includes the following four interfaces:

1. AgvControl: Connect to AGV

2. AgvStatus: Acquisition of AGV common status

3. Map: Map and control, etc

4. Log: Log information

5. Advance: Advanced settings

4.3.1 AgvControl Interface

The AgvControl interface is shown in Figure 4-4. Click the 【connect】 button to connect the AGV. After the connection is successful, the button is displayed as 【disconnect】, the right side of the button is displayed as 【connected】, and the Map name displays the current map name of the connected AGV, and the agv name and ID display the name and ID of the connected AGV. The IP address is fixed to 192.168.192.5, which cannot be changed by users.

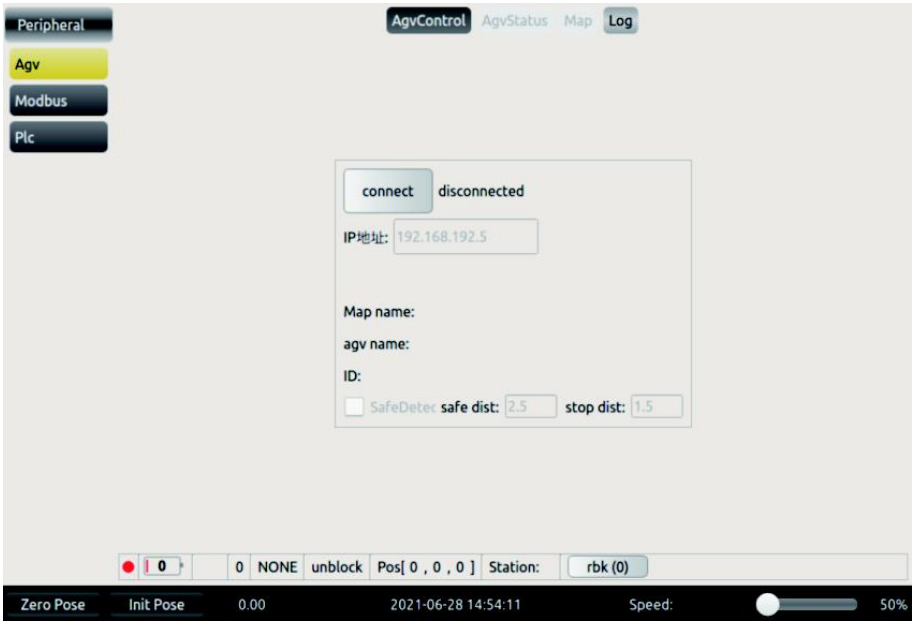

Figure 4-4 AgvControl Interface

If SafeDetect is checked, the safety detection of the Manipulator will be turned on. At this time, if the obstacle is close to the AGV, the Manipulator will actively slow down or suspend its movement. Safe dist is the safe distance, and stop dist is the stop distance. When the distance between the obstacle and AGV is greater than safedist, the manipulator move is not limited; When the distance is less than safe dist and greater than stop dist, the manipulator slows down; When the distance is less than stop dist, the manipulator stops moving.

4.3.2 AgvStatus Interface

The status information of the currently connected Agv will be displayed in the AgvStatus interface, as shown in Figure 4-5. Common statuses are displayed in the status bar at the bottom of the interface. The status bar is shown in Table 4-2 from sitting to right; Other AGV status information is displayed in the middle of the interface, such as real-time speed, current map, I/O status, laser blocking details.

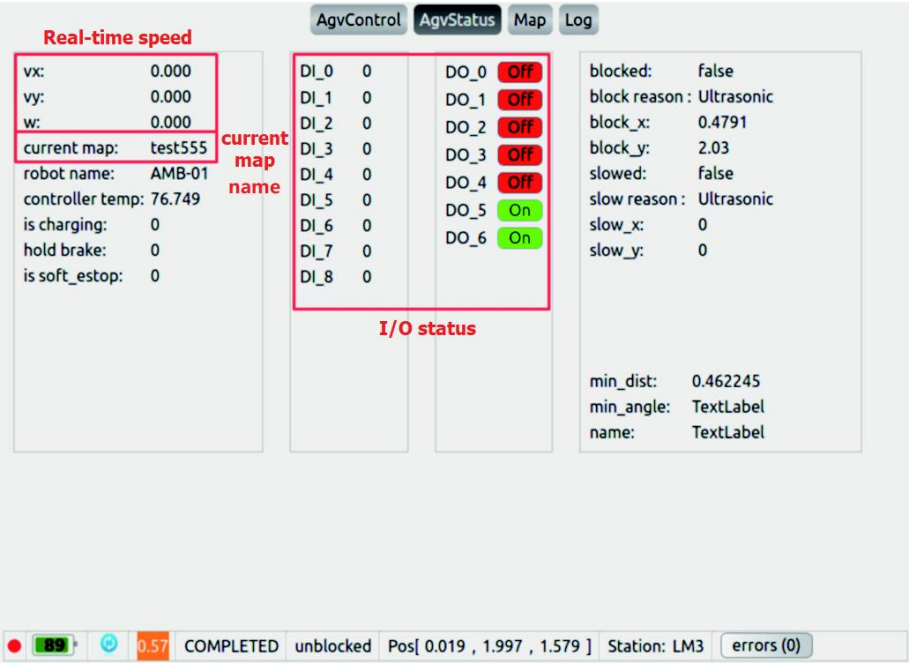

Figure 4-5 AgvStatus Interface

Table 4- 2 AgvStatus Interface Status Description

Display	Status	Description
	Laser Safety Detection Status	Red indicates that the distance between the obstacle and the AGV center is less than stop dist. If SafeDetect is enabled, the Manipulator will stop moving. Pink indicates that the distance between the obstacle and the AGV center is less than safe dist. If SafeDetect is turned on, the Manipulator will decelerate. Green indicates that the distance between the obstacle and the AGV center is greater than safe dist, and the Manipulator moves normally.
	Battery Level	Battery power percentage; If the robot is charging, the charging icon will be displayed.
	Emergency Stop Status	Blue indicates no emergency stop, and red indicates that the emergency stop is pressed.
	Confidence Interval	The interval value is [0,1]. The higher the value, the higher the accuracy of AGV position.
	Navigation Status	NONE: No navigation RUNNING: Navigating SUSPENDED: Navigation is suspended Completed: Navigation is completed FAILED: Navigation is failed CANCELED: Navigation is cancelled
	Laser State	Unblocked: The laser is not blocked Blocked: The laser is blocked, and AGV cannot move at this time Slowed: The laser decelerates, and AGV moves slowly at this time
	Real-time Position	x coordinate (m), y coordinate (m), angle (rad)
	Station	Current station
	Errors	Error Logs

4.3.3 Map Interface

The user can control the movement and map monitoring of Agv in the Map interface, as shown in Figure 4-6.

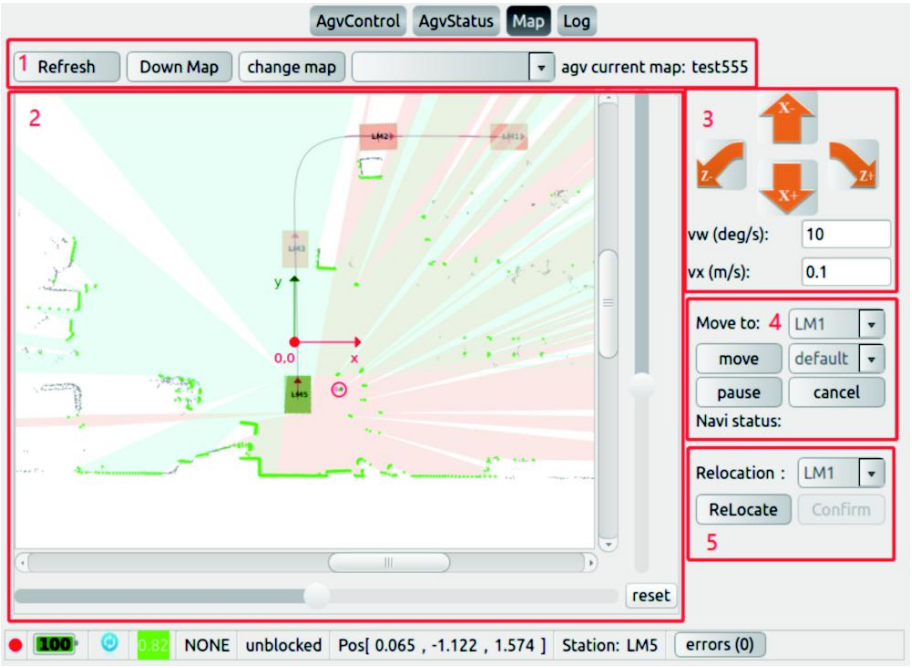

Figure 4-6 Map Interface

1. Map operation:

➢ **Refresh**

Obtain the list of map names currently stored in AGV and display it in the drop-down box.

Usage Scenario: When Roboshop creates and pushes a new map to AGV, click the Refresh button to get the new map name.

➢ **Down Map**

Download the map data corresponding to the current name of the drop-down box and draw it.

Usage Senario: When Roboshop edits and pushes a map to AGV, click the Down Map button to draw the latest map data.

➢ **Change Map**

Change the AGV current map to the map corresponding to the current name of the drop-down box.

Usage Scenario: When the AGV moves to a new map, users can switch the AGV current map to fit the new scenario by clicking the change map button.

➢ **Drop-down Box**

Displays all map names in the AGV.

➢ **Agv Current Map**

AGV Current Map Name

2. Mapping

The map drawing part supports the translation, rotation and zoom of the map. The elements that can be drawn are:

- AGV Real-time Position
- LM site location
- Path
- Normal points in the map
- Real-time laser point cloud data
- Origin coordinate system
- Dynamic obstacle position and distance from the car center

3. Move AGV

Press the button to move AGV forward, release the button to stop AGV.

Press the button to move AGV backward, release the button to stop AGV.

Press the button to turn AGV left, release the button to stop AGV.

Press the button to turn AGV right, release the button to stop AGV.

4. Navigation Control

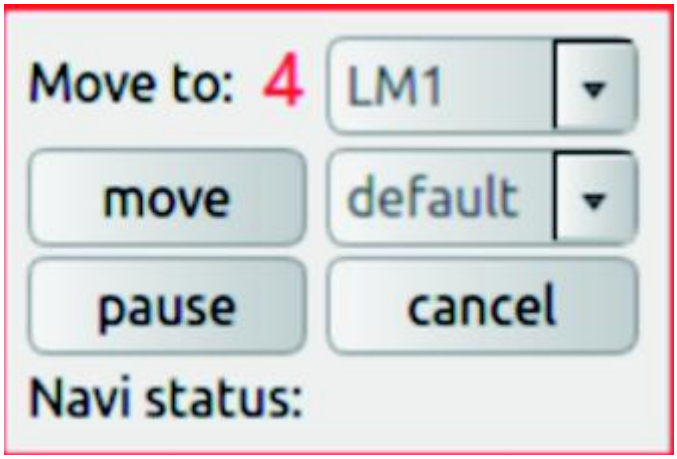

Figure 4- 7 Navigation control button

- Station drop-down box: When a new map is loaded, all station names in the map will be imported into the drop-down box for selection.
- Direction drop-down box: Default, navigate in the direction specified by the map. Forward, Move forward. Backward, Move backward.
- Move button: Click this button to navigate AGV to the specified station with the specified directional path.
- Pause button: Click this button during navigation to pause navigation (Agv pauses moving), and click it again to continue navigation (Agv continues moving).
- Cancel button: Click this button during navigation to cancel navigation, and Agv will immediately stop moving.
- Navi status: Navigation status. Same as Agvstatus status bar.

5. Reposition

When the AGV is restarted or the map is updated, it is necessary to reposition and confirm that the AGV position is correct before the navigation operation repositioning step can be performed. Move the AGV to a station near LMx (the direction should also be close), select LMx from the relocation station drop-down box, and click the ReLocate button. After completion, a window will pop up to confirm whether the position is correct.

4.3.4 Log Interface

The AGV current log and history log will be displayed in the Log interface.

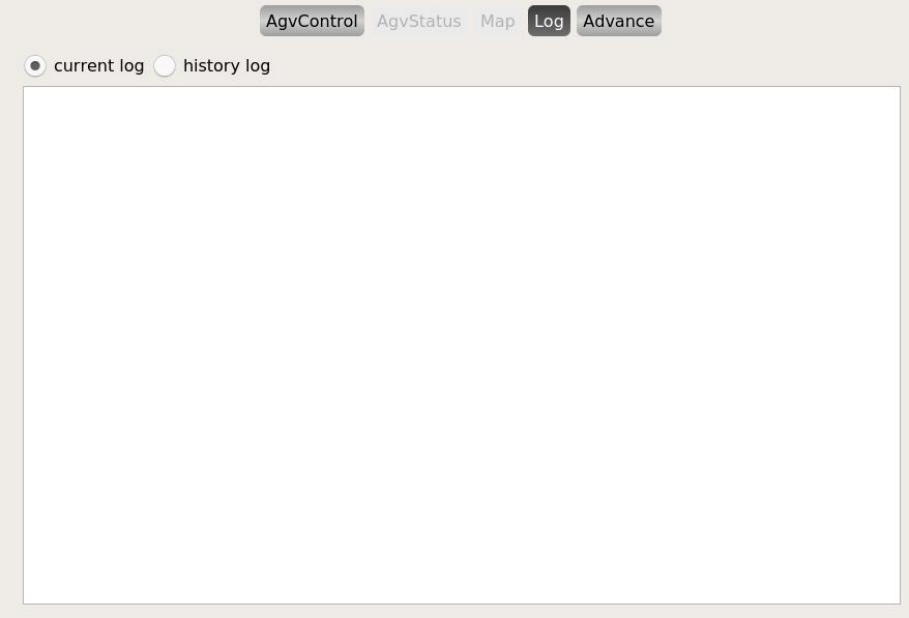

Figure 4-8 Log Interface

4.3.5 Advance Interface

Advanced settings can be made in the Advance Interface, as shown in Figure 4-9.

Figure 4-9 Advance Interface

4.3.6 AGV Programming

AGV programming can be operated by the peripheral conditions of programming. The path is: Programming -> Condition -> Peripheral -> AGV, as shown in Figure 4-10.

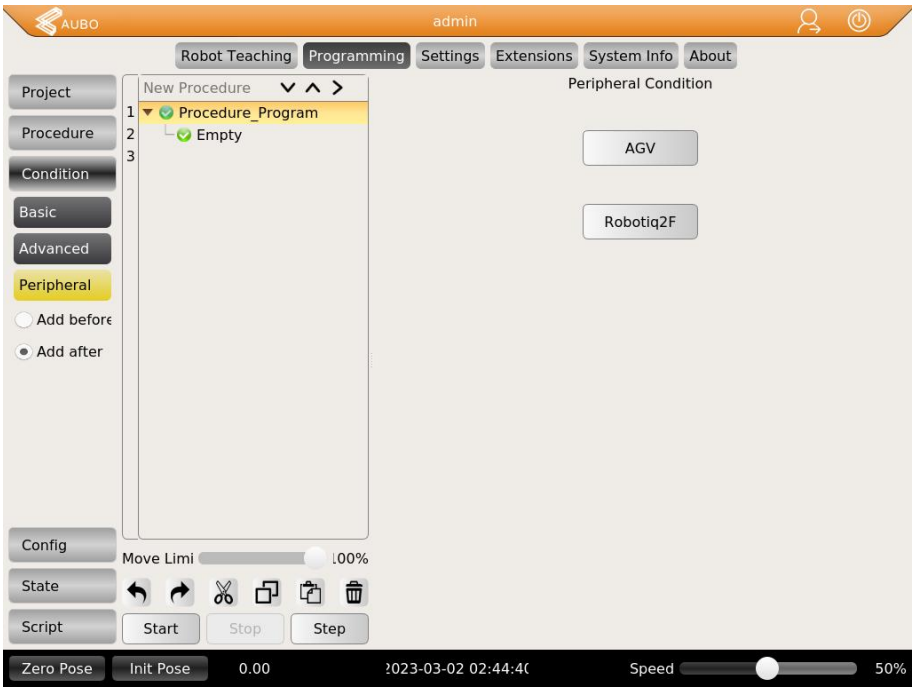

Figure 4-10 AGV programming interface

Click 【Agv】 to create a new Agv command, as shown in Figure 4-11.

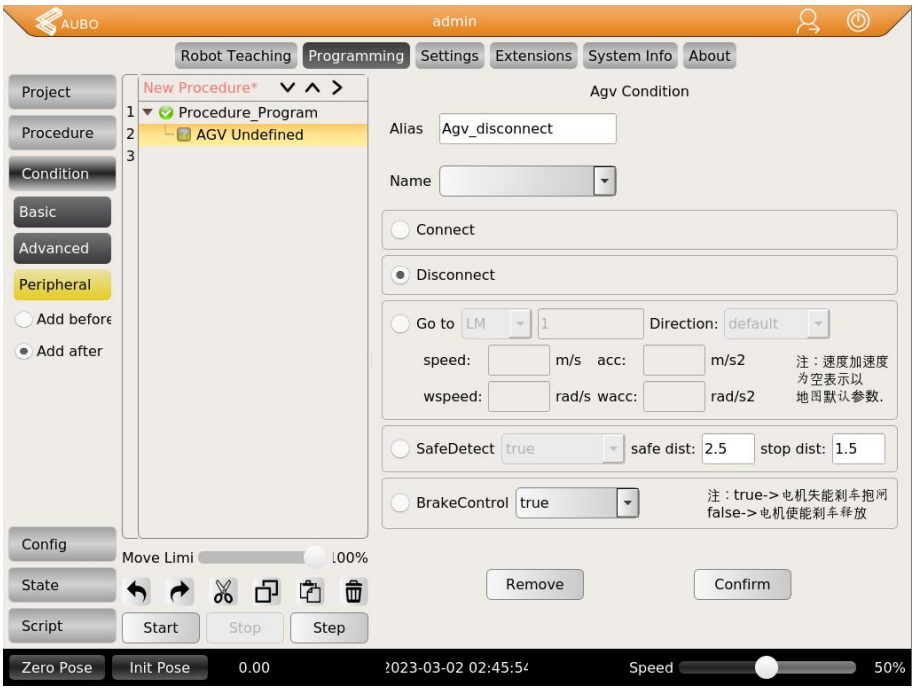

Figure 4-11 Agv command

- Click the blank port on the right side of Allias to pop up the input box to modify the command name.
- Click Name to enter the name of Agv extension, which can support different extensions.
- Connect is for connecting to AGV, which is generally called at the beginning of the project.
- Disconnect is for disconnecting the AGV, which is usually called at the end of the project.
- Go to is to navigate to the designated station according to the set direction path.
- SafeDetect is the function of opening and closing safety detection, and can set the safety detection distance.
- BreakControl refers to whether the motor enables the brake to release or not.

Example of AGV programming:

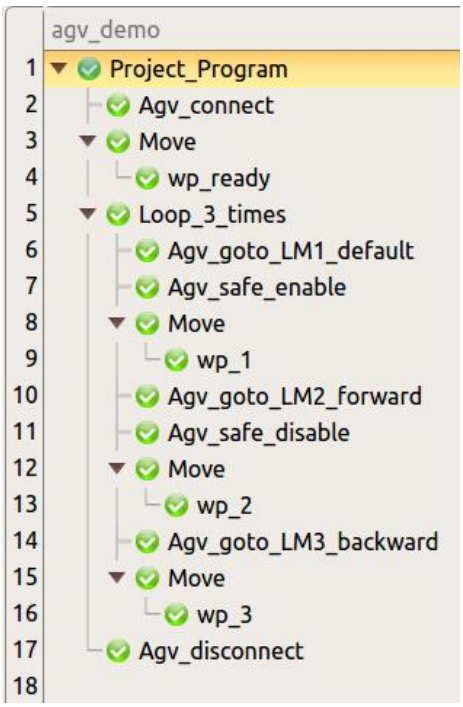

Figure 4- 12 Agv programming example

5. Dispatch System

5.1 Configuration

The teach pendant provides a visual operation interface for the user. User can control the manipulator and AGV to move and perform programming through the teach pendant with a small amount of programming basis.

5.1.1 Database Configuration File

The parameter file ***dbconfig.ini*** required for configuring the dispatch system software based on the ***MySQL*** database to be used is shown in Figure 5-1. The left side contains relevant information about the MySQL database, and the right side contains the corresponding ***dbconfig.ini*** configuration settings.

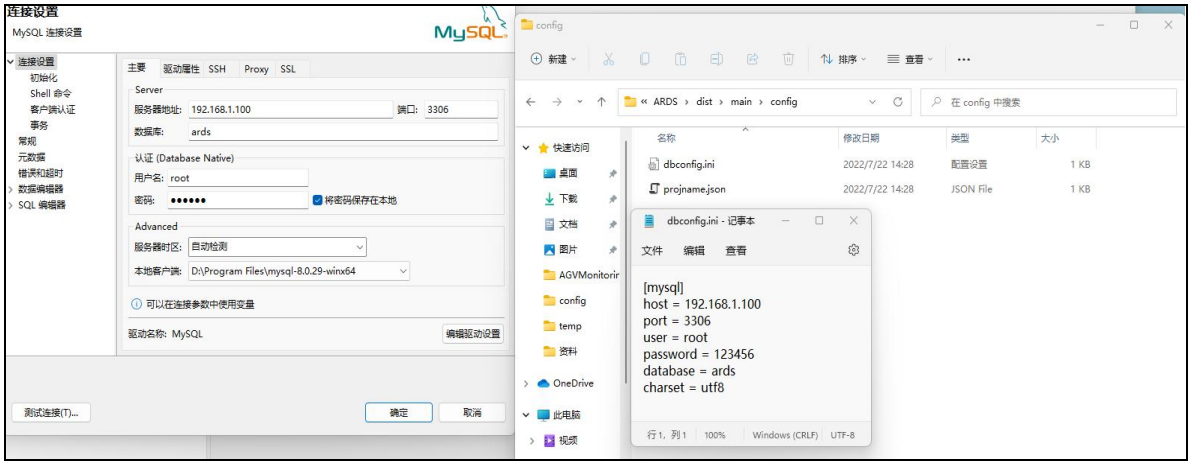

Figure 5-1 Database Configuration File

5.1.2 Datasheet Configuration

Machine tool configuration: Configure the name, IP address and port number, read register address, write register address, location of the machine tool on the map and the corresponding site inside the ***lathe_info*** table according to the actual situation, as shown in Figure 5-2.

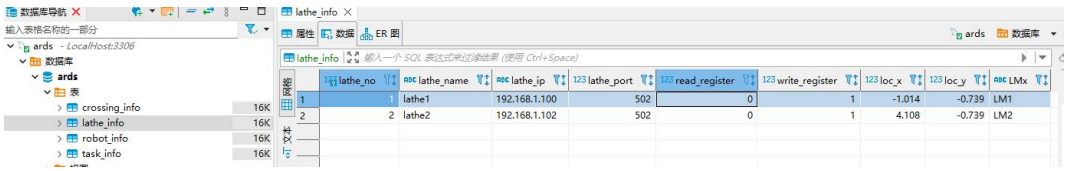

Figure 5-2 Database Configuration File

Robot configuration: Configure the IP address and name of the robot in the ***robot_info*** table according to the actual situation, as shown in Figure 5-3.

Figure 5-3 Database Configuration File

5.1.3 Project Name File Configuration

Configure the project name corresponding to the machine tool according to the actual situation, using ***json*** format.

```
{
  "lathe1": {
    "1": "proj_1",
    "2": "proj_2"
    }
```

The above information represents the value of the machine tool read register named lathe1. If it is 1, it represents the execution name proj_ 1 project, if the value of the read register is 2, it means the execution name is proj_ 2 projpects, and so on.
Configure the charging task of the car according to the actual situation, using ***json*** format, as shown in Figure 5-4.

Figure 5-4 Database Configuration File

5.1.4 Crossing_info Sheet Configuration

Configure crossing_location (site name), location_dir (site direction), crossing_location_mutex (mutex site name) and location_mutex _dir (mutex site direction) in the crossing_info sheet according to the actual map situation.

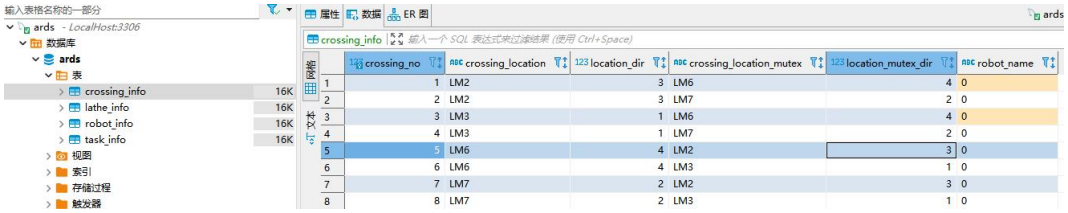

Figure 5-5 Database Configuration File

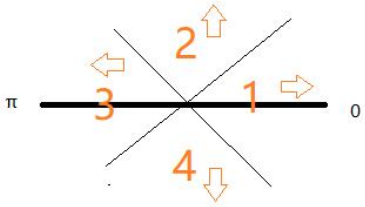

Figure 5-6 Database Configuration File

The following Figure 5-7 intersection example, LMx (dir) indicates that at the station LMx robot movement direction is dir, LM2 (3), LM3 (1), LM6 (4), LM7 (2) four intersection control points in the intersection control data table to achieve the way shown in Figure 5-5.

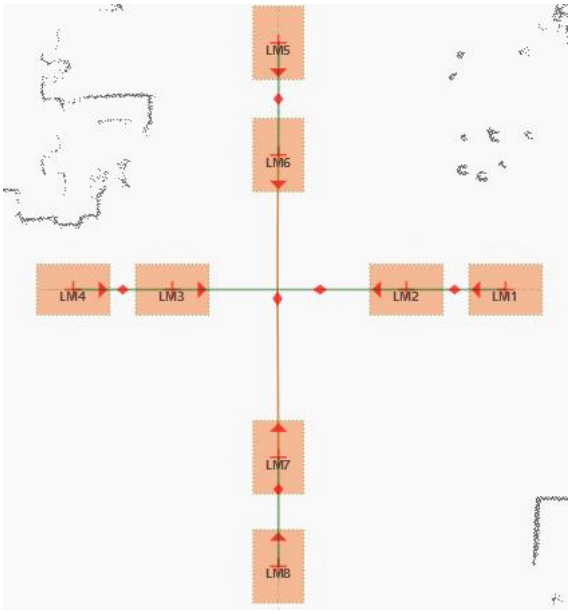

Figure 5-7 Database Configuration File

(i) site LM2(3) is mutually exclusive with sites LM6(4) and LM7(2);
(ii) Site LM3(1) is mutually exclusive with sites LM6(4) and LM7(2);
(iii) Site LM6(4) is mutually exclusive with sites LM2(3) and LM3(1);
(iv) Site LM7(2) is mutually exclusive with sites LM2(3) and LM3(1).

5.1.5 Map Configuration

The mobile collaborative robot needs to scan an available map with RoboShop software and store it as a file named ads.smap placed in the config folder, as shown in Figure 5-8.

Figure 5-8 Database Configuration File

5.2 Software Interface

5.2.1 Main Interface

The main interface contains four parts: software name, menu options (device management, map monitoring, data display and user settings), maximize/minimize/exit buttons, and menu options display area, as shown in Figure 5-9.

Figure 5-9 Database Configuration File

5.2.2 Device Management

Device management includes robot interface and machine interface. The robot interface displays the robot IP, robot code, work status (including idle and working) and online status (online and offline), as shown in Figure 5-10.

Figure 5-10 Database Configuration File

The machine interface displays the machine IP, machine code, operating status and online status (online and offline), as shown in Figure 5-11.

Figure 5-11 Database Configuration File

5.2.3 Map monitoring

The left side of the interface shows the robot and machine schematic modules, with different colors corresponding to the status of different robots and machine tools. The right side shows the location of machine tools and robots in real time, and the map display can be operated by the refresh, zoom in and zoom out buttons at the bottom right, as shown in Figure 5-12.

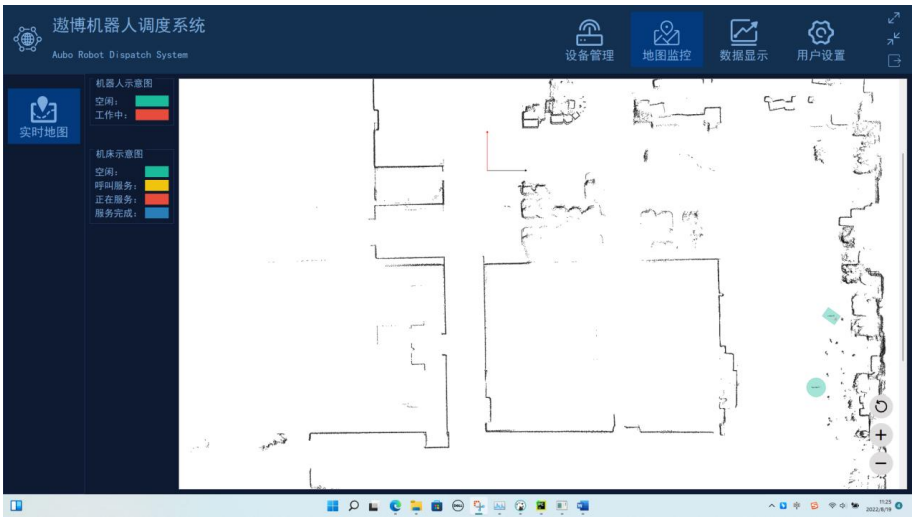

Figure 5-12 Database Configuration File

5.2.4 Data statistics

The data statistics screen (shown in Figure 5-13) allows you to count the robot's operation data, such as the working time, average power and mileage of each robot on a certain day; display the robot's working power graph, as shown in Figure 5-14, and count the robot's task execution data for a day as shown in Figure 5-15; and count the robot's working current, as shown in Figure 5-16.

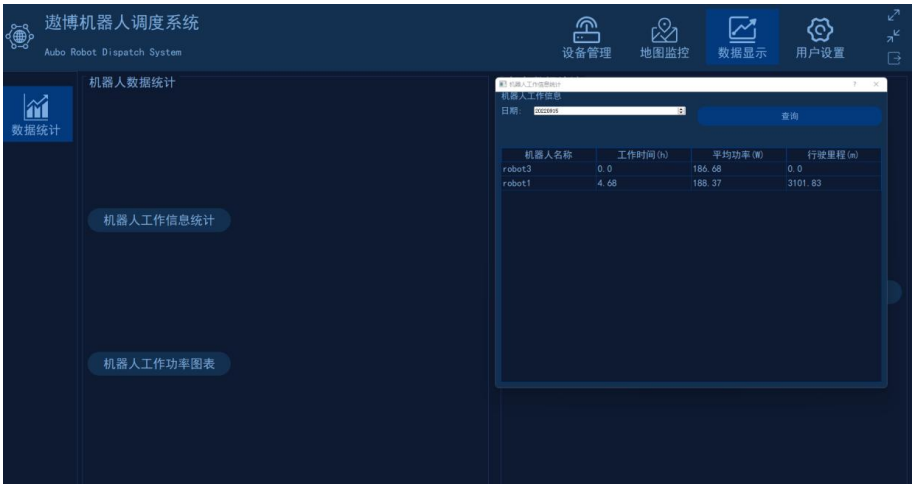

Figure 5-13 Database Configuration File

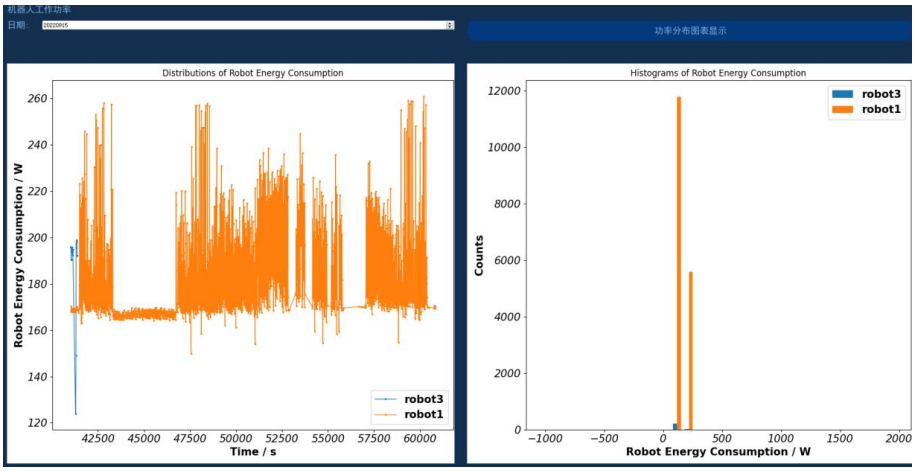

Figure 5-14 Database Configuration File

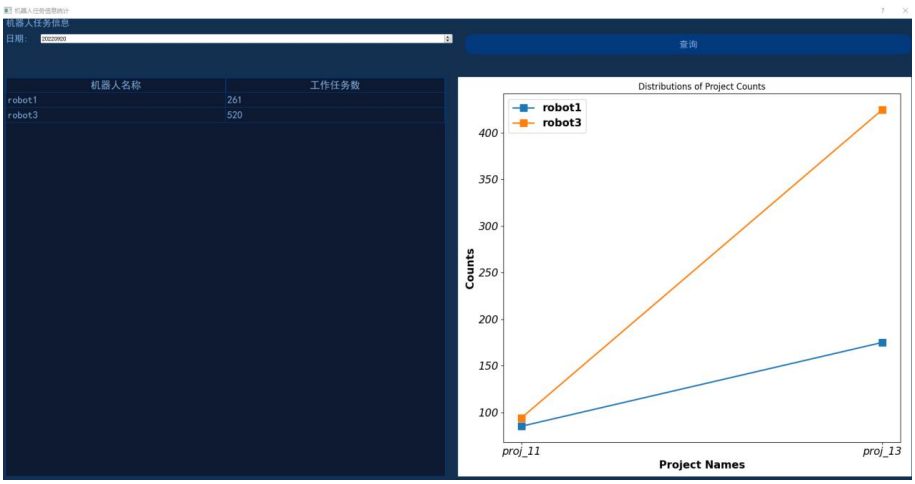

Figure 5-15 Database Configuration File

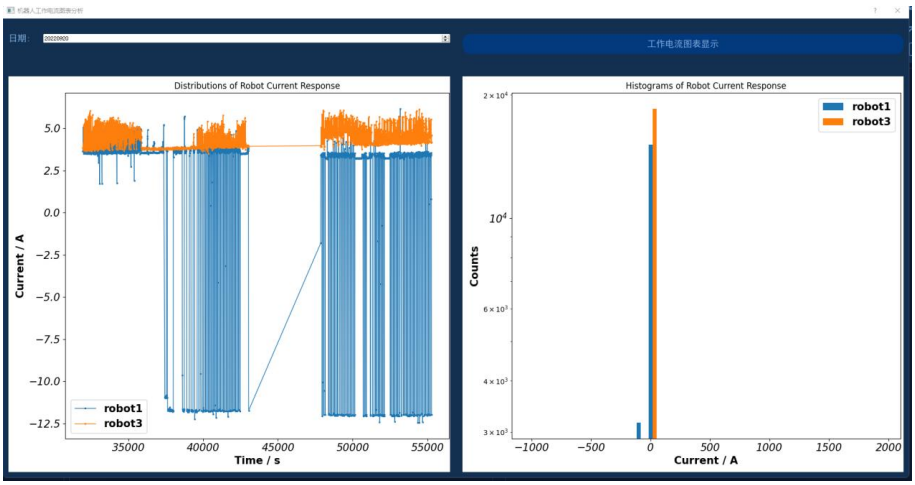

Figure 5-16 Database Configuration File

5.2.5 User settings

This interface includes permission management and device settings. Among them, device settings include robot settings, machine settings and mode settings, as shown in Figure 5-17. The mode setting is mainly to select the operation mode of the software according to the demand, only when the task scheduling mode is checked will the software enable the scheduling function, and only when the map monitoring mode is checked will the software enable the map monitoring function, after modifying the function, you need to click the button below to confirm the modification mode before the software operation mode can take effect.

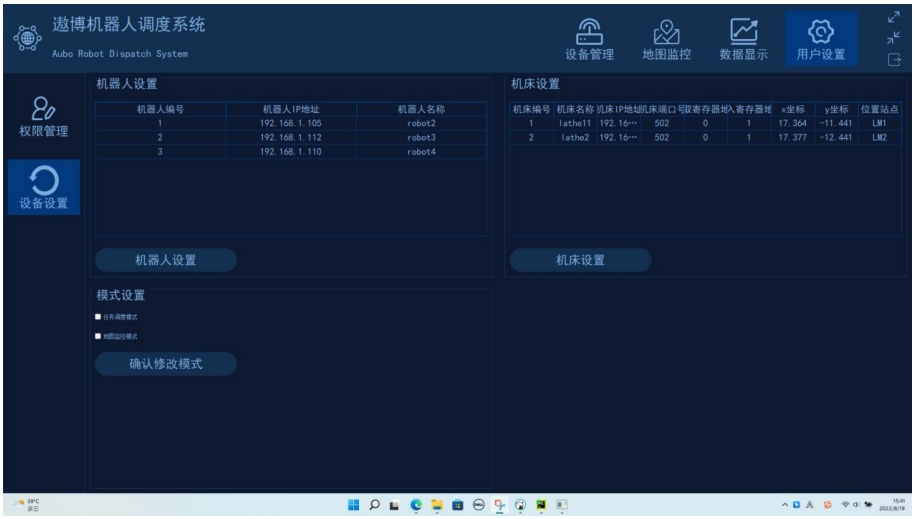

Figure 5-17 Database Configuration File

You can modify robot properties and add or delete robots in the Robot Settings screen (shown in Figure 5-18). You can modify the IP address and name of the specified numbered robot according to the robot number; you can delete the robot with the specified IP address according to the robot IP; and you can add the robot with the specified IP address and name by entering the robot IP address and robot name.

Figure 5-18 Database Configuration File

In the machine settings screen (as shown in Figure 5-19), you can modify machine properties and add or delete machines. According to the machine number, you can modify the name, IP address, port number, read register address, write register address, machine x coordinate, machine y coordinate and machine position value of the specified number of machines; according to the robot IP, you can delete the machine with the specified IP address; input the machine name, IP address, port number, read register address, write register address, machine x coordinate, machine y coordinate and the machine position value, you can add the specified machine.

Figure 5-19 Database Configuration File

1. All robots using the same mobile collaborative robot scheduling system software must use the same map.
2. Only one mobile collaborative robot scheduling software can be opened, and not more than one scheduling system software can be opened at the same time.
3. The area where the mobile collaborative robot is running must ensure full network coverage and stable network signal.
4. The computer using the scheduling system software must ensure a stable network connection during the operation of the software and must not be dormant.
5. When using the scheduling system, ensure that the intersection control points are set in such a way that robots at intersections can pass without obstacles, and that the intersection control points are outside the safety distance of the robots.
6. Before using the scheduling system, you must ensure that the mobile collaborative robot has been successfully positioned.

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