User Manual for Industrial Robots

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The statement

This manual gives a comprehensive description of the composition and operation of Turing industrial robots. Please be sure to read and fully understand the basis of the operation of the robot.

The illustration in the maintenance manual removes the cover or safety cover for drawing for details. When operating such parts, be sure to restore the cover or safety cover as specified, and then run according to the instructions.

The drawings and photos in the manual are representative examples and may be different from the purchased products.

The manual is sometimes modified due to product improvement, specification change an, the fact that the manual itself is easier to use and other appropriate reasons.

The company is not responsible for the customer's unauthorized modification of the product, which is not within the scope of warranty.

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Chapter 1 System security

1.1 Brief introduction of safety precautions

The safety precautions in this chapter are divided into two parts:

The first part is general safety precautions, which are generally applicable to all types of robots. See 1.2 for details

The second part is safety precautions for robots, mainly introducing safety precautions for robot operation and usage. See 1.3 for details

1.2 General safety precautions

1.2.1 Safety precautions for the robot system

This section does not include how to design and install the robot, nor does it include the introduction of peripheral equipment that affects the safety of the robot. In order to protect the users, the design of the robot should comply with the standards and laws of the region and country. Turing robot companies and individuals should be familiar with the local and national standards and laws, and install appropriate safety facilities to protect the robot users. The user should be familiar with the operating instructions of the robot system. But even if the operator completely follows all the safety information given in the manual, Turing cannot guarantee that the operator will not suffer any harm.

1.2.2 Security Risk

Overview: This section covers the dangers that may occur in the installation and service of the robot.

1) Security risks during installation and service of robots:

1. For the safety precautions of the robot, please refer to the installation and maintenance chapter;
2. The emergency stop button of the system must be in a position that is easy to touch to ensure that the robot can be stopped in an emergency when an accident occurs;
3. The operator must make sure that the installed safety facilities are available;
4. Operators must be trained in this area before installing, operating, or maintaining robots.

2) Non-voltage risk

1. The safe area needs to be confirmed and divided before installing the robot;
2. Need to have protective measures or fences to protect the operator from the working range of the robot;(Place signs such as "Idlers Stop", "Idlers Free" and "High Voltage Danger" in relevant areas);
3. There should be no hanging objects above the robot to prevent it from falling and damaging the robot and other equipment;
4. The spring in the balance cylinder may pop out due to the failure of other parts and cause injury;
5. When splitting the robot, pay attention to the robot may fall objects hurt people;
6. Be careful of being scalded by high temperature components in the electric control cabinet;
7. When maintaining the robot, it is forbidden to use the robot as a ladder and not to climb on the robot in case of falling down;
8. The high temperature in the reducer and the splash of high temperature oil are likely to cause damage to human body;
9. It is strictly forbidden to pull any axis of the robot;

10. It is strictly prohibited to rely on the electric control cabinet or touch the button at will to prevent the robot from acting as expected and causing personal injury or equipment damage.

3) Safety considerations for integrators

1. The integration supplier must confirm that all safety circuits are interlocked with externally applied safety circuits;
2. The integration supplier must confirm that the emergency stop safety circuit and the external application safety circuit are interlocked.

Integrated robot

Security risk	Specific description
High temperature parts	Servo motors and reducers will generate high temperatures after long-term operation, and it is easy to get scalded by touching these parts. In a high-temperature environment, the temperature of the robot rises faster, and burns are more likely to occur.
Removal of certain parts can easily cause the robot to collapse	Take some necessary measures to ensure that the robot does not collapse when removing some parts (for example, when removing the 2-axis motor, you need to fix the big arm and the small arm to prevent the robot from falling)

Cable

Security risk	Specific description
The cable is fragile and easily damaged	Cables are susceptible to mechanical damage, so pay special attention to cable damage during transportation, storage, and use, especially the connectors.

Motor reducer

Security risk	Specific description
The reducer is easily damaged by improper external force	Regardless of when the motor reducer is disassembled or when the motor reducer is installed, the reducer is easily damaged under excessive improper external force.

4) Pay attention to the parts in the robot that are easy to get hot

In normal work, many parts of the robot will heat up, especially the servo motor and reducer part. Sometimes the parts close to these two parts will also become hot, and touching these parts will easily cause burns. As the ambient temperature increases, more robot surfaces will become very hot and easily cause burn .

Avoidance measures:

1. Feel the temperature of these parts with your hand before touching them, so as not to burn them.
2. Wait for enough time after the shutdown for the high-temperature part to cool down before carrying out maintenance and other work.

5) Safety notes on dismantling parts

Safe operation: Open the cover or protect installation after confirming that the gear and other internal parts are no longer rotating or moving, and do not open the protection device when the gear and bearing are rotating.

Safety design: if necessary, use auxiliary devices to keep the parts that are no longer fixed inside from its original position

6) Safety notes on pneumatic/hydraulic

Overview: This paragraph is about the safety of pneumatic/hydraulic systems for robots

Residual energy: After the gas source or hydraulic pump is turned off, there are residual gases/liquids in the pneumatic/hydraulic system. These gases/liquids have a certain amount of energy. Certain measures must be taken to prevent the residual energy from harming the human body and equipment. Before servicing pneumatic and hydraulic components, the energy remaining in the system needs to be released.

Safety design: Prevent components from falling off and hydraulic oil from flowing out;
Safety valve shall be installed to prevent accidents;
Maintenance tools need to be prevented from falling.

7) Risks during operation

Overview: Industrial robot is a flexible system that can be applied in many industrial fields. All the work must be operated by professional personnel and follow certain safety guidelines. Always be careful when operating.

High-quality operators: Industrial robots must be operated by professionals who are familiar with the whole system and understand the risks in each subsystem.

Abnormal risk: If an abnormality occurs under normal working procedures, take extra care.

8) Electrical risks

Overview:
1. Although it is necessary to turn on the power during fault diagnosis in many cases, it is necessary to turn off the power and cut off other power connections when actually repairing the robot.
2. The main power supply of the robot needs to be installed outside the working range of the robot, so that even if the robot is out of control, the operator can turn off the robot outside the working range of the robot.

Operator's electrical hazard:

Operators need to pay attention to high voltage hazards:

1. The power line of the servo motor;

2. Connect fixtures and other external equipment. After the robot is turned off, the external equipment of the robot may still be running, so the power cord of the external equipment may also cause personal injury or damage to the power cable.

1.2.3 Safety behavior

1) Safety measures

Overview: Fences and warning signs should be installed around the working area of the robot to ensure the safe work of the robot, prevent the entry of other people and prevent the robot from injuring others.

Safety measures: When setting up safety protection measures, it is necessary to consider that the workpiece held by the robot can cause injury to people.

2) Remove the robot arm in an emergency

Description: In an emergency, any arm of the robot is caught by the operator and needs to be removed. (Refer to Chapter 5 Maintenance for the dismantling steps.) Small robot arms can be removed manually, but large robots need to be lifted by cranes or other equipment.

Secondary damage: Before releasing the joint brake, the mechanical arm needs to be fixed first to ensure that the mechanical arm will not cause secondary injury to the trapped person under the action of gravity.

3) Brake detection

Why it should be tested: In normal operation, the brake is usually worn out, so it is necessary to test the brake.

Check brake steps:
1. Let each joint of the robot move to the position where the joint bears the maximum load;
2. Turn off the robot and open the lock brake;

3. Mark each joint
4. After a period of time to see whether the robot's joints move.

4）Use the teaching box safely

Enable is a MOT button on the teaching box. When pressed, the servo motor is enabled; when it is disconnected, the servo motor is disconnected and enabled.
In order to ensure the safe use of the teaching pendant, the following rules need to be observed:

1. The enable button cannot fail at any time;
2. When programming or testing, the enable needs to be disconnected in time;
3. Teachers should bring a teaching box when entering the working area of the robot, so that others can not move the robot without the programmer's knowledge.

Enablement: When the robot is temporarily stopped, or when programming or testing, the enable must be turned off in time.

5) Work within the working scope of the robotIf the work must be carried out within the working range of the robot, the following rules need to be followed.

1. Only when the mode is selected as manual mode can the computer be enabled and other automatic controls such as computer control be disconnected;
2. When the robot is in manual mode, the speed must be limited below 250mm/s. When the robot needs to be adjusted to full manual speed, it can only be operated by professionals who fully understand the risks;
3. Pay attention to the rotation joints of the robot to prevent the hair and clothes from being caught in the joints; at the same time, pay attention to other dangers that may be caused by the movement of the robot, or other auxiliary equipment;
4. Test whether the motor holding brake is working properly to prevent personal injury caused by abnormal robot;
5. Consider the contingency plan when the robot suddenly moves to its prescribed position;
6. Make sure to set up shelters, just in case.

Danger: Do not stand under any robot arm under any circumstances to prevent the robot from moving abnormally or other people are enabled.

1.2.4 Emergency stop

Definition of emergency stop:

Emergency stop is independent of the electrical control of all robots, and can stop all robots. Emergency stop means that all power supplies connected to the robot are disconnected, but the power supply of the brake on the servo motor is not disconnected. You must release the emergency stop button and turn on the robot again, so that the robot can work again.

The emergency stop of the robot system needs to be distinguished:

1. A runaway emergency stop, which stops the robot by cutting off the power of all

servo motors.

2. A controllable emergency stop, which stops the robot by giving a command to the servo motor, so that the robot can complete the path, and when the path is completed, the servo motor stops supplying power.

Note: Emergency stop can only be used when it is really needed, it is indeed an emergency.

Note: Emergency stop cannot be used for normal program stop, shutdown of the robot, etc.

emergency button

There are several emergency stop buttons in the robot system to stop the robot, and there is a red button on the teaching box and the electric control cabinet (as shown in the figure below). Of course, users can also set their own emergency stop button as needed.

1.3 Safety precautions for robot operation

Before use (installation, operation, maintenance, overhaul), please be sure to thoroughly read and fully grasp this manual and other auxiliary materials, and start to use after you are familiar with all equipment knowledge, safety knowledge and precautions. The safety precautions in this manual are divided into four categories: "danger", "caution", "mandatory", and "prohibited".

1.3.1 Introduce safety signs

 **Dangerous**
There is danger in misuse, and death or serious injury may occur.

 **pay attention**
There is danger when it is mishandled. Moderate injuries, minor injuries or damage to objects may occur.

 **Force**
Things that must be complied with.

 **Forbid**
Absolutely prohibited matters.

1.3.2 Potentially fatal

Overview: Any working robot is a potentially fatal machine. When running, the robot may have unpredictable movements. All movements have strong forces that may cause serious injury to people in the early working range or equipment Cause damage.

Avoidance: Before preparing the robot to work, test the reliability of each safety measure (brake).

Safety measures include fence gates, holding brakes, and safety lights.

Measures to avoid: Before turning on the robot, make sure that there are no other idle people in the working range of the robot.

1.3.3 Possible dangers in testing

Overview: Because of the need for maintenance service work, the robot needs to be disassembled, and several risks need to be considered for the first test after the maintenance work is completed.

Measures: The first steps after repair, installation, maintenance and other services need to follow the steps below:

Clean up all maintenance and installation tools on the robot and within the scope of the robot's work;

Install all safety measures;

Make sure everyone stands outside the robot's safety range;

Pay special attention to the working conditions of the repaired parts during the test.

Note: When letting the robot go through the program, pay special attention to potential interference hazards.

1.3.4 Electrical hazard

Overview: The electric control cabinet is the center of the control robot. Any misoperation of the electric control cabinet may cause electric shock and robot misoperation, which in turn may cause injury to people and equipment.

Danger: 1. Never lean on the electric control cabinet or other control cabinets; do not press the operation keys at will. Otherwise, the robot may cause unexpected movements, which may cause personal injury and equipment damage.

2. During operation, never allow non-workers to touch the electric control cabinet. Otherwise, the robot may cause unexpected movements, causing personal injury and equipment damage.

3. Protective measures must be taken when wiring and piping between the electrical control cabinet and the robot and peripheral equipment, such as passing pipes, wires or cables through the pit or covering them with protective covers to avoid being trampled by people or being lifted by forklifts Rolled and broken. Operators and other personnel may be caught by open wires, cables or pipes and damage them, which may cause abnormal movement of the robot, resulting in personal injury or equipment damage.

4. When installing a tool to the robot, be sure to turn OFF the power supply on the control cabinet and the installed tool and lock the power switch, and hang a warning sign. If the power is turned on during installation, it may cause electric shock or abnormal movement of the robot, which may cause injury.
5. Before operating the robot, press the emergency stop button on the front door of the electric control cabinet and the upper right of the teaching programmer to check whether the "Servo Ready" indicator is off, and confirm that the power is turned off.

1.3.5 Gearbox danger

Overview: When lubricating the reducer, it may cause injury to people and equipment, so before refueling, the following safety information must be waited for.

Warnings and measures:

Warning	Description	Measure
High temperature oil or reducer	When refueling or draining oil, sometimes it is necessary to operate the oil or reducer at a high temperature of 90 degrees, and the operator may be allergic to the oil.	Therefore, wear protective measures (gloves) to carry out this work.
Beware of sputtering	When opening the oil chamber, there may be pressure in the oil chamber to cause sputtering	So be careful when opening the oil chamber cover, and stay away from the opening, do not fill too much when refueling, according to the amount of oil.
No top up	Adding too much oil in the reducer can easily cause high pressure in the reducer and damage the reducer.	When refueling, follow the instructions or follow the instructions, and check after completion.
Prohibition of mixing lubricants	Different types of oil cannot be added to the same reducer.	Always use the same type of oil, if you want to change to clean up the previous oil.
Suggest	Hot oil has a lower density than cold oil and flows faster.	Before draining the oil in the reducer, you can run the robot to heat the oil for a period of time. It is easier to drain the oil, or you can blow it with an air gun.
	The amount of refueling	So drain the oil completely

Refueling volume depends on the actual situation	depends on how much oil is contained in the oil chamber. More oil is needed and more oil needs to be discharged, and less oil needs less oil.	or check the oil indicator port after filling the oil

1.3.6 Operation notes

The robot system is complex and dangerous. During the re-practice, you must pay attention to the safety of any operation on the robot. Whenever you enter the working area of the robot, it may cause serious injury, and only trained and certified personnel can enter the area.

The following safety rules must be followed:

- In case of fire, use a carbon dioxide fire extinguisher.
- The emergency stop switch is not allowed to be short-circuited.
- When the robot is in automatic mode, no one is allowed to enter its area of motion.
- In any case, do not use the original boot disk of the robot, use a copy disk.
- When the robot is stopped, nothing should be placed on the fixture, and it must be empty.
- In the event of an accident or abnormal operation of the robot, you can use the emergency stop button to stop the operation.
- Because the robot is in the automatic state, even if the running speed is very low, its momentum is still very large, so when programming, testing and maintenance work, the robot must be placed in manual mode.
- The pressure in the gas circuit system can reach 0,6MP, and any relevant maintenance must cut off the gas source.
- Commission the robot in manual mode. If you do not need to move the robot, you must release the enabler in time.
- When the debugger enters the robot working area, he must carry the teach pendant with him to prevent misuse by others.
- When you receive a power outage notification, turn off the robot's main power supply and air supply in advance.
- After a sudden power outage, turn off the main power switch of the robot in advance before calling, and remove the workpiece on the fixture in time.
- Maintenance personnel must keep the robot keys well, and it is strictly forbidden for unauthorized personnel to enter the robot software system in manual mode, and read or modify the programs and parameters at will.

Chapter 2 Robot Roundup

2.1 Robot axis

2.1.1 Definition of robot axis

The robot axis can be a rotary axis or a translation axis, and the operation mode of the axis is determined by the mechanical structure.

The robot axis is divided into the motion axis of the robot body and the external axis.

The external shaft is divided into sliding table and positioner.

Unless otherwise specified, the robot axis refers to the motion axis of the robot body.

2.1.2 Robot joint motion

Turing robots are divided into three types of industrial robots:

◆Industrial six-axis robot: including six rotation axes

◆SCARA: contains three rotation axes and one translation axis

◆Palletizing manipulator: including four rotating shafts

The joint motion of the robot is shown in the figure.

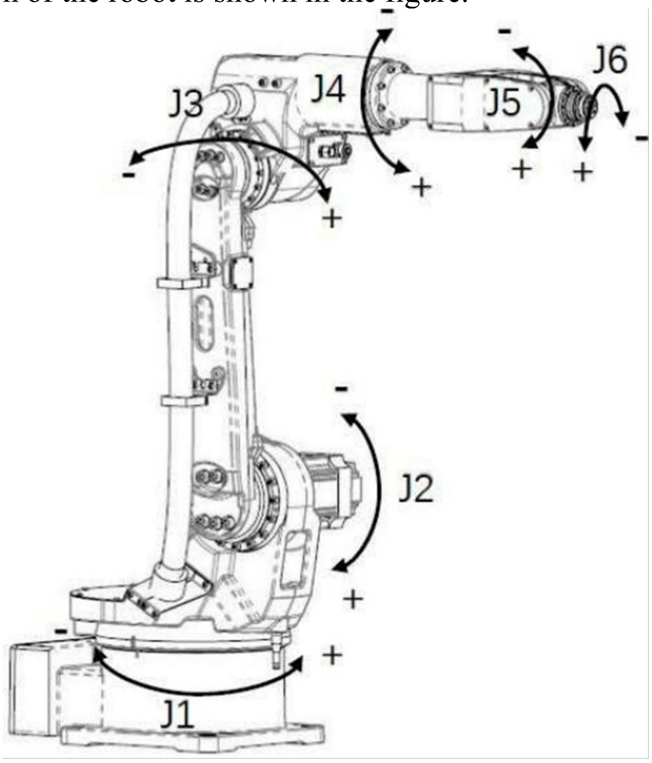


Figure 2-1 Schematic diagram of each axis of the industrial six-axis robot (TKB1400)

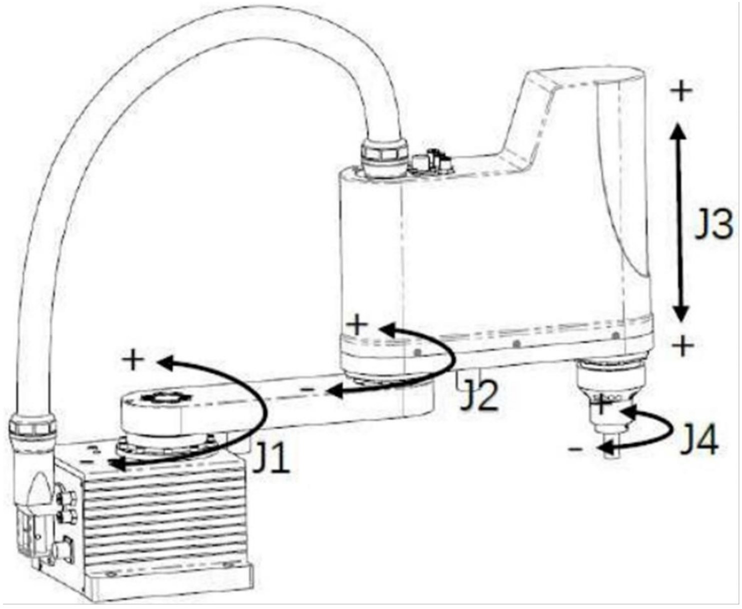


Fig. 2-2 SCARA (STH030-500) movement diagram of each axis

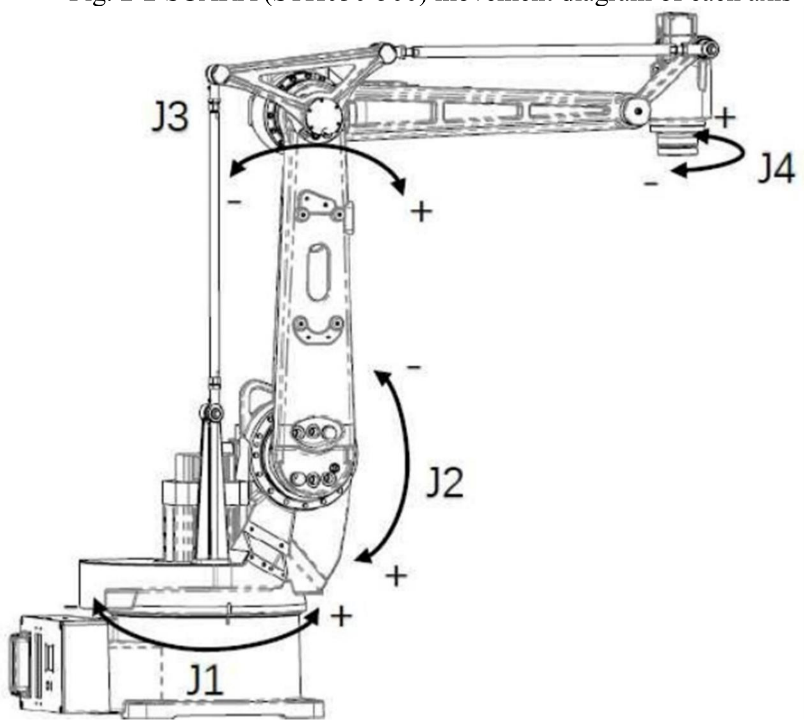


Figure 2-3 Schematic diagram of the movement of each axis of the palletizing robot (TKB4600)

Note: The definition of the movement direction of each joint follows the right-hand rule. That is: the right hand is holding the joint rotation axis, and the thumb is in the positive direction of the world coordinates (see 2.2.1). The direction of the four fingers is the positive direction of rotation, and the reverse direction is the negative direction of rotation.

2.2 Robot coordinate system

In teach mode, the robot axis movement is related to the currently selected coordinate system. Turing robot supports 4 kinds of coordinate systems: joint coordinate system, rectangular coordinate system, tool coordinate system user coordinate system.

◆Joint coordinate system

Each axis of the robot moves independently and becomes the joint coordinate system.

◆Cartesian coordinate system

The center of the end flange of the robot runs in the set X, Y, and Z directions.

◆Tool coordinate system

The tool coordinate system is located at the center of the tool and is defined by the user. The effective direction of the fixture is defined as the Z axis of the tool coordinate system.

◆User coordinate system

The user coordinate system is located on the working platform of the robot and is defined by the user.

2.2.1 Joint coordinate system

See 2.1.1 for the definition of robot joint motion axis.

When the current coordinate system is set to the joint coordinate system, the teach pendant operates the 6 axes of the robot in the positive and negative directions. Press the J1-J6 operation buttons, and the industrial robot will move in the direction corresponding to the schematic diagram.

In the coordinate system, select the 【positioner】 coordinate system, then press the J1-J3 axis operation button, the action will be the external three axes.

2.2.2 Cartesian coordinate system

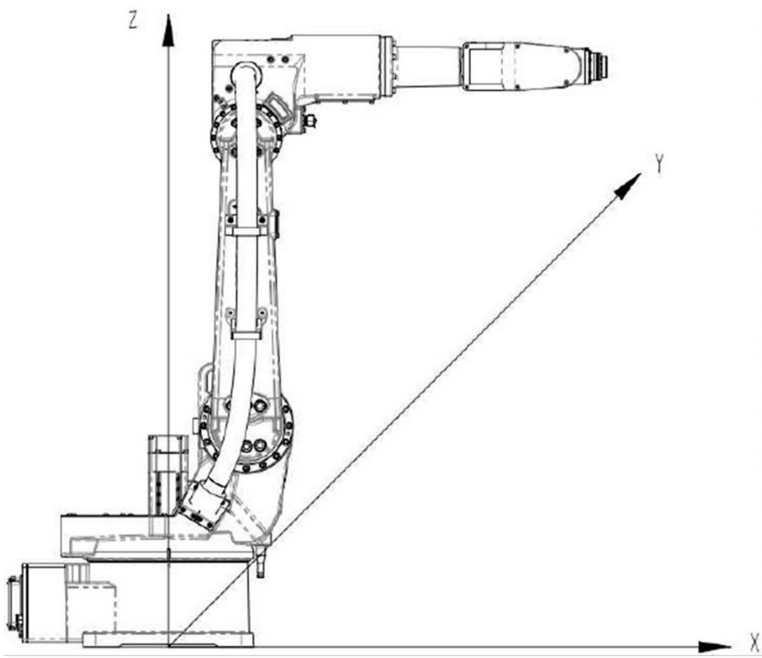


Figure 2-4 Cartesian coordinate system

The origin of the Cartesian coordinate system is defined on the axis of the robot 1 axis, and it intersects with the base mounting table.

The direction of the rectangular coordinate system is specified: the X axis direction is forward, the Z axis direction is upward, and the Y axis is determined according to the right-hand rule. (The direction of the cable socket on the robot base is the rear, and the direction of the robot flange is the front)

In the Cartesian coordinate system, the motion of the robot refers to the motion of the central point controlled by the robot. When the axis operation key is pressed, the coordinate point is controlled to move along or around the world coordinate axis. The corresponding ones of J1-J6 are X/Y/Z/RX/RY/RZ.

Note: When the fifth joint is in the zero position, the robot is at a singular point. In this case, rectangular coordinates cannot be used for teaching. You should first switch to the【joint】 coordinate system and move the five axes out of the zero position.

2.2.3 Tool coordinate system

1) Definition of tool coordinate system

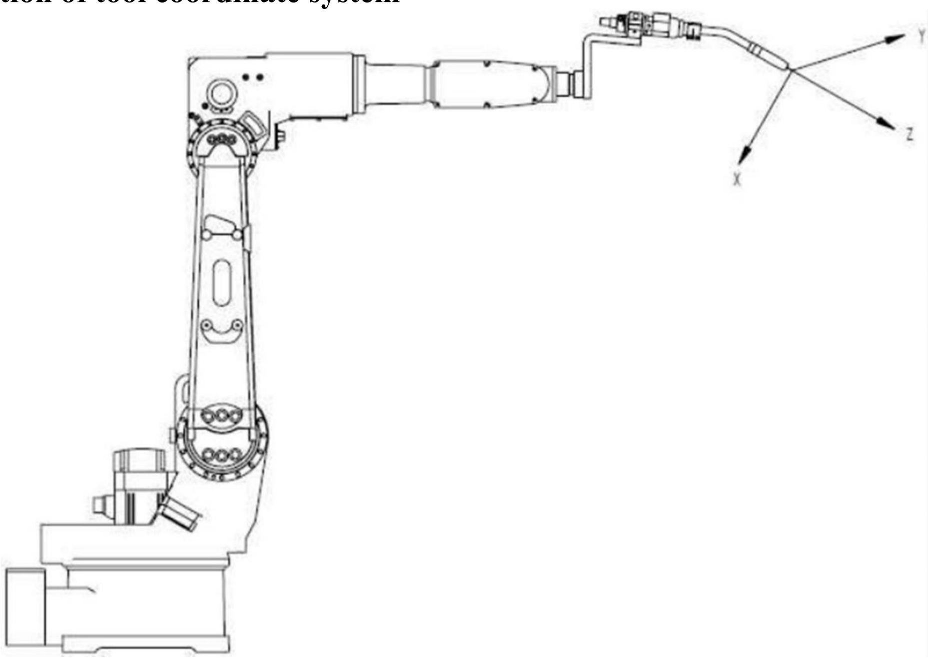


Figure 2-5 Tool coordinate system diagram

The coordinate system is defined on the tool and is defined by the user. Generally, the effective direction of the tool is defined as the Z axis direction of the tool coordinate system, and the X axis and Y axis directions are defined by the right-hand rule.

2) Calibration of six-axis robot tool coordinate system: six-point calibration method

The parameters of tool 01-10 refer to the relationship between tool 01-10 and tool 00. The origin of the coordinate of tool 00 is at the center of the six-axis flange. When the robot is at the zero position, the direction of tool 00 is consistent with the direction of the world coordinate system.

Tool 01-10 generally defines the effective direction of the tool as the Z axis direction of the tool coordinate system. A simple tool can directly input the size of the tool and the angle of rotation. Complex tools, such as welding torches, are generally calibrated by the six-point method. The specific calibration method is as follows:

Step 1: make two tip calibration rods (the sharper the better), one is installed at the center of the tool to be calibrated (you can use the tip of the tool itself, such as welding wire, but you need to sharpen it), and the other is placed horizontally at work On stage (not movable).

Step 2: Switch to【coordinate system】 on the teach pendant, select a tool coordinate, coordinate 00 is not selectable.

Step 3: Manually teach the robot, align the two tips and take six postures (see Figure 2-7). After adjusting a position, highlight the corresponding line in【Calculate Tool Coordinate Value】, and then click【Record】. (Tips for picking points: when looking at the point, look at the front and side directions. When there is no deviation in both directions, the tip is only aligned.)

Step 4: Click Calculate, and then click Save.

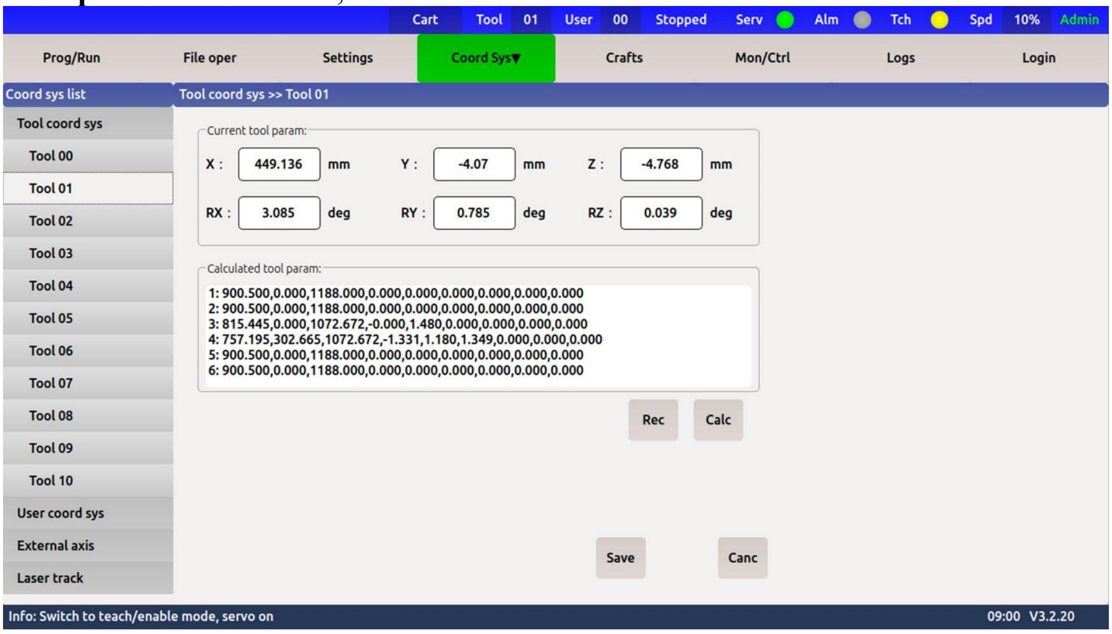


Figure 2-6 Tool coordinate calibration

Note: Before calibrating the tool coordinates, the robot should first return to the zero position. The zero position is very important for the accuracy of the tool coordinates. After returning to the zero position, please confirm whether the zero position is accurate. Normally, the robot will perform zero calibration at the factory. If there is a collision during use, the battery is dead, and the mechanical transmission parts have been replaced, the robot needs to be re-calibrated.

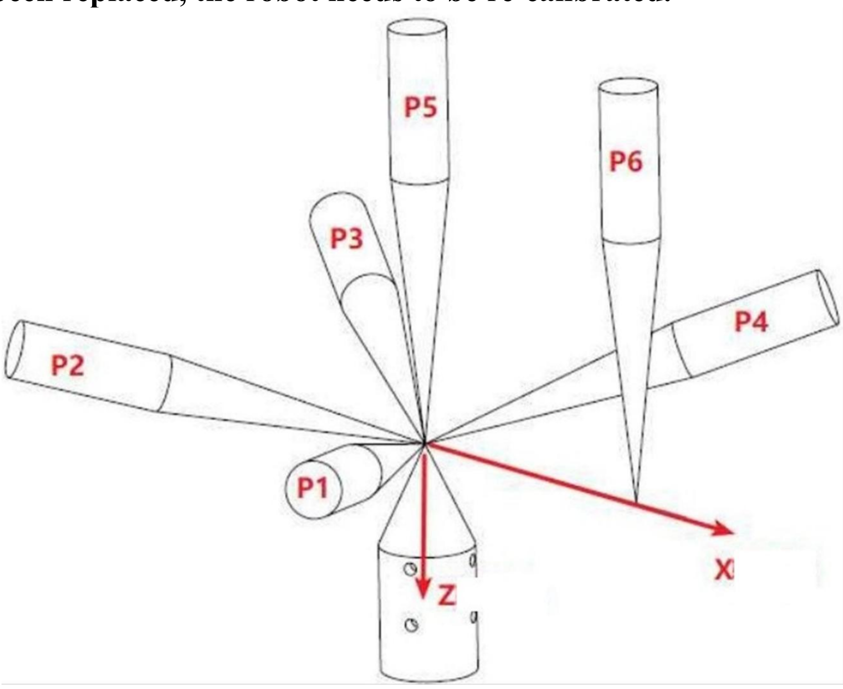


Figure 2-7 Six-point calibration of robot pose

Note: As shown in the figure above, P1-P4 and the tip calibration rod are scattered at a certain angle, and the posture change of the point should be as large as possible; the effective direction of the P5 point tool should be in line with the tip calibration rod to determine the Z axis direction, Point P6 is used to determine the X direction of the tool coordinates, that is, the connection between P5 and P6 is the X direction of the tool coordinates (generally, when P5 is completed, move the X axis directly under the 【rectangular】coordinate system to obtain point P6, namely The X direction of the tool coordinate is the same as the X direction of the rectangular coordinate).

3) SCARA tool coordinate calibration

Step 1: make two tip calibration rods (the sharper the better), one is installed at the center of the tool to be calibrated (you can use the tip of the tool itself), and the other is placed horizontally on the workbench (you can use it in the second step Placed).

Step 2: Switch to the 【joint】 coordinate system and the teach pendant robot moves out of zero; switch to the【rectangular】coordinate system and teach the robot, adjust RZ to 0 radians, and align the two tips (movable work The tip calibration rod on the stage is aligned, and it cannot be moved after being placed). The X, Y coordinate values at this time are recorded as X1, Y1.

Step 3: In the【rectangular】 coordinate system mode, teach the robot, adjust Rz to 3.141 radians, continue to teach the robot, and align the two tips. The X, Y coordinate values at this time are recorded as X2, Y2.

Step 4: Calculation

$$x = \frac{x_2 - x_1}{2}$$

$$y = \frac{y_2 - y_1}{2}$$

x,y is the tool coordinate parameter, select a tool coordinate on the teach pendant, fill in the x,y value, the rest is 0.

2.2.4 User coordinate system

1) User coordinate system definition

The user coordinate system is a rectangular coordinate system in which the user defines each working space. When there is no definition, the world coordinate system will replace the coordinate system.

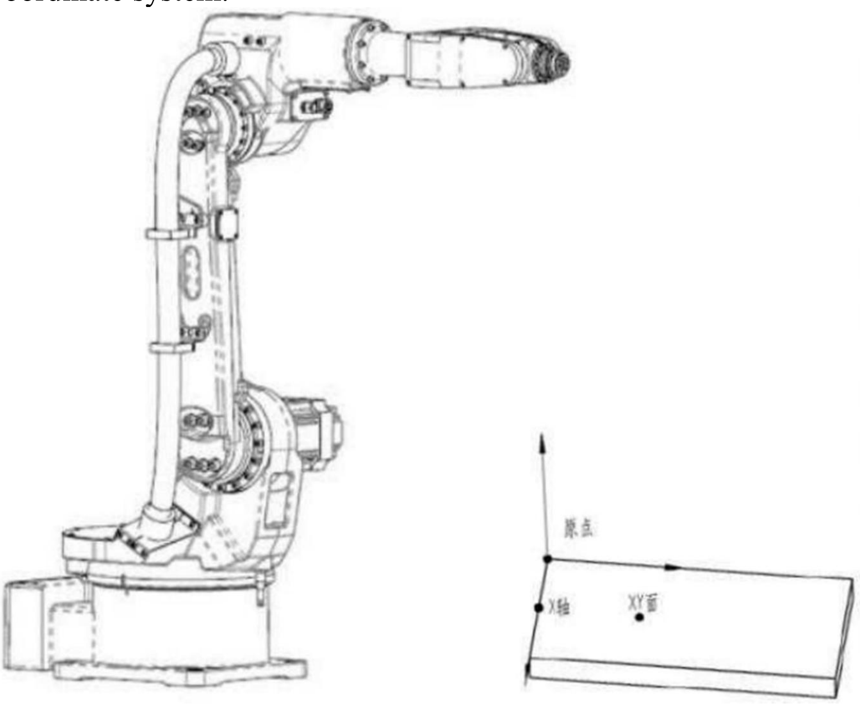


Figure 2-8 Robot user coordinates

2) User coordinate system setting (3-point method)

Step 1: Determine the working space to be calibrated.

Step 2: Move the robot with the operating tool to the origin of the coordinate system, and record this point as point 1.

Step 3: Move the robot with the operating tool to any point on the X axis of the coordinate system, and record the point as point 2.

Step 4: Move the robot with operating tool to any point in the XY plane that belongs to the first quadrant, and record the point as point 3.

Step 5: Click【Calculate】, then click【Save】.

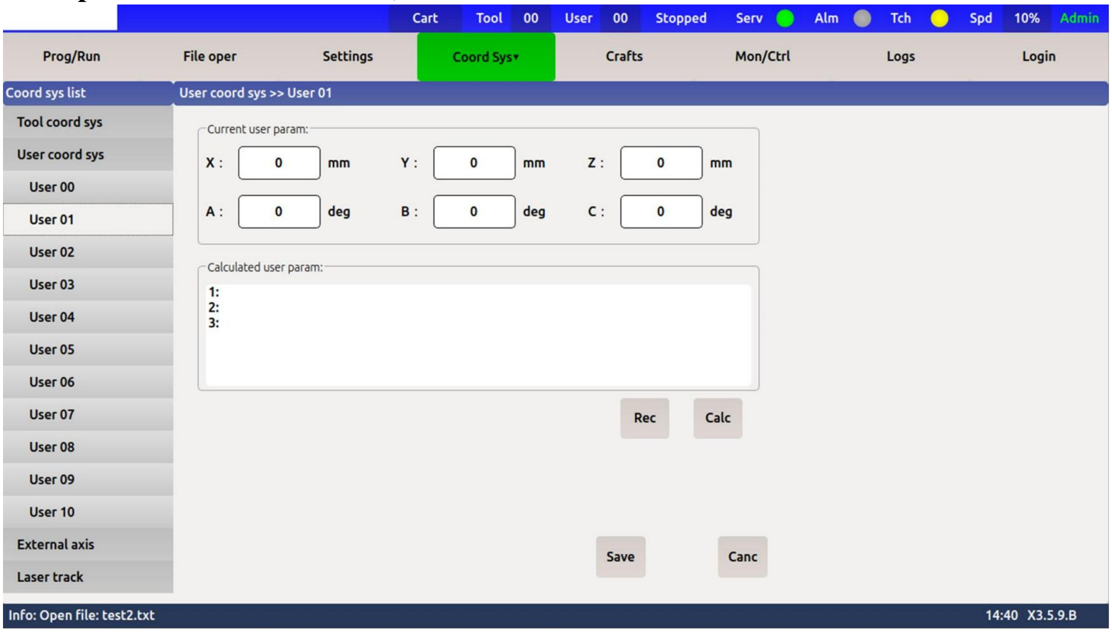


Figure 2-9 User coordinate system calibration

2.3 Robot zero point and calibration

Turing industrial robots all use Ehercat bus-type servos, which rely on multi-turn absolute encoders of servo motors to record positions. The multi-turn absolute encoder is equipped with a 3.6V battery recording position, and there is no need to change it when starting up. However, when the battery is empty and the battery is replaced, the robot collides or the transmission component is replaced and the zero position is lost, it is necessary to recalibrate the zero position and the joint parameters of the robot.

2.3.1 Robot zero

The zero attitude is the attitude where the joint value of each axis is 0. Zero calibration is actually the default zero attitude of the calibration system and the actual zero attitude of the robot.

In【Parameter Setting】->【Basic Setting】->【Zero Calibration】, you can calibrate the zero point.

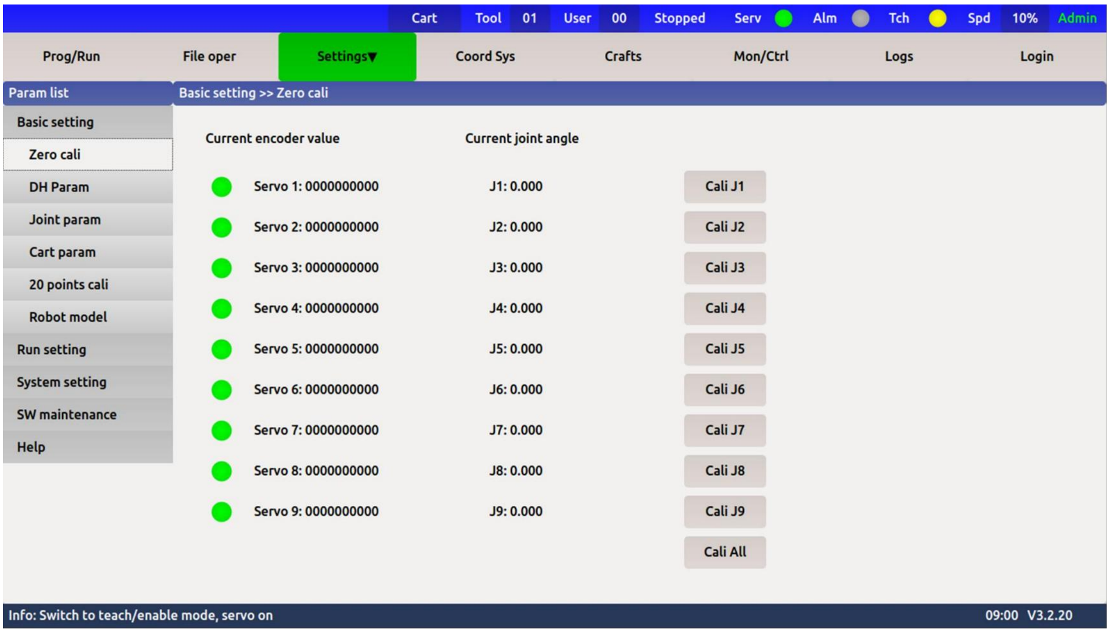


Figure 2-10 Robot zero calibration

When the robot is in the zero position, its posture is as shown below.

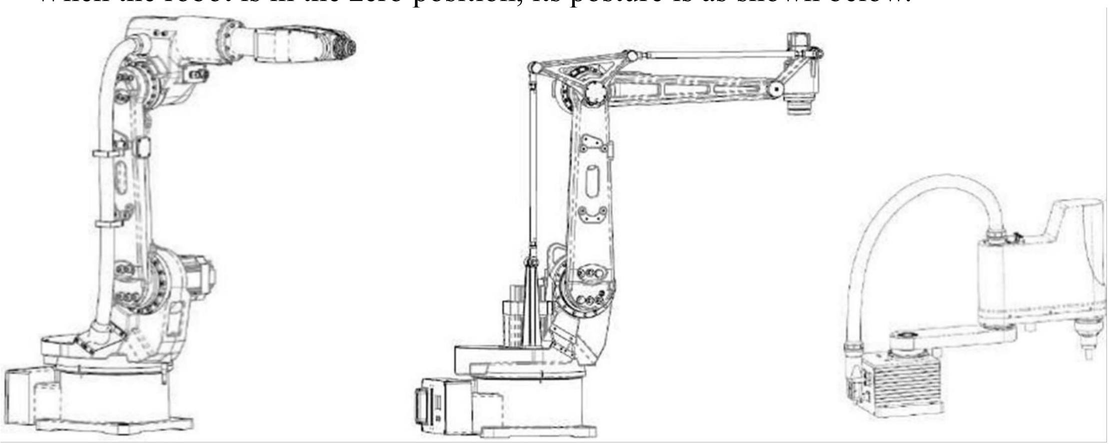


Figure 2-11 Zero position robot

When the robot zero position is lost, it is necessary to make a preliminary judgment to determine the zero position, and then use the software to correct the deviation (see 2.3.3). There are the following methods to judge the zero position initially:

◆ Visually or with the aid of a spirit level to observe the robot arm horizontal or vertical

◆Align the zero mark of each joint of the robot

The zero marks of different robots will be slightly different. The following are two basic marks.

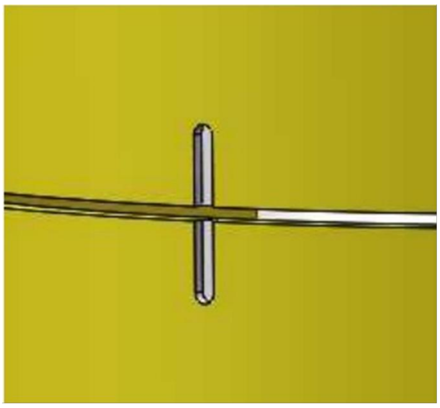


Figure 2-12 Keyway and scale zero mark

2.3.2 Battery replacement

When the encoder battery low voltage alarm occurs, the battery needs to be replaced.

During annual maintenance, the battery voltage needs to be checked. The specific operation is as follows: open the small cover plate of the encoder battery on the back of the robot base, and measure the battery voltage with a multimeter. The normal rated voltage is 3.6V. When the voltage is lower than 3.2V, the battery needs to be replaced.

The encoder batteries of Turing robots are all installed on the back cover of the base, and the battery can be replaced by removing the back cover (some models have a small battery cover, only need to remove the small cover to replace the battery).

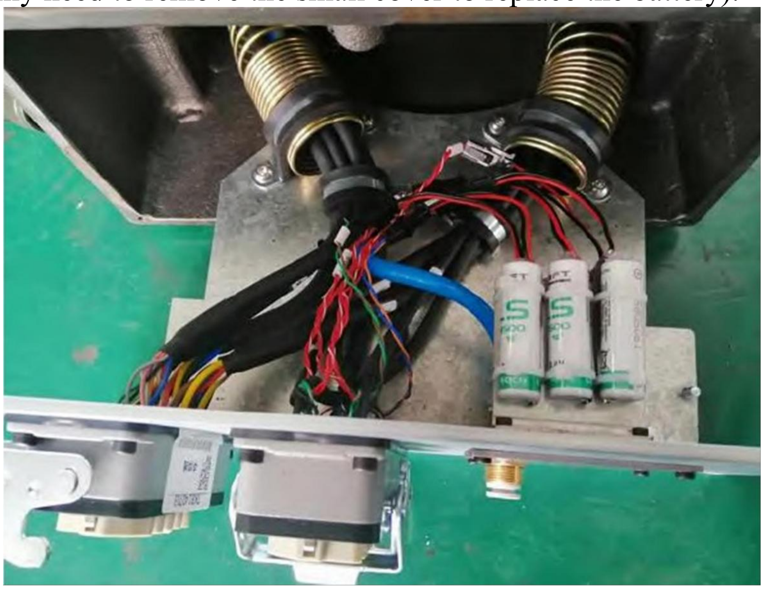


Figure 2-13 Six-axis robot encoder battery

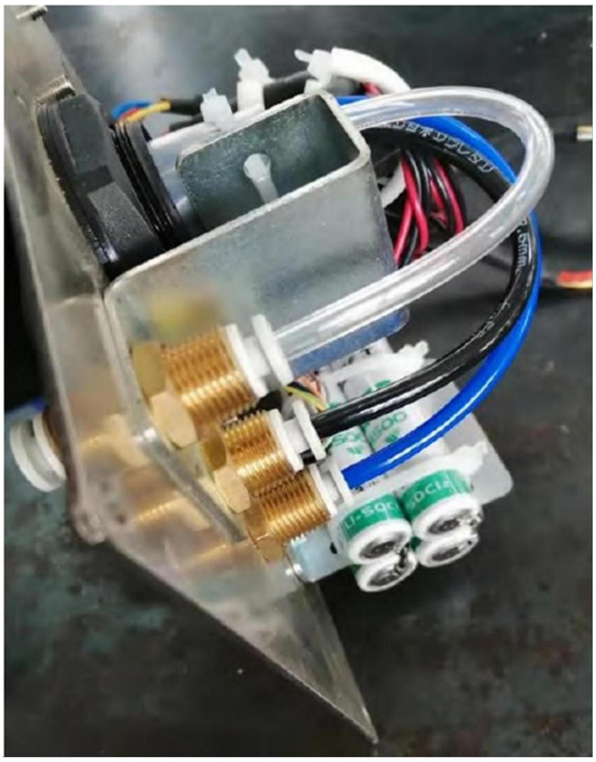


Figure 2-14 Four-axis robot encoder battery

Note: When replacing the battery, the robot needs to return to zero position, and use the motor brake to lock the robot joint. After the replacement is completed, the zero point needs to be re-calibrated. If you accidentally lose the zero position, you need to recalibrate.

2.3.3 Twenty-point correction method

Before calibration, it is necessary to ensure that the robot's link parameters, reduction ratio, and coupling ratio are accurate, and the zero position needs to be within the allowable deviation.

The specific calibration steps are as follows.

Step 1: make two tip calibration rods (the sharper the better), one is installed at the center of the tool to be calibrated (you can use the tip of the tool itself, such as welding wire, but you need to sharpen it), and the other is placed horizontally at work on stage (not movable).

Step 2: Create a new file on the teach pendant and customize the file name.

Step 3: Open the program. Run the robot in manual teaching mode, align the two tip calibration rods, then add a joint motion command, repeat the above steps, and record a total of 20 points (see Figure 2-16 and Figure 2-17 for posture). As shown below:

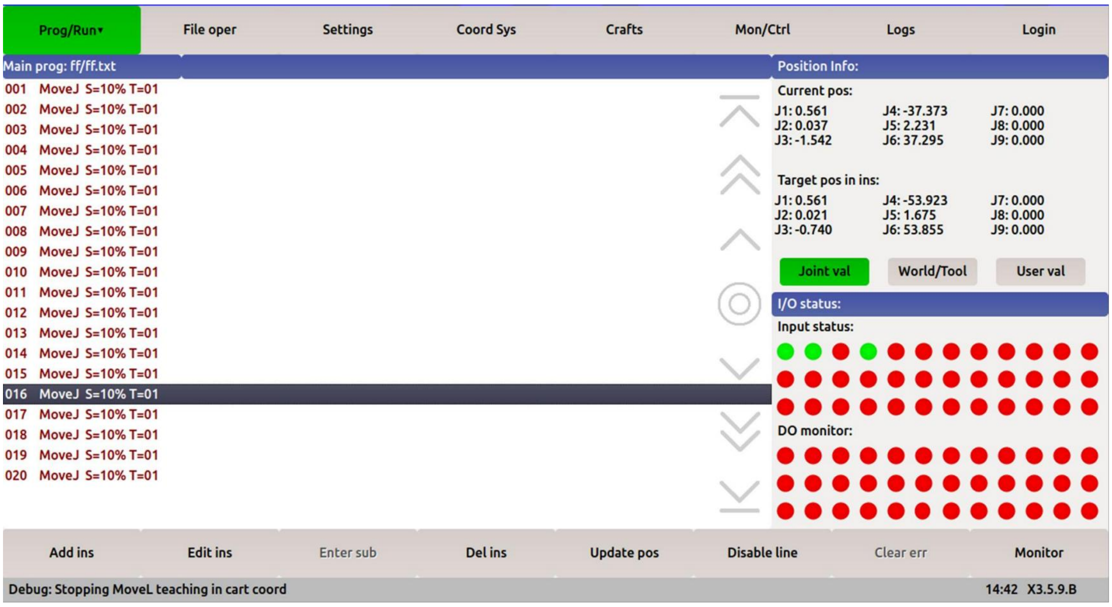


Figure 2-15 Twenty-point calibration

Description:

◆When making 20 points of a six-axis robot, make the tip calibration rod on the robot form a certain angle with the tip calibration rod on the worktable, and align them. Twenty points are scattered around (see Figure 2-16), and the greater the difference in the posture of the robot, the better.

◆When making a four-axis robot at 20 o'clock, place the tip calibration rod on the worktable at any position within the robot's motion range, and record two joint motion commands with left and right hand postures (see Figure 2-17). Ten positions are scattered in the robot's movement range, and the more dispersed, the better.

Figure 2-16 Six-axis robot twenty-point calibration

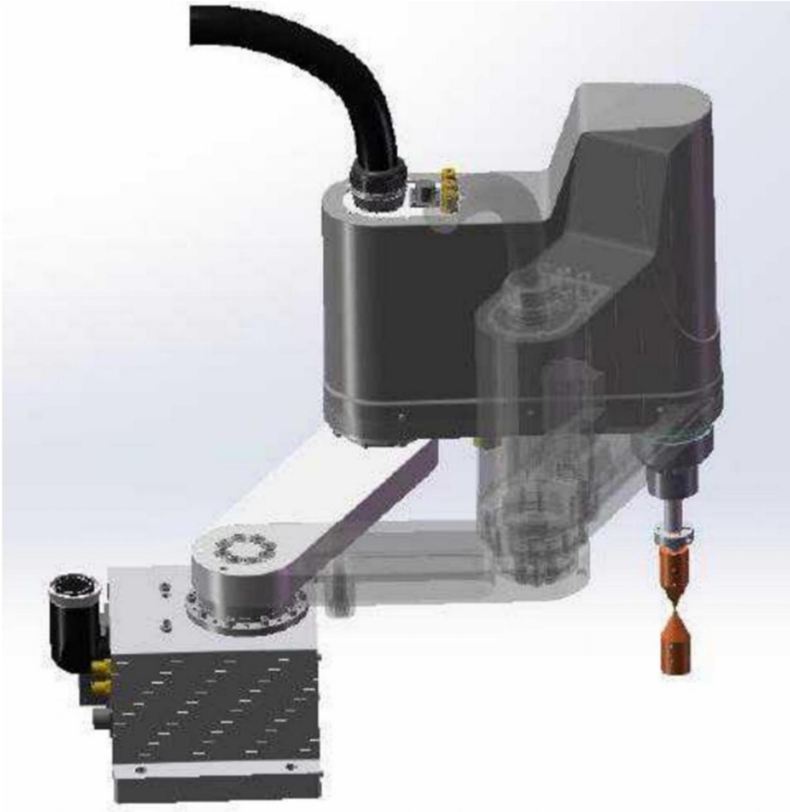


Figure 2-17 Four-axis robot 20-point calibration

Step 4: Switch to【Parameter Setting】-【Basic Setting】->【20 Point Calibration】 on the teach pendant, select the script file created in the second step, and click【Calculate】. During the calculation, a window will pop up to show the progress. After the calculation is completed, click【OK】. The information bar below will show: 20 points calculated successfully.

Step 5: Click【Save】 to bring up a window【Do you want to update directly to the connecting rod, zero point, tool? 】, if you click【OK】, the system parameters will be changed directly; if you click【Cancel】 or not【Save】, you need to manually update the system parameters.

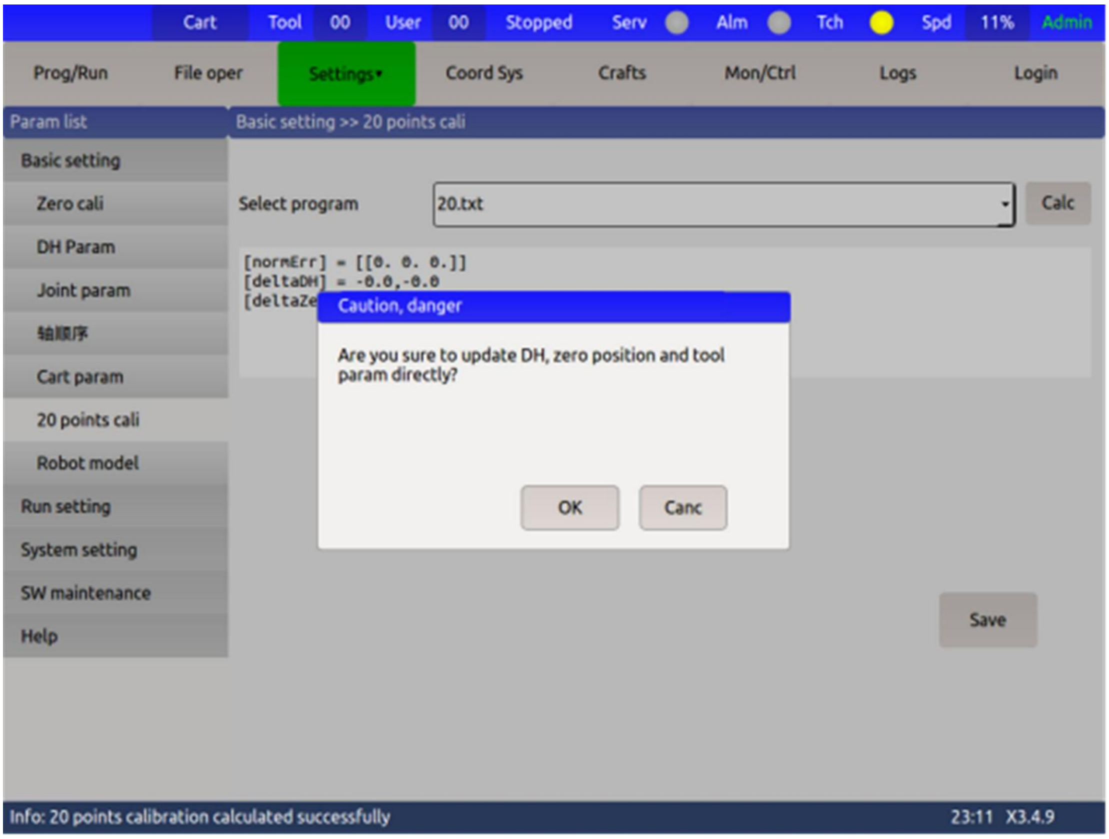


Figure 2-18 Twenty-point calibration

The following explains the 20-point calculation results:

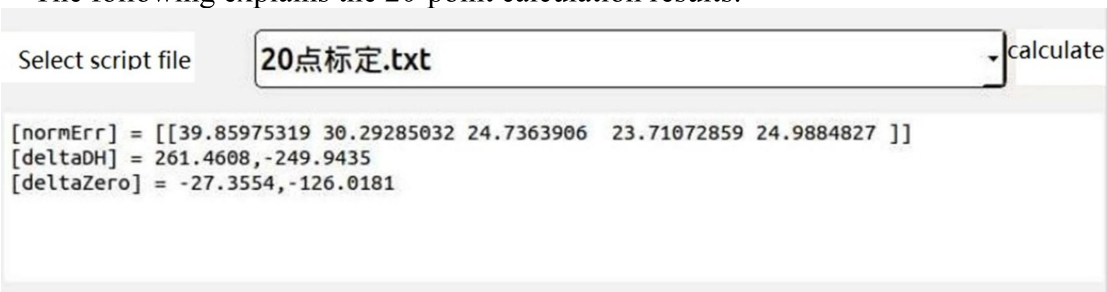


Fig. 2-19 Calculation result of 20-point calibration

【NormErr】: Tool coordinate error

【DeltaDH】: Calculated connecting rod parameter error

【DeltaZero】: Calculated zero error

Note: Generally speaking, the value of calibration will not exceed 5mm. If it exceeds 5mm, it may be the problem of joint parameter setting. It is recommended to calibrate after checking the correctness.

Chapter 3 Basic programming

3.1 Introduction to Teach Pendant

Before learning to operate a Turing robot, first know the Turing Teach Pendant. For safety reasons, safety precautions and operating specifications are also mentioned.

- The key switch selects local
- Confirm whether the emergency stop button can work normally
- Familiar with teaching programming interface

3.1.1 Teach pendant structure

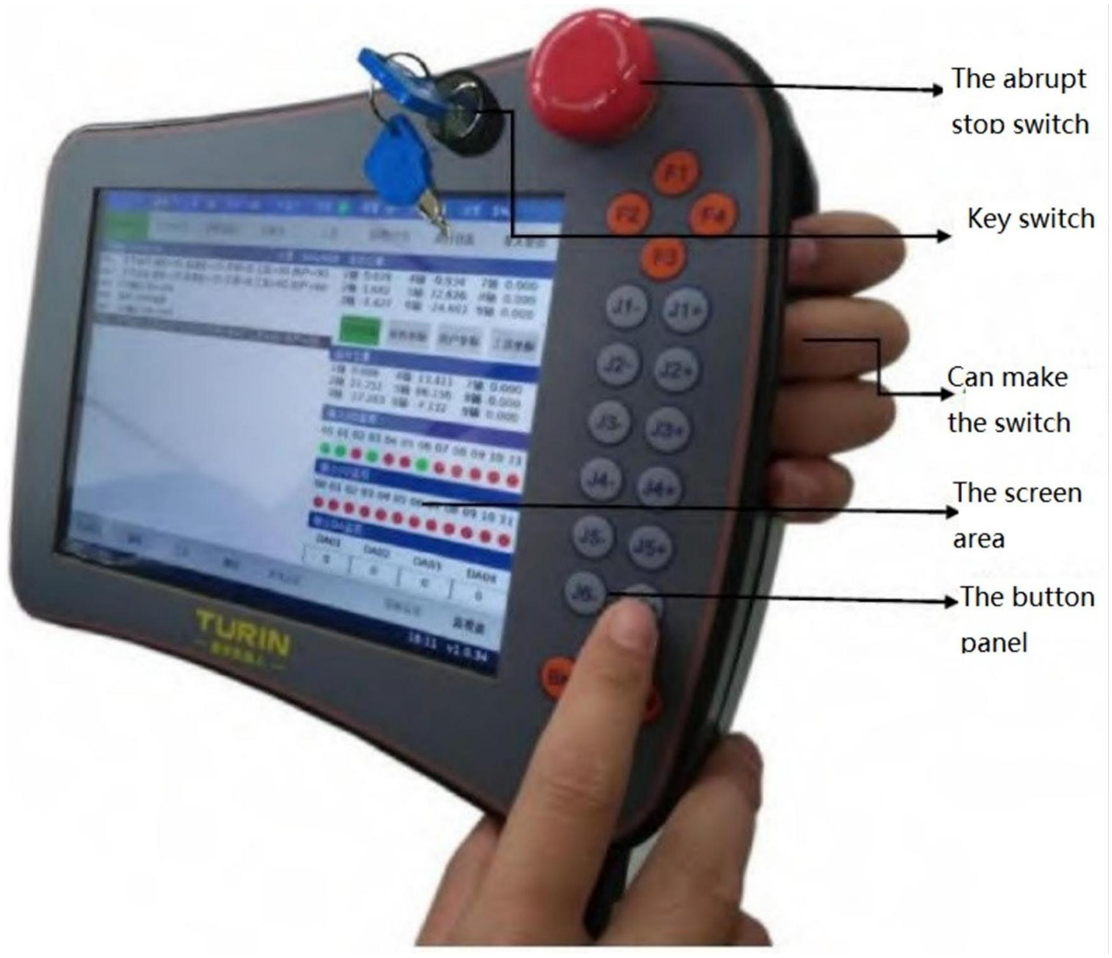


Figure 3-1 Teach pendant structure

Emergency stop switch: Normally closed is effective, and disconnected when photographed, the robot switches to emergency stop mode.

Key switch: Switch between manual (teaching mode, teach)/automatic (reproduction mode, play) mode.

Enabling switch: only useful in the teaching mode, the switch is divided into three gears, open, press and heavy pressure. When disconnected or under heavy pressure (no operation or emergency), the servo motor is not powered on. When pressed, the servo motor is powered on.

Screen area: The screen is an 8-inch resistive screen, pressure sensitive.

Button panel: commonly used function buttons, the specific functions are shown in the table below.

Table 3-1 Teach pendant key function comparison table

Button	Features
F1~F4	Custom function
J1-，J1+	One axis (external axis one axis) forward and reverse
J2-，J2+	Two axis (external axis two axis) forward and reverse
J3-，J3+	Three-axis (external axis three-axis) forward and reverse rotation
J4-，J4+	Four-axis forward and reverse rotation; forward and reverse rotation around the X axis (Rx)
J5-，J5+	Five-axis forward and reverse rotation; forward and reverse rotation around Y (Ry)
J6-，J6+	Six-axis forward and reverse rotation; forward and reverse rotation around Z (Rz)
SA	In playback mode, start running
BK	The robot returns to zero
ST	In playback mode, stop running
FW	Clear alarm

3.1.2 User Interface

The teach pendant interface is mainly the main part of the main menu, information bar, and program display, editing, status and so on. As shown below.

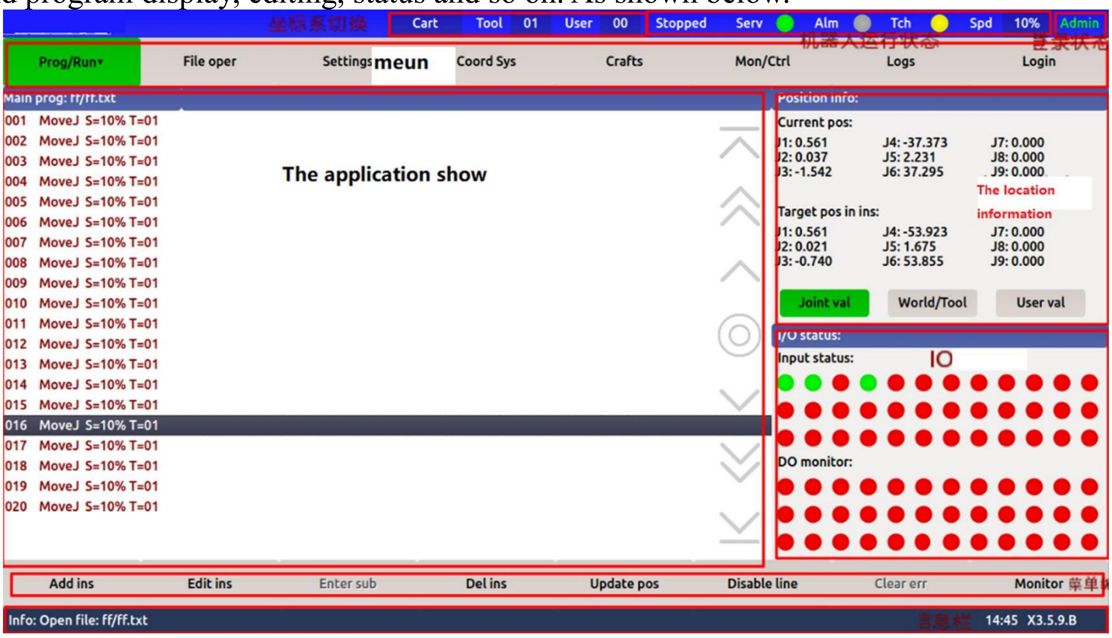


Figure 3-2 Teach pendant user interface

3.1.3 Teach pendant operation specification

For safety reasons, perform the following operations before teaching.

The key switch selects manual mode to prevent misoperation.

Confirm whether the emergency stop button can work normally, when the enable switch is pressed, the servo motor is under strong power.

The correct operation of the Teach Pendant should be: hold the Teach Pendant at the bottom with your left hand, pass the fastening belt on the back of your hand, and press the enable switch with four fingers, as shown in the figure.

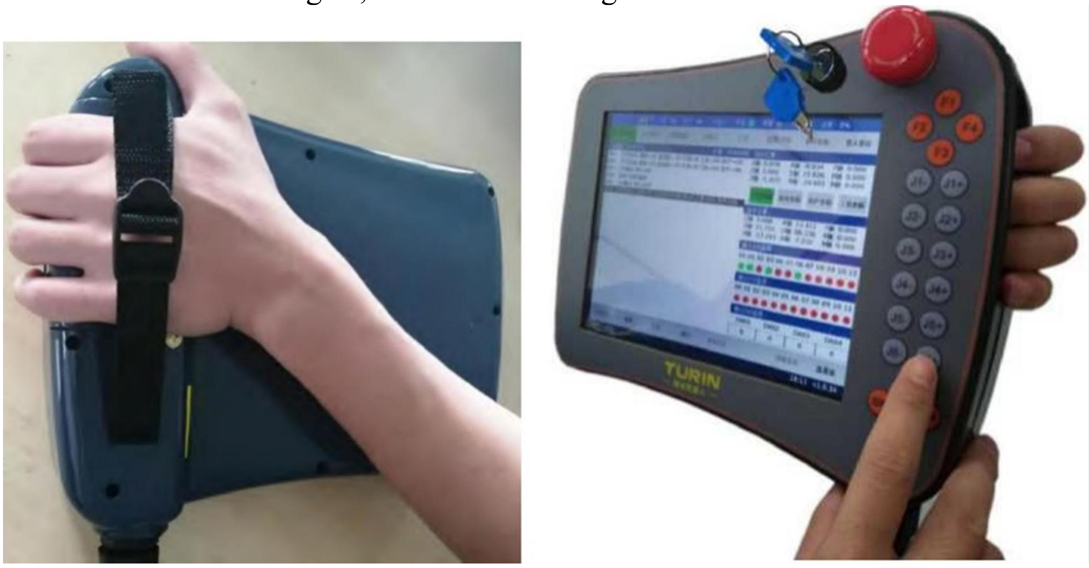


Figure 3-3 Teach pendant holding posture

3.2 Manual motion robot

3.2.1 system login

Before operating the robot, you need to log in to the system. System login is divided into three levels: no login, operator login and system login.

1) No login: only manual/automatic mode switching, program running and program stop operation can be performed. When the equipment is debugged, only need to start and stop production every day, no need to log in.

2) Operator login: The operator has the authority to modify programming and point teaching. During commissioning, or when replacing the product and re-teaching the point, operator login is required.

Operator login settings include operator login, operator logout, and password modification. The default password for operator login is "**33333333**".

3) Administrator login: The operator has the authority to set the mechanical parameters and modify the limit of the body. The system login should only be aimed at engineering personnel or advanced users, and should not be developed for ordinary operators. Inaccurate parameter setting will directly affect the operation of the robot.

System login settings include system login, system exit, and password modification. The default password for system login is "**12345678**".

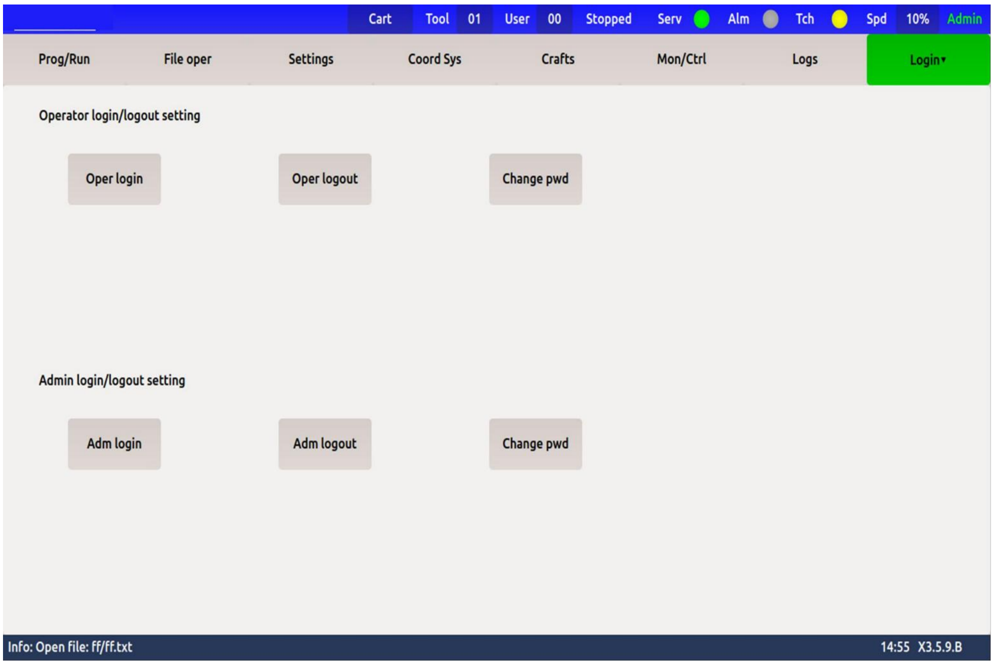


Figure 3-4 System login

3.2.2 Coordinate system selection

The default motion coordinates of the robot are joint coordinates.

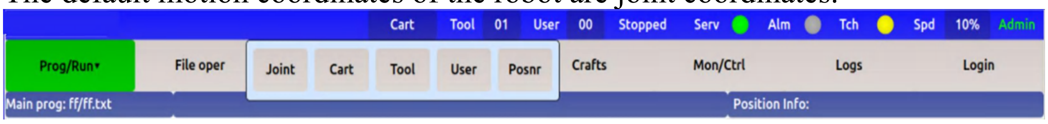
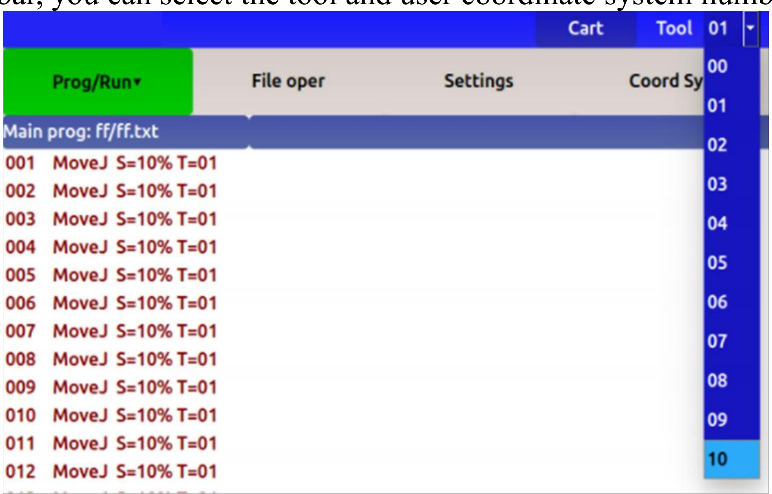


Figure 3-5 Coordinate system selection

Select the coordinate system selection in the toolbar on the upper right corner of the touch screen, there are "joint", "right angle", "tool", "user" and "positioner" (external axis) coordinate system can be selected, you can switch the robot coordinate system To the corresponding coordinate system.

3.2.3 Tool and user coordinate system number selection

In the toolbar, you can select the tool and user coordinate system number.



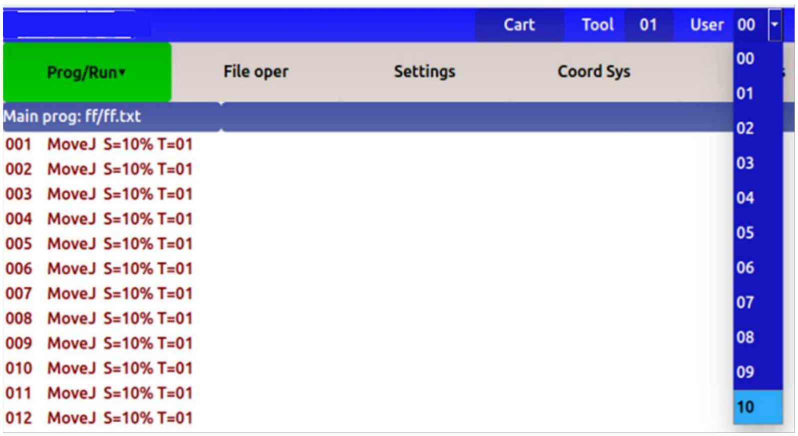


Figure 3-6 Selection of tool coordinates and user coordinates

3.2.4 Manual speed selection

The maximum speed of the robot under manual operation is 25% of the rated speed.

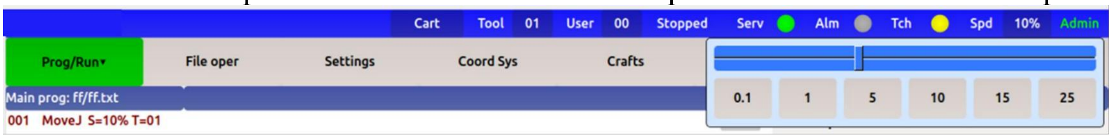


Figure 3-7 Manual speed selection

Click "Speed" in the upper right corner of the touch screen to set the robot movement speed for manual teaching.

3.2.5 Manually operated robot

Hold the Teach Pendant with your left hand and press and hold the【Enable Switch】, the right hand can operate the corresponding axis movement. See Table 3-1 for key functions.

3.3 Programming

In this section, a complete basic program will be introduced, but to complete more complicated programs or use more advanced commands, you need to consult other chapters.

3.3.1 Add an instruction

Take the "delay" instruction as an example.

Click【Add Command】->【Regular Command】->【Delay】

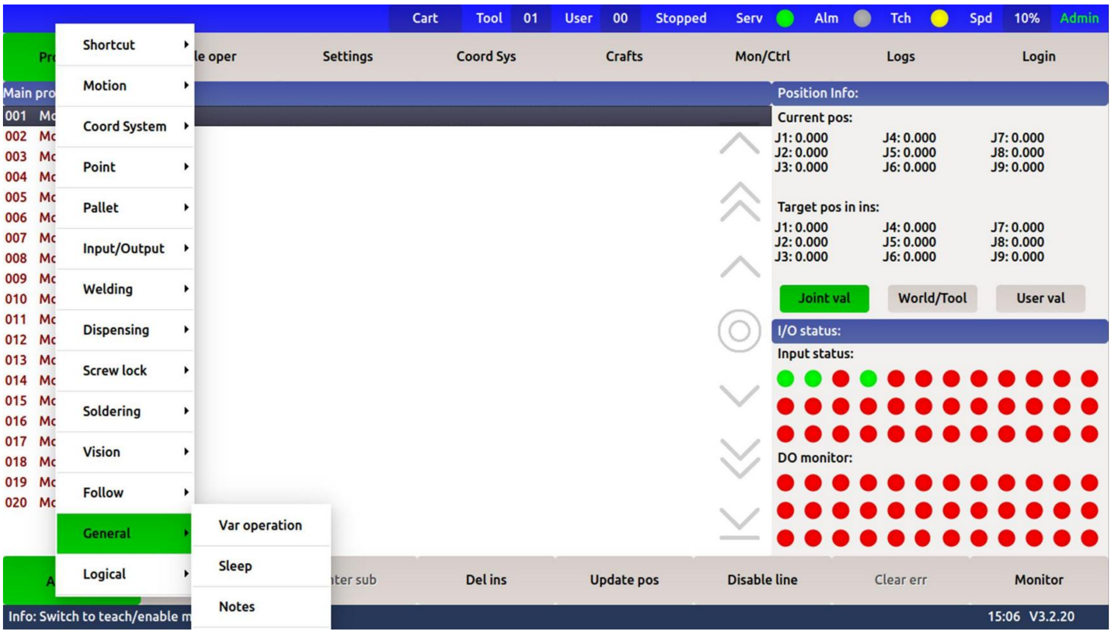


Figure 3-8 Add instruction

Enter the value in the pop-up window and click [【New】.

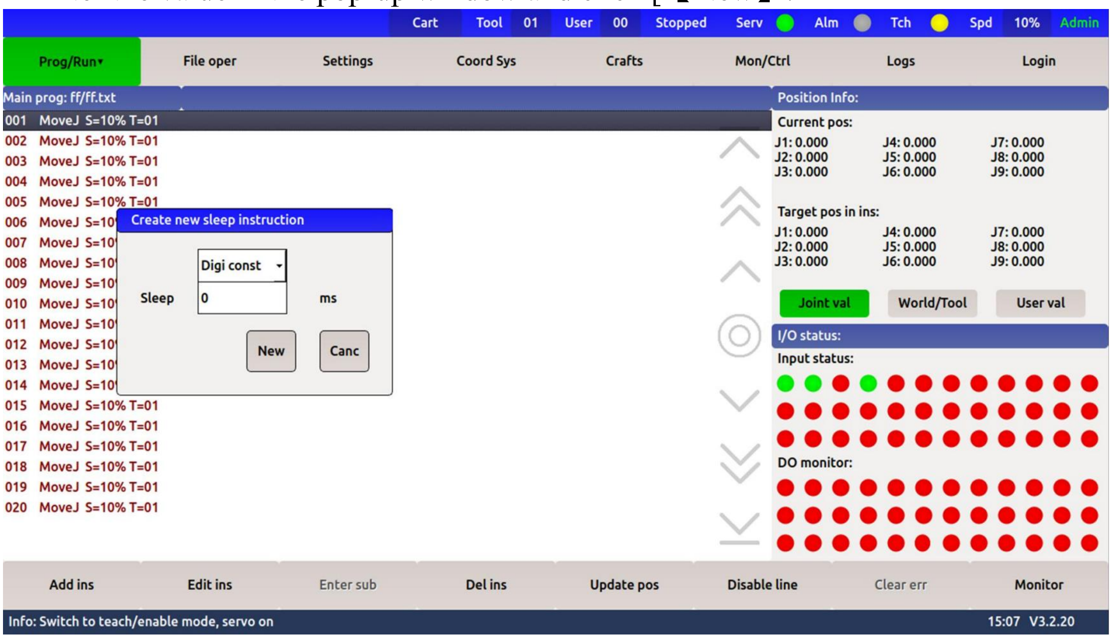


Figure 3-9 New command

After completion, see the figure below.

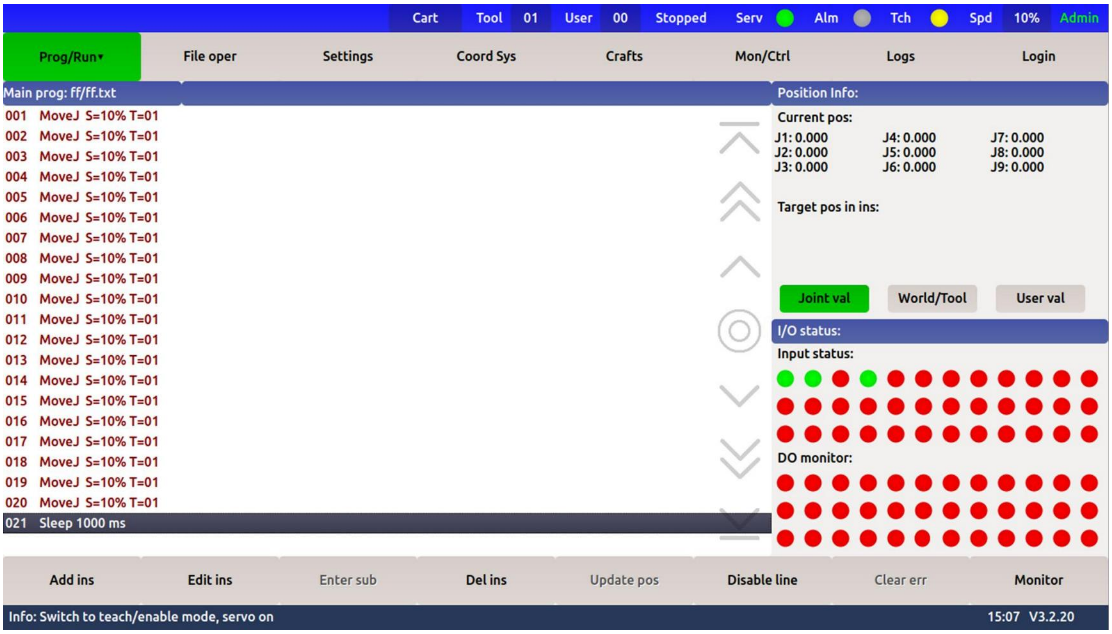


Figure 3-10 New command

Note: When adding an instruction, a new instruction is added after the instruction selected by the cursor by default. When the cursor selects the first line to add an instruction, a dialog window will pop up. Please select the first line or the second line.

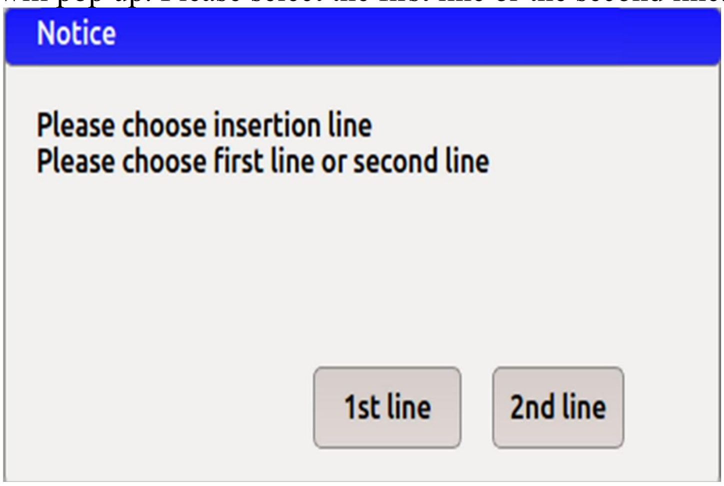


Figure 3-11 Position of the first command line

3.3.2 Deletion of instructions

Select the command to be deleted, click【Delete Command】, enter the number of lines to be deleted, and click 【OK】

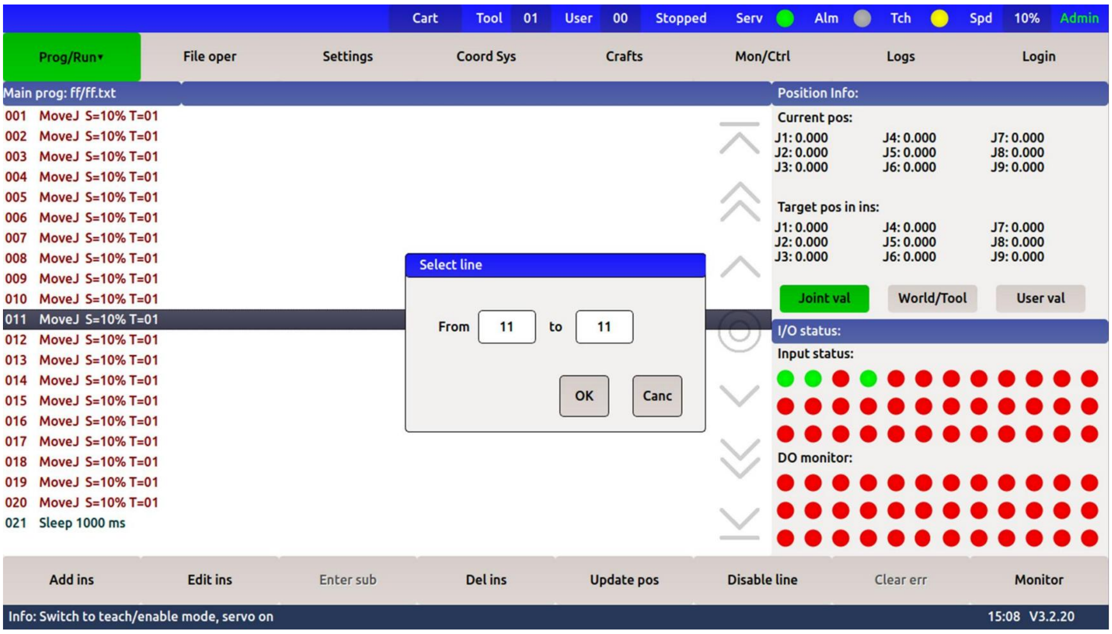


Figure 3-12 Delete command

3.3.3 Command editing

Select the command that needs to be edited and click【Edit Command】, a menu of edit commands will pop up, and edit the command as required.

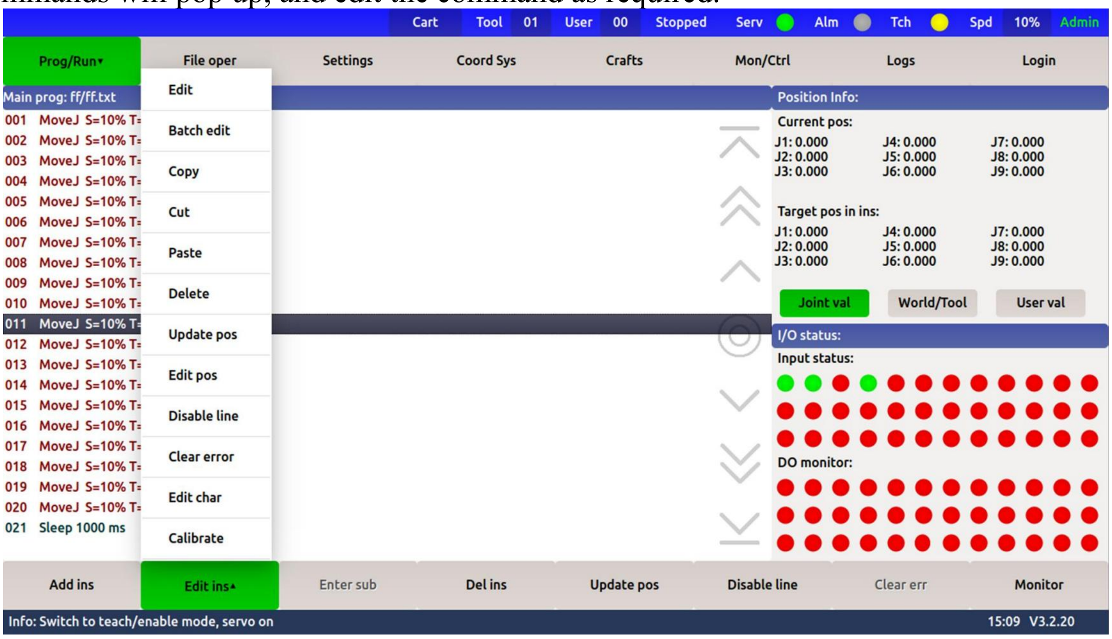


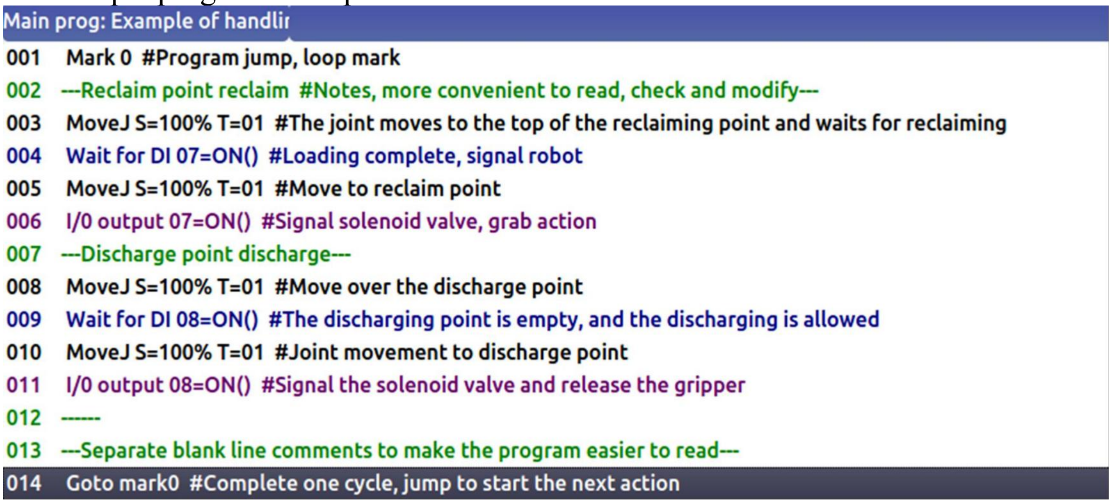
Figure 3-13 Edit command

3.3.4 Write a program

A program has no specific format and framework. Any complete instruction can constitute a program, the program is only related to the requirements, what tasks need to be completed, then edit what program.

Note: The program does not have a specific format that can be framed, but the instructions must be written according to the specifications, otherwise the compilation will fail. For instructions on the instructions, please refer to 3.5. For more instructions, please refer to the "Debugging Manual".

A simple program example is listed below.



```
Main prog: Example of handlir
001  Mark 0  #Program jump, loop mark
002  ---Reclaim point reclaim  #Notes, more convenient to read, check and modify---
003  MoveJ S=100% T=01  #The joint moves to the top of the reclaiming point and waits for reclaiming
004  Wait for DI 07=ON()  #Loading complete, signal robot
005  MoveJ S=100% T=01  #Move to reclaim point
006  I/0 output 07=ON()  #Signal solenoid valve, grab action
007  ---Discharge point discharge---
008  MoveJ S=100% T=01  #Move over the discharge point
009  Wait for DI 08=ON()  #The discharging point is empty, and the discharging is allowed
010  MoveJ S=100% T=01  #Joint movement to discharge point
011  I/0 output 08=ON()  #Signal the solenoid valve and release the gripper
012  ------
013  ---Separate blank line comments to make the program easier to read---
014  Goto mark0  #Complete one cycle, jump to start the next action
```

Figure 3-14 Program case

3.4 Program instructions

As shown in the figure, this is a collection of program instructions on the current teach pendant. In the following chapters, instructions will be divided into five categories and introduced separately. (In addition to the instructions on the teach pendant, there are background instructions, please refer to the "Debugging Manual")

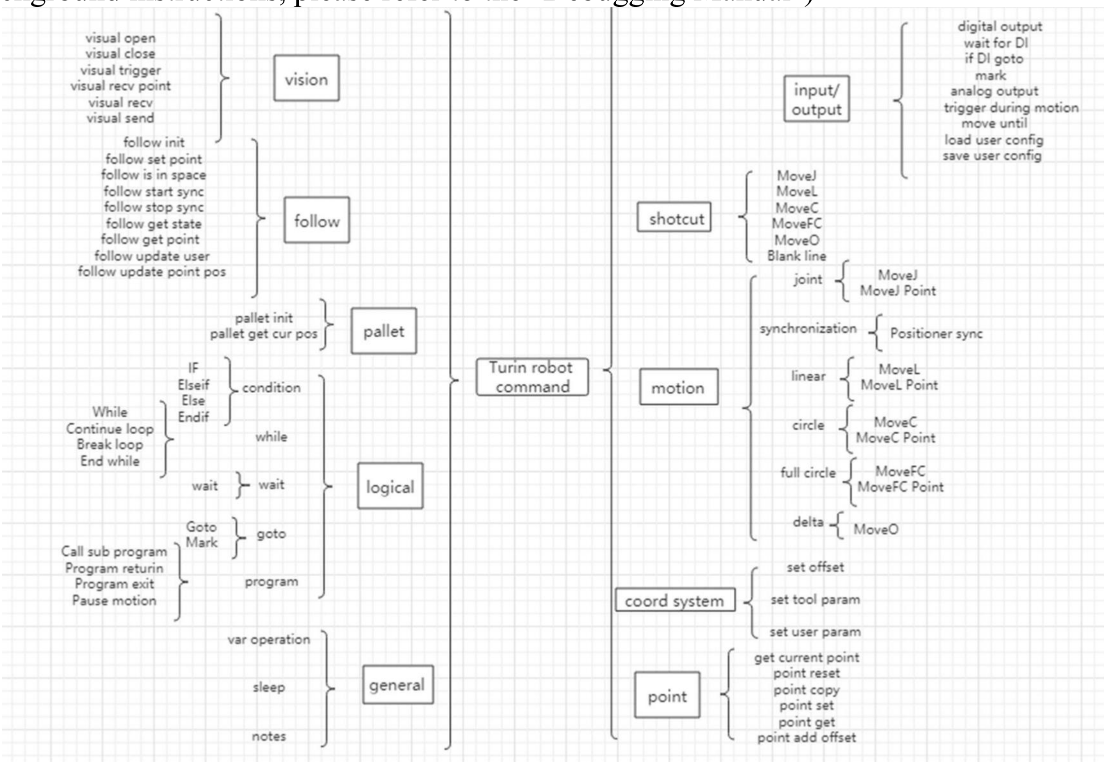


Figure 3-15 Command collection

3.4.1 Motion instruction

Usually the motion command records the position data, motion type and motion speed.

The position data records the current position information of the robot, and records the position information while recording the motion instruction.

The motion type specifies the trajectory between the teaching points during execution. Robots generally support three types of motion: joint motion (MOVJ), linear motion (MOVL), and circular motion (MOVC).

Movement speed refers to the speed at which the robot performs movement between the teaching points.

To add motion commands, press the "Enable" switch to enable the drive.

1) Types of joint motion

When the robot does not need to move to the current teaching point with the specified path, the joint motion type is adopted. The motion command corresponding to the joint motion type is【joint motion] 】(English command: MOVJ). In general, for safety, the joint motion type is used at the beginning of the program.

The characteristics of the joint motion type are the fastest speed and the unknown path. Therefore, this type of motion is generally used at a spatial point, and before running the program automatically, it must be checked at a low speed to observe whether the actual trajectory of the robot interferes with the surrounding equipment.

The operation of adding the【Joint Motion】 command is as follows.

Click【Add Instruction】->【Motion Instruction】->【Joint Motion】, enter the relevant parameters such as speed, acceleration, smoothing and tool, user coordinates, and then click the【New】button.

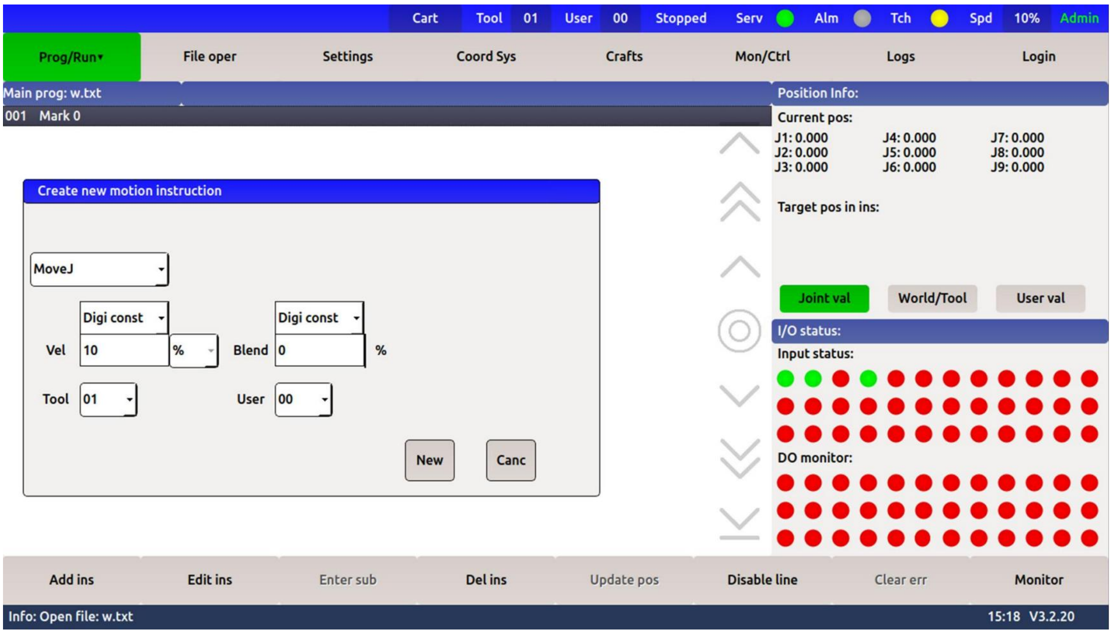


Figure 3-16 Joint command

The established command is shown in the figure below. The current teaching position becomes the end point of the joint motion.

Figure 3-17 Position information of joint motion command

2) Linear motion type

When the robot needs to move to the current teaching point through a linear path, the linear motion type is used. The motion command corresponding to the linear motion type is【linear motion】 (English command is MOVL). The starting point of linear motion is the teaching point of the previous motion command, and the ending point is the teaching point of the current command. For linear motion, during motion, the robot motion control point goes straight, and the posture of the fixture changes automatically.

The operation of adding the【linear motion】 instruction is as follows.

The end point of the previous motion command is the start point of linear motion. Manually move the robot to the end point of linear motion. Click【Add Command] 】->【Motion Command】 ->【Linear Motion】, enter the speed, acceleration, smoothing and tool, user coordinates After waiting for relevant parameters, click the【New] 】button.

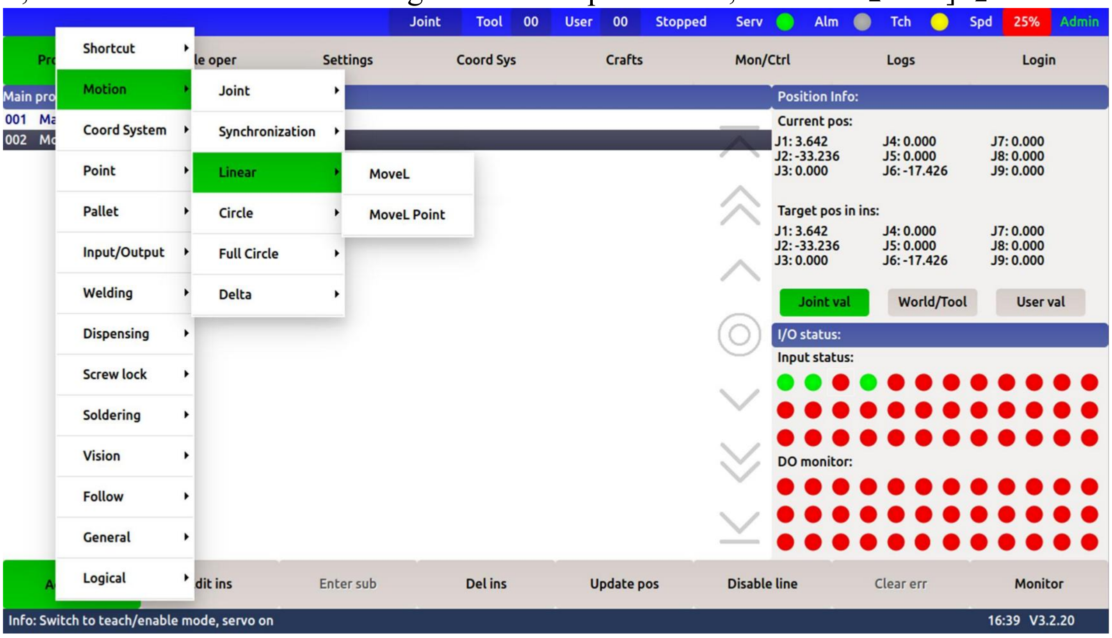


Figure 3-18 New linear motion

The established command is shown in the figure below. The current teaching position becomes the end point of linear motion.

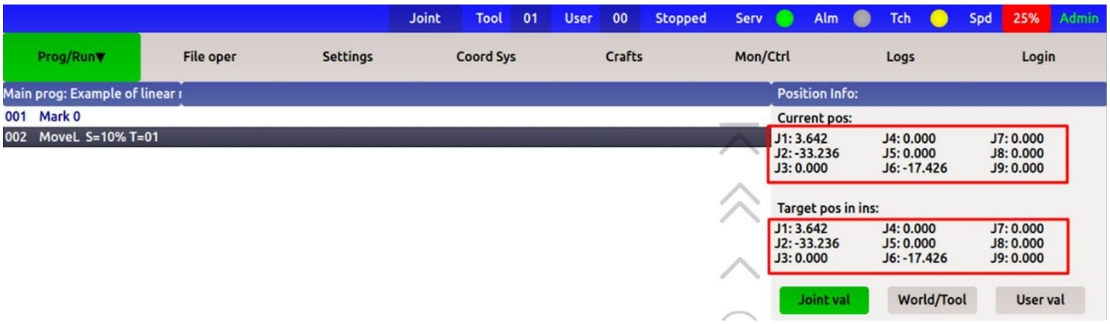


Figure 3-19 Position information of linear motion command

3) Circular motion type

When the robot needs to move to the current teaching point through the circular path, the circular motion type is adopted. The motion command corresponding to the circular motion type is【Circular motion] 】(English command is MOVC).

Three points determine a unique arc. Therefore, three motion points are required for arc movement. From the current point, through the first point (auxiliary point) to the second point (end point), the arc moves. We need to have two instructions.

The operation of adding the【Circular Motion] 】instruction is as follows.

The end point of the previous motion command is the starting point of circular motion. Manually move the robot to the auxiliary point of circular motion. Click【Add command】->【Motion command】->【Circular motion】, enter the speed, acceleration, smoothing and After related parameters such as tools and user coordinates, click the【New】button.

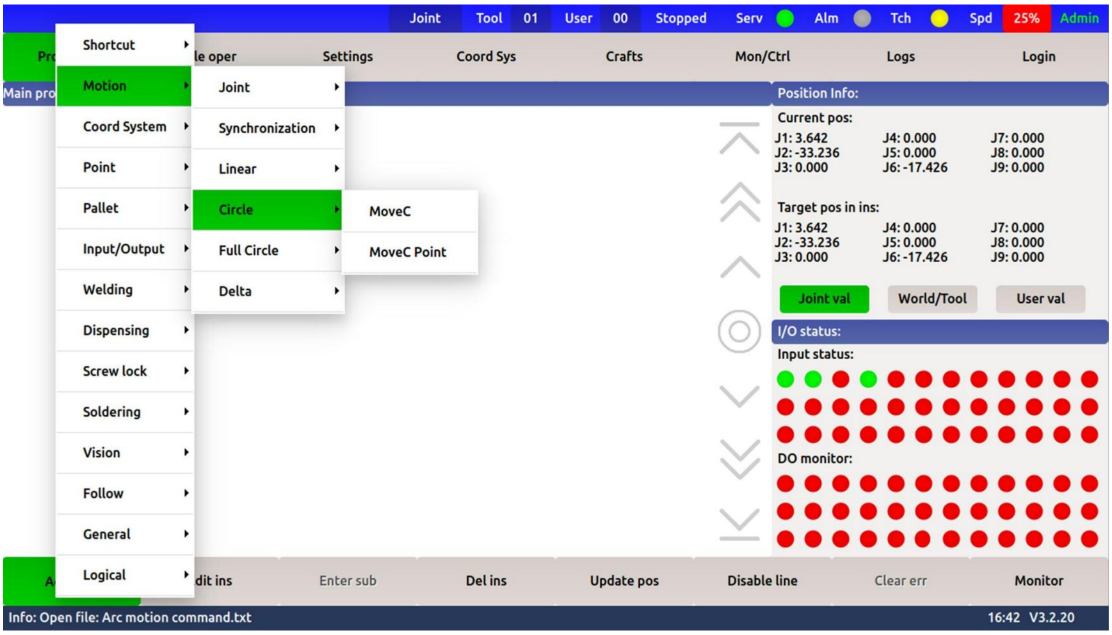


Fig. 3-20 New circular motion instruction

Set the parameters in the pop-up window and click New.

After the construction is completed, as shown below: the instruction to move to the auxiliary point is completed. As shown below:

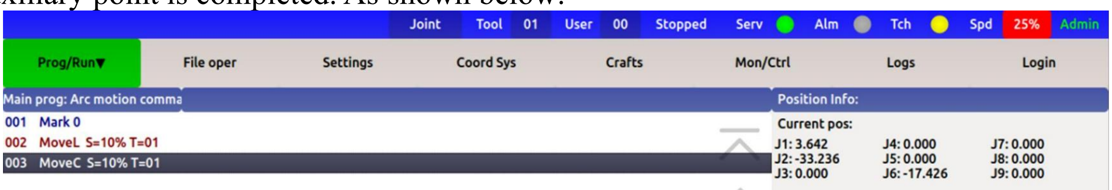


Figure 3-21 Add Auxiliary Point of Circular Motion Command

Continue to move the machine to the end of the arc, click【Add Command】 ->【Motion Command】 ->【Circle Motion] 】 to set the parameters and create a new one, as shown in the figure below after success. Such a complete circular arc trajectory composed of two【circular arc motion】instructions is established.

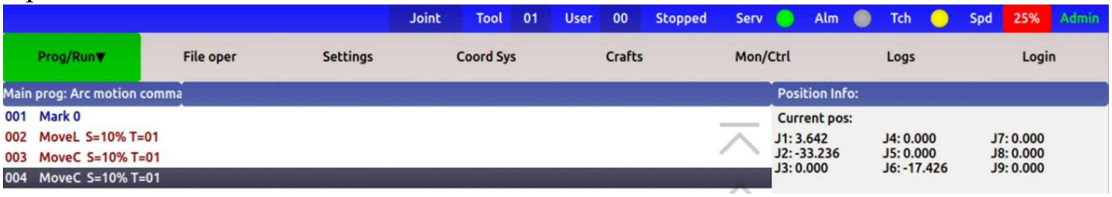


Figure 3-22 Circular command motion

4) Modify the movement position

When the robot is recording the position, the current position of the robot is recorded in the motion command. If you need to modify the position in the instruction, manually move the robot to the position you want to record and repeat the operation process of recording the movement instruction. When recording the instruction into the job, press【Change Point】 ->【OK】.

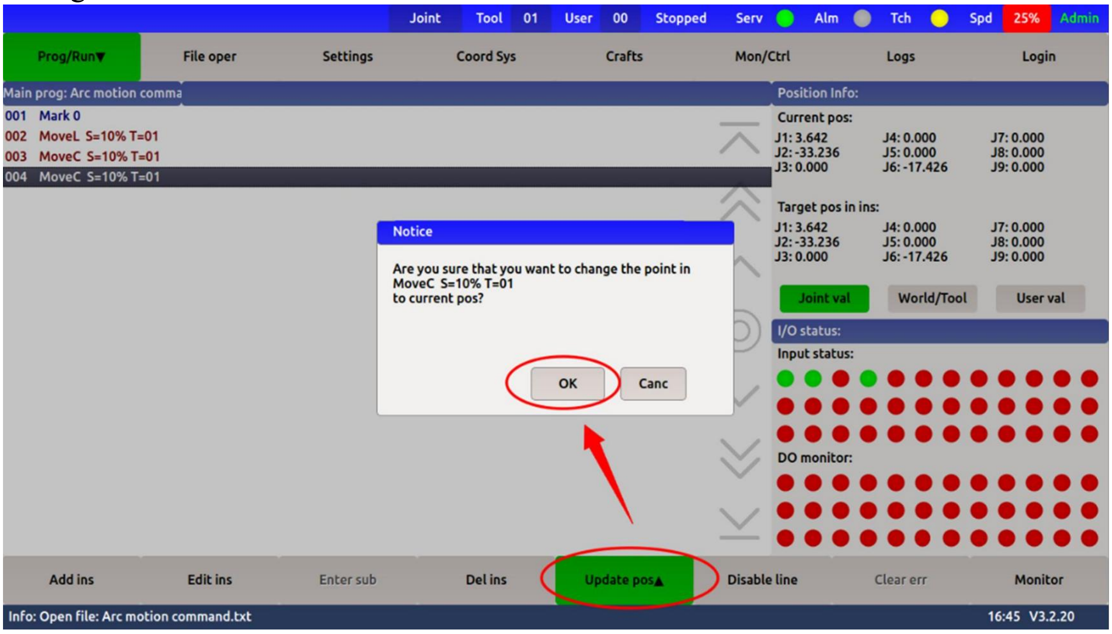


Figure 3-23 Change the position of the motion command

5) Modify the movement speed

Select the instruction to be modified and press【Edit】 to modify the movement speed in the pop-up window.

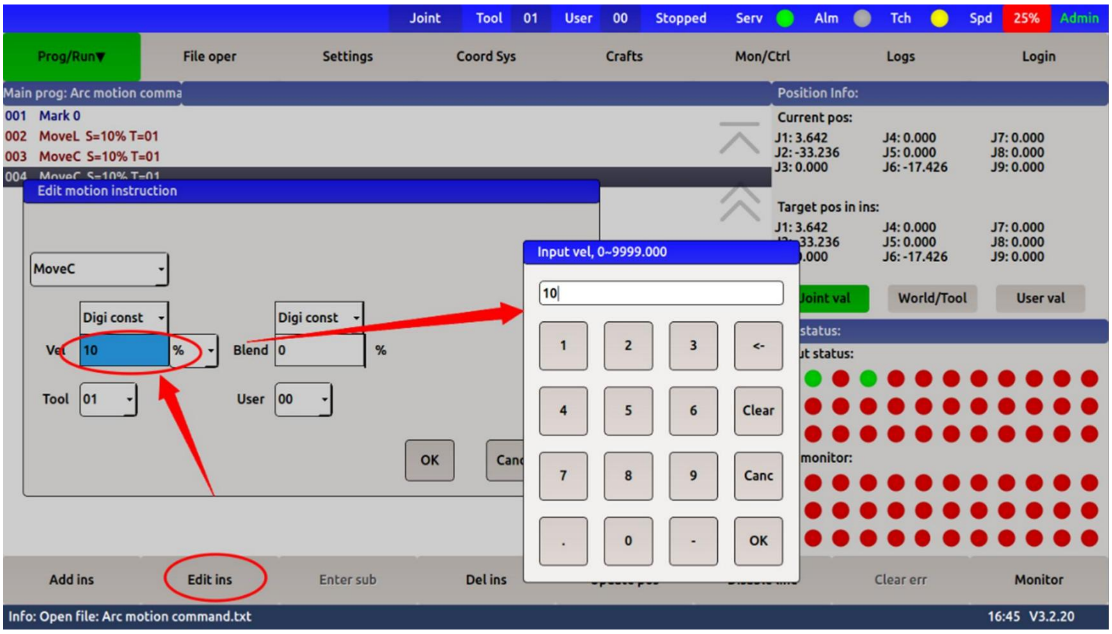


Figure 3-24 Editing motion instructions

3.4.2 Coordinate system and coordinate point instructions

1) Coordinate system instruction

Coordinate system instructions can automatically modify coordinate system information in the program.

The overall offset coordinate system can offset all motion commands based on this coordinate system in the program.

The offset can be either constant or variable.

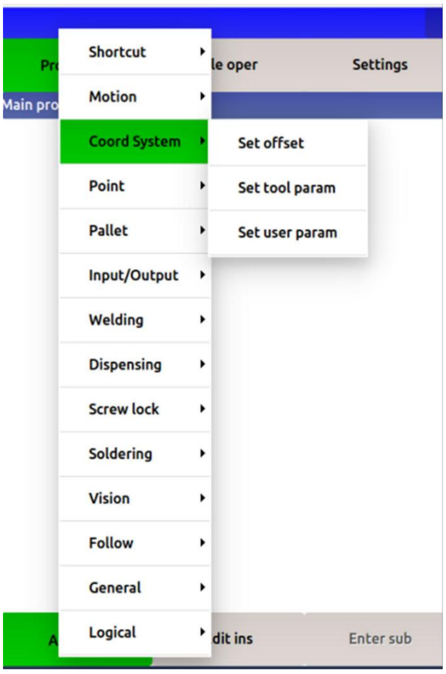


Figure 3-25 Coordinate command

Add offset to tool coordinate system;

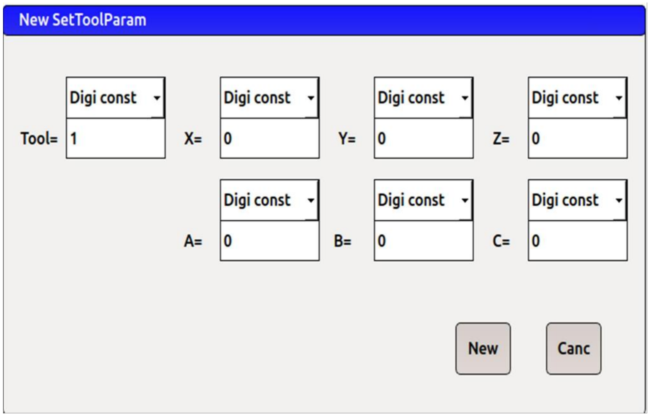


Figure 3-26 Tool coordinate system offset

Add offset to user coordinate system:

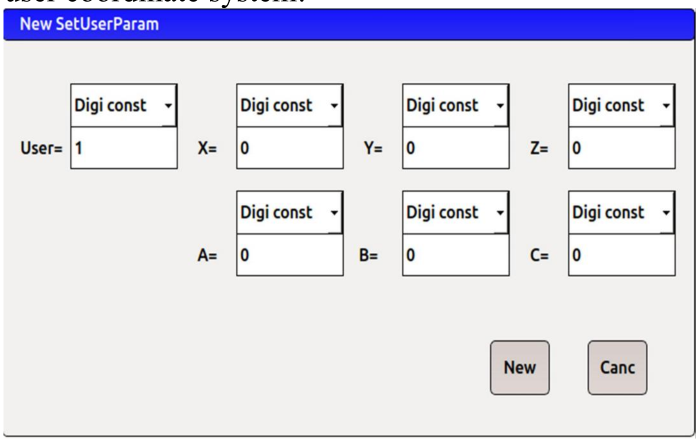


Figure 3-27 User coordinate system offset

2) Coordinate point instruction

The coordinate point instruction is for the coordinate point variable, and the coordinate point register is read and modified.

It is often used when guiding robots with machine vision. Based on the communication method, change the coordinate information of the target point.

Coordinate point storage is based on joints and rectangular coordinate systems. Pay attention to the consistency of the coordinate system when modifying and calling.

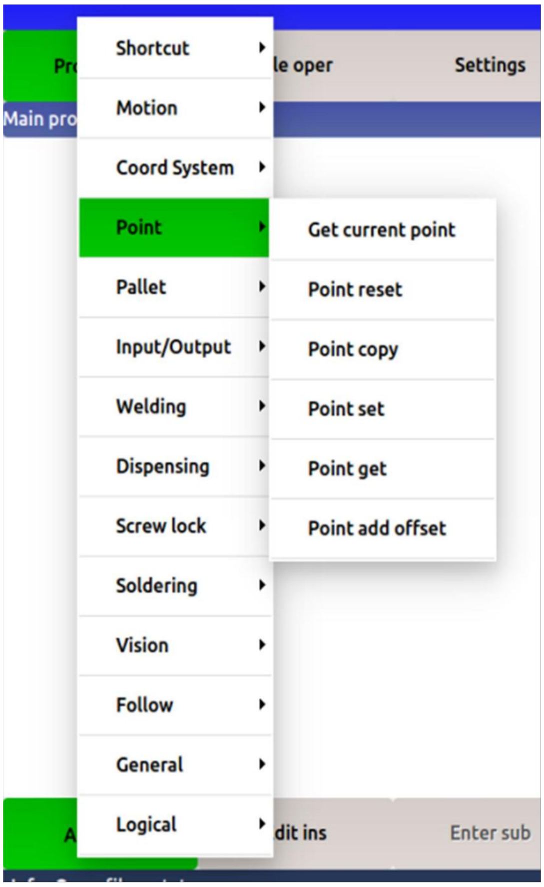


Figure 3-28 Coordinate point command

3.4.3 Input/output signal processing instructions

1) Control IO output

Control the target IO output port status.

If the negation function is set, it can be negated automatically after a certain time delay.

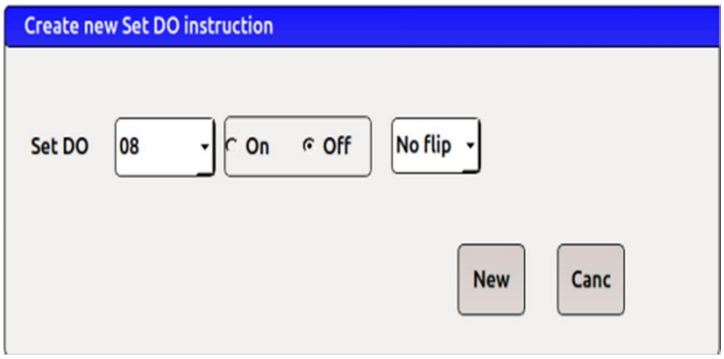


Figure 3-29 Control IO output

2) Wait for IO input

The program is blocked here. When the IO status meets the set conditions, the program continues to run.

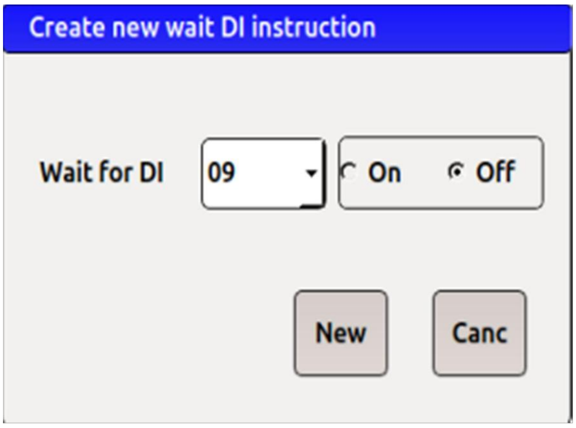


Figure 3-30 Waiting for IO input

3) IO input jump

When the target input port meets the set conditions, the program automatically jumps to the corresponding mark.

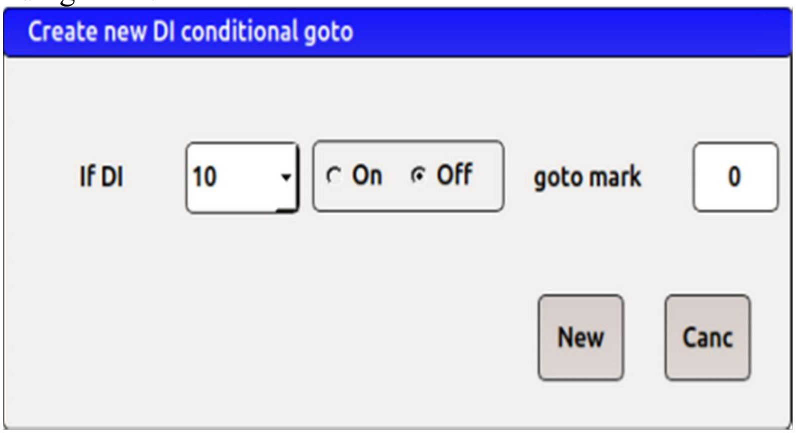


Figure 3-31 IO input jump

4) Trigger actions during exercise

The instruction is added before the motion instruction. Corresponding actions can be executed during the movement of the motion instruction, for example: IO output, variable change, etc.

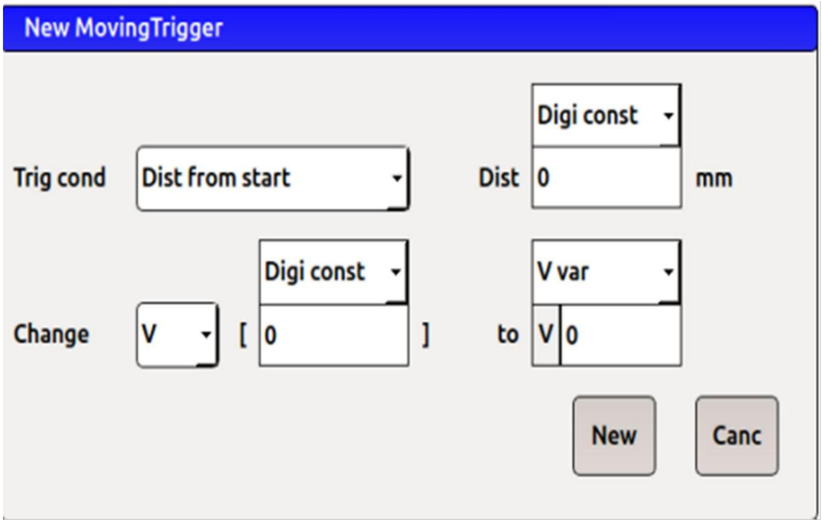


Figure 3-32 Trigger action during movement

5) Trigger stop during exercise

When the motion command is running, the conditions set in the "trigger stop" command are satisfied, and the robot can stop the motion in the set way.

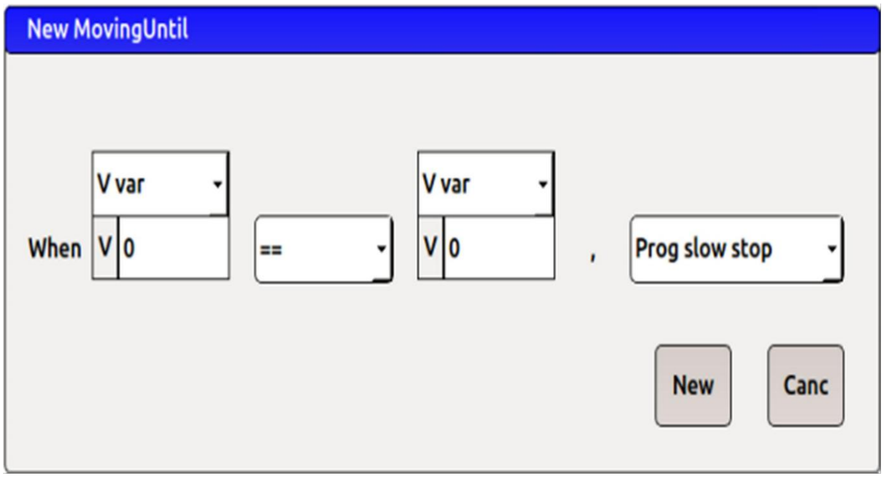


Figure 3-33 Trigger stop during movement

3.4.4 Process instruction

The technology instruction is an instruction to call the function of the technology package of the controller program. For details, please refer to Chapter 5 and "Debugging Manual".

3.4.5 General instructions and logic instructions

1. Regular Instructions

The general instructions include instructions for operating the controller variables, adding delays, and adding comments.

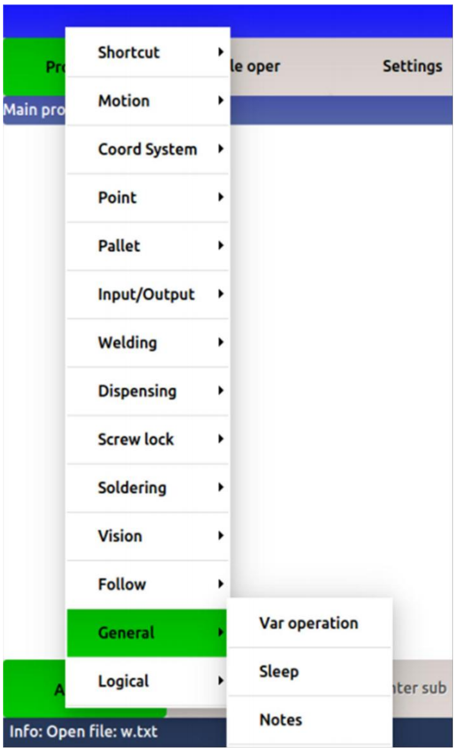


Figure 3-34 General instructions

【Variable operation】: Modification and calculation of digital variables, character variables, IO output status, etc.

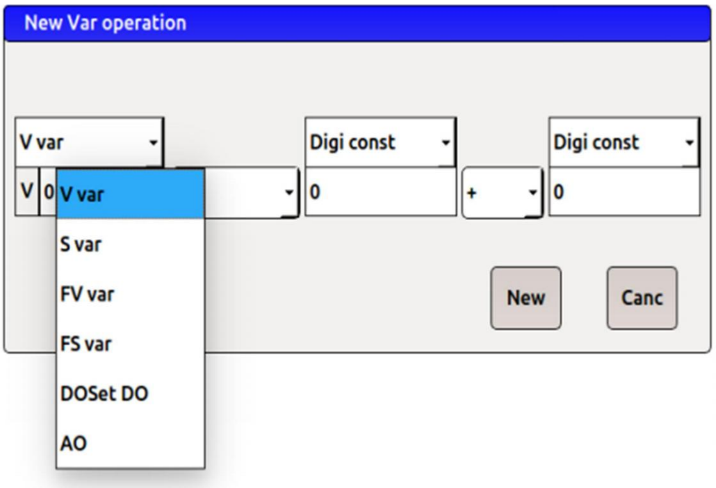


Figure 3-35 Variable operation

【Delay】: After the delay instruction is executed for a set time, continue to execute the next instruction.

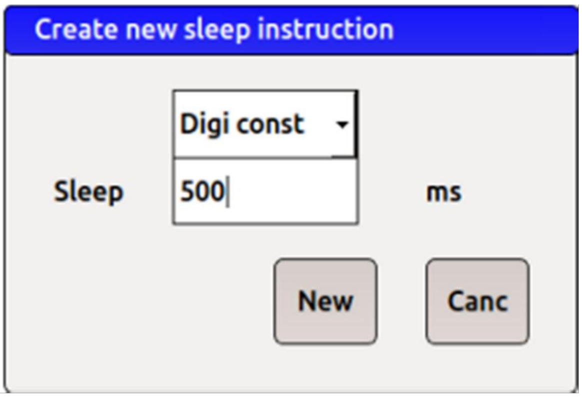


Figure 3-36 New Delay

【Notes】: Add comments to the program to increase the readability of the program.

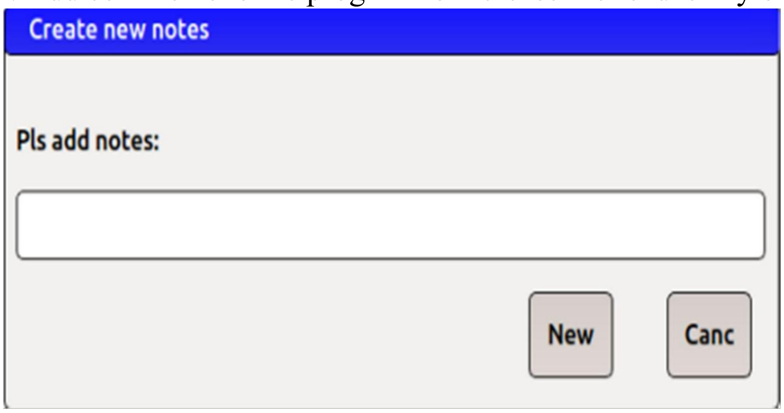


Figure 3-37 New Note

2. Logic instructions

Logic instructions can perform logic operations and are indispensable instructions for performing complex functions.

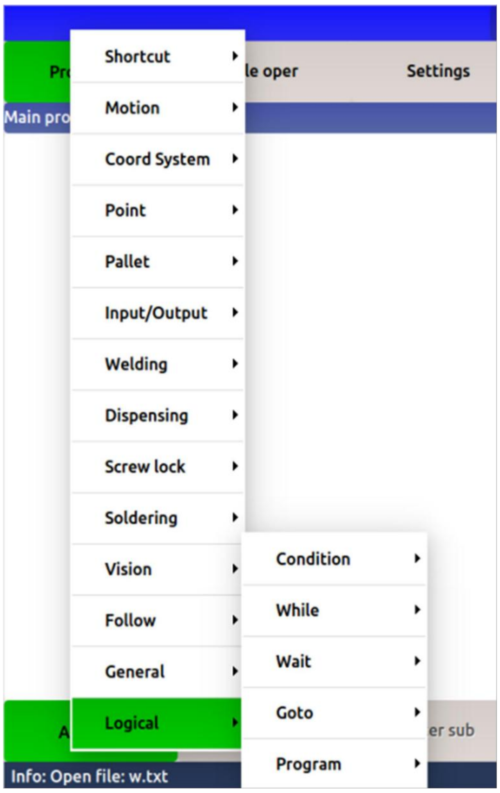


Figure 3-38 Logic instructions

Conditional statement: If one of the conditional statements corresponds to the end of a condition, it is used to judge multiple states. Otherwise, if not, otherwise the compilation cannot pass. When judging again under a condition, you need to add a conditional statement again using a nested structure.

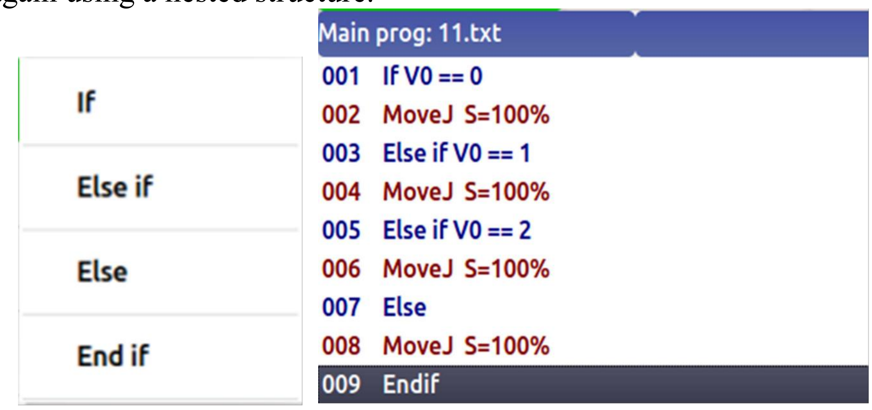


Figure 3-39 Conditional instructions

Loop statement: The condition after the loop statement meets the set condition, and the program repeatedly executes the content in the loop body.

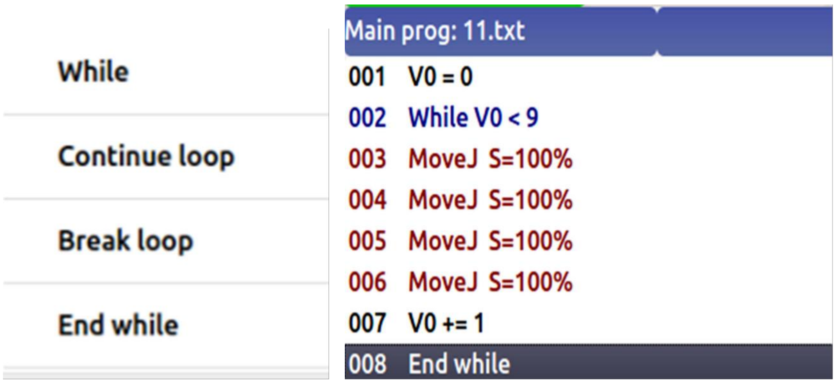


Figure 3-40 Loop statement

Wait statement: make the program continue to execute after it meets the set state.

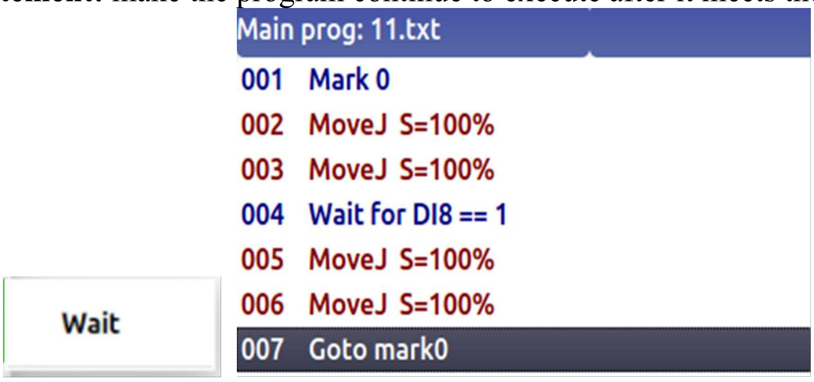


Figure 3-41 Waiting statement

Jump statement: Unconditional jump. Once the program executes the "jump to" instruction, the next step is to find the corresponding mark and continue running.

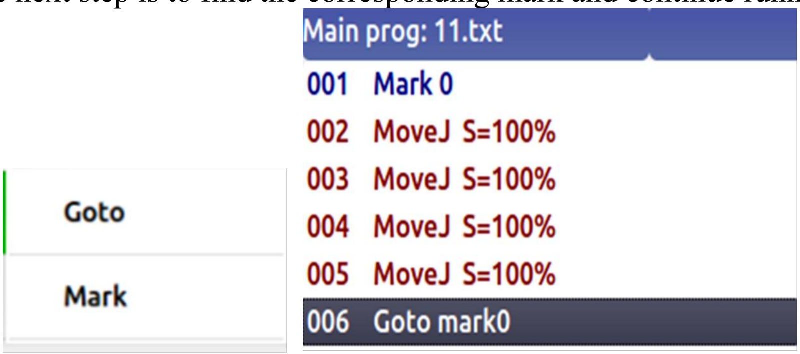


Figure 3-42 Jump statement

Program-related operations: instructions related to program control.

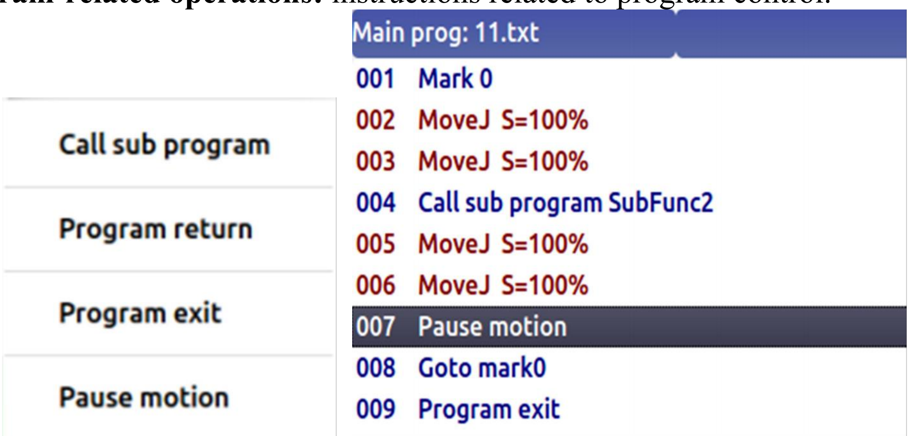


Figure 3-43 Program instructions

3.5 Program file management

The result of teaching exists in the form of a program. The program is composed of instructions. The instructions include not only motion instructions, but also control instructions, IO instructions, etc. A program formed by different instructions can perform a variety of functions including robot motion. The program is also called homework.

During the debugging process, it is inevitable that many test programs will be established. However, the storage capacity in the robot controller is limited. The operator needs to manage the existing programs frequently. For the program file operation, you can perform it under the【File Operation】 menu. Including【Open】, 【New】, 【Copy】, 【Rename】, 【Delete】, 【Find】, 【Sort】 these operations.

3.5.1 Open the program

The method of selecting the foreground job (teaching job) and the background job (program) are the same, but the menu position is different. The menu position and operation of the selection operation of the foreground operation:

Select the file you want to open, and click the【Open】 button in the lower right corner.

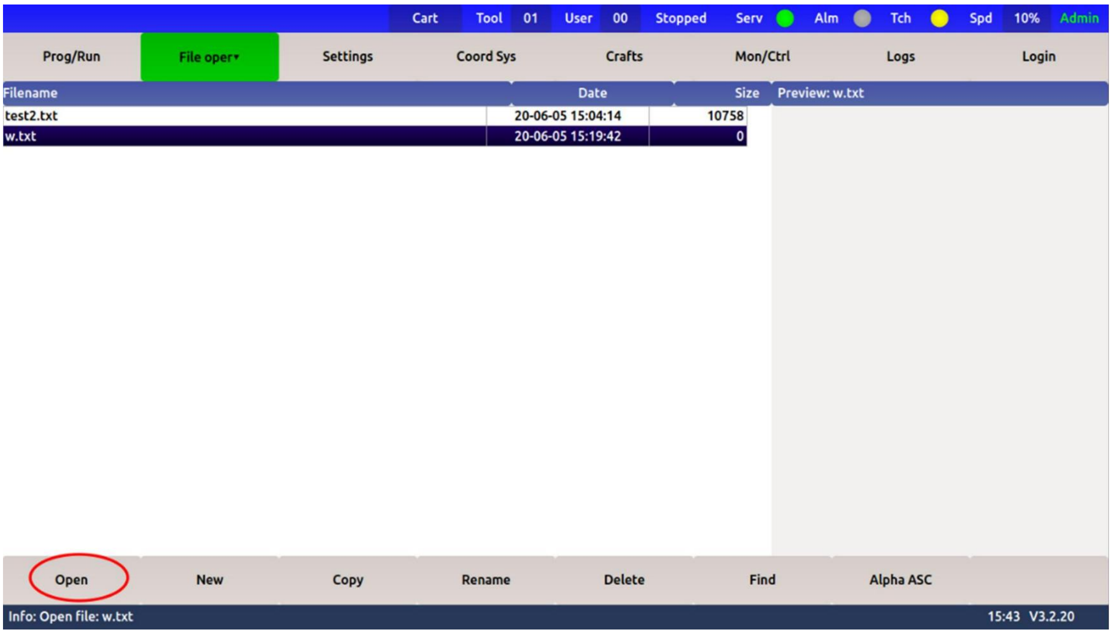


Figure 3-44 Open file

3.5.2 New program

The methods for creating foreground jobs (teaching jobs) and background jobs (programs) are the same, but the menu positions are different. The job name supports capital letters, numbers, and Chinese.

Menu location and operation of new foreground job:

Click【File Operation】 ->【New】 in the page selection area, and enter the file name in the pop-up window.

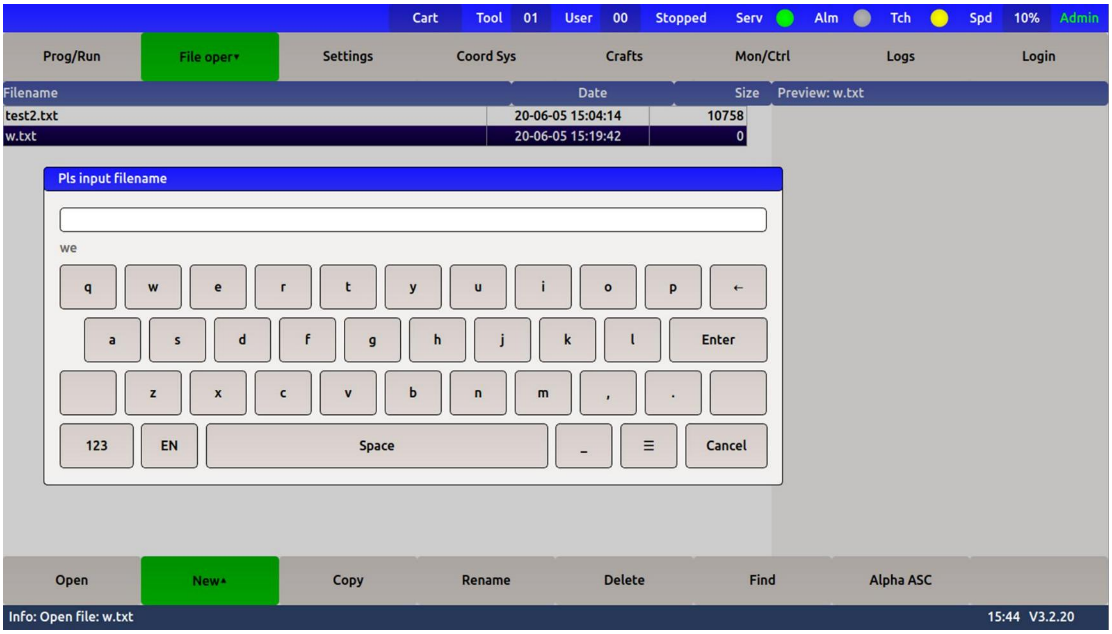


Figure 3-45 New File

3.5.3 Rename program

Select the file and click【Rename】. After modifying the name, click【Rename】. As shown below:

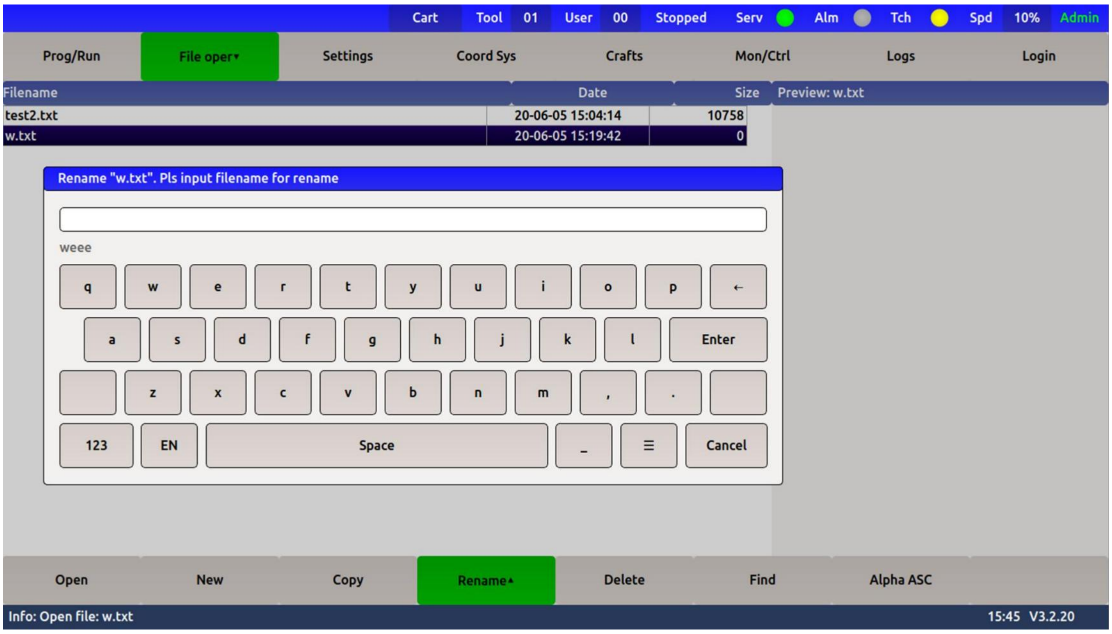


Figure 3-46 Rename file

3.5.4 Remove program

Select the program to be deleted and click【Delete] 】->【OK】. As shown below:

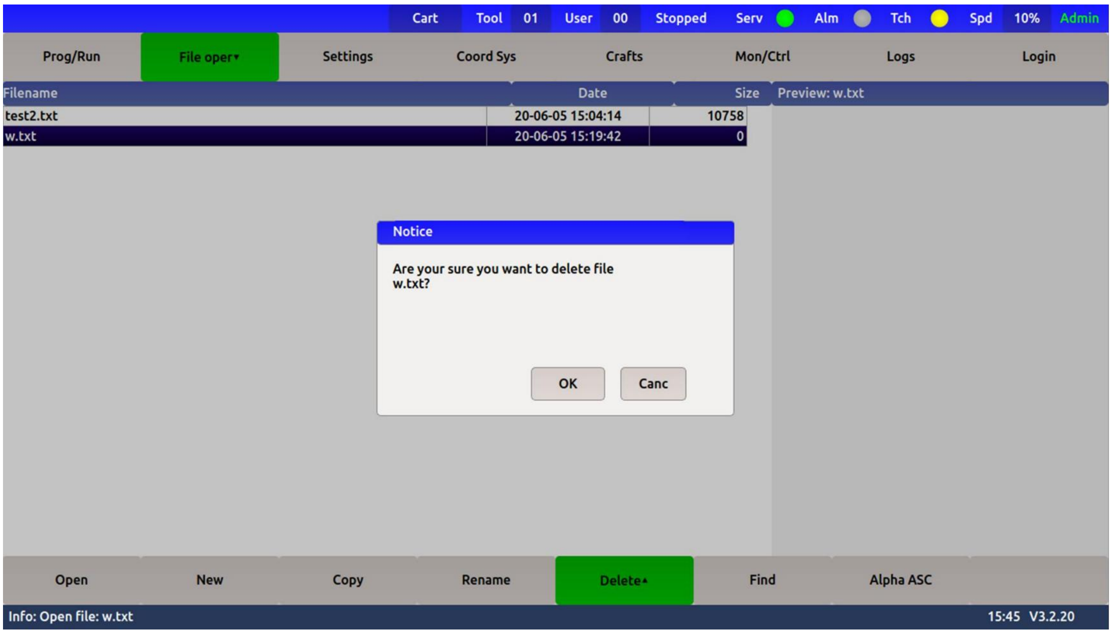


Figure 3-47 Delete program

3.5.5 Finder and file sorting

1) Finder

In a more complicated program, if you want to quickly move the cursor to the place that needs to be modified, you can use the search function. In the teaching mode, click the 【Search】 button, enter part of the letter of the file to be found, click【Search】, and enter the content to be found.

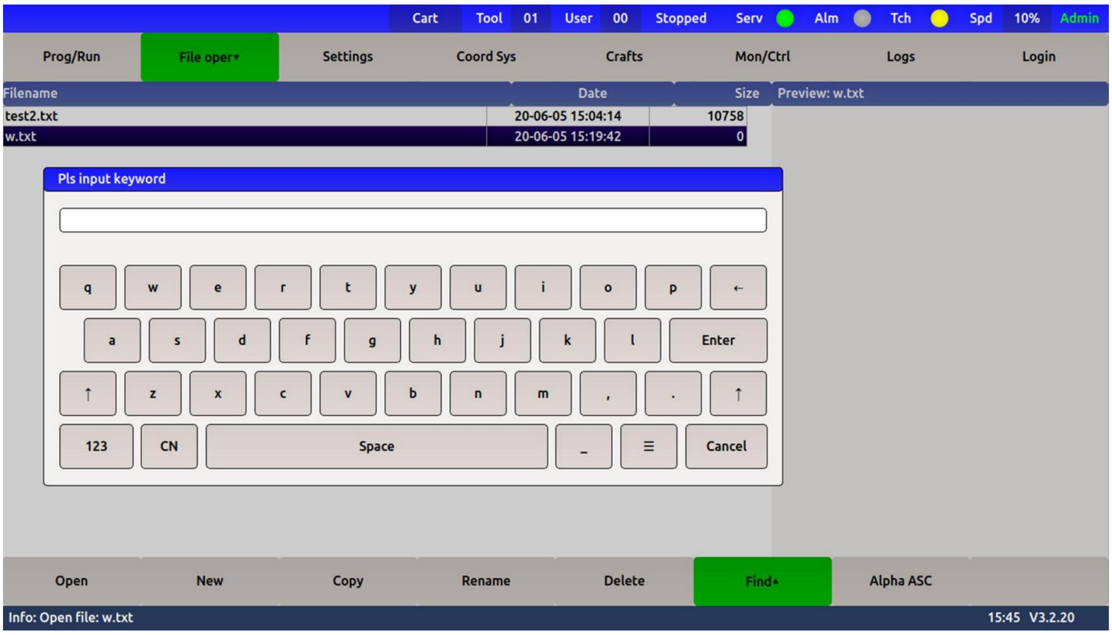


Figure 3-48 Search program

2) File sorting

You can sort the files according to the file size, time, and alphabetical order (ascending order, descending order). Just click the same button in the lower right corner. This button will switch between these modes. See below:

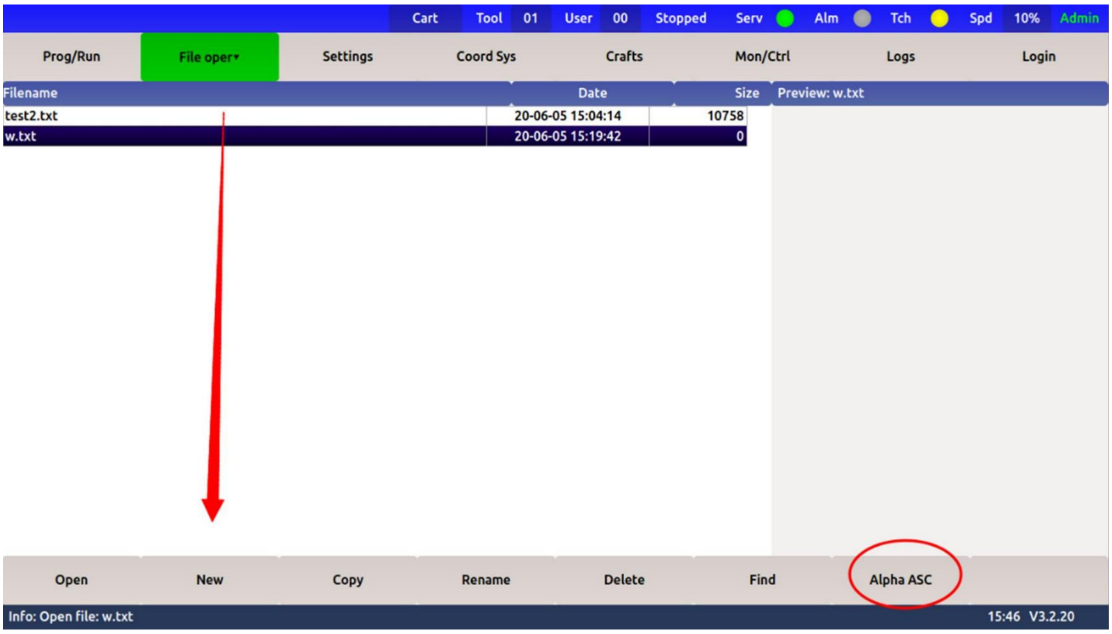


Figure 3-49 Sorting files

Chapter 4 Advanced robot debugging

4.1 Input/ Output

4.1.1 I/O control

During the use of the robot, it communicates with peripheral equipment through IO signals. After hard wiring, the user needs to check the current IO status. You can use 【Monitor/Control】>【Input/Output] 】->【I/O Control】 to view the current IO status.

Figure 4-1 IO control

4.1.2 DA Control

Welding process, analog communication with welding machine, generally use DA control.

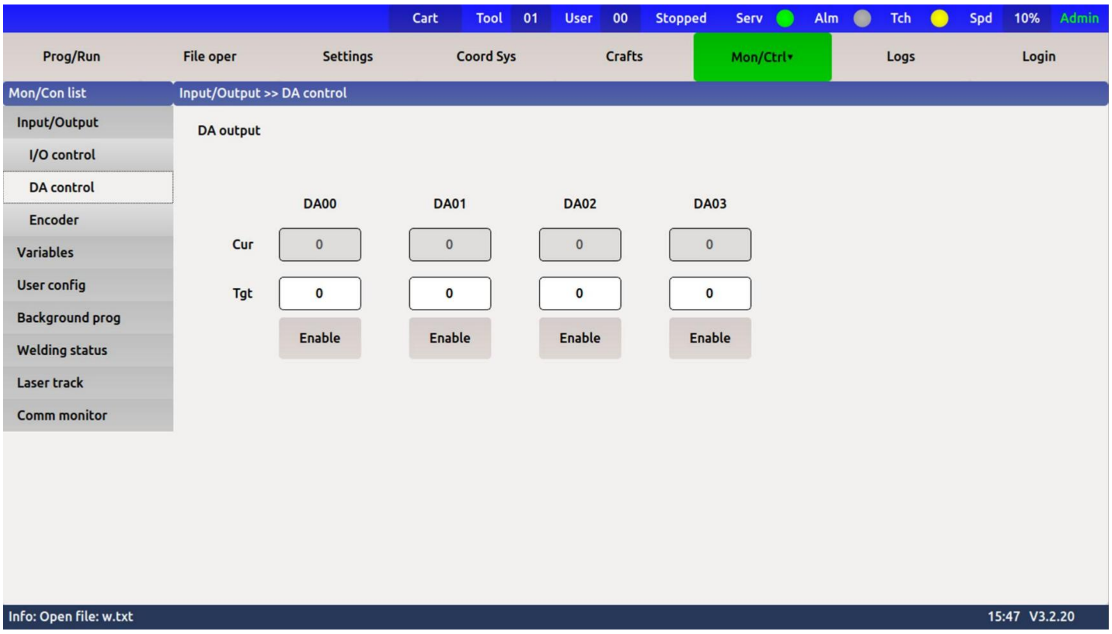


Figure 4-2 DA control

4.1.3 Encoder

Use the tracking process to coordinate with the conveyor belt. After establishing communication with the encoder, check the current position and running status of the encoder through【Monitor/Control】->【Encode】.

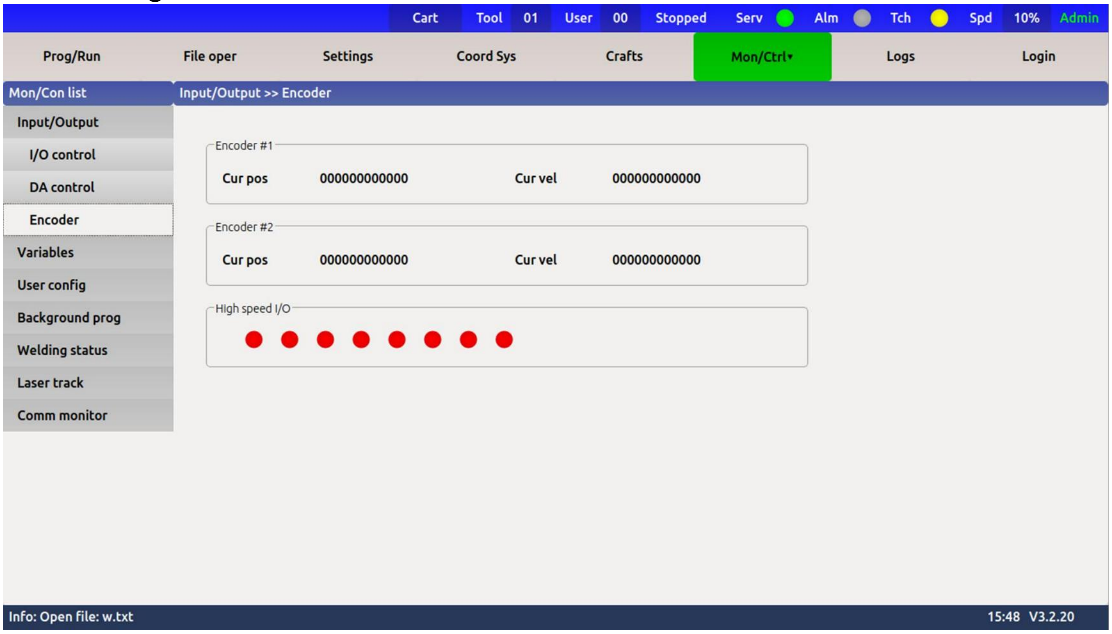


Figure 4-3 Econder

4.2 Variable

4.2.1 Variable usage instructions

1) Variable type

There are three types of variables that can be used in the control system, which are numeric variables (floating point numbers), character variables (1024 bytes), and coordinate point variables (save space and joints respectively, that is, there can be no kinematic relationship between the two).

2) Variable scope

To be precise, there are three scope variables in the system, namely system variables, global variables and file variables.

System variables: The system variable life cycle is created and destroyed as the system starts/stops. System variables are common variables in the entire system, that is, variables that can be used simultaneously by motion scripts and background script programs. System variables will not be initialized by the system because of which program starts and stops. Unless the script or network (such as tcp server) is deliberately modified, the system variables will never be changed by the system.

Global variables: The life cycle of global variables is created and destroyed with the start and stop of this script program. Global variables are shared in the scripts started this time. That is shared between the sub-file and the main file. Nowhere else (such as between front and back office, network, etc.) cannot access this variable.

File variables: Also called local variables, whose life cycle is consistent with global variables, the difference is that it cannot be shared between the main file and each sub-file.

3) Definition of variables

There are two ways to define variables, one is system pre-defined, and the other is user-defined. Some system variables and file variables have been defined in the system for users to use. Global variables are not predefined in the system, and can be replaced with system variables if necessary. The user-defined variable method is more suitable for background programming, this article will not introduce it first.

Predefined system variables:

1) V0~V999: 1000 system digital variables, it should be noted that, for convenience of writing, V0, V00, V000 represent the same variable, and if V011 and V11 are also the same variable, all system preset variables are the same, but in order to It looks comfortable, please use V000 format as much as possible when programming manually.

2) S0~S999: 1000 system character variables.

3) P0~P999: 1000 system coordinate point variables.

Predefined file variables:

1) FV0~FV999: 1000 file digital variables.

2) FS0～FS999: 1000 file character variables.

3) FP0～FP999: 1000 file coordinate point variables.

Note: As mentioned before, the scope of file variables is a single file, even if the name is the same, that is, each main file and each sub-file have 1,000 FV, FS, FP, etc. (a total of 3,000 variables), but they cannot be shared. The same variable uses its own memory.

4.2.2 Variable use

To be precise is the use of variables on the interface.

1) Variable operation interface

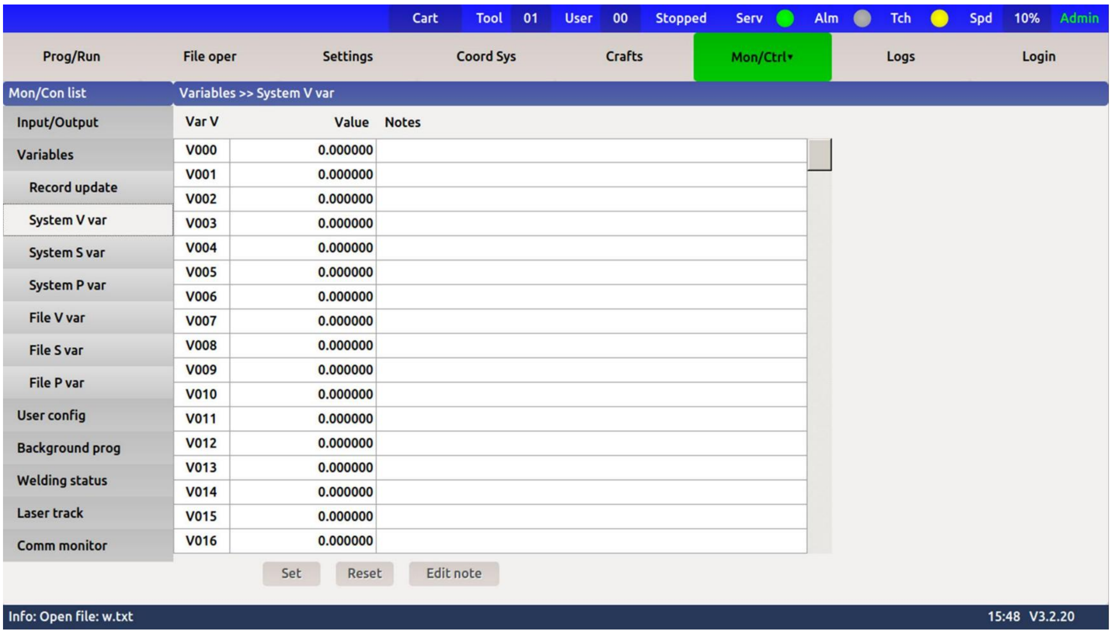


Figure 4-4 System V variables

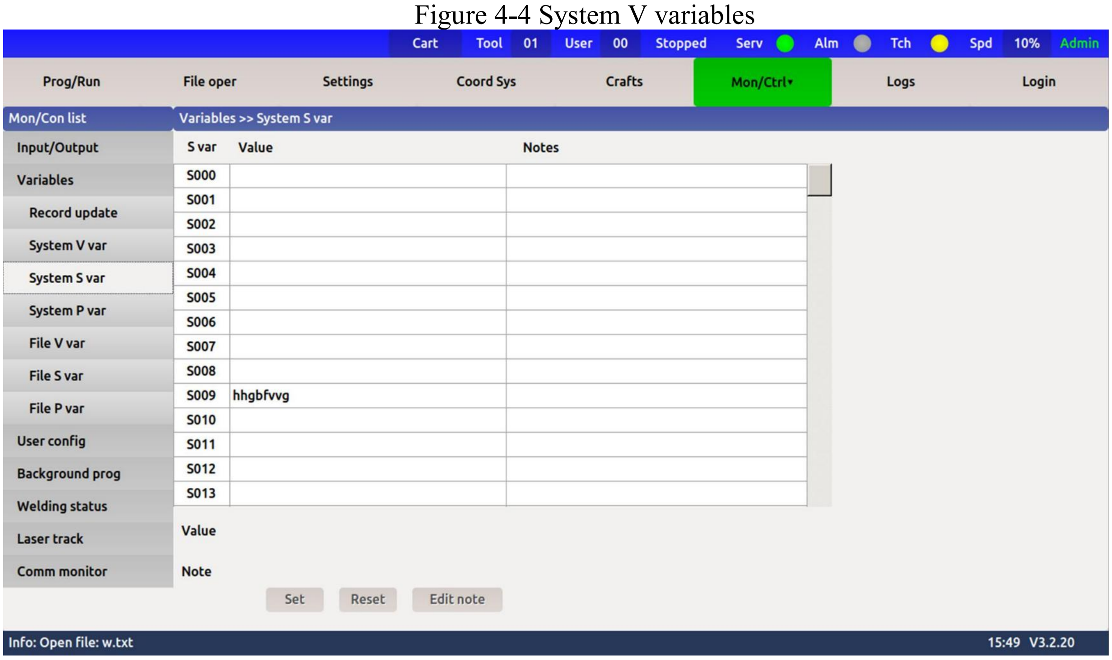


Figure 4-5 System S variables

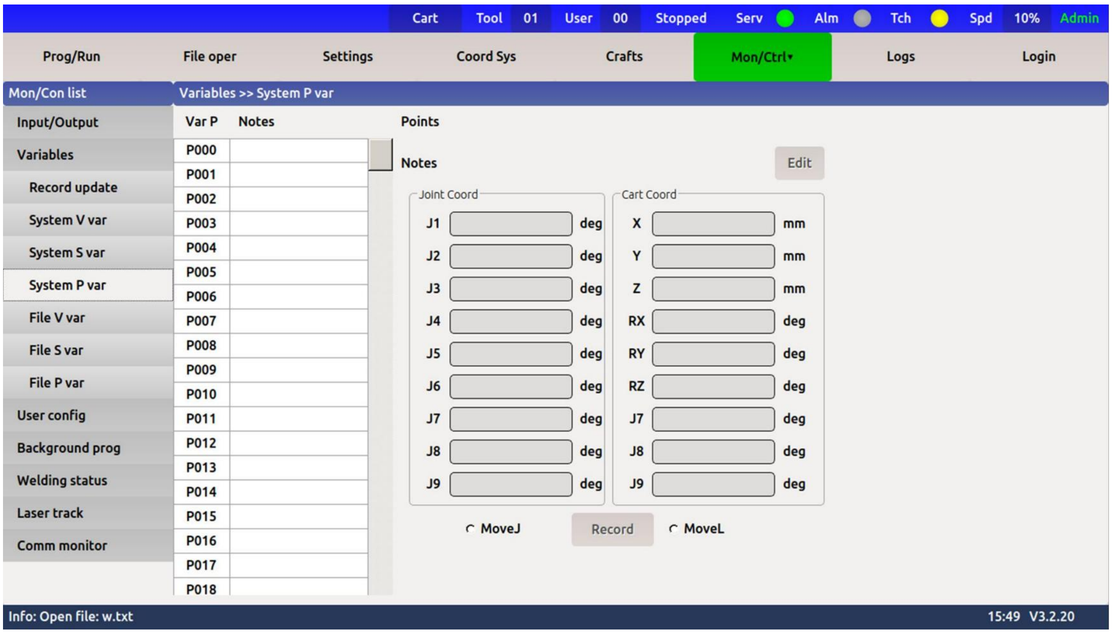


Figure 4-6 System P variables

The above three interfaces are digital variable operation interface, character variable operation interface and coordinate point variable operation interface. System variables and file variables operate in the same way. Among them file variables. The file variables of the file currently being opened are displayed. Variables that need to view subfiles or other files need to be opened to view the corresponding file.

The parts that can be changed in the interface are variable value and variable comment. Coordinate point variables support manual input and direct recording of the current position. There are two ways to change the value. Use the SA key to move to this point.

The variable values of all interfaces will be refreshed in real time, so this interface can be used to monitor variable values and view them in motion.

2) Use of variables in instructions

When programming, select the type of variable you want to use in the instruction editing window, and then fill in a variable index (000~999) can use this variable. See 3.4.5.

4.2.3 Variable automatic storage

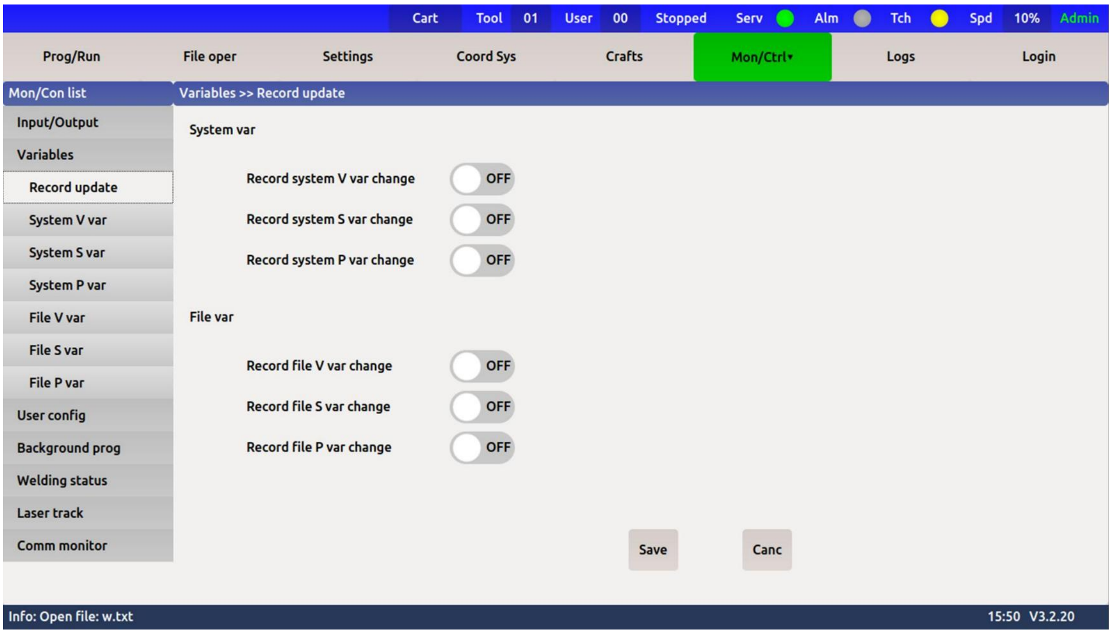


Figure 4-7 Automatically storing variables

When the corresponding variable is automatically stored as on, the system always monitors the variable that has been used in the script, and when its value changes, it will be immediately stored in the file. In order to use the changed value the next time the script is started.

Note: Because the current hardware system does not have power-off protection measures, when the program is running, abnormal power-off behavior (such as screwing the power supply) may cause the value that has just been changed to fail to be stored in the file. This point requires special attention.

4.3 Run settings

4.3.1 Reference position setting

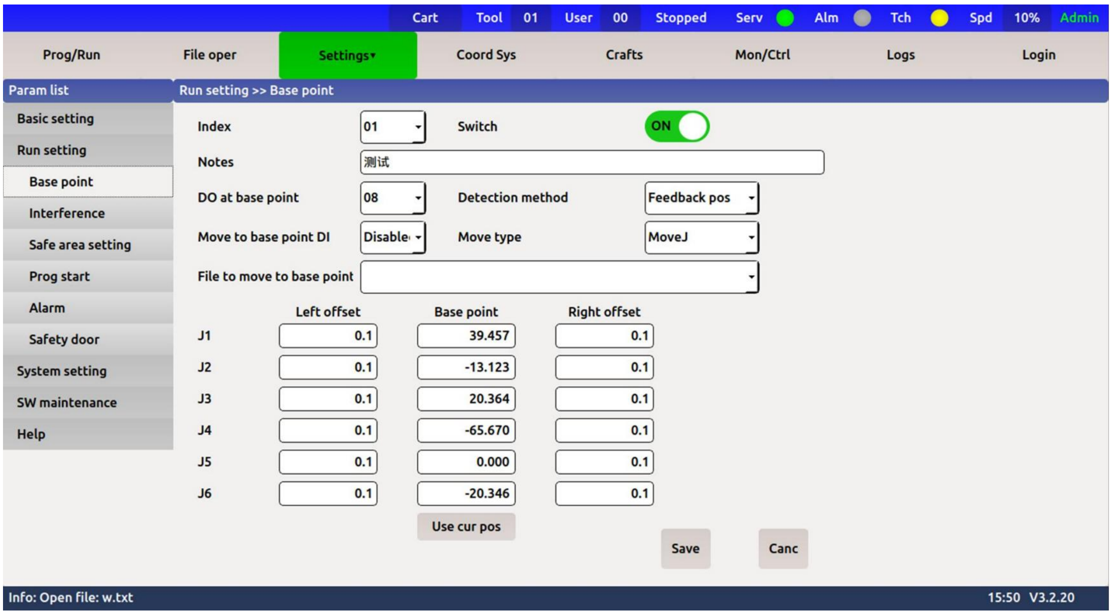


Figure 4-8 Reference position setting

1. Base condition number: 1~10
2. Reference condition switch: on/off.
3. Note: make a note for the current reference point.
4. Output IO at the reference point: When the robot position reaches the position of the reference point, IO outputs a high level, otherwise enters a low level.
5. Detection method: the method for acquiring whether the robot is at the reference position. Respectively, command position or current position..
6. Return to reference point input IO: When the input IO is a rising edge, the robot will return to the reference point.
7. Trigger mode for returning to reference point: There are three ways to return to the reference point: joint motion, linear motion and command file,
8. Return to reference point file: set the instruction file to return to reference point,
9. Reference point left value: the floating (negative) left value when detecting whether the robot is at the reference point,
10. Reference point: the exact value of the reference point of the robot,
11. Reference point right value: the floating (positive) right value when detecting whether the robot is at the reference point,

Description:

1) On this page, you can use the SA key joint to run to the reference point, the prerequisite is that the reference point must be turned on.

2) The reference point can be used in the motion command interface. The prerequisite is that the datum point must be turned on. When using linear motion to the reference point, the user and the tool must select 0.

4.3.2 Interference area setting

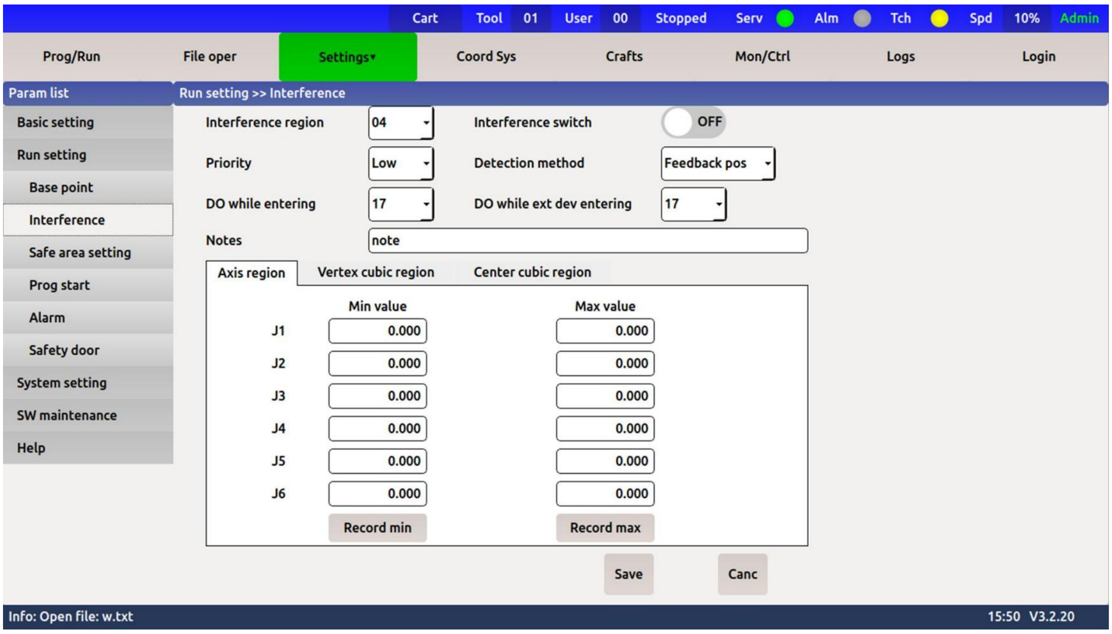


Figure 4-9 Interference area setting

1. Interference zone number: 1~10.
2. Interference zone switch: on/off .
3. Priority: high/low, when the high priority is set, the interference zone will become larger (joint angle increases by 0.5 degrees, the spatial position increases by 10mm in each axis direction), this function can guarantee High priority robots first send a signal to enter the interference zone.

4. Detection method: the reference method for detecting whether the robot is at the reference point. There is a command position or current position.

5. Output IO when entering the area: enter the area to output low level, otherwise output high level.

6. Input IO when the external device enters: the motion stops when the external device inputs a low level, and the motion continues when the external device inputs a high level (Note: this function is not applicable to the positioner).

7. Note: make a note for the current interference zone.

8. Axis interference area: Set the joint values of 6 start points and 6 end points.

9. Vertex interference zone: Set two vertices to form a cubic space (the flute line is parallel to the world coordinate XYZ axis).

10. Center point cubic interference zone: Set a center point and offset relative to the center point in front, back, left, and right (three directions of world coordinates XYZ) to form a cubic interference zone.

4.4 Ethernet communication

4.4.1 Robot IP configuration

Turing robots can communicate with peripheral devices through the network.

For example, modbus tcp, remote command control, remote browser control, visual communication, custom protocol communication, etc., all rely on the network for communication. The basis of network communication is the configuration of IP.

There are 2 methods for robot IP configuration:

1) Robot operation interface configuration:

Setting path: 【Parameter setting】 ->【System setting】 ->【Ethernet setting】 ->【Wired】

Just select Add below, and finally a list of connection names will appear. Choose the name of the connection (the default is Wired connection 1). The interface is as follows:

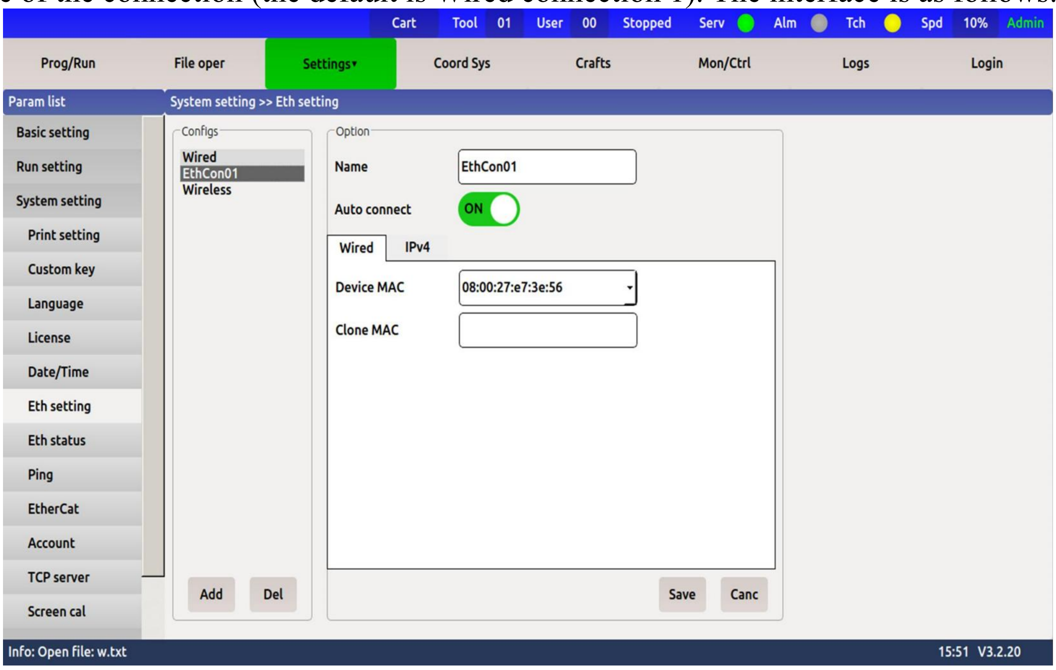


Figure 4-10 Ethernet connection

For example, configure the robot's IP to 192.168.1.6. The set interface is as follows:

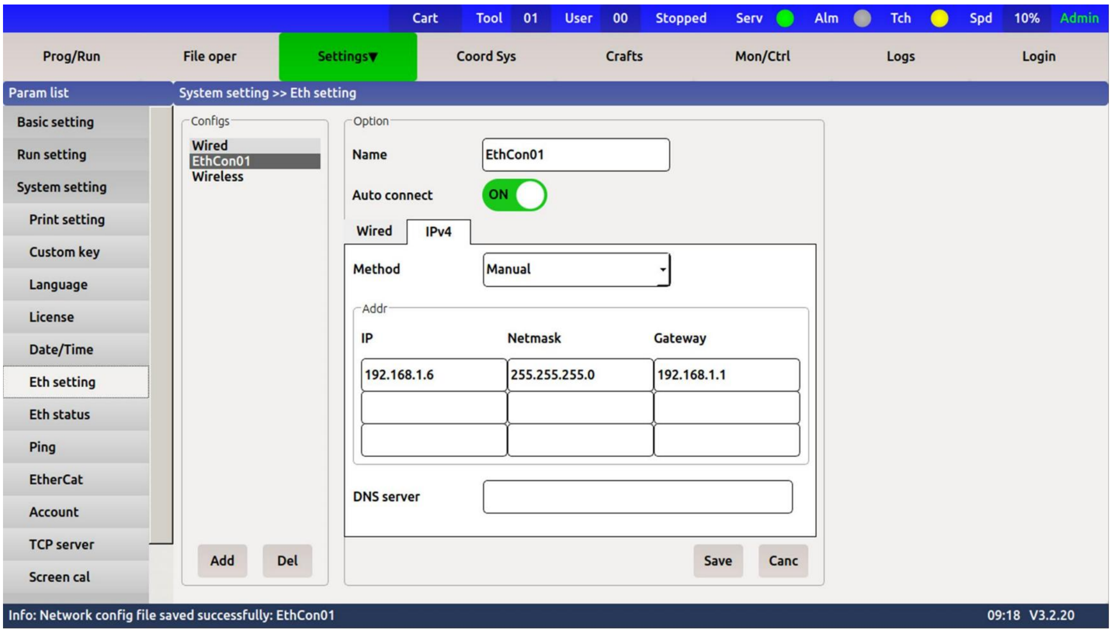


Figure 4-11 Ethernet IP settings

2) The ubuntu system changes the IP address:

Select【Parameter Setting】 ->【System Maintenance】 ->【Exit System】 ->【Exit Controller System】, the interface is as follows:

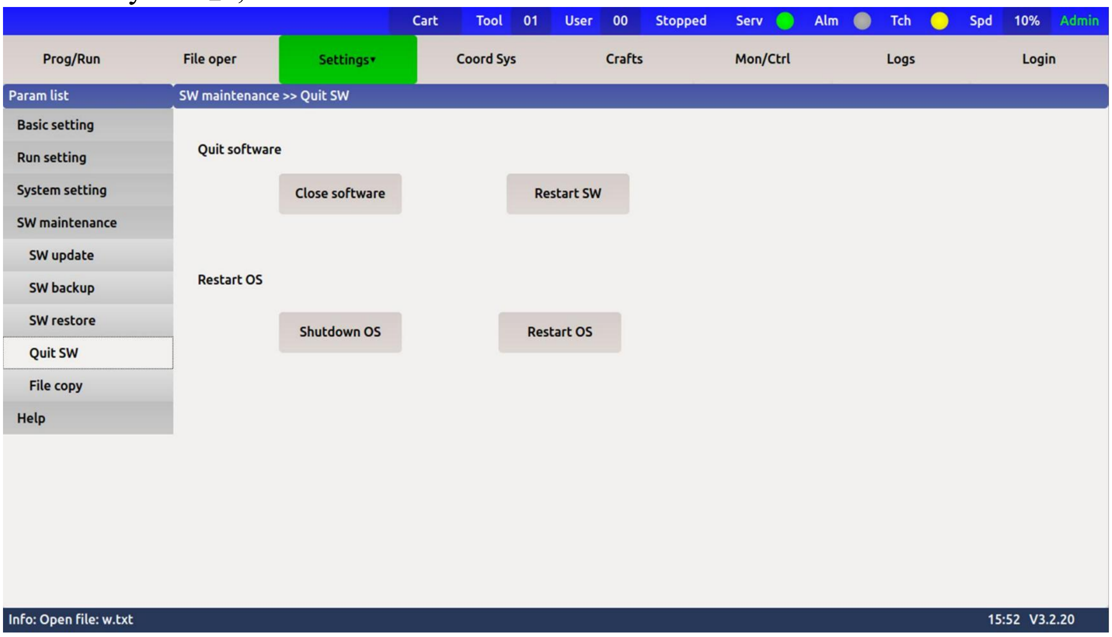


Figure 4-12 Exit the control system

Exit the TURIN controller system, enter the Ubuntu desktop, the network icon in the upper right corner of the stand-alone interface, the interface is as follows:

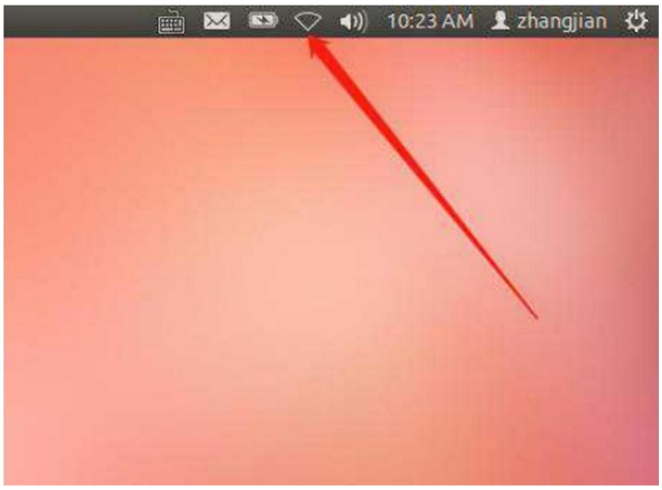


Figure 4-15 Restart the system

First enable the network, and choose to edit the connection:

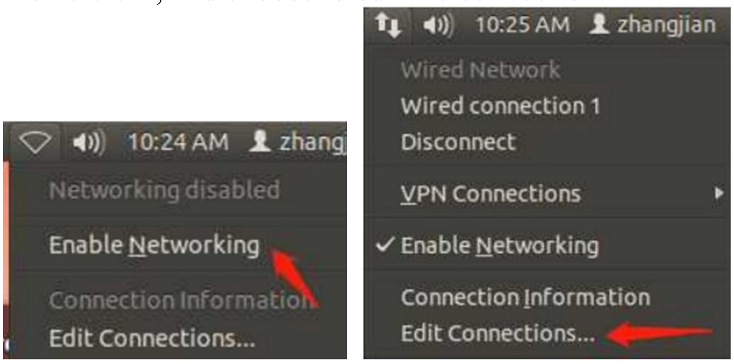


Figure 4-14 Enabling the network and connecting to the network

Edit IP:

Figure 4-15 Edit IP

Select manual IP, configure the IP as shown below, save it, and then restart the system.

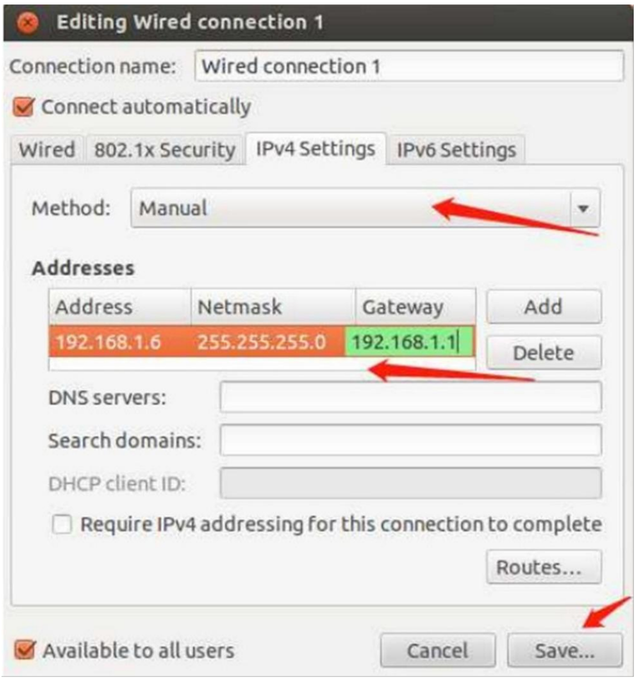


Figure 4-16 Restart the system

4.4.2 View Ethernet status

Set the IP address, if there is an external device connected, you can check the Ethernet status, as shown below:

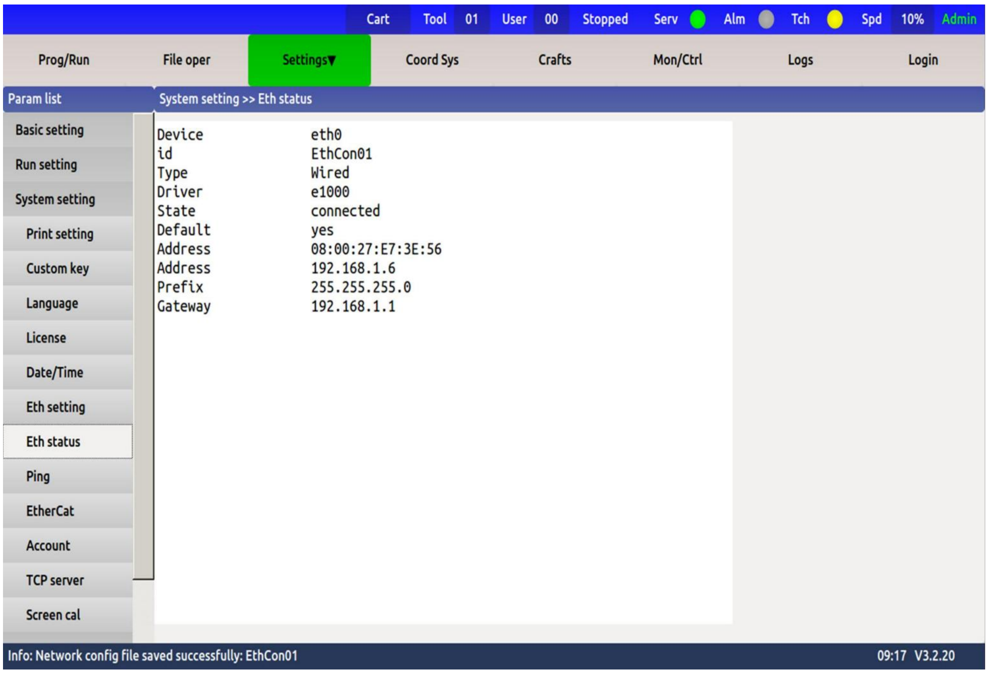


Figure 4-17 View Ethernet status

The parameters related to the Ethernet address are consistent with the set values, that is, the settings are correct.

4.4.3 Communication test

After the IP settings of both parties are completed, IP testing can be performed. 【Parameter setting】 ->【System setting】 ->【Ping】, the interface is as follows,

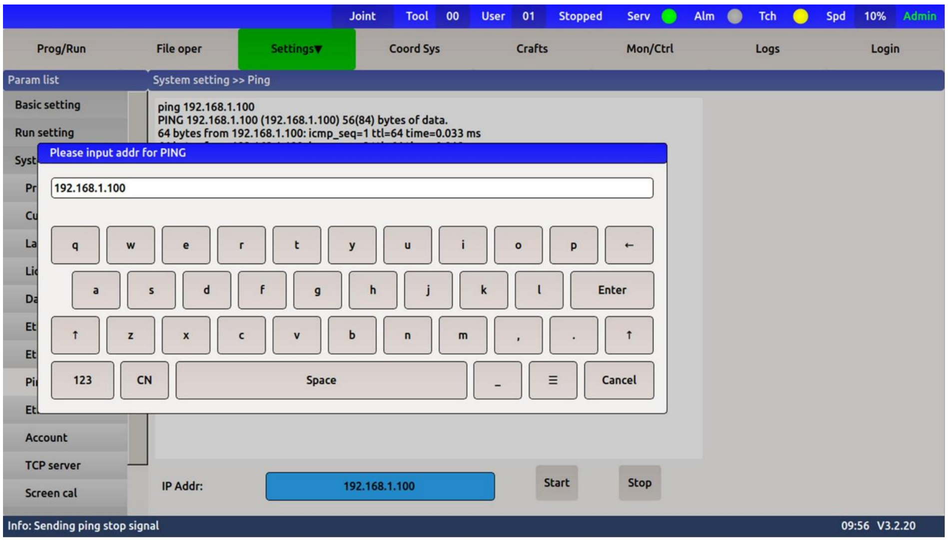


Figure 4-18 Communication test

The IP address is set as the destination IP address.

Click Start, and the interface shown below is displayed, indicating that the two parties have successfully connected.

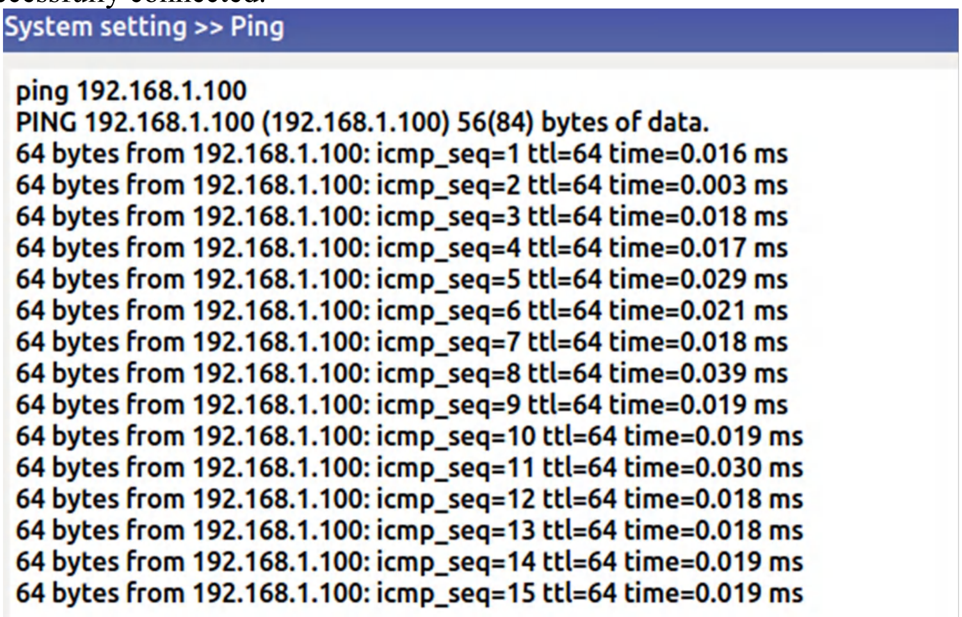


Figure 4-19 Successful connection interface

4.5 Remote browsing and remote commands

4.5.1 Remote interface operation

If the user needs not to use the teaching pendant, the robot interface can be accessed through the host computer browser. At this time, the functions of enabling, emergency stop, switching teaching/reproduction, etc. need to be operated by buttons on the cabinet. For detailed instructions, please refer to the "Debugging Manual" document.

4.5.2 Remote command

If the user needs to control the robot through the host computer, then remote command is a good choice. First set the IP of the robot, set the IP of the host computer to the same network segment as the robot, set the connection port number to the port number configured by the robot (default 8527), note that the port cannot be set to 502 (this port setting is set to modbus by default tcp communication port).

Then the standard XML format function will be used to open the interface as shown below.

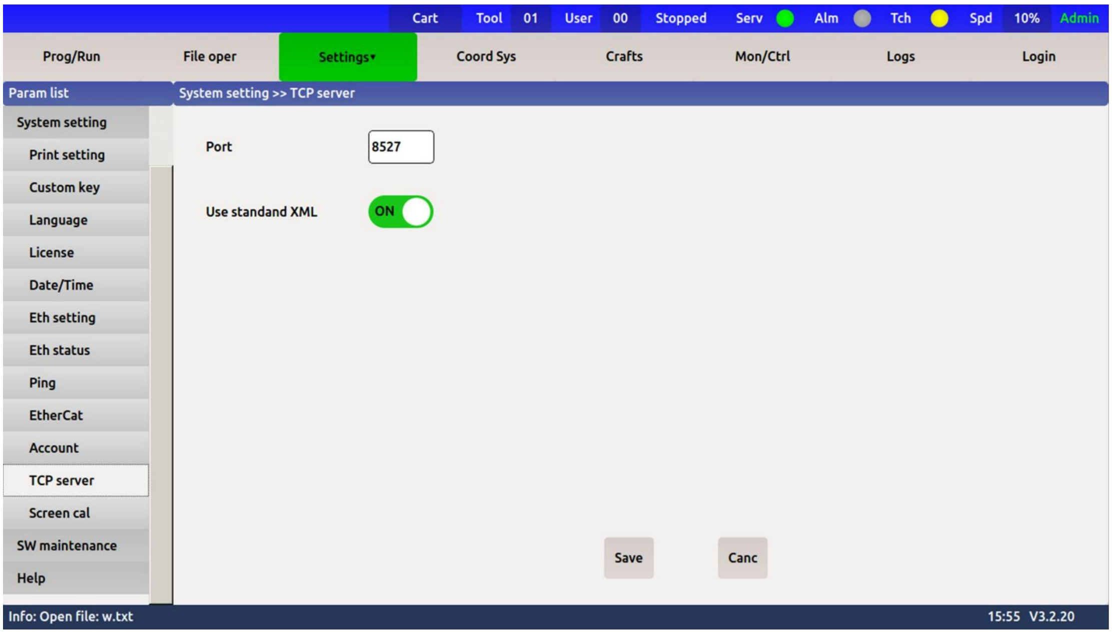


Figure 4-20 XML format function is enabled

Chapter 5 Process technology

Turing industrial robots provide special process software packages for several different applications, including: welding, palletizing, spraying, and visual tracking. Turing will provide as many process software packages as possible according to the needs of the actual application.

5.1 Welding process

5.1.1 Welding process description

At present, the welding process software package provided by Turing is mainly aimed at the field of arc welding. The industrial robot cooperates with the automatic wire feeding device and the welding power supply lamp to perform welding operations for various space welds. It has the characteristics of long-term welding operations, high productivity, high quality and stability of welding operations.

5.1.2 Welding parameter setting

Before the robot control system can control the welding machine, it is necessary to make corresponding settings according to the basic characteristics of the welding machine and the connection circuit between the welding machine and the control cabinet.

In the main menu, select 【Process】, and then select【Welding Process】, you can set the welding process parameters, including: basic settings, arc starting (welding) arc extinction, swing arc settings, voltage matching table and current matching table.

Basic settings: including welding trial operation and anti-collision detection

Welding test run: In the automatic state, if the welding test run is checked, the welding command will not start arc welding.

Anti-collision detection: Selective detection using anti-collision welding torch. If the torch collides, the anti-collision sensor will act and the system will alarm. The detection function can be cancelled and the alarm can be cancelled. At this time, the robot can be used as a welding torch to leave the collision point. Check the detection and continue to use the anti-collision detection function.

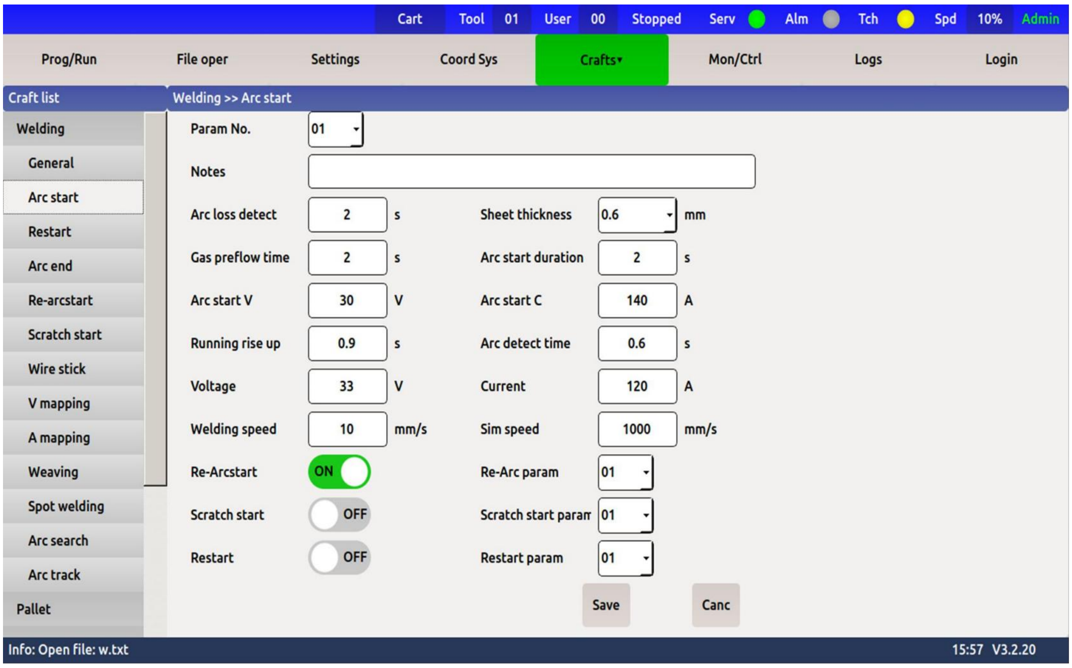


Figure 5-1 Welding settings

The next two figures are the matching table of the welding machine voltage and current, that is, the two analog voltages (0-10v) output by the controller are matched with the voltage and current displayed on the welding machine, so that they can operate according to the welding machine during welding The voltage and current are reversely calculated to calculate the voltage value that the controller needs to output. Click to make the controller output the corresponding voltage value. At this time, fill in the voltage or current value displayed on the welding machine. After all 20 files have been input, click Save.

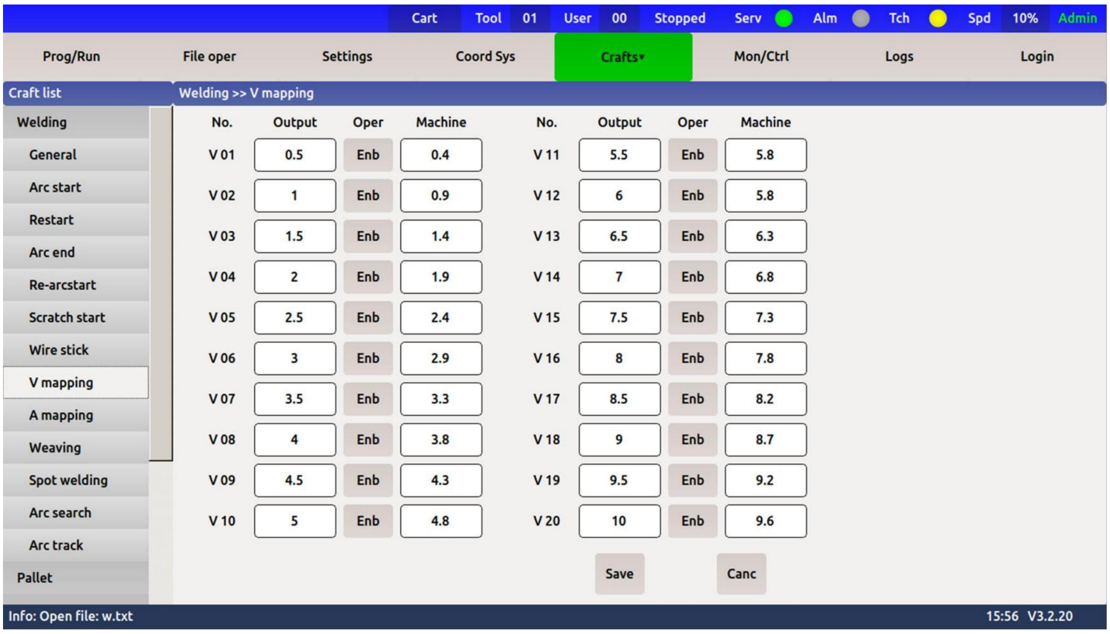


Figure 5-2 Welding voltage matching

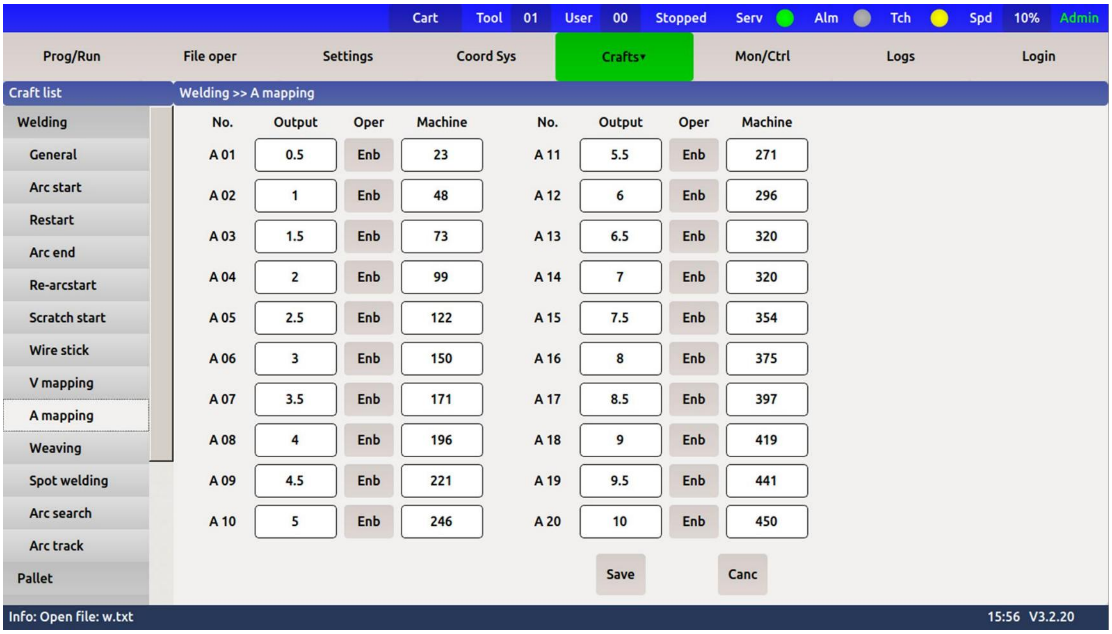


Figure 5-3 Welding current matching

Swing arc setting: During the welding process, the robot can swing the welding gun, which can achieve special welding process requirements and optimize the welding seam formation. The following figure:

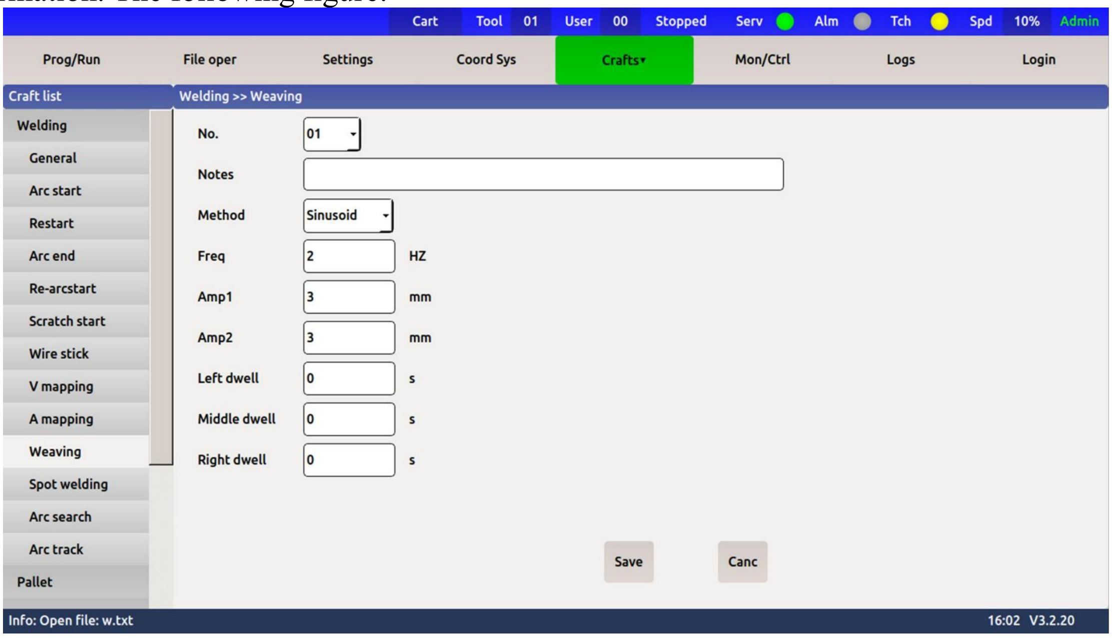


Figure 5-4 Swing arc setting

In the "Swing arc setting" column, enter the values of "Swing mode", "Swing frequency", "Swing amplitude", "Left dwell time" and "Right dwell time", and then press Exit (Save).

Ø Swing setting: used to set the swing mode, such as "Z-shaped pendulum", "arc pendulum" and "sinusoidal pendulum".

Ø Swing frequency: Set the number of swings per second.

Ø Swing amplitude: Set the distance of one-side swing.

Ø Left stay time: set the stay time when swinging to the left vertex

Ø Right stay time: set the stay time when swinging to the right vertex

Note: After setting the swing parameter, save it in the form of file number. When in use, the corresponding parameter number can be called, and multiple sets of welding swing arc parameters can be used in one program.

5.1.3 Welding process instruction

●Arc starting: Welding arc starting can choose a variety of arc starting methods, as shown in the following figure set to "arc starting method 1".

Arc starting command, by setting welding arc starting parameters, for welding arc starting, through the program setting interface to

"Welding process" can formulate the content of parameters and use it with the arc extinguishing command.

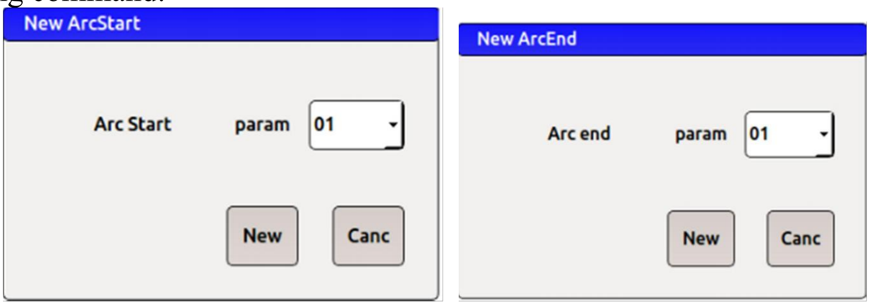


Figure 5-5 Arc start and arc stop command

●Arc extinguish: select this command to extinguish the arc of the welding machine.

5.2 Palletizing process

5.2.1 Typical palletizing applications

Pallet: User-defined robot table, usually flat.

Row: in a plane parallel to the tray, the working points are arranged in a straight line, perpendicular to the column.

Column: In a plane parallel to the tray, the working points are arranged in a straight line, perpendicular to the row.

Layer: a plane that the robot needs to work and is parallel to the pallet.

Serial number of palletizing point: number the palletizing points according to the order of the first row, the second column and the second layer.

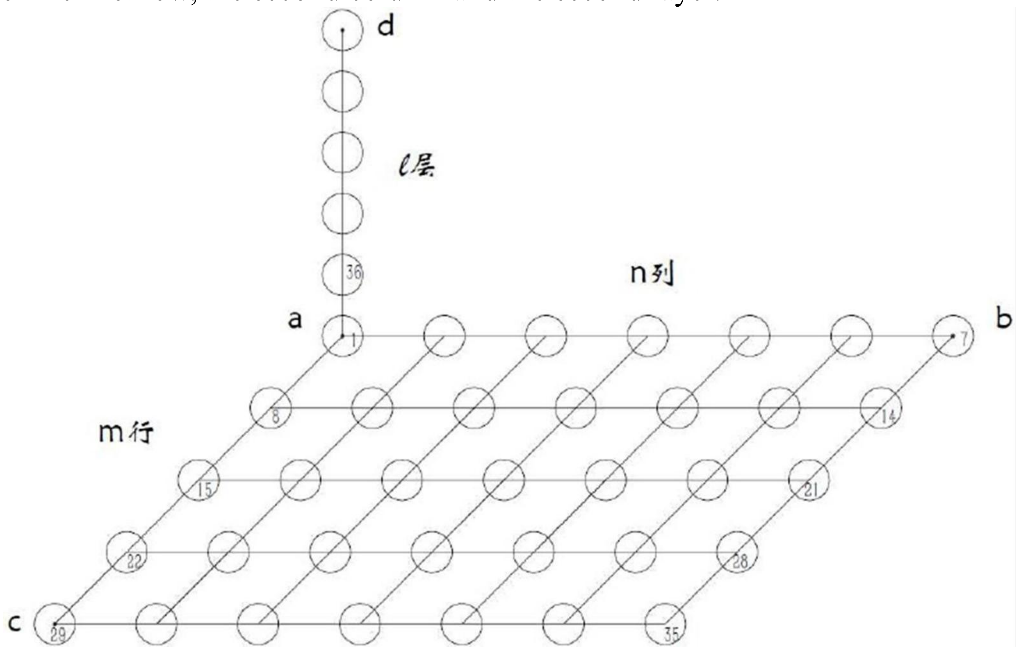


Figure 5-6 Schematic diagram of palletizing

5.2.2 Set palletizing parameters

Set the palletizing parameters in【Process】->【Palletizing Process】->【Palletizing Settings】.

a. First set the correct number of rows, columns and layers.

b. Set the coordinates of the origin of the placement, teach it to the point a in the figure above, and then click "Copy from current position" to record the coordinates of the origin of the placement.

c. Record the coordinates of the three point b, c, and d in sequence in the above order. (If not, the coordinates of the three points must be recorded. For example, if there is only one line, point c need not be recorded; if there is only one layer, point d need not be recorded.)

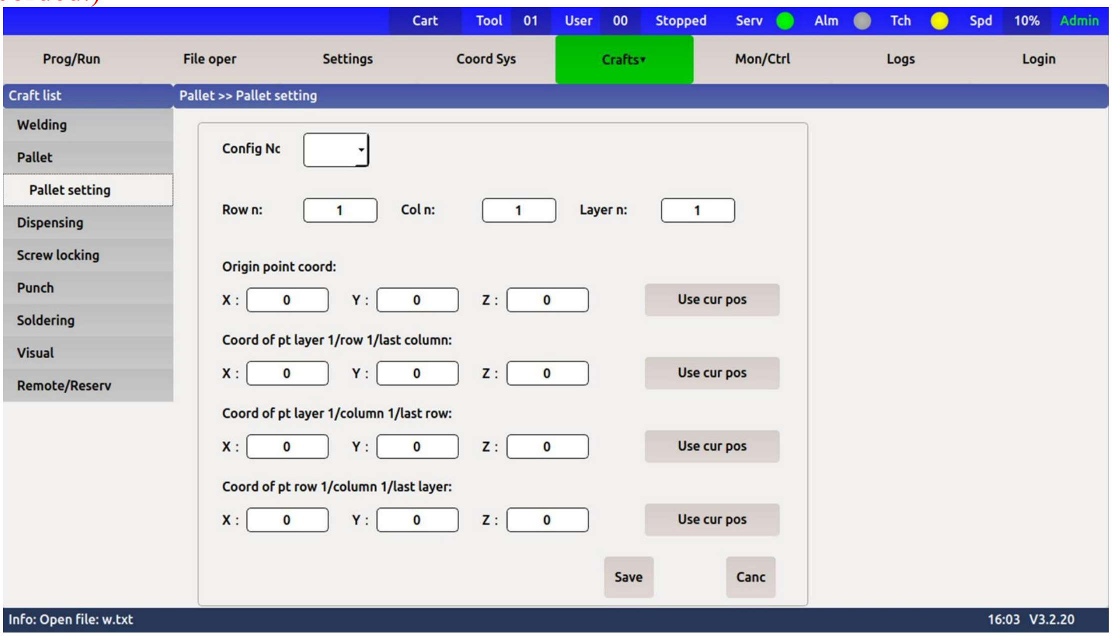


Figure 5-7 Palletizing parameter settings

5.2.3 Write a palletizing program

The figure below is a typical palletizing program.

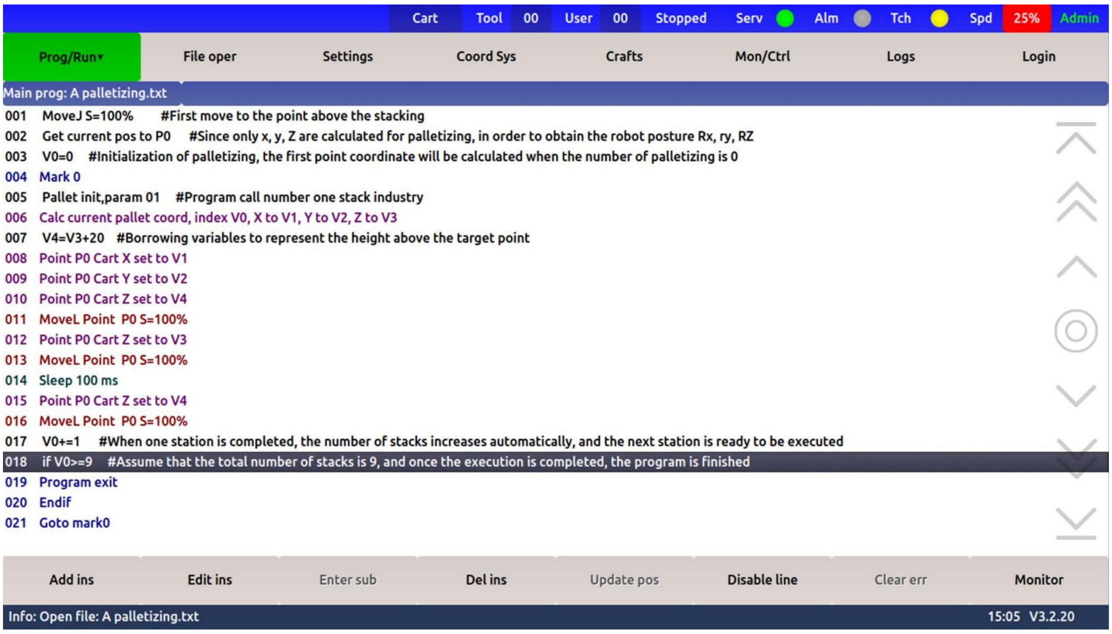


Figure 5-8 Example of palletizing program

5.3 Vision and tracking process

5.3.1 Network connection configuration

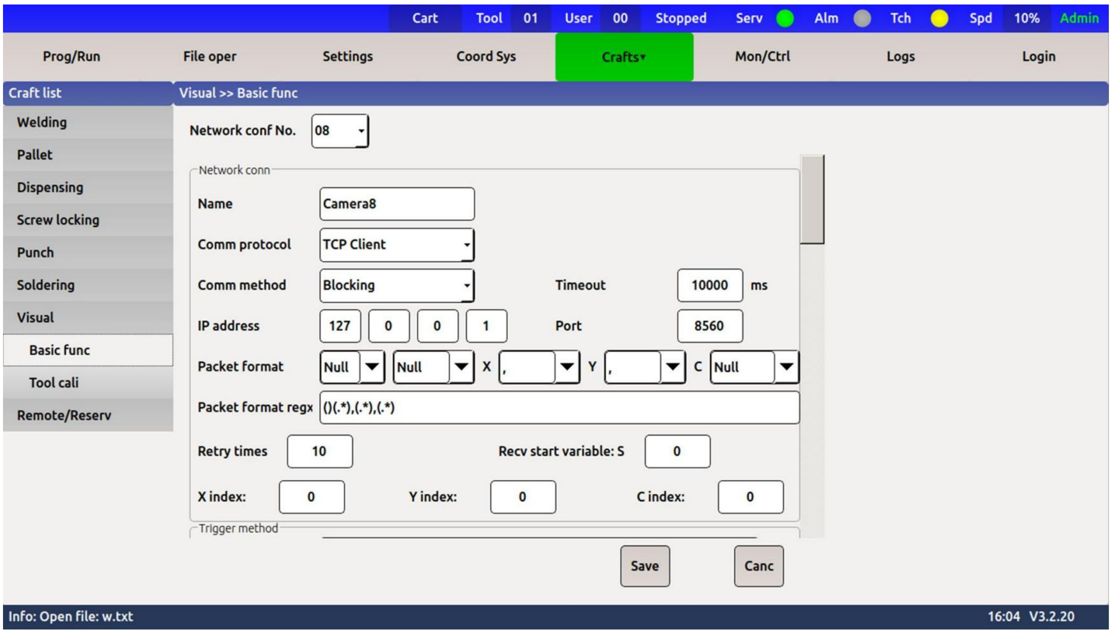


Figure 5-9 Network connection

5.3.2 Trigger method

This interface sets the mode that triggers the start of tracking.

For example, receiving external IO signals to start tracking, receiving network commands to start tracking, etc.

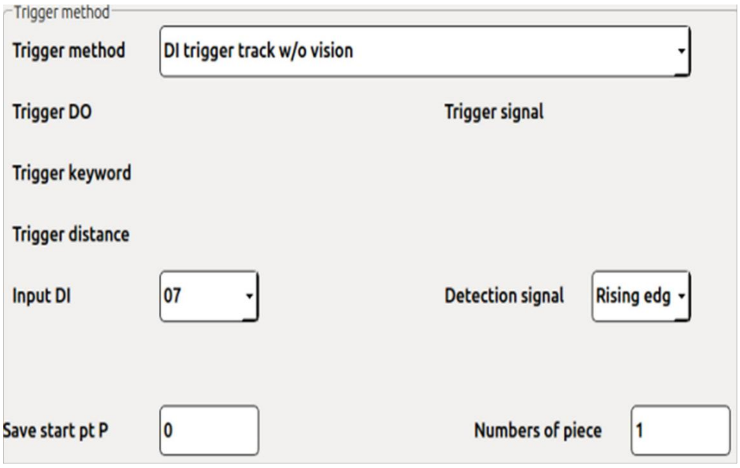


Figure 5-10 Trigger mode

5.3.3 Track

The tracking setting interface requires the user to measure the resolution and set the tracking direction and tracking interval.

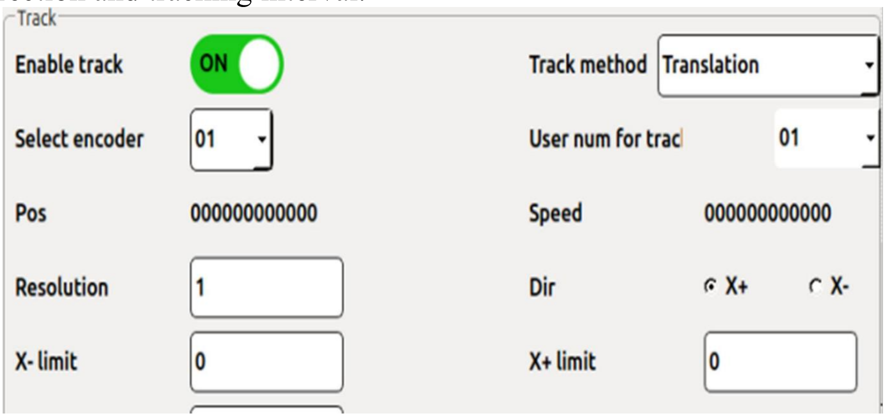


Figure 5-11 Tracking settings

5.3.4 Disk tracking calibration

When the tracking track is an arc track, the user needs to calibrate the arc track.

The simple translation tracking method does not need to set the disk tracking calibration.

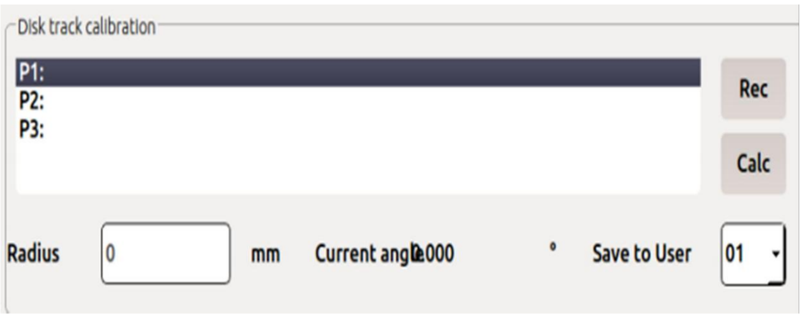


Figure 5-12 Disk tracking calibration

5.3.5 Calibration

After the visual calibration, the coordinates can be transformed in the controller.

Vision only needs to send pixel coordinates, and the robot can convert to world coordinates to perform actions.

Just install the calibration board at the end of the robot and run the calibration script automatically. Eliminate the need for manual calibration.

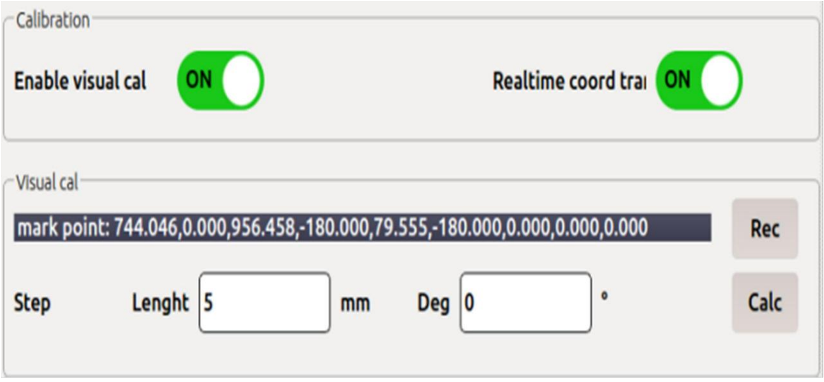


Figure 5-13 Calibration

Chapter 6 System parameters

6.1 Basic Settings

All the parameter settings in this section change the basic parameters of the robot, which will affect the use of the robot. Before setting the parameters, you must confirm the correctness of the steps and parameters before saving.

The basic setting interface of the teach pendant is shown below. The basic settings include zero point calibration, link parameters, joint parameters, space parameters, 20-point calibration, and robot model. These parameters are not recommended for the operator to change at will. Improper modification will cause the robot to work abnormally. Therefore, it is recommended that manufacturers use this interface to set parameters before debugging.

6.1.1 Zero calibration

On the zero calibration interface, the following figure shows the current encoder value and current joint angle. The right-most column is to calibrate the zero point calibration of each axis or all axes. The zero point is not allowed to be modified by the customer.

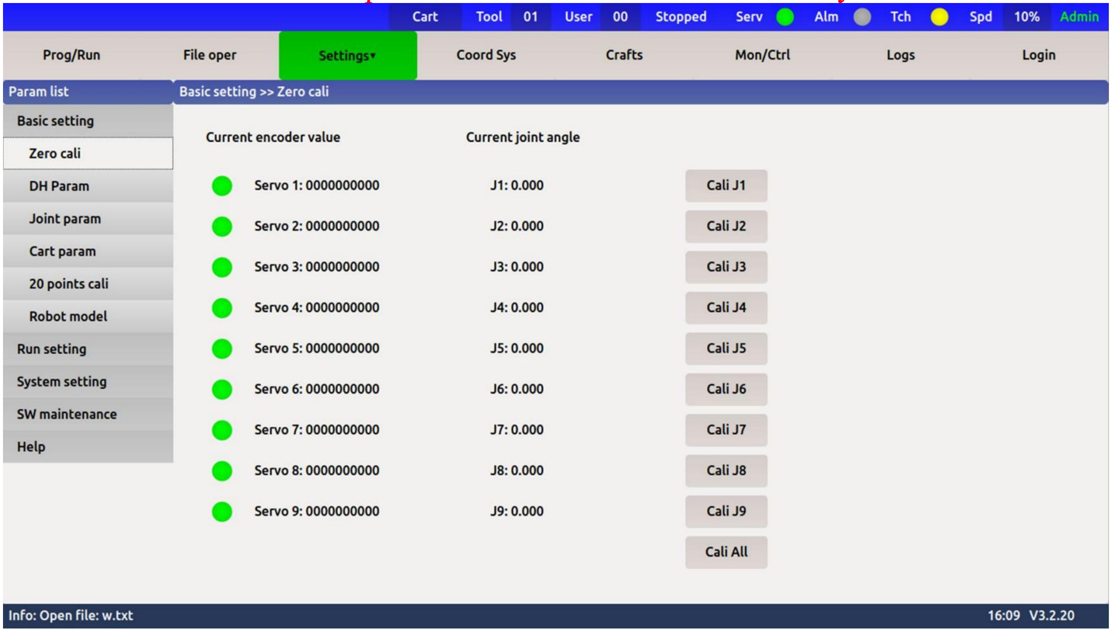


Figure 6-1 Zero calibration

6.1.2 Connecting rod parameters

The link parameters of each robot are different. The following figure shows the link parameters of the robot. These parameters are not allowed to be modified by the customer.

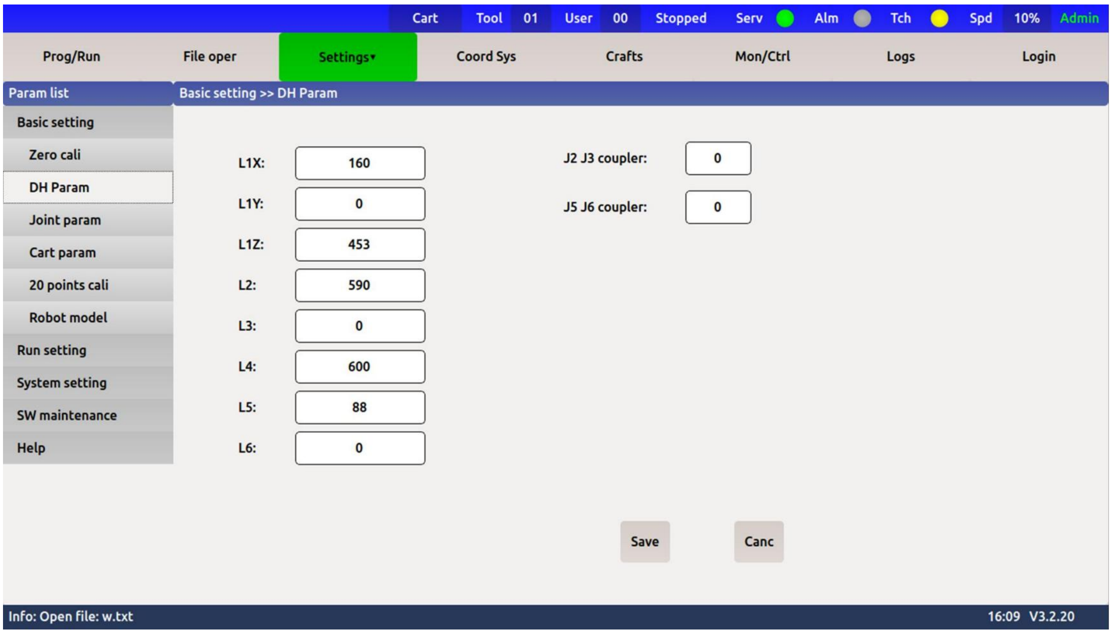


Figure 6-2 Connecting rod parameters

6.1.3 Joint parameters

We can set the joint parameters of each axis, joint parameter index 1-9, the displayed parameters of each axis, maximum speed, maximum acceleration, maximum stop speed, joint angle limit and so on.

This parameter affects the running speed of the robot, and the customer cannot modify it by himself.

The system automatically calculates it, and only needs to modify the speed to calculate the maximum speed of the shaft; if you modify the acceleration multiple, the maximum acceleration and the maximum stop speed will be displayed in real time. Note that this is for display only, and will not be saved in real time to save, click the【Save】button below.

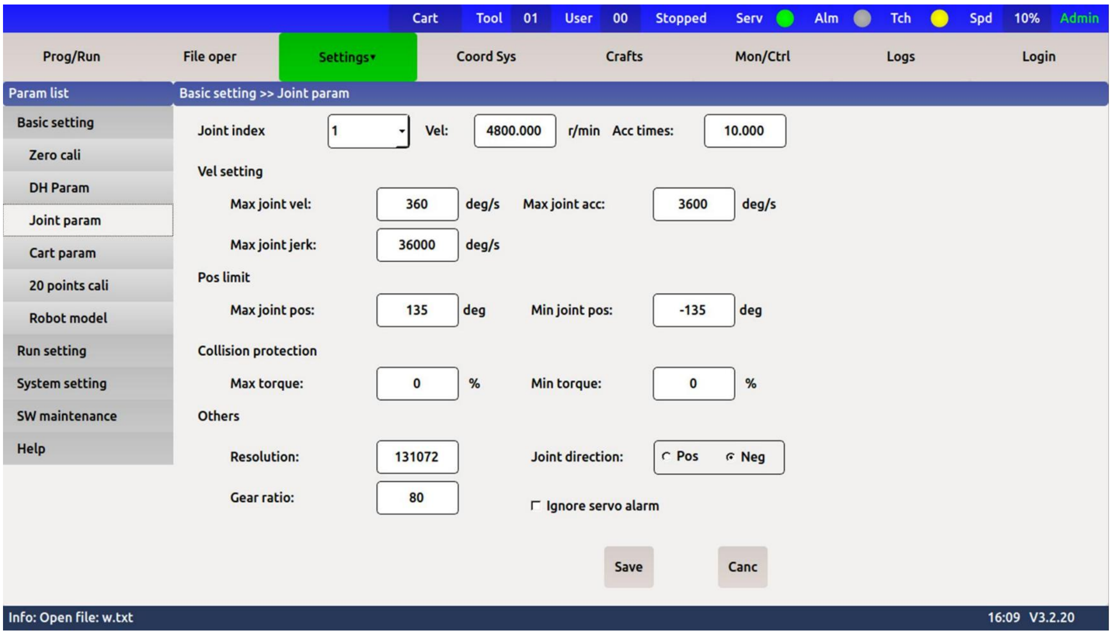


Figure 6-3 Joint parameters

6.1.4 Spatial parameters

The space parameter sets the linear running speed of the robot. When running along the Cartesian coordinate system, it involves attitude changes and requires multi-axis coordination. Therefore, the customer cannot modify it by himself, otherwise an overspeed alarm will occur, and the robot will be damaged in severe cases, or the trajectory will change and hit the surrounding equipment.

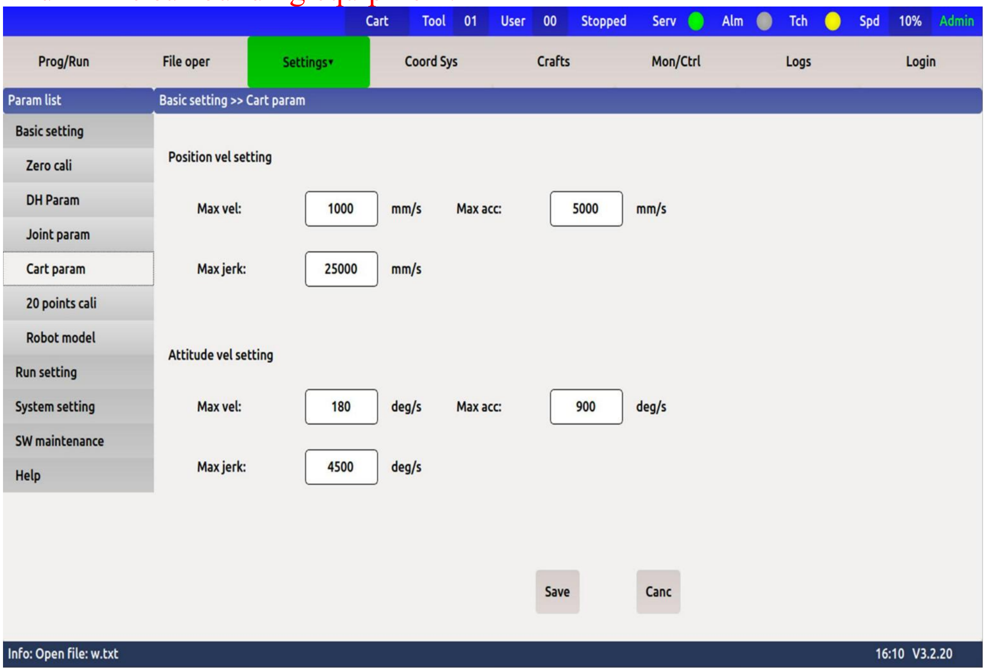


Figure 6-4 Spatial parameters

6.1.5 Twenty points calibration

If the robot loses the zero point, not only the zero position must be calibrated manually, but also the robot needs to be calibrated at 20 points to calibrate the zero position and the link error. Customers are generally not allowed to calibrate 20 points by themselves. The interface is shown below:

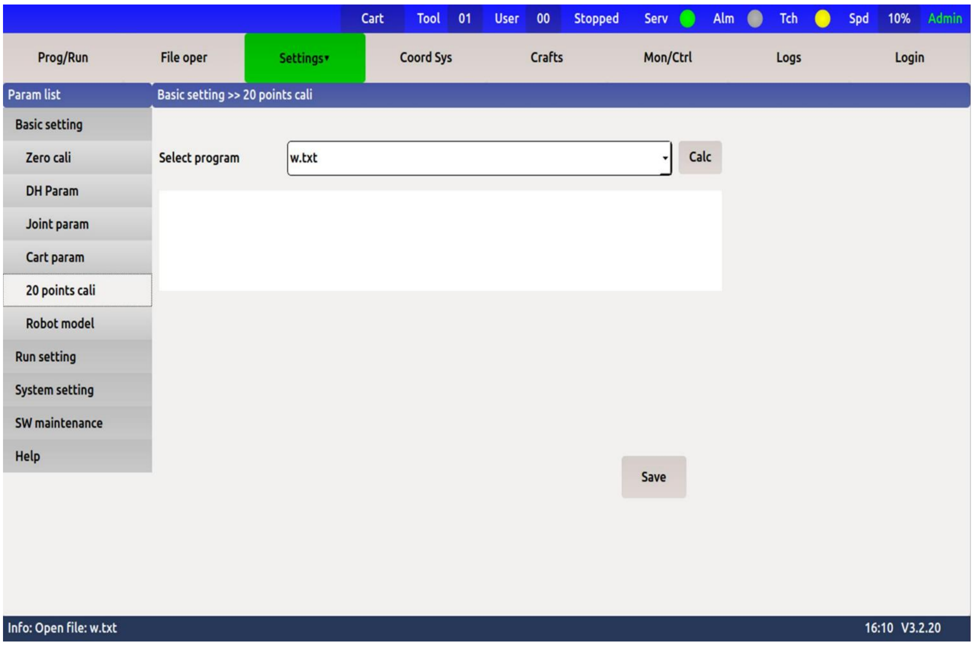


Figure 6-5 Twenty-point calibration

6.1.6 Robot model

This function is only used for the factory test of the robot. The customer is not allowed to modify it at any time, nor does it require modification.

This function will modify all the factory parameter settings of the robot, the joint parameters of each axis, the space parameters, the zero link and the tool.

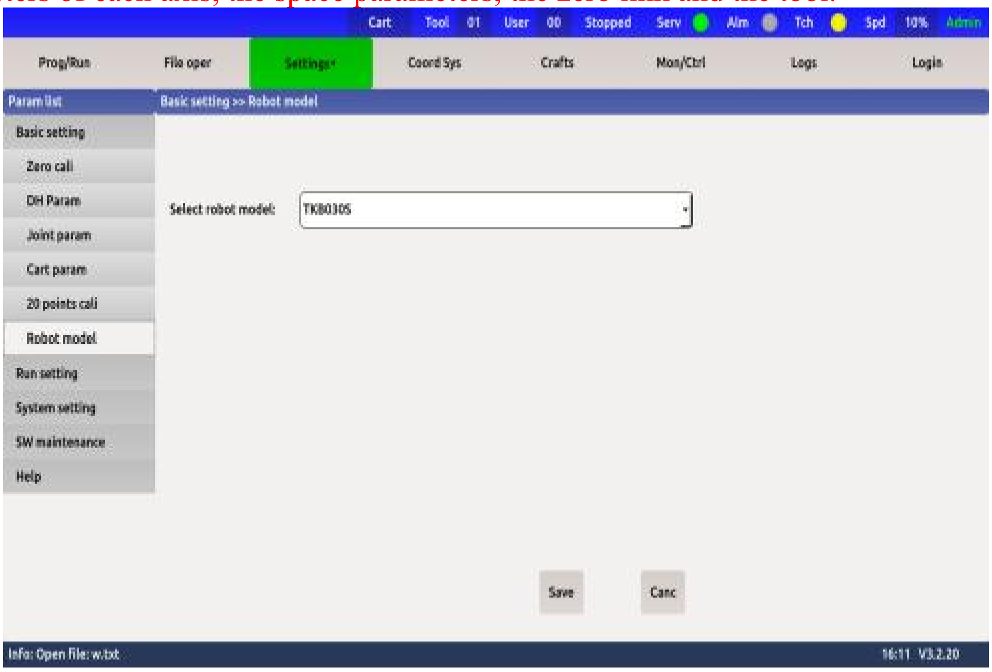


Figure 6-6 Robot model selection

6.2 System settings

6.2.1 Key definition

The key custom function can be used to set the function of F1-F4 shortcut keys, mainly used to control the output IO and welding process specific parameters.

Signal type:

Single: If the IO output is set, the user presses the corresponding button to set the corresponding IO output, and release it to reset the corresponding IO.

Double: If the IO output is set, the user presses the corresponding button to set the corresponding IO output, release the shortcut key, and press again to reset the corresponding IO.

Button F1: Set the function definition of the F1 button, the same applies to F2-F4.

Key input source:

Subsystem: You can get the key press information of the system directly, not through the interface. This way of teaching is faster. This input source should be selected without using VNC Teach Pendant.

UI interface: Get the key events through our interface program, this method is slower, but in the VNC network teach pendant, we need to select the UI interface method to control the robot.

Jog mode:

Traditional way: Control the axis movement of the robot through the interface. If the button input source selects a non-subsystem, it is set to the traditional mode. Non-jog cannot be used in subprograms, and it cannot be stepped back to the main program after use.

New method: When the button input source is set to a subsystem, a new method (jog mode) must be set, which is faster.

The operation interface is shown below:

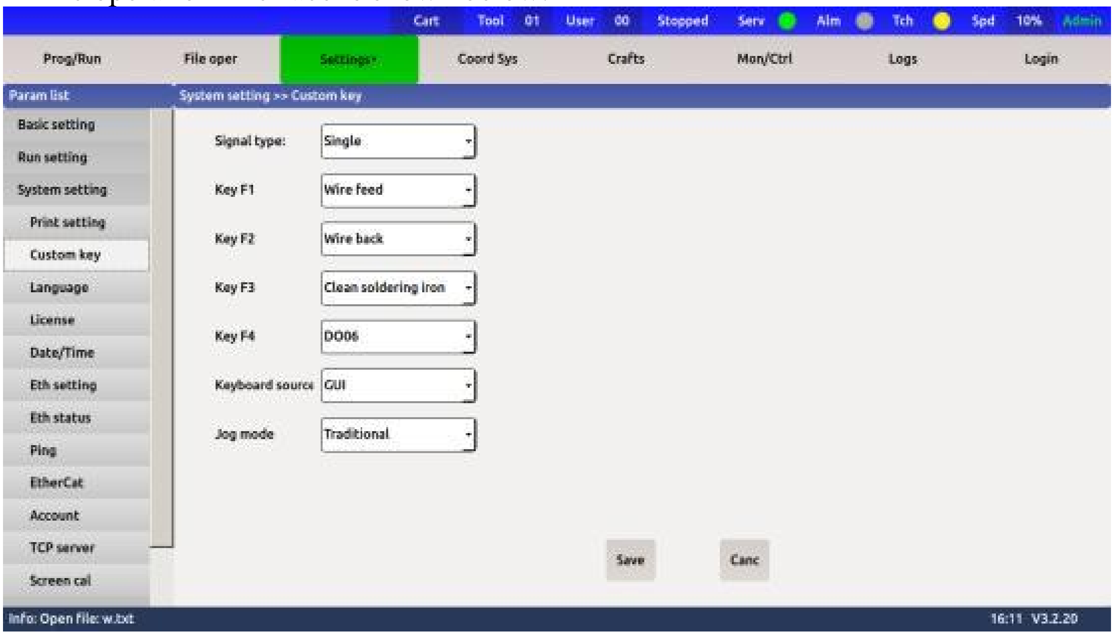


Figure 6-7 Key definition

6.2.2 Log print settings

For the consideration of system running speed and hard disk storage capacity, the setting of print log is divided into four levels:

【Error】<- 【Warning】<-【Information】<-【Debug】. Select high level log, it will automatically print low level log.

The Log is divided into the foreground log and the background log. The foreground log is displayed in the running log column of the teach pendant interface, and the background log is saved in the log folder, which needs to be copied out and checked with a computer. Background logs are usually more detailed than foreground logs. As a user, you usually only need to know the information in the front desk log .

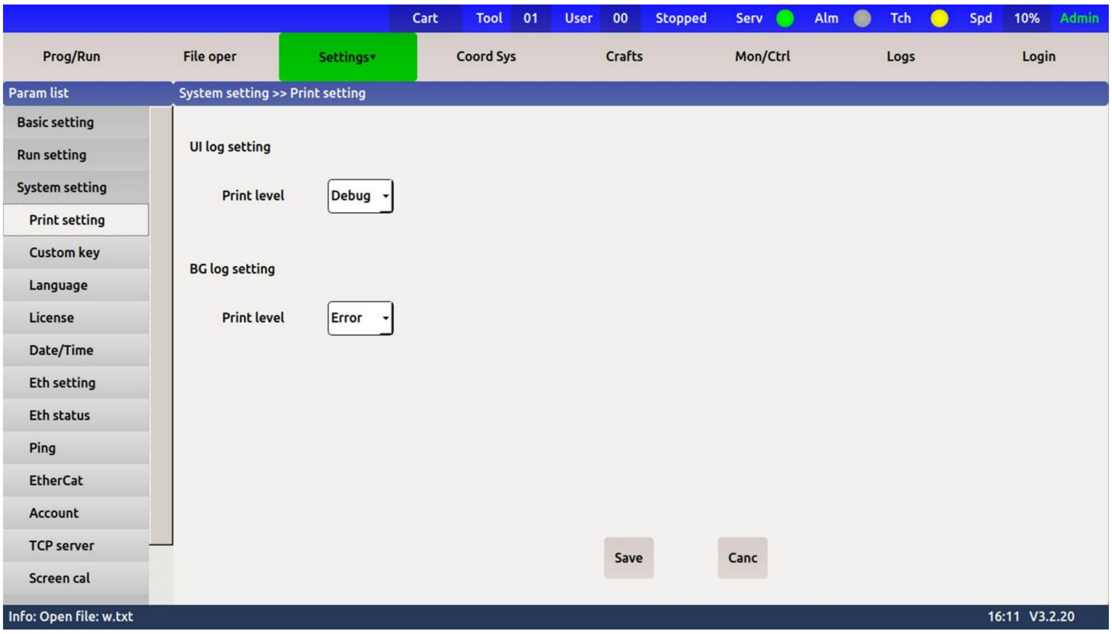


Figure 6-8 Log print settings

Chapter 7 System maintenance

7.1 System Upgrade

7.1.1 Upgrade from version 1.5 and below to version 1.6 and above

1. The first is to prohibit the old version of the controller program that has been installed. There are two methods: one is to set the administrator password for the system; the other is to delete the added old system startup items in the startup manager. It is recommended to do both.

2. Copy the controller software system package

(such as turin-package-V1.6.1-2017-1024-123306.tar.gz) to the home directory (other directory pages are available, this document is recommended to be placed in the home directory), and unpack compression. The decompression method is to right-click the file and select Extract here. As shown,

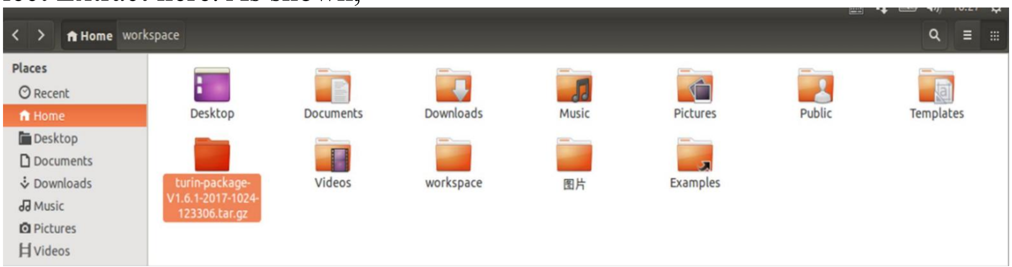


Figure 7-1 Copy to main folder

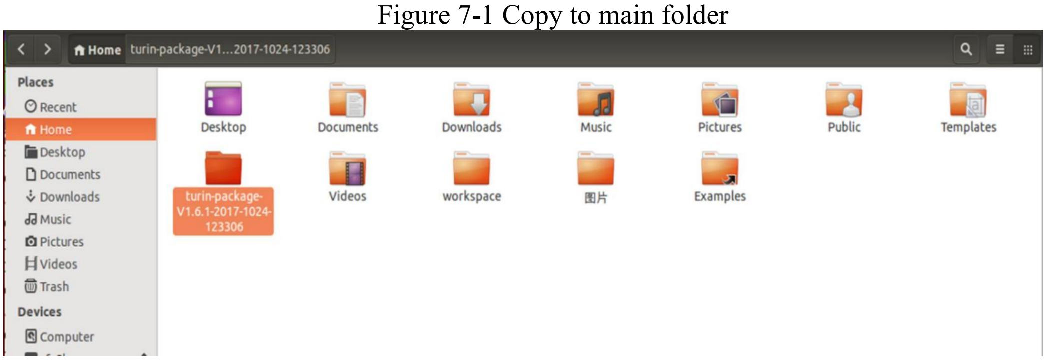


Figure 7-2 Extract

3. Enter the configuration directory to repair the configuration, this example is configured in

"/home/thinkrob/turin-package V1.6.1-2017-1024-123306/bin/configs/ethercat_x86".

Please note: This is a little different from the old version of the catalog. (Pictured)

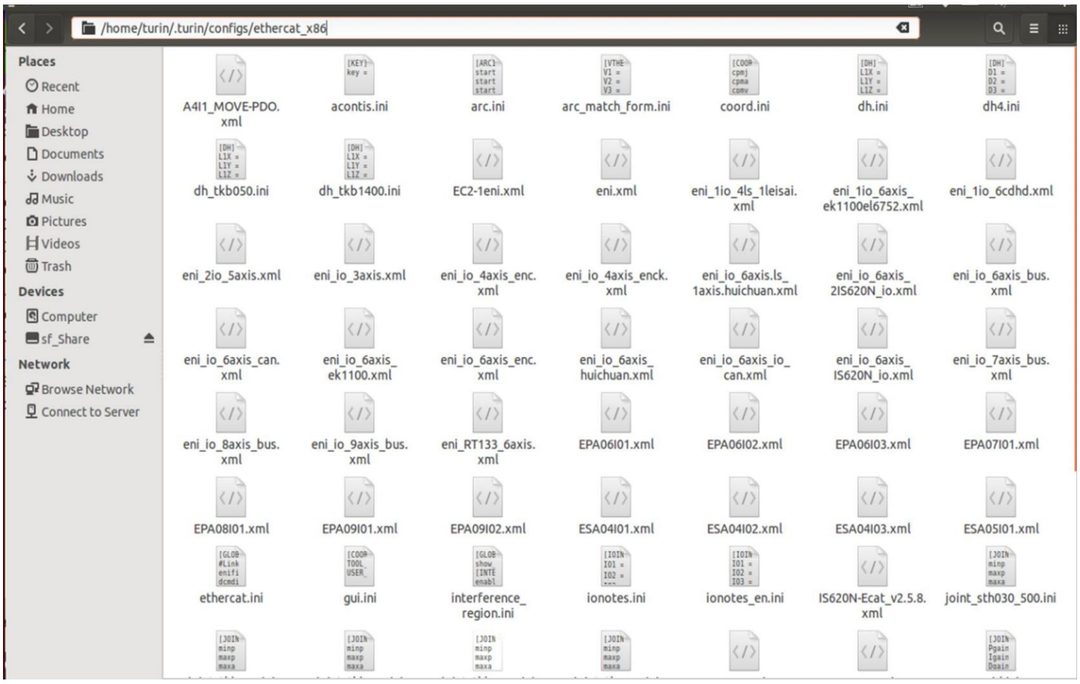


Figure 7-3 Repair configuration

The old version of joint.ini, dh.ini, dh4.ini, acontis.ini and other configuration files are repaired here. Note: If it is a welding system, the welding configuration does not need to be repaired. The welding function of the new version has changed greatly. Need to fill in the interface again.

4. Press Ctrl+Alt+T to open the terminal, and cd to the bin directory of the package (such as cd turin-package V1.6.1-2017-1024-123306/bin),

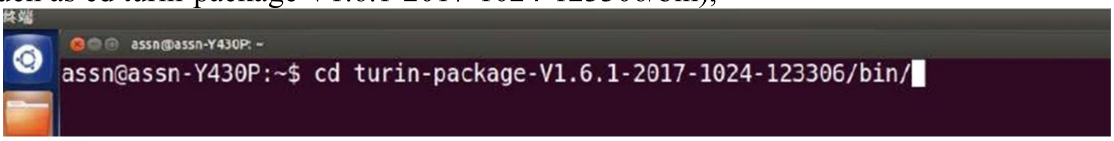


Figure 7-4 Open the terminal

Figure 7-5 Enter the bin directory

The new version of the controller has many more functions, among which turin-tools is responsible for system installation/maintenance and other functions

5. Execute the installation command: the new version only needs to execute one command to complete the installation. sudo ./turin tools install (by the way, uninstall is executed in any directory, sudo turin-toolsuninstall, note: the "./" character is missing, and it can be executed in any directory)

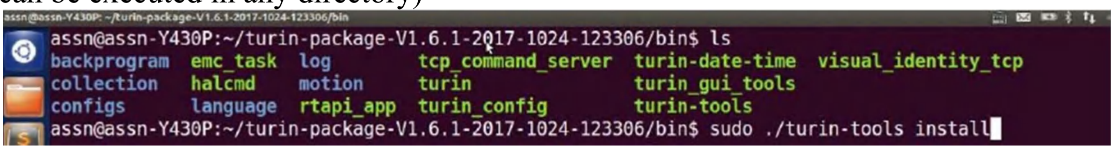


Figure 7-6 Execute installation command

All the prompts of the installation process are as shown in the figure.

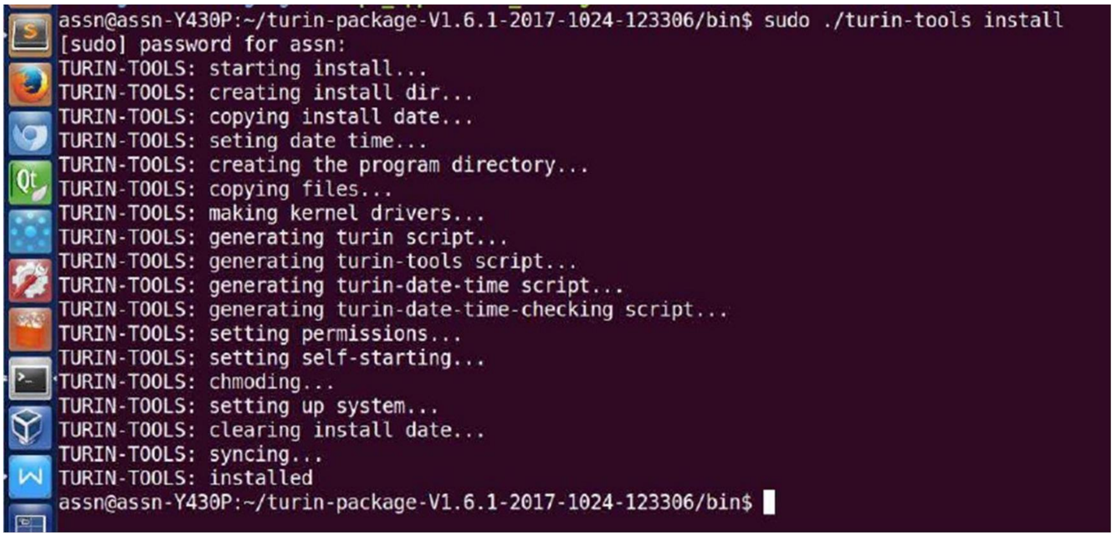


Figure 7-7 Installation process

Under normal circumstances, the installation process did not show "error" or "error", which means that the installation was successful.Restart the operating system at this time.

6. Serial number and license:

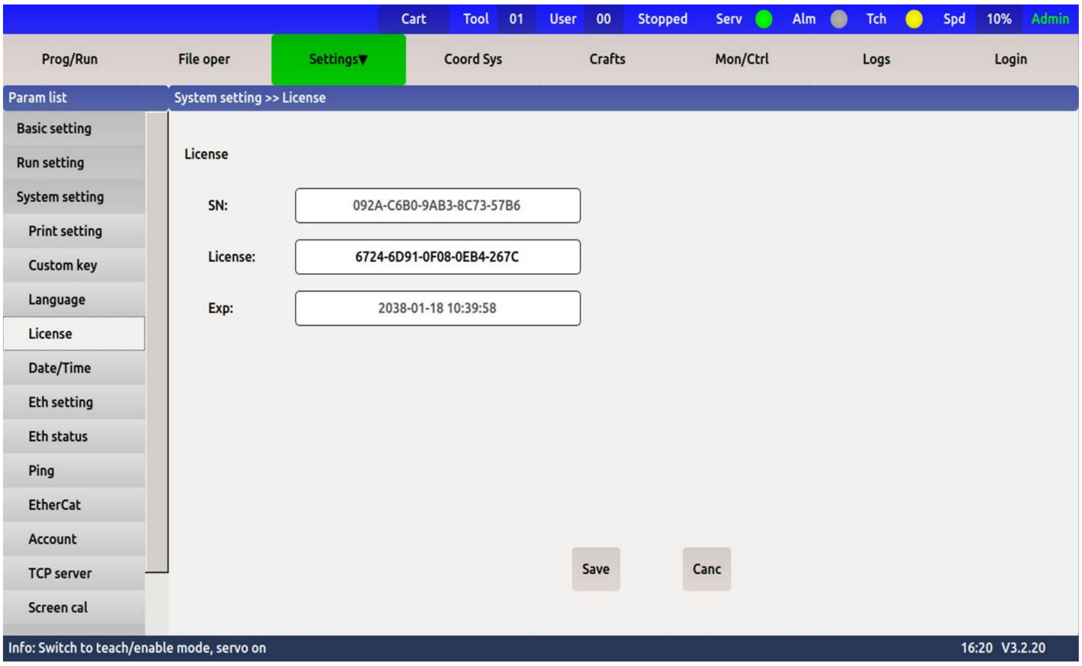


Figure 7-8 Update product license

After the system starts, if the system alarms and prompts that the license expires. At this time, the system serial number needs to be sent to the after-sales service department. When you receive the license, you need to fill in the license and click Save. The validity period will indicate the license status.

At this point, the new system is installed.

7.1.2 Upgrade from version 1.6 and above

Copy the version compressed package to the root directory of the U disk, insert the U disk into the USB port of the industrial computer, and then enter 【Parameter Settings】 -> 【System Maintenance】 -> 【System Upgrade】 on the teach pendant interface. Select the target version of the U disk, and then click "Update System". The system will automatically update. After the update is completed, it will automatically restart and enter the new system. The system upgrade is now complete.

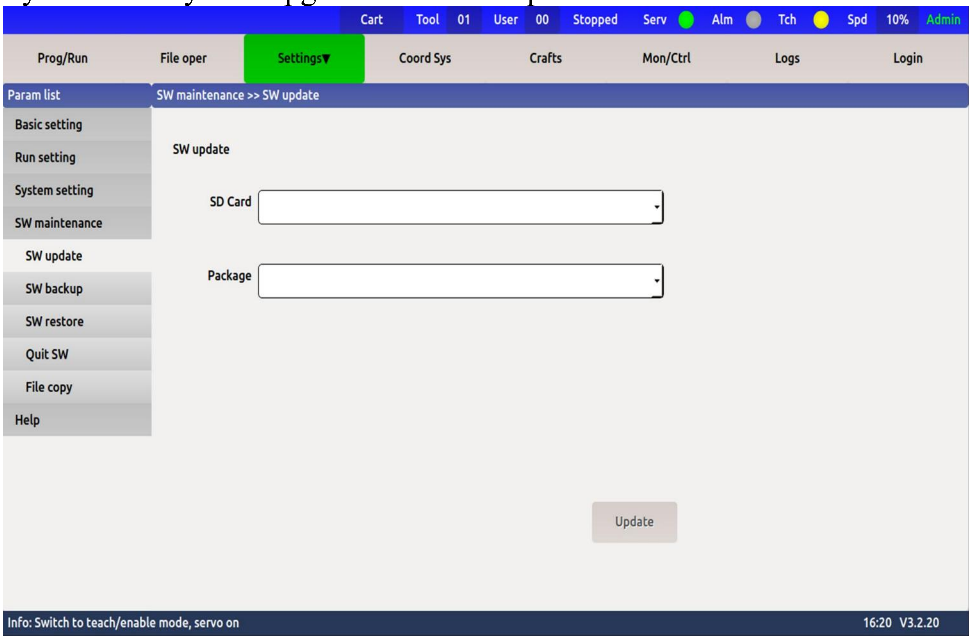


Figure 7-9 New system upgrade

7.2 System backup

If the software system needs to be backed up, or when there are operational problems that need to be resolved by the manufacturer, the customer is generally required to provide some operational-related parameters. The following figure shows some commonly used parameters.

Software system: The software system the robot is using.

Collecting data: Some data generated during the use of the robot, not commonly used.

Running log: Some logs generated by the robot during its operation, such as the status information of the robot.

Alarm information: debugging information, point information, network communication information, etc.

Motion program: Save the foreground running program of the robot.

Background program: Save the background motion program of the robot.

Configuration file: Save the configuration file of the robot, such as the robot's zero point, dh, activation code, vision tracking parameters, welding parameters, tool parameters, user parameters, etc.

Select the U disk and stand-alone need to backup content, and then start the backup. The backup will only pack the files and will not delete the original files in the system.

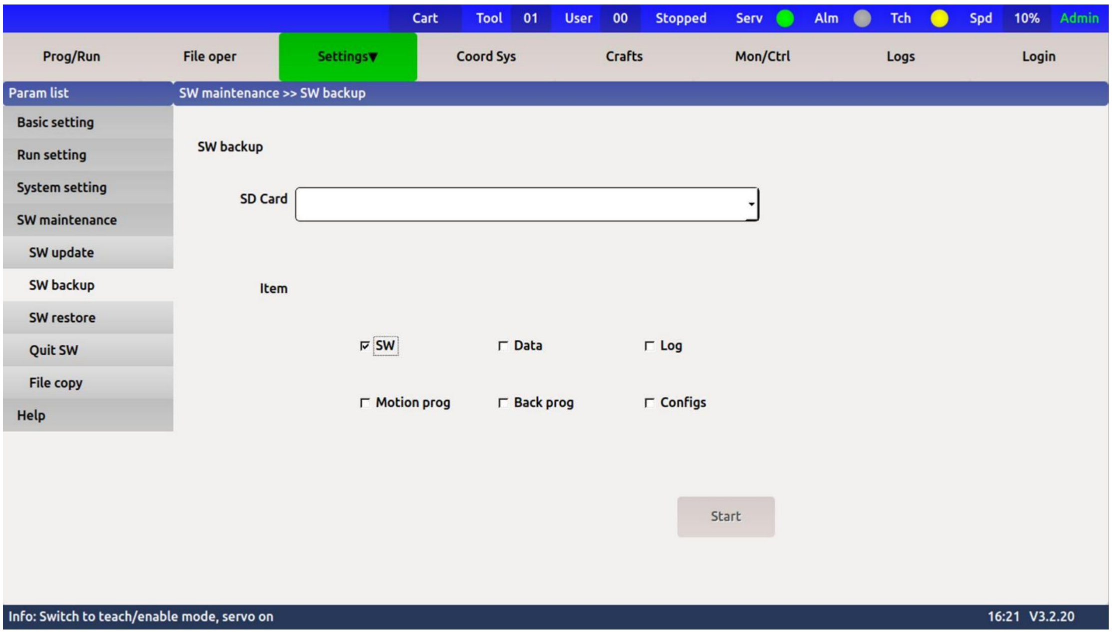


Figure 7-10 System backup

7.3 system recovery

When using the system recovery function, you must make sure that the data on the machine can be overwritten, otherwise the data on the machine cannot be retrieved after the system is restored.

Since the program of one system may need to be placed on another robot, the function of system recovery is needed.

The storage selects the storage where the backed up software package is located, the software package selects the software package to be restored, and different repair items are selected, and we will automatically filter out the software packages corresponding to the repair items.

The user can restore 4 options, exercise program, background program, configuration file and software system.

When you choose to restore the motion program, what you restore is the foreground motion program of the robot, which is to overwrite the program in the picture software package to the machine, or to overwrite directly. If the program in the machine needs to be retained, please back up the machine program first.

The background program is to cover the background program of the software package to the background program folder of the machine.

The configuration file is to overwrite the configuration file of the software package to the configuration folder of the machine. Note that it will directly overwrite important files such as zero point, DH, joint parameters, etc. Please confirm that the data of the software package is correct before restoring.

The software system directly restores the backed up controller software to the machine.

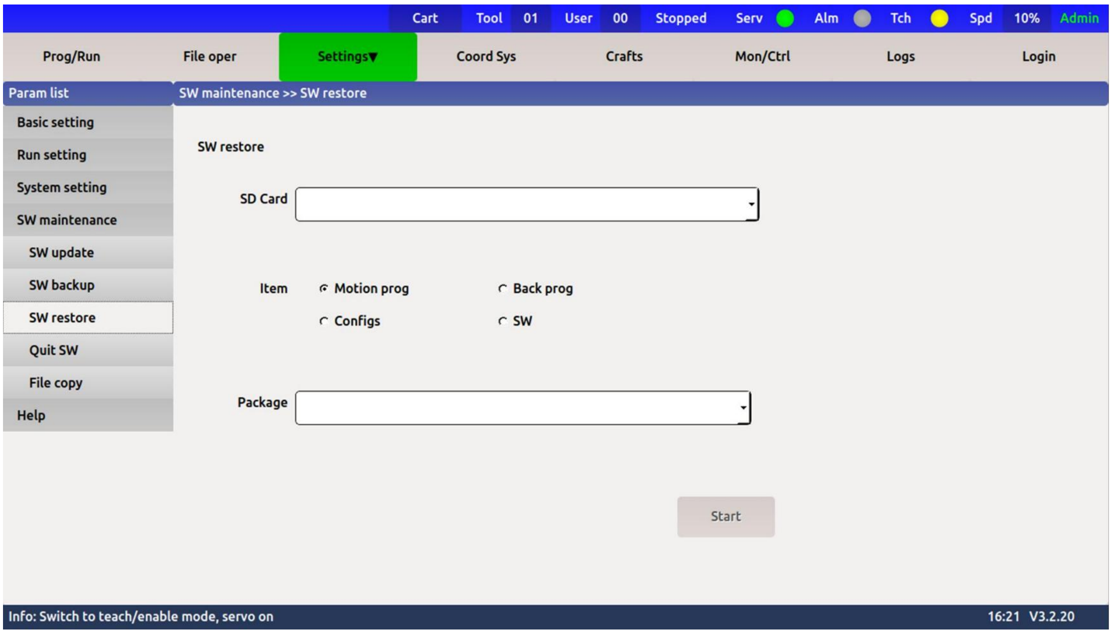


Figure 7-11 System Recovery

7.4 Exit system

The operating software of the TURIN controller is developed based on the ubuntu system. The user can exit or restart the robot's controller software. In addition, you can also shut down and restart the operating system (ubuntu). When copying and pasting files, it is recommended to restart the operating system, otherwise the files will only be written to the cache. If the power is cut off directly after the file is copied, the file will directly display 0kb when the file is turned on.

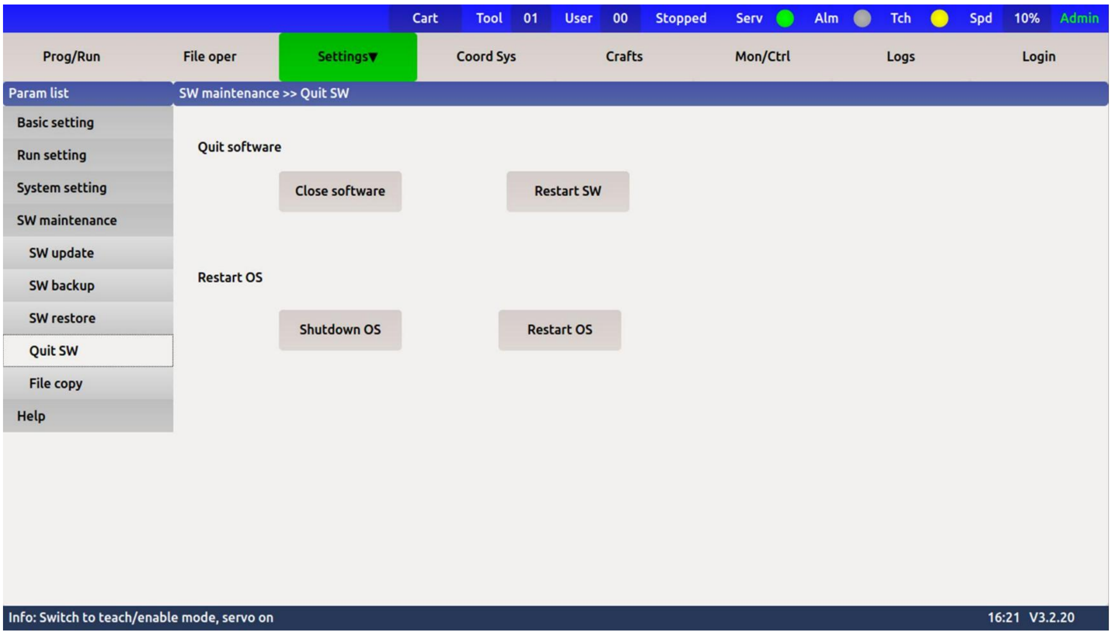


Figure 7-12 Exit the system

7.5 File copy

During the normal use of the robot, the user may need to copy files from the robot or copy files to the robot.

7.5.1 How to copy files from and robot to U disk

First insert the U disk into the USB socket of the robot industrial control board, and then select 【Parameter Settings】 -> 【System Maintenance】 -> 【File Copy】. As shown below:

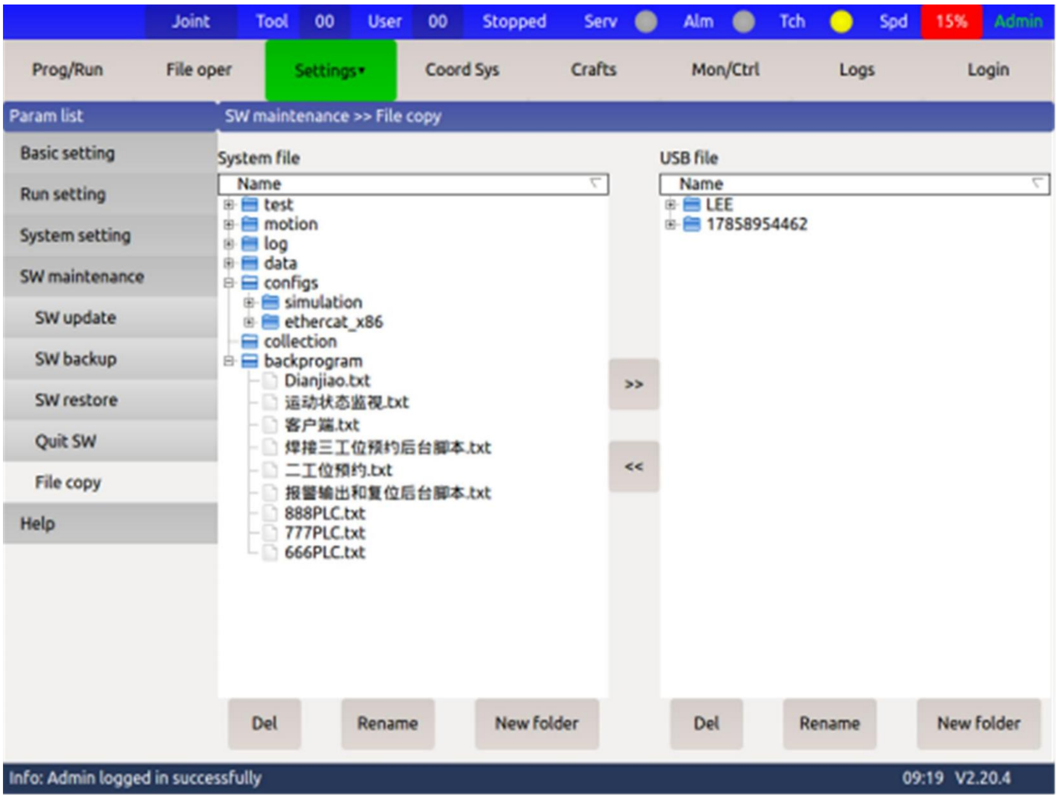


Figure 7-13 File directory

On the left is the folder of the robot, each folder corresponds to a different file.

backprogram: This folder saves back-end files.

collection: The file of collected data saved here.

configs: Here is the configuration file of the robot, where the subfolder ethercat_x86 is the folder where the configuration file of the robot is actually running, and the subfolder simulation is the folder for the configuration file saved when the robot is simulated (the client does not have a version to run, All are actually running, and the configuration files are all saved under ethercat_x86).

log: Saved under this folder is the robot running log file.

motion: Saved under this folder are the foreground running files of the robot.

Copy the robot file to the U disk. Select the robot file to be copied in the box on the left, and select the directory to be copied to the U disk on the right, and then click to copy the file to the U disk.

As shown below:

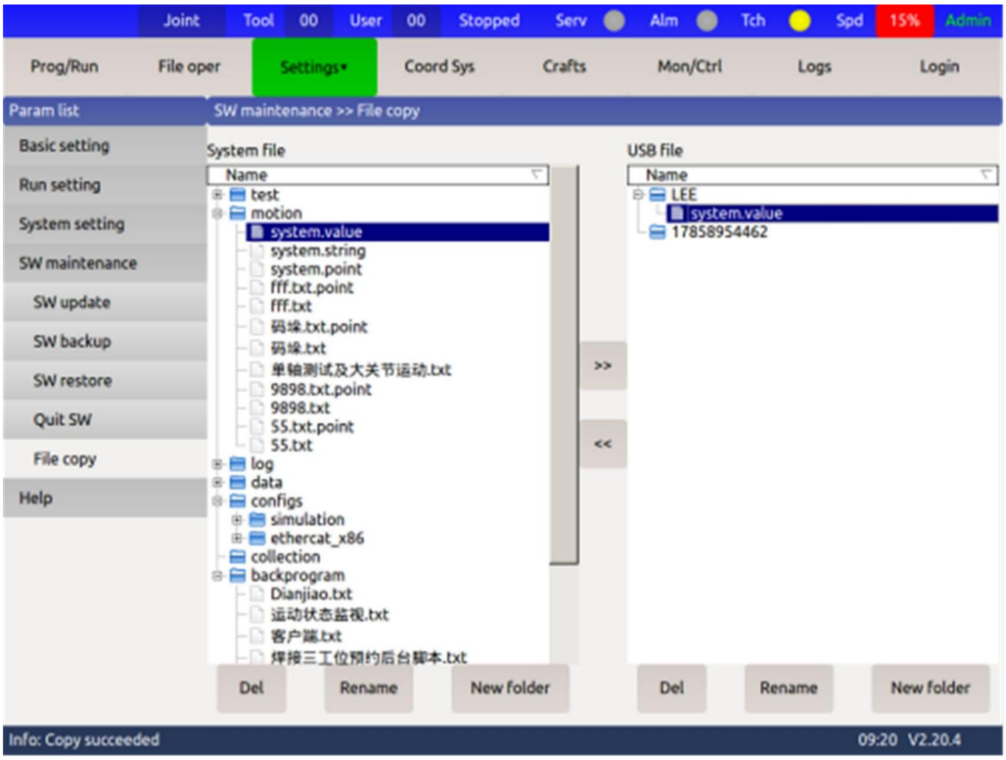


Figure 7-14 File copy

7.5.2 How to copy the U disk file to the robot system

Select the target directory to be copied to on the left, select the file to be copied on the right, and click to copy the U disk file to the robot control system, as shown in Figure 7-14.

Chapter 8 Troubleshooting

8.1 Run log

The operation log will show the status of the robot during its operation. The displayed content is related to the log print settings above.

The upper row of the interface is to display the filtering of the content of the log script. The checked option means that the log information of the level in the log script is displayed, and it is only used for filtering.

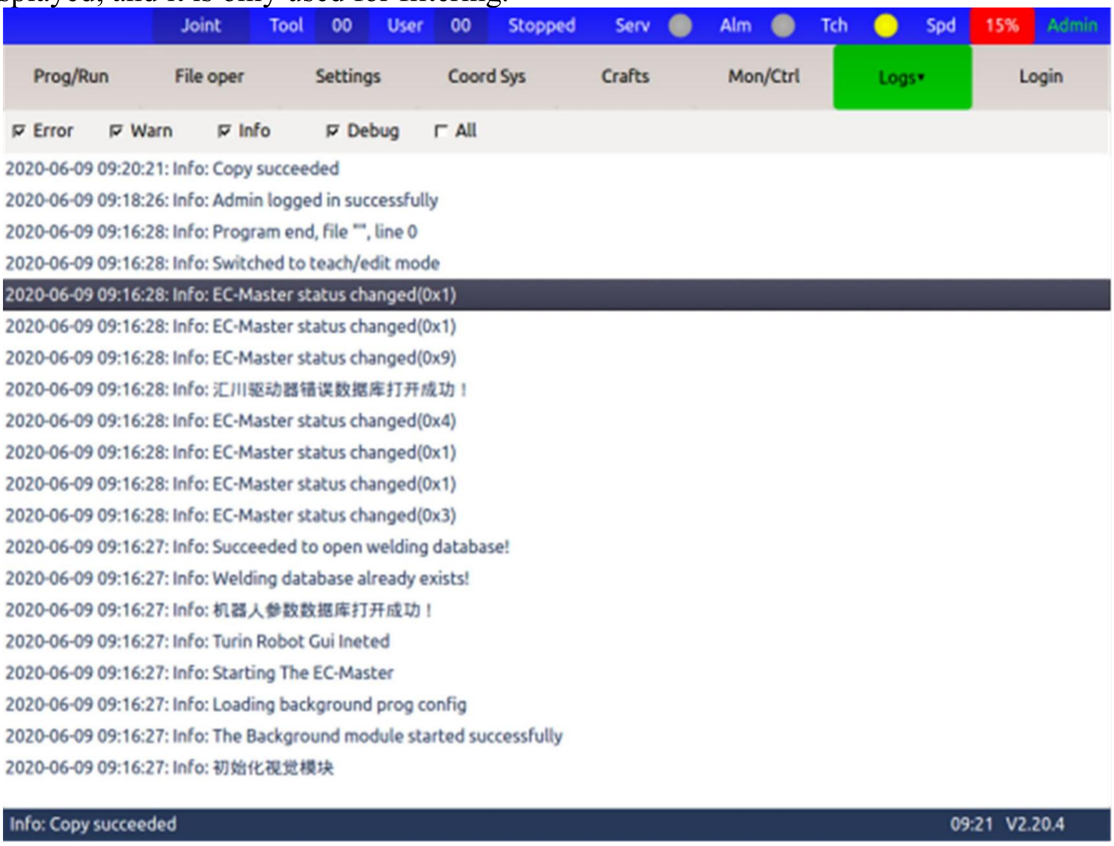


Figure 8-1 Run log

8.2 Common faults and treatment

The following table lists some common faults that the robot will encounter during operation.

Table 8-1 Common robot troubleshooting

Content	Troubleshooting	Problem analysis	Solution
Emergency stop	Press the pressure enable switch and turn the teach/replay switch key. If the optical coupler of the IO board changes, the controller cannot read the corresponding input signal.	Abnormal communication 1. The software version is abnormal 2. Ethecat communication configuration file does not match 3. Controller authorization expired	1. Change or upgrade the system version 2. Replace the configuration file 3. Replace the serial number
	Check input signal	1. The IO board is damaged 2. Poor contact of emergency stop line	1. Replace IO board optocoupler or replace IO board 2. Reconnect the emergency stop line
Abnormal operation		1. Super system soft limit 2. Unable to cross the singularity 3. Communication connection timeout 4. Tracking process is out of operating range	Replan trajectory Optimization process
Drive alarm	Check whether it is hit or stuck; check the drive alarm code; check the external wiring	1. Mechanical jam, overload 2. Poor cable contact 3. Lost battery	Deal with the corresponding fault

The following table shows the alarm codes that appear in the robot control system, and the alarm information is displayed in the message column below the teach pendant.

Table 8-2 Alarm codes at the front desk of the robot

0x65	Slave is missing*/
0x00010001	Cycle command: work counter error*/
0x00010002	master init command: Work counter error*/
0x00010003	slave init command: work counter error*/
0x00010007	EoE mbox sending: work counter error*/
0x00010008	CoE mbox sending: work counter error*/
0x00010009	FoE mbox sending: work counter error*/
0x0001000a	No response on the sent Ethernet frame*/
0x0001000b	No or unexpected response in the ecat init command sent from the slave*/
0x0001000c	There is no response in the ecat master init command sent again*/
0x0001000e	Waiting for the corresponding timeout of the mailbox init command
0x0001000f	When receiving cyclic frames, not all slave devices are running
0x00010010	Ethernet connection (cable) not connected*/
0x00010012	Redundancy: Line terminal detected*/
0x00010013	When receiving a cyclic frame (BRD al-status) */, there is at least one

	slave status error
0x00010014	Accessory error (status code)*/
0x00010015	Station address is missing (or slave station is missing)-FPRD to AL_STATUS failed*/
0x00010017	SoE mbox send: work counter error*/
0x00010018	SoE mbox write response error*/
0x00010019	CoE mbox SDO abort*/
0x0001001a	The client registration is deleted, and ecatConfigureMaster of other threads (RAS) */may be called
0x0001001b	Redundancy: the line is repaired*/
0x0001001c	FoM mbox aborted*/
0x0001001d	Invalid mailbox data received*/
0x0001001e	The PDI watchdog expires on the slave station, which is determined by IST*/
0x0001001f	Unsupported slave (if redundancy is activated, and the slave does not fully support automatic shutdown)*/
0x00010020	Slave station in unexpected state*/
0x00010021	All slave devices are running*/
0x00010022	VOE mbox send: work counter error*/
0x00010023	EEPROM checksum error detected*/
0x00010024	Testing*/
0x00010025	Connection redundancy change*/
0x00010026	Slave station in unexpected state*/
0x00010027	Slave error (AL status code)*/
0x00030002	The communication file does not match the actual connection status, such as expanding external axis, expanding IO board