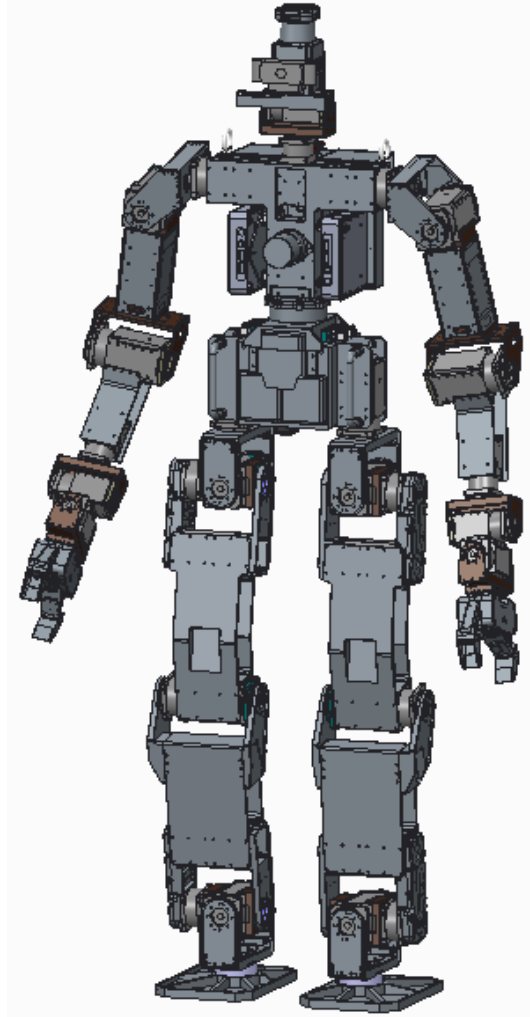


# THORMANG 3.0

## Quick Start





# Table of Contents



## 1. Introduction

1. Package Contents
2. Robot Layout
3. Charging the Battery

## 2. Basic Operation

1. System Configuration
2. Powering THORMANG
3. Running the Basic Program
4. Powering Off THORMANG

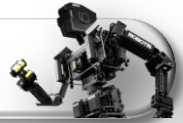
## 3. Miscellaneous

1. System Block Diagram
2. ID Map

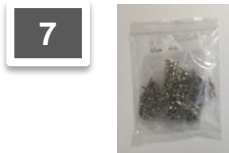
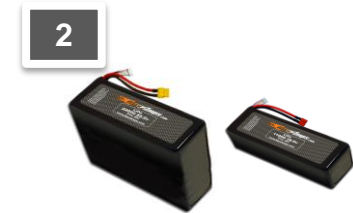
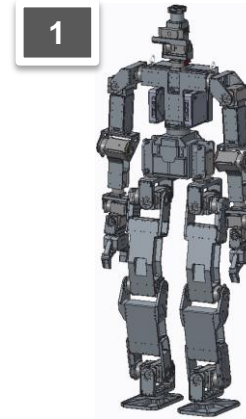
# **1. Introduction**



# 1. Package Contents

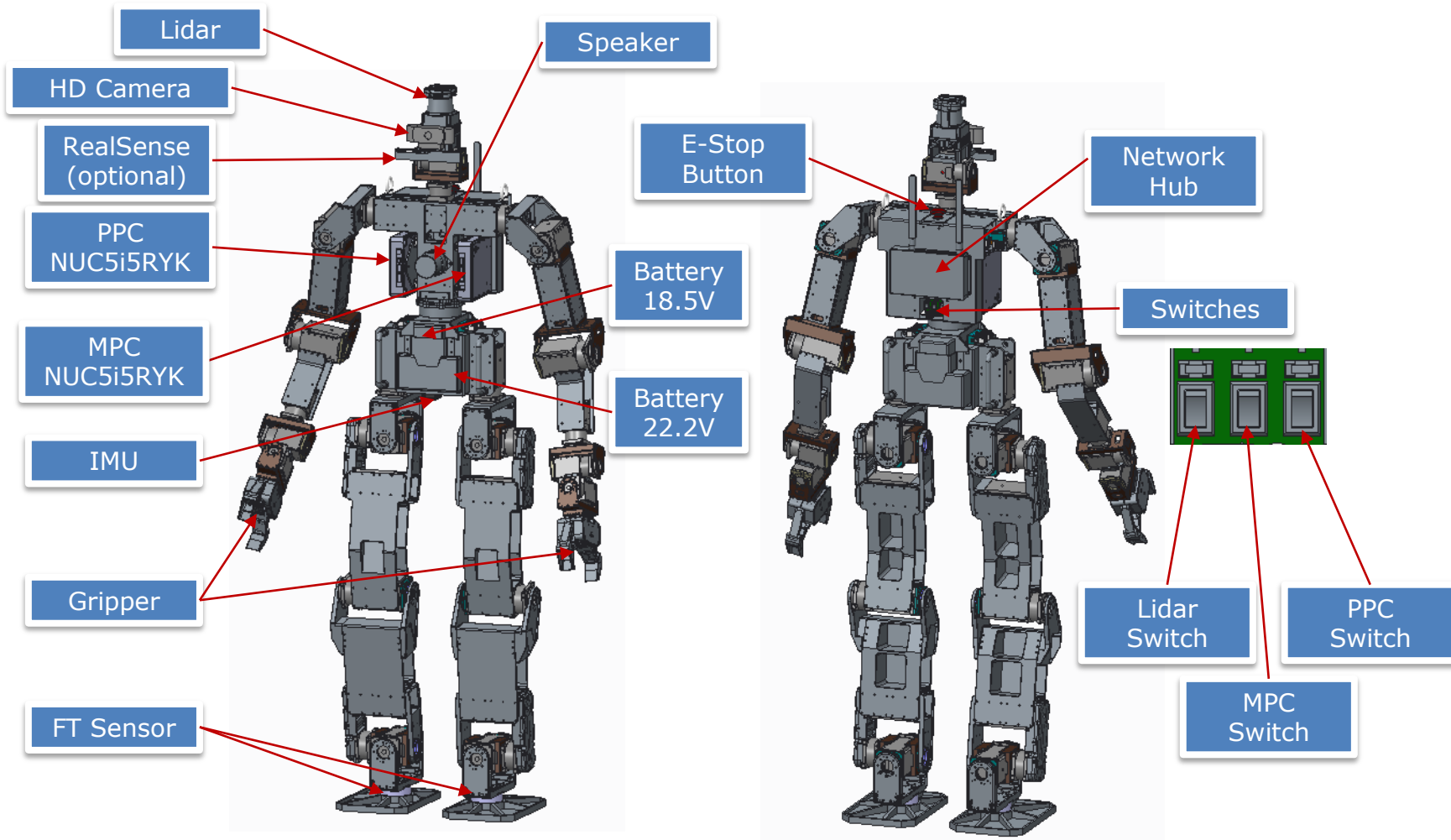


- |    |                                   |     |
|----|-----------------------------------|-----|
| 1. | Fully Assembled THORMANG Robot    | X 1 |
| 2. | Battery Packs (included in robot) | X 1 |
| 3. | Battery Charger                   | X 1 |
| 4. | Wrench Set                        | X 1 |
| 5. | Screwdrivers                      | X 2 |
| 6. | Spare Cables                      |     |
| 7. | Spare Nuts and Bolts              |     |
| 8. | Quick Start Manual                | X 1 |
| 9. | Pelican Case                      | X 3 |



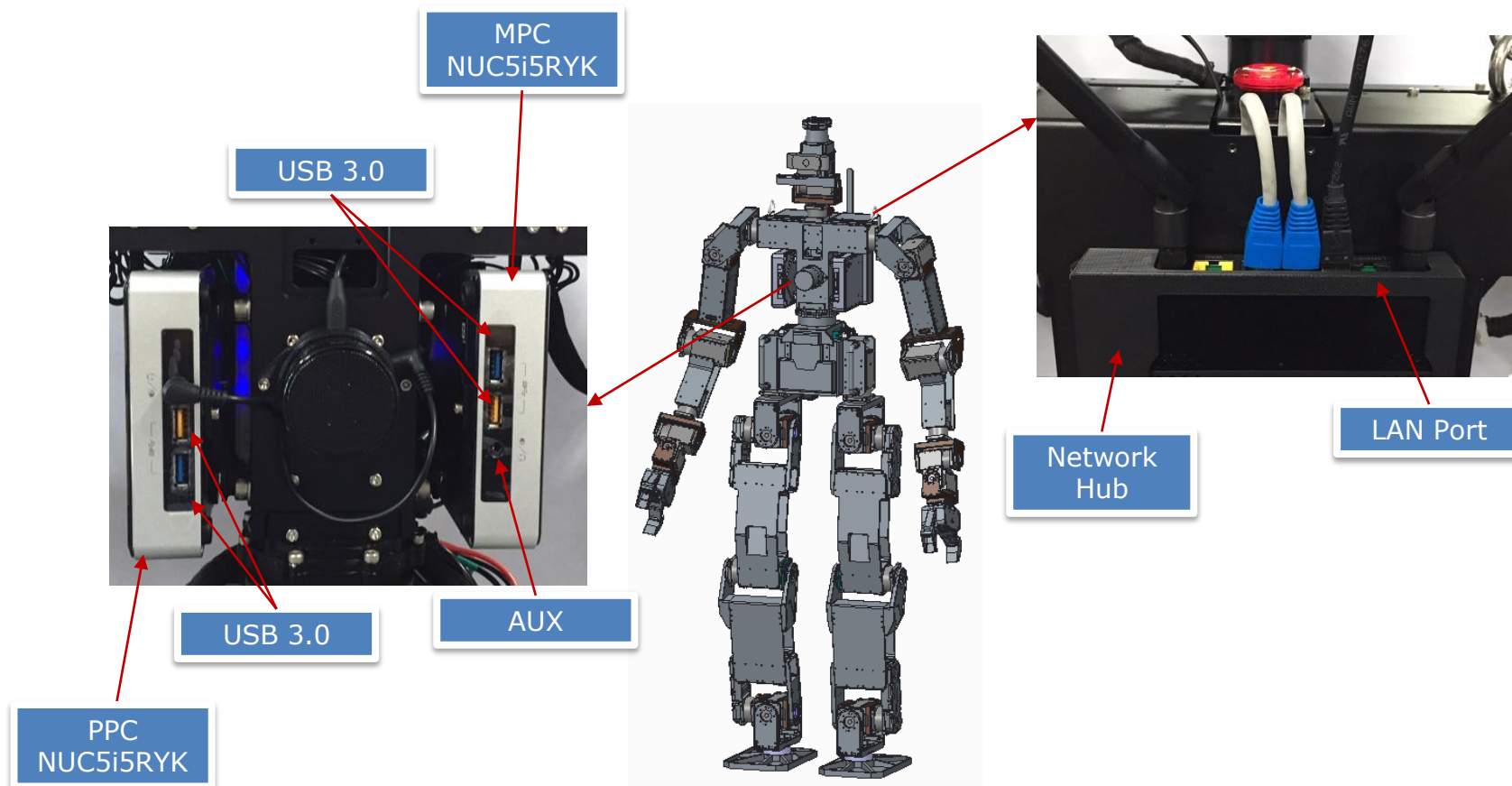


## 2. Robot Layout (1)



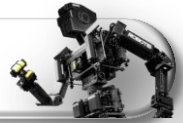


## 2. Robot Layout (2)





# 3. Charging the Battery (1)

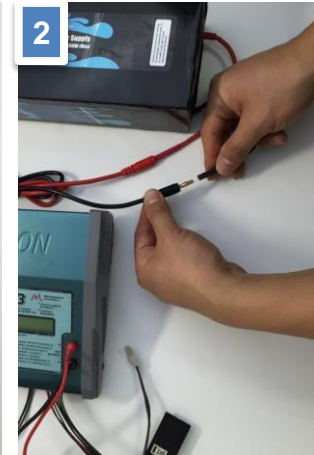


## 1. Connect all cables to the battery charger

- a) Channel 1 has a white terminal
- b) Connect the yellow jack to channel 2

## 2. Connect the DC power supply to the battery charger.

## 3. Connect the power supply's AC adapter to outlet



## 4. Match the settings with the image to the right by pressing the buttons on the charger.



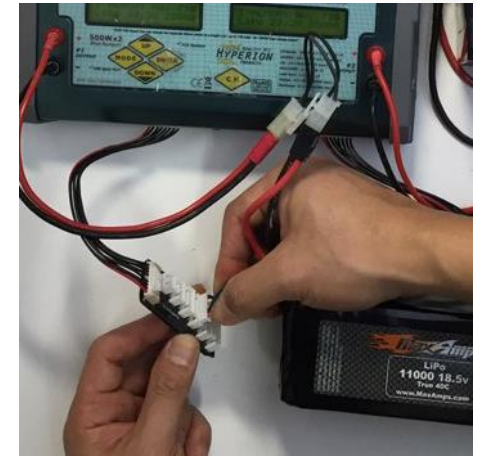




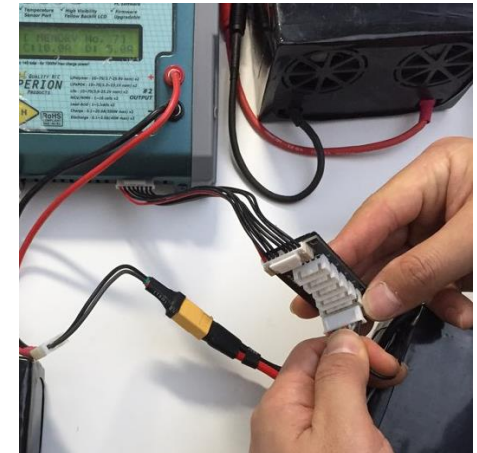
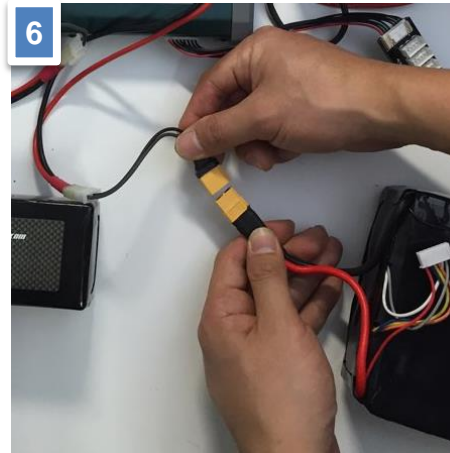
## 3. Charging the Battery (2)



5. Connect the charging cable's male connector (white terminal) to the battery's female connector. Then, connect the battery's balance cable to the 5-cell balance socket (6 pins).



6. Connect the charging cable's male connector (yellow jack) to the battery's female connector. Then, connect the battery's balance cable to the 6-cell balance socket (7 pins).



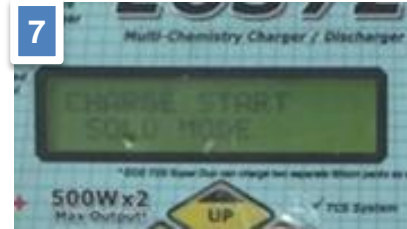




### 3. Charging the Battery (3)



7. Hold down the Enter button in channel 1.  
Press once more in solo mode.  
Press once more after confirming the cell.



8. Repeat step 7 for channel 2.



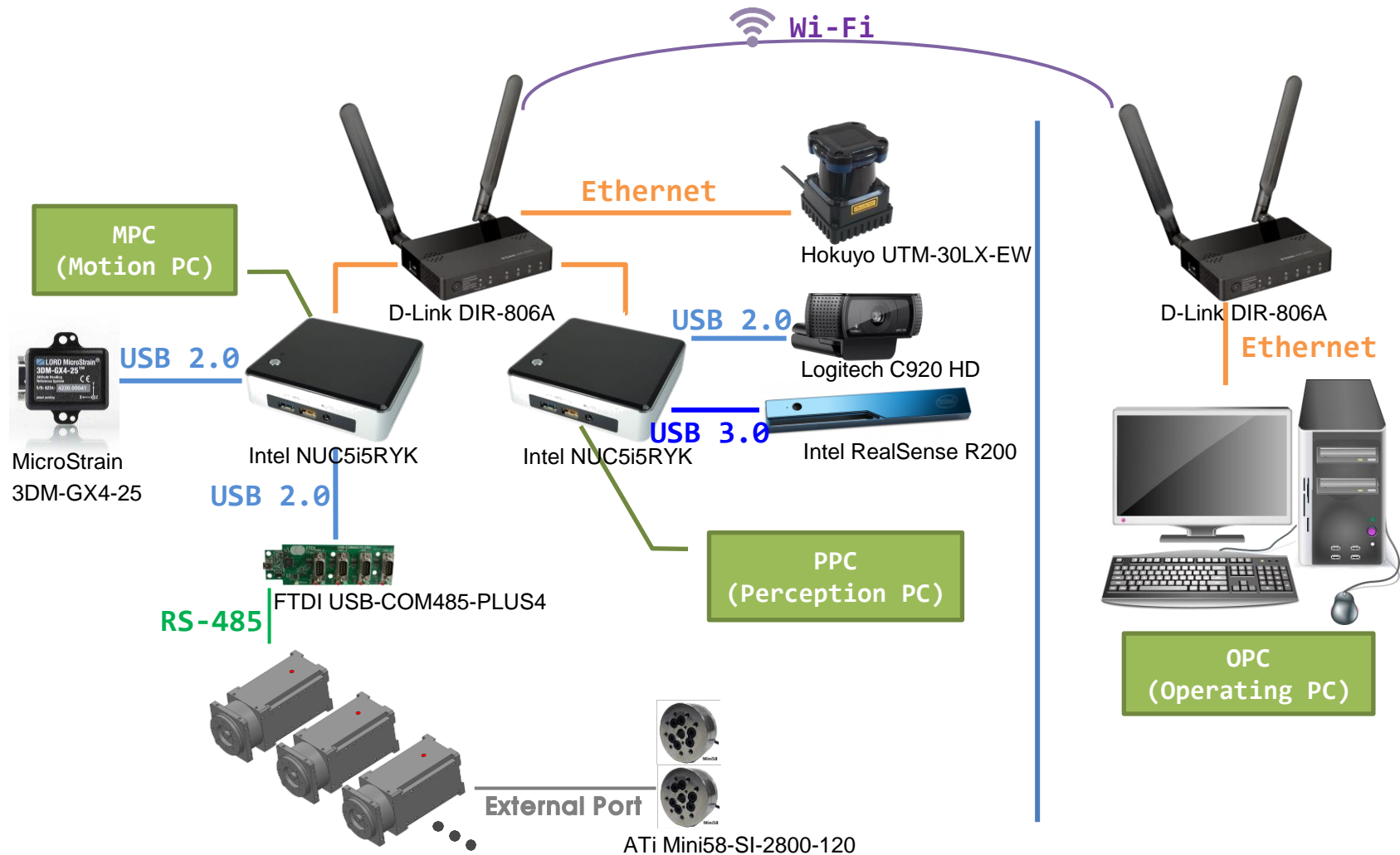
9. Melody sounds when the battery is fully charged. Press the Enter gives each plug pulled

❖ Each channel can be charged independently.

## **2. Basic Operation**



# 1. System Configuration





## 2. Powering THORMANG (1)

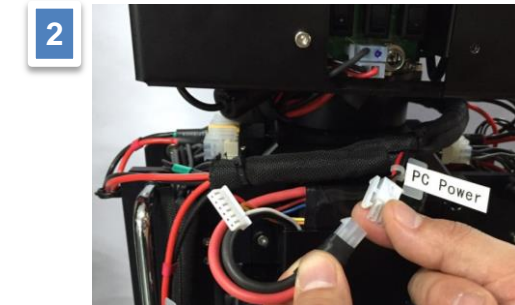


1. Hang THORMANG on lift. Lift THORMANG's feet off the ground.



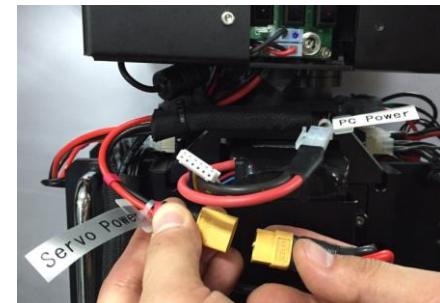
2. Using the Power Supply

- b) Connect the power supply (18V, > 10A) to the PC Power cable to provide power to the PCs.
- c) Connect the power supply (24V, >30A) to the Servo Power cable to provide power to the actuators.



3. Using the Battery Packs

- a) Ensure the batteries are fully charged.
- b) Open the battery compartment door by loosening the thumbscrew. Insert the battery packs. Close the compartment by tightening the thumbscrew.
- c) Connect the 22.2V battery's cable (yellow jack) to Servo Power and connect the 18.5V battery's cable (white terminal) to PC Power

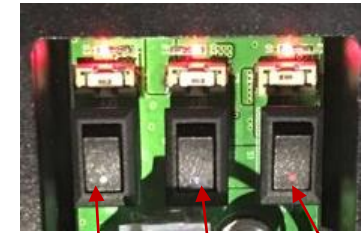
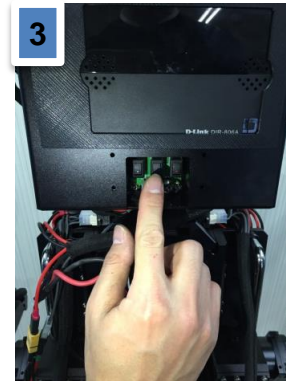




## 2. Powering THORMANG (2)



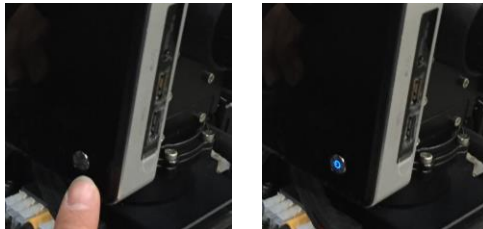
3. First, flip the three switch located on the power board (Lidar, MPC, PPC). Then push the MPC and PPC power buttons.



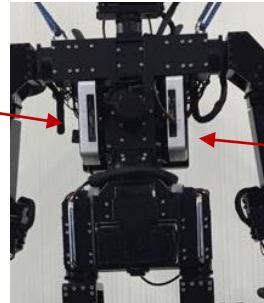
Lidar  
Switch

PPC  
Switch

MPC  
Switch



PPC Power Button



MPC Power Button

4. Turn the E-Stop Button.

❖ If the E-Stop Button is pressed, the DXL power is turned off.





## 3. Running the Basic Program (1)



### 1. Connecting THORMANG to your PC

From your computer go to your LAN settings and set static IP as follows:  
10.17.3.xxx

- Connection Information
  - 1) MPC (Motion PC) IP : **10.17.3.30**
  - 2) PPC (Perception PC) IP : **10.17.3.35**
  - 3) MPC & PPC User Name : **robotis**
  - 4) MPC & PPC Password : **111111**



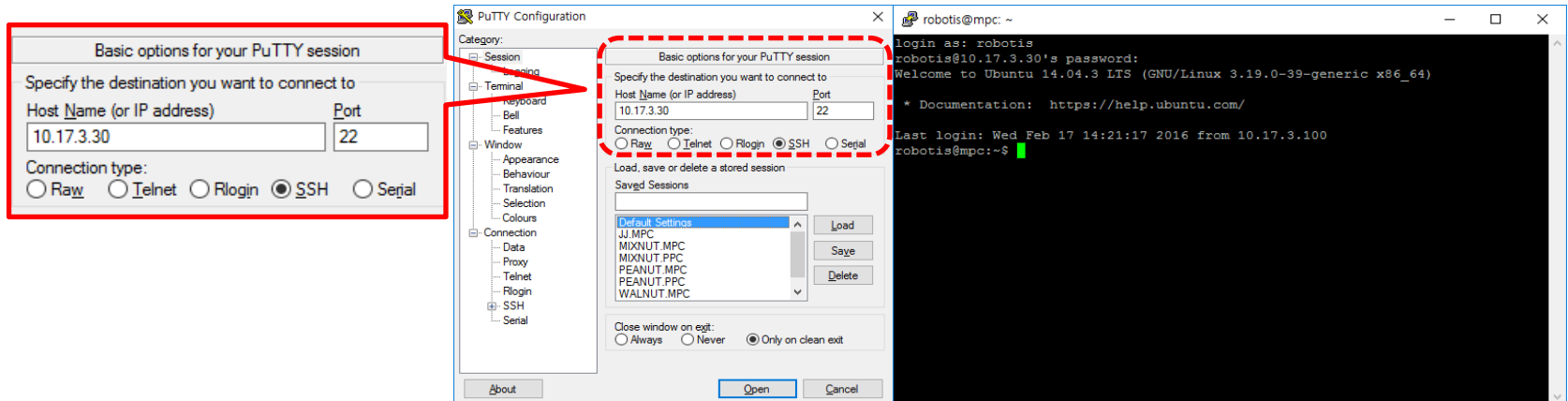


## 3. Running the Basic Program (2)



ROBOTIS recommends that users connect via an SSH client

- Example: Windows SSH Client
  - 1) Execute SSH client program (e.g. PuTTY)
  - 2) Input the MPC's IP address : **10.17.3.30**
  - 3) Select **SSH** as a connection type and then click Open.
  - 4) Input the MPC's user name : **robotis**
  - 5) Input the MPC's password : **111111**





## 3. Running the Basic Program (2)



- Example: Ubuntu SSH Client
  - 1) Open the terminal window
  - 2) Type the following SSH command utilizing the MPC's user name and IP address :  
`$ ssh -l robotis 10.17.3.30`
  - 3) Input the MPC's password : `111111`

```
robotis@mpc: ~  
thor@thor-OPC:~$ ssh -l robotis 10.17.3.30  
robotis@10.17.3.30's password:  
Welcome to Ubuntu 14.04.3 LTS (GNU/Linux 3.19.0-39-generic x86_64)  
  
* Documentation:  https://help.ubuntu.com/  
  
545 packages can be updated.  
150 updates are security updates.  
  
Last login: Wed Feb 17 13:31:15 2016 from 10.17.3.110  
robotis@mpc:~$
```

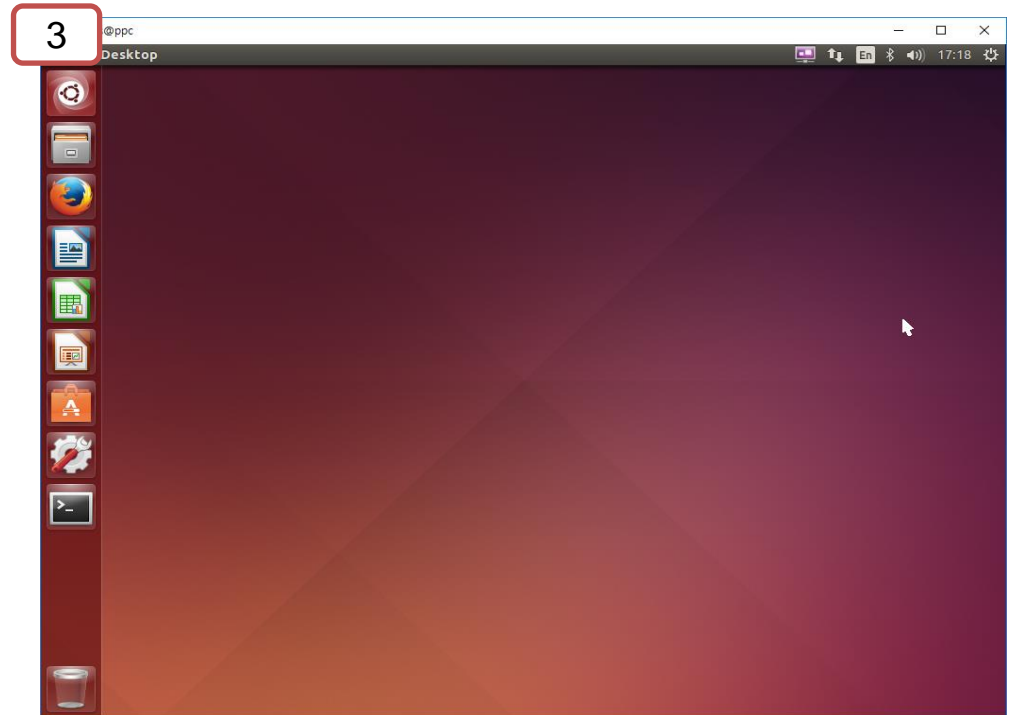
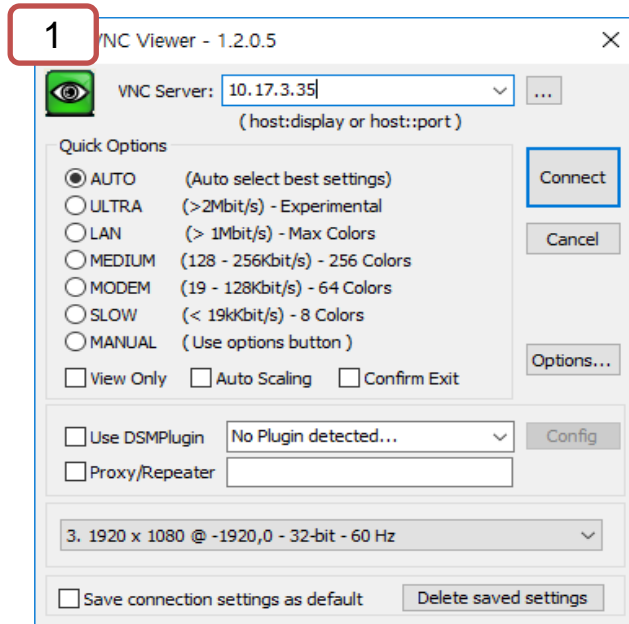


# 3. Running the Basic Program (3)



Accessing the MPC via remote desktop may result in slower performance.

- Example: Windows VNC client
  - 1) Execute VNC client program (e.g. Ultra VNC Viewer)
  - 2) Input the MPC's IP address : **10.17.3.30**
  - 3) Input the MPC's password : **111111**





# 3. Running the Basic Program (3)



## 2. Running roscore and THORMANG3 Manager

### 1. roscore

**roscore** is a collection of nodes and programs that are prerequisites of a ROS-based system. You **must** have **roscore** running in order for ROS nodes to communicate. It is launched using the **roscore** command.

**NOTE:** If you use roslaunch, it will automatically run **roscore** if it is not already running.

- Connect to the PPC via SSH client program. (IP: **10.17.3.35**)
- **roscore** can be launched using the **roscore** executable:  
`$ roscore`

### 2. THORMANG3 Manager

**thormang3\_manager** is a base node using ROBOTIS' framework. **thormang3\_manager** must be running before you can run the Simple Demo nodes and before you can check the sensors because they are using **thormang3\_manager**.

- Connect to the MPC via SSH client program. (IP: **10.17.3.30**)
- To launch THORMANG3 Manager, simply type the following :  
`$ sudo bash`  
`# roslaunch thormang3_manager thormang3_manager.launch`



## 3. Running the Basic Program (4)



### 3. Running the Simple Demo Programs and Checking the Sensors

#### 1. Manipulation Simple Demo

- Manipulation Control Module allows for two kinds of control :
  - Joint Space Control
  - Task Space Control
- Connect to the PPC via SSH client program. (IP: **10.17.3.35**)
- Execute the Manipulation Simple Demo by typing the following command :  
`$ rosrn thormang3_manipulation_demo thormang3_manipulation_demo`
- These commands should be executed in new terminal.
  - 1) **Initialization 1** : go to initial pose (from Base Module)  
`$ rostopic pub -1 /robotis/manipulation_demo/command std_msgs/String "ini_pose"`
  - 2) **Initialization 2** : set Manipulation Control Module  
`$ rostopic pub -1 /robotis/manipulation_demo/command std_msgs/String "set_mode"`
  - 3) **demo 3** : go to manipulation base pose – **Joint Space Control**  
`$ rostopic pub -1 /robotis/manipulation_demo/command std_msgs/String "base_pose"`
  - 4) **demo 4** : move right arm (torso joint is not included) – **Task Space Control**  
`$ rostopic pub -1 /robotis/manipulation_demo/command std_msgs/String "right_arm"`
  - 5) **demo 5** : move left arm (torso joint is not included) – **Task Space Control**  
`$ rostopic pub -1 /robotis/manipulation_demo/command std_msgs/String "left_arm"`



### 3. Running the Basic Program (5)



In terminal, you can confirm successful demo execution by comparing your screen output to the following:

```
thor@SIM-PC:~$ rosrun thormang3_manipulation_demo thormang3_manipulation_demo
[ INFO] [1456273852.518346294]: Robotis Thormang3 Manipulation Simple Demo
[ INFO] [1456273858.108976598, 1877.168000000]: demo 1: go to initial pose
[ INFO] [1456273929.708964751, 1946.535000000]: demo 2: set manipulation control mode
[ INFO] [1456273935.924793739, 1952.625000000]: demo 3: go to manipulation base pose
[ INFO] [1456273943.555563594, 1960.293000000]: demo 4: move right arm
[ INFO] [1456273949.728911625, 1966.374000000]: demo 5: move left arm
```





### 3. Running the Basic Program (6)



Manipulation Simple Demo Video





## 3. Running the Basic Program (7)



### 2. Walking Simple Demo

- Walking Module provides two kinds of functions
  - One step forward/backward walking
  - Balance ON/OFF : All balance parameter will be loaded from "data/balance\_param.yaml"
- Connect to the PPC via SSH client program. (IP: **10.17.3.35**)
- Execute the Walking Simple Demo by typing the following command :  
`$ rosrun thormang3_walking_demo thormang3_walking_demo`
- These commands should be executed in new terminal.
  - 1) **Initialization 1** : go to initial pose (from Base Module)  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "ini_pose"`
  - 2) **Initialization 2** : set Walking Control Module  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "set_mode"`
  - 3) **demo 3** : make balance algorithm enable/disable – **Balance ON / OFF**  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "balance_on"`  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "balance_off"`
  - 4) **demo 4** : walk forward – **One step forward walking**  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "forward"`
  - 5) **demo 5** : walk backward – **One step backward walking**  
`$ rostopic pub -1 /robotis/walking_demo/command std_msgs/String "backward"`



### 3. Running the Basic Program (8)



In terminal, you can confirm successful demo execution by comparing your screen output to the following:

```
robotis@mpc:~$ rosrn thormang3_walking_demo thormang3_walking_demo_node
[ INFO] [1455875066.217024182]: [Demo] : receive [ini_pose] msg
[ INFO] [1455875066.217090233]: [Demo] : go to initial pose
[ INFO] [1455875066.217208610]: [Demo] : please wait 5 seconds
[ INFO] [1455875075.729093836]: [Demo] : receive [set_mode] msg
[ INFO] [1455875075.729155435]: [Demo] : set walking control mode
[ INFO] [1455875075.731306347]: [Robot] : Walking_Module_is_enabled
[ INFO] [1455875085.883878337]: [Demo] : receive [balance_on] msg
[ INFO] [1455875085.883942699]: [Demo] : balance enable
[ INFO] [1455875085.890794091]: [Demo] : Succeed to set balance param
[ INFO] [1455875085.890860928]: [Robot] : Balance_Param_Setting_Started
[ INFO] [1455875086.885257816]: [Robot] : Balance_Param_Setting_Finished
[ INFO] [1455875097.554503231]: [Demo] : receive [forward] msg
[ INFO] [1455875097.554568993]: [Demo] : forward walking
[ INFO] [1455875097.562789075]: [Demo] : Succeed to add step data array
[ INFO] [1455875097.563741307]: [Robot] : Walking_Started
[ INFO] [1455875104.660218824]: [Robot] : Walking_Finished
[ INFO] [1455875110.671069684]: [Demo] : receive [backward] msg
[ INFO] [1455875110.671131309]: [Demo] : backward walking
[ INFO] [1455875110.674200761]: [Demo] : Succeed to add step data array
[ INFO] [1455875110.675751408]: [Robot] : Walking_Started
[ INFO] [1455875117.772244468]: [Robot] : Walking_Finished
```



## 3. Running the Basic Program (9)



Walking Simple Demo Video





## 3. Running the Basic Program (10)



### 3. Check the Sensors

- Run the MPC's Sensors (IMU, FT, Lidar)
  - Type the following commands to run the MPC's sensors :

```
$ sudo bash
# roslaunch thormang3_manager thormang3_manager.launch
$ roslaunch robotis_humanoid_description thor_laserscan.launch
```
- How to Check the MPC's Sensors
  - IMU** : Type the following command and check the output :

```
$ rostopic echo /robotis/sensor/imu/imu
```

```
robotis@mpc:~$ rostopic echo /robotis/sensor/imu/imu
header:
  seq: 218798
  stamp:
    secs: 1456227058
    nsecs: 657393447
  frame_id: imu
orientation:
  x: 0.551555931568
  y: 0.831686019897
  z: -0.0350182652473
  w: 0.0534624755383
orientation_covariance: [-1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
angular_velocity:
  x: 0.00529906712472
  y: 0.0256397109479
  z: 0.108881101012
angular_velocity_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
linear_acceleration:
  x: 1.40463167375
  y: 0.0995190255708
  z: 9.7412729802
linear_acceleration_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```



# 3. Running the Basic Program (11)



- How to Check the MPC's Sensors
  - FT Sensor** : Type the following commands and check the output :  
`$ rostopic echo /robotis/sensor/ft_right_foot/raw`  
`$ rostopic echo /robotis/sensor/ft_left_foot/raw`

```
robotis@mpc:~$ rostopic echo /robotis/sensor/ft_right_foot/raw
header:
  seq: 110484
  stamp:
    secs: 1456227469
    nsecs: 577939051
  frame_id: r_leg_foot_link
wrench:
  force:
    x: 5175.13464253
    y: 12796.9383106
    z: 9230.67538064
  torque:
    x: -134.298186423
    y: -234.033554692
    z: -267.399062596
```

```
robotis@mpc:~$ rostopic echo /robotis/sensor/ft_left_foot/raw
header:
  seq: 113669
  stamp:
    secs: 1456227506
    nsecs: 383800602
  frame_id: l_leg_foot_link
wrench:
  force:
    x: 9699.47838375
    y: 5305.99705173
    z: 10538.1527615
  torque:
    x: -243.133327243
    y: -325.658292323
    z: -202.514837491
```





## 3. Running the Basic Program (12)



- How to Check the MPC's Sensors
  - **Lidar** : Type the following command and check the output :

```
$ rostopic echo /robotis/sensor/scan --noarr
```

```
robotis@mpc:~$ rostopic echo /robotis/sensor/scan --noarr
header:
  seq: 403902
  stamp:
    secs: 1456227605
    nsecs: 320116247
  frame_id: lidar_link
angle_min: -2.35619449615
angle_max: 2.35619449615
angle_increment: 0.00436332309619
time_increment: 1.73611151695e-05
scan_time: 0.0250000003725
range_min: 0.02300000000447
range_max: 60.0
---
header:
  seq: 403903
  stamp:
    secs: 1456227605
    nsecs: 350245326
  frame_id: lidar_link
angle_min: -2.35619449615
angle_max: 2.35619449615
angle_increment: 0.00436332309619
time_increment: 1.73611151695e-05
scan_time: 0.0250000003725
range_min: 0.02300000000447
range_max: 60.0
```



### 3. Running the Basic Program (13)



- Run the PPC's Sensors (Web Camera (HD Camera), Depth Camera (RealSense))
  - Type the following command to run PPC's sensors :  
`$ roslaunch thormang3_sensors thormang3_sensors.launch`
- How to Check the PPC's Sensors
  - **Web Camera** : Type the following command and check the output.  
`$ rostopic echo /robotis/sensor/camera/image_raw --noarr`

```
robotis@ppc:~$ rostopic echo /robotis/sensor/camera/image_raw --noarr
header:
  seq: 23
  stamp:
    secs: 1456228631
    nsecs: 803098057
  frame_id: head_p_link
height: 480
width: 640
encoding: rgb8
is_bigendian: 0
step: 1920
---
header:
  seq: 24
  stamp:
    secs: 1456228631
    nsecs: 903091604
  frame_id: head_p_link
height: 480
width: 640
encoding: rgb8
is_bigendian: 0
step: 1920
```



## 3. Running the Basic Program (14)

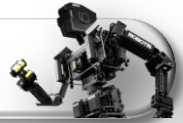


- How to Check the PPC's Sensors
  - **Depth Camera:** Type the following command and check the output.  
`$ rostopic echo /camera/depth/points --noarr`

```
robotis@ppc:~$ rostopic echo /camera/depth/points --noarr
header:
  seq: 10430
  stamp:
    secs: 1456228679
    nsecs: 180915493
  frame_id: camera_depth_optical_frame
height: 360
width: 480
is_bigendian: False
point_step: 32
row_step: 15360
is_dense: True
---
header:
  seq: 10431
  stamp:
    secs: 1456228679
    nsecs: 199269937
  frame_id: camera_depth_optical_frame
height: 360
width: 480
is_bigendian: False
point_step: 32
row_step: 15360
is_dense: True
```



# 3. Running the Basic Program (15)



- How to Check the THORMANG's Sensors in the GUI
  - Refer to Demo or Vision Presentations

The screenshot displays the THORMANG GUI interface. On the left, a 'Displays' panel lists various sensors and their configurations. The 'Depth Camera' is highlighted with a green dashed box. The 'IMU' is highlighted with a yellow dashed box. The 'Lidar' is highlighted with a white dashed box. The 'FT Sensor' is highlighted with a red dashed box. The 'Web Camera' is highlighted with a blue dashed box. The main 3D view shows a robot model with a red cone representing the FT sensor's field of view. The bottom status bar shows ROS Time, ROS Elapsed, Wall Time, and Wall Elapsed.

**Displays Panel:**

- Alpha: 1
- Arrow Scale: 0.005
- Arrow Width: 0.4
- History Length: 10
- WrenchStamped
  - Status: Ok
  - Topic: /robotis/sensor/ft\_right\_foot/scaled
  - Force Color: 204; 51; 51
  - Torque Color: 204; 204; 51
  - Alpha: 1
  - Arrow Scale: 0.005
  - Arrow Width: 0.4
  - History Length: 10
- Imu
  - Status: Ok
  - Topic: /robotis/sensor/imu/imu
  - Color: 204; 51; 204
  - Alpha: 0.2
  - History Length: 1

**Status Bar:**

- ROS Time: 1456231070.07
- ROS Elapsed: 37.27
- Wall Time: 1456231070.11
- Wall Elapsed: 37.24
- Reset
- Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel: Zoom. Shift: More options.
- Experimental
- 30 fps



## 4. Powering Off THORMANG



1. Hang THORMANG on lift. Lift THORMANG's feet off the ground.

- First, shut down the MPC and the PPC by typing the following commands.

- MPC :

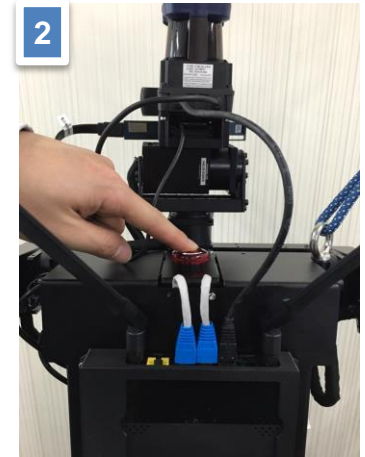
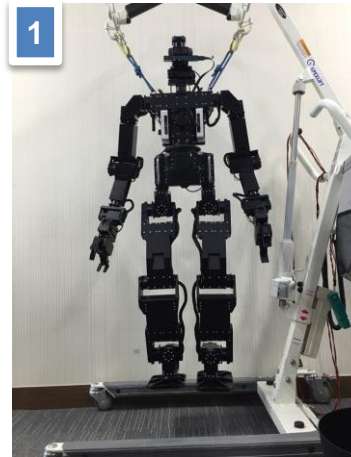
```
$ sudo poweroff
```

- PPC :

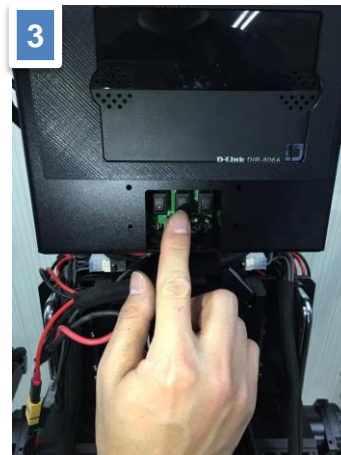
```
$ sudo poweroff
```

- **NOTE:** If P/W is needed, P/W is 111111

2. Press the E-Stop Button to turn off the DXL's power.



3. After confirming that you have shut down the PCs, flip the three switches on the power board.

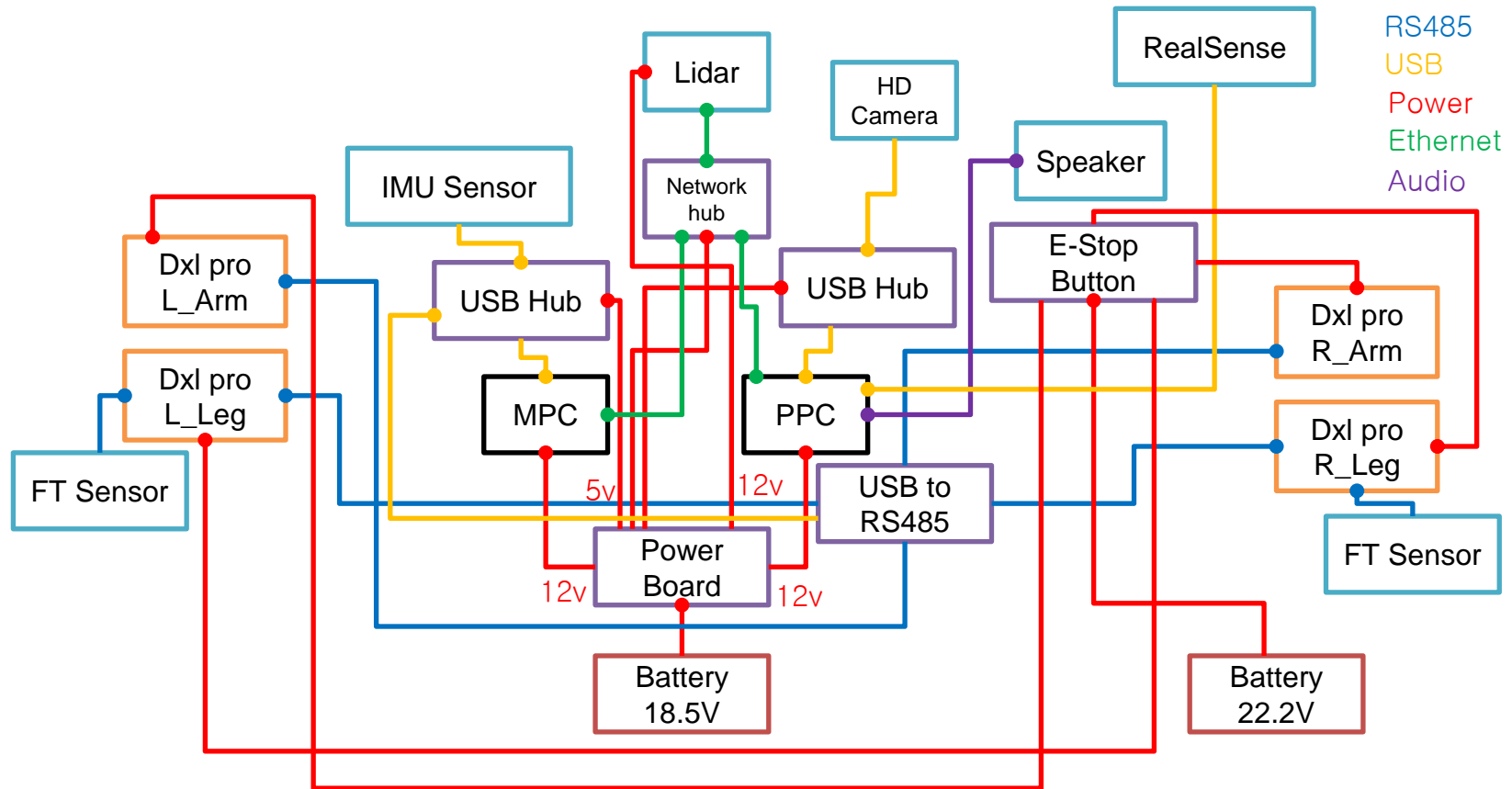


# **3. Miscellaneous**





# 1. System Block Diagram





## 2. Actuator's ID Map

