TECHNICAL REFERENCE

MODEL

Name: Pulse Type 6-axis Control System

Series: Industrial Robot Control System

Issue Date: August 08, 2020

Revision Date: August 28, 2020

Copyright Instructions

The teaching and using instruction manual (hereinafter referred to as the “instruction manual”) of this controlz system is subject to change without prior notice.

Without express written permission provided by HWASHI. (hereinafter referred to as “the Company”), any part of the manual is not permitted to be copied or propagated in any form or means (electronic or mechanical) for any purpose.

The manual and related procedures are only used to provide information for final users with information, and the Company has the right to change or withdraw its content at any time. The manual is the exclusive information of the Company and is protected by copyright law of People's Republic of China and international conventions.

Within the permissible scope of relevant laws, the Company shall provide this manual by in an “established” way and shall not provide any form of warranty for this manual, which includes (but not limited to) the fact that no implied warranty is done to the enforceability, applicability of a particular purpose and non-infringement . In any case, the Company shall not be responsible for any direct or indirect loss or damage caused by using of the manual by the final users or any third party, and the loss or damage includes (but not limited to) loss of profits, business interruption, business impact or loss of information, etc., even if such loss or damage has been expressly informed to the Company.

The munual and use of any product mentioned in this specification are limited by the applicable user license agreement. This instruction is made by Hunan Bochuang Robot Co., Ltd.

Version and Function List

Publishing Time	Version Number	Newly Increased Function	Marking
2016-8-28	V1.0	First edition	

Catalogue

1. Terms, Definitions, Symbols and Abbreviations

In order to facilitate use of the control system for users, the system explains some terms, definitions, symbols, and abbreviations that are involved in the use procedure.

1.1 Point

The “point position” indicates the position and posture of the end of the robot in space.

1.2 Angle of Articulation

Reading of “angle of articulation” indicates reading of the position and posture of the current “point” in space, and the angle of articulation is expressed in “degrees”. When using a 6-axis robot, it is indicated by 6 articulation angle degrees, i. e. the “6-dimension” angle (“J7” and “J8” are the angles of articulation of “0 degree” by default); When the additional axes J7 and J8 are used, the angles of the additional axes are also read, i. e. the “8-dimension” angle.

1.3 Procedure

A series of statements and instructions of operation of the system according to steps of procedure establishment and for achieving the intended purpose includes the creation, management, and operation of the procedure.

1.4 Machine Parameters

Before operation of the control system, “machine parameters” are needed to be set up firstly; the setting of the machine parameters includes setting of machine parameters such as “length of connecting rod”, “reduction ratio”, “articulation positive/negative limit”, “maximum rotational speed”, “PNOUT”, “PNIN”, and “direction of encoding”.

1.5 Coordinate System

Two coordinate systems of “articulation coordinate system” and “base coordinate system” are provided in the control system, and a user can create a “user coordinate system” by himself.

1.6 I/O Interface

The control system is provided with 8-way relay outputs, 10-way collector open circuits, and in total 18-way I/O output ports. The initial state defaults to low level “0”; 20-way photo-coupling isolation input ports are provided, and the initial state defaults to low level “0”.

1.7 Analog Output

The control system provides 4 analog channels of “0”, “1”, “2” and “3”. The analog value can be output, and the analog value range is 0V-12 V.

1.8 Additional Axis

The control system is provided with 8 pulse driver interfaces of “J1– J8”, six interfaces are used in normal usage, that is to say, “6-axis robot”, so that when the “J7” and the “J8” are connected to the driver interface external articulation shaft, it is also referred to as an“additional axis”. The “J7” shaft is configured as an “additional axis_0” in the control system, and the “J8” shaft is configured as an “additional axis_1”.

1.9 Zero Angle

Setting the system “zero angle” is a very important step in preparatory work before the system is running, because when reading the articulation angle of the “point”, it is positioned taking the set “zero angle” as the reference point.

1.10 Task Type

The “task type” of the control system is mainly divided into two categories: curves and non-curves. The non-curvesinclude 9 types of tasks of “output”, “analogue quantity”, “additional axis motion”, “global variable”, “forbidden axis”, “time delay”, “waiting an event”, “logical instruction” and “PCALL”.

1.11 Type of Motion

When applying the “curve” task type, the system provides four kinds of motion types of articulation motion, linear motion, circular arc motion and circular motion.

1.12 Process

The control system adopts a complicated and mode-fixed workflow, and forms a “process package” (hereinafter referred to as “process”) through internal “collection”, so that the user can easily finish the originally complicated and cumbersome work. At present, “common spray painting process” and “nine-axis spray painting process” is supported in the system process at present.

1.13 Tracking

It is also the “tracking” function of the system. In some special cases, such as pipeline operation, the end of the robot and the “pipeline” can be kept in the “relative rest” state through the “tracking” function, and the normal operation flow is completed accordingly.

1.14 System Update and Backup

The control system provides the upgrade and update function and the backup function of the system procedure, which include update and backup of the controller system and update and backup of the demonstrator system, and the system update and backup can be completed through the USB interface.

1.15 Limit

Limit is divided into “hard limit” and “soft limit”. The mechanical arm rotation angle has extremity, i. e. “hard limit”; for machine safety, the rotating angle size of the mechanical arm can be controlled by a procedure, i. e., the “soft” limit is set, but the value cannot exceed the “hard limit” scope.

1.16 Direction of Encoding

It is the motion direction of each articulation of the robot body. The control system sets the motion direction of each articulation. If it is different from the set motion direction, it is necessary to modify the value of the “direction of encoding” to make them consistent (if the value of the “direction of encoding” is “1” originally, it is modified to “0”; if it is originally “0”, it is modified to “1”).

1.17 Origin, Zero Point, and Start Point

The origin is the position where the first step runs of the whole curve motion trail in a full procedure containing a “curve” task type, and it is the “origin” position of the whole procedure (distinguished from the “origin” in the user coordinate system; the coordinate system “origin” represents the origin coordinate (0,0,0) of the coordinate system plane.

The zero is the “zero position angle” position.

The starting point is referenced in the process of procedure creation, and a “curve” has two certain points, namely, “starting point” and “end point”.

2. Overview

2.1 Introduction to the System

A pulse type 8-axis control system (hereinafter referred to as “control system” or “system”) is to provide a control system for an industrial robot, and a pulse-type driving servo and a speed reducer are arranged on an industrial robot to finish the corresponding workflow instead of manual, and the pulse type 8-axis control system can be widely applied to the automobile industry, electronic appliances and machinery manufacturing and other industries.

Over the years, the company has invested heavily in the research and development of the control system, and has completed a series of technical problems and has obtained fruitful results. The function of the system has been diversified and can meet needs of different users.

(1) Motion function: The system provides 4 motion types of “ articulation” motion, “straight line” motion, “circular arc” and “circle” motion; “smoothness” can be added to the curve; manual teaching can be carried out through the “articulation motion” coordinate system, the “base coordinate system” and the “user coordinate system”; the “singular point” alarm function and the motion protection function are added, so that it is safer for a user when using.

(2) Programming function: The system adopts “modularization” programming, except the fact that the basic program is created, saved and modified; the basic program can be called through the “PCALL” instruction, so that the utilization rate and the programming efficiency of the user program are greatly improved.

(3) Program running control: “pause”, “go on”, “stop”, “return to zero” and other operations are supported; “single step”, “single”, and “cycle” motion modes are supported; and parameter input interfaces such as “global motion speed” and “load weight” are provided.

(4) “Point” operation function: The “point” and the “procedure” are mutually alone and can be used for multiple “reference” of the user program, in this way, the user programming efficiency is greatly improved.

(5) Articulation definition: The 6 articulations and 2 additional axle articulations of the 6-axis mechanical arm can be mapped to any driver interface of the controller, and the articulations are flexible and convenient for system maintenance.

(6) Additional shaft function: With 2 additional axes and the additional axes can be arbitrarily set in “articulation mode”, “speed mode” or “trace mode”.

(7) Hot key function: The normal I/O input port can be configured as special functions of “pause”, “go on”, “return to zero”, “switching of working mode”, “running to start point” and “emergency stop”; The normal I/O output port is configured as special functions of “operation instruction”, “servo state”, and “alarm state”.

(8) Commissioning function: It is possible to manually control the I/O output port on the controller and control the output of analog quantity and monitoring of I/O input port.

(9) Tracking function: it is divided into two modes: “body tracking” and “Sliding track tracking”.

(10) Processs support: There are “common spray painting process” and “nine-axis spray painting process” of supported processes at present.

(11) System update and backup: the system provides convenient update and backup functions, and the updating and backup of the controller and the demonstrator program can be realized by using a USB flash disk.

(12) “On-line” system operation: The system provides the “on-line” help document, and the user can consult the system help file at any time through the demonstrator, so that the user can quickly understand the function and operation method of the system conveniently and immediately.

2.2 System Composition

2.2.1 Controller

As shown in Fig. 2.1, a well-assembled control box is shown, including a control module and a power supply module. The meaning of each part is as follows:

1. 8-way pulse drive interface

2. Screen is “COM5”, system “RS485” communication interface and “RS232” communication interface

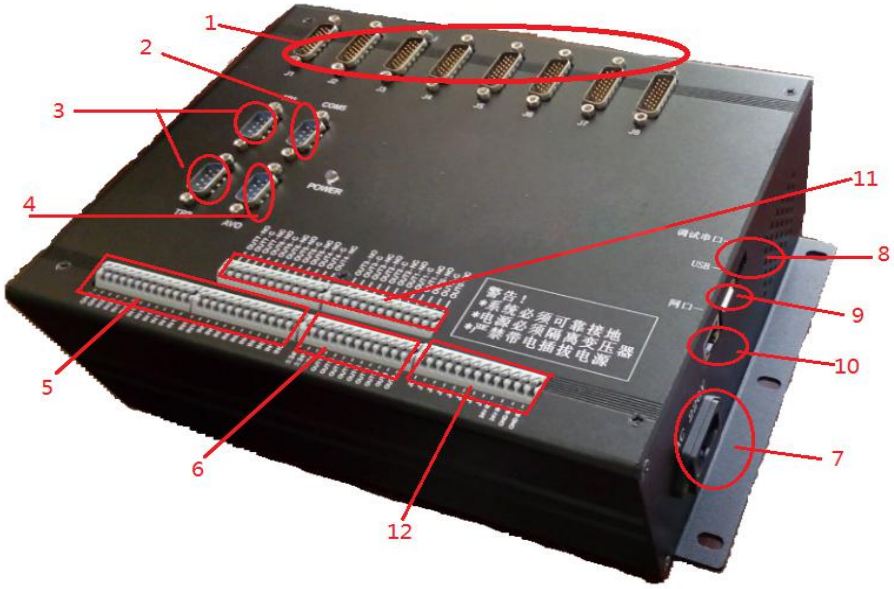


Fig. 2.1 Composition Structure of Control Box of Control System

3. Silk-screen is “TP1” and “TP2” and indicates system “RS422” interface, and is connected with teaching module

4. Silk-screen is “AVO”, and indicates analog quantity output interface

5. The 20-way optical coupler isolated input ports should be pulled down when being used.

6. The 10-way collector open-circuit output ports should be pulled up when being used.

7. Input of alternating current 220 VAC

8. Debug port

9. USB interface can update and backup system procedure

10. Ethernet Port

11. 8-way relay output ports

12. 8-way braking outputs, thebraking line should be connected with “24V-BK” and “J1-J8” interfaces.

(1) J1-J8 pulse driving interface signal definition

Pin	Signals	Explanation	Pin	Signals	Explanation
1	JX_PULS-	JX-axis position command pulse negative	14	JX_PC+	JX-axis encoder pulse C phase positive
2	JX_SIGN-	JX-axis position command direction negative	15	JX_S-RDY-	JX-axis servo ready
3	JX_PA-	JX-axis encoder pulse A phase negative	16	JX_SEN	JX-axis encoder initial value
4	JX_PB-	JX-axis encoder pulse B phase negative	17	JX_ALM-RST	JX-axis alarm removal
5	JX_PC-	JX-axis encoder pulse C phase negative	18	GND	Ground 0V
6	JX_ALM-	JX-axis alarm signal input	19	GND	Ground 0V
7	JX_S-ON	JX-axis servo-enabling output	20	JX_BK+	JX-axis braking positive
8	+24V	Output+24 V	21	NC	Empty, no signal
9	GND	Ground 0 V	22	NC	Empty, no signal
10	JX_PULS+	JX axis position command pulse positive	23	NC	Empty, no signal
11	JX_SIGN+	JX axis position command direction positive	24	NC	Empty, no signal
12	JX_PA+	JX-axis encoder pulse A phase positive	25	NC	Empty, no signal
13	JX_PB+	JX-axis encoder pulse B phase positive	26	+24V	Output+24 V

(2) Signal definition of RS485 and RS232 communication interface

Pin	Signals	Explanation	Pin	Signals	Explanation
1	+5V	+5V output	6	I2C2_SDA	Bi-directional data line
2	I2C2_SCL	clock line	7	RS232_TX4	RS232 sending signal
3	RS485B	RS485 signal B	8	RS232_RX4	RS232 receiving signal
4	RS485A	RS485 signal A	9	GND	Ground 0 V
5	GND	Ground 0 V			

(3) Definition of analog quantity output interface

Pin	Signals	Explanation	Pin	Signals	Explanation
1	DA_OUT1	Analog quantity output 1	6	NC	Empty, no signal

2	DA_OUT2	Analog quantityoutput 2	7	NC	Empty, no signal
3	DA_OUT3	Analog quantity output 3	8	GND	Ground 0 V
4	DA_OUT4	Analog quantity output 4	9	GND	Ground 0 V
5	NC	Empty, no signal			

2.2.2 Demonstrator

As shown in Fig. 2.2, a well-assembled demonstration box is shown in the figure, and the demonstration module is in it. The meaning of each element on the demonstration box is as follows:

Fig. 2.2 Composition Structure of Demonstration Box

1. Mode changeover switch, “manual” and “auto” operating modes are switchable

2. “Procedure stop” physical key to stop the procedure during “operation”

3. “Procedure starting” physical key to enable “procedure” to start “operation”

4. “UP” physical key, not be used temporarily

5. The outgoing line hole of the demonstration box is connected with the “RS422” interface in the control box.

6. “DOWN” physical key, not be used temporarily

7. “Returning” physical key can return to the previous step

8. “Menu” physical key, which can set the curve “starting point” when the procedure is inserted into the “procedure management”

9. The physical keys of “J6-” and “J6+” respectively; after “enabling”, the J6 articulation motion can be controlled.

10. The physical keys of “J5-” and “J5+” respectively; after “enabling”, the J5 articulation motion can be controlled.

11. The the physical keys of “J4-” and “J4+” respectively; after “enabling”, the J4 articulation motion can be controlled.

12. The the physical keys of “J3-” and “J3+” respectively; after “enabling”, the J3 articulation motion can be controlled.

13. The physical keys of “J2-” and “J2+” respectively; the J2 articulation motion can be controlled after “enabling”, and the J8 articulation motion can be controlled due to the fact that the additional shaft is arranged.

14. The the physical keys of “J1-” and “J1+” respectively; after “enabling”, the J1 articulation motion can be controlled, and the J7 articulation motion can be controlled due to the fact that the additional shaft is arranged.

15. Touch screen, most of the data input and function switching, and the like in the system are achieved through the touch screen.

16. Emergency stop switch, people can press down the “emergency stop” under “emergency circumstances”, and all the operation of the system and servo can be stopped.

17. 2 enabling switches to “enabling” the servo

2.3 Software Interface

The software interface of the control system can be classified into two types: manual interface and automatic interface.

2.3.1 Automatic Interface

By switching the “mode changeover switch” on the demonstration box to the “auto mode”, and an “automatic interface” appeared. As shown in Fig. 2.3, the “operation” of the procedure can be performed on the “automatic interface”.

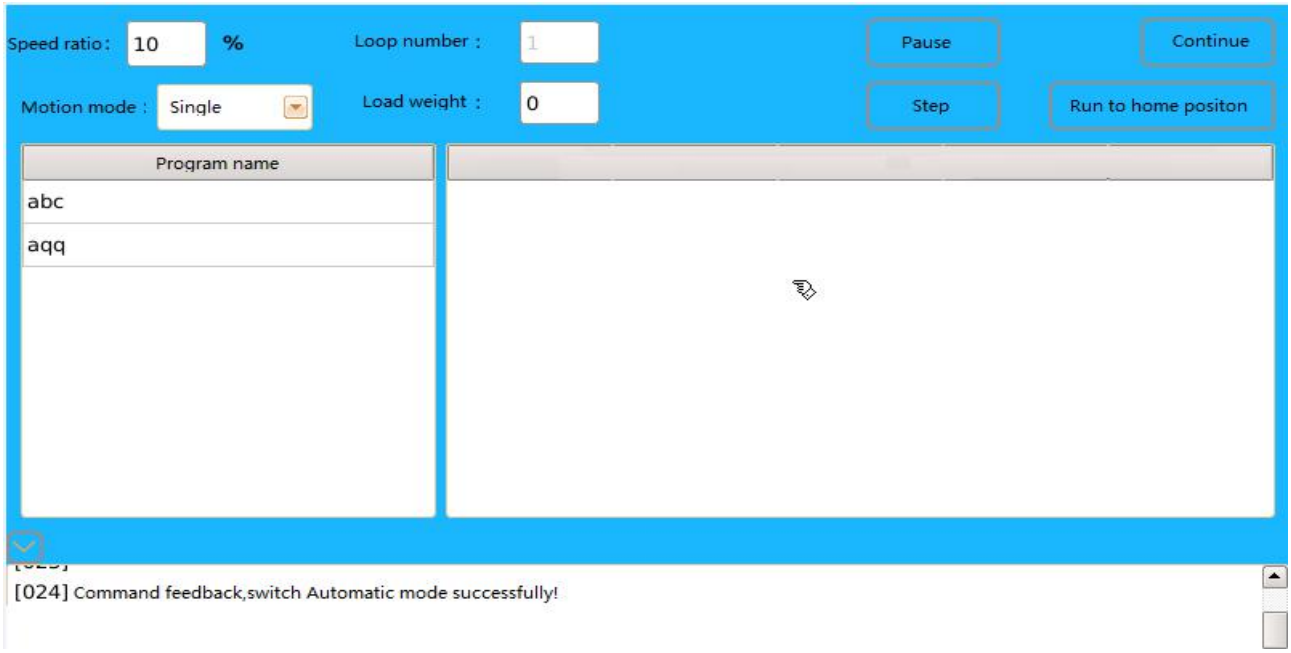


Fig. 2.3 Automatic Interface

2.3.2 Manual Interface

The manual interface of the control system consists of three parts: [Motion], [Configuration] and [Tools], as shown in Fig. 2.4.

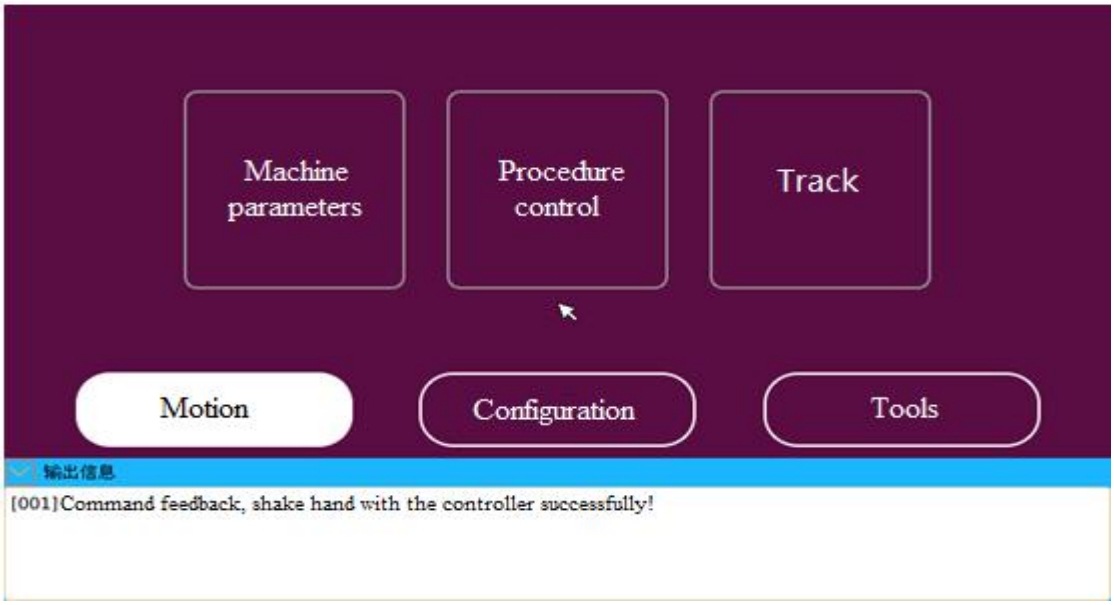


Fig. 2.4 Composition of Manual Interface Structure

- **Motion**

In [Motion], there are three parts, such as “machine parameters”, “procedure control” and “tracking function”, as shown in Fig. 2.4.

Machine Parameters

“Machine parameter” is a very important part of the composition of the control system. The corresponding

machine parameters, zero angle and arrangement of additional axes can be set in machine parameters. It is one of the necessary tasks to be done before the system is operated. This will be described in detail in chapter 3 of "preparation work before operation".

◆ **Procedure Control**

"P**rocedure control** " is an important constituent part of the system, and is composed of four parts of "procedure management", "process pack", "basic procedures" and "modularization procedure", as shown in Fig. 2.5 below:

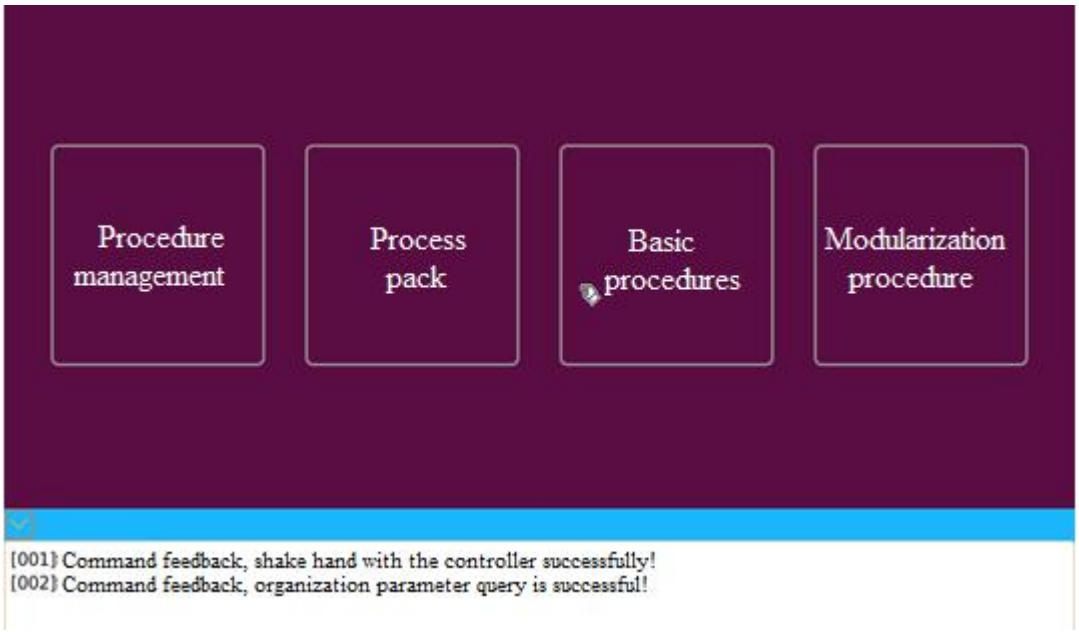


Figure 2.5 Composition of "Procedure Control" Structure

(1) **Procedure management:** Here is the place where "completed procedure" is stored; all the procedures successfully created and completely "saved" will be generated here. The procedure management includes four parts of "basic procedures", "points", "process procedures" and "modularization procedures" (as shown in Fig. 2.6), wherein the "process procedure" contains two procedures of "nine-axis spray painting" and "ordinary spray painting". At the same time, the generated "procedures" and "points" can be subjected to operations such as "querying", "modifying" and "checking".

Figure 2.6 Composition Structure of "Procedure Management"

(2) Process pack: The process for which the control system provides support will be created here. There are two processes currently of "9-axis spray painting" and "ordinary spray painting", and the specific operation will be described in detail in the "process pack procedure creation" section in "procedure control" of Chapter 4 below.

(3) Basic procedure: After clicking into, you can create and manage the procedure.

(4) Modularization procedure: The control system uses modularization procedure framework programming, which is slightly different from the creation of the basic procedure. By using the PCALL task type, a plurality of basic procedures completely designed can be embedded into the framework, so that the utilization rate and the programming efficiency of the user procedure are improved. After creation of the modular procedure is completed, in the "saving" process, the "modularization procedure" is generated firstly, and then the "basic procedure" is converted and generated.

◆ **Tracking Function**

"Tracking function", as a special function, will be used in some special occasions, such as pipeline operation. The tracking function can be classified into "do not use encoders" and "pulse type" according to the "encoder type"; according to the"tracking mode", it can be classified into two categories of "body tracking" and "sliding track tracking". The specific usage will be described in more detail in the "tracking function" section of Chapter 6 below.

➢ **Configuration**

[Configuration] consists of three parts of "coordinate system configuration", "interface configuration" and "system configuration", as shown in Fig. 2.7.

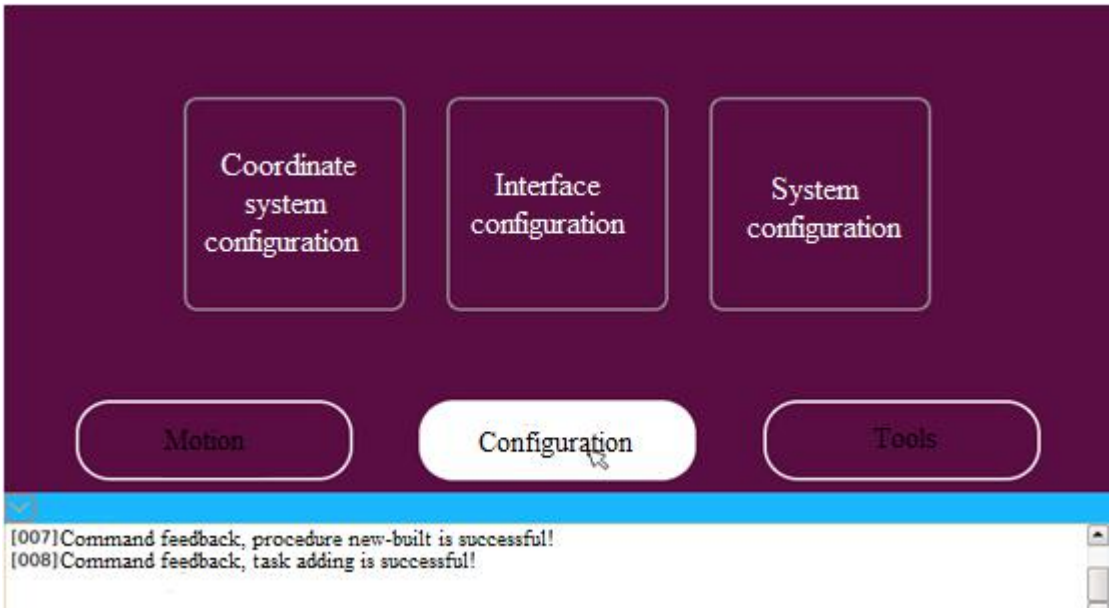


Fig. 2.7 “Configuration” Structure Composition Picture

◆ **Coordinate System Configuration**

Click into “coordinate system configuration” interface to create and delete the “user coordinate system”. Specific details can be seen in Chapter 5 of “use of coordinate system”.

◆ **Interface Configuration**

The servo type needs to be configured when the control system is connected with the external servo. The system also provides special functions to make the I/O ports be capable of bearing any configuration. The “interface configuration” can be divided into two categories: “driver configuration” and “I/O port configuration”, as shown in Fig. 2.8.

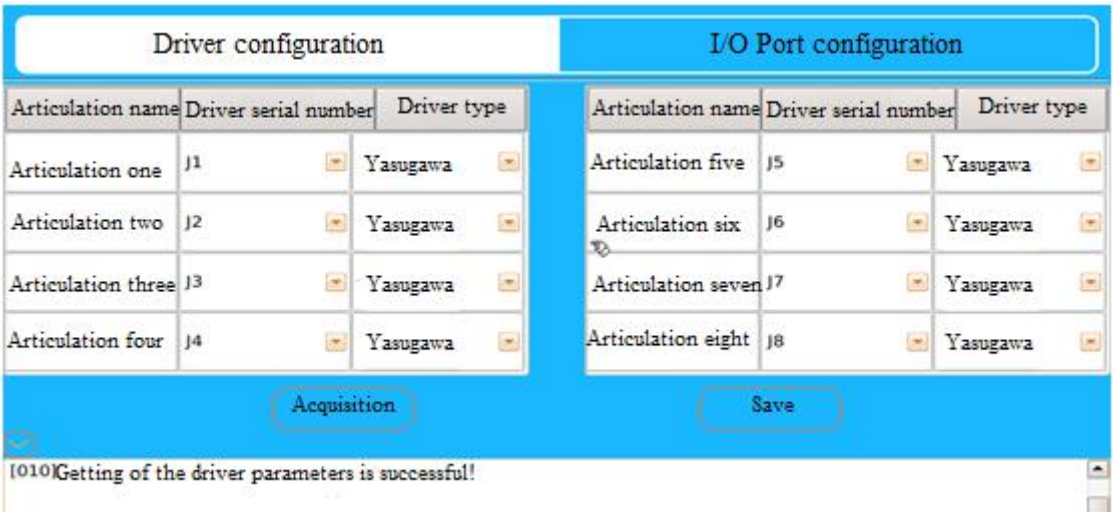


Figure 2.8 “Interface Configuration” Structure Picture

The “I/O port configuration” is further composed of “functional port configuration” and “indication port configuration”.

The “driver configuration” is configuration of the driving type connected with the controller, and

configuration is carried out according to the actual types of external servo. At present, the control system only matches three driving types of “Yasugawa”-driving servo, “Tuoke's pulse”-driving servo and the “Tuoke485”-driving servo.

In “I/O port configuration” is a function provided in the system in order to facilitate the user to use the system, and special functions such as “pause” function, “go on” function and “emergency stop” function can be configured on the “I/O port”. The “I/O port configuration” will be described in detail in Chapter 3 of “preparation before operation” later.

◆ **System Configuration**

The “system configuration” contains three parts of “authorization”, “program updates and backups” and “login system”, as shown in Fig. 2.9 below.

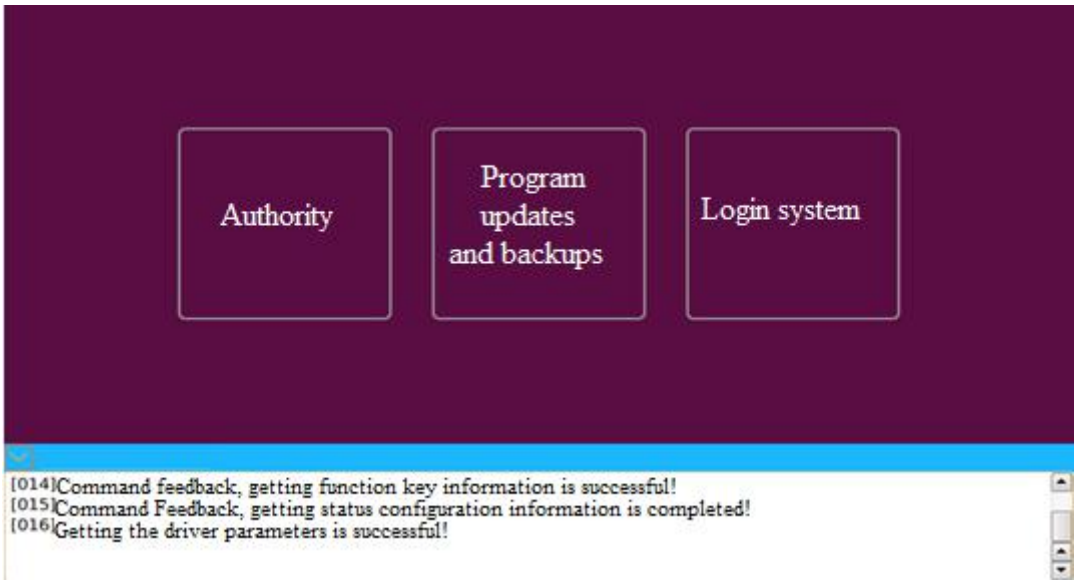


Figure 2.9 “System Configuration” Structure Composition Picture

(1) Authorization: You can set the authorization code and machine code of the system, and the manufacturer.

(2) Procedure updates and backups: update upgrades and procedure backups of system procedures, (including “demonstrator procedure” and “controller procedure”), are all completed in this interface.

(3) Login system: Click to return to the login interface, and you can select the login mode again.

➢ **Tools**

“Tools” is also a major component of the system, and is composed of three parts of “interface debugging”, “version information” and “operation instructions”, as shown in Fig. 2.10.

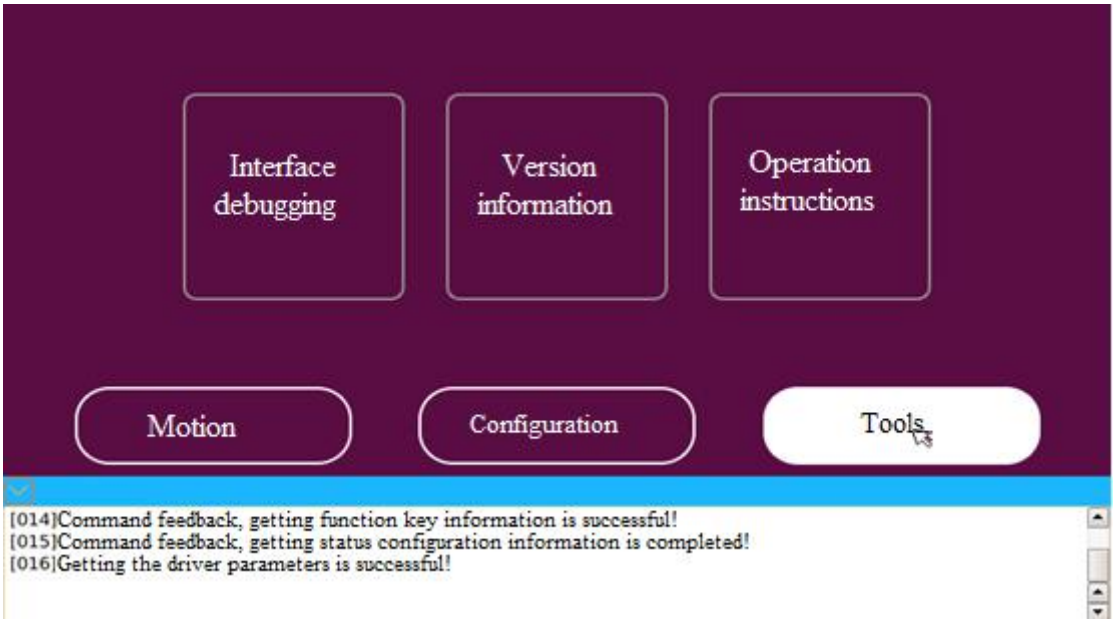


Fig. 2.10 “Tools” Composition Picture

◆ **Interface Debugging**

The function of “interface debugging” is mainly for the purpose of making it convenient for the user to test the state of the external equipment connection during manual teaching, and judging whether the expected effect can be achieved. It mainly composed of four parts of “set up the test authority”, “set the output port”, “monitor the input port” and “set the analog quantity”, as shown in Fig. 2.11.

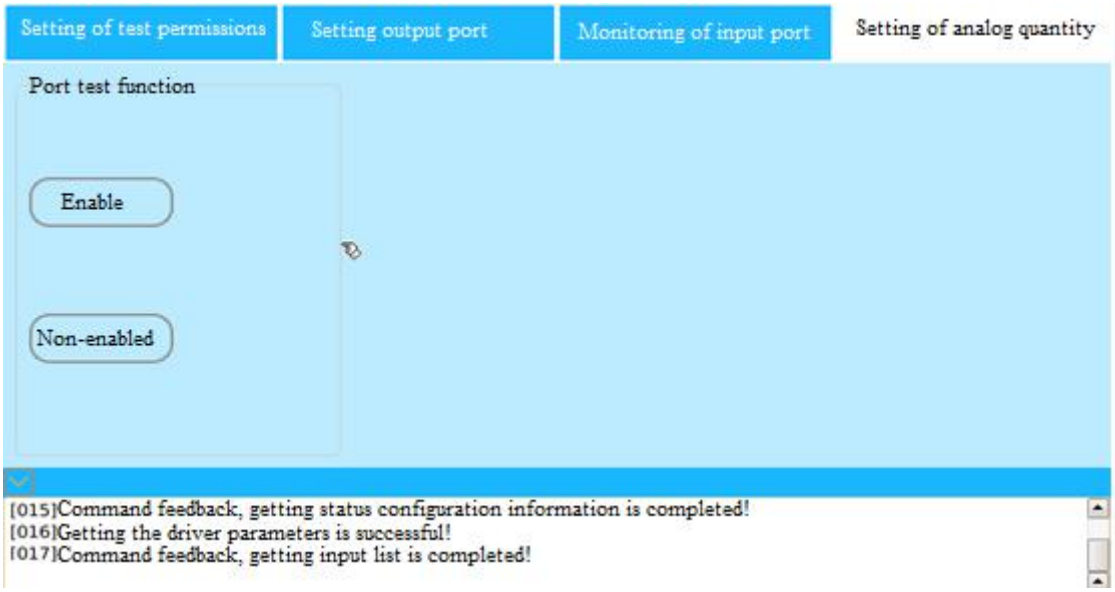


Fig. 2.11 “Interface Debugging” Structure Composition Picture

(1) Set the test authority: When using the “interface debugging” tool, the “test authority” should be set firstly, and as shown in Fig. 2.11; click the “enabling” button, and the “test authority” setting is successful; when not in use, you can click the “non-enabling” button to close the test authority .

(2) Set the output port: After “set test authority” is completed, I/O output port status can be tested.

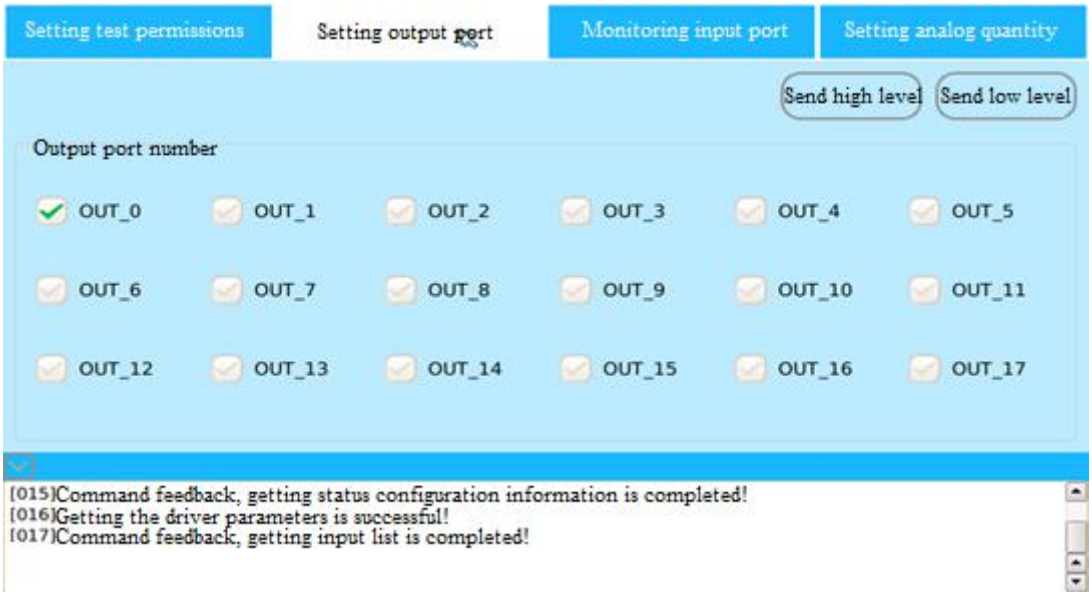


Fig. 2.12 Setting Output Port

As shown in Fig. 2.12, you can test each output port status by selecting the 18-way I/O output port in output port number “0-17”; and then send a “high/low electrical level” to test each output port status. The control system provides an 8-way relay output with the serial number of “0-7”, a 10-way collector open circuit with the serial number of “8-17”, and the 18-way I/O output port initial state defaults to the low electrical level “0”.

(3) Monitoring input port: I/O input port monitoring is also performed after the “test authority” setting is completed. As shown in Fig. 2.13, the control system represents different status with different colors, and the “grey” represents an external “no signal” access system, i. e., a low electrical level (the system initial state is low electrical level), and the “Yellow” represents an external “signal” access system, i. e., a high electrical level.

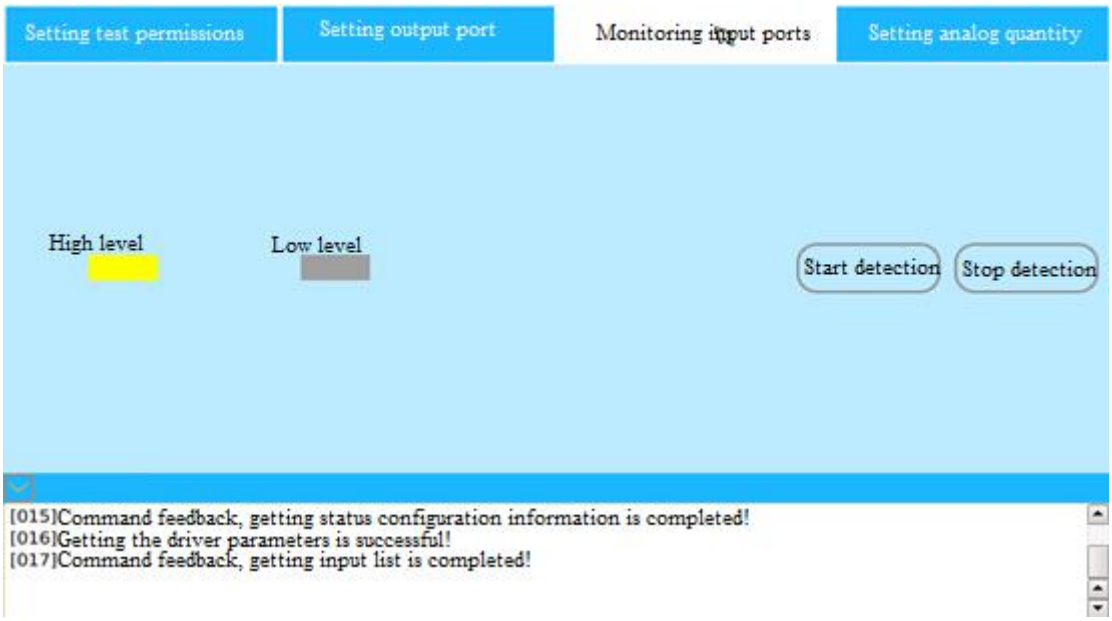


Fig. 2.13 Monitoring Input Port

As shown in Fig. 2.14, clicking of the “start monitoring” button represents the start of monitoring of the I/O input port. When the external input is high electrical level, the corresponding I/O port displays “yellow”; the I/O

port displays “grey” represents that the external input of the port is low electrical level.

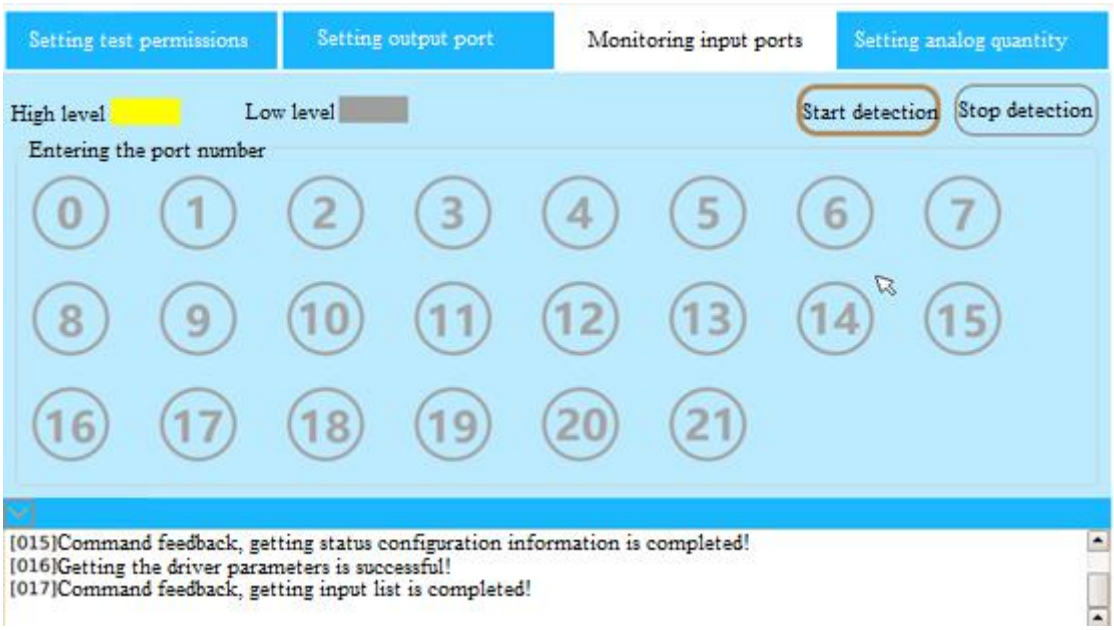


Fig. 2.14 Monitoring the Input Port

The control system provides 20-way I/O port input, and the sequence number is 0-19; the initial state of the port is low electrical level “0” by default, and the external use of 20-way photo-coupling isolation input requires drop-down.

(4) Set the analog quantity: After “set the test authority” is completed, the analog quantity output can be set.

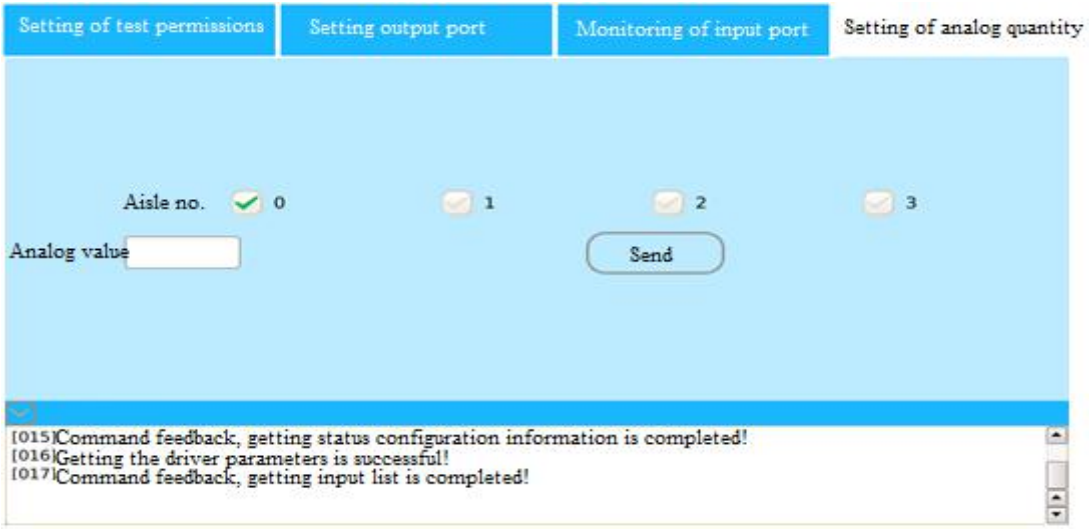


Fig. 2.15 Setting of the Analog Quantity

The control system provides 4 analog aisles of “0”, “1”, “2” and “3”. The analog value can be output, and the analog value range is 0 V-12V. As shown in Fig. 2.15, the analog quantity “aisle no.” should be selected firstly, the “analog value” should be determined, and then click the “send” button to set the “analog value” output to the corresponding analog aisle. After the “analog value” is sent out, the “analog value” of the “Analog Aisle” has determined. “Tools” of the “exit” or the “close” does not affect the “analog value” of the analog value, but the “analog value” output by the “Analog Aisle” can be modified. Four Aisle “analog value” will return to the initial value “0V” after power-on reboot of the control system.

◆ **Version information**

"Version information" is related procedure information of current control system. After clicking into the "version information", you can view specific information about the "machine code", "controller system version number", "indicator system version number", "authorization status", and "copyright" of the control system, as shown in Fig. 2.16.

Fig. 2.16 System "Version Information"

◆ **Operation instructions**

In this "operation instructions", the operating manual of the control system is stored, and the operation instructions includes some basic operation steps for debugging of the control system, preparation work before operation and solution method of error feedback.

2.4 Login of the System

After power-on reboot of the control system (220V single-phase alternating current), login interface appears on the teaching box screen, and there are three login modes of administrator, operator and browser, as shown in Fig. 2.17 below.

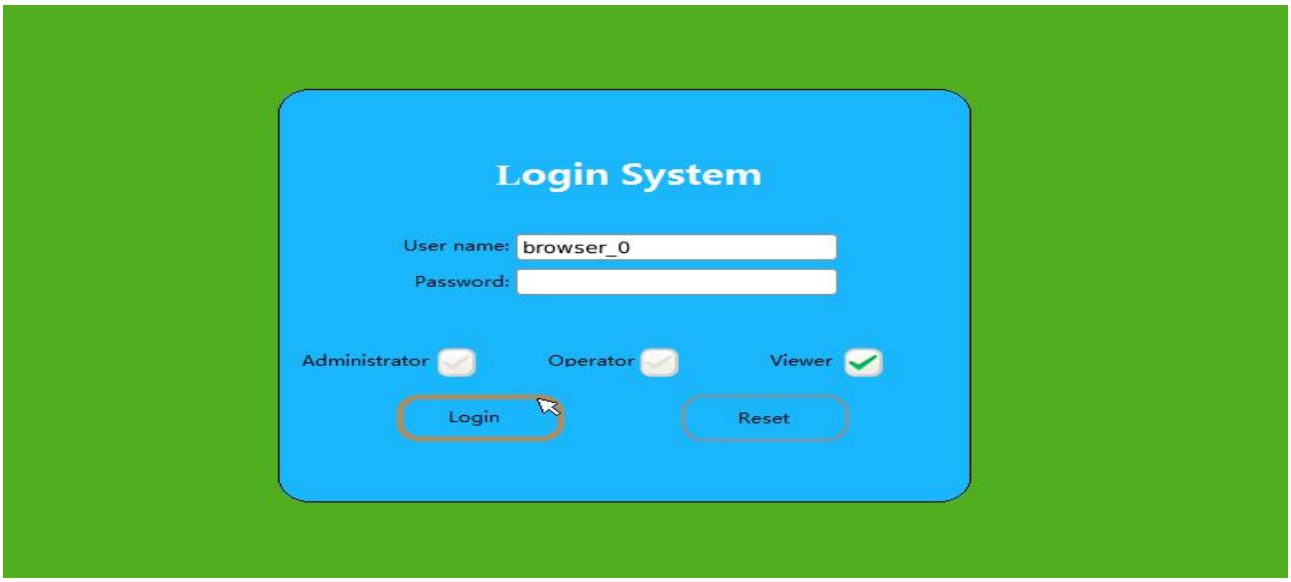


Figure 2.17 System Login Interface

Different user login mode different has different permissions. The login permissions are divided into "administrator" mode login, "operator" mode login and "browser" mode login respectively from high to low.

Administrator mode—User Name: **admin** Password: **admin** "Administrator" mode login permissions are the highest, and you can change all operations such as machine parameters, driver configuration, editing procedures, and running procedures, and the administrator mode is generally used as maintenance for the system.

Operator Mode—The "operator" mode login permissions are slightly lower, and the machine parameters and system configuration cannot be changed, but operations such as procedure creating and managing and procedure running can be done.

Browser Mode—The "browser" mode login permissions are the lowest, and only the system can be browsed, and no other operation can be carried out.

3. Preparation Work before Running

After logging into the system, you can not directly use the system "programming", and you need to complete some preparation works before you run the control system. The preparation works are **(1) the driver configuration; (2) I/O port configuration; (3) machine parameter setting; (4) zero position angle setting.**

3.1 Driver Configuration

Enter the manual software interface of the control system (as shown in Fig. 2.4); select **[Configure] — [Interface Configuration] — [Driver Configuration**]; set the "driver serial number" and "driver type" according to the external servo of the control system. After the configuration is completed, select "Store" to complete the configuration, as shown in Fig. 3.1 below.

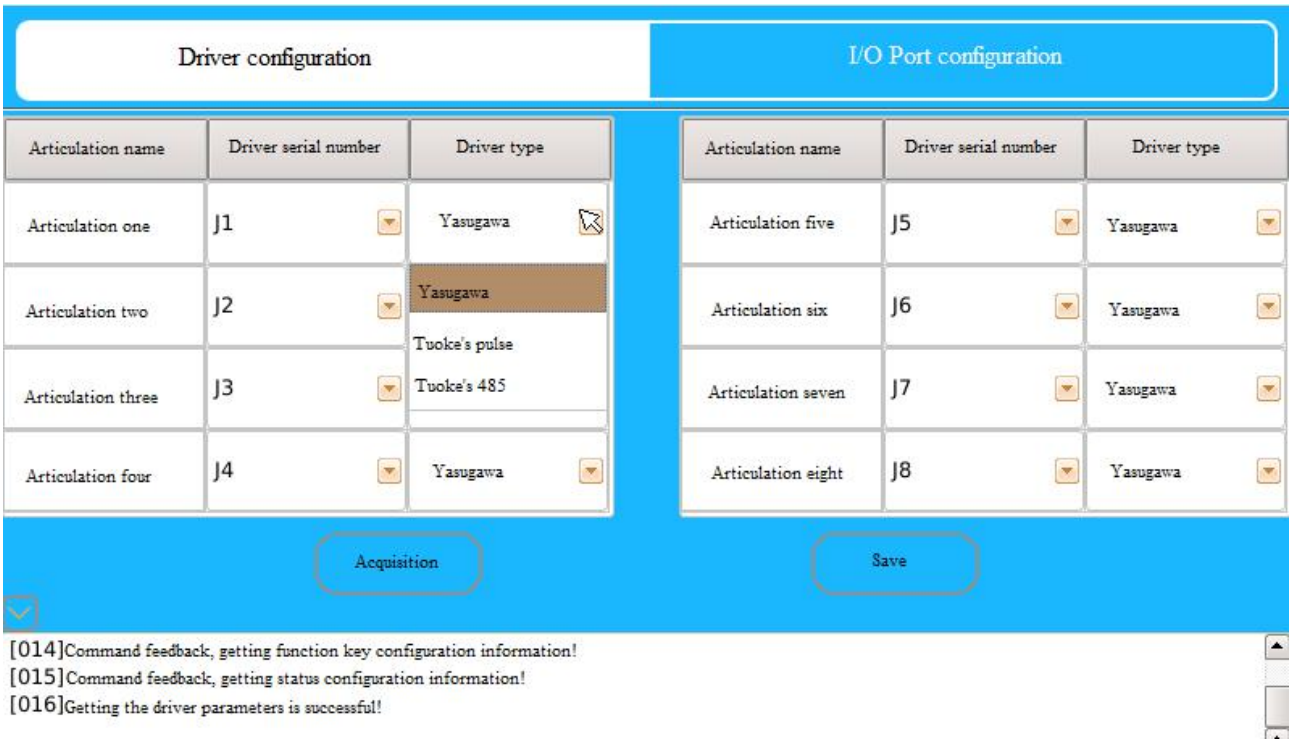


Fig. 3.1 Driver Configuration Picture

The "Driver serial number" is set according to the mechanical arm of the robot body specifically according to the interface of the control system, such as the "Articulation I" and the "J1" setting, that is to say, the control

system pulse driver interface “J1” controls the first articulation of the robot body. The “Driver type” is setting of the specific installed driving servo type, which is determined by the specific configuration of the robot. The system currently supports three driving servo types of “Ankawa driving”, “Tucco pulse driving” and “Tucco 485 driving”.

When the [Obtain] button is clicked, the “Initial” configuration of the system appears. Each “articulation” is in one-to-one correspondence with the “Driver serial number”, and the “Driver type” is the “Yasugawa” driving servo.

3.2 I/O Port Configuration

The control system provides some special functions, such as “Pause”, “Go on”, “Return to zero”, “Switching of work mode”, “Running to start point” and “Emergency stop”, etc. These functions can be arbitrarily configured with I/O ports, so that the user can use the system more flexibly and conveniently. Select the path [Configuration] — [Interface configuration] — [I/O port configuration] to enter the “I/O Port configuration interface”, as shown in Fig. 3.2, and the “I/O Port configuration” is divided into “Functional port configuration” and “Indication port configuration”.

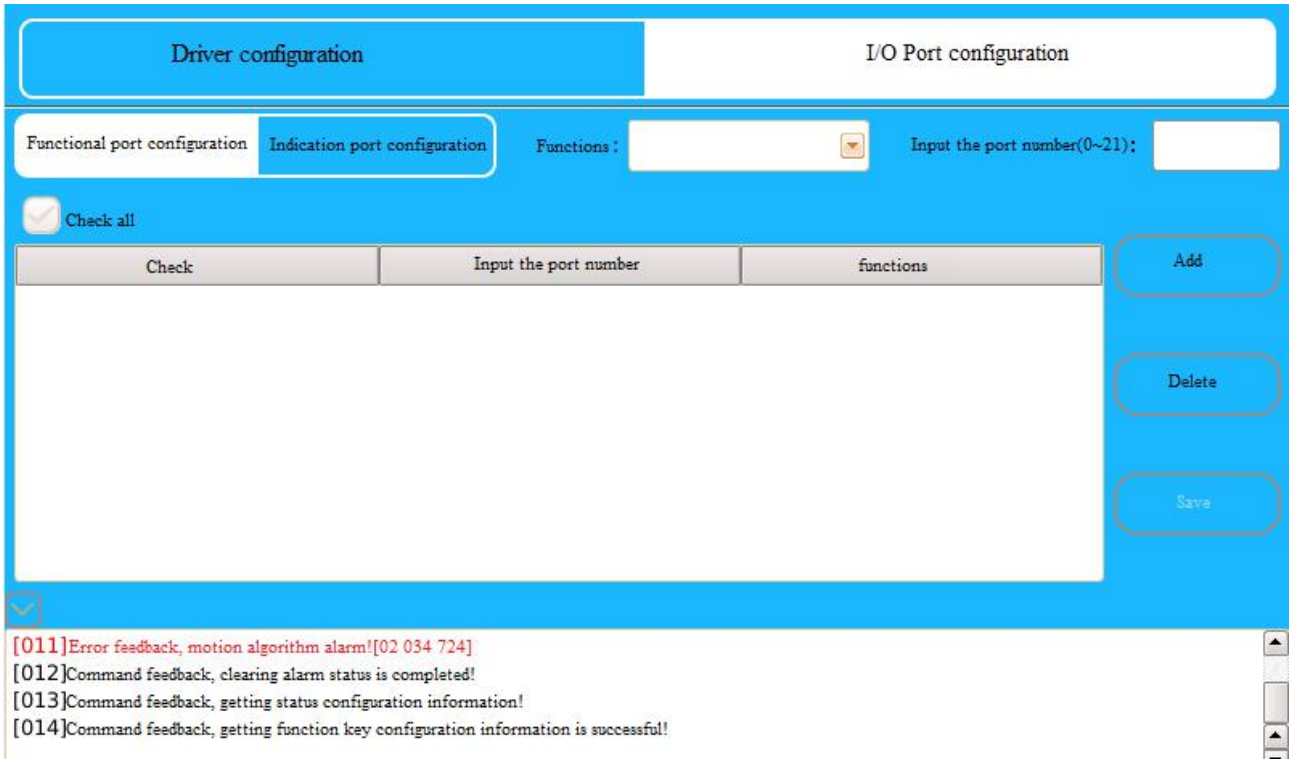


Fig. 3.2 I/O Port Configuration

(1) Functional port configuration: The control system provides 7 special functions of “emergency stop”, “Switching Mode of Work”, “Go on”, “Pause”, “returning to zero”, “Running to start point” and “Launching Procedure”. I/O input port number is “0-21”. You can configure these functions arbitrarily, as shown in Fig. 3.3. The same special feature allows different I/O input ports to be configured, but only one special function is configured for the same I/O input port, and in order to take effect, the “Save” button needs to be clicked after the “Add” is configured; I/O input ports cannot be used again as common I/O input ports if special functions are configured, but after the special functions configured of the “I/O input port” are “deleted” , the “I/O input port” becomes the common I/O input port again.

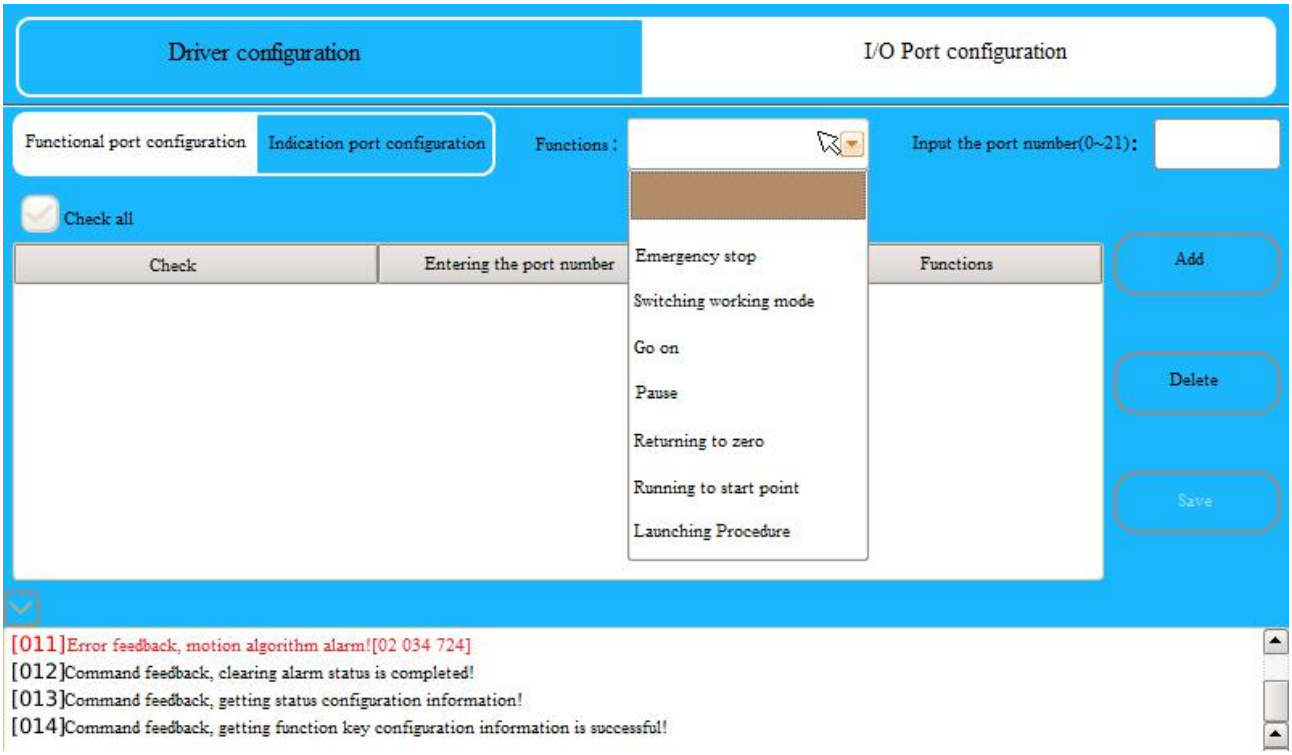


Fig. 3.3 Functional Port Configuration

(2) Indication port configuration: The control system provides three special functions of "Operation instruction", "Servo status" and "Alarm status" for "8-17" 10-way "I/O output port" configuration, as shown in Fig. 3.4. The "I/O output port" configuration format is consistent with the "I/O input port" configuration function."

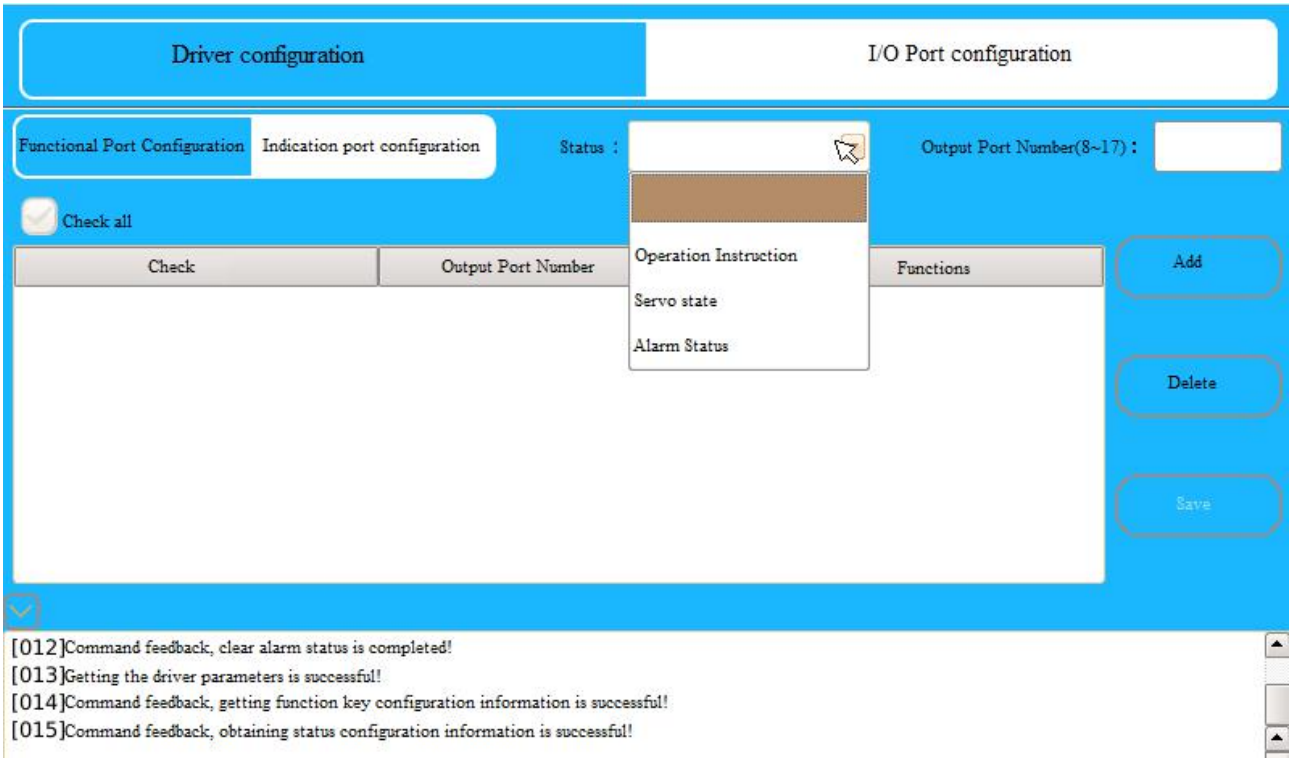


Fig. 3.4 Indication Port Configuration

3.3 Machine Parameter Setting

Setting of machine parameters includes setting of link length, reduction ratio, articulation positive/negative limit, maximum speed, PNOUT, PNIN, and coding direction, as shown in Fig. 3.5 below.

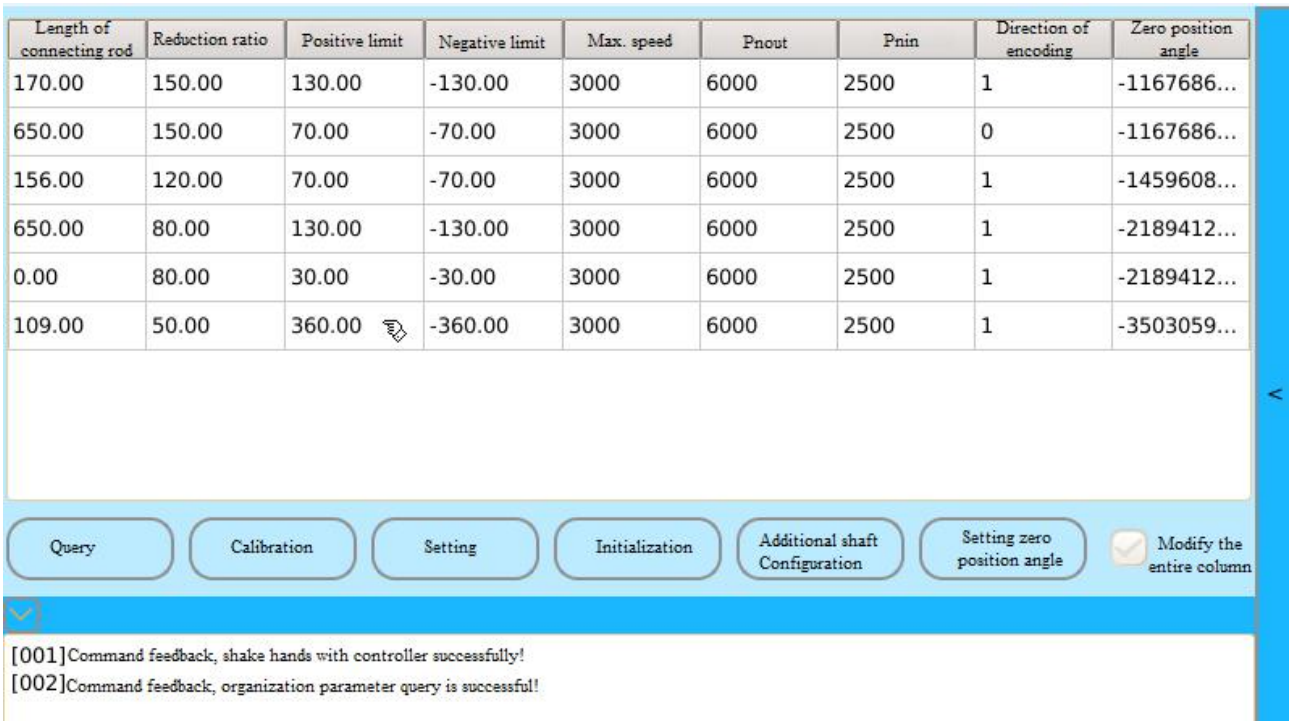


Fig. 3.5 Structure Diagram of The Machine Parameters

(1) Link length — length of each articulation mechanical arm body, in mm

(2) The reduction ratio is determined by the specification of the speed reducer of each articulation, and the reduction ratio value of the speed reducer can be input.

(3) Articulation positive/negative limit — The rotation angle of the robot body is limited, that is, “Hard limit”. For machine safety, the angle of rotation of the mechanical arm should be controlled by procedure, that is, the “Soft” limit should be set, and the value should not exceed the “Hard limit” category (otherwise it is meaningless to set the “Soft” limit)

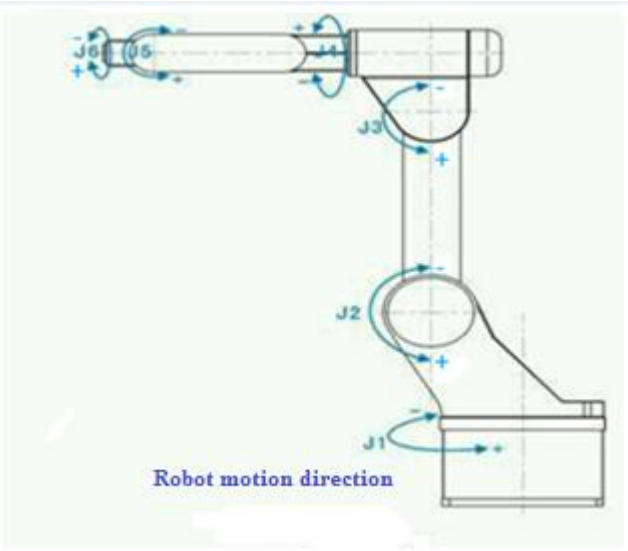
(4) Maximum rotating speed — should be set according to the motor specifications of each articulation, and should not exceed the rated speed of the motor.

(5) PNOUT — Setting 6000, system setting cannot be modified

(6) PNIN — Setting 2500, the system setting cannot be modified (if the driving type is “Tuco 485 number” driving servo, the motor encoder “Digits” is indicated, for instance, the motor encoder digit is “23”, it is set to “23”)

(7) Coding direction — Articulation motion direction is determined using “Right-hand screw rule”. The motion direction of each articulation of the machine body is set as the motion direction of the following fig. “Robot motion direction”, and the “J+” and the “J-” correspond to the positions of the matrix switches on the film switches of the teaching device in the manual teaching system. If the direction of the articulation motion and the orientation of each articulation of the robot in the figure are different, you need to modify the value of the “coding

direction” in the parameter to make them consistent (if it is 1originally, modify it to 0; if it is 0 originally, modify it to 1).



The direction of motion of each articulation identified when a person stands at the rear of the robot body

After input of each machine parameter is completed, click button [Establish] — [Query], and the “Machine parameters” are set successfully (the “Information output” under the screen will also have corresponding information feedback).

3.3.1 Additional Shaft Arrangement

The control system is provided with eight pulse driver interfaces of “J1 – J8”, so that eight axes can be controlled simultaneously, and six interfaces are normally used. When the “J7” and the “J8” pulse driver interfaces are externally connected with the articulation shaft, the control system is also called an “additional shaft”. The “J7” shaft is configured as an “Additional shaft_0” in the control system, and the “J8” shaft is configured as an “Additional shaft_1”.

(1) “Additional shaft” use mode: the control system provides 3 modes for use of the additional shaft, as shown in Fig. 3.6 of “Additional shaft use mode”, respectively, a. articulation mode; b. speed mode; C. tracking mode.

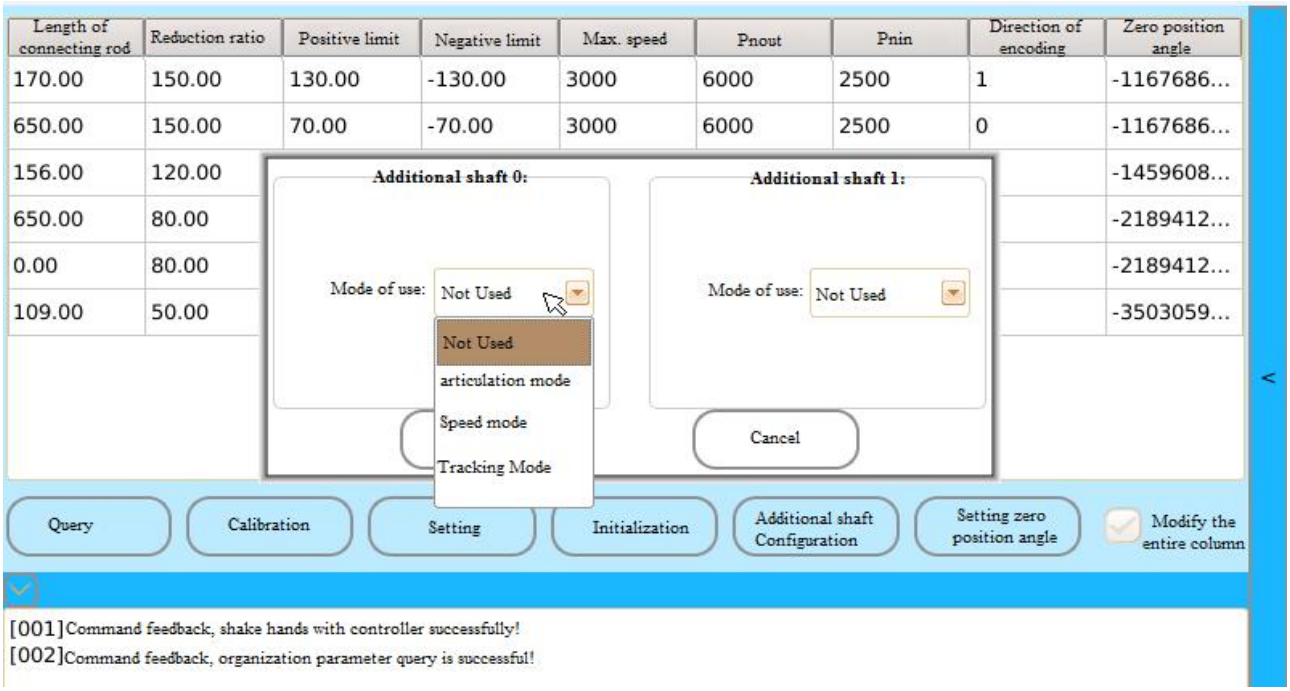


Fig. 3.6 Additional Shaft Use Mode

a. Articulation mode: When the "Additional shaft" is set to "Articulation mode", the "Additional shaft" is in the same use as that of the six common "Articulation shafts" of "J1– J6".

b. Speed mode: When the "Additional shaft" is set to "Speed mode", it is necessary to set the "Acceleration time" and the "Speed", as shown in Fig. 3.7.

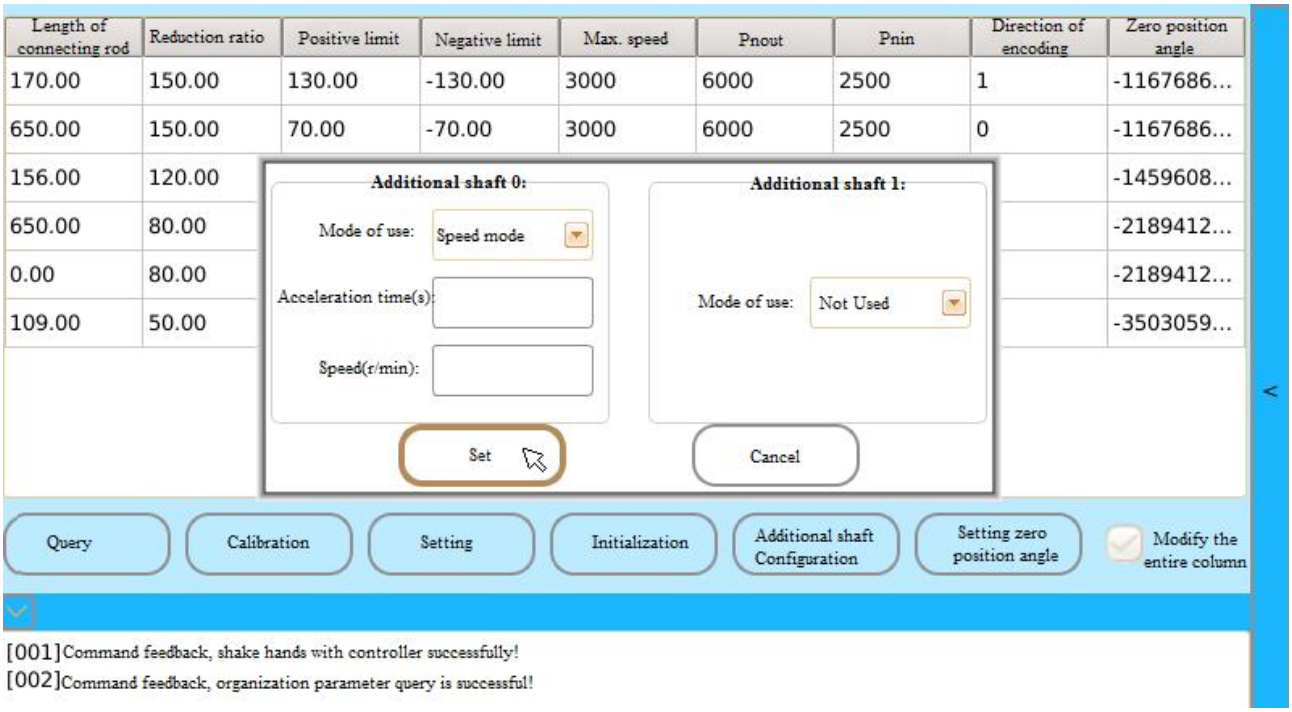


Fig. 3.7 Additional Shaft "Speed" Mode Setting

When the "Additional shaft" is set to the "Speed" mode, the "additional shaft" sequence number, the "Start/Stop" additional shaft motion and the "Positive/Negative" rotation direction can be set by the programming instruction "Additional shaft motion" during programming, as shown in Fig. 3.8.

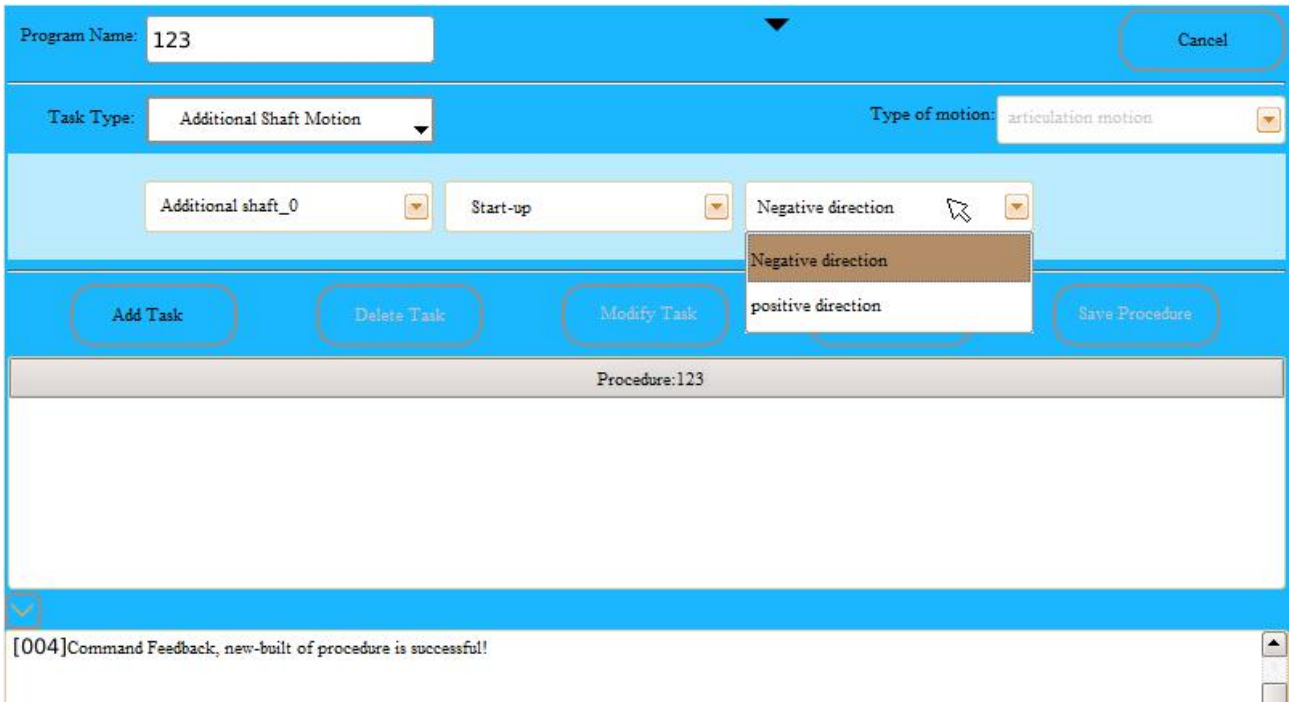


Fig. 3.8 “Additional Shaft Motion” Task Type Setting

c. Tracking mode: After the “Additional shaft” is set to “Tracking mode”, it is mainly applied in the “Tracking function”, so that the “Pipeline” motion tracking can be realized by using the “Additional shaft”.

(2) “Additional shaft” application: After completing setting of the additional shaft “Driver configuration” and the “additional shaft using mode”, click the “Setting”_ “Query” keys in “Additional shaft using mode” to complete setting of the additional shaft. As shown in Fig. 3.6.

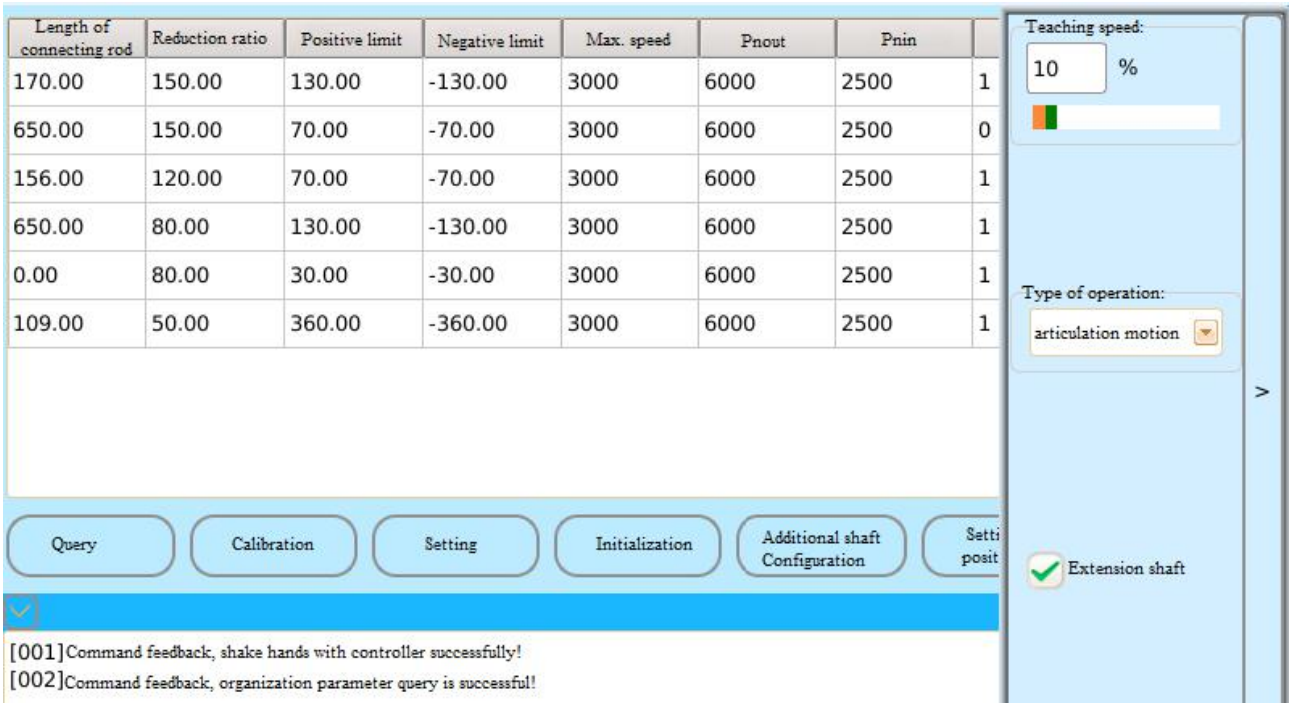


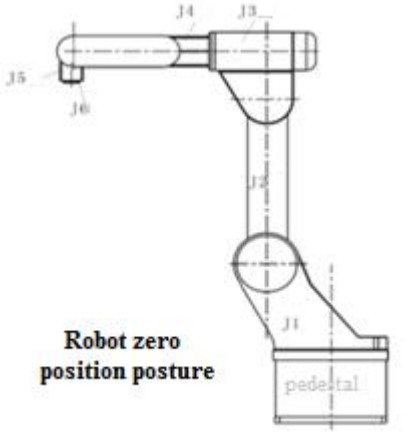
Fig. 3.9 Additional Shaft Application

As shown in Fig. 3.9, after the “Additional shaft” is configured, you can click the small arrow mark on the right side to pop up a frame, and then click the check box in front of the “Extension axis” to select the “Extension

axis", and you can manually teach the additional shaft motion through the "J1" and the "J2" of the film matrix switches on the teaching box. At this time, "J1" can control the motion of the "J7" shaft, and "J2" can control the motion of the "8" shaft.

3.4 Zero Position Angle Setting

It is an important step to set up the system "zero position angle" before the system runs because the posterior reading of the articulation angle of the "point" is positioned taking "zero position angle" as the reference point.



Robot zero position posture

As shown in the picture on the left, move each articulation of the robot body to each position in the left picture, and click the button [Setting zero position angle] — [Query] on the "Machine parameter setting" interface (as shown in Fig.e 3.5); setting is successful.

After the system "Zero position angle" is successfully set, the angle value verification of each current articulation can be read, and when the angle value is displayed as "0", setting is successful. Validation path: [Motion] — [Procedure control] — [Procedure management] — [Point] — [New-built]. Click "Read current articulation angle" to display the articulation angle.

4. Procedure Control

After all preparations are ready before running of the control system, the system can be formally used to carry out operations such as "Manual teaching" and "System programming" and "Procedure running". Returning to the manual software interface of the system, click [Motion] to enter the [Procedure control] interface, and the "Procedure control" mainly carries out a series of editing and processing on the procedure, and includes the creation of the "Basic procedures", the creation of the "Modularization procedure", the creation of the "Process pack" procedure, and "Procedure management" as shown in Fig. 4.1.

Fig. 4.1 Structure Composition of Procedure Control

4.1 Creation of Basic Procedure

In manual teaching mode, as shown in Fig. 4.1, click the [Basic procedure] icon to enter the “Basic procedure” creation interface, you can create “Basic Procedure” here.

4.1.1 Creation and Cancellation Of Procedures

After entering the procedure creating interface, the name of the procedure should beestablished firstly. As shown in Fig. 4.2 below, enter the “XXX” procedure name at the “Procedure name”; click the “New-built” button in the upper right corner, and the procedure name “Procedure: XXX” will appear in the middle space on the upper line, and the “New-built” button will become the “Cancel” button. The fact indicates that creation of the procedure name is completed; Click the “Cancel” button to cancel the whole current procedure operation.

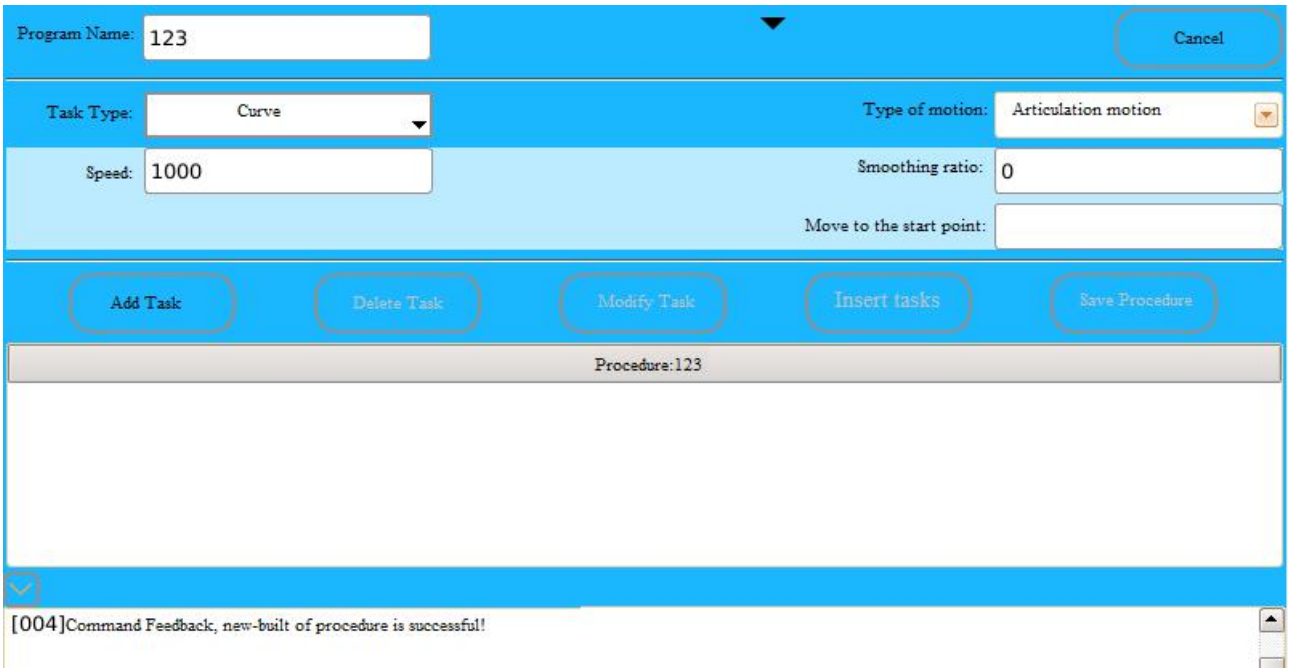


Fig.4.2 Creation of a Procedure Name

4.1.2 Types of Tasks And Classification of Motion Types

Task Type

The “Task type” can be divided into two categories: curves and non-curves. Non-curves include 8 task types of “Output”, “Analogue quantity”, “Additional shaft motion”, “Global variable”, “Forbidden shaft”, “Time delay”, “Waiting for an event”, and “Logical instruction”. The task type in the “Modularization procedure” should be added with the “PCALL” task type, which is the calling of “Subroutine” command, as shown in Fig. 4.3 below.

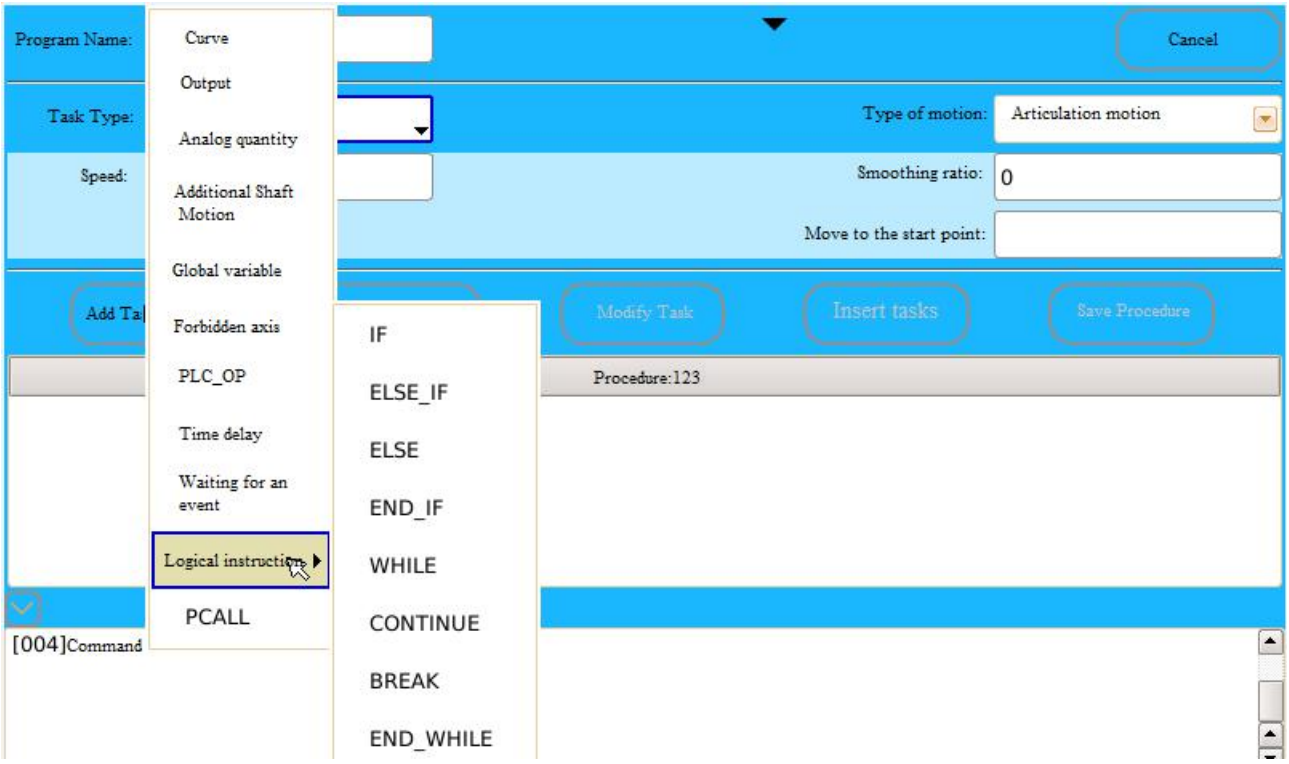


Fig. 4.3 Composition Diagram of Task Type

a. Curve task type: Curve needs 2 “Point”, including “Starting point” and “End point”. In a complete procedure, if there is a curve, the start point P of the entire procedure is the end point S of the last curve, and the end point S runs to the start point A (this is the first step setting point in the build-up curve after the procedure is created) to form a closed loop. The “Starting point A” established in the first step is not the “Starting point P” of the entire procedure (o be distinguished, the underlying “PCALL” generated by the modular procedure established when the “subroutine” is invoked at the back).

b. Non-curve task types: During the creation of “Basic procedures”, the system provides 8 types of tasks, such as “Output”, “Analogue quantity”, “Additional shaft motion”, “Global variable”, “Forbidden shaft”, “Time delay”, “Waiting for an event” and “Logical instruction”. The specific usage as follows:

(1) The “Output” task type needs to be used with the I/O port, and the system provides an 18-way I/O port output, including an 8-way relay output and a 10-way collector open circuit. After select the “Output” task type, enter the corresponding value in the “Output port number” and “Input electrical level value” prompt boxes, and click the “Add task” button to complete the operation, as shown in Fig. 4.4.

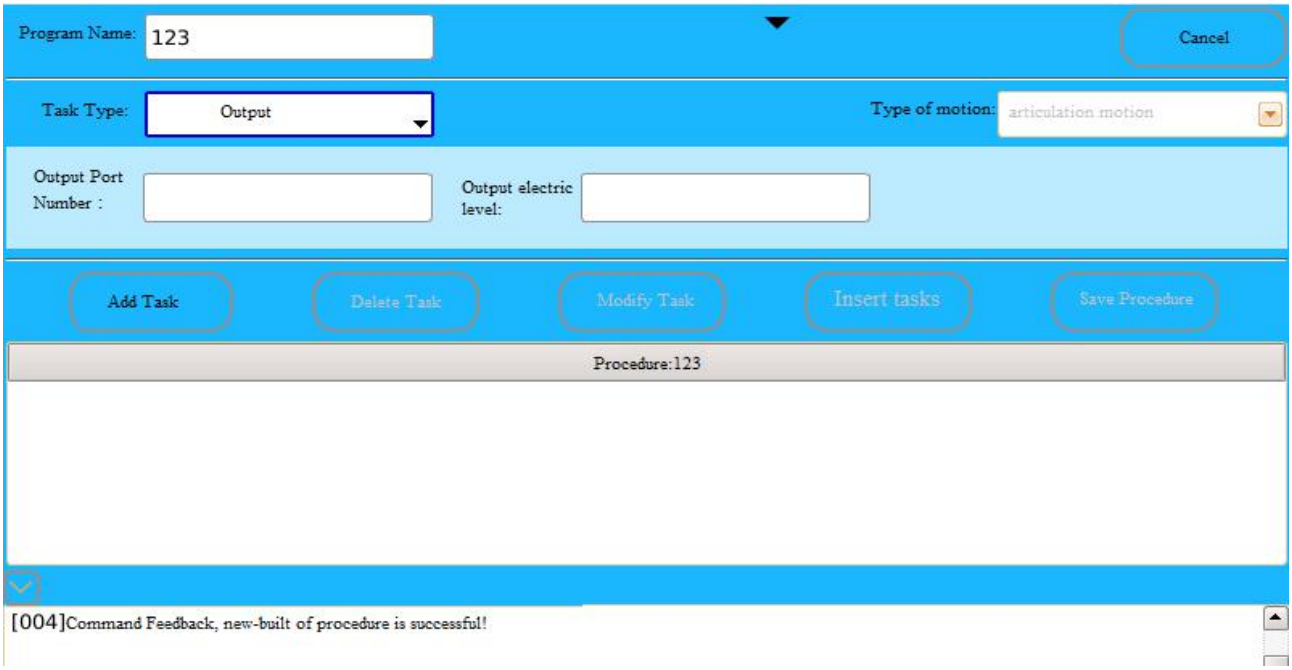


Fig. 4.4 “Output” Task Types

The I/O output port output electrical level value is only two types of low electrical level “0” and high electrical level “1”, and the system initial state defaults to all I/O output ports low “0”. If the output port is multiple, it can also be connected by connecting the connector “-” in the middle of the port serial number, and the value of each output port in the “Output level value” is also connected with the connector “-”, and the one-step editing is completed. If the middle numbers of the output port numbers are “8-9-10”, and the middle numbers of the output electrical level value is “1-0-1”, the I/O output port “8” and “10” output a high electrical level “1” while the I/O output port “9” outputs a low electrical level “0”.

(2) “Analogue quantity” task type — The system provides 4 analogue quantity output aisles which are “0”, “1”, “2” and “3” respectively. The value range of “Analogue value” is 0-12V, as shown in Fig. 4.5.

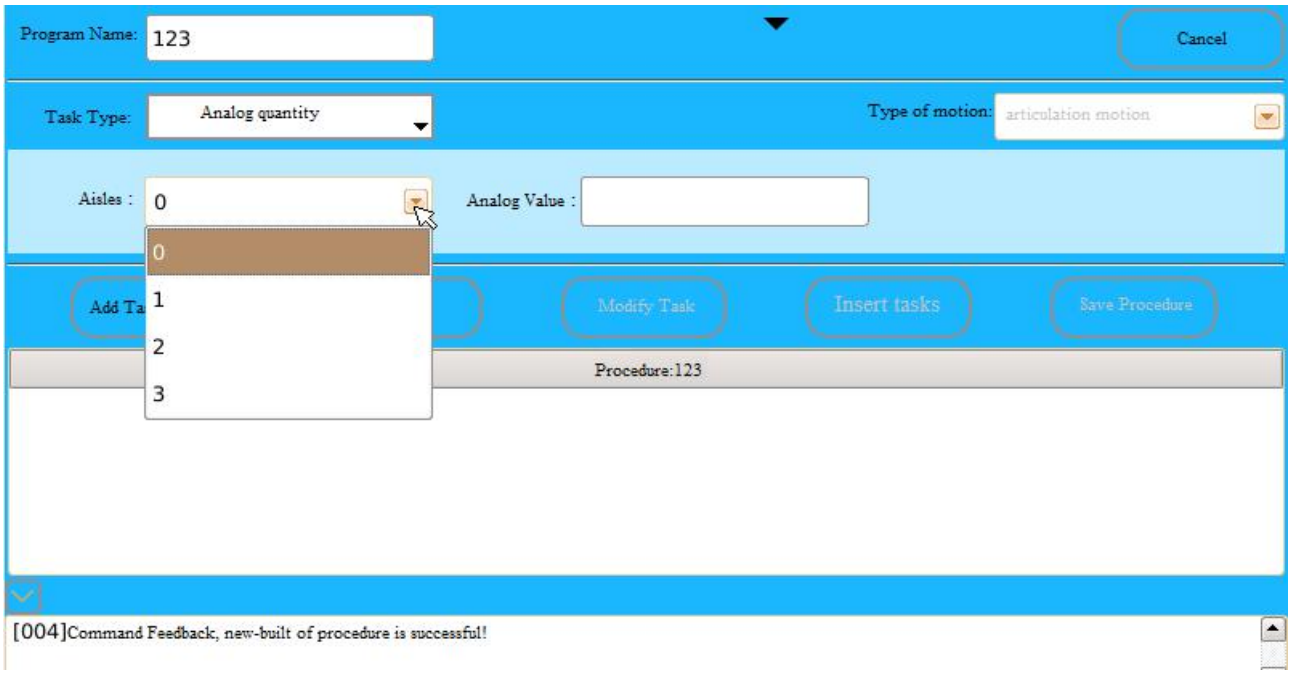


Fig. 4.5 “Analogue Quantity” Task Types

(3) "Additional shaft motion" task type — When the additional shaft is set to "Speed mode", the "Additional shaft" can be set "Start-up" and "Stop" through the "Additional shaft motion" task type, wherein the "Additional shaft_0" represents the J7 shaft, and the "Additional shaft 1" represents the J8 shaft; the "Positvie direction" and the "Negative direction" rotation directions can be set when the additional shaft "start-up" is added, as shown in Fig. 3.8.

(4) "Global variable" task type — The "Global variable" can be defined and assigned to and "Operation" for the "Global variable", as shown in Fig. 4.6.

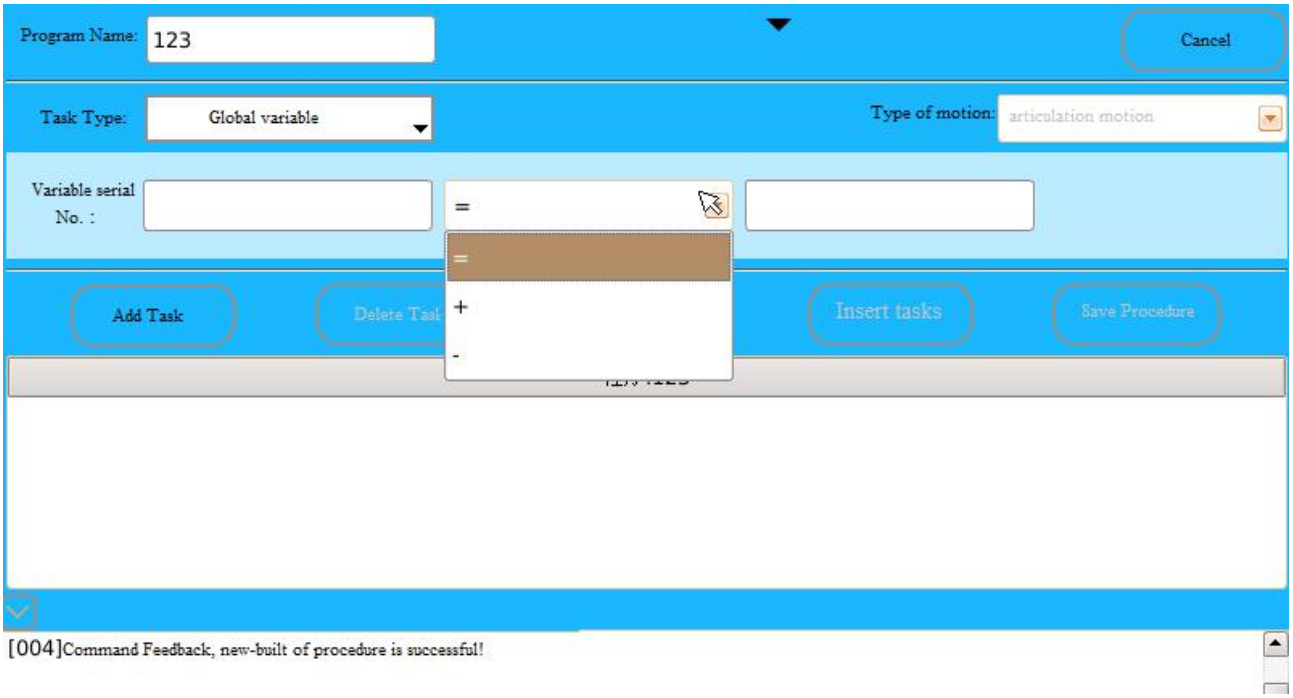


Fig. 4.6 "Global Variable" Task Types

(5) The "Forbidden shaft" task type — When the "Additional shaft" is set to "Articulation mode", the "Additional shaft" can be set as "Enable additional shafts" or "Disable additional shafts" through the "Forbidden shaft" task type, wherein the "Additional shaft_0" represents the J7 shaft, and the "Additional shaft_1" represents the J8 shaft.

(6) "Time delay" task type — when the "Time delay" task type is selected, enter a number at the "Delay time" in milliseconds, and click "Add task", as shown in Fig. 4.7.

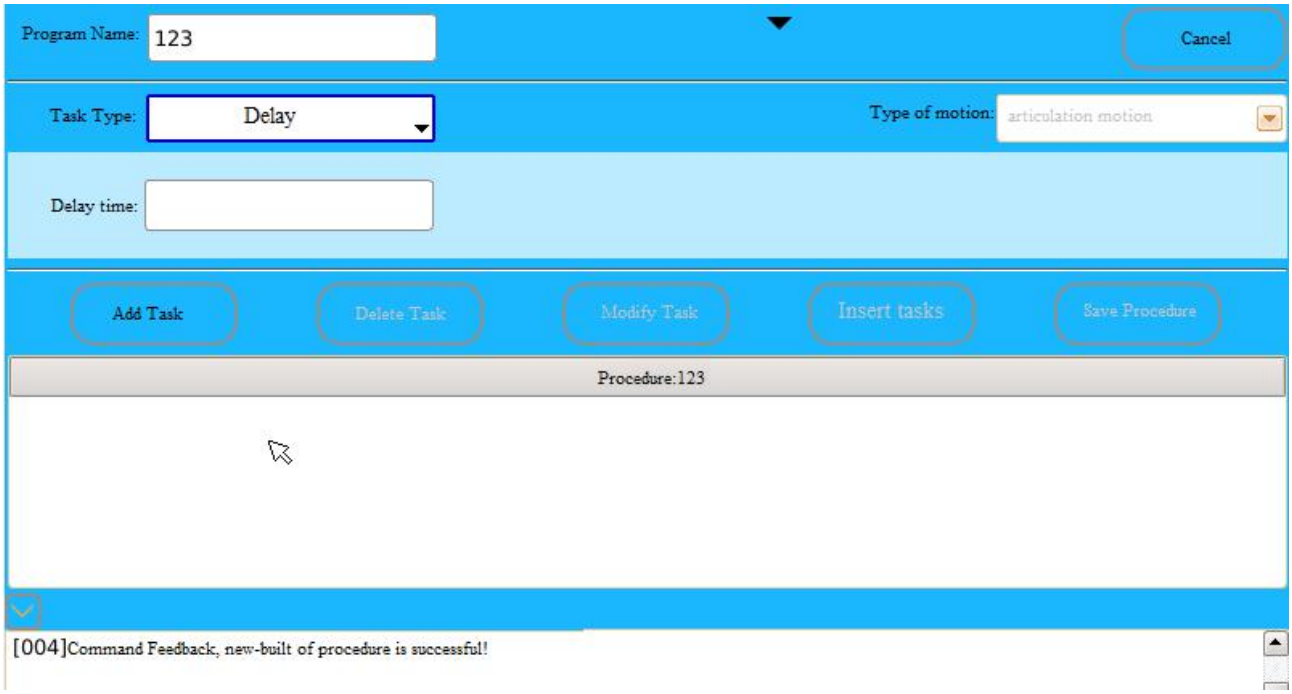


Fig. 4.7 “Time Delay” Task Types

(7) The “Waiting for an event” task type — the “Waiting for an event” task type should be used with the I/O port, and the system provides 20-way coupling isolation input port. After selecting the “Waiting for an event” task type, enter the corresponding value in the “Enter the port number”, “Input electrical level value” and “Event relationship” prompt boxes as shown in Fig. 4.8. Click the “Add task” button to complete the operation, as shown in Fig. 4.8.

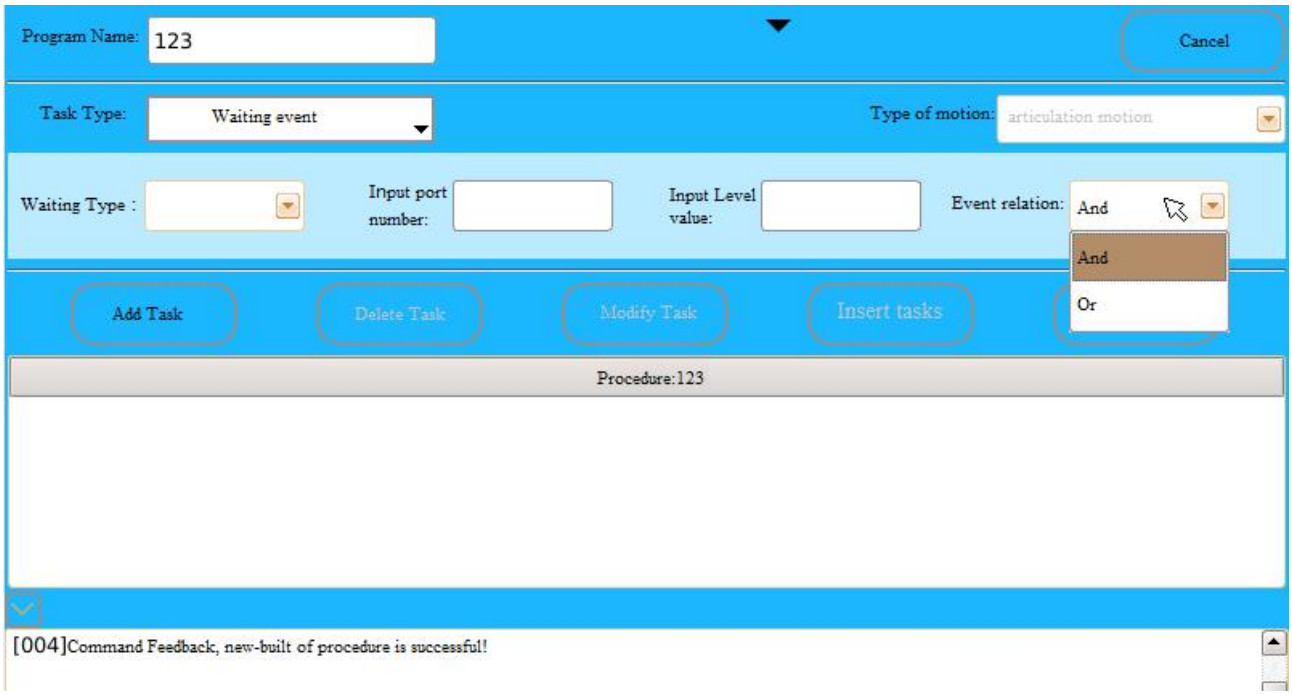


Fig.4.8 “Waiting for an Event” Task Types

The same as “Output task”, “Input level value” has “Low electric level” and “High electric level”, the initial state of the system is low electric level “0”; Or between a plurality of input port numbers and an input level value. You can also use “-” to connect to implement one-step process to edit multiple IO input port wait events.

The “Wait an event” task type is also different from the “Output” task type, and there is a “event relationship”_“contrary to” and a “or” relationship between them when multiple input ports of the “wait an event” task type are connected to the system at the same time. if the median value of the input port number is 1-2-3, the input level value is 1-0-1, the event relationship is the same, the representative only meets the I/O input port 1 and 3 input high level 1 at the same time, The input port “2” is at the low level “0”, and the three conditions can continue to run next, otherwise it can only continue to “wait” and stop in this position; Similarly, if the median “Enter the port number” is “1-2-3”, the “Input Level Value” is a “1-0-1”, and the “event relationship” is a “or”, it is indicated that only one or more of these three conditions need to be met to continue the subsequent procedure execution.

8) The “Logical instruction” task type — “Logical instruction” task type contains “IF”, “ELSE_IF”, “ELSE”, “END_IF”, “WHILE”, “CONTINUE”, “BREAK” and “END_WHILE” 8 logic instructions, and the basic procedure can be built up greatly by using these logical instruction sets.

IF instructions: Condition judgment instructions for use with ELSE, ELSE_IF, END_IF.

Instruction Format: a. IF... END_IF；

b. IF...ELSE...END_IF；

c. IF...ELSE_IF...ELSE...END_IF；

A. judging whether the content in the IF condition is satisfied; if the condition is true (condition), executing the following procedure; If the condition is false (the condition is not satisfied), the procedure does not perform the content contained in the “IF...END_IF”.

B. judging whether the content in the IF condition is satisfied; if the condition is true (condition), executing the content contained in the “IF...ELSE”; If the condition is false (the condition is not satisfied), the procedure executes the content contained in the “ELSE...END_IF”.

C. If multiple conditions are needed for judgment, “IF...ELSE_IF...ELSE...END_IF” format instructions (where ELSE_IF can be used multiple times in one “IF...END_IF”, ELSE can also be used).

Each IF must correspond to an END_IF, i. e. “IF...END_IF”.

For example:

```
GLOBAL_VAR_OP:GV_0 = 0    // Set global variable 0, and assign GV_0 为 0
IF(GV_0 == 0)             IF Condition
OUTPUT:Y1 = 1             // I/O output port 1 outputs high potential “1”
ELSE_ IF(GV_0 == 1)       // ELSE_IF Condition
OUTPUT:Y1 = 0             // I/O output port 1 output low potential “0”
ELSE
OUTPUT:Y1 = 0             // I/O output port 1 outputs high potential “1”
OUTPUT:Y2 = 1             // I/O output port 2 outputs high potential “1”
END_IF                    // IF procedure ended
```

Procedure description: if condition GV_0==0, Y1=1; If condition GV_0==1, Y1=0; Y0=0, Y2=1 if both conditions are not satisfied.

WHILE instruction: Cyclic instructions for use with END_WHILE.

Instruction format: WHILE...END_WHILE

When the condition behind WHILE is satisfied, that is, the condition is true (condition), the procedure in the "WHILE...END_WHILE" is executed until the condition after WHILE is false (the condition is not satisfied), and then the WHILE loop is retired.

Each WHILE must correspond to an END_WHILE, that is, a "WHILE...END_WHILE".

For example:

```
GLOBAL_VAR_OP:GV_0 = 0        // Set global variable 0, and assign GV_0 to 0
WHILE (GV_0 < 3)              // WHILE condition
GLOBAL_VAR_OP:GV_0 = GV_0 + 1    // global variable plus 1
OUTPUT:Y2 = 1                 // I/O output port 2 outputs high potential "1"
END_WHILE                     // WHILE Cycle End
OUTPUT:Y2 = 0                 // I/O output port 2 output low potential "0"
```

Procedure description: If GV_0 <3, GV_0=GV_0+1, Y2=1; Otherwise, Y2=0, that is, if the condition is not satisfied after 3 output Y2=1, the WHILE cycle is finished, and the output Y2=0.

BREAK instruction: terminate the loop instruction.

The BREAK instruction is used in the middle of the "WHILE...END_WHILE" instruction to terminate the "WHILE...END_WHILE" loop statement. In general, BREAK instructions are used matching with IF...END_IF, and when the condition is satisfied, it jumps out of the loop body.

For example:

```
GLOBAL_VAR_OP:GV_0 = 0//Set global variable 0, and assign GV_0 to 0
WHILE(GV_0 < 10)              // WHILE Condition
IF(GV_0 == 5)                 // IF Condition
BREAK                         // Interrupt Procedure
END_IF                        // Procedure ended
GLOBAL_VAR_OP:GV_0 = GV_0 + 1 // Global variable plus 1
OUTPUT:Y2 = 1                 // I/O output port 2 outputs high electric potential "1"
END_WHILE                     // WHILE Cycle ended
OUTPUT:Y2 = 0                 // I/O Output port 2 outputs low electric potential "0"
```

Procedure description: When IF (GV_0=5) is satisfied, WHILE terminates the cycle, i. e., after five consecutive outputs of Y2=1, IF (GV_0==5) meets the condition. Jump out of the WHILE cycle, and output

Y2=0.

CONTINUE instruction: terminate this loop instruction.

CONTINUE instruction is used in WHILE...END_WHILE instruction.The next cycle is enforced after skipping the remaining statements in the WHILE...END_WHILE circulation body. Normally, the CONTINUE instruction is used in combination with the IF...END_IF, i. e. when the condition is satisfied, it jumps out of this cycle to accelerate the cycle.

For example:

```
GLOBAL_VAR_OP:GV_0 = 0          // Set global variable 0, and assign GV_0 to 0
WHILE(GV_0 < 10)                // WHILE Condition
GLOBAL_VAR_OP:GV_0 = GV_0 + 1   // Global variable plus 1
IF (GV_0 == 5)                  // IF Condition
OUTPUT: Y3 = 1                  // I/O Output port 3 outputs high electric potential "1."
CONTINUE                        // Abort this cycle
END_IF                          // Procedure ended
OUTPUT:Y2 = 1                   // I/O Output port 2 outputs high electric potential "1"
END_WHILE                       // WHILE Cycle Ended
OUTPUT:Y2 = 0                   // I/O Output port 2 outputs high electric potential "0"
```

Procedure description: When IF (GV_0=5) is satisfied, the statement behind this circulation CONTINUE will not be executed (jump out of this cycle, WHILE circulation continues), i. e., after four consecutive outputs of Y2=1, the 5th outputs Y3=1, the sixth, seventh, eighth, ninth consecutive outputs Y2=1; the condition is not satisfied; the WHILE cycle is finished; Output Y2=0.

Type of Motion

The "type of motion" is applied to the "curve" task type, and the system provides four kinds of motion types of articulation motion, linear motion, circular arc motion and circular motion. Both the "circular arc motion" and "circular motion" types of motion need to determine a "point" firstly on the "curve" in the created procedure to show both "circular arc motion" and "circular motion", as shown in Fig. 4.9 and Fig. 4.10.

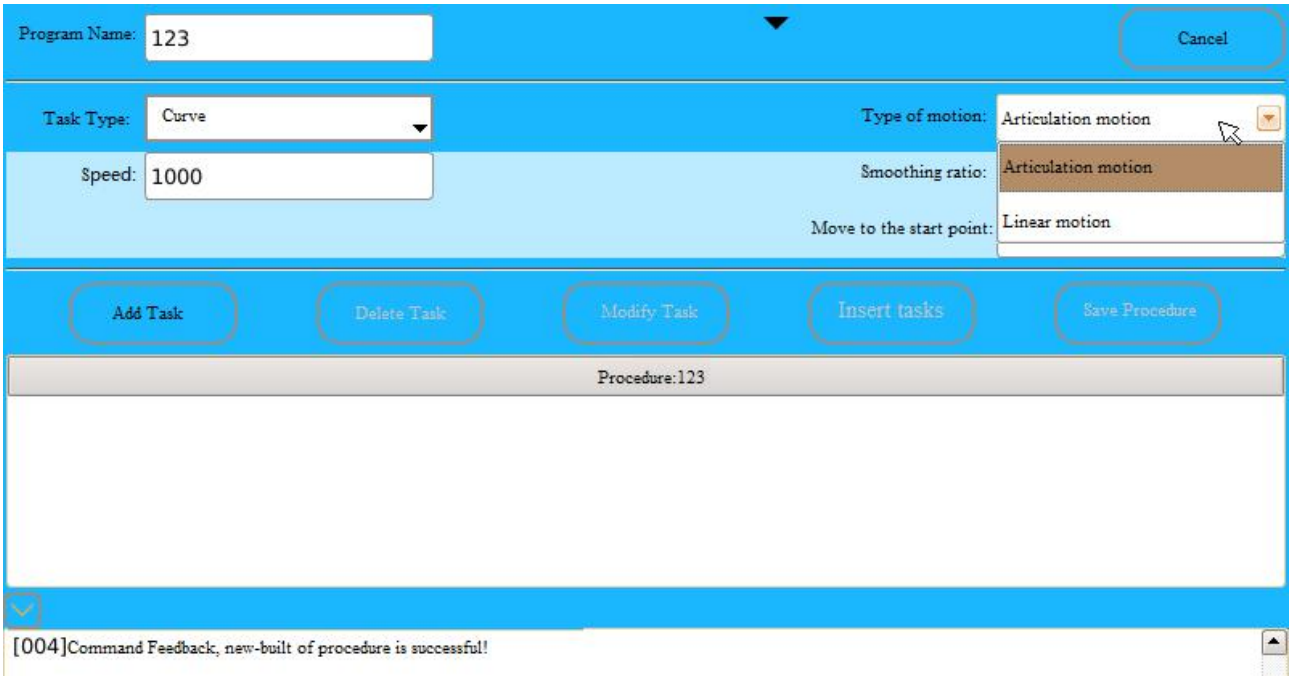


Fig. 4.9 “Type of motion” Type 1

(1) Articulation motion: The end of the robot moves to a certain position, and the motion track is not concerned during the motion process.

(2) Linear motion: the end of the robot moves in a straight line to a specified position.

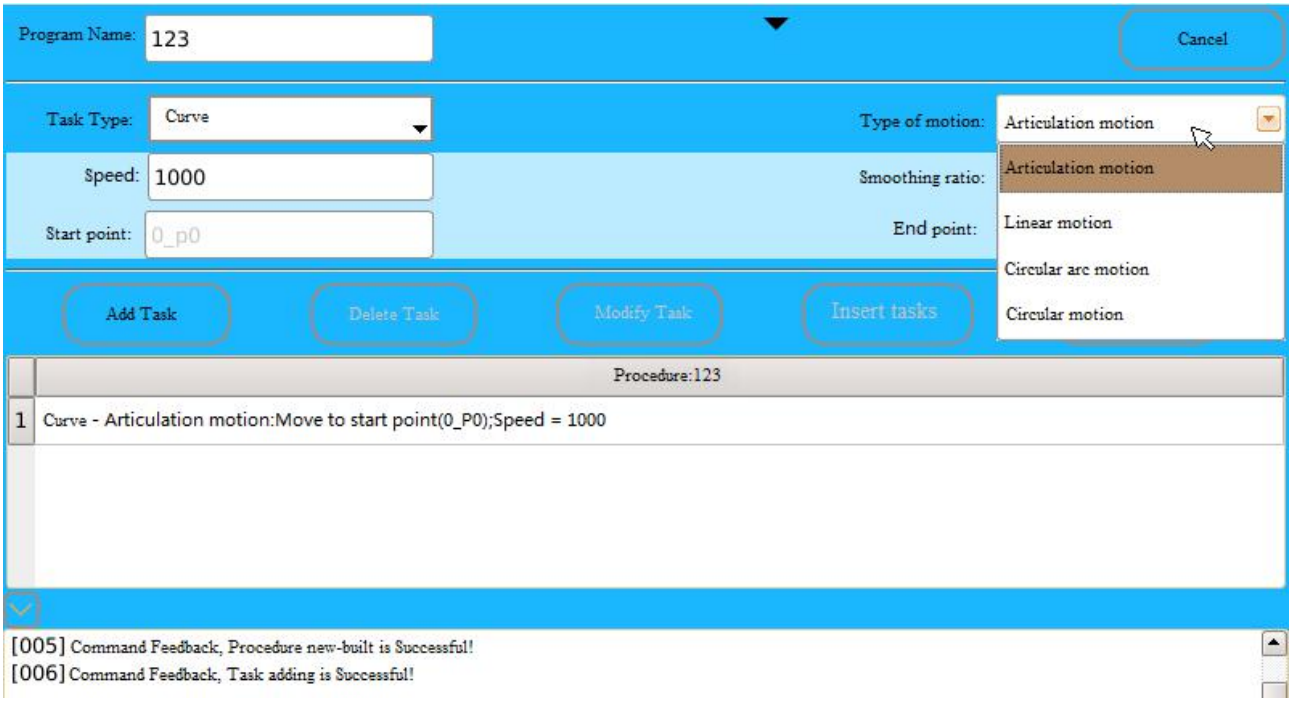


Fig.4.10 “Type of motion” Category 2

(3) Circular arc motion: the end of the robot moves in a circular arc way, and a section of arc is determined by three points, including “starting point”, “middle point” and “end point”, as shown in Fig. 4.11.

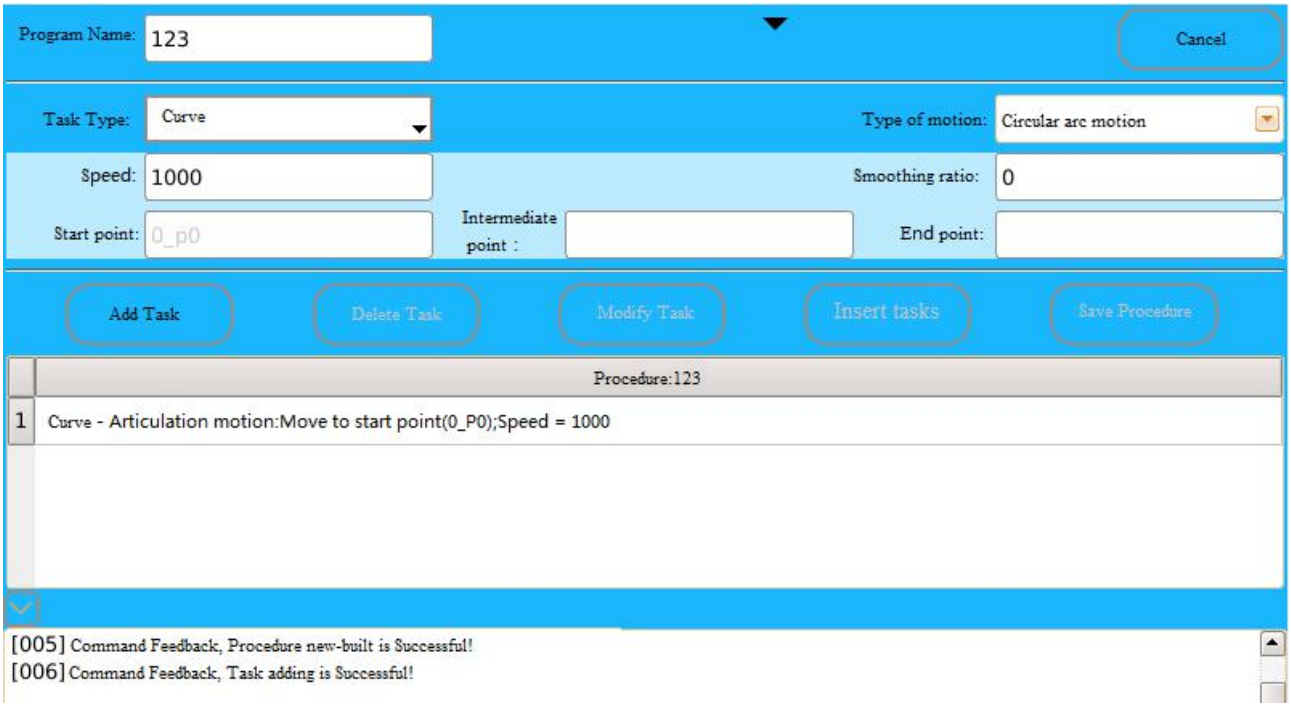


Fig. 4.11 “Circular Arc” Motion Type

(4) Circular motion: The end of the robot moves in a circular mode, and three points define a circle, the three points include “starting point”, “circle center point” and “point of circle surface”, as shown in Fig. 4.12. The “point of circle surface” indicates the direction of “drawing circle”.

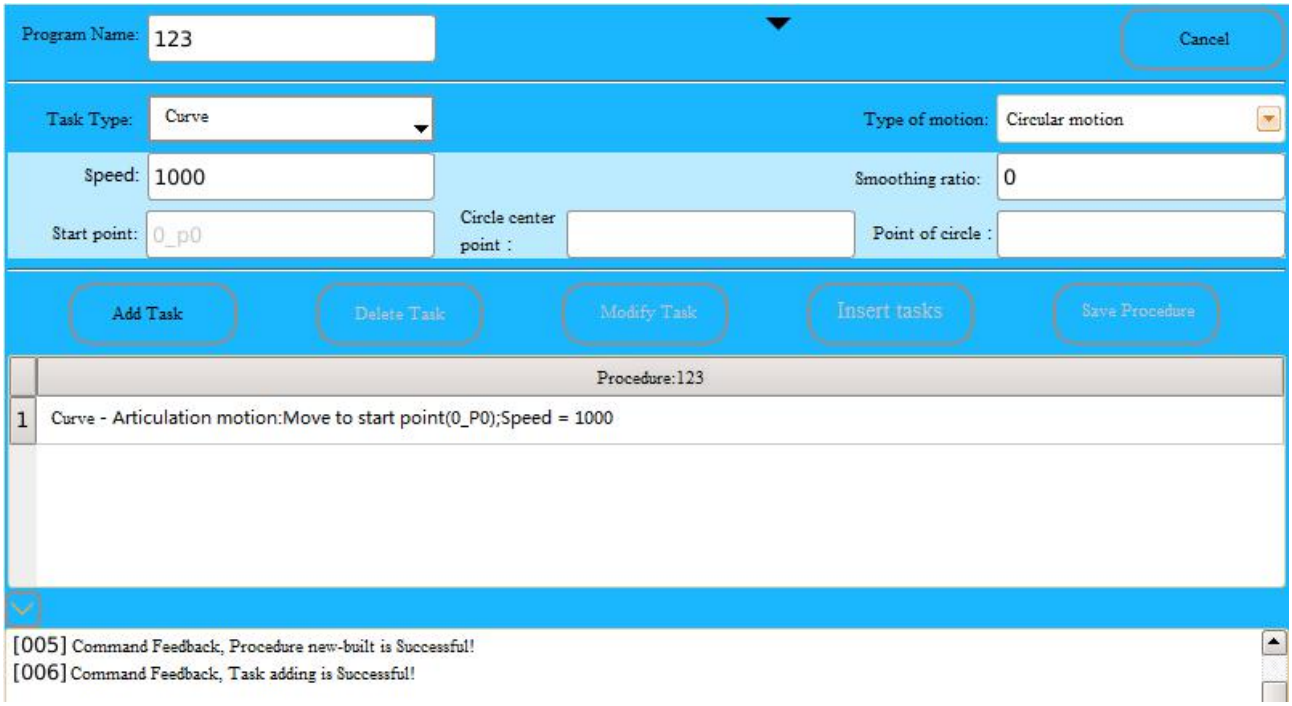


Fig. 4.12. “Circle” Motion Type

4.1.3 Establish of Curves

Once the procedure name is created, the procedure can be formally created. When creating a “curve” task type, it is mainly determined the “Starting Point” and “End points” of the curve (“circular arc” and “circle” motion

also need to take into account the “intermediate point”), the concrete steps: Select the “curve” task type_determine the “Type of motion”_“smoothing ratio”_“speed of motion”_determining “Starting Point” or “End points” (first determine the “Starting Point” when the “curve” is first established, followed by taking the “End points” of the previous curve as the "trunk" Starting Point "</trunk> of the second curve), You need to set “End points”)_Click the Add Task button_Complete Curve Establishment."

(1) Setting of “speed of motion”: The speed unit in the “articulation” motion type is the “pulse”, and the maximum value shall not exceed the setting parameters in the “machine parameters”; The “linear motion”, “circular arc motion” and “circle” motion type. The speed units shall be mm mm and shall not exceed 2000 mm/sec (mm/s).

(2) Setting of the “smoothing ratio”: When the “linear motion”, “circular arc motion” and “circle” motion type, the “smoothing ratio” can be set so that the machine end can run faster. The smoothing ratio parameter range is 0-100, and 0 indicates no smoothing, and the maximum smoothing is 100.

(3) “Starting Point” or “end point” setting: Click at the “run to start point” or the “Endpoints” to appear a small page box. At the [New Point] page, set the “The alias for the point: “ P1 ”, press“ enable switch ” (There are two green buttons on the back of the teaching box, you can move to the next one); move the robot to the desired position; loosen the“ enable switch ” and select“ to read the current point ”Press the key to display the current point“ P1 ”for each articulation coordinate value. Press“Save”to complete“ Start ”Or“ End point setting and return to the procedure creation page.

If you have determined the “Starting Point” and “Endpoints” position, or you need the “point” position to complete (the saved “point” will be stored in the “point” file in the “procedure management”), you can also click the “reference point” button to switch to the Reference Point Interface. The direct “reference” is as shown in Figure 4.13.

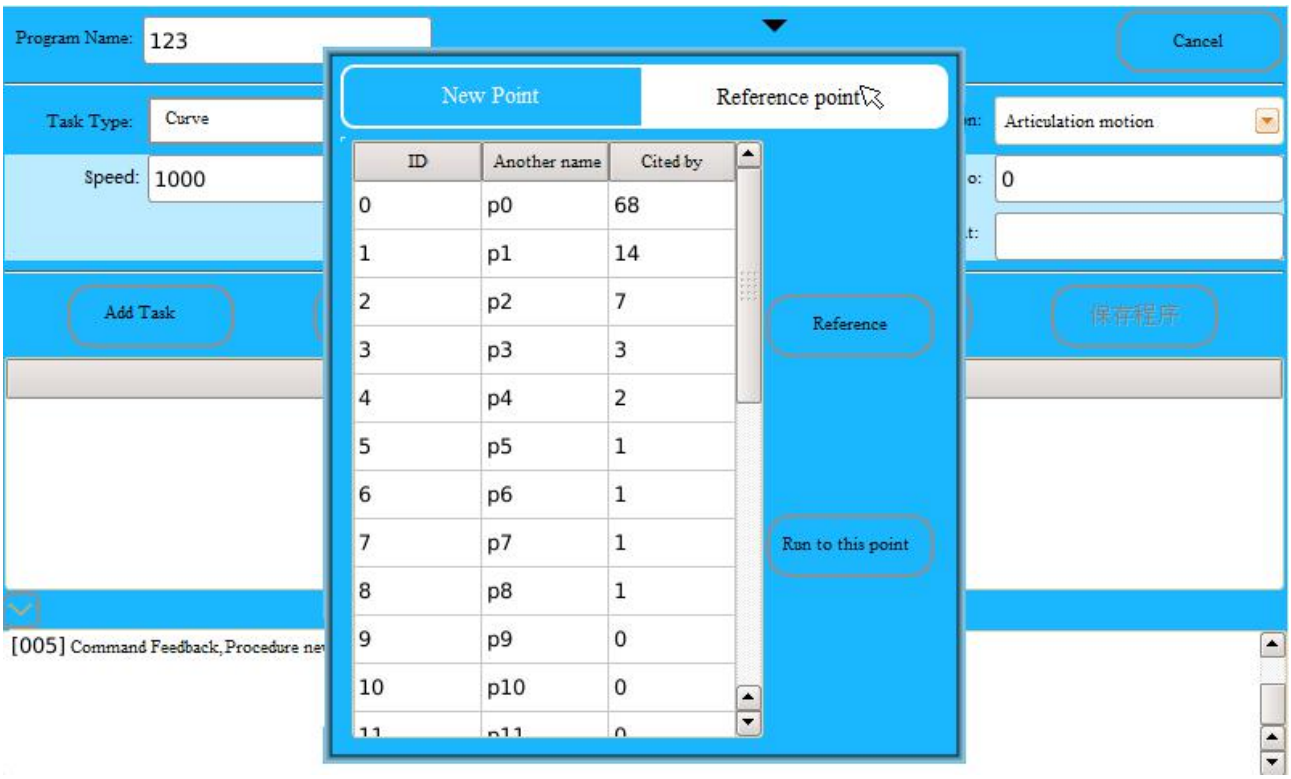


Fig. 4.13. “Starting Point” and “Endpoints” reference

4.1.4 Establishment of non-curve

When you build a procedure, you may sometimes need to use the “non-curve” task type, such as “time delay”, “wait an event”, “output”, and “analogue quantity”, and then you need to create a “non-curve” task type. The specific steps are: select the corresponding non-curve task type_the format value corresponding to the “non-curve editing prompt box”_input in the corresponding “Task Type” value (see 4.1.2.1 chapter “Task Type” introduction)_Click Add Task to complete the non-curve establishment.

4.1.5 Preservation of procedures

After the procedure passes through the name and curve of the procedure and the non-curve is established, it is not possible to complete the establishment of a basic procedure. Click the Save Procedure button to save the procedure to [procedure management] to complete the building of the basic procedure.

4.2 Creation of Modularization Procedure

4.2.1 Creation and cancellation of procedures

The “creation of a procedure” in the “modularization procedure” is consistent with the “Creation of Basic Procedure”, and the details can be seen in Section 4.1.1.

4.2.2 Types of tasks, classification of motion types

The “Task Type” and “Type of motion” classification of the “modularization procedure” is consistent with the “Basic Procedures”, as detailed in Section 4.1.2, but multiple “PCALL” task types are added in the “Modularization procedure”. In “Modularization procedure”, you can call the “subroutine” through the “PCALL” task type to generate a “Modularization procedure”. The “subroutine” of the “PCALL” task type is the completed “Basic Procedures”, as shown in Figure 4.14.

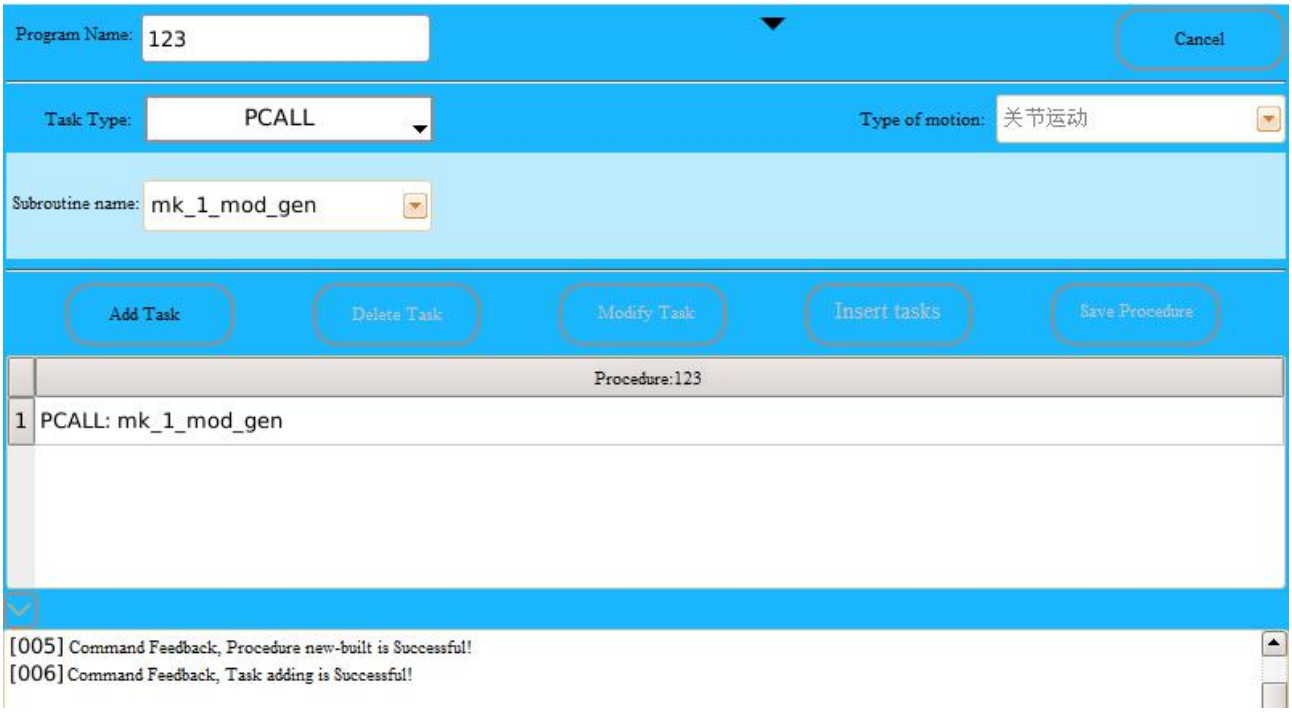


Fig.4.14. “PCALL” Task Types and Use

4.2.3 Establishment of curve

The “Establishment of Curve” in the “Modularization procedure” is consistent with the “Basic Procedures”,

and the details can be seen in Section 4.1.3.

4.2.4 Establishment of Non-Curve

The “the establishment of non-curve” in the “Modularization procedure” is consistent with the “Basic Procedures”, as detailed in Section 4.1.4.

4.2.5 Preservation of Procedure

The “Save” in the “Modularization procedure” is consistent with the “Basic Procedures”, and the “Modularization procedure” is saved by clicking the Save Procedure button. But after the procedure creation in the modularization procedure is completed, the modularization procedure is generated first in the modularization procedure file stored in the computer procedure, and then the prompt is converted to generate the basic procedure, and after the determination is selected, the modularization procedure is converted into a basic procedure, meanwhile, it is also stored in the “Basic Procedures” file of the “procedure management ”.

4.3 Creation of process package procedure

In order to facilitate r use of the control system by the user, for some work with fixed operational processes and particularly cumbersome, the “process pack” can be formed by “setting”, so that the user can easily finish the complicated and cumbersome work. Click [Motion] _[Procedure Control]_[Process Package] to enter the “process package” creation interface, as shown in Figure 4.15. At present, there are two processes of “common spray painting process” and “nine-axis spray painting process” for the process of the system.

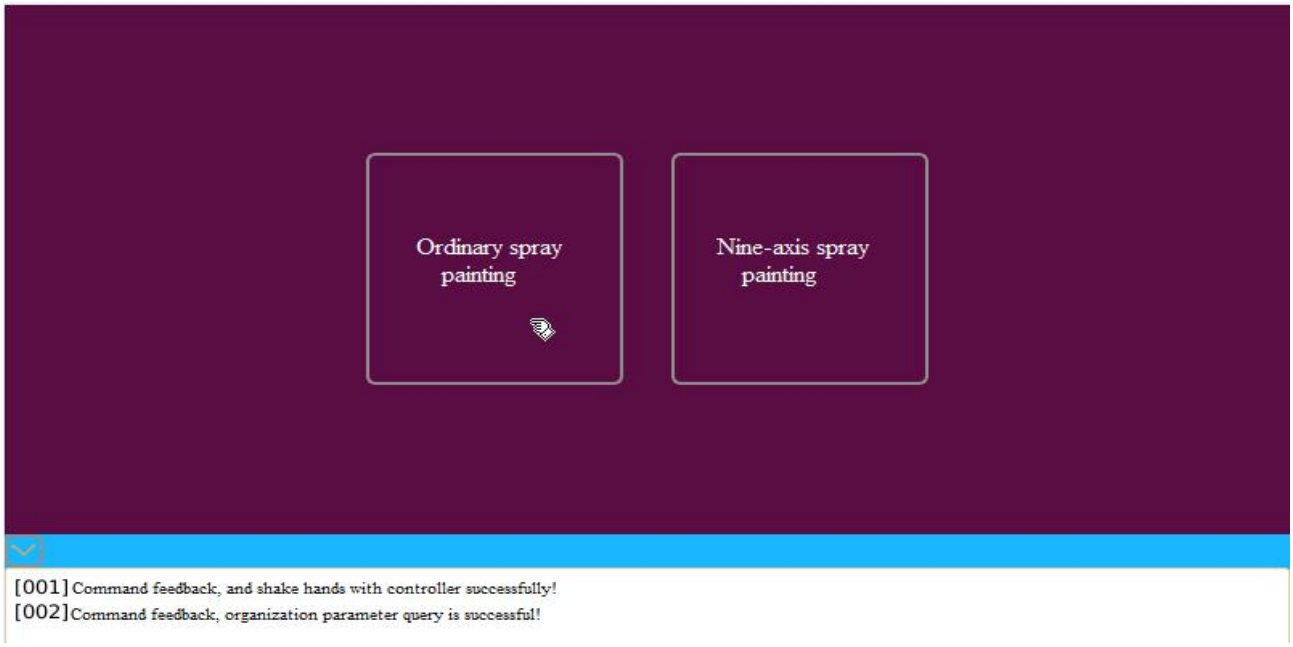


Figure 4.15 “process package” Create Interface

4.3.1 Common spray painting process

Creation of common spray painting process **procedure**

As shown in Fig. 4.15, click [ordinary spray painting] key to enter the creation interface of common spray painting process. As shown in Figure 4.16, the “motion parameter” and “control parameters” need to be set for the creation of common spray painting process.

A. Motion parameters: As shown in Figure 4.16, the motion parameters will vary depending on the “Spraying

mode". According to the present "Spraying mode", six spraying patterns can be divided into "straight line", "plane", "plane inch", "arc", "cambered surface" and "arc surface inch".

(1) "Common straight-line spray painting mode" motion parameters: As shown in Figure 4.16, the "process procedure name" is to create a process name; "Spraying mode" is a "straight line"; The "roundtrips" is repeated, and if it is set to "0", the motion is not repeated; The "P1" and the "P2" are to determine the "Starting Point" and the "Endpoint" of the "linear spray painting pattern", and move between two points in a "straight line" motion type; The "roundtrip speed" and the "end-to-start speed" can set the speed.

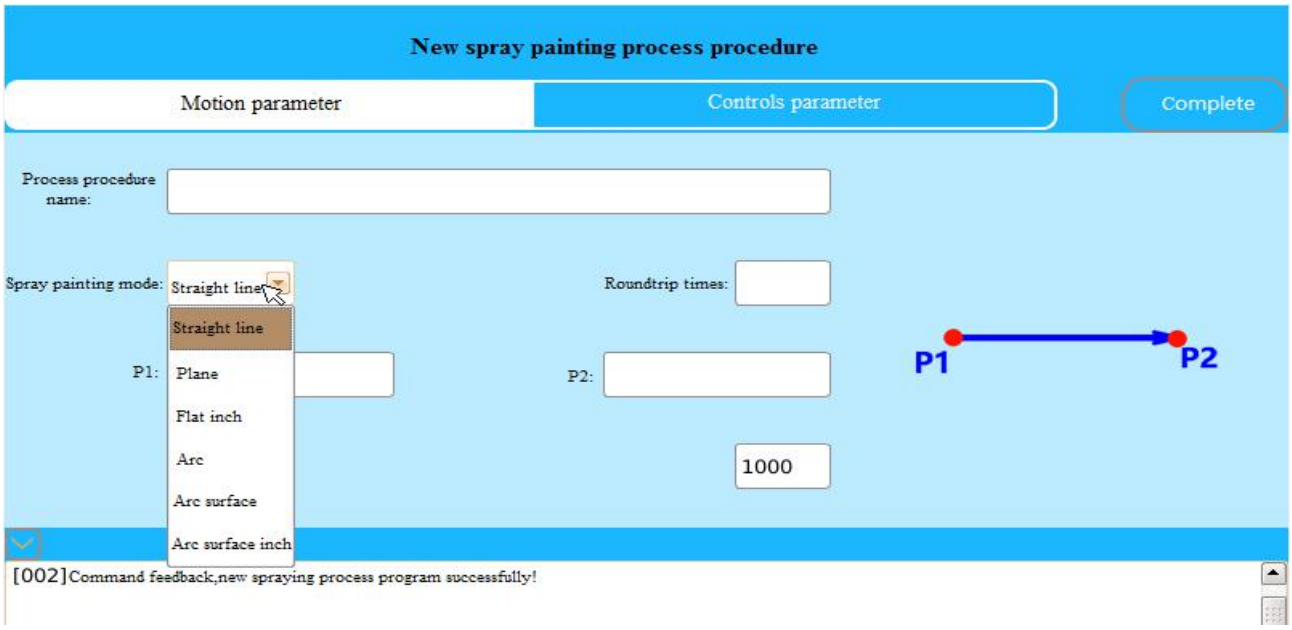


Fig. 4.16 "Common spray painting process" Creation Interface

(2) Motion parameters of common plane spray painting mode: As shown in Fig. 4.17, the normal straight-line spraying mode is basically consistent with common linear spray painting mode, but the number of intersections and turn-back smoothness are increased. The "number of intersections" is to put the "P1" to the "vertical" of the "P3".

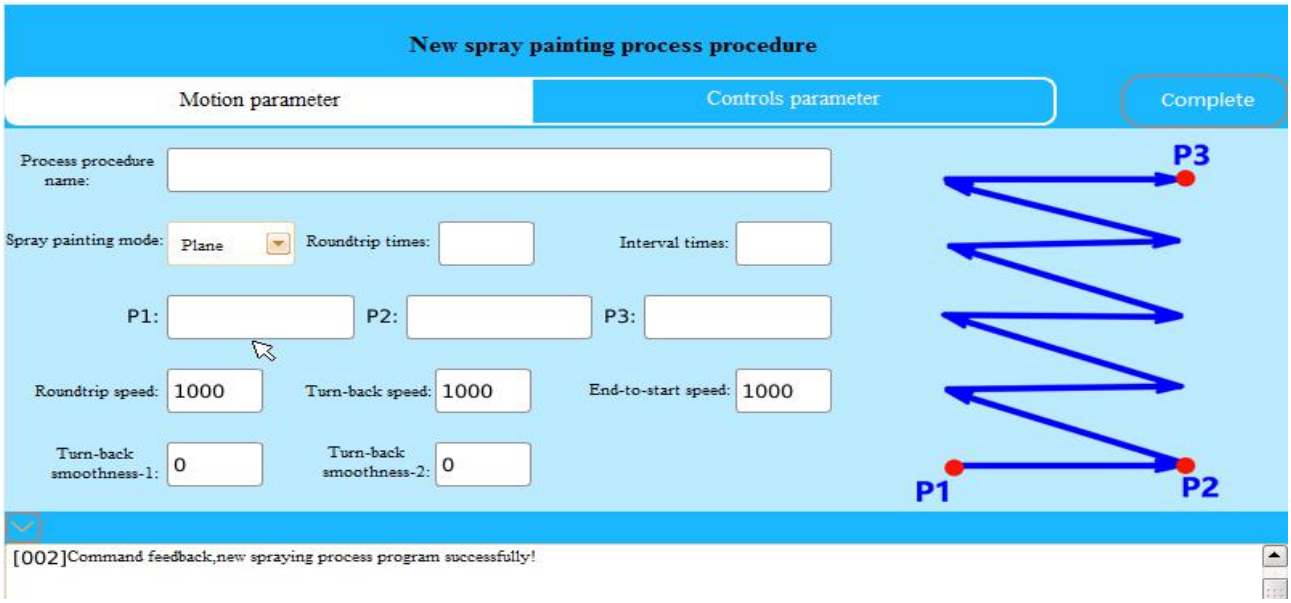


Fig. 4.17 "General plane spray painting process" Creation Interface

"Equal division"of straight distance. (d) The "turn-back smoothness" is to add "smooth" between the two curves to make the procedure run faster.

(3) Motion parameter of the common plane inch spray painting mode: as shown in Fig. 4.18, the spraying mode is basically consistent with the normal plane spray painting mode; only one inch of moving section is used to close the oil gun; after selecting, the oil gun will be closed at the inching position, and then the oil gun is opened again after the inching position.

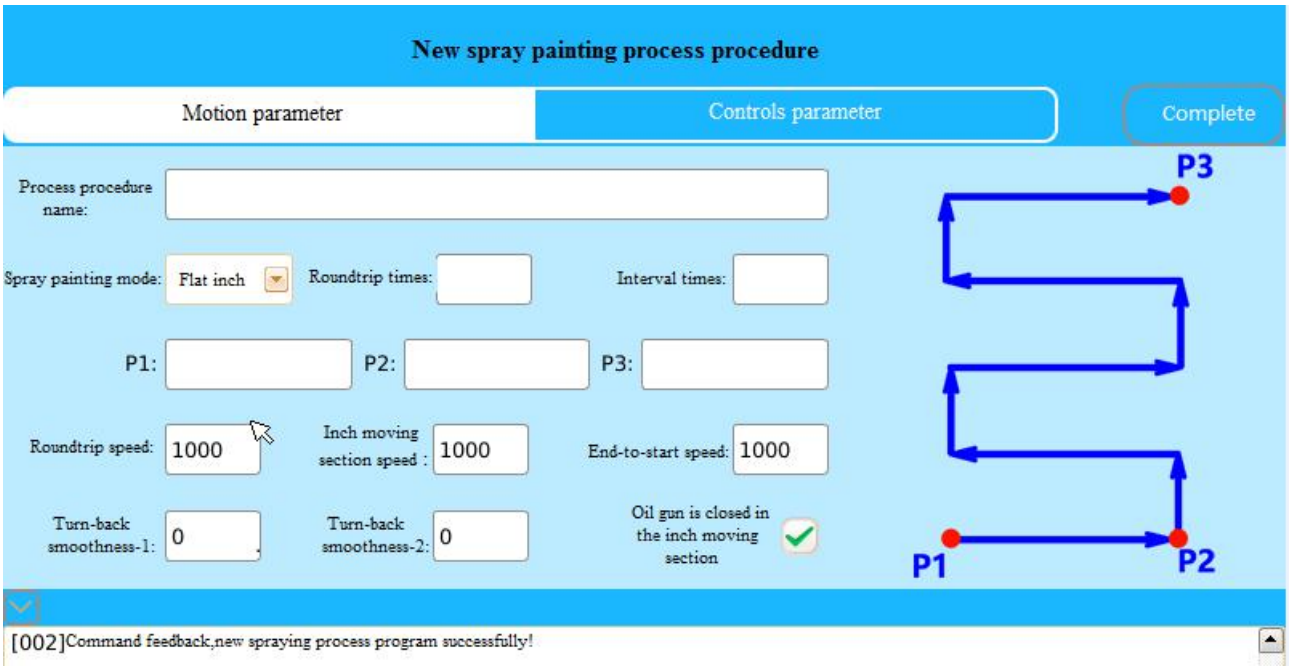


Fig.4.18 "Common plane inch spray painting process" Creation Interface

(4) Moving parameters of common arc spraying mode: As shown in Fig. 4.19, it is basically consistent with the normal straight line spraying mode, except that more than one intermediate point P2 is in the circular arc motion .

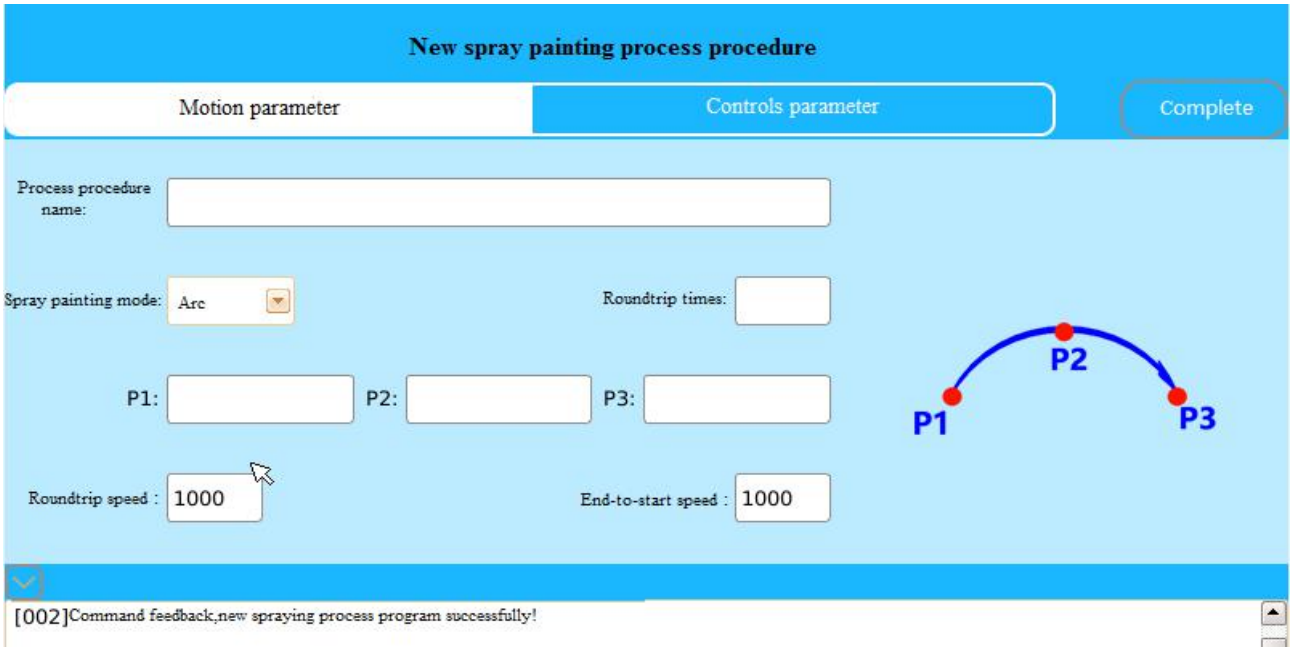


Fig. 4.19 "Common arc spray painting process" Creation Interface

(5) “Normal arc surface spray painting mode” motion parameter: As shown in Fig. 4.20, it is basically consistent with the “normal plane spray painting mode”, that is, there is more than one intermediate point “P2” in the “circular arc” motion.

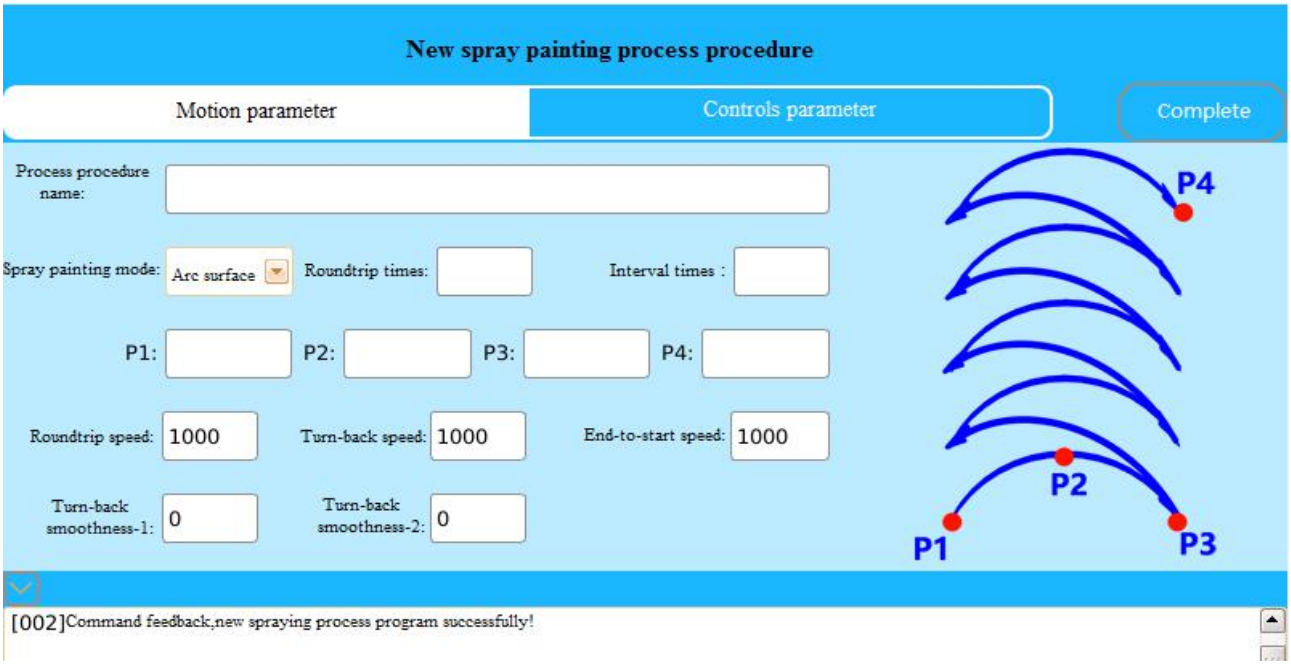


Figure 4.20“Common arc surface spray paintingprocess” Creation Interface

(6) Motion parameter of the common arc surface inch spray painting mode: as shown in Fig. 4.21, the inch spray painting mode of the common arc surface is basically consistent with the common arc surface spray painting mode, and only one inch of moving section is used to close the oil gun. After selecting, the oil gun is closed at the inching position, and the oil gun is opened again after the inching position.

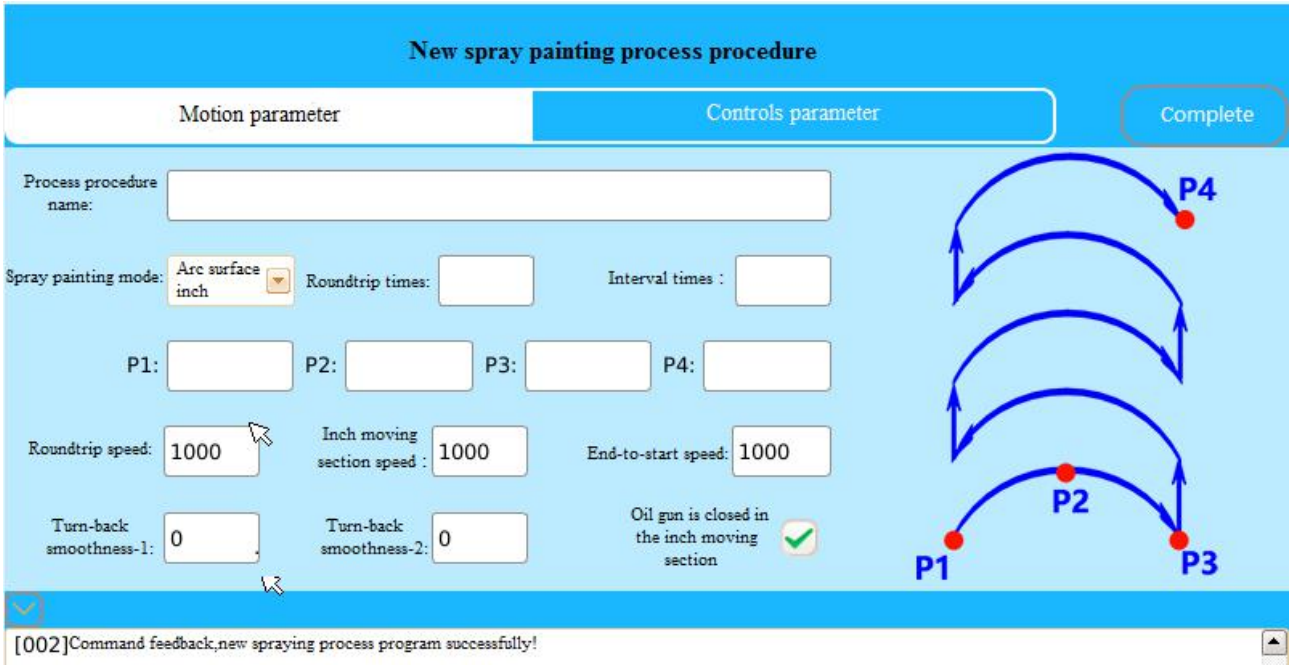


Figure 4.21 “Common arc surface inch spray painting process” Creation Interface

B. Control parameters: common spray painting process includes 6 kinds of spray painting modes of straight line, plane, plane inch, curve, arc surface and arc surface inch, and the control parametersare the same, as shown

in Fig. 4.22.

Fig.4.22 “Common spray painting process” Control Parameters

The “Oil pump output port number” is to set the “On/Off” of the “Oil pump” with the I/O port output “High/Low electric level”; The “Number of spray guns” and the “Spray gun output port” are used together, the “Number of spray guns” determines the setting of the “Spray gun output port”, and if it is a plurality of “Spray guns”, the “Spray gun output port” sequence numbers are connected with the connector “-”. The quantity range of the spray gun is “1-4”, that is, at most 4 guns can be controlled at the same time.

4.3 Preservation of common spray process procedure

After completing the “motion parameter” and “control parameters” setting, the “common spray painting process” procedure should be “saved”. After clicking the “Complete” button, a “Generates” button will appear, and click the “Generates” button_“OK” to generate and storing of the process is completed.

The “common spray painting process” of the “process procedure” is first “Save”, and then click the “task generating” button to convert and generate the “basic procedure”.

4.4 Management of procedures

After the establishment of the procedure has been completed, sometimes the “point” position that has been set has changed and needs to be modified for the procedure has been completed, and then the procedure is implemented through the “procedure management”. [Procedure management] It can be divided into the management of the procedure and the management of the point, and the management of the procedure can be divided into the management of the basic procedure, the management of the process procedure (including the 9-axis spraying process and the common spraying process) and the management of the modularization procedure, as shown in Fig. 4.24.

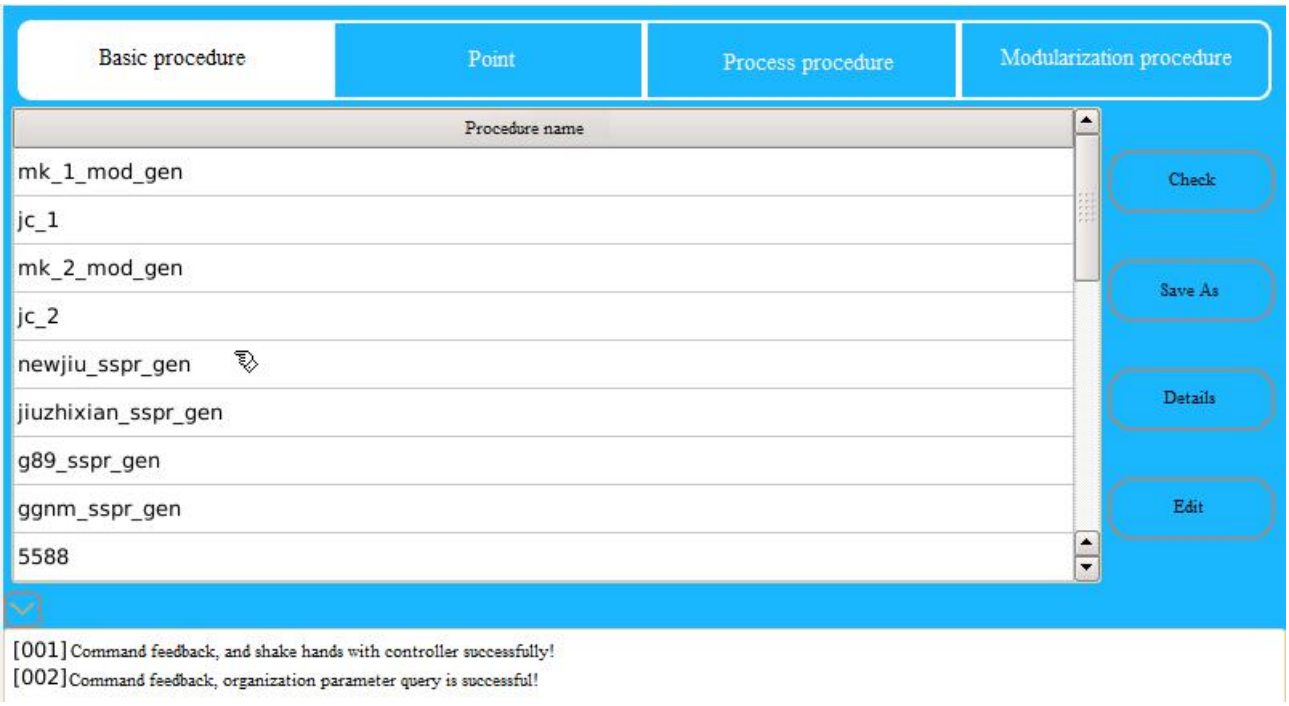


Fig. 4.24 Composition of "procedure management " structure

4.4.1 Management of procedures

Management of "Basic Procedures"

Select and click the "procedure management" button in the "procedure control" structure composition interface of Fig. 2.6 to enter the management interface of the "Basic Procedures", as shown in Fig. 4.24. The management of the "Basic Procedures" is divided into "check", "Save As", "Details" and "edit" of the procedure.

(1) Check: This is used in conjunction with the "point" of the "change point". When a "reference point" in the procedure has a change, it must be "check" to this procedure (other procedures refer to the "check" as required by other procedures), otherwise the motion path in the procedure will go wrong to raise an accident, and special attention is required.

(2) Save As: Select the "Procedure Name", and click the "Save As" button to enter the "Basic procedure creation interface" of the selected "procedure". If the "Procedure Name" is modified, you can copy the "procedure" again.

(3) Edit: Check the "edit" button to perform "delete" operation on the completed "procedure".

(4) Details: This is a major part of the "procedure management". Click the "Details" button to return to the "Basic procedure creation" interface to conduct "delete", "Modify" and "insert in" operation on the selected "procedure", as shown in following Figure 4.25.

A. Delete: Select the procedure line to delete, and click "Delete Task"_"OK" to complete the deletion of the procedure.

B. Modification: The procedure modification is divided into two categories: curve and non-curve (including delay, wait events, output and analog quantity, etc.)

(1) When the curve is modified to a curve, select the "curve" to modify, and modify the "Type of motion", "speed of motion" and track "Starting Point" or "Endpoints" to complete the modification, and then click Modify

Task and select OK to complete the modification.

If the procedure editing has been completed, select Save Procedure to complete the modification of the procedure.

(2) When the non-curve is modified into a non-curve, select the “non-curve” to modify, and modify the “Task Type” to complete the corresponding content input, and click Modify Task to select OK to complete the modification.

If the procedure editing has been completed, select Save Procedure to complete the modification of the procedure. The modification can not be directly conductedfrom non-curve to curve or from curve to non-curve, but can be realized by insertion of the procedure.

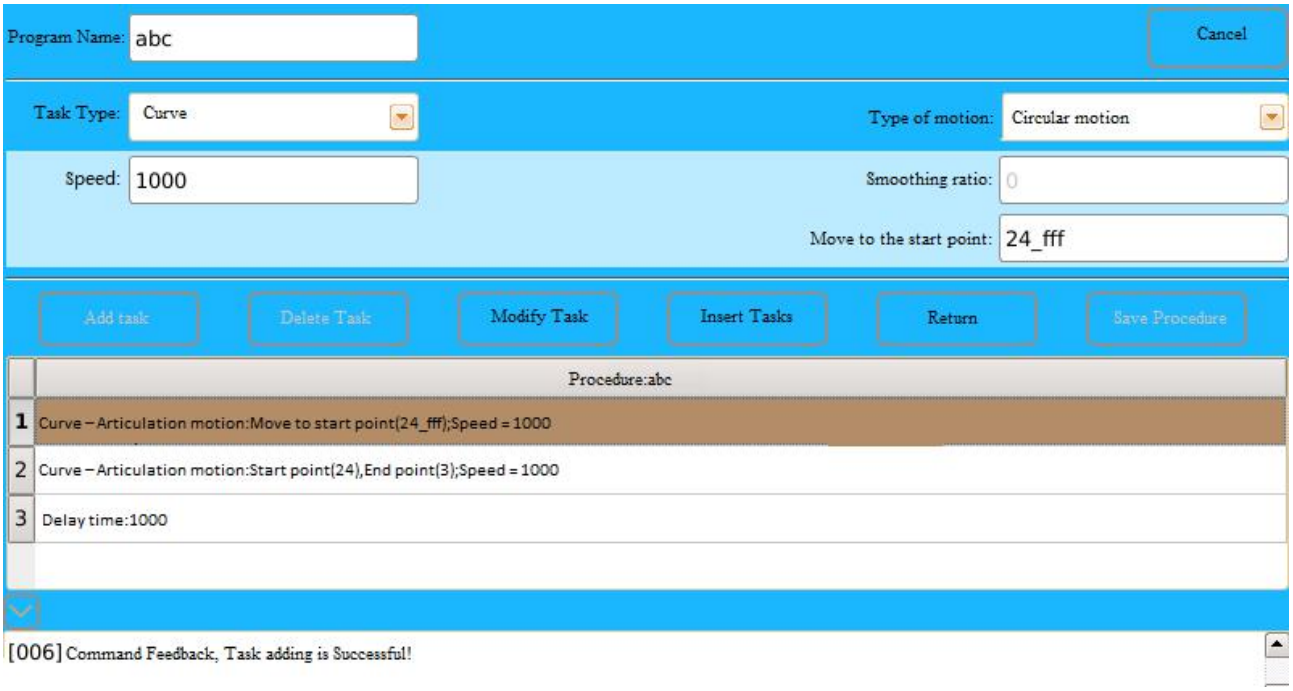


Figure 4.25. Management of “Basic Procedures” Creation Interface

C. insertion: The procedure insertion includes the insertion of the curve and the insertion of the non-curve.

(1) Non-curve insertion: select the position to be inserted (the inserted procedure position is the previous step of the selected procedure). After determining the task type, complete the non-curve corresponding content input, and click Insert Procedure and select OK to complete the non-curve insertion.

(2) Insertion of the curve: Select the position of the procedure to be inserted; select the “curve” in the “Task Type”; click the “ procedure insertion”; set the “Type of motion”, the “speed of motion” and the track “Starting Point” or the “End point” (if it is the insertion curve before the first curve, the “Starting Point” needs to be set; if it is not the insertion curve before the first curve, the “end point” needs to be set), then click “determine the insertion”_“OK” to complete the insertion of the curve.

Remark:

A. When the procedure is inserted into the curve, the back insertion format is adopted, that is, the motion trajectory of the latter curve is unchanged (that is, the selected procedure curve trajectory is unchanged), for example, A moves to B, and B moves to E, E to F, that is, the motion track of the curve is A-B-E-F, If a point C is to be added between B and E, the motion track of the curve becomes A-B-C--E-F, then the curve procedure E-F is

selected (E is the starting point in the curve procedure, F is the end point), and the “procedure insertion” is clicked. The task type is “curve”; the starting point is C point, and the procedure insertion is completed.

B. During the “Management” of the procedure, if you want to cancel the current step, you can press the [Return] button to complete it; after the procedure editing is completed, select Save Procedure to complete the “Save” of the editing operation of the procedure, otherwise the editing operation of the procedure is not modified, and it is maintained as it is.

C. When the “insertion” is operated, the “Starting Point” of the inserted curve can be set by yourself by pressing the “Menu” physical button of the film matrix switch on the teaching box.

Management of “process procedure”

As shown in FIG. 4.26, the management of the “process procedure” includes both “Nine-axis spray painting” and “common spray painting”. It is basically consistent with the basic procedure management. Only the details in the process procedure, entering the process package creation interface, and you can modify the motion parameters and control parameters.

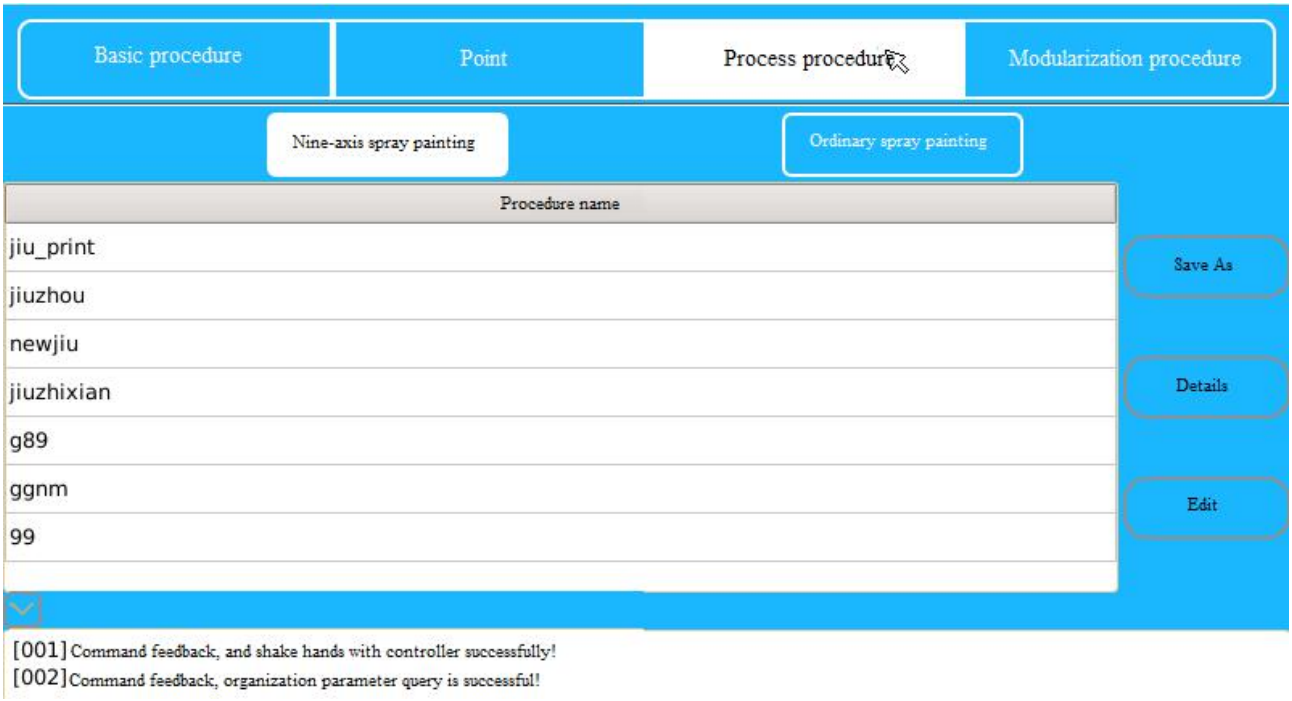


Fig. 4.26 Management of “process procedure”

Management of “Modularization procedure”

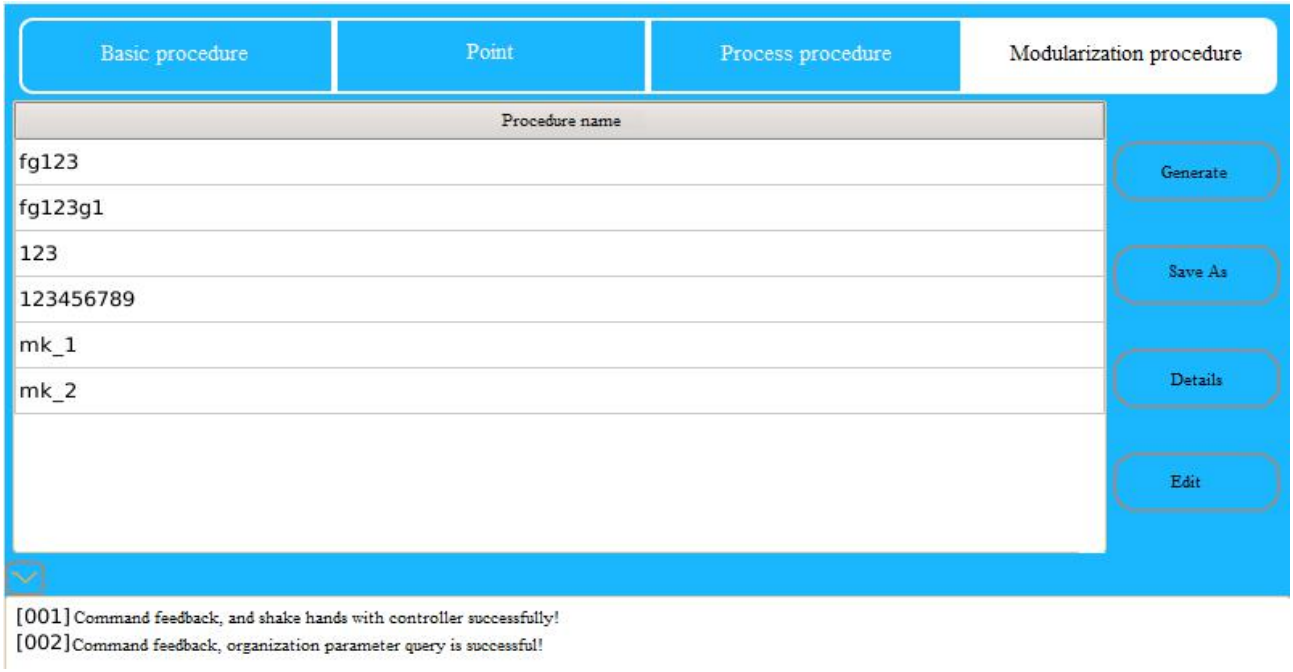


Fig. 4.27 Management of "Modularization procedure"

As shown in Figure 4.27, the management of the "Modularization procedure" is basically consistent with the management of the "Basic procedures", only the "Details" in the "Modularization procedure", and enters the "Modularization procedure" creation interface.

4.4.2 Management of points

The system adopts the point positioning function, and the "point" and the "procedure" are mutual independence with each other, so the same "point" can be used for multiple procedures at the same time. As shown in FIG. 4.28 below, the management of the "point" includes: "New-build", "Details", "Edit" and "Run to this point".

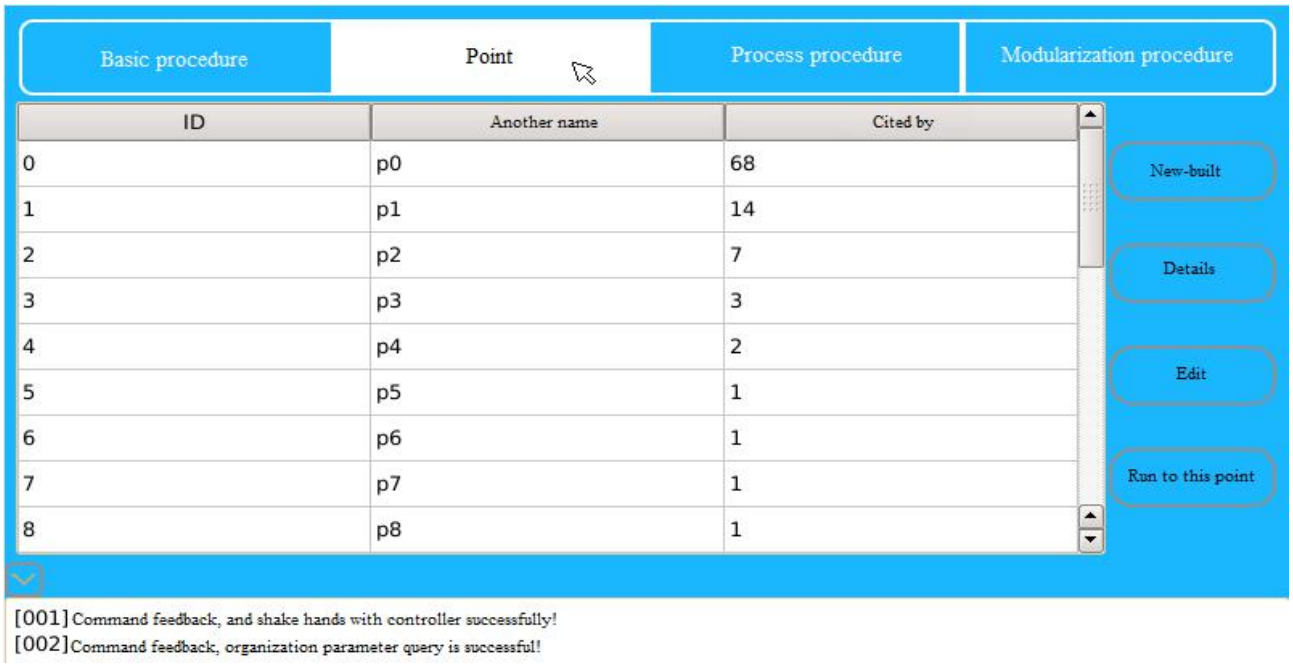


Fig. 4.28 Management of "point"

(1) New: Click the [New-build] button to create a “Edit prompt box”; set up the name of the “point”; manually teach the position and attitude of each articulation to the required “point”, and click the “Read the current point” to completenew-build of the “point” by clicking the “Save”.

(2) Details: See the information situation at this point, the information situation includes the “Name of the point” and each “articulation angle”, and can modify the “Position and posture” of the “point”. The specific format is: Select the “point” to be modified (click the line corresponding to the “point”); click the Details button to appear the “Edit prompt box” of the selected “point”; open the enable switch; manually teach to the new position, posture; click the “Read the current point”; and Click the “Save” to complete the modification of the “point”.

(3) Edit: Click the Edit button to conduct “delete” operation on the “point”.

(4) Run to this point: Check the “point”_open servo enable_click [Run to this point] button, and the robot body moves to this point in the “articulation motion” type.

After the “point” management (i. e., the “point” has been modified) is completed, be sure to switch to the “procedure” management interface to [verify] the “reference” that has passed the modified “point”. Otherwise, the motion track in the procedure will go wrong; an accident will be caused, and special attention is required.

4.5 Operation of the procedure

4.5.1 Parameter setting

After the procedure creation is completed, the mode is converted to [AUTO state] to run the procedure, as shown in Figure 4.29 below. All kinds of parameters need to be set before the “Operation”, so that the “Operation” effect of the procedure is optimal. Parameter setting has “speed of motion”, “Number of motion”, “mode of motion” and “load weight”.

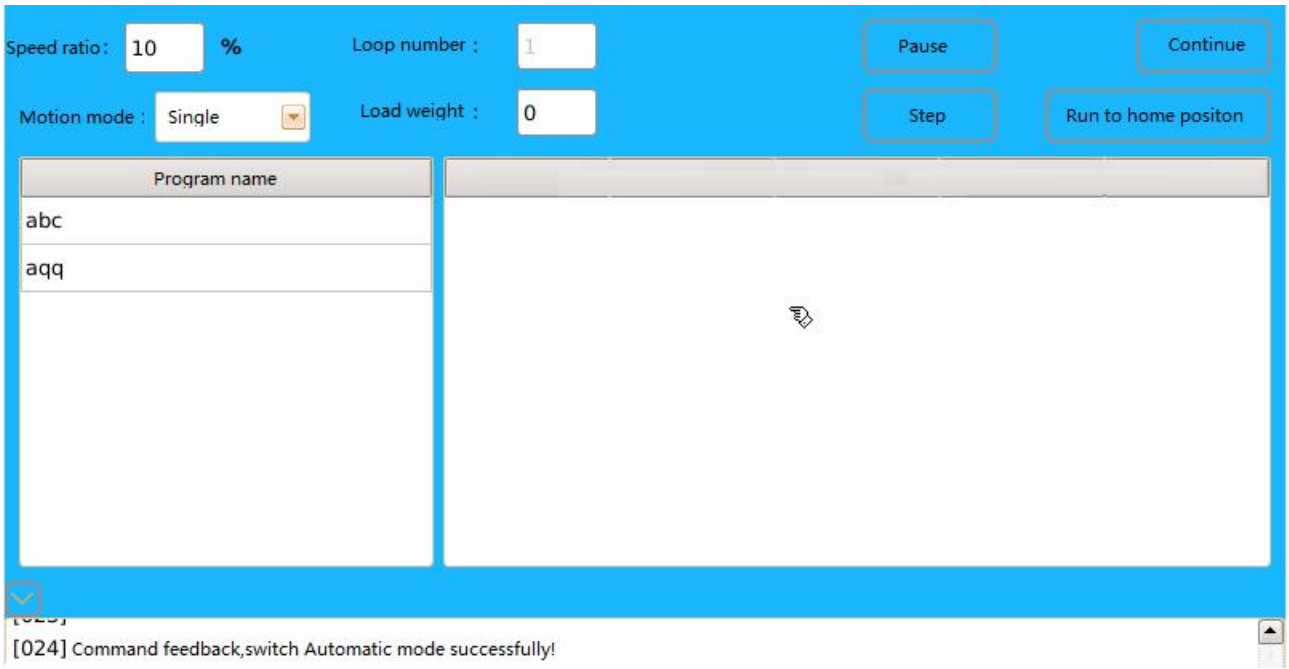


Fig. 4.29 Automatic Mode Interface

(1) Motion speed: This parameter mainly sets the overall speed of the “procedure”, with a range of 1-100(percent).

(2) Number of times of motion: It is the number of times of motion of “procedure”, and if it is the “cyclic motion” mode, the parameter in the “Number of motions” is changed to “0”, so that the “peocedure” can be endlessly circulated and the motion can be continued.

(3) Motion mode: The system provides three modes of motion, such as “single motion”, “single step motion” and “cyclic motion”.

A. Single motion: Perform a complete operation of the procedure, that is, the motion track is run from the “Starting Point” along the “procedure” setting track to the “Endpoint”.

B. Single-step motion: A “procedure” is made up of many “steps”, selecting the “single step motion” mode can let the procedure start from the “Starting Point” along the “procedure” setting trace “one by one step”. Specific format: Select the “Procedure Name” to be executed, press the physical button [procedure start] on the teaching box to complete the first step of the robot body, then click the Single Step Execution button to proceed to the next step, and then repeatedly click the Single Step Execution button to complete the “single step motion” operation.

C. Cyclic motion: Select the “cyclic motion” mode to make the procedure run in circulation. It should be used in conjunction with the “number of motion times” setting, and when the parameter in the “number of motion times” is set to “0”, the cyclic motion becomes the “infinite circulation” motion mode. When “cyclic motion” mode is set, a prompt of “completed cyclic times” appears when the procedure runs, and this is a count of the times of completed “procedure”.

(4) Load weight: Set the “load weight” parameters to adjust the acceleration.

In order to be safe, it is preferable to slow down the [motion speed] before the procedure runs; select the “single step motion” motion mode to test the running track, and then set the “speed” and “mode of motion” if no problem.

4.5.2 Use of the physical buttons and the buttons on the touch screen

There are still some “buttons” on the “procedure running” interface, and the buttons have a great impact on the procedure running. The buttons mainly include physical keys of “Procedure Stop” and “Procedure Launch”; buttons on the touch screen: “Pause”, “go on”, “Run to zero” and switch mode switch rotating knob.

(1) “Procedure Stop” physical key: When the “procedure” is running, the “Procedure Stop” physical key can be used to make the procedure “stop”, and only by pressing“Procedure Stop” physical key firstly, the motion mode can be modified . After the modification is completed, the “procedure” can be started by pressing the physical key of “Procedure Launch”.

(2) “Procedure launch” physical key: To run the procedure, you should select the “Procedure launch” physical key. After all the parameters needed to be set before the operation are completely set, the “procedure” starts to run from the “Starting point” along the designed “Trajectory of motion” by pressing the “Procedure launch” physical key procedure.

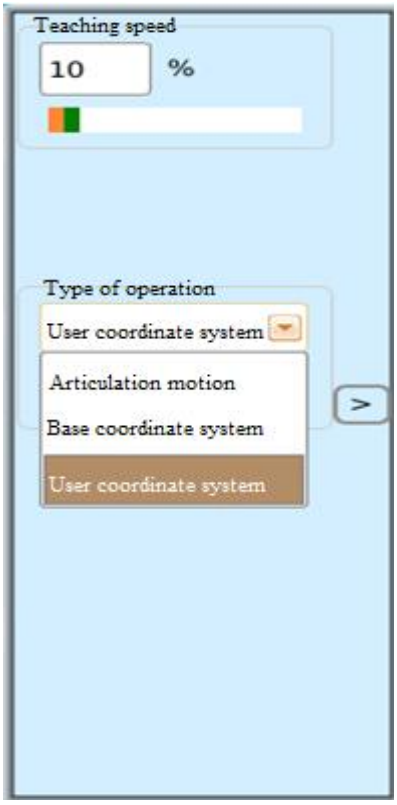
(3) The “Pause” and “Go on” buttons on the touch screen are to be used together. When the “Procedure” is in operation, click the [Pause] button to stop the “Procedure”, and then click the [Continue] button, and the “Procedure” motion track will follow the position after the “Pause”. Continue to run according to the procedure edited by the procedure. When the “Run to zero” touch key is the “stop” state to be in the “Auto mode” (whether in “Pause” or after “Procedure stop”), click the [Run to Zero] button to make the robot body to return to the set “zero position angle” state.

(4) Switch mode switch: when the “procedure” is running, switching mode is realized through the switch mode key rotation button, that is, the automatic mode is converted into a manual mode, and the switching mode key rotation button function corresponds to the procedure stop physical key, so that the procedure can be stopped.

Pressing the [Pause] — [Continue] touch screen button and pressing the “Procedure launch” physical key are two completely different motion trajectories: when [Continue] is selected, the motion track moves along the [Pause] position and continues to run according to the procedure edited by the procedure; When you select the “Procedure launch” physical key, the motion track will firstly return to the “Origin” position at the time of the procedure design, and then continue to run along the track of the procedure editing.

5. Use of Coordinate System

The “manual teaching control” can complete control of the motion of the robot under different coordinate systems, and in the “Type of operation” (as shown in the right) interface of “Configuration parameters window”, the system provides three coordinate systems: “Articulation motion” coordinate system, “Base coordinate system” and “User coordinate system”.



Click the drop-down box at the “Type of operation”, and the three “coordinate system” selection interface appears. Click the coordinate system you want to select, and the system completes the selection of the coordinate system.

Three different “Coordinate systems” are different. After selecting different “Coordinate systems”, the trajectory of the machine end motion in “Manual teaching” is different, so the user needs to select the necessary “Coordinate system” according to the actual situations during operation.

Articulation motion coordinate system: Select the “Articulation motion” operation type represents the fact that the “Articulation motion” coordinate system is selected during manual teaching. During the motion, each articulation of the robot body is mutually dependent, and after opening the servo-enabled, the position and the posture of the end of the robot can be achieved through the 12 “J1—J6”-axis “+”, physical keys on the right side of the “teaching box”

Base coordinate system: The motion track is divided into three directions: “X”, “Y”, and “Z” axis. The physical key “J1+” is used respectively, and the “J1-” represents the “X” axis, the “J2+”, the “J2-” represents the “Y” axis, the “J3+”, and the “J3-” represents the “Z” shaft. The motion track corresponding to the robot body is that the “X+” and the “X-” represent the robot end “stretches out” and “rearward shrinkage”, and the “Y+” and the “Y-” represent the robot end “Left and right translation”, and the “Z+” and the “Z-” represent the robot end “moves up and down”. The “base coordinate system” also provides an auxiliary shaft “A”, a “B” and a “C” 3 shaft for the “X”, the “Y” and the “Z” shaft, wherein the physical key “J4+” is used, and the “J4-” represents the “A” shaft; the “J5+”, and the “J5-” represent the “B” shaft; the “J6+”, and the “J6-” represents the “C” shaft. The “A”, the “B” and the “C” shafts are respectively used as the auxiliary shafts of the “X”, the “Y” and the “Z”, the posture of the end of the machine can be adjusted, and the motion direction is judged by the “right-hand screw rule”.

User coordinate system: It is the “Coordinate system” that the “User” establishes by establishing “X”, “Y” and “Z” axes according to the corresponding “Planes” at the end of the robot.

5.1 Establishment and Use of User Coordinate Systems

Enter the main interface of the system manual software, as shown in “Composition of manual interface structure” of Fig. 2.5; select [Configuration] — [Coordinate System Configuration] to enter the “Coordinate system” management interface, where you can conduct “Create” and “Delete” on the “Coordinate system”.

5.1.1 Establishment of User Coordinate System

Users can create “User coordinate system” themselves. Specific steps: enter the “Coordinate system” management interface (as shown in Fig. 5.1 below) — Set the “Origin”, “X”, “Y”, “Z” of the “X” axis and “Y” axis, respectively coordinate — input “Coordinate system name” — click [New-build] button — complete the establishment of the “User coordinate system”.

A user coordinate system can be determined by three points that are not on the same line. Firstly, the origin of the coordinate system is selected, and the X-axis direction is determined by the straight line from the origin to the XX point. The XOY plane is determined by the other point YY and the X-axis which are not in the same straight line, and the Z-axis (right-handed screw rule) is determined by the vector perpendicular to the XOY plane through the original point.

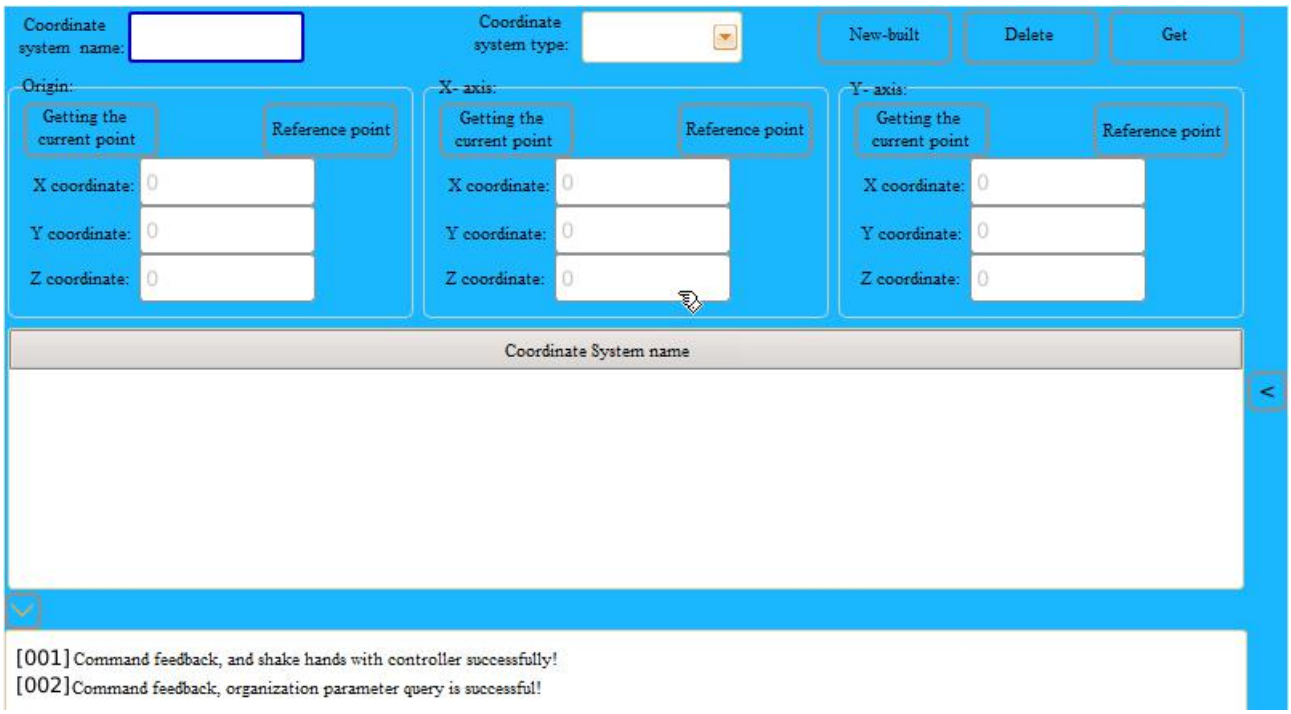


Fig. 5.1 “Coordinate System Configuration” Interface

Set the origin: Click the [Get current point] button at the corresponding position of the “Origin”, and the system reads the position of the current robot end as the origin position of the user coordinate and automatically fills the data input box below the “Origin” position. The origin position data is base-based data. If that “Point” in the “Origin” position has been established, you can click the Reference Points button to reference that “Point” in the [reference point], and you can also create a “Origin” after the “Save” operation.

Set the “X”, the “Y” axis (i. e., the “1-axis” and the “two-axis” in the figure show the “X” shaft and the “Y” shaft, respectively) “Coordinate point”, and the coordinate point can be input by the method of the “Origin”

setting.

After complete the “Origin”, the “X” axis, the “Y” axis setting, and “create” successfully “User coordinate system”, as shown in the following Fig. 5.2 (the picture shows a “User coordinate system” with the name “Usr”), and the “User coordinate system” name successfully“Created” will appear in the intermediate position “Coordinate system name”.

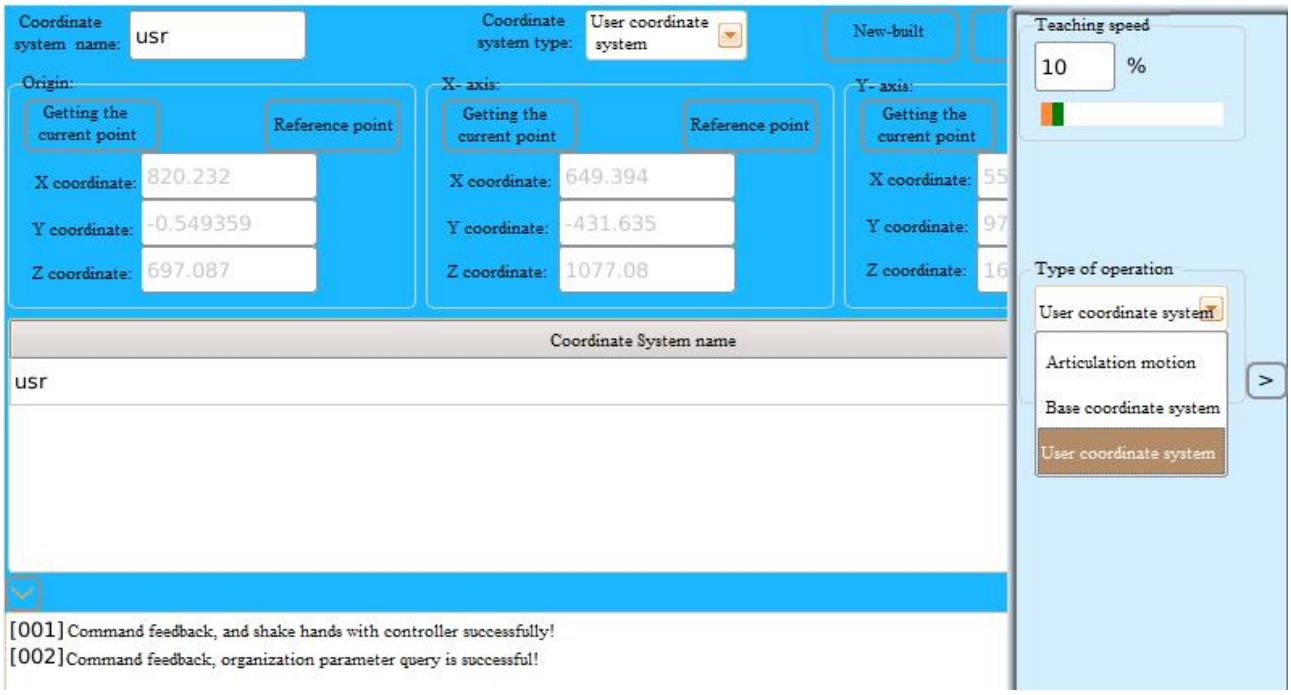


Figure 5.2 Establishment of the Completed “user coordinate system”

5.1.2 Use of User Coordinate System

After the “User coordinate system” is established, the “Manual teaching” can be performed using the coordinate system. Specific use of the “User coordinate system” includes “Select” and “Delete” of the “User coordinate system”.

In the “coordinate system management interface” (see Fig. 5.2), select the “User coordinate system” at the “Coordinate system type”, and click the [Get] button to display all the completed “User coordinate system” names, and then you can conduct “Delete” operations on them.

“Delete” operation: At the middle “Coordinate system name” of the “Coordinate system management interface”, select the corresponding “Coordinate system name”, and then click “Delete” on the upper right corner, and you can delete it after “OK”.

“Select” operation: Selection of the “User coordinate system”is mainly conductedwhen the “Manual teaching” is selected. In the “Configuration parameters window” interface “Type of operation”, select the “User coordinate system”, and all the “User coordinate system name” have been established will be shown. Select it.

6 Tracking Functions

6.1 Creation of Trace Procedure

The “Tracking function” of the control system is provided with two types of tracking modes of “Body tracking” and “Sliding track tracking”, as shown in Fig. 6.1. The “Body tracking” is used for realizing pipeline

motion tracking by using a mechanical arm body, and is suitable for small range tracking application occasions; “Sliding track tracking”, a pipeline motion tracking is realized by using an additional shaft articulation and an external sliding rail, and is suitable for large-range tracking occasions.

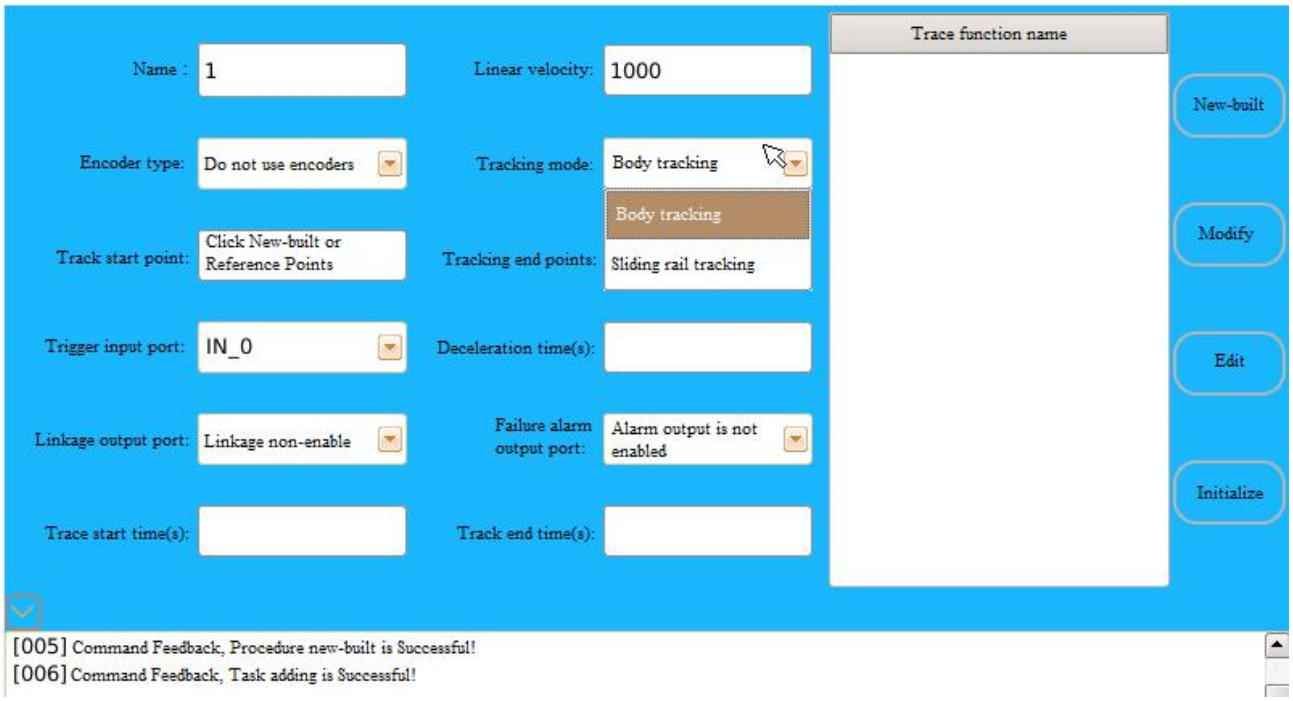


Fig. 6.1 Classification of “Tracking mode”

6.1.1 Ontology Tracking

According to the encoder type, the “Body tracking” can be divided into two types of encoder types: “Do not use encoders” and “Pulse type”, as shown in Fig. 6.2.

(1) No encoder body tracking is used: after selecting the “Encoder body tracking is not used” tracking function, the parameters required to be set are shown in Fig. 6.2. The “Name” is to create a trace function name; “Linear velocity” means the body tracking speed; “Track start point” and “Tracking end points” are directions to determine the body tracking; In “Trigger input port” to determine an I/O input port, a high electrical level “1. ” needs to be provided when triggered; The “Deceleration time” determines the “acceleration”; “Linkage output port” means that through a system I/O output port associated with the pipeline, the “Pause”, “go on” and “Start-up” of the system can also control the operation of the pipeline, and the parameter can not be set; failure alarm output port is connected with remote monitoring through a system I/O output port. When tracing fails, it can be displayed at the remote monitoring end, and this parameter is not necessary to be set; The “Trace start time” is “Tracking” after the I/O input port is triggered and through this setting time; “Track end time” means that after the I/O input port is triggered, this “Tracking” fails if this setting time is not on the “Tracking”.

Fig. 6.2 Classification of "Encoder type"

(2) Pulse encoder body tracking: After selectthe "Pulse encoder body tracking" tracking function, the parameters needed to be set are basically consistent with the parameter setting parameters of the "Encoder body tracking is not used" tracking function as shown in Fig. 6.3, but there are some differences: the "Number of Encoder Lines" is determined by pulse encoder specification; Firstly, the "Start detection trigger point" is required, and the input port is triggered to obtain a high-level "1" to trigger the success; the "Track start encoder values" is position detection, which starts with the I/O input port trigger, the encoder running these "coder value" and starting the "Tracking"; The "Tracking end encoder values" is also a position detection, starting with the I/O input port trigger, the encoder runs these "coder value", and if the "Tracking" is not started, the "Tracking" fails.

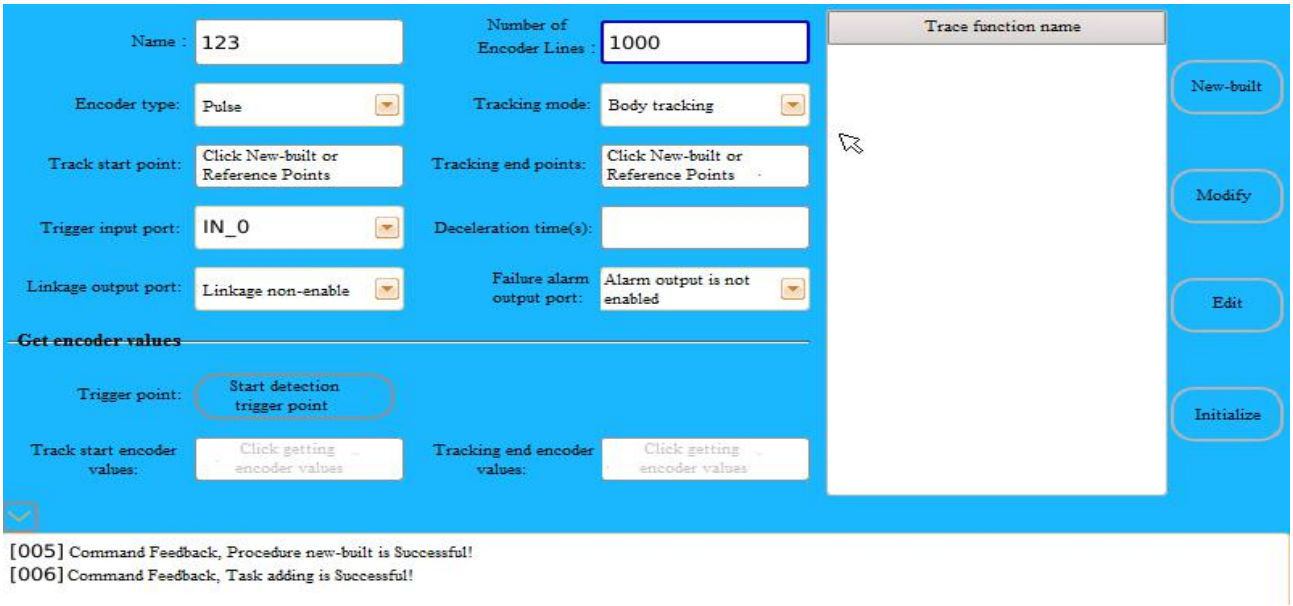


Fig. 6.3 Pulse Encoder Body Tracking Mode

6.1.2 Track of Slide Rail

Like "Body tracking", according to the encoder type, the "Sliding rail tracking" mode is also divided into two types of encoder types: "Do not use encoders" and "Pulse type".

(1) No encoder sliding rail tracking is used: after select the “Encoder track tracking is not used” tracking function, the parameters required to be set are shown in Fig. 6.4. The follow-up function of the “Encoder body tracking is not used” is basically consistent, but only the additional shaft of the connection is set to be a “Trace Mode” in the “Machine parameters”; Run the “Additional shaft” to the specified position, and click the “Tracking initial articulation angle” to determine the “Starting position”. During sliding rail tracking, the sliding rail will return to its starting position after each tracing is completed.

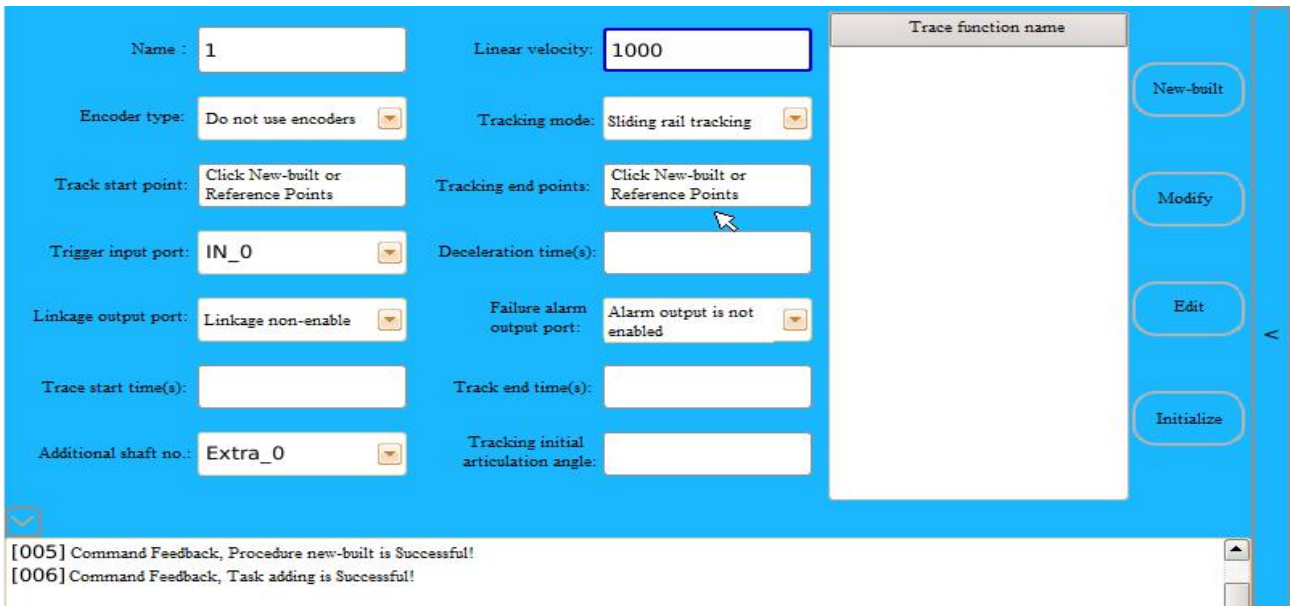


Fig. 6.4 No Encoder Sliding Rail Tracking

6.2 Management of Tracking Procedure

As shown in Fig. 6.4, you can also manage the tracking procedure, including 4 modes of operation “New-build”, “Modify”, “Edit”, and “Initialize” in the “Tracking function” creation interface.

(1) New-build: After setting the parameters of the tracking procedure, click “New-build” to complete saving of the tracking procedure, and save it under the name of the tracking function. As shown in Fig. 6.6, the tracking function procedure name is “1”, that is, the successfully created “Tracking procedure”.

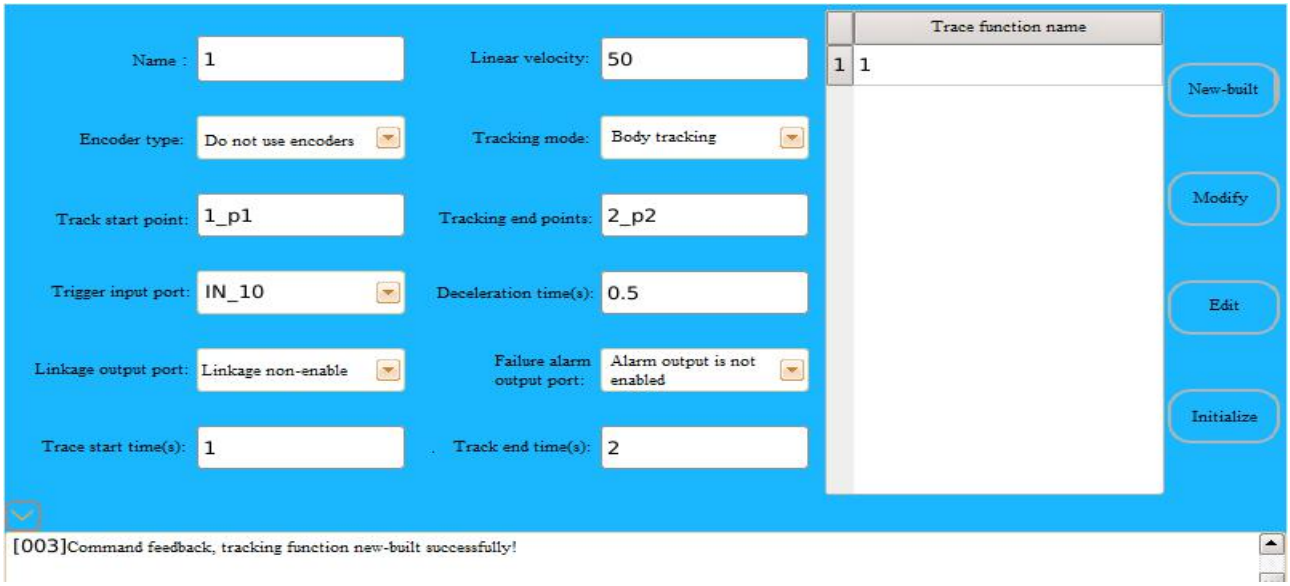


Fig. 6.6 Tracking Function Successfully Created

(2) Modification: The “Tracing procedure” of the “Parameter” that has been saved can be modified.

(3) Edit: You can delete the completed “Tracing procedure”.

(4) Initialization: The unsaved “Tracing procedure” can be conducted “Initialize” operation. After clicking the “Initialize” key and “OK”, the whole creation interface returns to the state before the “Create” is not started.

6.3 Operation of the Tracking Procedure

In “Auto mode”, you can enable “Tracing procedure”, as shown in Fig. 6.7. Turn the “Speed of motion”, “Number of motions”, “Mode of motion” (only two motion modes of “Single motion” and “Cyclic motion”, the “Single step” mode cannot enable the tracking function) and the “Load weight” setting to complete, select the “Procedure name” to run, and then you can select the “Enable tracking” to determine the “Tracing procedure” name, it is possible to carry out the operation of the “Tracing procedure”.

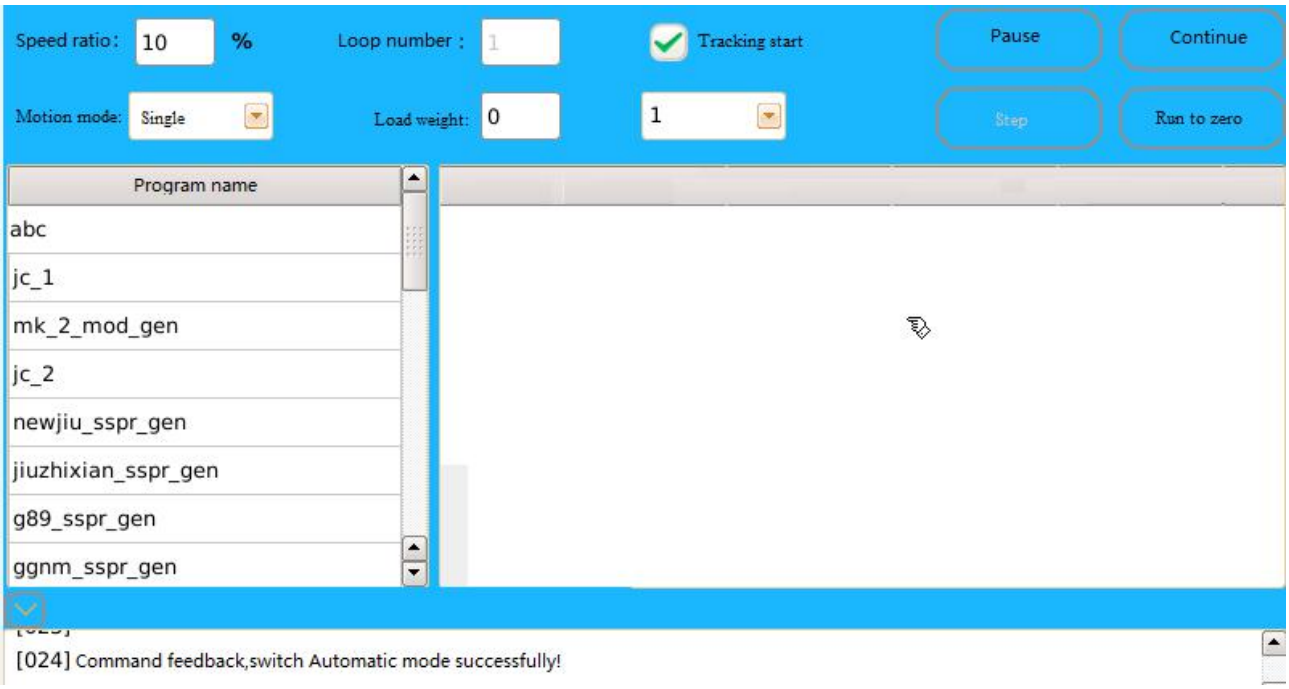


Fig. 6.7 Enabling Trace Procedure

When the procedure is in “Enable tracking” mode, the “mode of motion” can only set two motion modes of “Single motion” and “Cyclic motion”, and both the “Pause” and the “Go on” touch screen keys cannot be used, but the “Operation” of the “Procedure stop” physical key control procedure can be used.

7. System updates and backups

The system update is divided into controller system update and indication system update. Update path: Select [Configuration] — [System configuration] — [Procedure update and backup] in the main interface. Click [Procedure update and backup] to enter the “Updating and backup of procedures” interface as shown in Fig. 7.1 below, as shown in Fig. 7.2.

Fig. 7.1 “Procedure updates and backups” Path

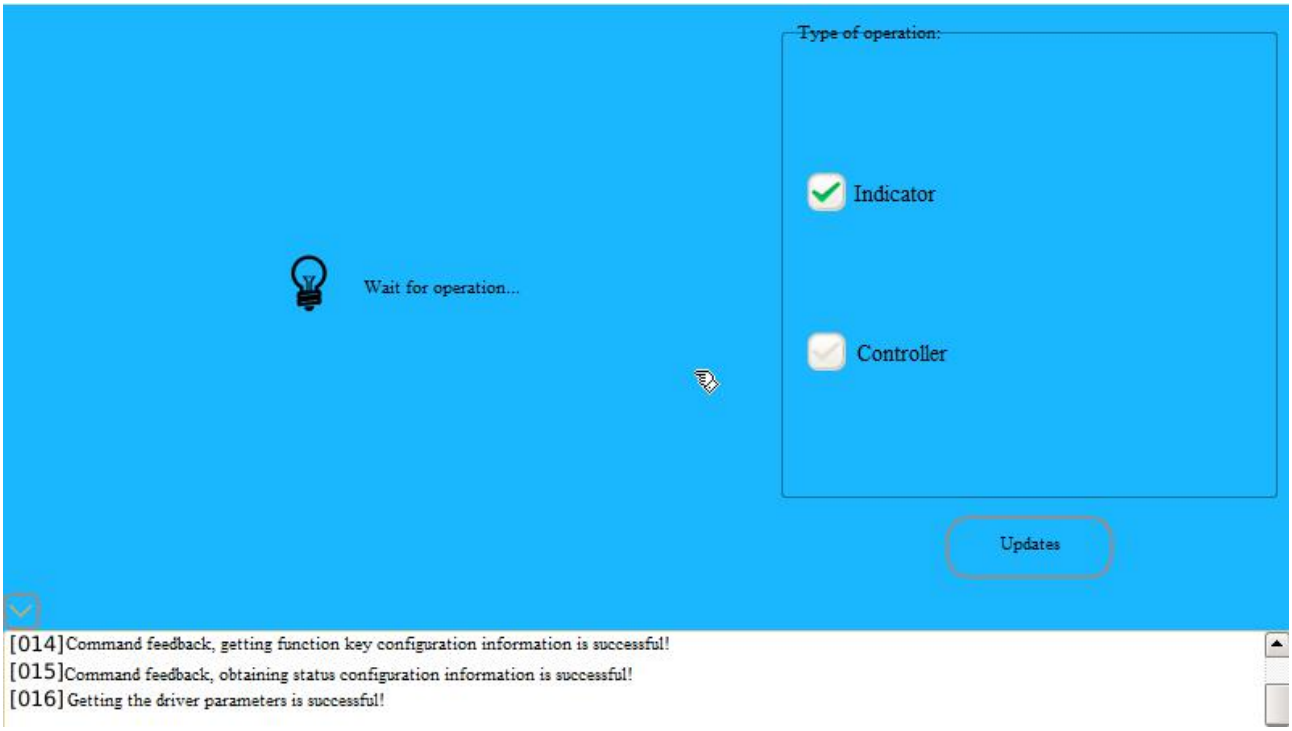


Fig. 7.2 “Procedure Updates and Backups” Interface

Updating of the controller system and the indication system: placing the required updated procedure folder “robcon” (including the controller system procedure “robcon” and the teaching device system procedure “robteach” and configuration file “config”, provided by the manufacturer) under the root directory of the U disk, Select the “Controller” or “Teaching device” operation type in the update interface, click the “Update” key, update the procedure, and after the update is complete, the system automatically restarts and re-“Login”.

The system procedure update contains “Application” updates, “FPGA (Field Proceduremable Gate Array) procedure” updates, “User procedure” and “Help Documents”, and the type of update can be set in the configuration file “config”; there is no “De-energized” in the system update process.

After the system procedure “Update” is successful, you can verify it by viewing the current “Procedure” version information. Select the path as [Tools] — [Version information] as shown in Fig. 7.3 and Fig. 7.4 below.

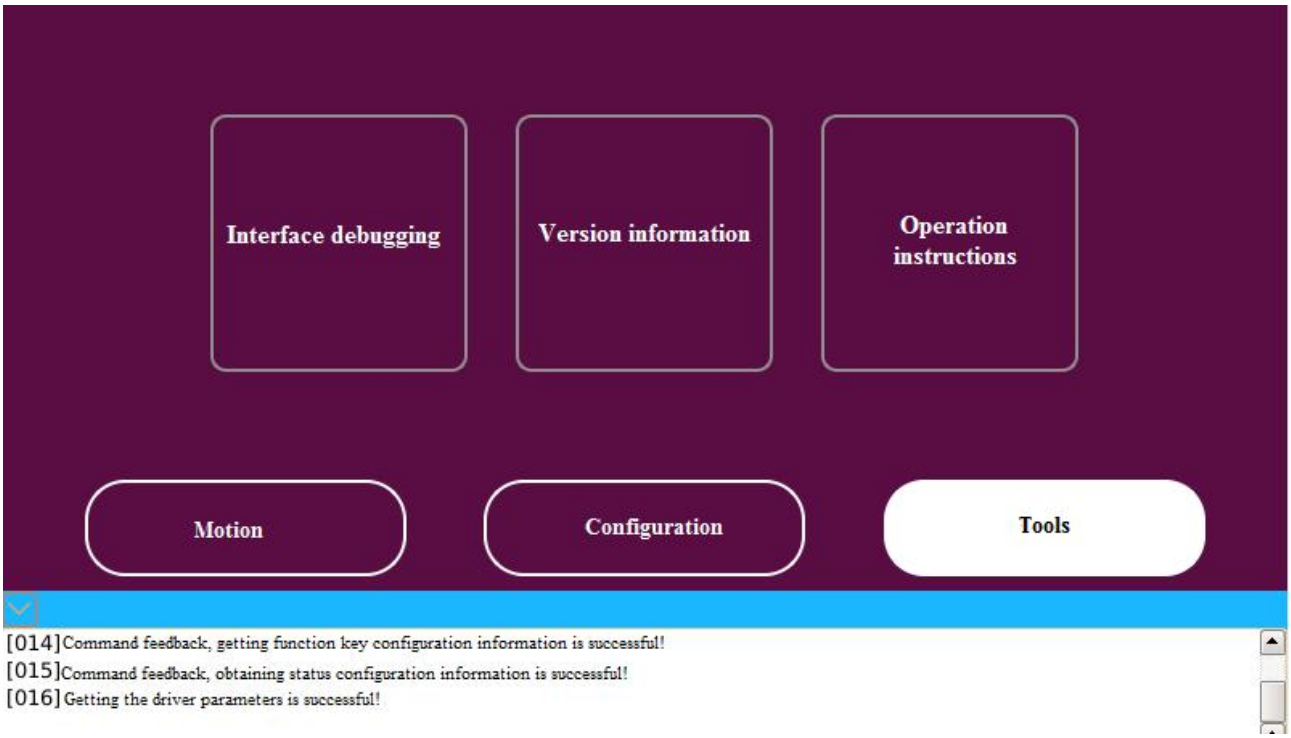


Fig. 7.3 “Version Information” Path

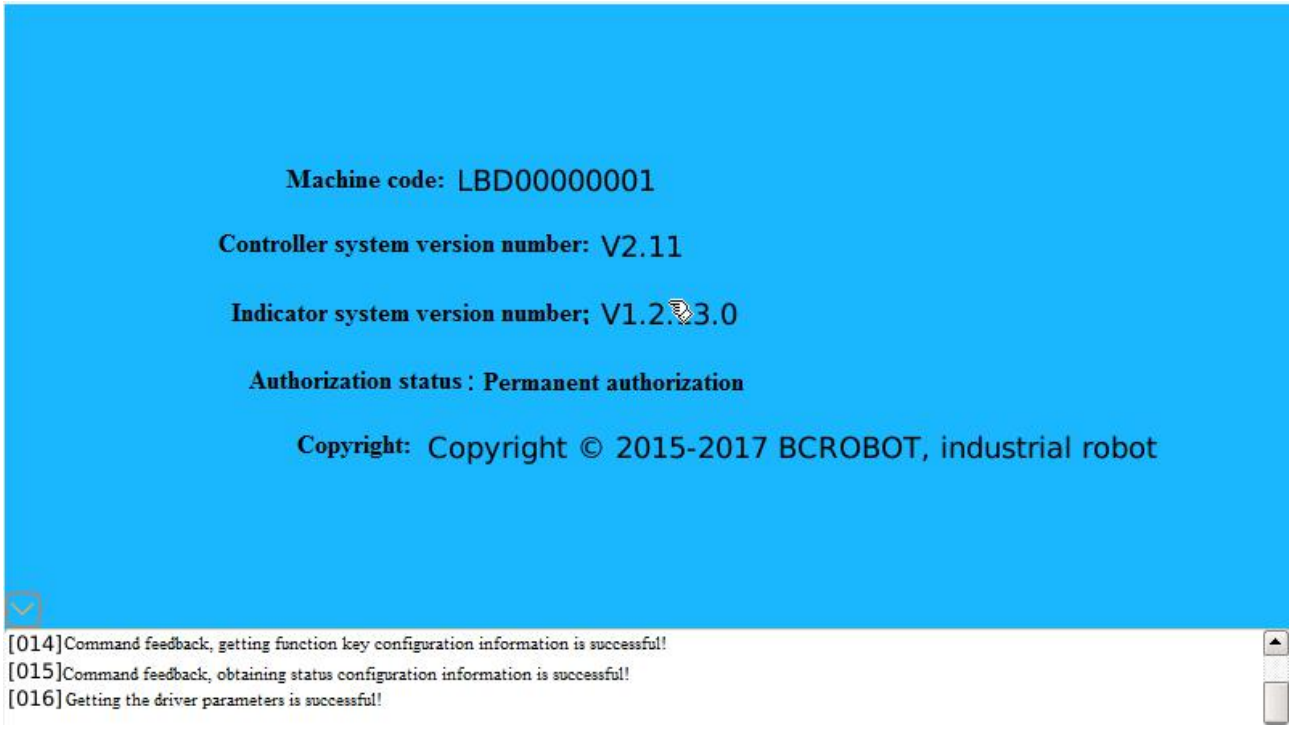


Fig. 7.4 Viewing of System Procedure Version Information

8. Fault Description and Handling

Fault Code	Fault Content	Reason	Confirmation Method	Handling Measures
1；10	Articulation reduction ratio setting error	Reduction ratio> 0	Modify parameters	Modify parameters
2；14	Articulation motor speed setting error	Motor speed ≥ 1	Modify parameters	Modify parameters
3；15	Articulation PN_OUT parameter setting error	PN_OUT ≥ 1	Modify parameters	Modify parameters
4；16	Articulation PN_IN parameter setting error	PN_IN ≥ 1	Modify parameters	Modify parameters
5；17	Articulation encoder direction setting error	Encoder direction=1 or 0	Modify parameters	Modify parameters
6；13	Articulation limit value setting error	Articulation positive limit value> negative limit value	Modify parameters	Modify parameters
9	Wrong connection length setting	Connecting rod length ≥ 0	Modify parameters	Modify parameters
11	Articular limit value set error (6-articulation infinite bit)	Articulation positive limit value ≤ 360	Modify parameters	Modify parameters
12	Articulation negative limit value setting error (6-articulation infinite bit)	Articulation positive limit value ≥ -360	Modify parameters	Modify parameters
20	error of setting of circular motion time	Cycle motion time ≥ 0 and ≤ 60000.0 represents infinite circulation	Modify parameters	Modify parameters
134	It is not reasonable to set the motion speed setting value.	Motion speed > 0 and ≤ 2000	Modify parameters	Modify parameters
477	Small distance between tracking start point and end point	Distance between start point and end point > 0	Error saving tracing procedure	Modify distance between start point and end point
548；731	Articulation is about to exceed the limit	Articulation coordinates are close to set positive and negative soft limit parameter values	The articulation cannot move in that direction again	Modify the parameter value of the positive and negative soft limit

				machines of the articulation
554；560；567 573；584；593 613；622；633 642；653；661 671	The additional shaft angle is about to exceed the limit.	The additional shaft motion angle value is close to the set additional shaft parameter value	The additional shaft cannot move in that direction again	Modify additional shaft machine parameter values
88；113；118 125；133；136 175；181；188 195；229；252 255；261；264 295；297；311 335；337；356 359；362；497 513；520；526 543；676；682 686；690；722 734；737；740 743；749；752 759；762；765 768；771；774 778；781；784 787；790；793	The curve goes through a strange point	The singular point is not applicable to the calculation algorithm, and the calculation error	Select the base coordinate system, and the machine will be alarmed when manually teaching the machine.	Avoid strange points while manually teaching the machine