



ROBOTIS OP3



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目录 Agenda

- 1、硬件 **Hardware**
- 2、软件 **Software**
- 3、示例 **Demonstration**
- 4、Q&A

硬件
Hardware



ROBOTIS OP3 Specs



ROBOTIS OP3	Specifications
身高	510mm
体重	3.5kg without skin
自由度	20
主控制器	Intel NUC i3, OpenCR
传感器	FHD Webcam, 9-Axis IMU
IO Devices	LEDs(x4), Buttons(x4), Speaker(x1)
电池	LiPo 11.1V, 1800mA
开发环境	Linux Mint 18.1(64-bit) C++, ROS, Dynamixel SDK



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OP3 Hardware Specs

	ROBOTIS OP2	ROBOTIS OP3
舵机	MX-28	XM430-W350
CPU	Intel Atom N2600 @1.6GHz dual core	Intel Core i3 processor dual core
RAM	2GB DDR3 SODIMM 1066MHz (user-replaceable)	8GB DDR4 SODIMMs 2133MHz (32GB maximum) (user-replaceable)
Storage	half-size mSATA module (32GB) (user-replaceable)	M.2 SSD module (128GB) (user-replaceable)
操作系统	any Linux release (32-bit) any Windows release (32-bit)	any Linux release (32-bit/64-bit) any Windows release (32-bit/64-bit)
网络	Realtek 10/100/1000 Mbps Ethernet 802.11n (2.4GHz-only)	Intel 10/100/1000 Mbps Ethernet 802.11ac (2.4GHz, 5GHz) Bluetooth 4.1
摄像头	Logitech C905 (1600x1200)	Logitech C920 (1920x1080)





OP3 Hardware (Dynamixel)



	MX-28	XM430-W350
Operation Mode	Wheel Joint Multi-turn	Current Velocity Position Extended Position Current based Position PWM
Gear Ratio	193 : 1	353.5 : 1
Stall Torque	2.5 Nm @ 12.0V	4.1 Nm @ 12.0V
No Load Speed	55 RPM @ 12.0V	46 RPM @ 12.0V
Protocol	Protocol 1.0 / Protocol 2.0	Protocol 1.0 / Protocol 2.0
Dimension	35.6 x 50.6 x 35.5	28.5 x 46.5 x 34
Material	Full Metal Gear Engineering Plastic	Full Metal Gear Body Metal Body
Weight	77g	82g



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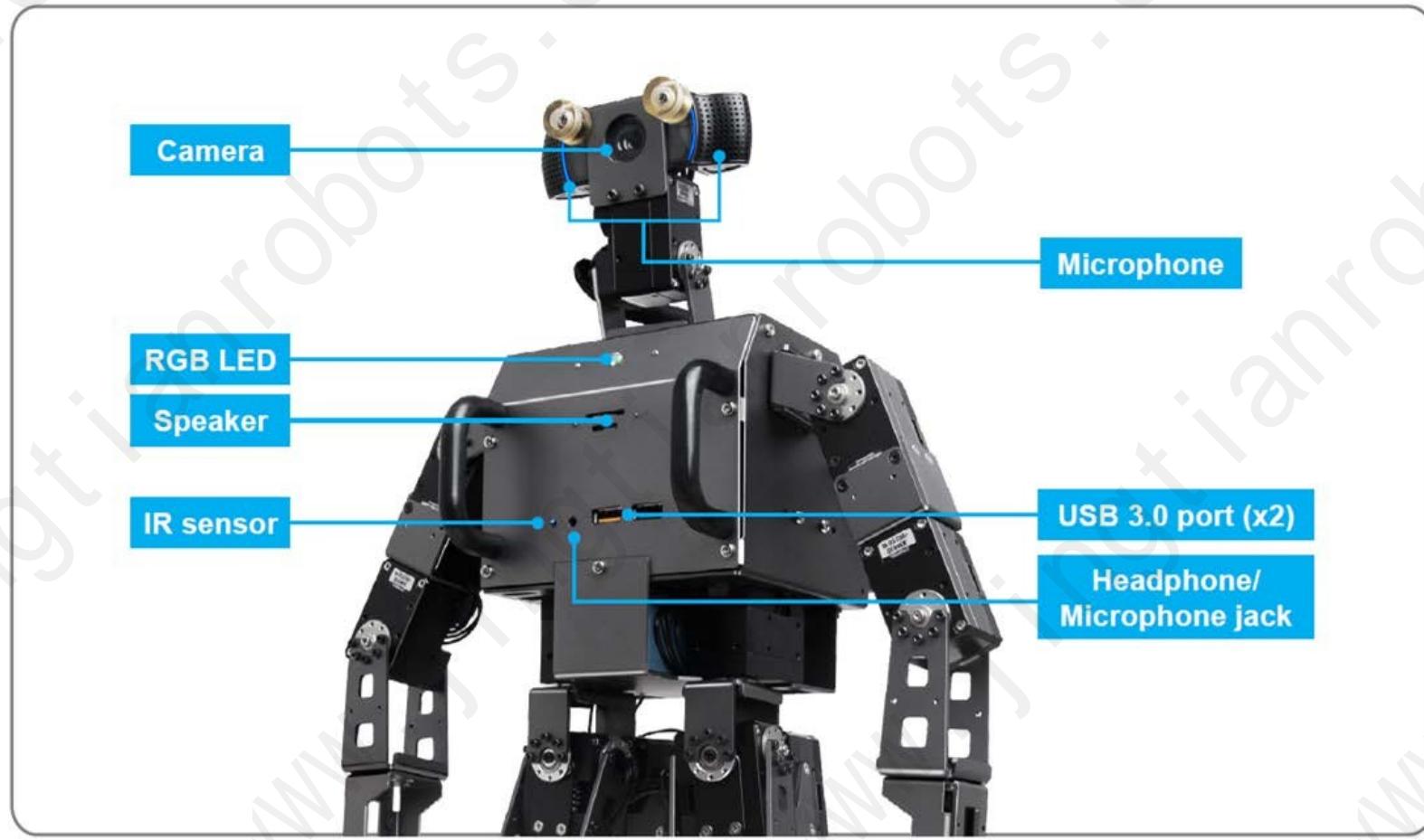
OP3 装箱包清单



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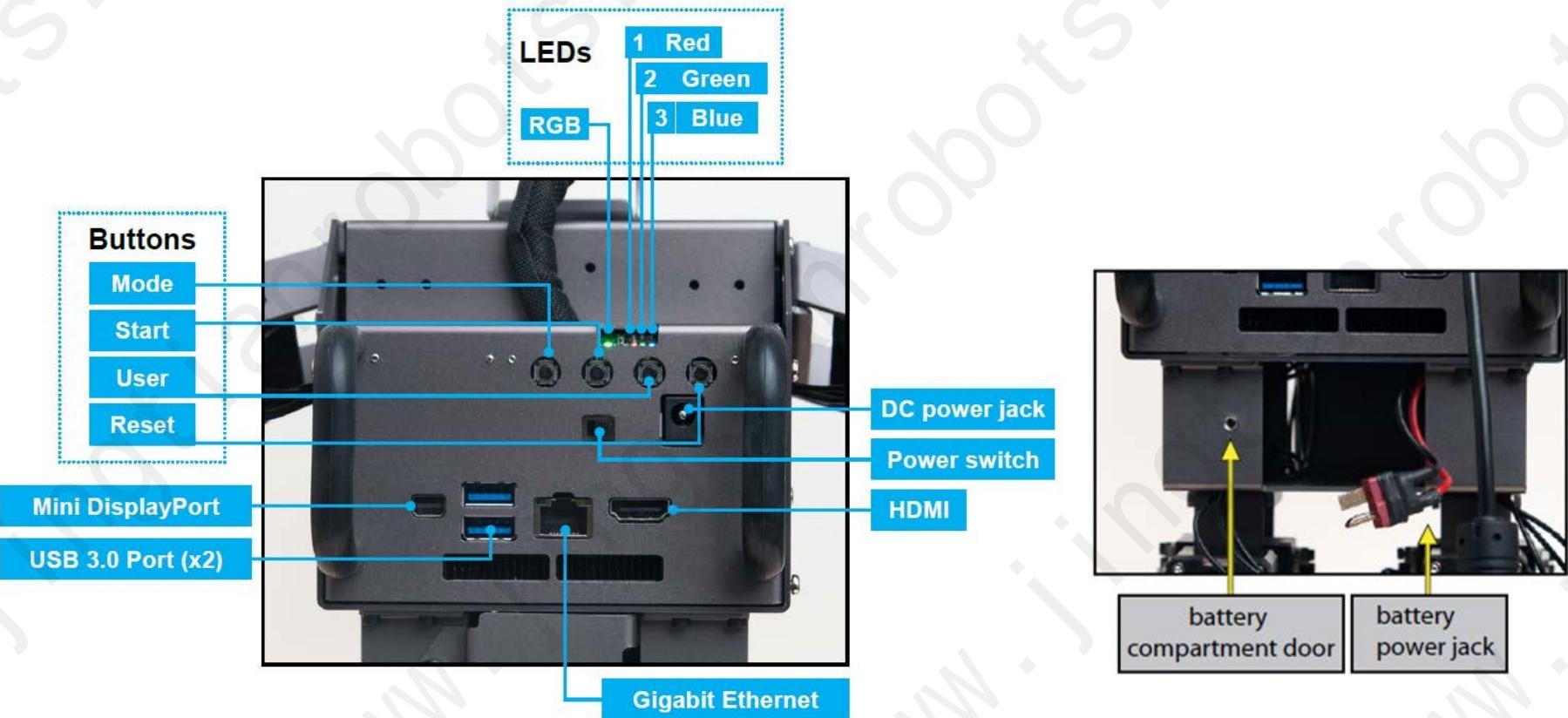
Layout - 正面



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Layout - 背面

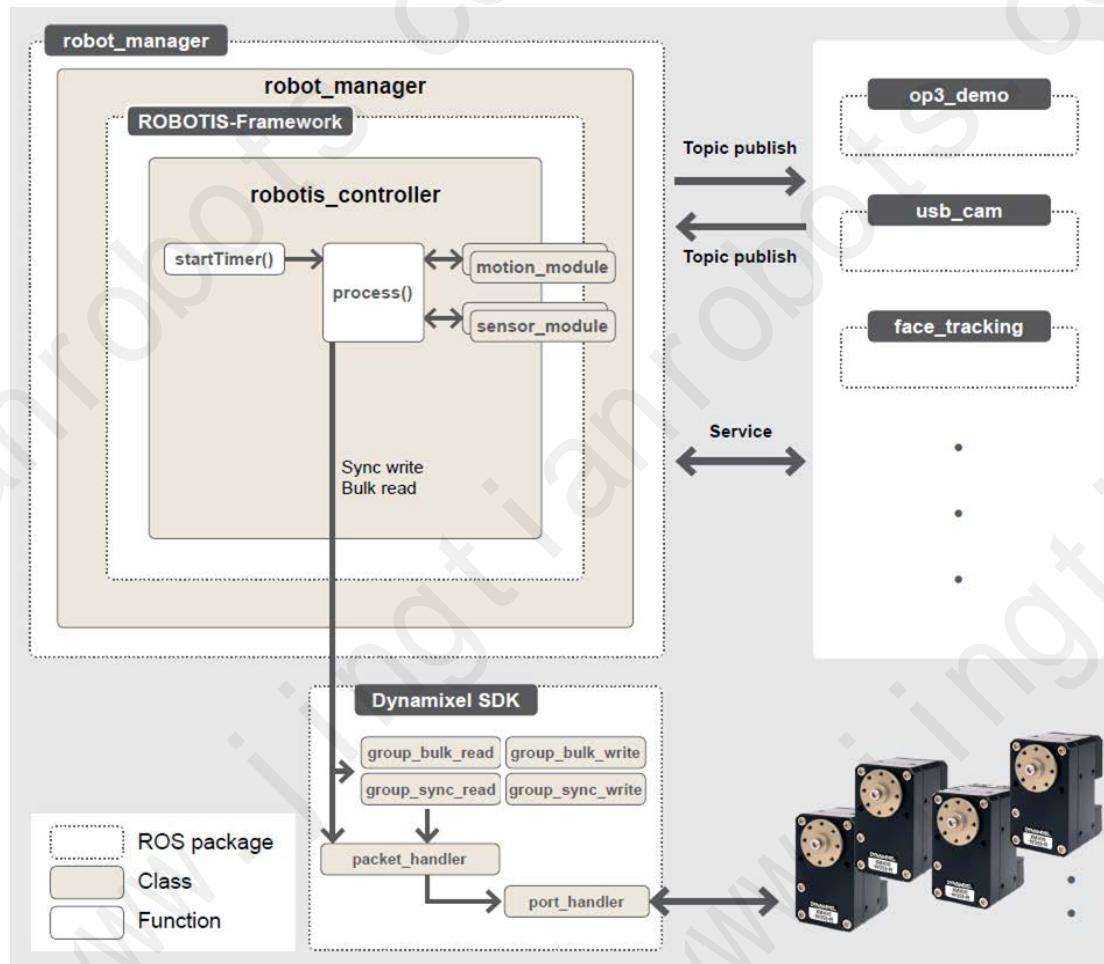


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软件
Software



OP3 框架图





OP3 ROS Packages

ROBOTIS-OP3

Motion Module

- [op3_action_module](#) : This module manages every joint actions.
- [op3_base_module](#) : This module manages initial pose and basic functions.
- [op3_head_control_module](#) : This module controls the head.
- [op3_walking_module](#) : This module controls walking.

Sensor Module

- [open_cr_module](#) : This module is required to use OpenCR as a sensor.



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OP3 ROS Packages

ROBOTIS-OP3-msgs

Module msgs

- [op3_action_module_msgs](#) : This message/service is used for op3_action_module.
- [op3_walking_module_msgs](#) : This message/service is used for op3_walking_module.

Tool msgs

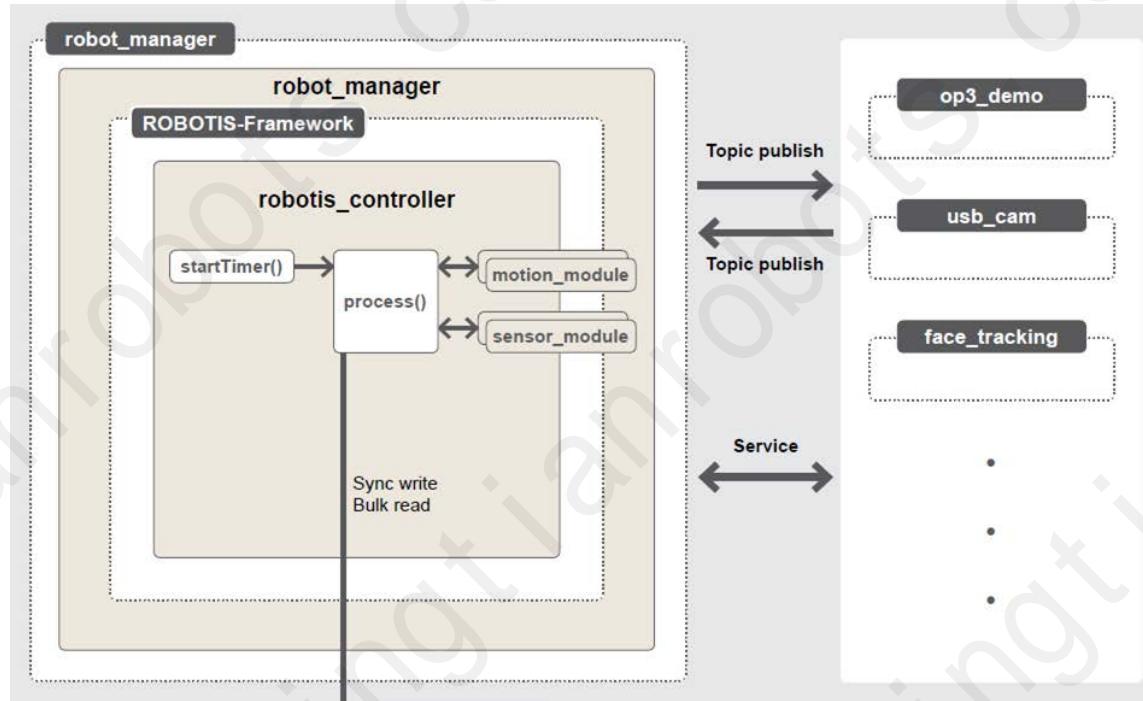
- [op3_offset_tuner_msgs](#) : This message/service is used for OP3 offset tuning.



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OP3 ROS Packages



op3_manager

op3_manager package applies ROBOTIS Framework to ROBOTIS OP3 using configuration files.



Function



OP3 ROS Packages

ROBOTIS-OP3/op3_manager

Robot File(op3_manager/config/OP3.robot)

```
[ control info ]
control_cycle = 8 # milliseconds

[ port info ]
# PORT NAME | BAUDRATE | DEFAULT JOINT
/dev/U2D2    | 2000000  | r_sho_pitch

[ device info ]
# TYPE      | PORT NAME   | ID | MODEL        | PROTOCOL | DEV NAME       | BULK READ ITEMS
dynamixel  | /dev/U2D2    | 1  | XM-430      | 2.0       | r_sho_pitch    | present_position
dynamixel  | /dev/U2D2    | 2  | XM-430      | 2.0       | l_sho_pitch    | present_position
dynamixel  | /dev/U2D2    | 3  | XM-430      | 2.0       | r_sho_roll     | present_position
...
...
dynamixel  | /dev/U2D2    | 19 | XM-430      | 2.0       | head_pan       | present_position
dynamixel  | /dev/U2D2    | 20 | XM-430      | 2.0       | head_tilt      | present_position
sensor      | /dev/U2D2    | 200| OPEN-CR     | 2.0       | open-cr        | button, present_voltage, gyro_x, gyro_y, gyro_z,
acc_x, acc_y, acc_z, roll, pitch, yaw
```



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OP3 ROS Packages

ROBOTIS-OP3/op3_manager

Joint Initialize File(op3_manager/config/dxl_init_OP3.yaml)

```
r_sho_pitch : # XM-430
  return_delay_time      : 1    # item name : value
  min_position_limit     : 0
  max_position_limit     : 4095

r_sho_pitch : # XM-430
  return_delay_time      : 1    # item name : value
  min_position_limit     : 0
  max_position_limit     : 4095

...
```



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OP3 ROS Packages

ROBOTIS-OP3/op3_manager

Offset File(op3_manager/config/offset.yaml)

```
offset:  
  head_pan: 0  
  head_tilt: 0  
  l_ank_pitch: 0.0174532925199433  
  l_ank_roll: 0  
  l_el: 0  
  l_hip_pitch: 0.01221730476396031  
  l_hip_roll: -0.01570796326794897  
  l_hip_yaw: 0.004363323129985824  
  l_knee: 0.006981317007977318  
  l_sho_pitch: 0  
  l_sho_roll: 0  
  r_ank_pitch: 0.008726646259971646  
  r_ank_roll: 0  
  r_el: 0  
  r_hip_pitch: 0.01658062789394613  
  r_hip_roll: 0.0148352986419518  
  r_hip_yaw: 0.008726646259971646  
  r_knee: 0.008726646259971646  
  r_sho_pitch: 0  
  r_sho_roll: 0
```

```
init_pose_for_offset_tuner: head_pan: 0  
  head_tilt: 0  
  l_ank_pitch: 0  
  l_ank_roll: 0  
  l_el: 0  
  l_hip_pitch: 0  
  l_hip_roll: 0  
  l_hip_yaw: 0  
  l_knee: 0  
  l_sho_pitch: 0  
  l_sho_roll: 0  
  r_ank_pitch: 0  
  r_ank_roll: 0  
  r_el: 0  
  r_hip_pitch: 0  
  r_hip_roll: 0  
  r_hip_yaw: 0  
  r_knee: 0  
  r_sho_pitch: 0  
  r_sho_roll: 0
```



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OP3 ROS Packages

ROBOTIS-OP3-Demo

- [ball_detector](#) : This package detects a specific colored ball from the image acquired from USB camera.
- [op3_demo](#) : Basic Demo for OP3(Soccer, Vision, Action)



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OP3 ROS Packages

ROBOTIS-OP3-Common

robotis_op3_description

- doc : document for ROBOTIS OP3 joint & link information
- launch : launch file to execute Rviz
- stl : STL files of ROBOTIS OP3's each parts
- src : ROS node for Rviz to publish imaginary gripper joint
- urdf : urdf & xacro files for Thormang3 model

robotis_op3_gazebo

- config : ROS controller for gazebo
- launch : launch files to execute gazebo simulation
- worlds : simulation environments



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OP3 ROS Packages

ROBOTIS-OP3-Tools

- [op3 action editor](#) : The software that can create and edit actions for ROBOTIS-OP3
- [op3 gui demo](#) : GUI software for ROBOTIS-OP3
- [op3 offset tuner server](#) : op3_offset_tuner_server communicates with op3_offset_tuner_client to control OP3 for offset tuning, and manages tuned offset file.
- [op3 offset tuner client](#) : op3_offset_tuner_client is a GUI program to communicate with op3_offset_tuner_server for offset tuning.
- [op3 walking tuner](#) : This package is used to tune OP3 walking motion



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Install OP3 Packages

OP3 Dependent Packages from ROBOTIS

```
$ cd ~/catkin_ws/src/  
$ git clone https://github.com/ROBOTIS-GIT/DynamixelSDK.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-Framework.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-Framework-msgs.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-Math.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-OP3.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-OP3-Common.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-OP3-Demo.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-OP3-msgs.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-OP3-Tools.git  
$ git clone https://github.com/ROBOTIS-GIT/ROBOTIS-Utility.git
```



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Install OP3 Packages

OP3 Additional Dependent Packages

```
$ git clone https://github.com/ROBOTIS-GIT/face_detection.git  
$ git clone https://github.com/clearpathrobotics/robot_upstart.git  
$ sudo apt install v4l-utils  
# apt-get install ros-kinetic-ros-control  
# apt-get install ros-kinetic-ros-controllers  
# apt-get install ros-kinetic-gazebo-ros-control
```

Build Dependent Packages

```
$ cd ~/catkin_ws && catkin_make
```



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Network Configuration

OP3



Remote PC



ROS_MASTER_URI = <http://10.41.0.1:11311>
ROS_HOSTNAME = 10.41.0.1(IP of OP3)

ROS_MASTER_URI = <http://10.41.0.1:11311>
ROS_HOSTNAME = 10.41.0.XXX(IP of Remote PC)

* ROS Master is running on OP3



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Gazebo Simulator



Gazebo Simulator

1. Run “roscore”

```
$ roscore
```

2. Run OP3 gui demo

```
$ roslaunch op3_gui_demo op3_demo.launch
```

3. Run OP3 manager

```
$ roslaunch op3_manager op3_gazebo.launch
```

4. Run Gazebo

```
$ roslaunch robotis_op3_gazebo robotis_world.launch
```





OP3 GUI

The screenshot displays the OP3 GUI interface, which includes two main sections: "Ros Communications" and "Basic Control".

Ros Communications (Left Side):

- Logging:** A large text area for displaying log messages.
- Clear:** A button to clear the log area.

Basic Control (Right Side):

- Robot Init Pose:** A section for initializing the robot's pose.
- Mode Control:** A tabbed interface for selecting control modes. The "Walking" tab is selected, showing the following configuration:

Joint	Module
[01] r_sho_pitch	none
[03] r_sho_roll	none
[05] r_el	none
[07] r_hip_yaw	none
[09] r_hip_roll	none
[11] r_hip_pitch	none
[13] r_knee	none
[15] r_ank_pitch	none
[17] r_ank_roll	none
[19] head_pan	none
[200] opencr	none
[02] l_sho_pitch	head_control_module
[04] l_sho_roll	action_module
[06] l_el	walking_module
[08] l_hip_yaw	direct_control_module
[10] l_hip_roll	
[12] l_hip_pitch	
[14] l_knee	
[16] l_ank_pitch	
[18] l_ank_roll	
[20] head_tilt	

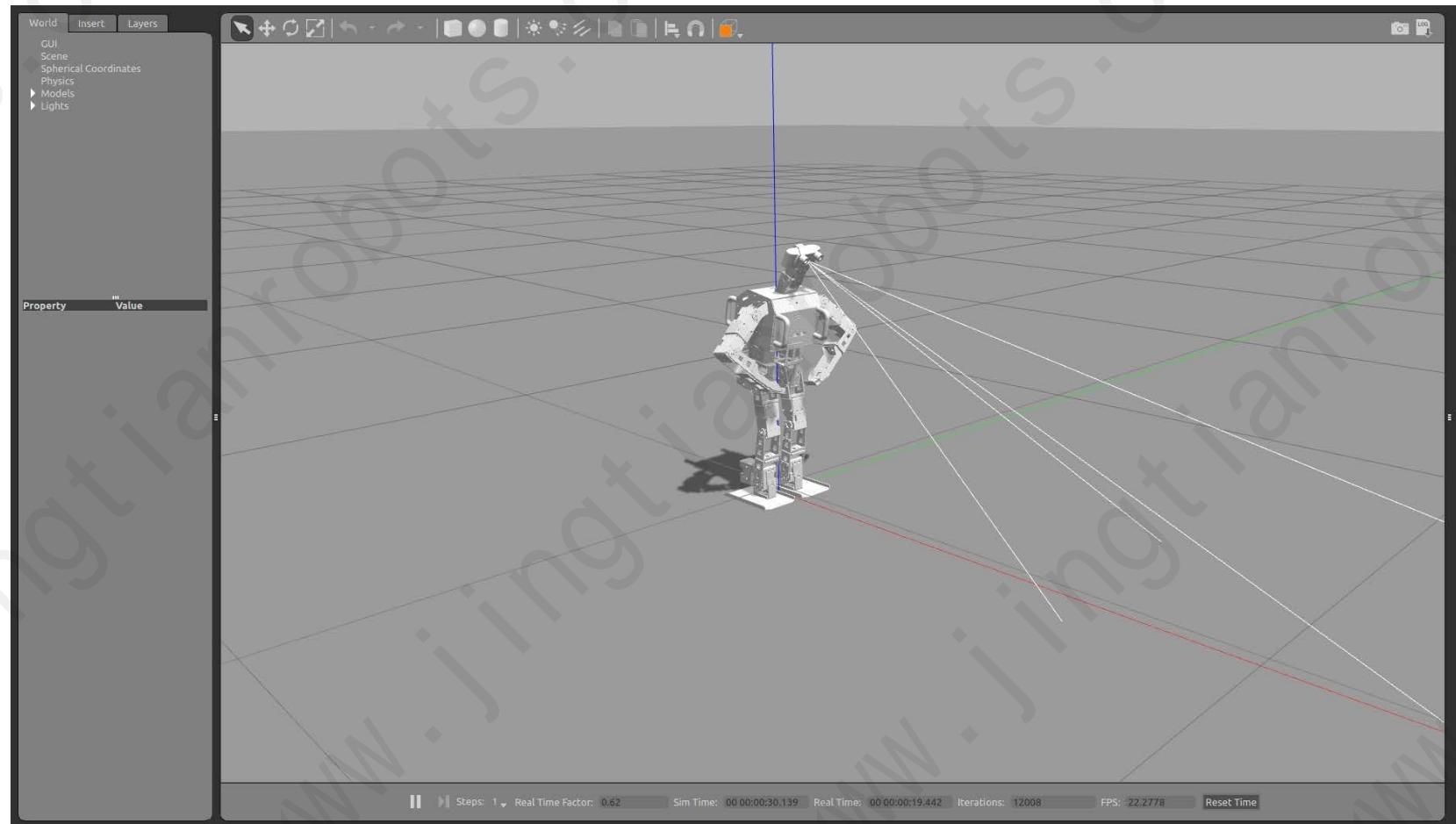
- Get Mode:** A button to retrieve the current mode settings.



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OP3 Gazebo





OpenPose



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https://github.com/Seri-Lee/robotis_op3_following_motion

<https://youtu.be/gfljsGqKERk>

示例

Demonstration



Basic Operation

1. Power On

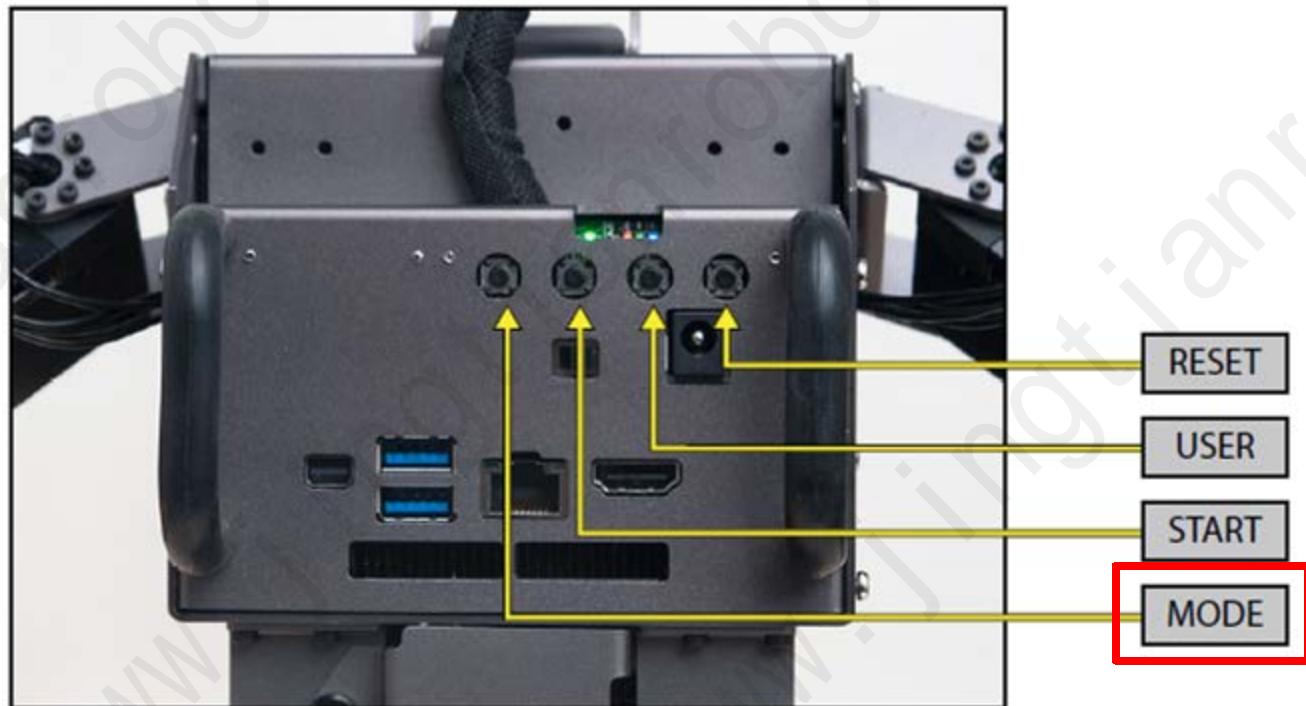


On/Off
Switch



Basic Operation

2. Select Demonstration Program



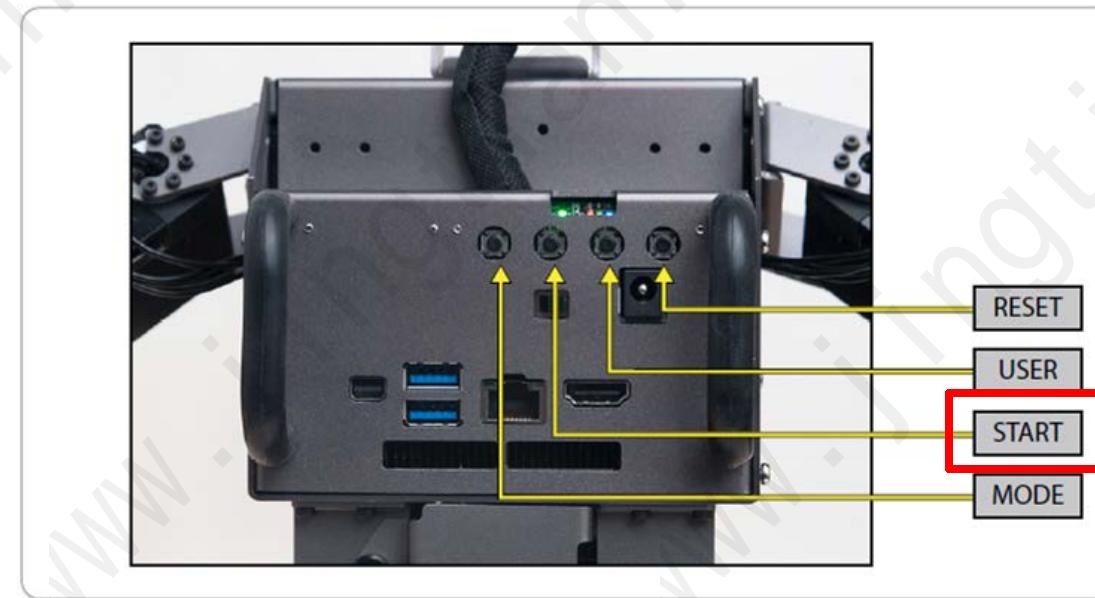
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Basic Operation

3. Run Demonstration Programs

1. Autonomous Soccer Mode
2. Vision Processing Mode
3. Interactive Motion Mode

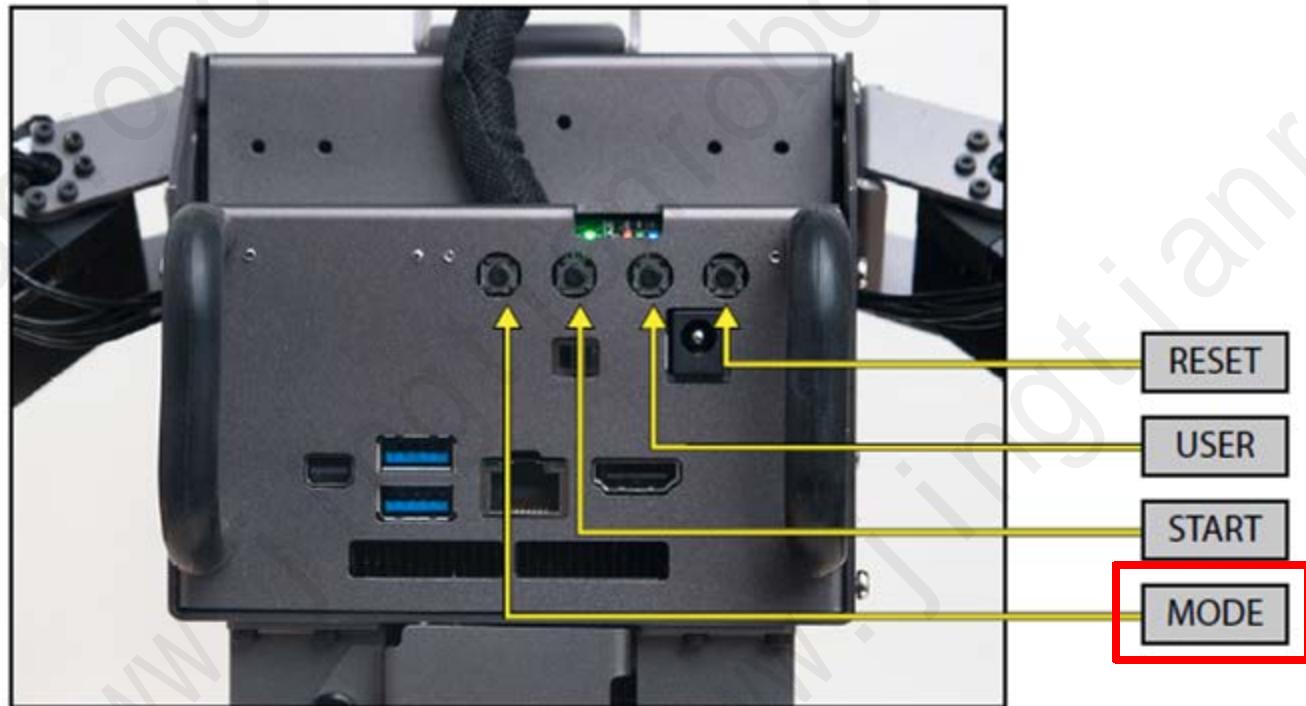


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Basic Operation

4. Quit Demonstration Program





Connecting to OP3

SSID : ROBOTIS-OP3-share

AP Password : 11111111

A screenshot of a terminal window titled "robotis@robotis-op3 ~". The window shows an SSH session to a host at 10.42.0.1. The session starts with a warning about host key fingerprint authentication, followed by a password prompt. Once logged in, the user is presented with the Linux Mint 18.1 command-line interface. The terminal window title is "robotis@robotis-op3 ~ 80x24".

```
robotis@TH0R-laptop:~$ ssh robotis@10.42.0.1
The authenticity of host '10.42.0.1 (10.42.0.1)' can't be established.
ECDSA key fingerprint is SHA256:FIMLkQtfonyHAFe4hzFqe+6pXRmePiiU3W4sZeP020U.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.42.0.1' (ECDSA) to the list of known hosts.
robotis@10.42.0.1's password:
Welcome to Linux Mint 18.1 Serena (GNU/Linux 4.4.0-53-generic x86_64)

* Documentation: https://www.linuxmint.com
Last login: Fri Jun  2 14:26:16 2017 from 10.42.0.77
robotis@robotis-op3 ~ $
```

\$ ssh [robotis@10.42.0.1](https://www.linuxmint.com)

Password : 111111



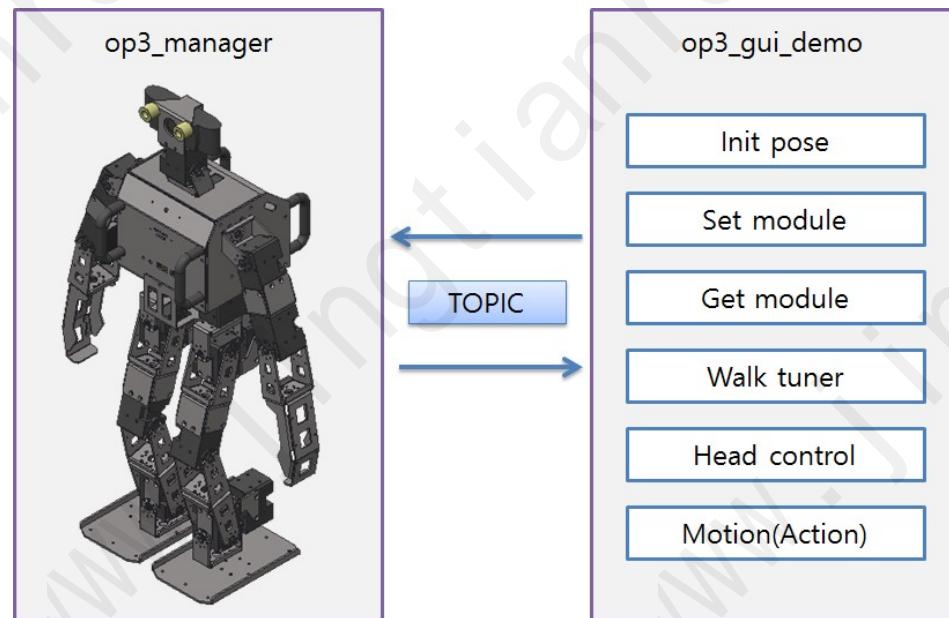
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GUI Tool

```
$ sudo bash  
# roslaunch op3_manager op3_manager.launch
```

```
$ roslaunch op3_gui_demo op3_demo.launch
```



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GUI Tool(Walking Tuner)

Basic Control

Robot Init Pose

Mode Control Walking Head Control Motion Demo

2

1

Get Mode

none head_control_module action_module walking_module

[01] r_sho_pitch [02] l_sho_pitch [03] r_sho_roll [04] l_sho_roll [05] r_el [06] l_el [07] r_hip_yaw [08] r_hip_pitch [09] r_hip_roll [11] r_hip_pitch [13] r_knee [15] r_ank_pitch [17] r_ank_roll [19] head_pan [200] opencr



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GUI Tool(Walking Tuner)

The screenshot displays the 'Walking Tuner' interface, which includes the following sections:

- Ros Communications**: A panel showing log messages:
 - [INFO] [00:06]: [Demo] Set Mode : walking_module
 - [INFO] [00:07]: [Manager] Applied Mode
 - [INFO] [00:07]: [Demo] Get walking parameters
- Basic Control**:
 - Robot Init Pose**: Includes fields for X, Y, Z coordinates and Roll, Pitch, Yaw, Hip Pitch Offset.
 - Walking Parameter**: Includes fields for Period Time (750 ms), DSP Ratio (0.20), Step FB Ratio (0.28), Move Aim (checkboxes for On and Off), and X, Y, Z Move Amplitude.
 - Balance Control**: Includes fields for Balance (checkboxes for On and Off), Hip Roll Gain (0.35), Knee Gain (0.25), Ankle Roll Gain (0.70), Ankle Pitch Gain (0.75), and Inertial Gyro parameters (Y Swap Amplitude, Z Swap Amplitude, Arm Swing Gain, Pelvis Offset).
- Walking Command**: A timeline with two red boxes labeled 1 and 2, and markers for Start and Stop.



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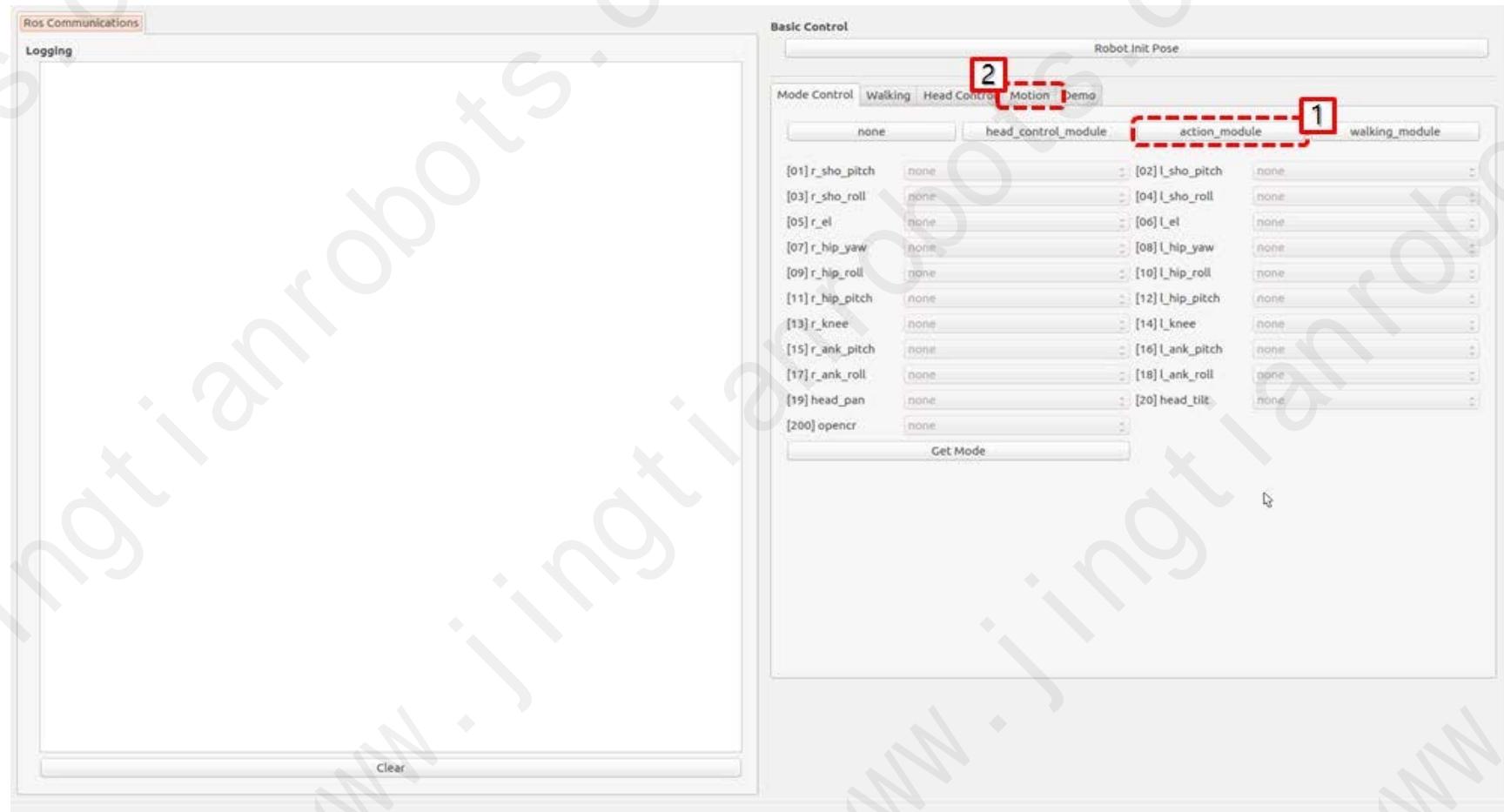


GUI Tool(Walking Tuner)



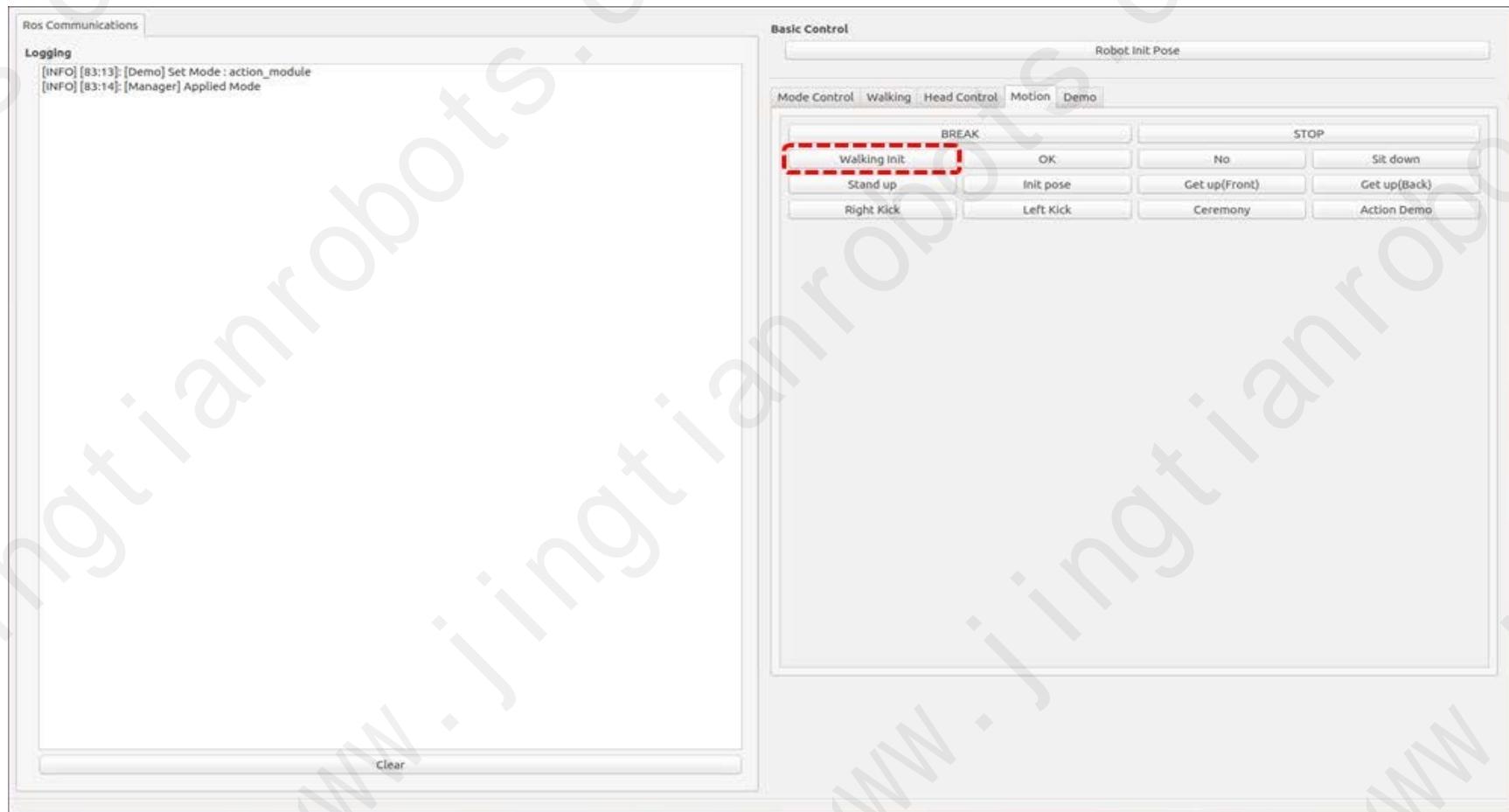


GUI Tool (Motion Play)





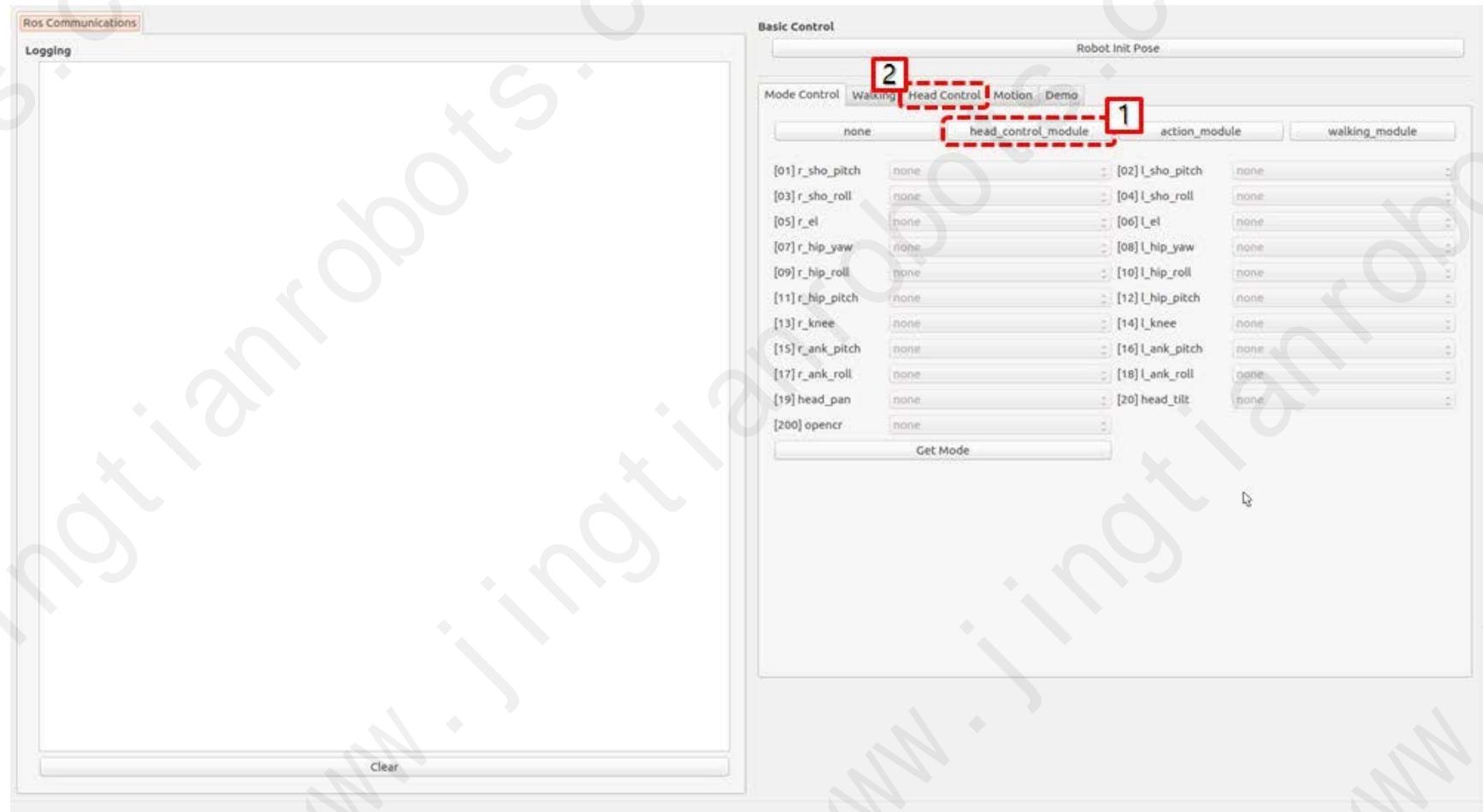
GUI Tool (Motion Play)



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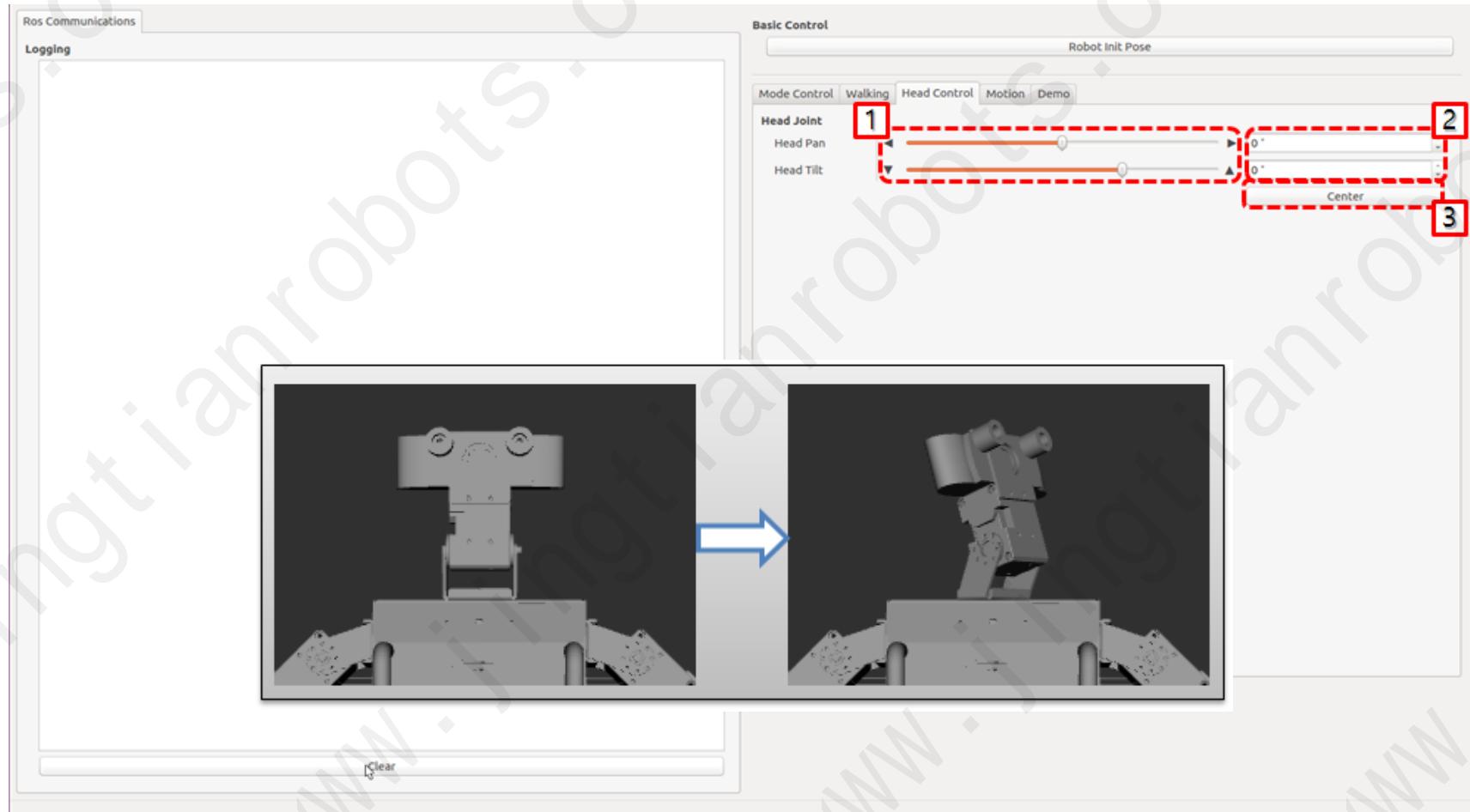


GUI Tool (Control Head)





GUI Tool (Control Head)





Offset Tuner

```
$ roslaunch op3_offset_tuner_server op3_offset_tuner_server.launch
```

```
$ rosrun op3_offset_tuner_client op3_offset_tuner_client
```

1. **op3_offset_tuner_server configuration files**

offset.yaml : Offset data and offset adjusting posture information are saved

OP3.robot : Description of ROBOTIS-OP3 is saved

dxl_init_OP3.yaml : Dynamixel configurations are saved and used for joint initialization

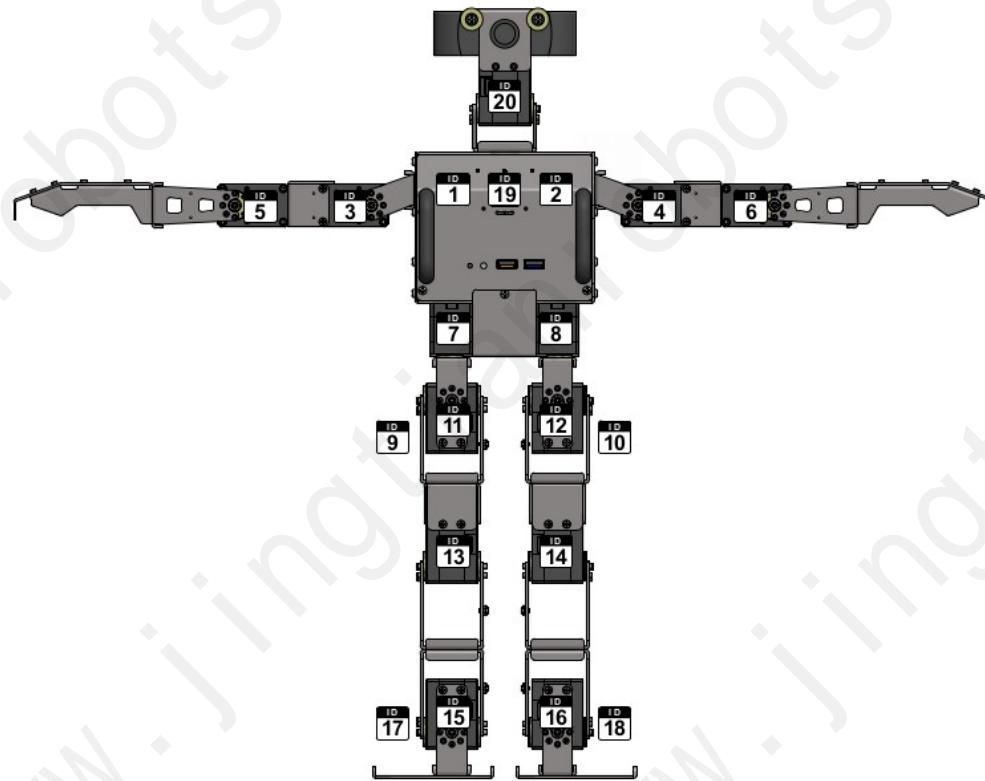
2. **op3_offset_tuner_client configuration file**

joint_data.yaml : GUI menu configuration file





Offset Tuner



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Offset Tuner

The screenshot shows the QRosApp Offset Tuner window. The interface includes a Command Panel with tabs for Right Arm, Left Arm, Legs, and Body (the Right Arm tab is selected). Below the tabs is a table for Joint Offset Data, which lists various joints with their Goal Pos. [deg], Offset [deg], ModVal [deg], Present Pos. [deg], and P, I, D Gain values. A red box highlights the Offset column. The bottom section contains a Torque On/Off panel with checkboxes for joints r_arm_sh_p1, r_arm_sh_r, r_arm_sh_p2, r_arm_el_y, r_arm_wr_r, r_arm_wr_y, r_arm_wr_p, and r_arm_grip. It also features 'All Torque On' and 'All Torque Off' buttons. The bottom bar has buttons for Initial Pose, Refresh, Save, and Quit. Red annotations provide instructions:

1. Go to initial pose
2. Select kinematics group
3. Load current offset
4. Change the value
5. Save





Action Editor

```
$ roslaunch op3_action_editor op3_action_editor.launch
```

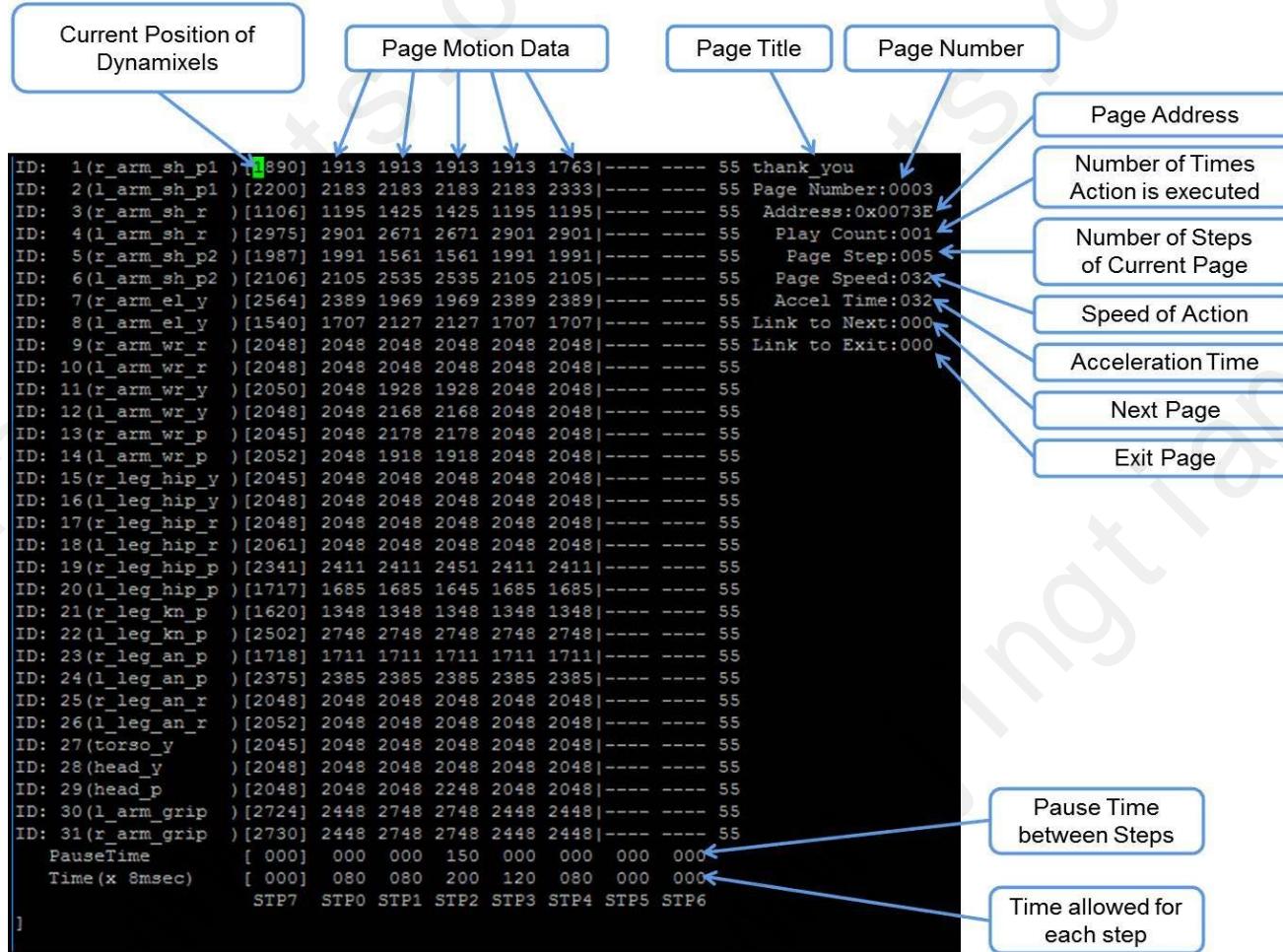
Action file is located at “op3_action_module/data” folder.

The action file contains 256 pages and each page can store up to 7 steps of motion.





Action Editor



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Ball Detector

```
$ roslaunch ball_detector ball_detector_from_usb_cam.launch
```

```
$ rqt
```





Ball Detector

Default - rqt

File Plugins Running Perspectives Help

Dynamic Reconfigure

Filter key: Collapse all Expand all

▶ ball_detector_... face_tracki... facerec ▶ usb_cam_n...

/ball_detector_node

gaussian.blur.size	1	11	7
gaussian.blur.sigma	1.0	5.0	2.0
canny.edge.th	50.0	200.0	100.0
hough.accum.resolution	1.0	8.0	1.0
min.circle.dist	10.0	200.0	98.8
hough.accum.th	10.0	200.0	32.3
min.radius	10	200	30
max.radius	100	500	153
filter.h_min	0	359	356
filter.h_max	0	359	10
filter.s_min	0	400	204
filter.s_max	0	255	255
filter.v_min	0	255	25
filter.v_max	0	255	160

Image View /ball_detector_node/image_out /ball_detector_node/image_out_mouse_left Smooth scaling 10.00m

Value

Hue

Saturation

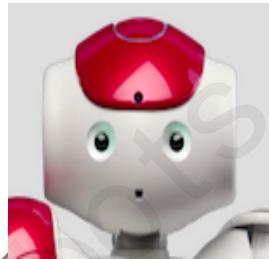


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Q&A



谢谢观赏



致力于机器人工程专业教育方案的提供



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