Arduino Compatible Open Source Humanoid ——

IRONBOY(IRH-100)

User Manual

IR ROBOT
Intelligent & Recreational

INDEX

Robotics for everybody.

1 Before Use.

1.1. Introduction

Thank you for purchasing world's First Arduino compatible Humanoid - IRONBOY, IRH-100. The IRduino, - Open source Arduino compatible board is basically included in the package to expand your humanoid functionality drastically. For safe & joyful use of IRONBOY, please read this manual thoroughly before use.

IRH-100 consists of 16 durable digital servo motors, dedicated main control board and metal frames with other hardware.
For compatibility with Arduino, IRH-100 is also equipped with IRduino board which simply plugs into main control board. The IRduino board are perfectly compatible with all existing Arduino shields which extends capabilities of IRH-100 drastically. There are already various kinds of existing Arduino shields in the market and user may mount the shield onto IRduino board easily at really reasonable cost.

We basically provide IRduino API & Libraries for IRH-100, so you can build your own unique robot tasks freely. Most flexible open source Humanoid for Arduino is here and you can combine your imagination with IRH-100.

Fully Assembled, Ready-to-Operate

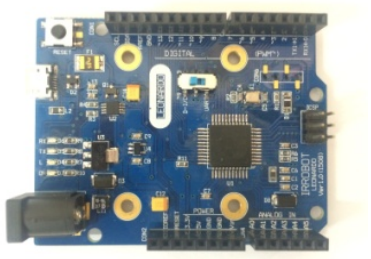
It is our philosophy that current robot learning should be focused on learning software and its algorithm rather than learning hardware assembly. So, all IRH-100s will be delivered as a fully assembled version to minimize user's unnecessary effort to assemble the robot. You do not need to put your endeavor into time-consuming, troublesome assembling which sometimes results parts breakage. Just open the box and enjoy robot learning immediately.

"All-in-One" Main Board

Do not buy optional components. The IRH-100 includes most of necessary robotic components in the box like 6 axis gyro/accelerometer sensor and Bluetooth 4.0 module. In addition, the biggest merit point of IRH-100 is that it also includes IRduino board which is perfectly compatible with most of existing Arduino shields. Simply dock IRduino board onto the main control board of IRH-100 to extend the capability.

Last, but not least, IRH-100's main board supports to expand upto 24DOF maximum and faster data processing is available through 16bit microcontroller. 1MB data memory capacity enables user to be free from the restriction of storage unit. (100 different pre-programmed motions, plus 100 more motions created by user can be stored in IRH-100.)

IRduino Board

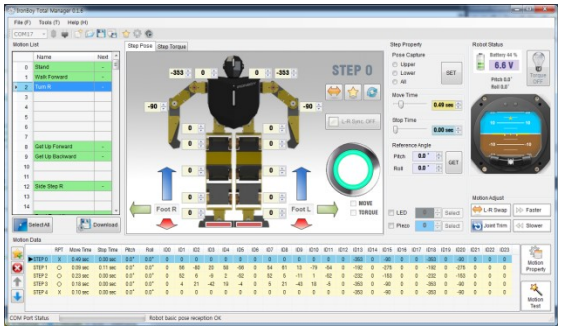


The IRduino is a microcontroller board based on the ATmega32u4 and it simply can be docked onto IRH-100's main board. It has 20 digital input/output pins (7 can be used as PWM outputs and 12 as analog inputs), a micro USB connection, a power jack, an ICSP header, and a reset button. To manage port expandability efficiently, user may select between Hardware serial and Software serial communication. Also, you are able to use IRduino board as an individual microcontroller board which is completely compatible with Arduino for your further robotic task. API, examples and Library will be provided with API manual.

Servo Motor

The IRH-100 consists of 16 durable, energetic programmable digital servos called IRS-430. Featured with highly durable super engineering plastic gear train, powerful motor and elaborate circuit board with 32bit Micom and 4096 resolution, IRH-100 ensures users to perform various challenging robot tasks. Overload protection and position feedback feature are basic of this sturdy servo motor.

Total Manager Software



Total Manager Software is an intuitive interface software for setting of motion, motion task, programming LEDs/Buzzer and monitor various sensor value. Thanks to "Inverse-Kinematics" UI and motion synchronization for the left and right, user is able to create their own motions intuitively and time for motion creation will be saved drastically.

[Features]

- Fully Assembled
- Arduino Compatible Board(IRduino) Included
- 6-axe Inertia Sensor
- Bluetooth 4.0 BLE
- Mobile Control (Android Only)
- Versatile Robot Stand Included
  - 20 Basic Preprogrammed Motions + 80 Additional Motions

1.2. Specification

[IRH-100 IRONBOY]

Control System	Pulse Width Modulation Control, 1500usec Neutral
Degree of Freedom	16 DOF (Max. expandable up to 24 DOF)
Operating Voltage	5.5V ~ 7.0VDC (Ni-MH 5Cell Battery)
Robot Control	Mobile App Control via Bluetooth 4.0 BLE (Android App) Infrared Remote controller (Remote controller is not included)
Main Controller (IRC-24)	16bit, ATXmega128, Firmware Upgradeable 1MB data memory (Basic 100 library motions + User's new 100 motions) IRduino Docking Port 6 Axis Gyro/Accelerometer Sensor, Bluetooth 4.0 Embedded
Management Software	Total Manager Software featured with Motion Feedback, Motion Capture and Inverse-Kinematics Motion and Task Setting LED/Piezo Control, Sensor Monitoring
Gyro Sensor	3 Axis Accelerometer, 3 Axis Gyro (Embedded on Main controller)
Battery	1,500mA Ni-MH Battery 5 Cells
Arduino Compatibility	Exclusive Arduino Board((IRduino) Included. (Compatible with various Arduino Shields in the market) Arduino API, Examples, Libraries to be provided. 20 digital input /output pin (7 for PWM output, 12 for Analog inputs) Micro USB Connector, Power Jack, ICSP Header and Reset button 32KB Flash memory, 2.5KB SRAM, 1KB EEPROM and 16MHz Clock Speed
LED Control	Programmable 3 colors LED(Chest), 1x Blue LED(Bluetooth Link Indication : Head)
Operating Temperature	-20℃ ~ +60℃
Dimension	170 X 99 X 335mm
Weight	1.3kg
Standard Accessories	Robot Stand with adjustable arm (3 axis) / Carrying Bag

[IRS-440 Servo Motor]

CPU	32Bit Micom, 4096 Resolution, Programmable
Operating Voltage	4.8 ~ 6.5VDC
Operating Temp	-20℃ ~ +60℃
Speed	0.2sec at 6.0V
Stall Torque	8kgf.cm at 6.0V
Standing Torque	12kgf.cm at 6.0V
IDLE Current	20mA
Running Current	200mA / No load
Deadband	3usec
Angle of Pulse	1° / 10usec
Max Angle Range	-65° +65°
Dimension	40 x 20 x 47mm
Weight	55g

1.3. For Safety

- Please note that damage or malfunction of the product caused by user's mistake or abuse may void warranty.
- Therefore, please read carefully this manual before use to prevent unexpected damage of the product and injury of users and follow instructions stipulated on this manual.

Please read carefully below instructions for safety.

Warning : Risk of Death or Serious Injury

Caution : Risk of Injury or Product Damage

Warning

- Do NOT modify any circuitries at user's discretion.
- Keep away the robot from hot place like inside of car, direct light and any heating devices.
- Protect battery. Do NOT make a physical damage, short circuit and keep it away from water, fire and hot materials.
- Use genuine battery and charger included in the package.
- Uncertified battery and charger may cause serious injury by a fire, explosion and serious damage of products as well.
- Be careful not to make a physical damage, modification, heating on electrical wires of charger, battery and servo motors to prevent electric shock & fire.
- Do NOT disassemble/modify main board and servo motors.
- Keep away the robot from wet condition to prevent electric shock and fire.
- Disconnect battery once damage/abnormal smell/abnormal heat are recognized to minimize product damage or user's injury.
- Do NOT use battery if there is any chemical leakage from battery. Do NOT touch hazardous leaked material.
- For long term storage of robot, disconnect battery from the robot and store battery in dry & cool place.

- Pay attention to your fingers & head during robot operation. Fingers can be jammed between the joints during operation. Also keep proper distance your head from the robot to prevent unexpected injury.
- Make sure to put connector correctly. Otherwise it may damage circuitry or battery and may cause fire.

Caution

- Secure enough space before robot operation. Robot operation in narrow space may cause damage of product due to the fall from the desk.
- Make sure to check your local law before use.
- Do not pull the wire. To separate wire from the robot, hold the connector (or plug) firmly, then take out wires or charger.

Caution - 1.4. Battery and Charger

Things need to know to use Battery and Charger properly.

1. After full charging, IRONBOY can be operated between 10~30min according to motion level.
2. Basically, it is highly recommended to charge the battery full before use, then remove charger when charger shows green LED. Operate robot until robot shows low battery alarm in the red LED on the chest. (Or, 20% battery level on Total manager software) After that, charge the battery full again.
3. On the charger, green LED will be ON when battery is fully charged. Please note that charging will be ceased after full charging even if green LED keeps ON for battery safety. To charge battery again, please disconnect and connect charger, but it is NOT recommendable to charge "fully charged" battery repeatedly for safety.
4. Battery level on Total Manager Software will be shown as below.
   - When charger is DISCONNECTTED : Actual level of battery remains
   - When charger is CONNECTTED : Real-time charging current level. Note the figure is NOT actual level of battery remains.

     ▶▶**Real-time charging current will be shown on the Total manager software when charger is connected. Please remember the figure is NOT actual level of battery remains. Under low battery condition, if user misunderstand the figure is actual level of battery, and try to operate the robot aggressively, battery may be discharged completely which leads bad influence on battery lifespan.**
5. After power on the robot, 16pcs of servo motors are trying to keep its positions even if there is no motion and consume some current continuously. Please note that discharging rate can be bigger than charging rate even if charger is connected when robot power is ON.
6. If robot needs to be operated for more than 30min, it is recommended to have spare battery so that user can replace the battery to operate robot continuously.

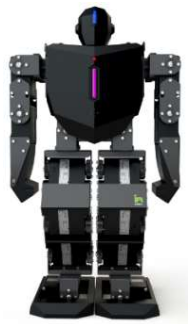
Use properly.

1. Use genuine charger and battery supplied by IR Robot.
2. Charge battery full for next use. Use the robot under full charging condition. It will take 1 hour 30mi for full charging. Do NOT operate the robot continuously under low battery condition for battery lifespan.
3. **It is recommended to disconnect the charger during robot power is ON.** (to prevent misunderstanding between actual level of battery remains and real-time charging current.)
4. When battery shows low battery alarm in the red LED on the chest or, Total manager software shows 20% battery level, please cease operation and charge the battery again (or replace with fully charged battery)
5. After full charging (Green LED on the charger), charging will be ceased even if green LED is ON. For safety, do NOT charge "fully charged" battery repeatedly. Otherwise, battery may get hot and may cause fire or explosion.

2 Composition (IRH-100)

2.1. Pack Composition

IRH-100



IRduino Board (Arduino compatible board)

Micro B type USB Cable (For main board)

Battery (1500mA, 6V NiMh)

Charger

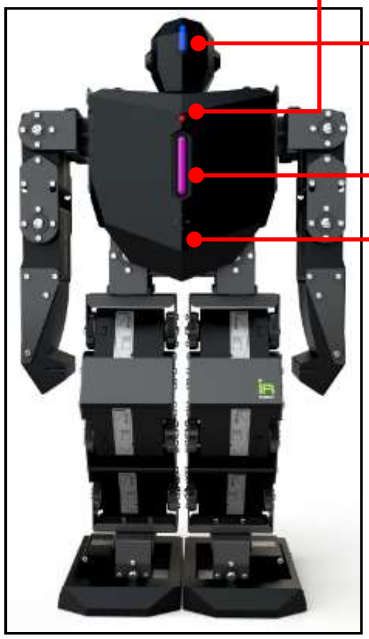
Robot Stand

Carrying Bag

* Inner paper box in the carrying bag can be used continuously to protect the robot properly.

2.2. Names and Descriptions

(1) Front



① Power Status LED

② Bluetooth Status LED

③ RGB LED

④ Piezo

① Power Status LED

Round type RED LED on the chest shows power status as well as battery status.

Status	LED Indication
Power S/W OFF	OFF
Power S/W ON	ON (RED)
Low Battery	Flickering under less than 20% of battery capacity.

② Bluetooth Status LED

This LED on the head shows Bluetooth module's power and connection status.

Status	LED Indication
Bluetooth Power OFF	OFF
Bluetooth Power ON	ON (WHITE)
Bluetooth Connected	ON (BLUE)

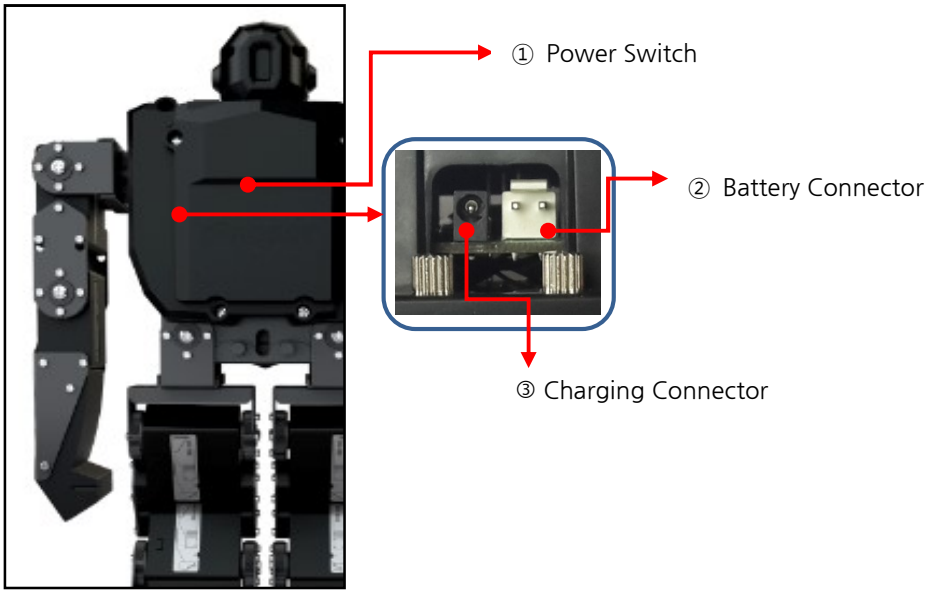
③ RGB LED

Editable RGB LED. You can edit LED color using smart phone App and PC program(Total manager software) as well. Color designation can be available even during motion operation. Setting by Smart phone is available and setting can be done during robot motions.

④ PIEZO

Desired melody can be made using Piezo. Melody can be editable even during motion operation.

(2) Back



① Power Switch

Push upward to power on and push downward to power off.

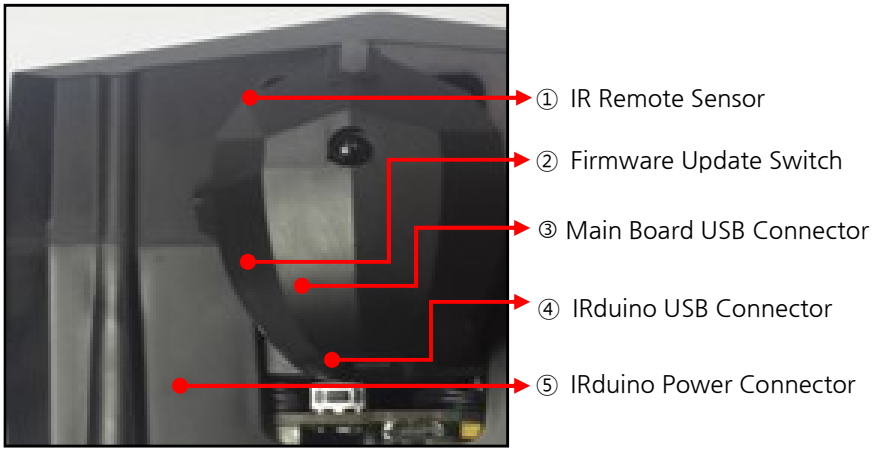
② Battery Connector

Connect the genuine battery (1500mA, 6V NiMH) with this connector to supply power.

③ Charging Connector

Connect the genuine charger to charge the battery. Full charging will take about 2 hours.

(3) Top



① IR Remote Sensor

IR remote controller is not included in the package, but you may use "SAMSUNG" remote controller or its compatible universal remote controller. Simply save information in IRONBOY defining respective motion and concerned button on the remote controller according to remote code table.

② Firmware Update Swtich

To enter into firmware update mode for main board, press & hold this button and then power on the robot.

③ Main Board USB Connector (Micro-B Type)

USB connector to connect IROBOY's main board with your PC. Using Total Manager software, various tasks like robot setting, motion setting/editing, and motion download can be done.

④ IRduino USB Connector

USB connector to connect IRduino board and your PC.

⑤IRduino Power Connector

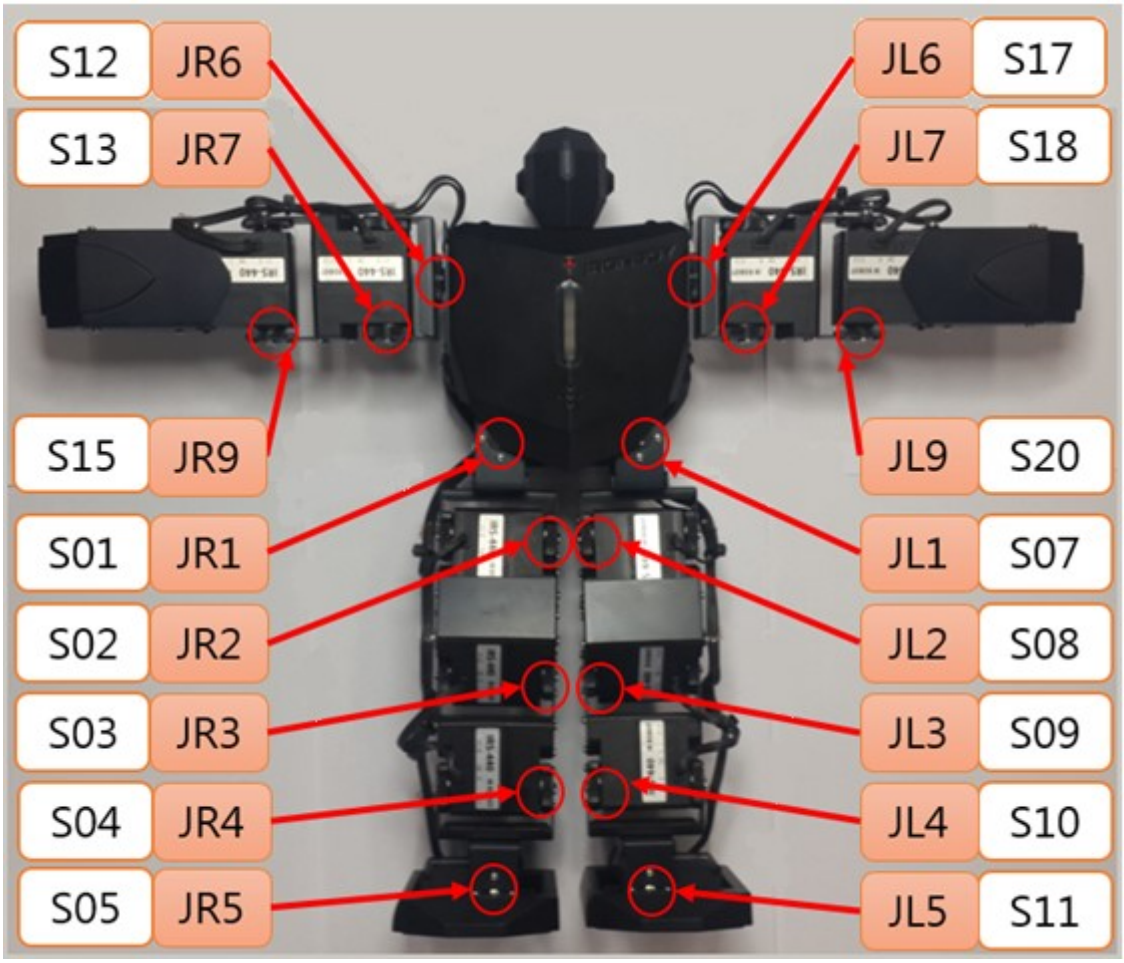
Use this power connector when you want to use IRduino board individually to supply power to IRduino

Input voltage : 6V ~ 12V

※ **NOTE** : Even if power is supplied to IRduino board through this connector, power is not supplied to IRONBOY's main board or its main body.

2.3. Joint Structure and Names

IRH-100 consists of joint structure and names as below. On the main board, each servo channel needs to be correspondent to each different servo. So, each servo must be connected to correct position of servo channels on the main board.



(1) Name of Joints

- JLn : "n"th joint of LEFT part of body
- JRn : "n"th joint of RIGHT part of body

(2) Joints Number

Joint #(n)	Joint Position
1	Pelvis Left/Right Rotation
2	Pelvis Forward/Backward Rotation
3	Knee Joints
4	Ankle Forward/Backward Rotation
5	Ankle Left/Right Rotation
6	Shoulder Forward/Backward Rotation
7	Shoulder Left/Right Rotation
9	Elbow Joints

(3) Servo Number

Total 24 different servos can be operated independently on the main board. As IRH-100 is 16 DOF humanoid, 16 servo channels have been assigned on the main board at the factory. Spare & empty channels can be activated in case of adding more DOF by users.

[Recommended Joint Positions of Spare Channels]

CH #	Joint Position
S00	Right Pelvis Vertical Rotation
S06	Left Pelvis Vertical Rotation
S14	Right Shoulder Rotation
S16	Right Wrist or Gripper
S19	Left Shoulder Rotation
S21	Left Wrist or Gripper
S22	Head Left/Right Rotation (Pan)
S23	Head Up/Down (Tilt)

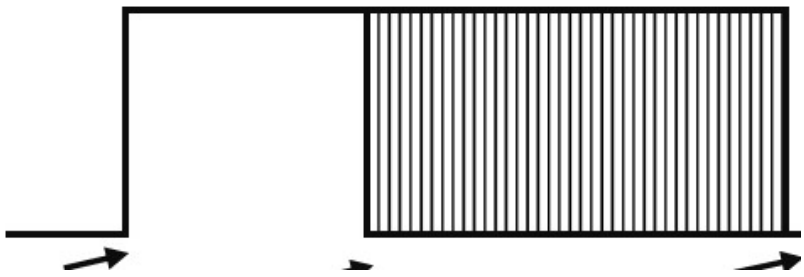
3 Main Controller (IRC-24)

Main controller is a main system to control IRH-100. Its main features are : Servo motor control, 6 axis gyro/accelerometer sensor, Bluetooth 4.0 module, motion data memory, LED display, Piezo output, battery charging connection, IRduino port and IR sensor port, etc.

3.1. Main Features

(1) Servo Control (24ch)

Servo pulse control for 24 servos and Same as R/C(Radio control) servo pulse standard.



PPM(Pulse Position Modulation) Compatible [Radio-Control Servo Pulse Mode]

(2) Motion Control and Management

Through main controller, various motion management such as motion creation, motion Editing, motion test, motion execution, torque on/off can be done. 100 different motions are basically provided, and another 100 x user motions can be saved in the controller. Motion data can be downloaded(saved) into the controller and

motion data saved in the controller can be uploaded to Total manager software (management program) for further task.

Motion#	Definition	Description
0 ~ 99	MOTION_USER_00 ~ _99	User's motion 0 ~ 99 (To be saved in the external memory)
100 ~ 199	MOTION_LIBRARY_00 ~ 99	Library motion 0 ~ 99 (To be saved in the internal memory)
200	MOTION_TORQUE_OFF	All servos' torque will be removed.
201	MOTION_USER_TEST	Temporary motion test while user creates motions.
255	MOTION_STOP	Motion Stop (Stop executed motion)

(3) Operating Utility

Main board can be connected with Total Manager software which provides motion control and other various settings. Firmware for main board can be updated through PC.

(4) Wireless Control by Bluetooth 4.0

Bluetooth 4.0 BLE module is embedded on the main board. So, the robot can be connected with smart phone, and desktop/laptop PC if they have Bluetooth function. Robot control App for Android smart phone can be downloaded from the web.

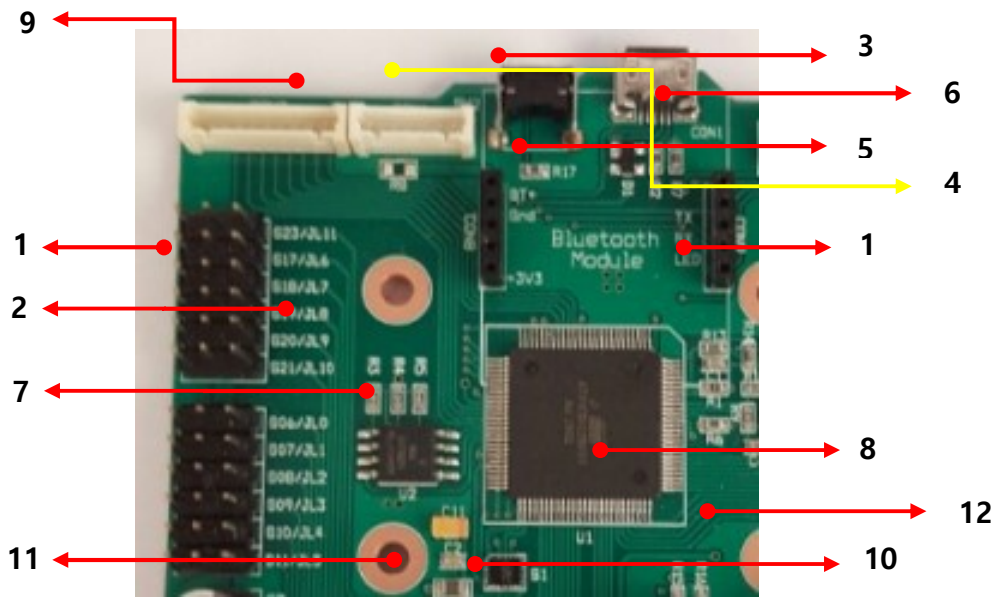
(5) Remote Control by IR(Infrared)

SAMSUG IR remote controller and any SAMSUNG compatible remote controller can be used with IRONBOY.

(6) Tilt Measurement using Gyro/Accelerometer Sensor

Thanks to 6 Axis inertial sensor(3 Axis gyro and 3 Axis accelerometer), inclination of robot posture can be measured in Roll and Pitch value.

3.2. Names and Description



(1) Servo Control Ports (24ch)

Control ports for 24 servos. (Pulse width modulation)

(2) Motion Data Memory

100 library motions, plus another 100 user's motion can be saved in the memory.

※ Among 100 library motions, first 20(#1~20) motions are finely tuned at factory. For the rest of 80motions library, user may do fine-tuning according to each robot's mechanical condition.

(3) Micro-B Type USB Port for PC Interface (Total Manager Software)

Using this port, firmware for main board can be updated through PC and user may use Total Manager software for robot setting, motion editing, etc.

(4) Firmware Update Switch

To enter into firmware update mode, press & hold this button when robot power is off, then power on the robot.

(5) Bluetooth Module

Bluetooth 4.0 BLE module is embedded on the main board which means robot can be connected/controlled wirelessly via Bluetooth with smartphone, laptop or desktop PC. Robot control APP for Android is available.

(6) Connector for Head PC Board

Head PC board includes IR remote sensor and Bluetooth status LED.

(7) Gyro Sensor (Gyro/Accelerometer)

6 Axis inertia sensor is embedded.(3 Axis Gyro + 3 Axis accelerometer sensor)

(8) IRduino Docking Connector

IRduino board can be installed and works with the main board using this docking connector.

(9) Connector for Chest PC Board

Chest PC board includes Power indicator LED, RGB LED and Piezo.

(10) Battery Connector

Connector for Battery.

(11) Charging Connector

Connector for Charger. Battery needs to be installed in the robot before charging. Charging can be done in both cases - when robot power is OFF and robot power is ON.

(12) Power Switch

Turn on/off the power. (Push upward - ON / Push downward - OFF)

4 Total Manager Software

Total Manager Software is a PC programming interface for IRH-100 which enables users to create/edit motions, set various parameters of IRH-100.

4.1. Operating Condition

Install "Total Manager" software in your PC. Total manager software can be downloaded at www.irrobot.com → "Digital Archive" menu. For required PC specification, please refer to the below.
Then, power on the robot and connect USB wire between the robot and your PC. (Micro B type USB - Main board USB connector- See page.9-③)

COM port will be assigned automatically and activate “Total Manager” software to connect the robot.
(To check assigned COM port, check "Control Panel"-"Device Manager" in your Windows menu.)

After power on, be careful that Robot joints may move while it returns to the basic posture.

USB COM port cannot be recognized if the battery capacity is low. Please charge the battery to proper level before use.

[Required PC Specification for Total Manager]

▶ OS : Windows XP Service Pack 2 / Vista/ 7 (32/64bit)/8 (32/64bit) or Higher

▶ 800MHz(or higher) 32bit(x86) or 64bit (x64) processor

▶ 512MB(or higher) system memory

▶ 500MB (or higher) hard disk space

4.2. Installation

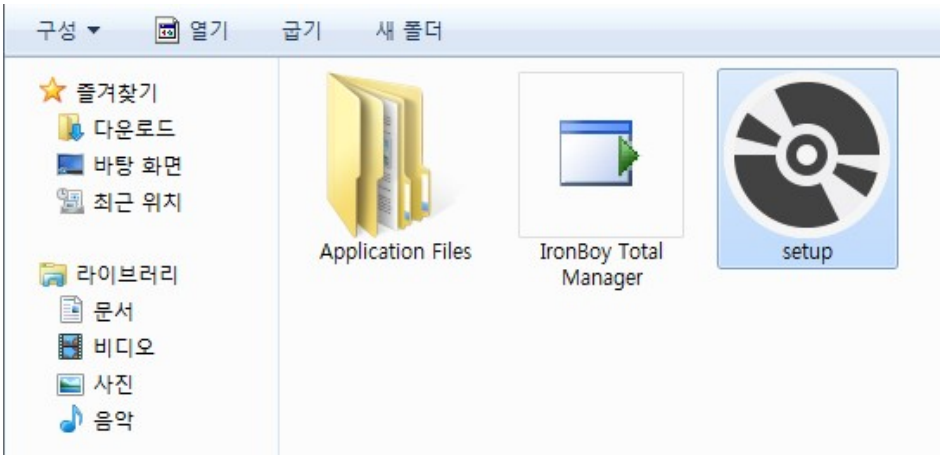
Follow instructions below to install Total Manager software.

(1) Download

Download "IRONBOY Total Manager" file from www.irrobot.com → "Digital Archive" menu.

(2) Set Up File

Unzip the downloaded file, then click setup.exe as below.



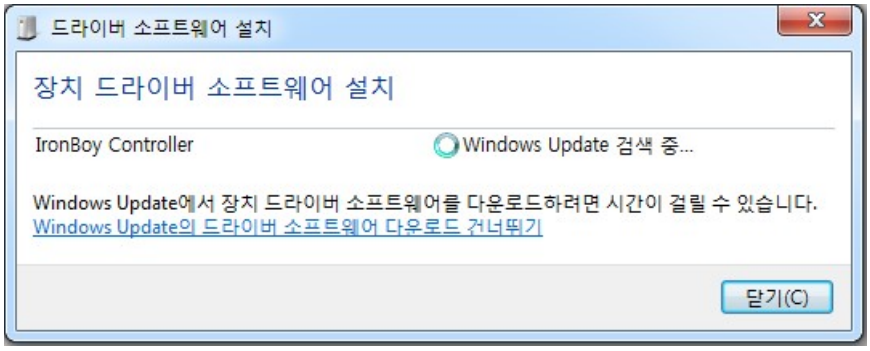
(3) Intro Screen

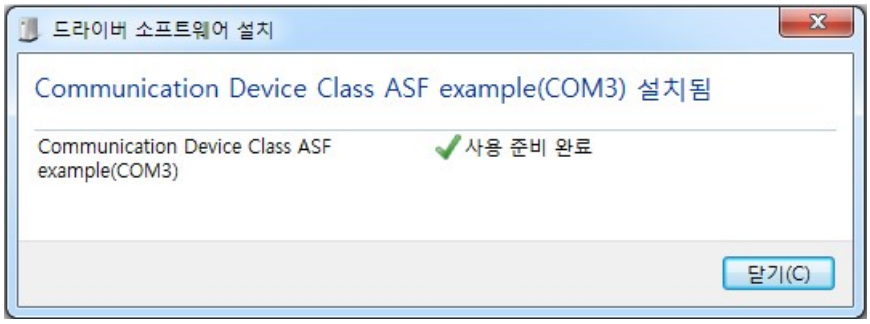
If installation is done successfully, you can see below screen.

4.3. Communication Setting

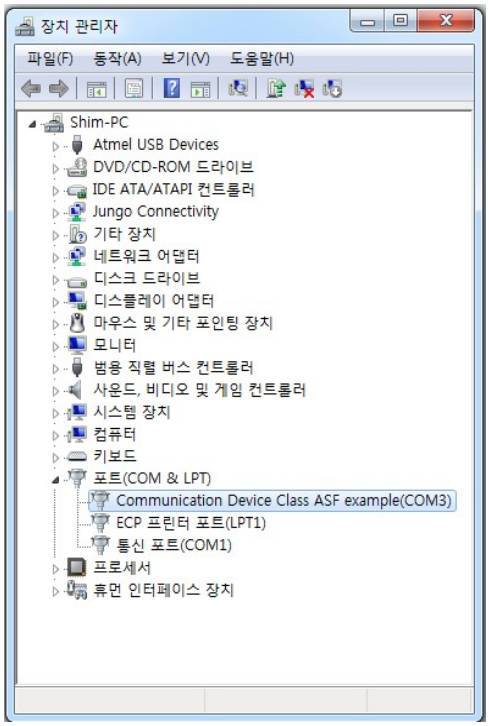
Connect IRH-100 with PC using USB wire and activate Total manager software. Then you will see intro screen as above. After then, power on the robot and follow instructions below.

(1) Device driver will be installed automatically via internet when your IRH-100 is connected with your PC for the first time.



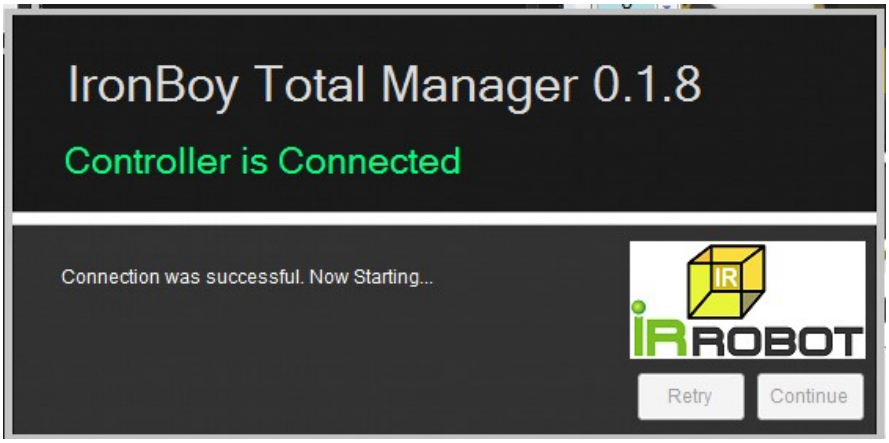


(2) Check assigned COM port on "Device manager"
(Below picture shows COM3 has been assigned, but it can be changed in your PC.)



(3) Now, activate Total manager software and click "Retry" button on the intro screen.

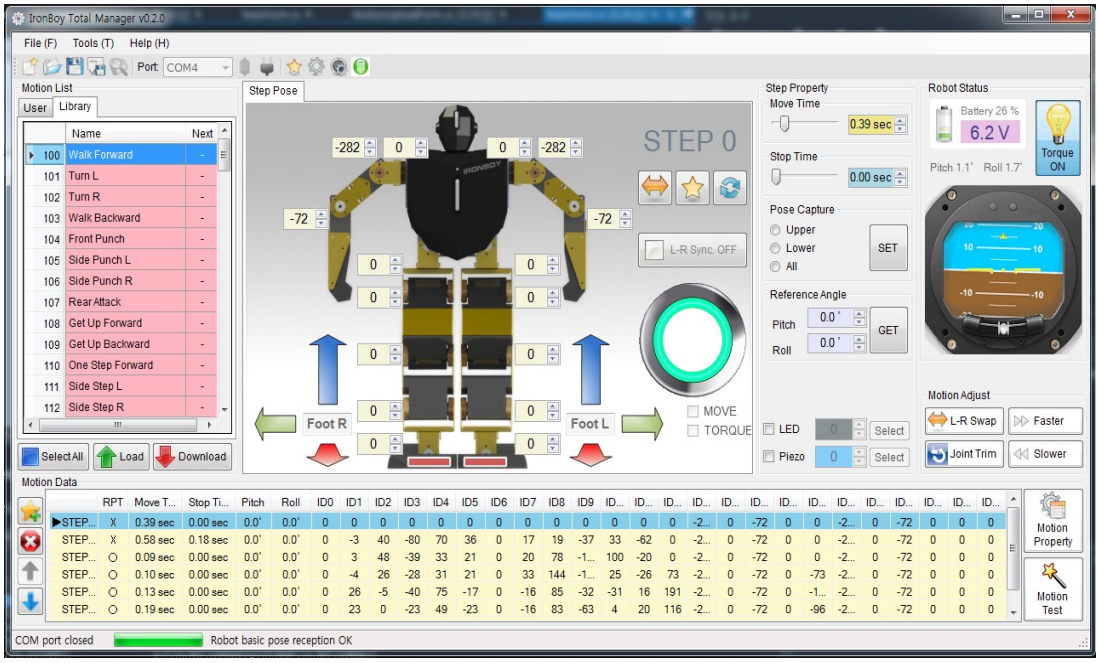
(4) COM port will be recognized automatically in your PC and you will see below screen.



(5) If COM port is assigned incorrectly, click COM port menu(marked in red) below to see connected COM port list. Select connected COM port. (Example shows COM 3 is assigned.)

If necessary, use COM port connect/disconnect icons shown above. (marked in blue.)

4.4. Description of Main Screen



(1) Menu

① File

- New : Create New motion data

Create new motion data. Previous motion data in the screen will be erased, so if necessary, save previous motion data before opening new one.

- **Open : Open saved motion data**
  Select & load saved motion data into current task window.
- **Save : Save motion data**
  Save current motion data with previous name.
- **Save As** : Save motion data as a different, new name.

② **Tools**

- **Robot Basic Pose**
  Open Robot basic pose window.
- **Robot Basic Setting**
  Open basic setting window (Zero Point and Other basic settings)
- **Robot Control**
  Open "User robot control(Virtual controller)" window.
- **IR Remote Setting**
  Open "IR Remote setting" window to combine Infrared remote controller codes with certain motions..

③ **Help :** Help and other product related info.

(2) Tool Bar and COM Port Connection

Frequently used functions are included in the tool bar.

① **Tool Bar**

 Create New motion data

 Open saved motion data

 Save motion data in PC. This does not mean that final motion data is saved in the robot.

 Save motion file as a different name (Save as..)

 Open Robot basic pose window

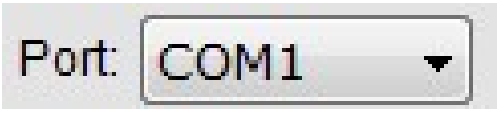
 Open basic setting window (Zero Point and Other basic settings)

 Open "User robot control(Virtual controller)" window

 IR Remote Setting : Combine Infrared remote controller codes with certain motions.

② COM Port Connection

 Automatic Search & connect available COM port



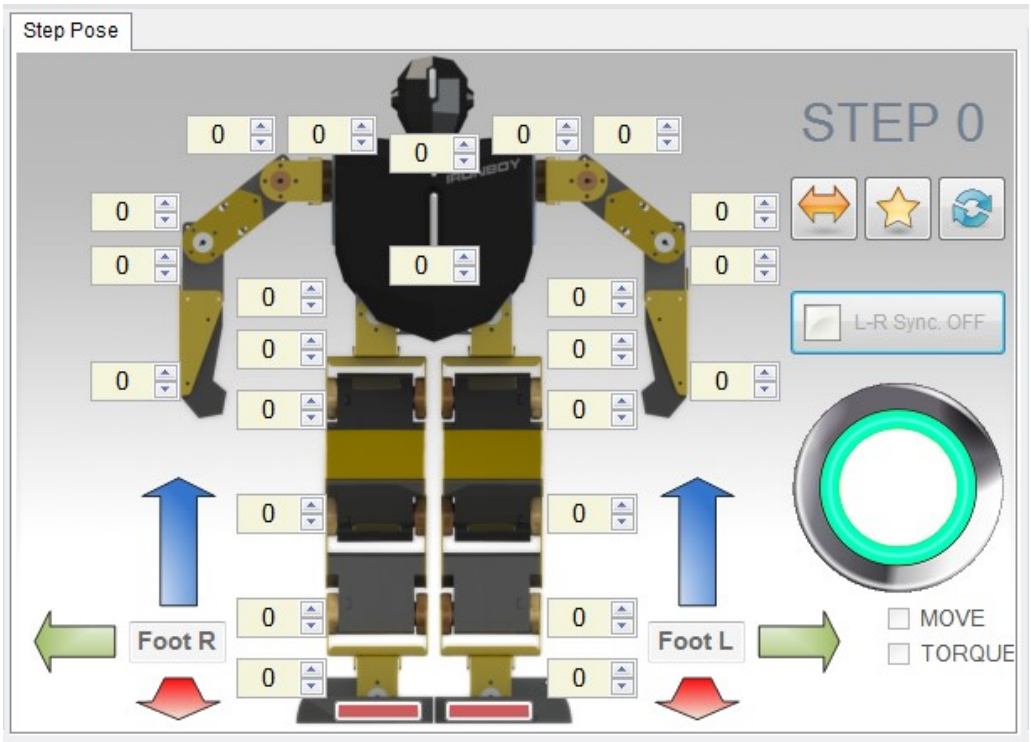
Search & assign COM port.

 Connect COM port

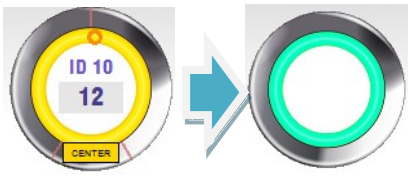
 Disconnect COM port

(3) Robot Joint Control (Step Pose)

In this window, you can control servo motor and see the status of each servo's position. This screen is composed that Position status/adjustment of each servo, torque on/off of each servo, inverse kinematics joint control, motion editing tool bar and etc.



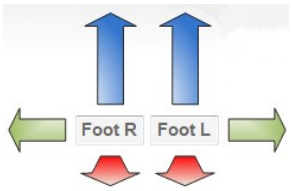
 Position value of each servo. Use scroll buttons or mouse scroll to set value between 511~+511. You can also directly put desired value in the blank after press "Enter".



When you click position value of each servo, you will see blue-green colored circle turns into Yellow color as above. Along with yellow line, you can drag small Red circle as a jog to change concerned servo's position value. Pay attention robot may lose balance due to sudden change of jog circle. Value will reset to 0 immediately when you click "CENTER" button.

When this function is activated, position value of each servo will be synchronized with physical servo position. This means that position setting value of servo will be transferred to the main board, but it will not be reflected to the servo physically when this function is inactivated.

Torque ON/OFF control for each individual servo.



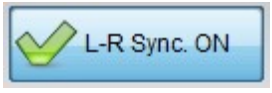
For convenience sake, the position of leg and foot can be changed generally in X/Y/Z direction by dragging the mouse based on inverse kinematics.

Step# : Current Step number of current step pose window

Left/Right Pose Conversion : Left/Right conversion of current servo setting.

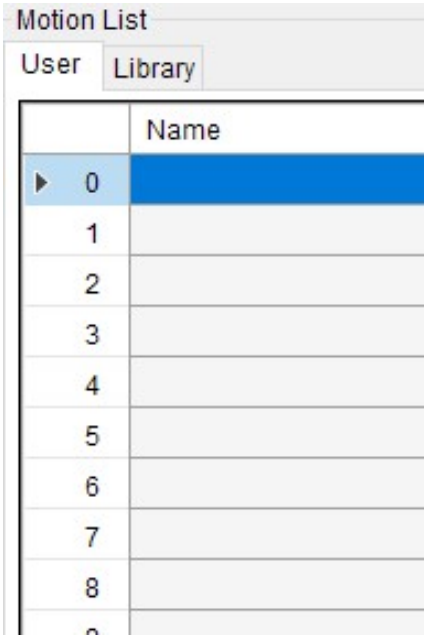
Load basic pose

Restore changed value to previous one.



For convenience sake, left and right motion value can be synchronized with this button.

(4) Motion List

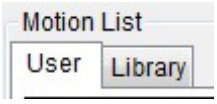


Space for 100 motions at User's motion area, and space for another 100 motions at factory Library motion area are provided.
Multiple motions selection, motion upload/download functions are available in this window.
100 Factory Library motions will be shown in "Library" tap and you can make/save your own motions in "User" tab.

Please note first 20 motions among 100 are finely tuned at factory. But, you may simply do fine-tuning for the rest of 80 motions according to your robot condition. (just in case robot loses balance with certain motion.)

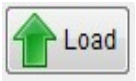
※ How to upload motion library :

Motion library cannot be seen when you start software for the first time. Motion library can be uploaded from the robot by clicking "**Select All**" button, then clicking "**Upload**" Button. Please pay attention NOT to click "Download" button after clicking "Select All" as it removes all motion library in the robot. If the motion library is removed by mistake, you can download motion library file to your PC, then upload it on the software. After motion editing, download final motions into the robot for saving.

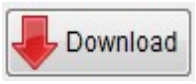


"User" and "Factory Library" motion list are separated. Select as you wish.

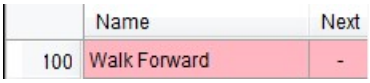
Select all motions in the list.



Upload motion data which is saved in the robot to the list.



Download & save selected motions into the robot

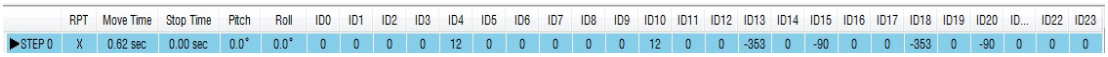


The blank named "Next" : Combine next motion with current motion to make consecutive motion task. Simple put next motion number in the blank.

(5) Motion Data

Motion data shows each "Step" data for a motion and you can edit each step data. Also, Motion property setting and motion test are available.

	RPT	Move Time	Stop Time	Pitch	Roll	ID0	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8	ID9	ID10	ID11	ID12	ID13	ID
▶STEP 0	X	0.62 sec	0.00 sec	0.0°	0.0°	0	0	0	0	12	0	0	0	0	0	12	0	0	-353	
STEP 1	X	0.63 sec	0.00 sec	0.0°	0.0°	0	-4	50	-101	62	52	0	22	24	-47	33	-49	0	-353	
STEP 2	X	0.54 sec	0.00 sec	0.0°	0.0°	0	-30	40	-44	31	69	0	47	30	-29	21	-47	0	-353	
STEP 3	○	0.14 sec	0.00 sec	0.0°	0.0°	0	4	60	-49	35	27	0	25	98	-196	119	-25	-1	-353	



	RPT	Move Time	Stop Time	Pitch	Roll	ID0	ID1	ID2	ID3	ID4	ID5	ID6	ID7	ID8	ID9	ID10	ID11	ID12	ID13	ID14	ID15	ID16	ID17	ID18	ID19	ID20	ID...	ID22	ID23
▶STEP 0	X	0.62 sec	0.00 sec	0.0°	0.0°	0	0	0	0	12	0	0	0	0	0	12	0	0	-353	0	-90	0	0	-353	0	-90	0	0	0

Each Step data shows Repeat setting status, Operating time(move time), Delay time(stop time), Robot inclination(Pitch & Roll) value, and positional value of each servo.

Add new Step. Maximum 24 steps can be made for 1 motion.

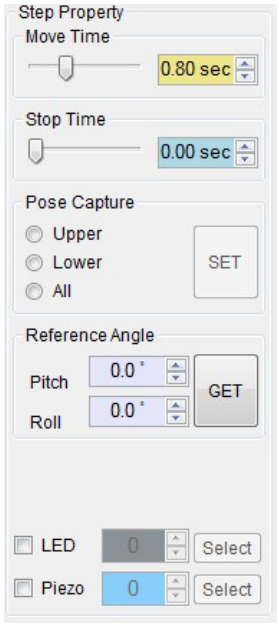
Remove selected Step.

Adjust Step sequence. Select a Step and move it to desired location using arrow button.

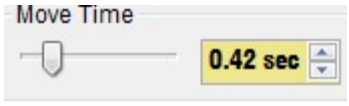
Motion property setting. Motion repeat section, other options can be set.

Test selected motion. Created motion will be saved in the robot temporarily and can be tested in real time.

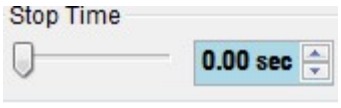
(6) Step Property



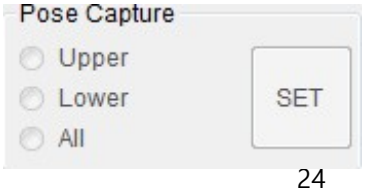
This section shows property information of selected Step. Move time, stop time, pose capture, angle setting, Chest LED setting, Piezo sound setting can be done.



Set move(operating) time of selected step.

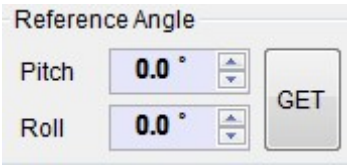


Delay time after selected step motion is completed.



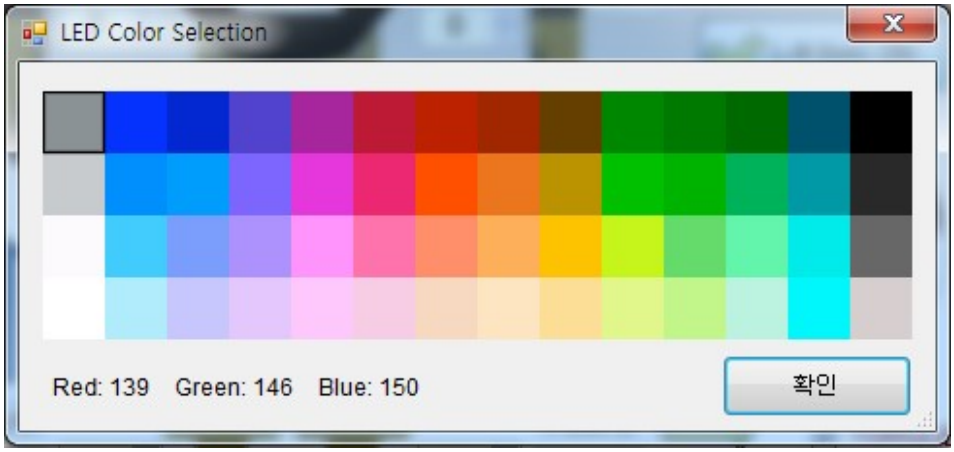
You can make motor position value easily by pose capture without putting position value manually for all individual servos. Motor torque will be removed for selected part(Upper, Lower, All) so as to make desired

pose and read its position value.

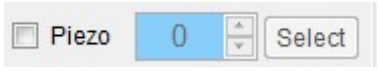


Pitch and roll value setting. Angle setting to maintain balance of robot.

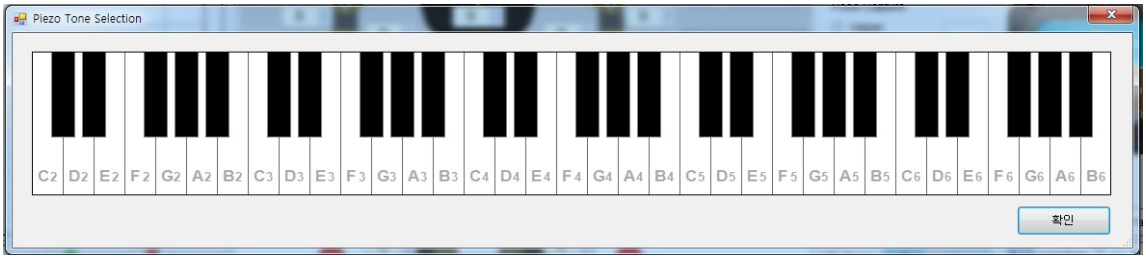
Chest LED color setting for desired motion step. LED color will be changed according to selected number.



※ For color list for each LED number, refer to the annex.



Piezo sound setting for desired motion step. Piezo sound will be changed according to selected number.



※ For scale list for each Piezo number, refer to the annex.

(7) Robot Status

Battery capacity, inclination status can be shown in real time. Torque ON/OFF control for all servos.

Real time Battery capacity (Voltage and Charging rate)

Torque ON/OFF control for all servos.

This dashboard shows robot's inclination for up/down/Left/Right directions.

Real time Pitch and Roll value to be seen.

(8) Motion Adjust Tool

All steps' operating & stop time of selected motion will get faster.

All steps' operating & stop time of selected motion will get slower.

Particular servo motor 's values in all steps of selected motion can be changed at once. (Offset & scale trim of selected servo can be adjusted)

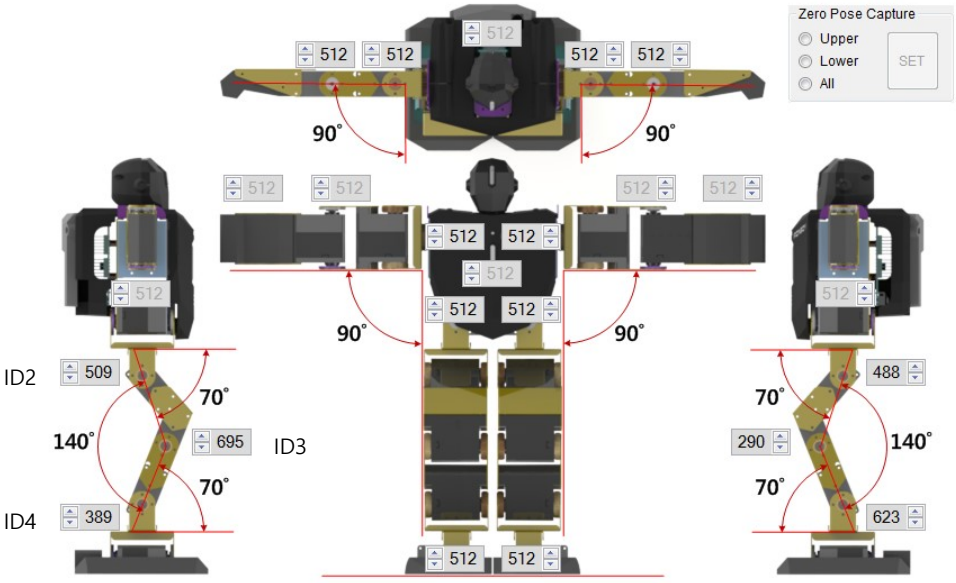
Left/Right symmetry value Swap for All steps of selected motion

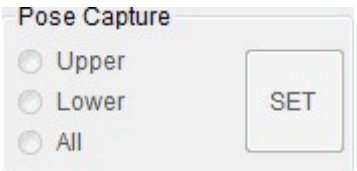
4.5. Joint Zero Point & Basic Parameter Setting

Click this icon on the tool bar. Setting for zero point, Actuator(servo) property, Basic robot setting and auto recovery function.

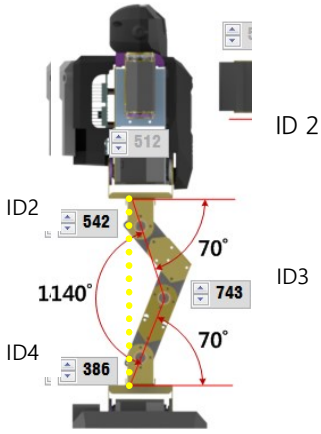
(1) Zero Point Adjustment for Joints

Zero point can be adjusted by adjusting value of concerned servo motor.

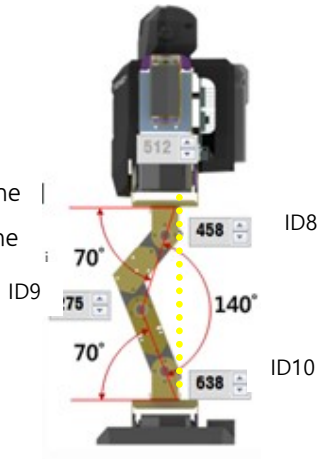




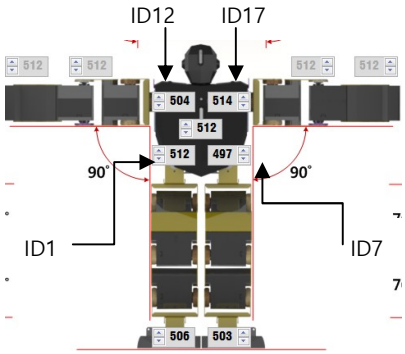
- Capture the pose to set zero point pose
- Select Upper or Lower or All (servos). The torque of selected part of servos will be Off so that you can make desired pose freely.



- As shown in left picture, make angle 140° between ID 2 and 4. And the axis of ID 2 and 4 should be aligned in straight line (see Yellow line in the picture)
- On ID 3 servo basis, make 70° between "ID2 and 3" and "ID4 and 3" as well.

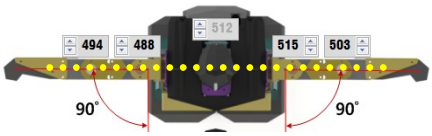


- As shown in right picture, make angle 140° between ID 8 and 10. And the axis of ID 8 and 10 should be aligned in straight line (see Yellow line in the picture)
- On ID 9 servo basis, make 70° between "ID8 and 9" and "ID10 and 9" as well.



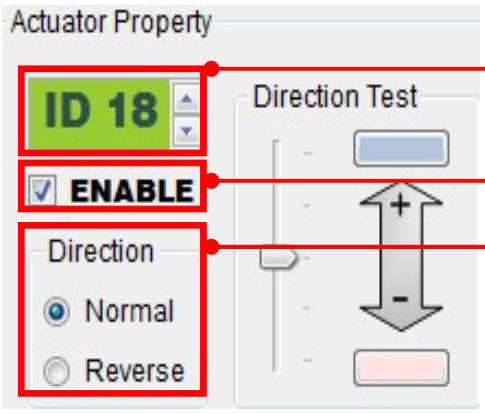
- In front view, align pelvis motors (ID 1 and 7) as picture so that upper & lower body can be in the straight line. And make arm position as shown in the picture (set ID 17 and 12 in 90° from the body.)

- Palms of robot should look forth front side. Set 90° between elbow and main body as shown in the picture. From the shoulder and hands, it should alsgned in straight line as shown as yellow line.



(2) Actuator(Servo) Property Setting

Servo ID setting, motor enable/disable, movement test are available.



Servo ID of selected motor (Changeable).

Servo will function when "Enable" is checked.

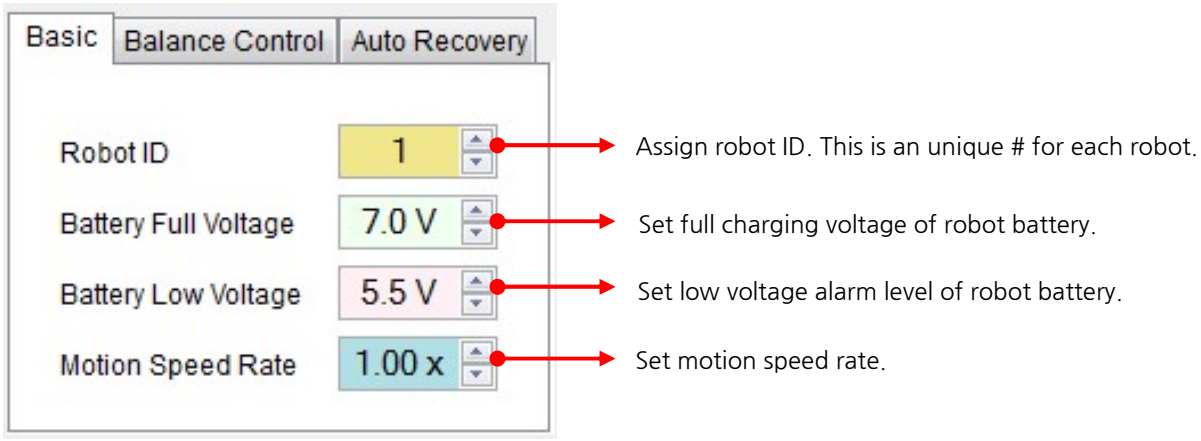
Motor direction can be changed. (Normal/Reverse)

※ **Note** : If there are already created motion library, please be careful

to change servo motor direction as it will change all motions.

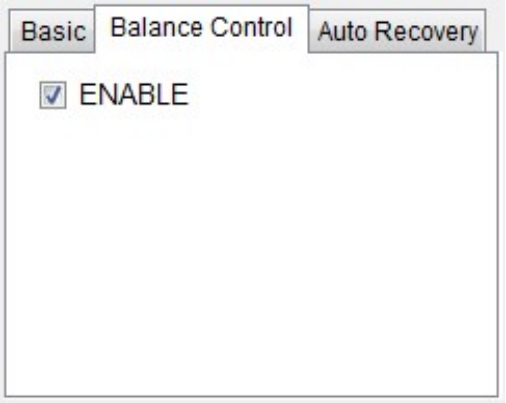
(3) Robot Basic Property

Robot ID, Battery voltage range, motion speed rate can be set.



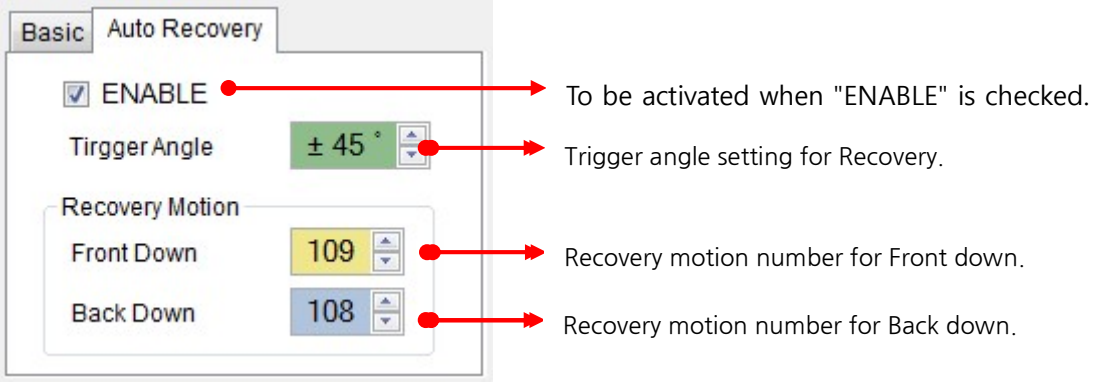
(4) Balance Control

To be activated when "ENABLE" is checked. When this function is activated, robot will try to keep balance automatically during motion processing and waiting mode through gyro sensor.



(5) Auto Recovery Setting

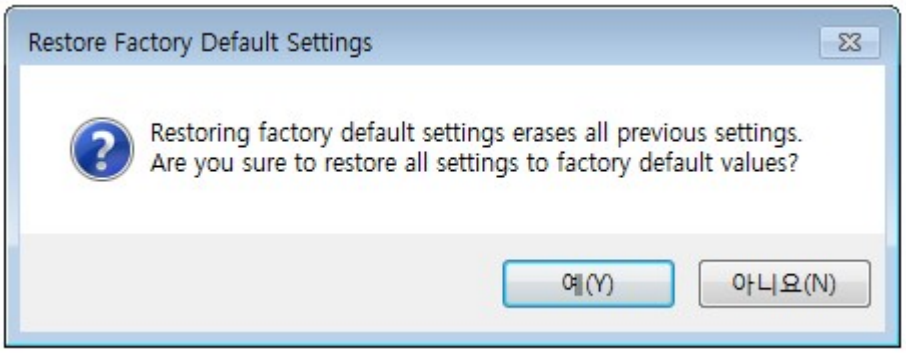
Robot will stand up automatically when it falls down according to assigned motion number.



Warning : Be careful when you pick up the robot while Auto recovery feature is activated. Robot may recognize "fall down" posture when you pick up the robot which leads robot enters into recovery mode. During this procedure, your fingers can be jammed unexpectedly and may hurt seriously.

(6) Factory Reset

Click this icon and you will see below window.



Click "Yes" Factory reset will proceed. It will take some time for factory reset, so please wait until it completes without cutting power. Click "No", factory reset will be canceled.

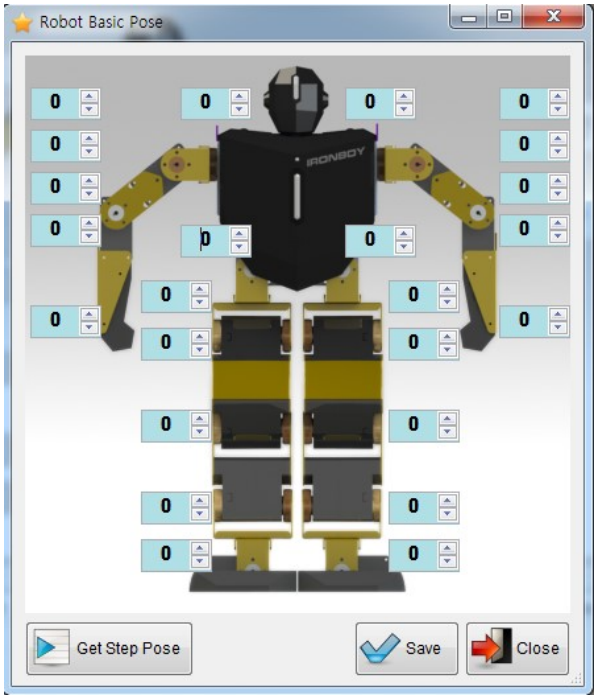
(7) Save

Save all setting data into the robot.

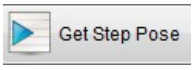
(8) Close

Exit from Basic parameter setting.

4.6. Basic Pose Setting



Setting for basic pose value. You can freely modify basic pose value for each servo.



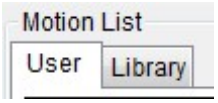
Read all servos' value which are put in the basic pose setting.

Save as basic pose.

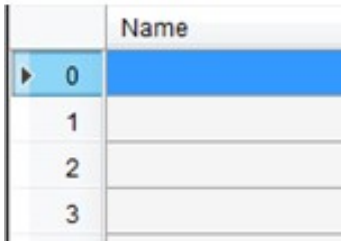
4.7. Motion Edit & Library

(1) Motion Editing

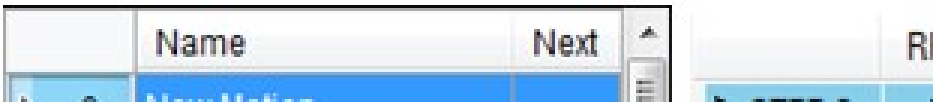
① Motion Creation



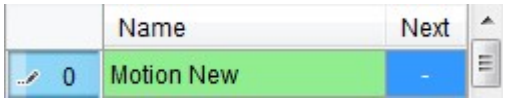
Select desired motion tab. Please make sure if concerned motion is properly saved in the robot before motion editing.. "User" motion list should be made by users at their end, so you will see just blank page initially. The IRH-100 will be delivered with "Library" motions which saved at the factory.



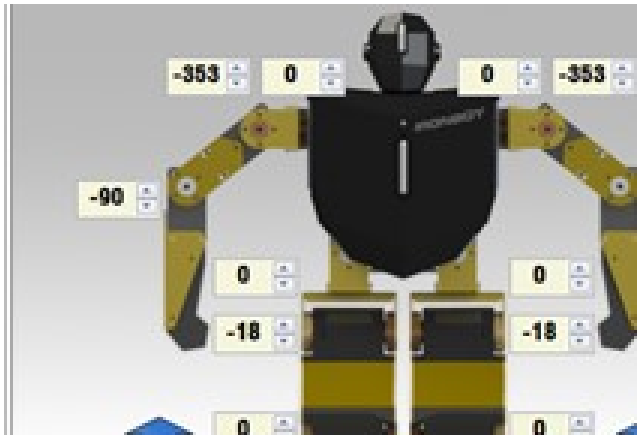
To make a new motion, click motion number, then click  icon in "motion data" window.



Then, you will see motion name named "New Motion" and "Step0" line is created.



Motion name can be changed when you click each motion name(green area)

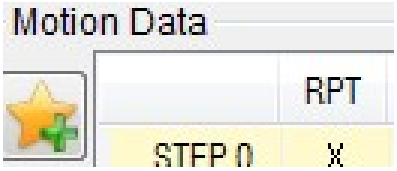


Like the left picture, put each motor value by mouse wheel or keyboard. Click "L-R Sync OFF" button to put same value in both left and right motors.

If it is difficult to put motor value for all individual servos, you can use "Pose capture" function. "Upper" means upper body, and "Lower" means lower body joint. "All" means that all joints of the robot. When you click desired point, motors' torque in concerned joints will be removed so that you can make desired posture freely. You will see motor values are changing while you move each joint. When you complete certain motion posture, click "SET" button, then motor torque will be ON to keep posture of joint.

Set "Move Time" value to control moving speed of concerned Step motion.
Set "Stop Time" value to control delay time to next step motion.

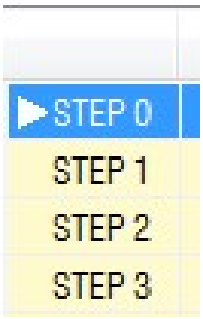
You can set LEDs in chest and Piezo of current step. Check desired function(LED and Piezo) and you will see different colors and hear different sound for each number.



Create next step by clicking  icon. You can repeat the same as 1st step to make a 2nd step.

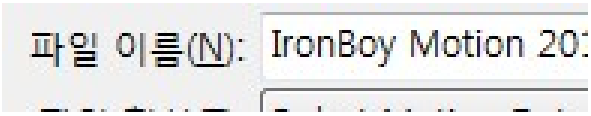
To make "Repeat section" for certain steps, click "Motion property" button.

You can set desired repeat section by put start and end step number. Left picture shows repeat section is made between Step 2 and Step 5.
You can see that acceleration rate is set at 1.05x and it is repeated 3 times. Acceleration will be increased whenever it is repeated by 1.05x rate.
For the rest of setting, please refer to the page 31.



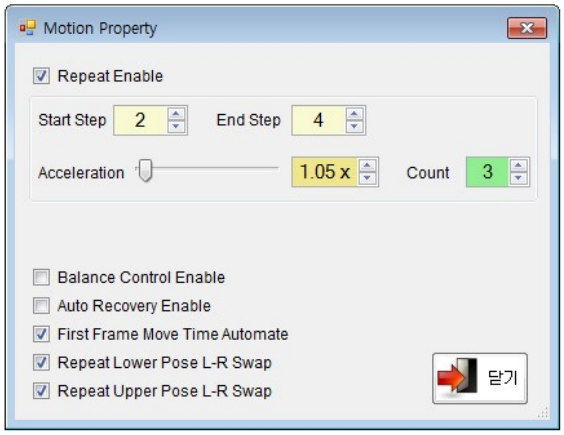
You will see "O" mark in RPT when you set repeat section for certain steps. "X" means that they are not in repeat section. Repeat section will be continued as below.
- Control App : During concerned buttons are pressed.
- Motion test in Total manager software : Until Stop button in motion test window is pressed.
For step 6(not in the repeat section), it will be executed after step 5 when stop button is pressed in the Total manager software. (or remove finger from the button in the APP.)

When Motion or Motions are completed, select concerned motions or click "SelectALL" button. Then, click "Download" button to download selected motion library into robot..



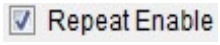
After download, please make sure to save created library. Click "File" in the menu and select "Save" or "Save As". File format is "Robot motion data file" as shown in the picture, and file name can be made as you wish.

② Motion Property Setting



In this setting, you can set,

- Motion repeat section(see page 30)
- Motion repeat acceleration rate and repeat count.



Repeat Section setting

Set repeat step section. Above picture shows repeat step is set between Step 2 and 4.

Acceleration rate & count : In the picture, acceleration rate is set at 1.05x and it is repeated 3 times. Acceleration will be increased whenever it is repeated by 1.05x rate.
(Caution : If acceleration rate is too excessive, it will influence bad effect to the servo.)

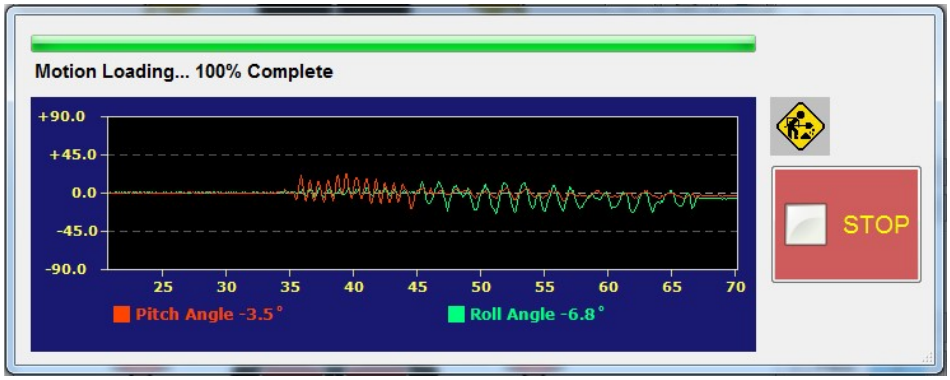
Enable Auto recovery function during motion operating so that robot may stand up when it falls. See page 27 for auto recovery setting.

This makes first step movement more smooth. Use this function to make smooth transition from current posture between the steps.

Exchange lower joints motor value and repeat it.

Exchange Upper joints motor value and repeat it.

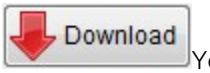
③ Motion Test



Motion will be shown as a graph with pitch and roll value. X axis show operating time and Y axis is pitch and roll graph based on 0 point.

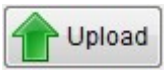
Stop button to complete Test

④ Download (Save motion to Robot)



You will see progress bar and selected motion will be saved in the robot.

⑤ Motion Upload



This button enables to upload motion to your PC from the robot.

⑥ Save Motion as file


Selected motion files will be save as file in your PC.

⑦ Open File

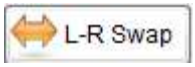

Saved motion file will be loaded from your PC.

⑧ Create New Motion File


Create New motion file, previous motion file will be removed from the screen.

⑨ Motion Trim

All step's value of selected motion can be tuned as below 4 different methods.



Swap values in bilateral symmetry (between Left/Right servos)

Tuning for servo positional value of particular joint
See [Annex] Motion data Joint trim

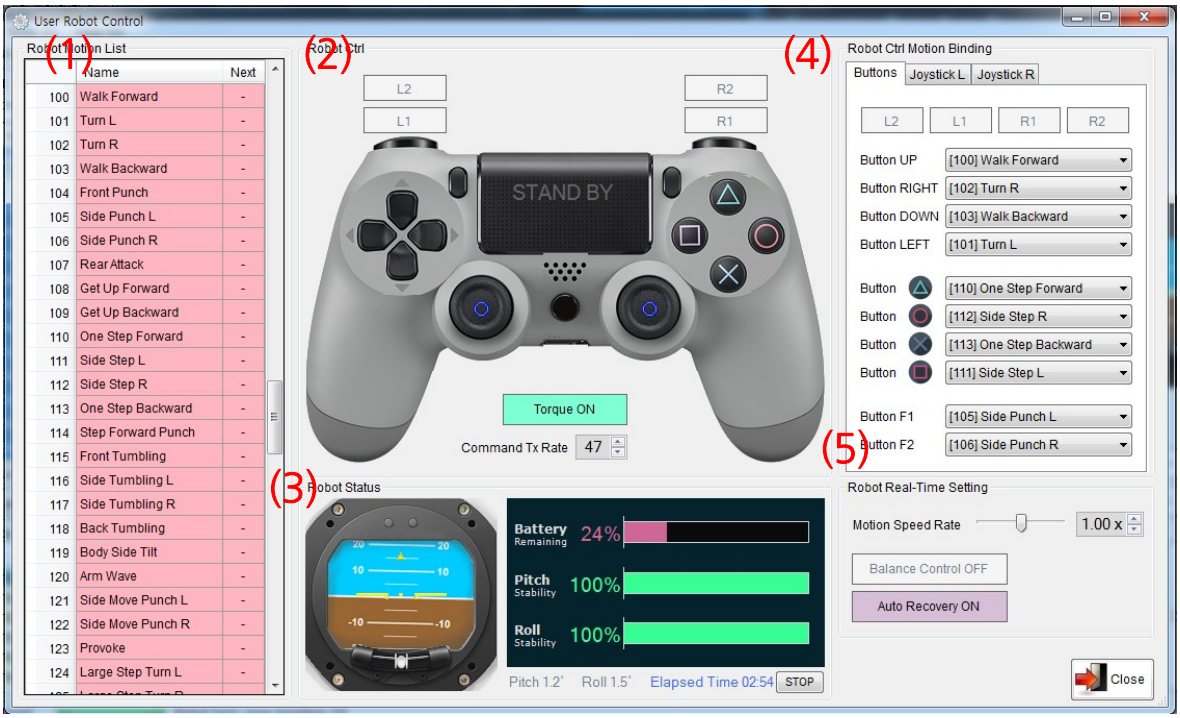
Increase for certain amount of Move time & Stop time

Decrease for certain amount of Move time & Stop time

(2) Motion Library

Fine tuning for Motion number 100~123 will be done at factory. For other 80 motions in library, if necessary, user may do fine-tuning according to each robot's mechanical condition

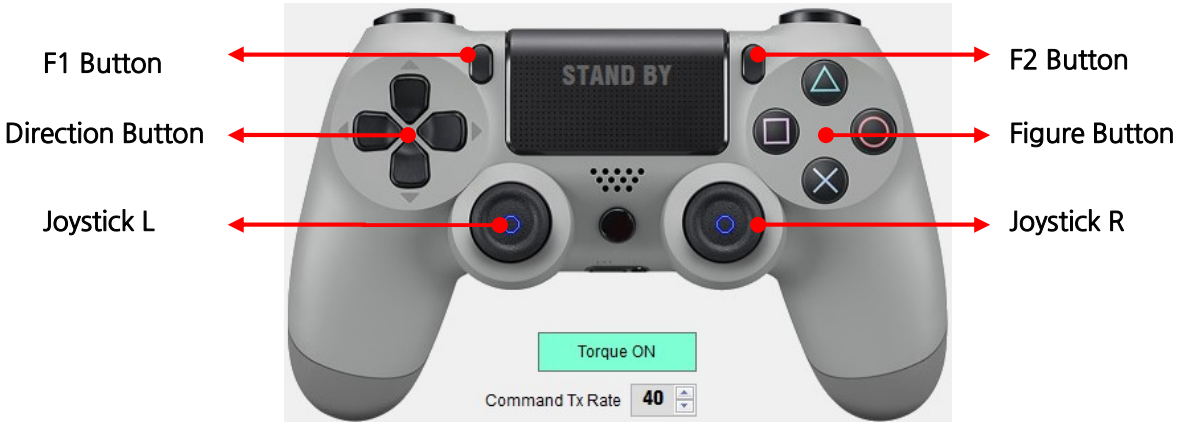
4.8. User Robot Control (Virtual Controller)



(1) Robot Motion List

Saved motion list in the robot will be shown in this window. Motion number, name, next motion number are shown.

(2) Robot Control (Virtual Controller)



Motion Status to be shown in this window.

Direction buttons. (Up, Down, Left and Right). Match walking motions with these buttons.

4 different Figure buttons. Match desired motions with these buttons.

8 directional joystick(Up, down, left, right, 4 x diagonal directions) / 2 Joysticks on Left/Right side.

Additional function buttons. (2 functions buttons on Left/Right side). Match desired motions with these buttons.

Torque ON/OFF control for all servos.(For emergency).

Interval setting for data transfer. Default setting is set at 40 and you may increase it in case of communication is getting bad.

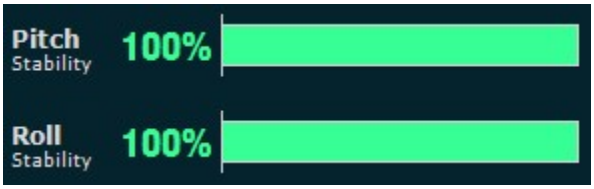
(3) Robot Status

Current robot status is shown such as balance(picth&roll), Elapsed time of controller, and battery status.

Current robot balance is shown in pitch(Front/Rear) & roll(Left/Right) standpoint.

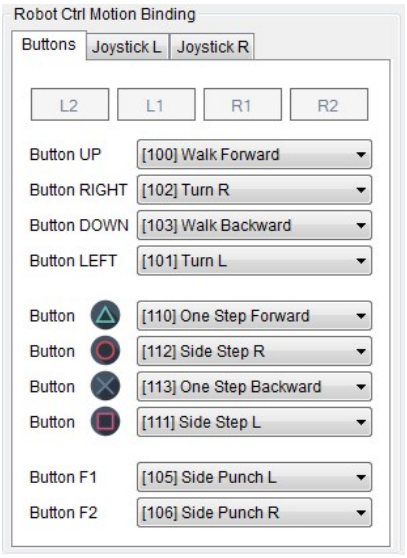
Elapsed time of controller. Press "stop" and "reset" button as you wish.

Current battery capacity.



Stability of pose in pitch and roll direction.

(4) Robot Control Motion Binding



You can assign desired motions to each joystick button.

Assignment for buttons and Joysticks are separated.

You can set multiple "button assignment" as shown below which enables you to use same buttons for different command combination.

Basic Group button assignment.

L1 Group button assignment.

L2 Group button assignment.

R1 Group button assignment.

R2 Group button assignment.

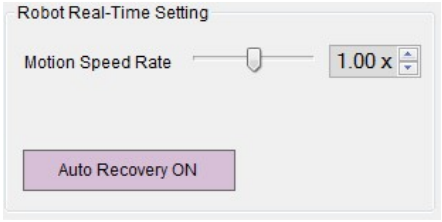
Desired motions can be assigned to 10 different buttons below.

In Joystick L tap, desired motions can be assigned to 8 different directions as below.

In Joystick R tap, desired motions can be assigned to 8 different directions as below.

(5) Robot Real-Time Setting

Motion speed rate can be set and other real time settings are available.



Set motion speed rate. Lower rate makes motion faster and higher rate makes motion slower. This setting will be reflected to all motions and it does not mean that it changes original motion data.

When this button is activated(ON), robot will stand up automatically when robot falls down. This function will be OFF when robot power is turned ON again.

4.9. Control by IR(Infrared) Remote Controller

(1) Compatible IR Remote Controller

TV Remote Controllers from SAMSUNG and any SAMSUNG compatible remote controllers are compatible with IRH-100.

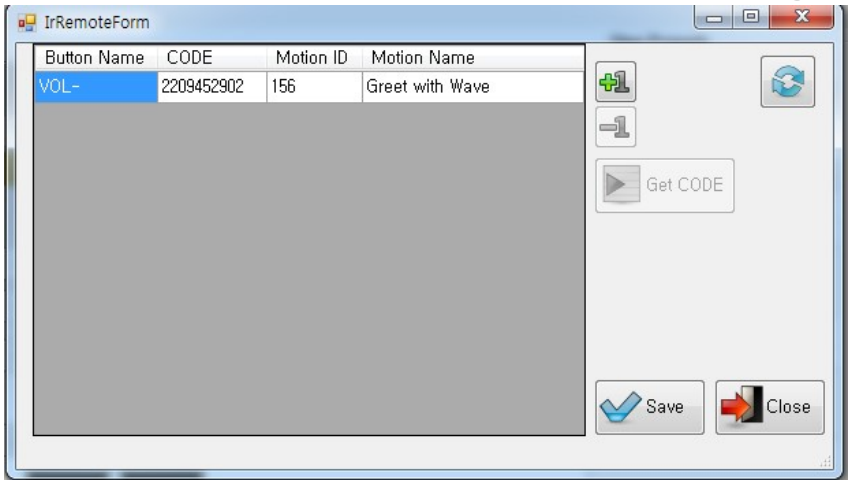
(2) Remote Controller Setting

For SAMSUNG remote controller, press "Volume Down" button to check if robot performs “Greet with Wave” motion. For SAMSUNG compatible remote controllers, search & select "SAMSUNG Home Appliances". Note that overall setting will be completed when IRH-100 perform “Greet with Wave” when you press "Volume Down" button.

(3) IR Remote Form (Remote Code Setting)

Click this button on the tool bar.

Set Remote codes in the window below.



[Button Name] Put each Button name.

[CODE] Unique code corresponding concerned remote button.(No need to put manually. See "Get code" below)

[Motion ID] Put motion number to bind certain motion with certain remote button..

[Motion Name] Motion name will be shown automatically when Motion ID is assigned.

Select concerned "CODE" area, then press concerned remote button, corresponding unique remote code will be shown automatically.

Add new line for additional remote button setting.

Delete selected line.

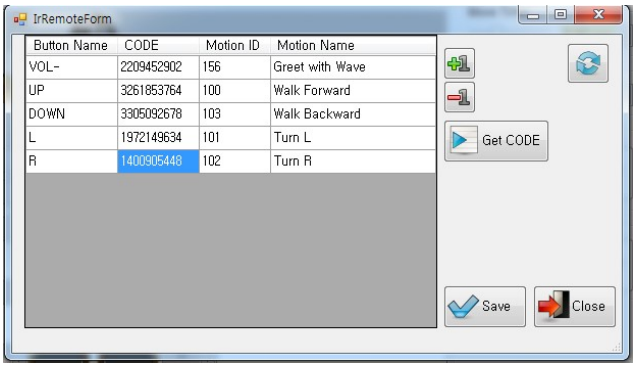
Load remote codes which are currently saved in IRH-100.

Save current code registration into IRH-100.

Close / Exit

(4) Control

Press assigned button of remote controller to perform motion.



5 Robot Control APP

5.1. Installation

(1) Required Specification of Smart Phone

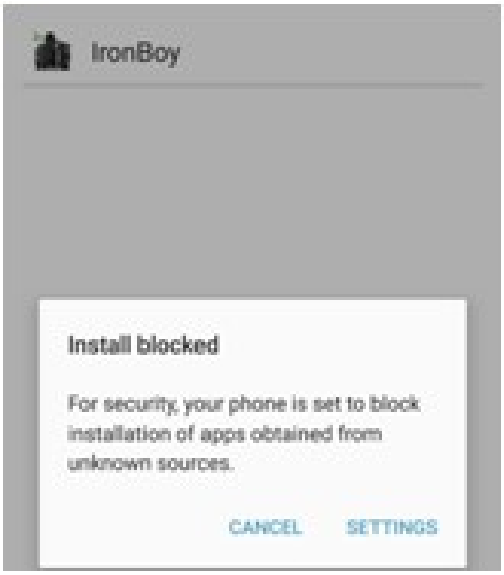
- Android OS 5.1 Lollipop or higher
- Bluetooth 4.0 BLE or higher

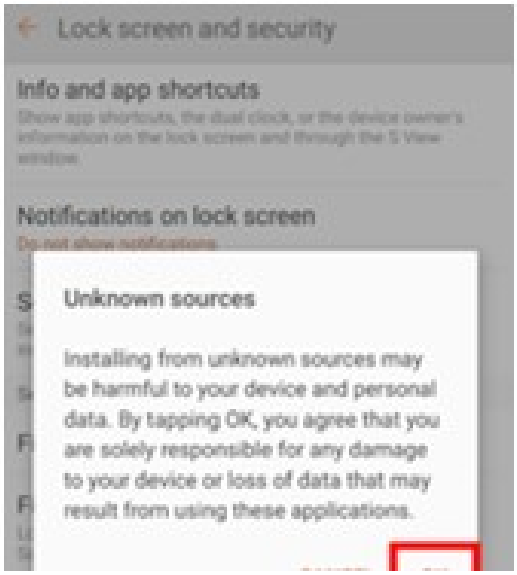
(2) Installation File Download

Download IRONBOY Controller APK from www. irrobot.com → Digital Archives

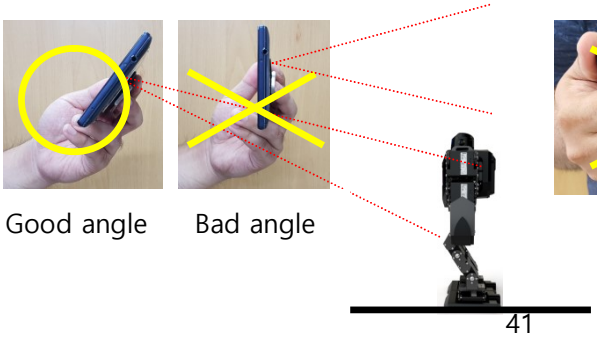
(3) Installation

Activate installation file (APK file). If you encounter block while installation, go to "Security" menu on your smart phone and enable "Unknown sources".





NOTE : Bluetooth module in IRONBOY has been developed for short distance communication between the robot and user's Android smart phone. Please be advised that Reception rate can be varied according to each smart phone, the way how to grip the phone, and angle between robot and your smart phone.
Please refer to the recommendation below.



Good angle Bad angle

Bad Grip

Good Grip

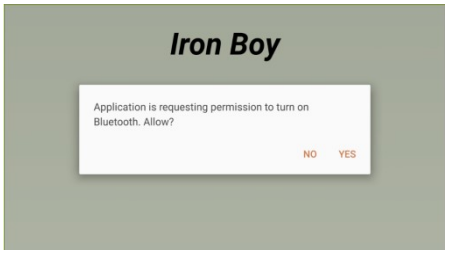
5.2. Setting

(1) Button Setting

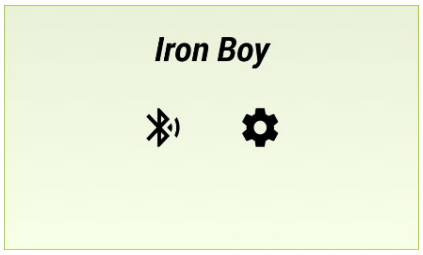
Click App Icon.

In case Bluetooth is inactivated on your smart phone, you will see Bluetooth approval request as below.

If Bluetooth is already activated, you will see main screen below.

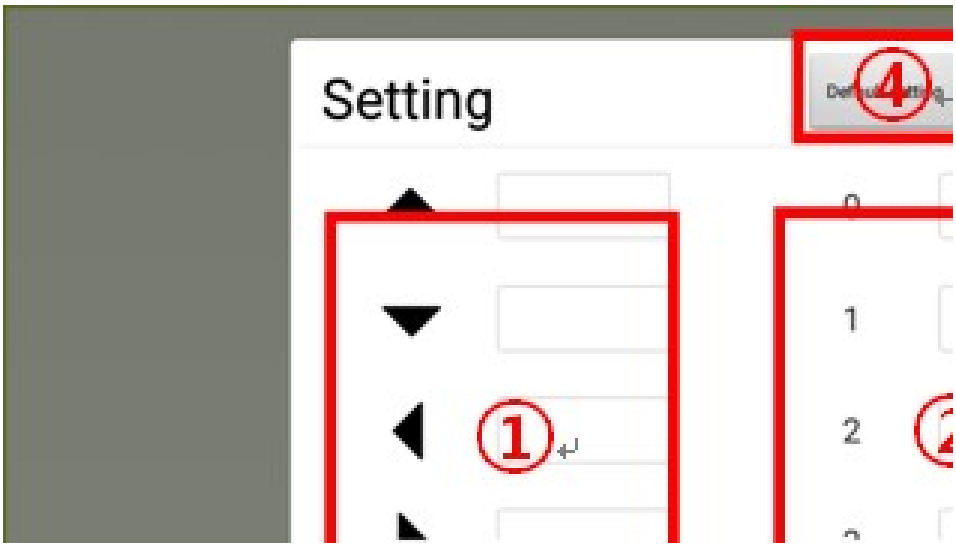


Click "Yes"



[Bluetooth Approval Request] [Main Screen]

Press  key on Main screen, then you will see below setting page.

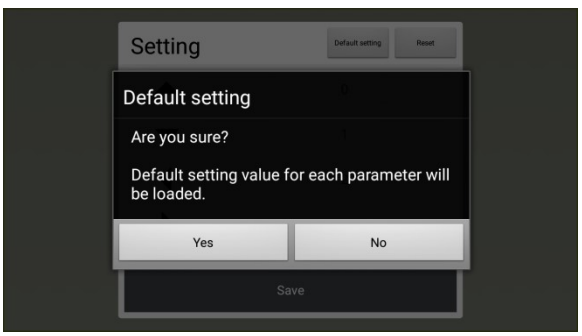


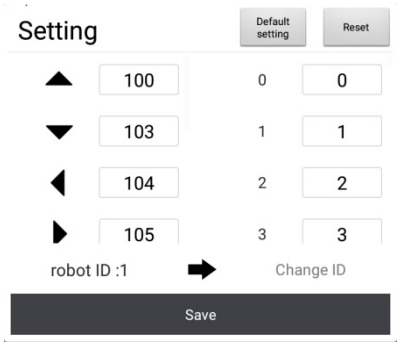
① Section 1 : Motion 0~199 can be assigned to 9 different figure keys freely. The only exception is "●" and this key can be assigned for 255(Stop) motion only.

② Section 2 : In this section, motions 0~199 can be assigned to 200 different keys freely.

③ Section 3 : This section is for Robot ID. Robot ID can be assigned between 1~253. This robot ID should be same as Robot ID of the robot you set in Total manager.

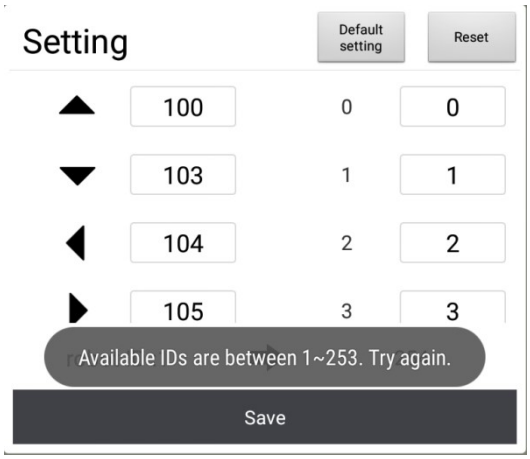
④ Section 4 : This is Default value button. If this button is pressed, factory values will be put into all buttons.
You will see the message for default setting as right picture for confirmation.
If you select "Yes", factory values will be stored in all buttons and "1" will be assigned as robot ID as below.



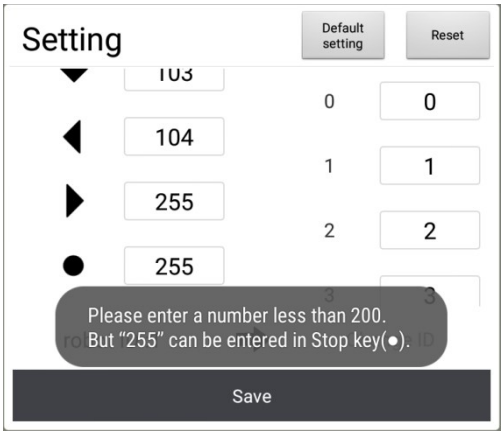


⑤ Section 5 : This is reset button. All setting values will be removed by this button.
You will see the message for reset setting as right picture for confirmation.
If you select "Yes", current value will be removed and reset to the initial status.

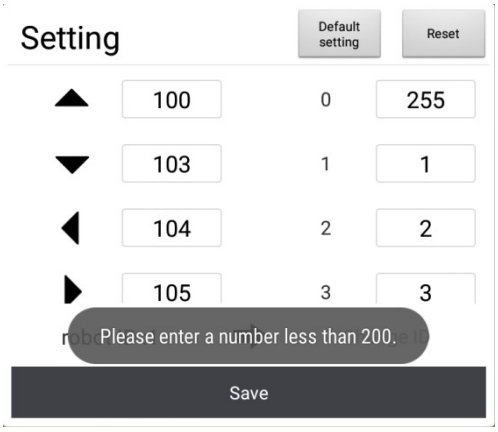
Click "Save" button after the setting. Then, it will revert to the main screen.



If robot ID in the above setting is out of 1~253, you will see message as left picture and the it will not be saved. Please put the number in the range of 1~253 again.



If any value for the keys are out of 0~199 in left section of button, you will see the message as right picture. Put correct motion number between 0~199. (Exception : 255 for Stop key(●))



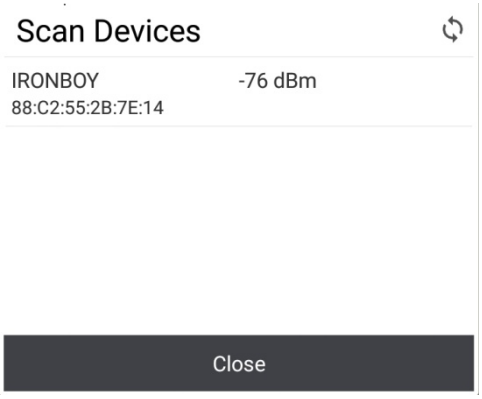
If any value for the keys are out of 0~199 in Right section of button, you will see the message as left picture. Put correct motion number between 0~199.

When you press back button on your smart phone, you will see message in right picture. If you select "Yes", you can exit.

5.3. Bluetooth Connection

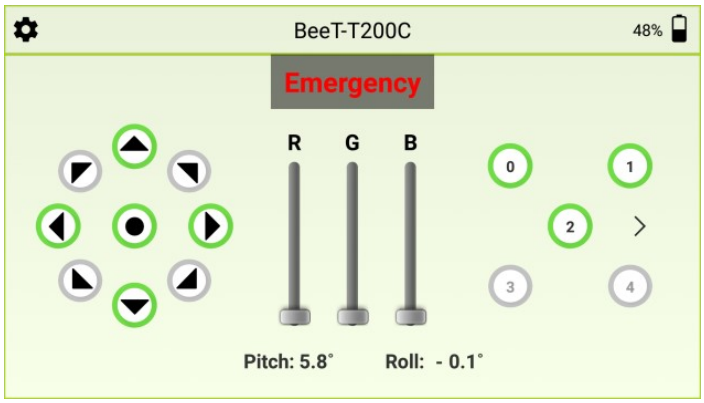
Turn on the robot power.

Press  button in main screen of the App, then you will see available Bluetooth list in “Scan Devices” window. (The name of bluetooth for IRH-100 is "IRONBOY".)



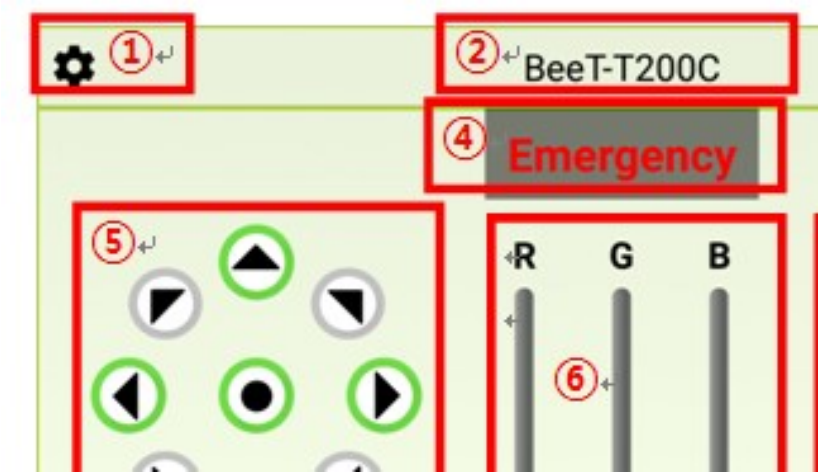
Select your IRH-100's Bluetooth number. Then, screen will go to main control screen.

Motion assigned keys will be shown with Green circle while grey circle keys show motion unassigned.



5.4. Control

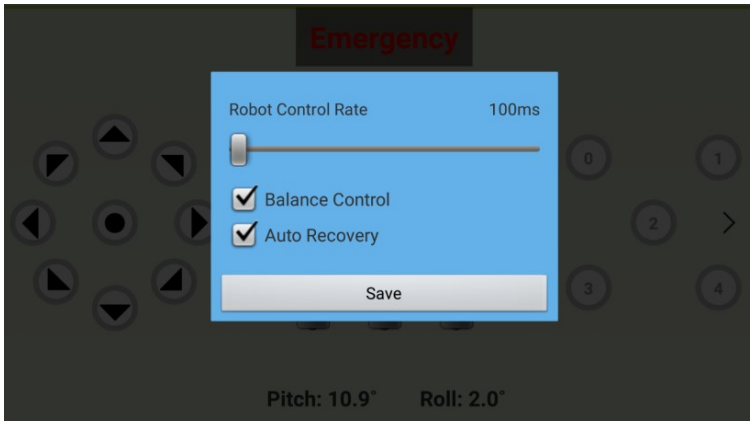
(1) Control Screen



① Function Setting
② Selected Bluetooth name
③ Robot Battery status
④ Emergency setting
⑤ Left Control panel
⑥ RGB LED(in the robot chest) control panel
⑦ Right Control panel
⑧ Pitch and Roll value of robot

(2) Control Screen Function

① Function Setting Button



Function setting in the App will be removed when the robot power is off & on again while function setting in the total manager software will be kept constantly before user changes setting.

- **Robot Control Rate** : This is the command transfers speed (per sec) from App to the robot between the range 40~100ms.
- **Balance Control** : When this function is activated, robot will try to keep balance automatically during motion processing and waiting mode.
- **Auto Recovery** : When this function is activated, robot will stand up automatically when it falls down.
- **Save** : Save current setting and exit.

② Selected Bluetooth Name

Shows selected Bluetooth name.

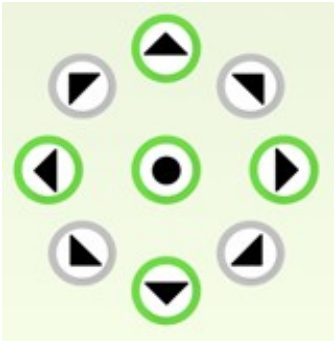
③ Robot Battery Status

Shows remaining battery status of Robot.

④ Emergency Setting

This is an emergency button which makes all servos' torque OFF in case of emergency. To make Torque ON of all servos, robot power should be reboot again.

⑤ Left Control Panel



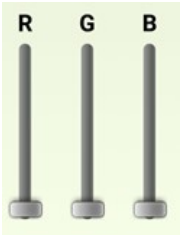
8 directional keys with 1 center key. Green circled key shows motion assigned key and grey circled key shows motion unassigned.

Motion will be repeated when you press and hold the key. When you takes away finger from the key, motion stops after it finishes full cycle.

For example, if "●" key is assigned for "255(stop)", you can stop the motion by pressing "●" when certain motion cannot be stopped due to some reason.

When green circled key is pressed, concerned motion will be executed with key value and motion number value display.

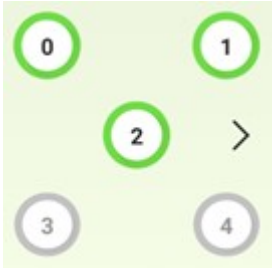
⑥ RGB LED(in the robot chest) control panel



RGB LEDs in the chest can be controlled in 255 colors with this slide type panel.

⑦ Right Control Panel

Consists of 5 keys. Green circled key shows motion assigned key and grey circled key shows motion unassigned. Motion will be repeated when you press and hold the key. When you takes away finger from the key, motion stops after it finishes full cycle.



When green circled key is pressed, concerned motion will be executed with key value and motion number value display.

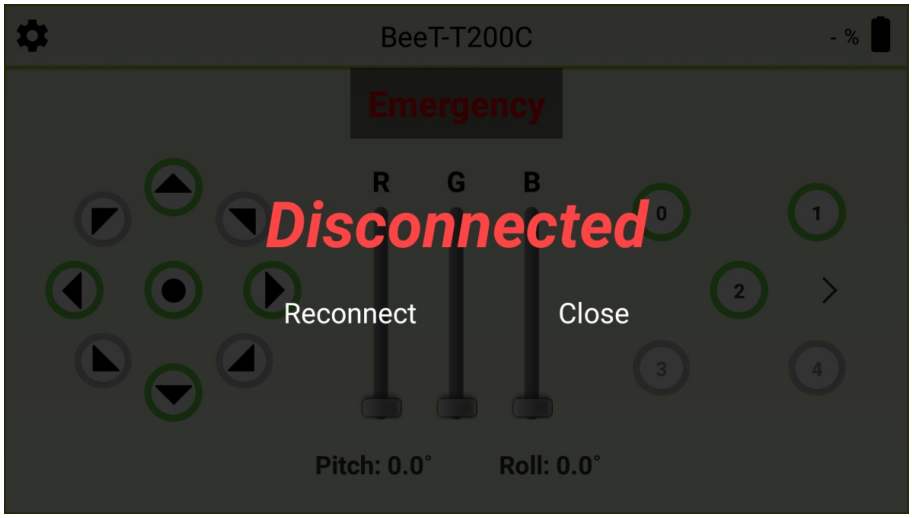
Press ➢ key to move to the additional motion key section. Whenever pressed once, it shows 5 different motion keys.

Total 200 different motions can be saved in this panel.

⑧ Pitch and Roll Value of Robot

Robot Pitch &Roll value shows inclination value of robot in real time.

5.5. Disconnected



You will see above screen when Bluetooth communication between robot and your smart phone is disconnected due to some reason.

Reconnect Try to reconnect with Robot.

Close Back to the main screen of the APP.

You will see above message when bluetooth connection is failed.
In this case, please try to connect after robot power is off and on again. If the problem still exists, finish the APP and reactivate it, then try to connect after turning off/on robot power

6 Arduino Programming (IRduino)

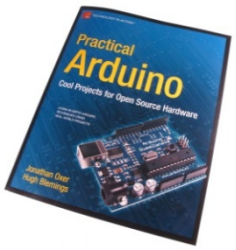
6.1. Arduino & IRduino

(1) Why Open Source?

① Open source from beginner to expert.

: IRduino is an open-source platform based on easy-to-use hardware and software which is easy-to-use for beginners, yet flexible enough for advanced users, so developer may edit it freely & flexibly.

② Abundant information : Developer may easily acquire abundant technical information through Arduino community. There are tons of Arduino communities on the web and even beginner may get necessary information, advice easily from the communities and may also approach various kinds of self-teaching books for Arduino anywhere, anytime.



③ Simple, Easy & Hassle-Free.

With IRduino, you do not need to be an electronic professional. Even many artists like interactive music and video artiest may utilize it for their project. Non-professional may learn Robotics easily and build their own robotic structures effectively for proto type using IRduino platform based on easy programming and abundant information on the internet. Soldering will be minimized thanks to "Breadboard" system.

④ Best solution to learn C language.

Since IRduino is using similar language as C, it is a good tool to learn C language effectively. The language can be expanded through C++ libraries, and user who wants to understand more technical details may skip to the AVR C programming language on which it's based. On the other hand, user may add AVR-C code directly into their IRduino programs if they wish. Also, you may utilize your knowledge if you have some experience in Flash, Android, MaxMSP, Processing and Object C.

⑤ Abundant "Shields" at reasonable cost in the market. Immediate solution.

There are already existing "shield(like sensors)" which enable developer to try various kinds of robot tasks in short time. Most of Shield Boards are relatively reasonable in cost-wise comparing to other microcontroller system, so developer may also minimize development cost.

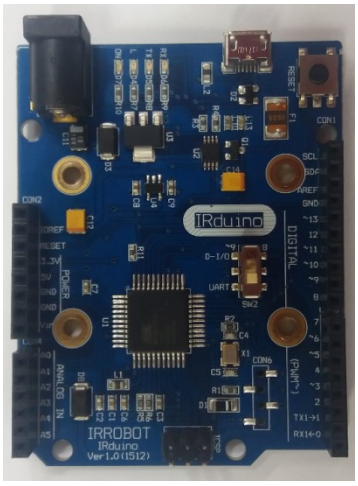
⑥ Convenience

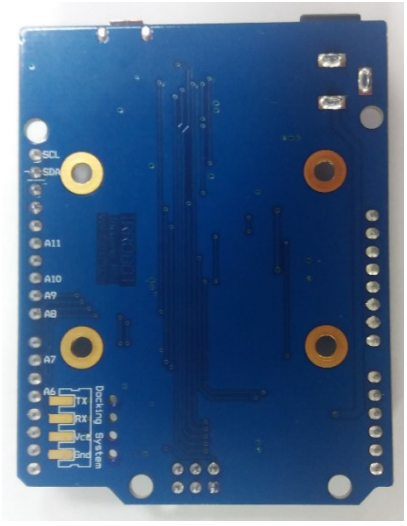
- Using USB port : Thanks to using the most popular USB port (No Serial or Parallel port as like conventional Micom development). No need converting gender. Simply plug in your USB port to enter into the new world of IRduino.
- Cross-platform : Compatible with the most of O/S like Windows, Mackintosh OSX and Linux operating system while most of microcontroller system support Windows only.

.

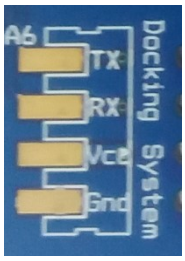
(2) IRduino

IRduino board is an Arduino compatible board and has been designed based on Arduino Leonardo. More functions have been added as below.





① Communication interface with main board(IRC-24)



This docking system is to connect the main board with IRduino for its UART and battery power by contact method.

② Function Switch (For the Arduino shield using UART protocol)

From the factory, the switch is set at "UART"mode for the communication between main board and IRduino board. But, in case of applying Arduino shield using UART protocol onto IRduino board, you can switch it to D-I/O mode

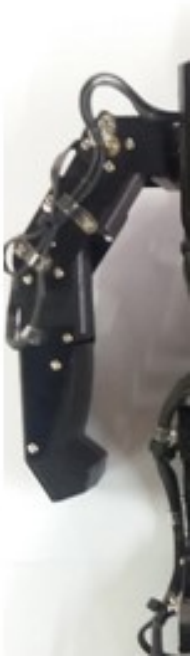
6.2. Shield (Arduino Shield)

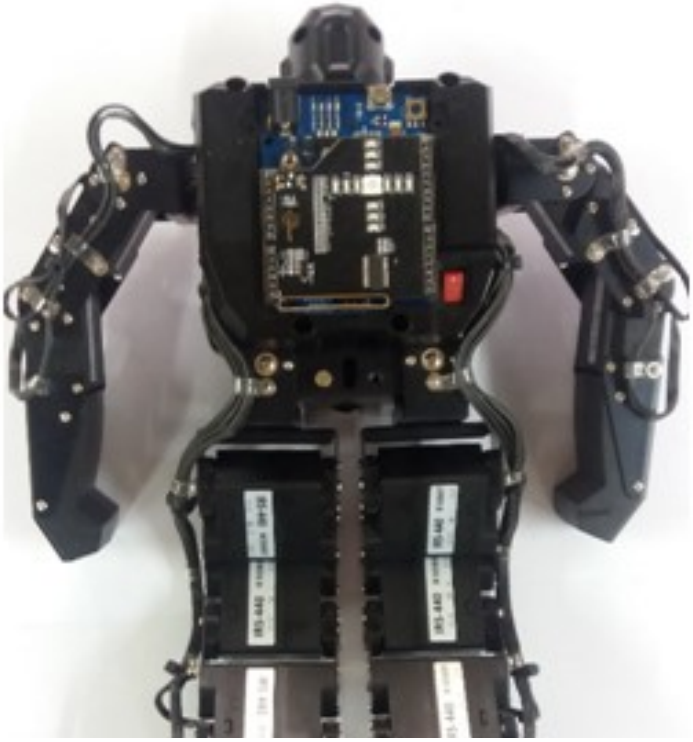
Arduino shield is a hardware to expand functionality of Arduino by connecting with Arduino(IRduino) board. For example, you can use Bluetooth function when you connect Bluetooth shield with Arduino board. Currently, there are more than 300 different Arduino shields in the market at reasonable cost such as LCD button shield, Ethernet shield, WiFi shield, SD card shield and Bluetooth shield.

(1) Applicable Arduino Shields

- LED control
- FND control
- DOT MATRIX control
- TEXT LCD control
- COMMUNICATION control
- DIP SW control
- KEYPAD control
- SERVO MOTOR control
- STEP MOTOR control
- Making calculator using KEYPAD
- DOT MATRIX control using KEYPAD
- SERVO MOTOR Property Output
- SERVO MOTOR control using Keypad
- STEP MOTOR Property Output
- STEP MOTOR control using Keypad
- COMPASS SENSOR control
- PIR SENSOR control
- CDS SENSOR control
- ULTRASONIC SENSOR control
- VR SENSOR control
- Temperature/Humidity SENSOR control
- NFC control
- BLUETOOTH control

(3) Example of Shield Application





(4) API and Library

① Library File Composition

	Library Name	API Name	Description
Instruction	MotionDriver	ExecuteRobotMotion	Execute Robot Motion
	ActuatorDriver	writeActuatorRawPosition	Actuator actual position value move
	ActuatorDriver	writeActuatorPosition	Actuator Goal position value move
	MotionDriver	WriteMonoStep	Mono Step move
	ParameterDriver	RealtimeFunction	Robot real-time function setting
	MotionDriver	MotionCaptureEnable	Robot motion capture setting
	ParameterDriver	StoreBaseParameter	Save Robot basic setting
	MotionDriver	StoreActivityProperty	Save robot activity property
	ParameterDriver	FeedBackRobotData	Request Robot data Feedback
	LedDriver	ChestFullColor	LED color output
	PiezoDriver	playSound	Piezo sound output
Feedback	ParameterDriver	FeedBackRobotData	Command reception check
	ParameterDriver	FeedBackRobotData	Robot current status check
	ParameterDriver	FeedBackRobotData	Standard position value of robot servos
	ParameterDriver	FeedBackRobotData	Robot Basic Setting
	ParameterDriver	FeedBackRobotData	Robot Basic Posture
	MotionDriver	FeedBackRobotData	Robot Current Posture
	MotionDriver	FeedBackRobotData	Robot Motion execution feedback
	MotionDriver	FeedBackActivityProperty	Robot operating property
	MotionDriver	FeedBackMonoStep	Robot Motion Step

② API Description

ExecuteRobotMotion (uint8_t MotionNum, protocol_feedback_execute_robot_motion_t *recv_buf)

- Function : Robot Motion Execution
- Parameter
  - MotionNum : Motion number

※ Robot Motion number Definition

Motion number	Definition	Description	Torque Status
0 ~ 99	MOTION_USER_00 ~ _99	User Motion 0 ~ 99 (Saved in external memory)	ON
100 ~ 199	MOTION_LIBRARY_00 ~ _99	Factory Library Motion 0 ~ 99 (Saved in internal memory)	
200	MOTION_TORQUE_OFF	All Actuator torque OFF	OFF
201	MOTION_USER_TEST	Temporary User's test motion (Save in RAM area)	ON
255	MOTION_STOP	Motion Stop (Stop for already executed motion)	No change

  - Recv_buf : Motion execution feedback data storage position

writeActuatorRawPosition(uint8_t _id,int16_t _position)

- Function : Move to Servo Actual Position
- Parameter
  - id : The ID of servo which will be moved.
  - _position : Actual position value which will be moved. Setting between 0~1023.

writeActuatorPosition(uint8_t _id,int16_t _position,bool move, bool torque)

- Function : Move to Servo Goal Position
- Parameter
  - id : The ID of servo which will be moved.
  - _position : Goal position value. Setting between -512~511.
  - move : when it is '0', Save position value only. When it is "1", execute motion too.
  - torque : when it is '0', torque will be off. when it is '1', torque will be ON.

WriteMonoStep(uint8_t step_move_time, uint8_t step_stop_time, uint8_t step_led, bool step_led_enable, uint8_t step_piezo, bool step_piezo_enable, int16_t step_reference_pitch, int16_t step_reference_roll, int16_t *position)

- Function : Mono Step movement
- Parameter
  - step_move_time : Step Move time (Range: 1 ~ 255, Unit: 0.01 sec)
  - step_stop_time : Step Stop time (Range: 1 ~ 255, Unit: 0.01 sec)
  - step_led : Step LED color number (Range: 0 ~ 63), Refer to the annex "LED Control Color Chart"
  - step_led_enable : LED color enable Bit, when it is '1', color will be ON.
  - step_piezo : Step Piezo sound number (Range: 0 ~ 63), Refer to the annex "Piezo Sound Number Chart".
  - step_piezo_enable : Piezo sound enable bit, when it is '1', sound will be made.
  - step_reference_pitch : Step Pitch reference angle (Range: -900 ~ 900, Unit: 0.1 °)
  - step_reference_roll : Step Roll reference angle (Range: -1800 ~ 1799, Unit: 0.1 °)
  - position : Address of array saving Actuator goal position value (Range: -511 ~ 511)

RealtimeFunction(uint8_t motion_speed_rate, uint8_t realtime_function_enable)

- Function : Robot Real-time Function Setting
- Parameter
  - motion_speed_rate : Motion speed rate (Range: 50 ~ 150, Unit: 0.01 x)
  - realtime_function_enable : Real-time Function Enable Byte

Bit	Definition	Description
Bit 0	BALANCE_CONTROL	Balance control Enable Bit (1: Enable, 0: Disable)
Bit 1	AUTO_RECOVERY	Auto recovery Enable Bit (1: Enable, 0: Disable)
Bit 2	RESERVED	Reserved Enable Bit
Bit 3	RESERVED	Reserved Enable Bit
Bit 4	RESERVED	Reserved Enable Bit
Bit 5	RESERVED	Reserved Enable Bit
Bit 6	RESERVED	Reserved Enable Bit
Bit 7	TOTAL_TORQUE	Total Torque Enable Bit (1: Enabled, 0: Disabled)

MotionCaptureEnable(protocol_servo_bit_t pose_capture_enable)

- Function : Robot Posture Capture Setting
- Parameter
  - pose_catpture_enable : Posture Capture Enable Byte (3Byte)

※ Posture Capture Enable Byte 0

Bit	Definition	Description
Bit 0	CAPTURE_ENABLE_ACTUATOR_0	Actuator #0 Capture Enable Bit (1: Enable, 0: Disable)
Bit 1	CAPTURE_ENABLE_ACTUATOR_1	Actuator #1 Capture Enable Bit (1: Enable, 0: Disable)
Bit 2	CAPTURE_ENABLE_ACTUATOR_2	Actuator# 2 Capture Enable Bit (1: Enable, 0: Disable)
Bit 3	CAPTURE_ENABLE_ACTUATOR_3	Actuator #3 Capture Enable Bit (1: Enable, 0: Disable)
Bit 4	CAPTURE_ENABLE_ACTUATOR_4	Actuator #4 Capture Enable Bit (1: Enable, 0: Disable)
Bit 5	CAPTURE_ENABLE_ACTUATOR_5	Actuator# 5 Capture Enable Bit (1: Enable, 0: Disable)
Bit 6	CAPTURE_ENABLE_ACTUATOR_6	Actuator #6 Capture Enable Bit (1: Enable, 0: Disable)
Bit 7	CAPTURE_ENABLE_ACTUATOR_7	Actuator #7 Capture Enable Bit (1: Enable, 0: Disable)

※ Posture Capture Enable Byte 1

Bit	Definition	Description
Bit 0	CAPTURE_ENABLE_ACTUATOR_8	Actuator #8 Capture Enable Bit (1: Enable, 0: Disable)
Bit 1	CAPTURE_ENABLE_ACTUATOR_9	Actuator #9 Capture Enable Bit (1: Enable, 0: Disable)
Bit 2	CAPTURE_ENABLE_ACTUATOR_10	Actuator #10 Capture Enable Bit (1: Enable, 0: Disable)
Bit 3	CAPTURE_ENABLE_ACTUATOR_11	Actuator #11 Capture Enable Bit (1: Enable, 0: Disable)

Bit 4	CAPTURE_ENABLE_ACTUATOR_12	Actuator #12 Capture Enable Bit (1: Enable, 0: Disable)
Bit 5	CAPTURE_ENABLE_ACTUATOR_13	Actuator #13 Capture Enable Bit (1: Enable, 0: Disable)
Bit 6	CAPTURE_ENABLE_ACTUATOR_14	Actuator #14 Capture Enable Bit (1: Enable, 0: Disable)
Bit 7	CAPTURE_ENABLE_ACTUATOR_15	Actuator #15 Capture Enable Bit (1: Enable, 0: Disable)

※ Posture Capture Enable Byte 2

Bit	Definition	Description
Bit 0	CAPTURE_ENABLE_ACTUATOR_16	Actuator #16 Capture Enable Bit (1: Enable, 0: Disable)
Bit 1	CAPTURE_ENABLE_ACTUATOR_17	Actuator #17 Capture Enable Bit (1: Enable, 0: Disable)
Bit 2	CAPTURE_ENABLE_ACTUATOR_18	Actuator #18 Capture Enable Bit (1: Enable, 0: Disable)
Bit 3	CAPTURE_ENABLE_ACTUATOR_19	Actuator #19 Capture Enable Bit (1: Enable, 0: Disable)
Bit 4	CAPTURE_ENABLE_ACTUATOR_20	Actuator #20 Capture Enable Bit (1: Enable, 0: Disable)
Bit 5	CAPTURE_ENABLE_ACTUATOR_21	Actuator #21 Capture Enable Bit (1: Enable, 0: Disable)
Bit 6	CAPTURE_ENABLE_ACTUATOR_22	Actuator #22 Capture Enable Bit (1: Enable, 0: Disable)
Bit 7	CAPTURE_ENABLE_ACTUATOR_23	Actuator #23 Capture Enable Bit (1: Enable, 0: Disable)

```
StoreBaseParameter(uint8_t  battery_full_voltage,
                   uint8_t battery_low_warning_voltage, uint8_t motion_speed_rate,
                   uint8_t *balance_PID, uint8_t auto_recovery_trigger_angle,
                   uint8_t auto_recovery_front_down_motion,
                   uint8_t auto_recovery_rear_down_motion,
                   uint8_t  function_enable_byte);
```

- Function : Robot Basic Setting Save
- Parameter
  - battery_full_voltage : Battery Full charging Voltage (Range: 40 ~ 255: Unit: 0.1 V)
  - battery_low_warning_voltage : Battery Low Voltage Warning Voltage (Range: 40 ~ 255: Unit: 0.1 V)
  - motion_speed_rate : Motion speed rate (Range: 50 ~ 150, Unit: 0.01 x)
  - balance_PID : Balance control PID proportional constant (RESERVED)
  - auto_recovery_trigger_angle : Auto recovery start angle (Range: 1 ~ 90, Unit: ±1 °)
  - auto_recovery_front_down_motion : Auto recovery motion for front down (Range: 0 ~ 200)
  - auto_recovery_rear_down_motion : Auto recovery motion for back down (Range: 0 ~ 200)
  - function_enable_byte : Motion Function Enable Byte

Bit	Definition	Description
Bit 0	BALANCE_CONTROL	Balance control Enable Bit (1: Enable, 0: Disable)
Bit 1	AUTO_RECOVERY	Auto recovery Enable Bit (1: Enable, 0: Disable)
Bit 2	FIRST_STEP_MOVE_TIME_AUTO_CALCULATE	First Step move time auto calculate Bit (1: Enable, 0: Disable)
Bit 3	REPEAT_ENABLE	Motion Repeat Enable Bit (1: Enable, 0: Disable)

Bit 4	REPEAT_LOWER_POSE_EXCHANGE	Repeat section lower pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 5	REPEAT_UPPER_POSE_EXCHANGE	Repeat section Upper pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 6	RESERVED	Reserved Bit
Bit 7	RESERVED	Reserved Bit

StoreActivityProperty (uint8_t motion, uint8_t step_size, uint8_t repeat_start_step, uint8_t repeat_end_step, uint8_t repeat_acceleration_rate, uint8_t repeat_acceleration_count, uint8_t next_motion, uint8_t motion_function_enable_byte, char *motion_name)

- Function : Robot Motion Property Save
- Parameter
  - motion : Motion number (Range: 0 ~ 199)
  - step_size : Motion Step size (Range: 0 ~ 23)
  - repeat_start_step : Repeat start step (Range: 1 ~ 22)
  - repeat_end_step : Repeat end step (Range: 1 ~ 22)
  - repeat_acceleration_rate : Repeat section acceleration rate (Range: 100 ~ 250, Unit: 0.01 x)
  - repeat_acceleration_count : Repeat section acceleration count (Range: 0 ~ 15)
  - next_motion : Next Motion (Range: 0 ~ 200, No Motion : 255)
  - motion_function_enable_byte : Enable byte for Motion Function

※ Motion Function Enable Byte Definition

Bit	Definition	Description
Bit 0	BALANCE_CONTROL	Balance control enable bit (1: Enable, 0: Disable)
Bit 1	AUTO_RECOVERY	Auto recovery enable bit (1: Enable, 0: Disable)
Bit 2	FIRST_STEP_MOVE_TIME_AUTO_CALCULATE	First step move time automatic calculate Bit (1: Enable, 0: Disable)
Bit 3	REPEAT_ENABLE	Motion repeat enable bit (1: Enable, 0: Disable)
Bit 4	REPEAT_LOWER_POSE_EXCHANGE	Repeat section lower pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 5	REPEAT_UPPER_POSE_EXCHANGE	Repeat section upper pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 6	RESERVED	Reserved bit
Bit 7	RESERVED	Reserved bit

  - motion_name : Motion name (60 characters)

FeedBackRobotData(uint8_t feedback_num, protocol_header_t *recv_buf_head)

- Function : Robot Data Feedback Request
- Parameter
  - feedback_num : Feedback Request Data ID

ID	Definition	Description
1	PACKET_feedback_ack	Command reception check
2	PACKET_feedback_robot_status	Robot Present Status
3	PACKET_feedback_zero_position	Robot Actuator Standard position value
4	PACKET_feedback_base_parameter	Robot Basic Setting
5	PACKET_feedback_default_pose	Robot Basic Posture
6	PACKET_feedback_pose_capture	Robot Current Posture
7	PACKET_feedback_execute_robot_motion	Robot Motion execution feedback

- recv_buf_head : Header Address of Feedback request data

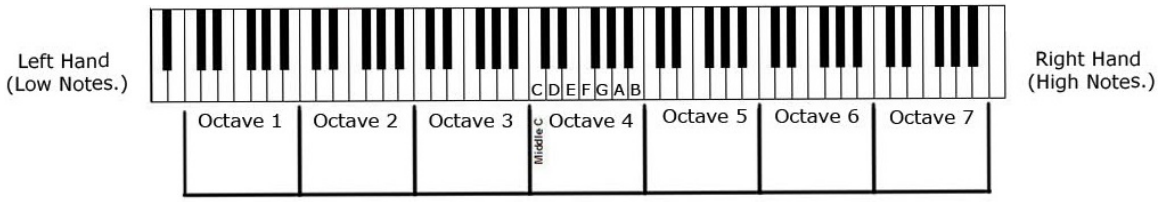
ChestFullColor(uint8_t _bright,uint8_t _red,uint8_t _green, uint8_t _blue)

- Function : LED Color output
- Parameter
  - _bright : All LED's brightness (Range: 0 ~ 255)
  - _red : Red Color (Range: 0 ~ 255)
  - _green : Green color (Range: 0 ~ 255)
  - _blue : Blue color (Range: 0 ~ 255)

playSound(uint8_t _octave,uint8_t _syllable, uint8_t _beat)

- Function : Piezo sound output
- Parameter
  - _octave : Octave number (Range: 1 ~ 7)
  - _syllable : Tone number (Range: 0 ~ 11)
  - _beat : Tone length (Range: 1 ~ 255, Unit: 4 msec)

※ Octave number Definition



※ Tone number Definition

Index	Note	Tone
0	C	Do
1	C#	Do#
2	D	Re
3	D#	Re#
4	E	Mi
5	F	Fa
6	F#	Fa#
7	G	Sol
8	G#	Sol#
9	A	La
10	A#	La#
11	B	Si

- #define PACKET_feedback_activity_property 120
- #define PACKET_feedback_motion_step 121

FeedBackActivityProperty (uint8_t motion, protocol_store_activity_property_t *recv_buf)

protocol_store_activity_property_t Parameter

- motion : Motion number (Range: 0 ~ 199)
- step_size : Motion Step size (Range: 0 ~ 23)
- repeat_start_step : Repeat start step (Range: 1 ~ 22)
- repeat_end_step : Repeat end Step (Range: 1 ~ 22)
- repeat_acceleration_rate : Acceleration rate of Repeat section (Range: 100 ~ 250, Unit: 0.01 x)
- repeat_acceleration_count : Acceleration count of Repeat section (Range: 0 ~ 15)
- next_motion : Next Motion (Range: 0 ~ 200, No Motion: 255)

- motion_function_enable_byte : Motion Function Enable Byte
  Motion Function Enable Byte Definition

Bit	Definition	Description
Bit 0	BALANCE_CONTROL	Balance control Enable Bit (1: Enable, 0: Disable)
Bit 1	AUTO_RECOVERY	Auto recovery Enable Bit (1: Enable, 0: Disable)
Bit 2	FIRST_STEP_MOVE_TIME_AUTO_CALCULATE	Frist Step move time auto calculate Bit (1: Enable, 0: Disable)
Bit 3	REPEAT_ENABLE	Motion Repeat Enable Bit (1: Enable, 0: Disable)
Bit 4	REPEAT_LOWER_POSE_EXCHANGE	Repeat section lower pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 5	REPEAT_UPPER_POSE_EXCHANGE	Repeat section upper pose L-F Swap Bit (1: Enable, 0: Disable)
Bit 6	RESERVED	Reserved Bit
Bit 7	RESERVED	Reserved Bit

- motion_name : Motion Name (60 Characters)

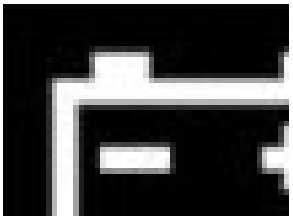
FeedBackMonoStep(uint8_t motion, uint8_t step, protocol_store_motion_step_t *recv_buf)

protocol_store_motion_step_t Parameter

- step_move_time : Step move time (Range: 1 ~ 255, Unit: 0.01 sec)
- step_stop_time : Step stop time (Range: 1 ~ 255, Unit: 0.01 sec)
- step_led : Step LED color number (Range: 0 ~ 63), Refer to the annex "LED control color Chart".
- step_led_enable : LED color enable Bit, when it is '1', color will be ON.
- step_piezo : Step Piezo sound number (Range: 0 ~ 63), Refer to the annex "Piezo Sound Number Chart".
- step_piezo_enable : Piezo sound enable Bit, when it is '1', piezo sound will be made.
- step_reference_pitch : Step Pitch reference angle (Range: -900 ~ 900, Unit: 0.1 °)
- step_reference_roll : Step Roll reference angle (Range: -1800 ~ 1799, Unit: 0.1 °)
- position : Address of array saving Actuator goal position value

7 Annex

[Battery Management and Battery Charging]



IROBOY is equipped with rechargeable secondary cell called Nickel-metal hydride Battery pack.
Battery is convenient, but it may cause dangerous condition like explosion and fire, so please pay close attention while using and storing battery.

■ Management for Nickel-Metal Hydride Battery Pack

1. If robot will not be used for long time, charge the battery at least 50% and disconnect the battery from the robot for safety and long lifespan of battery.
2. Keep away from heat, direct ray and hot area.
3. Keep away from Children.
4. In winter season, please store & use the battery in the room temperature. Low temperature may affect bad influence on battery's performance.
5. Do not disassemble, puncture the battery at discretion.
6. Do not touch any leaked material. It is harmful.
7. The battery is a consumable item. Replace the battery when performance get worse.

■ Charging

1. Use genuine charger in the package. Connect the charger into charging jack of robot for charging.
2. Full Charging time will be about 70 min and can be varied according to battery remaining capacity.
3. Do not charge the battery right after use. Wait until it cools down for charging.

[LED Control Color Chart]

Color number	Color	(R, G, B) Value
0		(139, 146, 150)
1		(5, 50, 253)
2		(3, 39, 208)
3		(82, 67, 207)
4		(167, 37, 157)
5		(189, 27, 53)
6		(188, 34, 0)
7		(160, 39, 0)
8		(100, 63, 0)
9		(0, 135, 0)
10		(0, 121, 0)
11		(0, 105, 0)
12		(0, 81, 107)
13		(0, 0, 0)
14		(0, 0, 0)
15		(0, 0, 0)
16		(199, 203, 206)
17		(0, 143, 253)
18		(0, 157, 253)
19		(125, 102, 253)
20		(230, 55, 220)
21		(236, 40, 115)
22		(255, 80, 0)
23		(236, 118, 30)
24		(187, 146, 0)
25		(0, 192, 0)
26		(0, 179, 0)
27		(0, 179, 90)
28		(0, 153, 165)
29		(41, 41, 41)
30		(0, 0, 0)
31		(0, 0, 0)
32		(253, 250, 253)
33		(65, 204, 253)

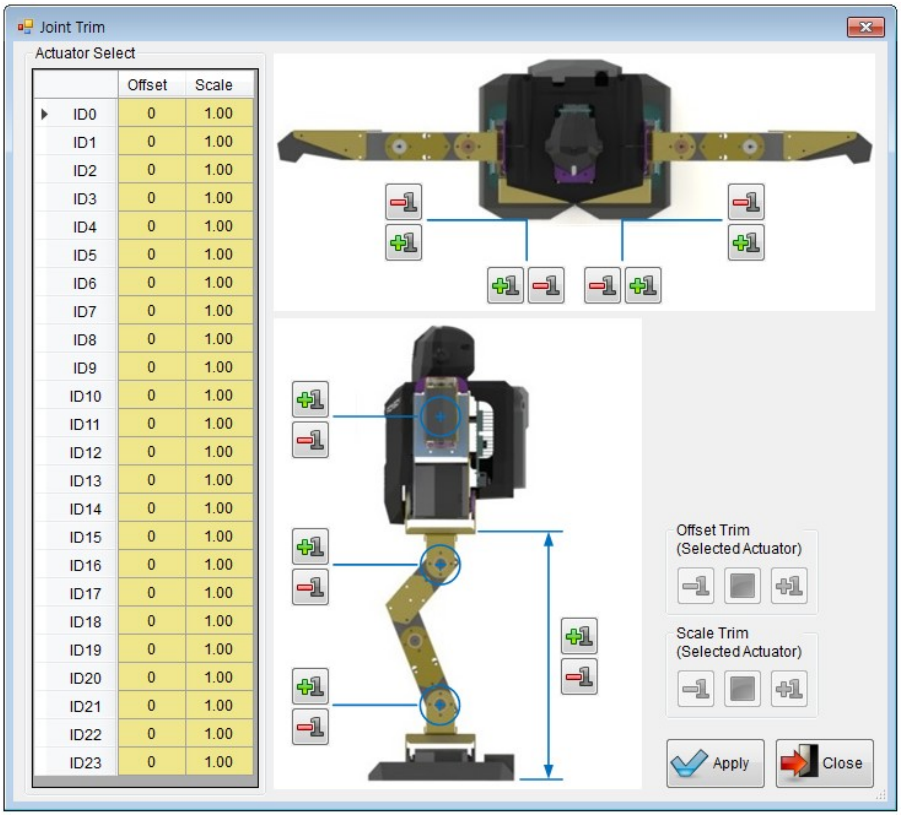
34		(123, 158, 253)
35		(173, 146, 253)
36		(255, 148, 253)
37		(255, 115, 172)
38		(255, 142, 107)
39		(254, 175, 90)
40		(254, 195, 0)
41		(198, 245, 28)
42		(101, 219, 107)
43		(99, 245, 172)
44		(0, 235, 234)
45		(103, 103, 103)
46		(0, 0, 0)
47		(0, 0, 0)
48		(255, 255, 255)
49		(177, 236, 253)
50		(200, 199, 253)
51		(228, 199, 253)
52		(254, 200, 252)
53		(247, 205, 230)
54		(247, 217, 193)
55		(253, 229, 193)
56		(253, 222, 150)
57		(226, 247, 139)
58		(194, 246, 138)
59		(188, 242, 224)
60		(0, 248, 253)
61		(214, 207, 207)
62		(0, 0, 0)
63		(0, 0, 0)

[Piezo Sound number chart]

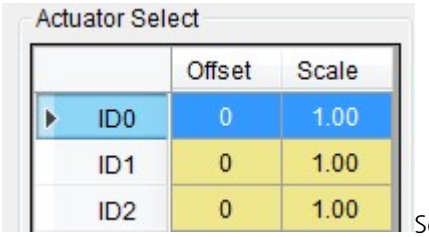
음 number	Octave	Note	Tone
0	Octave 2	C	Do
1		C#	Do#
2		D	Re
3		D#	Re#
4		E	Mi
5		F	Fa
6		F#	Fa#
7		G	Sol
8		G#	Sol#
9		A	La
10		A#	La#
11		B	Si
12	Octave 3	C	Do
13		C#	Do#
14		D	Re
15		D#	Re#
16		E	Mi
17		F	Fa
18		F#	Fa#
19		G	Sol
20		G#	Sol#
21		A	La
22		A#	La#
23		B	Si
24	Octave 4	C	Do
25		C#	Do#
26		D	Re
27		D#	Re#
28		E	Mi
29		F	Fa
30		F#	Fa#
31		G	Sol
32		G#	Sol#
33		A	La
34		A#	La#
35		B	Si
36	Octave 5	C	Do
37		C#	Do#
38		D	Re
39		D#	Re#
40		E	Mi
41		F	Fa
42		F#	Fa#
43		G	Sol
44		G#	Sol#
45		A	La
46		A#	La#
47		B	Si
48	Octave 6	C	Do
49		C#	Do#

50		D	Re
51		D#	Re#
52		E	Mi
53		F	Fa
54		F#	Fa#
55		G	Sol
56		G#	Sol#
57		A	La
58		A#	La#
59		B	Si
60	Octave 7	C	Do
61		C#	Do#
62		D	Re
63		D#	Re#

[Joint Trim Setting]



[Joint Trim Window]



Select desired actuator (servo) in this window.

Adjust offset value of selected servo. Values of ALL steps in selected motion will be changed according to offset value.


Increase Offset value by 1. Can be increased up to 511.


Decrease Offset value by 1. Can be decreased up to -511.

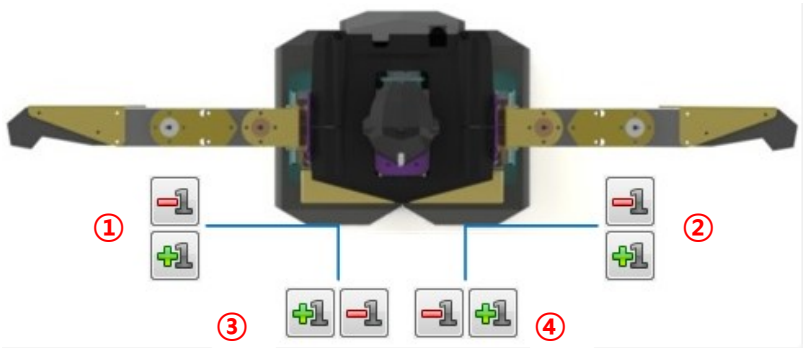

Change Offset value to “0”

Adjust Scale value of selected servo. Scale value based on Offset value will be applied.


Increase Scale value by 0.01. Can be increased up to 1.5.


Decrease Scale value by 0.01. Can be decreased up to 0.50.


Change Scale value to “1.00”



① Center of gravity Front/Rear Adjustment (Right side)

Increase Offset value of ID2 by 1, Decrease offset value of ID4 by 1.

Decrease Offset value of ID2 by “1”, increase offset value of ID4 by “1”

② Center of gravity Front/Rear Adjustment (Left Side)

Increase Offset value of ID8 by 1, Decrease offset value of ID10 by 1.

Decrease Offset value of ID8 by “1”, increase offset value of ID10 by “1”.

③ Center of gravity Left/Right Adjustment (Right side)

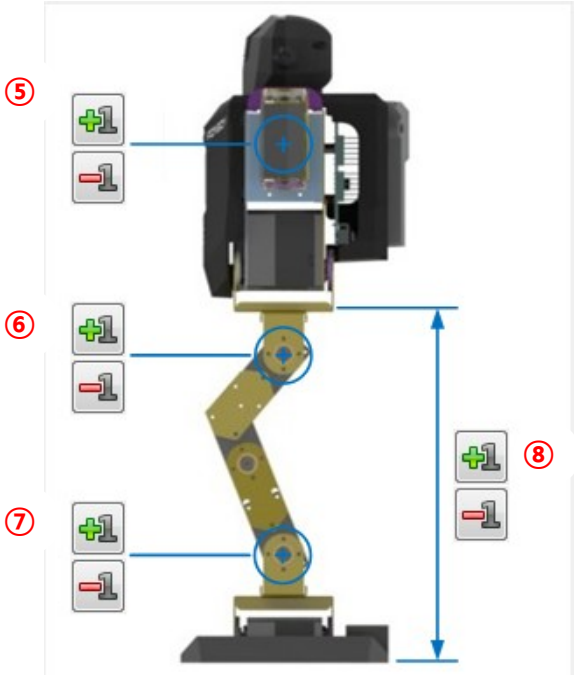
Increase Offset value of ID1 by 1, Decrease offset value of ID5 by 1.

Decrease Offset value of ID1 by “1”, increase offset value of ID5 by “1”.

④ Center of gravity Left/Right Adjustment (Left side)

Increase Offset value of ID7 by 1, Decrease offset value of ID11 by 1.

Decrease Offset value of ID7 by “1”, increase offset value of ID11 by “1”



⑤ Both arm's Front/Rear Adjustment

Increase Offset value of ID12 by 1, Decrease offset value of ID17 by 1.

Decrease Offset value of ID12 by “1”, increase offset value of ID17 by “1”

⑥ Thigh Front/Rear Adjustment

Increase Offset value of ID2 by 1, Decrease offset value of ID8 by 1.

Decrease Offset value of ID2 by “1”, increase offset value of ID8 by “1”

⑦ Ankle Front/Rear Adjustment

Increase Offset value of ID4 by 1, Decrease offset value of

ID10 by 1.

 Decrease Offset value of ID4 by “1”, increase offset value of ID10 by “1”

⑧ Leg length Adjustment

 Increase Offset value of ID3, ID9 by 2, Decrease offset value of ID2, ID4, ID8, ID10 by 1.

 Decrease Offset value of ID3, ID9 by “2”, increase offset value of ID2, ID4, ID8, ID10 by “1”

[Motion Library Chart]

※ Fine tuning for Motion number 100~121 will be done at factory. For other 80 motions in library, if necessary, user may do fine-tuning according to each robot's mechanical condition

※ "L" denotes "Left" and "R" denotes "Right" in the chart

Motion number	Motion Description
100	Walk Forward
101	Turn L
102	Turn R
103	Walk Backward
104	Side Step L
105	Side Step R
106	Stand
107	Sit Down
108	Get Up Forward
109	Get Up Backward
110	Body Side Tilt
111	Provoke
112	Pushup
113	Side Kick L
114	Side Kick R
115	Celebrate the Victory
116	Bow Down
117	Arm Whirl
118	Clap
119	Greet with Wave
120	Wing Flap L
121	Wing Flap R
122	Side Tumbling L
123	Side Tumbling R

124	Front Punch
125	Side Punch L
126	Side Punch R
127	Rear Attack
128	One Step Forward
129	One Step Backward
130	Step Forward Punch
131	Front Tumbling
132	Back Tumbling
133	Arm Wave
134	Butterfly
135	Side Move Punch L
136	Side Move Punch R
137	Large Step Turn L
138	Large Step Turn R
139	Front Lift Attack
140	Side Lift Attack L
141	Side Lift Attack R
142	Back Drop Attack
143	Sit Side Move L
144	Sit Side Move R
145	Sit Front Attack
146	Sit Side Attack L
147	Sit Side Attack R
148	Sit Around Attack
149	Stomping Move Forward
150	Stomping Turn L
151	Stomping Turn R

152	Stomping Move Backward
153	Ball Tackle Front
154	Ball Front Kick L
155	Ball Front Kick R
156	Ball Heel Kick
157	Ball Side Kick L
158	Ball Side Kick R
159	Stomping Move Attack
160	Jump
161	Lie Face Down
162	Lie Face Up
163	Hold and Topple Attack L
164	Hold and Topple Attack R
165	Rise Up From Face Down
166	Crawl Forward
167	Crawl Side L
168	Crawl Side R
169	Crawl Backward
170	Crawl and Rise Up
171	Keeper Stance
172	Keeper Front Block
173	Keeper Side Block L
174	Keeper Side Block R
175	Keeper Ball Kick
176	Keeper Low Block
177	Breathe Action
178	One Leg Squat L
179	One Leg Squat R

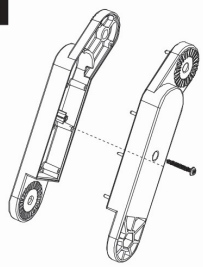
180	Dance KPOP 1
181	Dance KPOP 2
182	Dance KPOP 3
183	Dance KPOP 4
184	Dance KPOP 5
185	Dance KPOP 6
186	Dance KPOP 7
187	Dance KPOP 8
188	Dance KPOP 9
189	Heart
190	Tiptoe Move Forward
191	Tiptoe Turn L
192	Tiptoe Turn R
193	Tiptoe Move Backward
194	Flying Stand Up
195	Large Side Step L
196	Large Side Step R
197	Flying Sit Down
198	Large Step Forward
199	Large Step Backward

[Robot Stand Assembly]

IR-RS01 [IRONBOY ROBOT STAND] Assembly

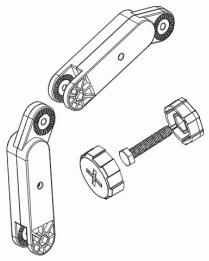
IR ROBOT Imagination & Realization

1



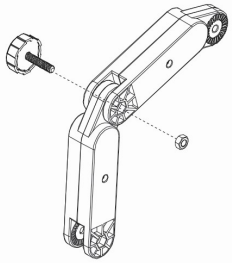
Assemble left and right arm
왼쪽, 오른쪽 Stand Arm을 조립하십시오.(2개)

2



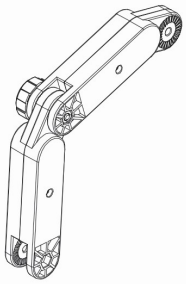
Join two arms together.
조립된 두 개의 Stand Arm을 연결하십시오.

3

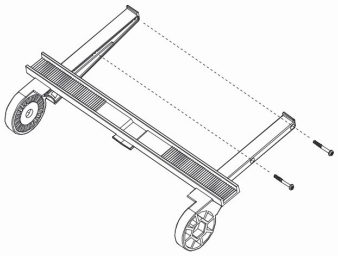


Use screw and nut to fasten the arms.
스크류와 너트를 이용하여 원하는 위치에 Arm을 고정하십시오.

4

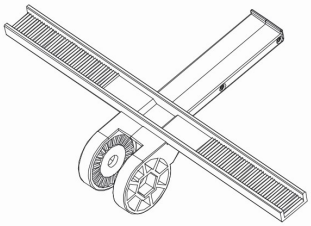


5

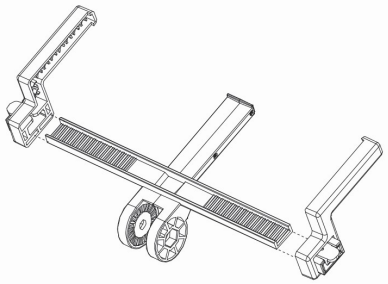


Assemble the hinge as shown in the picture.
로봇 거치 힌지를 조립하십시오.

6

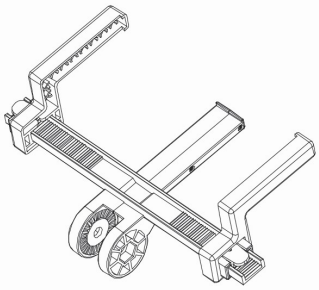


7

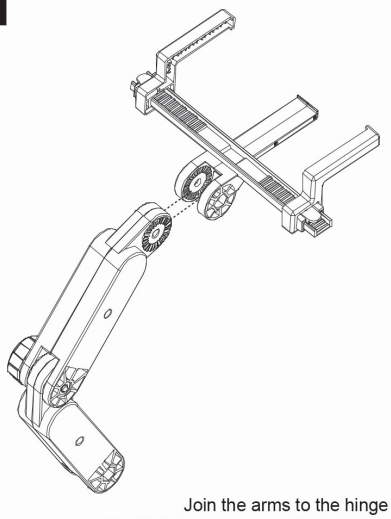


Insert hooks to the hinge
Hook를 힌지 양쪽에 끼워주십시오.

8

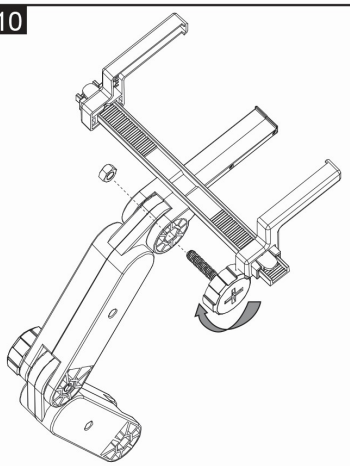


9

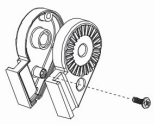


Join the arms to the hinge
조립된 힌지를 stand arm과 결합해 주십시오.

10

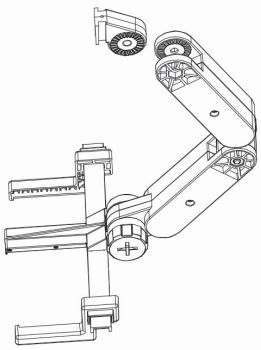


11



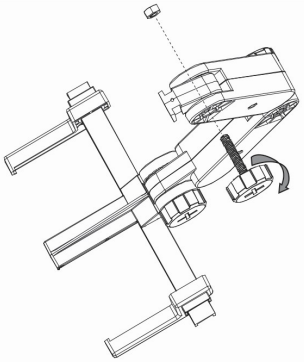
Put these parts together.
본 파트를 조립하십시오.

12



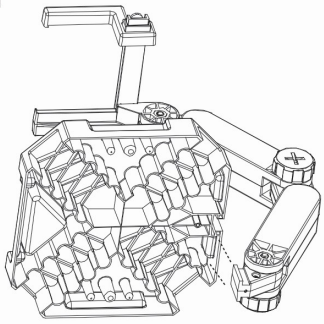
Assemble #11 to the bottom part of #10
11번의 조립된 부품을 10번 조립품의 하단에 결합하십시오.

13



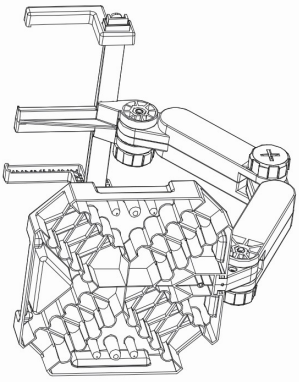
Use screw and nut to fasten the arms.
스크류와 너트를 이용하여 고정하여 주십시오.

14

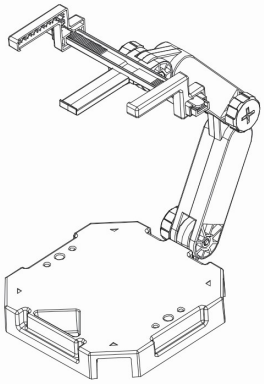


Fasten #13 to the base of the robot stand.
13번 조립품을 스탠드 베이스에 끼워 주십시오.

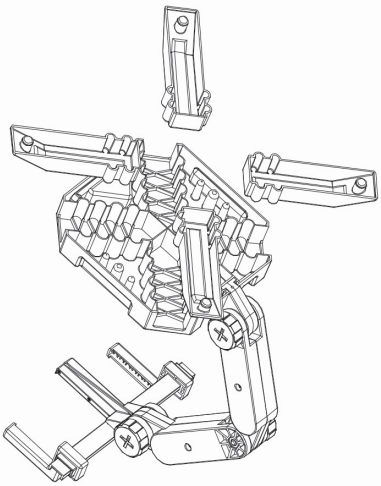
15



16

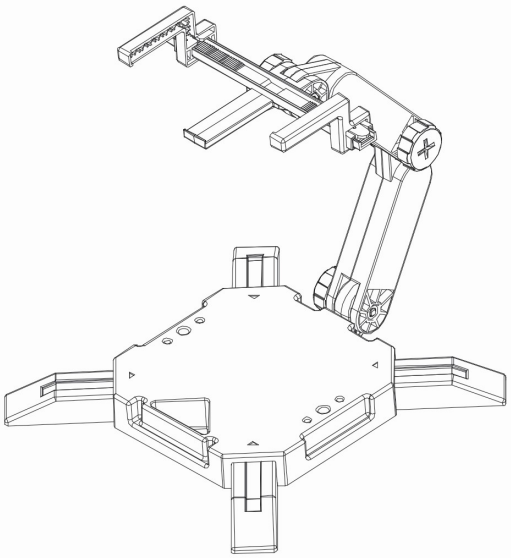


17



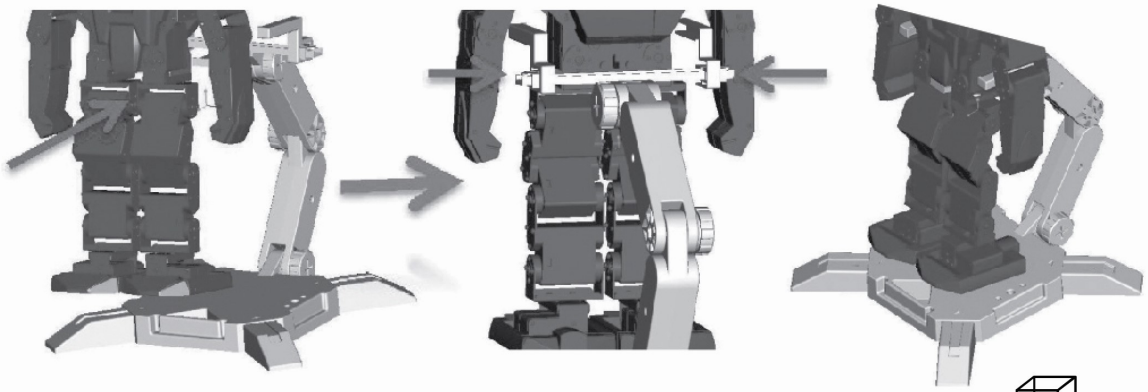
Place the legs to the bottom of the base properly. The length of legs is variable.
스탠드 베이스에 4개의 지지대를 적절히 끼워주십시오. 지지대의 길이는 가변형입니다.

18



Place IRONBOY on the hinge
그림과 같이 힌지부에 로봇을 거치합니다.

Adjust the hooks to secure the robot
후크를 이용하여 로봇을 단단히 고정합니다.



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