Intro. to Turtlebot3

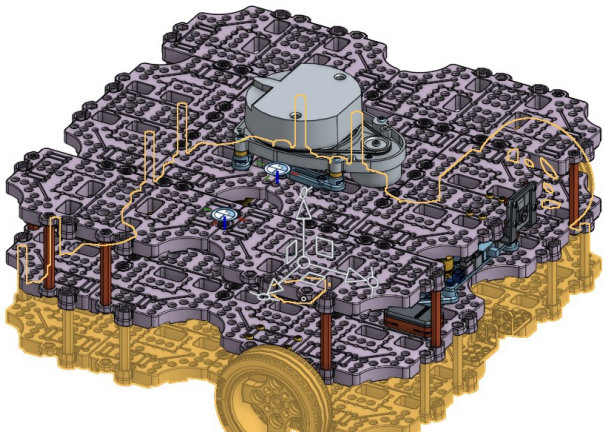
Content

- Environment
  - Windows + VM ware + Ubuntu 20.04 + ROS2 (Foxy)

- Intro to Turtlebot3 Waffle Pi
  - Specifications
  - Components
- Hardware assembly

- Quick start (Software) - Foxy
  - PC setup
  - SBC setup
  - OpenCR Setup
  - Bringup

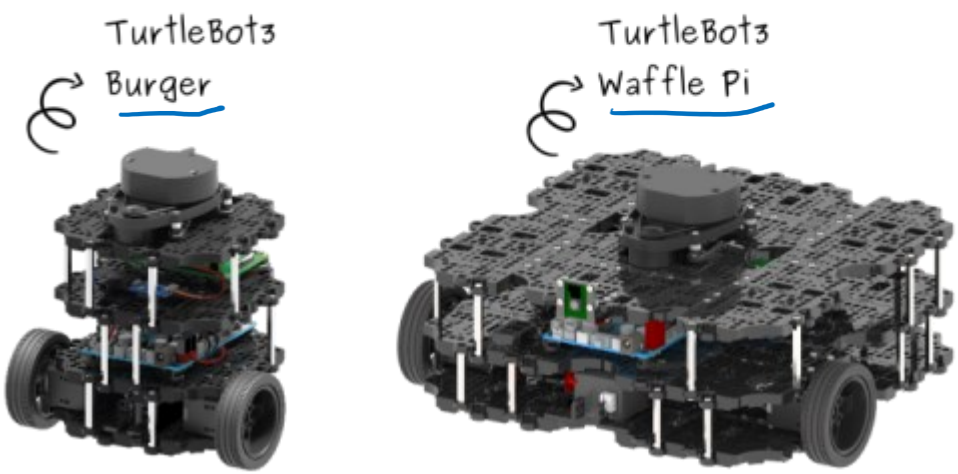
SD card



https://emanual.robotis.com/docs/en/platform/turtlebot3/quick-start/

Robot

- turtlebot 3
-



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turtlebot 3 manual:
https://emanual.robotis.com/docs/en/platform/turtlebot3/overview/#overview

Turtlbbot3

- Features
  - Personal robot kit with open-source software and hardware
  - Burger/waffle
  - Modular, compact and customizable
  - ROS platform

    Robot Operating System.
- Components (Waffle)
  - Single board computer (Raspberry pi)
  - Sensors
    - Laser (LiDAR, laser scanner)
    - Depth/video camera
  - Control board (OpenCR)
  - Actuators – DYNAMIXEL XM series

	Burger	Waffle Pi
Remote Controller	-	RC-100B + BT-410 Set (Bluetooth 4, BLE)
Actuator	XL430-W250	XM430-W210
LDS(Laser Distance Sensor)	360 Laser Distance Sensor LDS-01 or LDS-02	360 Laser Distance Sensor LDS-01 or LDS-02
Camera	-	Raspberry Pi Camera Module v2.1

Turtlebot3: features

WORLD'S MOST POPULAR ROS PLATFORM

TurtleBot is the world's most popular open source robot for education and research.

AFFORDABLE COST

TurtleBot is the most affordable platform for educations and prototype research & developments.

SMALL SIZE

Imagine the TurtleBot in your backpack and bring it anywhere.

EXTENSIBILITY

Extend ideas beyond imagination with various SBC, sensor, motor and flexible structure.

MODULAR ACTUATOR

Easy to assemble, maintain, replace and reconfigure.

OPEN SOURCE SOFTWARE

Variety of open source software for the user.
You can modify downloaded source code and share it with your friends.

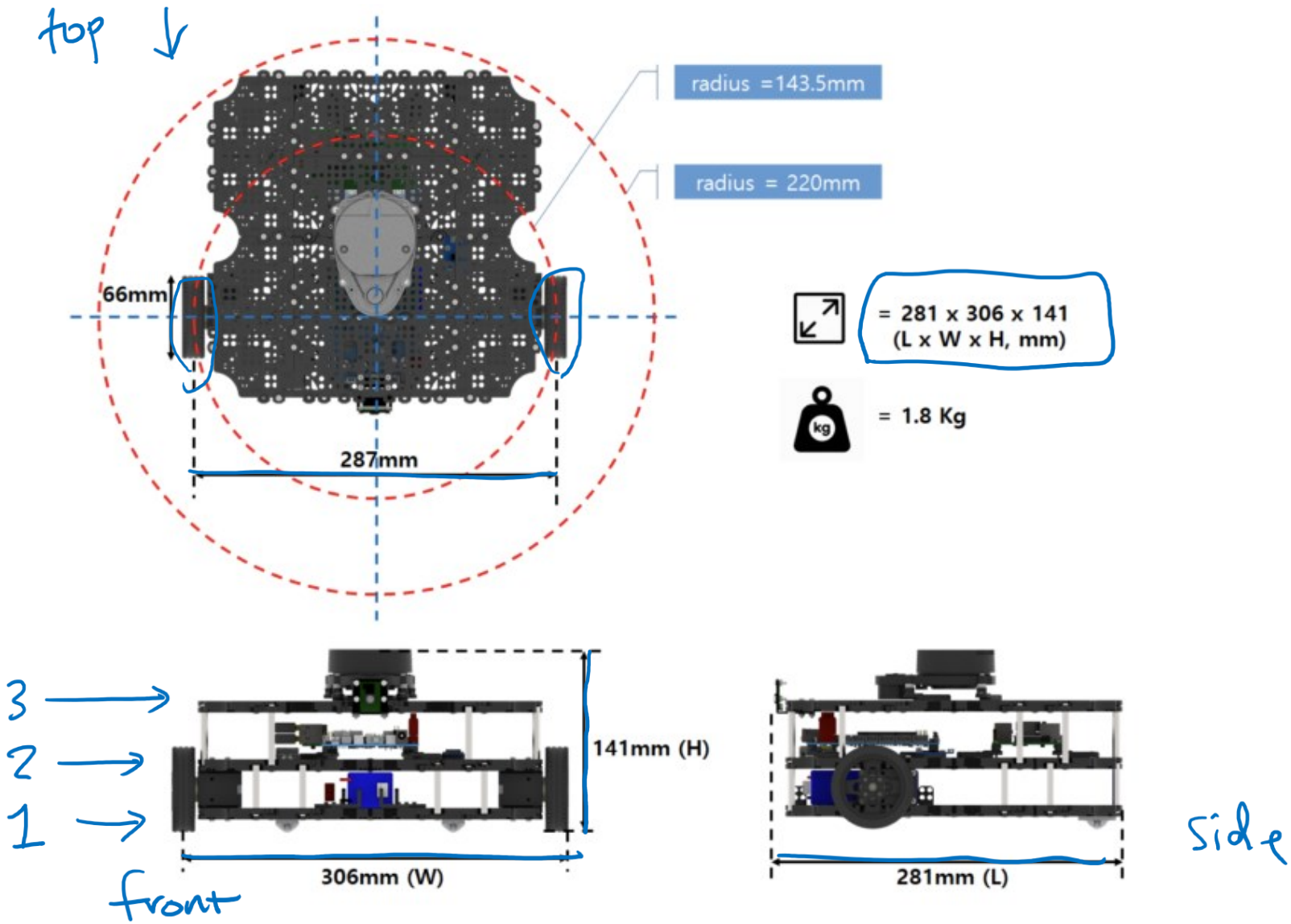
OPEN SOURCE HARDWARE

Schematics, PCB Gerber, BOM and 3D CAD data are fully opened to the user.

STRONG SENSOR LINEUPS

8MP Camera, Enhanced 360° LiDAR,
9-Axis Inertial Measurement Unit and precise encoder for your robot.

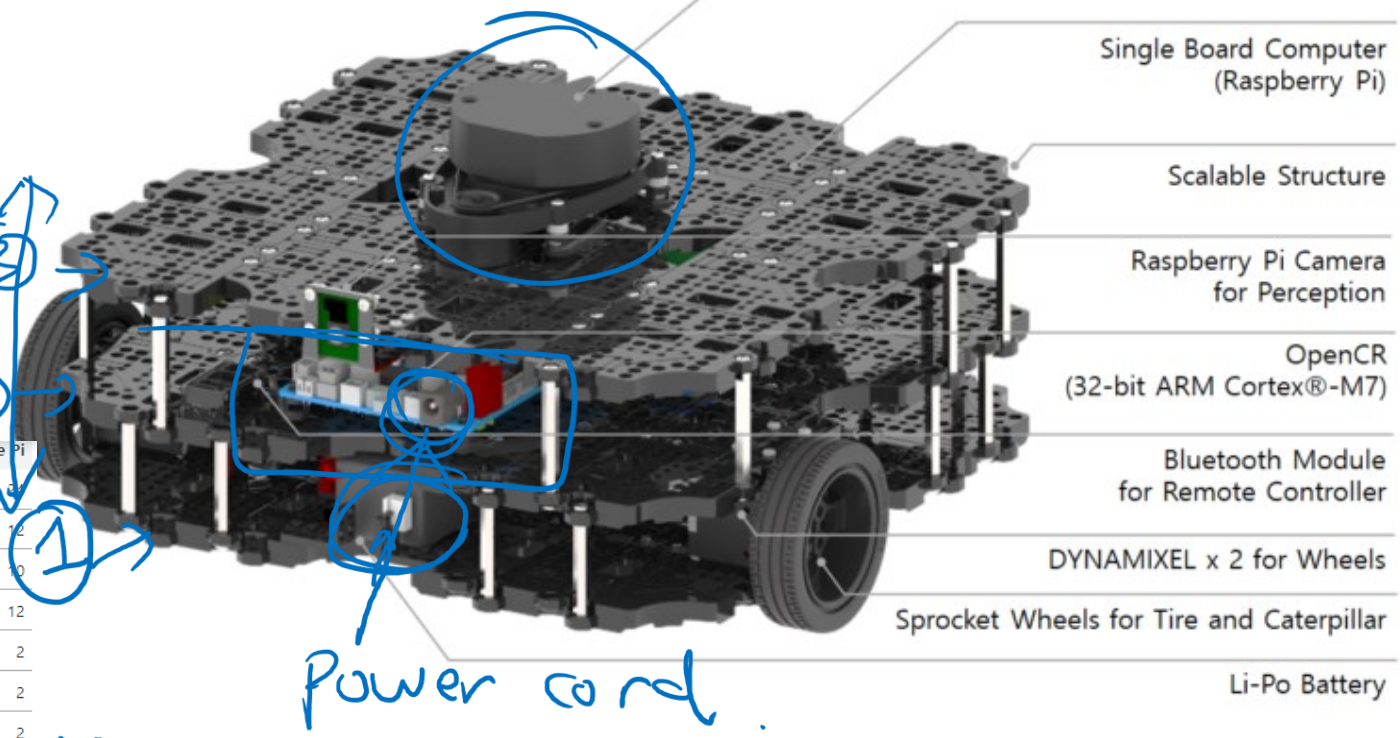
Turtlebot3 Waffle Pi



Components

Light Detection & Ranging

TurtleBot3 Waffle Pi



SLAM (Simultaneous Localization And Mapping)

③ ② ①

Power cord.

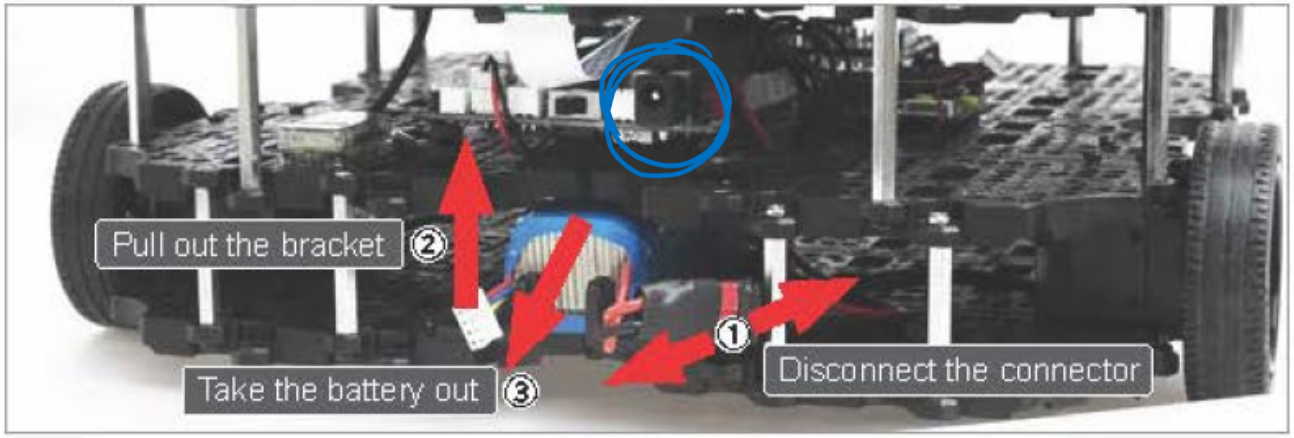
	Part Name	Burger	Waffle Pi
Chassis Parts	Waffle Plate	8	[illegible]
.	Plate Support M3x35mm	4	12
.	Plate Support M3x45mm	10	10
.	PCB Support	12	12
.	Wheel	2	2
.	Tire	2	2
.	Ball Caster	1	2
.	Camera Bracket	0	1
Motors	DYNAMIXEL (XL430-W250-T)	2	0
.	DYNAMIXEL (XM430-W210-T)	0	2
Boards	OpenCR1.0	1	1
.	*Raspberry Pi	1	1
.	USB2LDS	1	1
Remote Controllers	BT-410 Set (Bluetooth 4, BLE)	0	1
.	RC-100B (Remote Controller)	0	1
Sensors	**LDS-01 or LDS-02	1	1
.	Raspberry Pi Camera v2.1	0	1

☆ disconnect your battery when you don't use your robot.

- Raspberry Pi 4 Model B is applied since 2021 September.
- LDS-02 is applied since 2022.

Battery

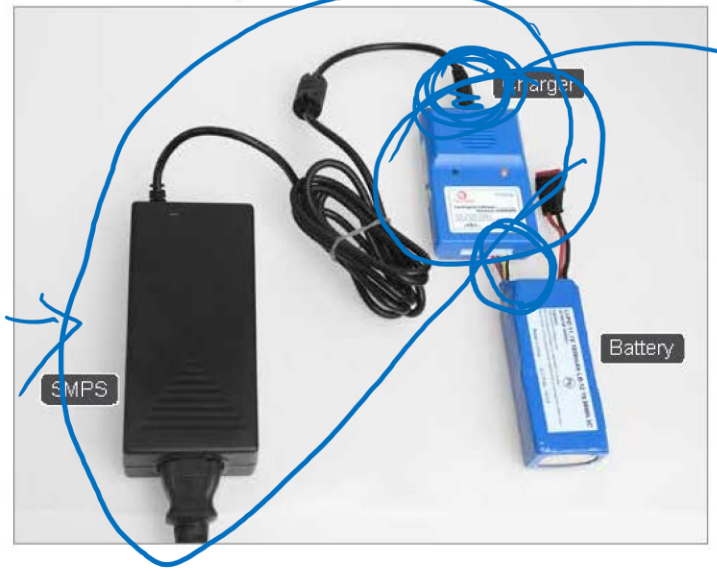
1. Take the battery out.

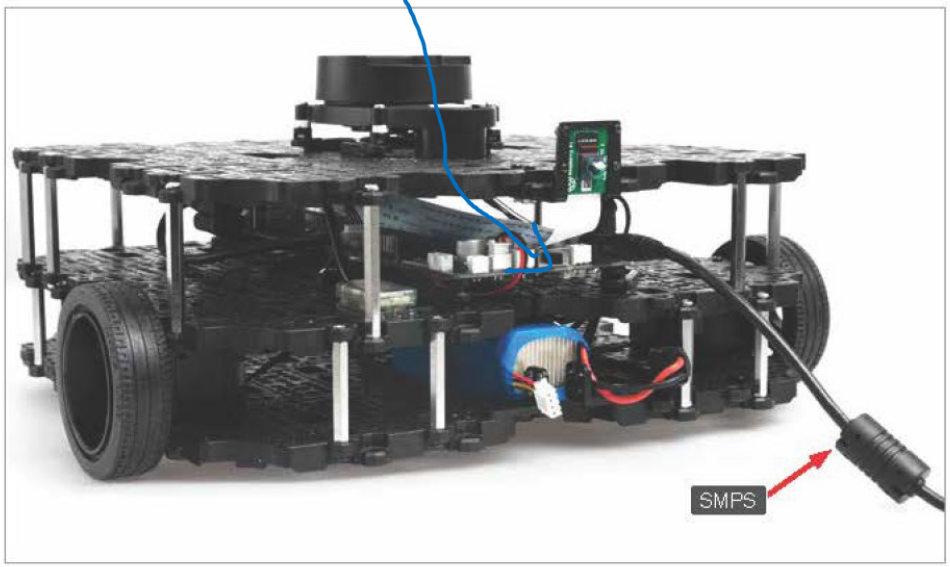


2. There are two connectors on the battery. One is for the robot and the other is for the charger.

Battery

3. Connect to the charger





If you connect the SMPS directly to the robot, the battery can be removed from the robot for charging while the robot is remaining online.

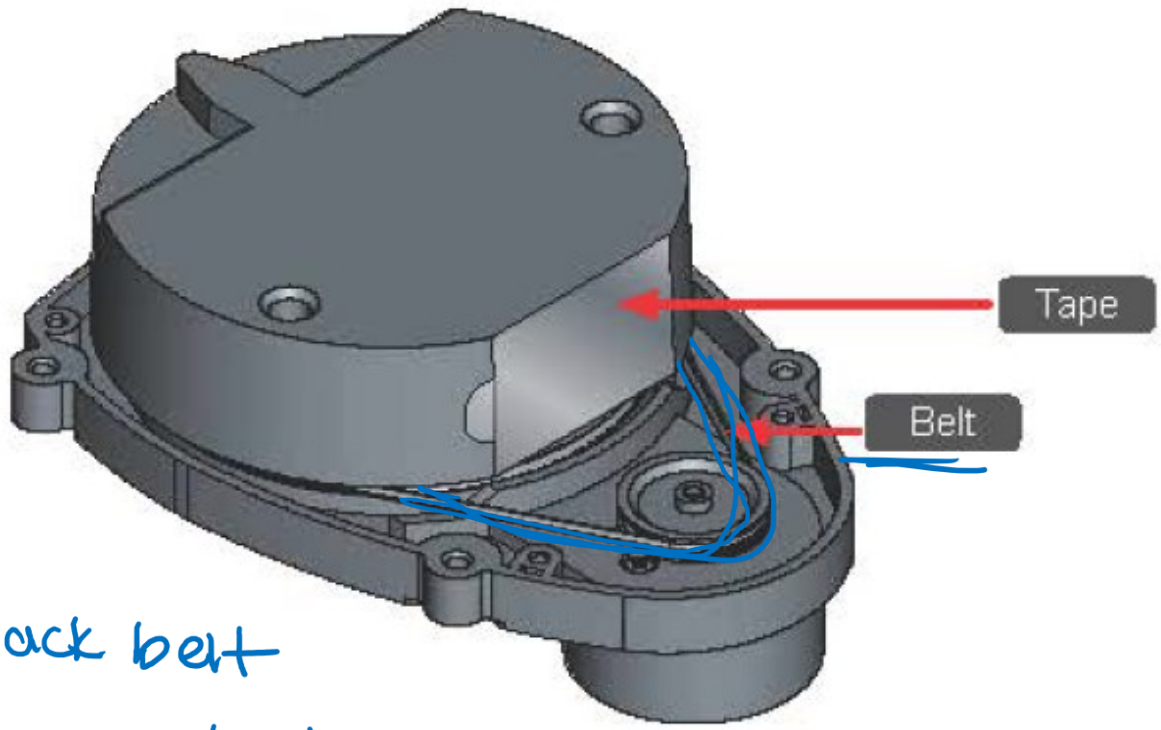
4. Charge

Charging
(LED: Red)

Completed
(LED: Green)

LDS (Laser Distance Sensor)

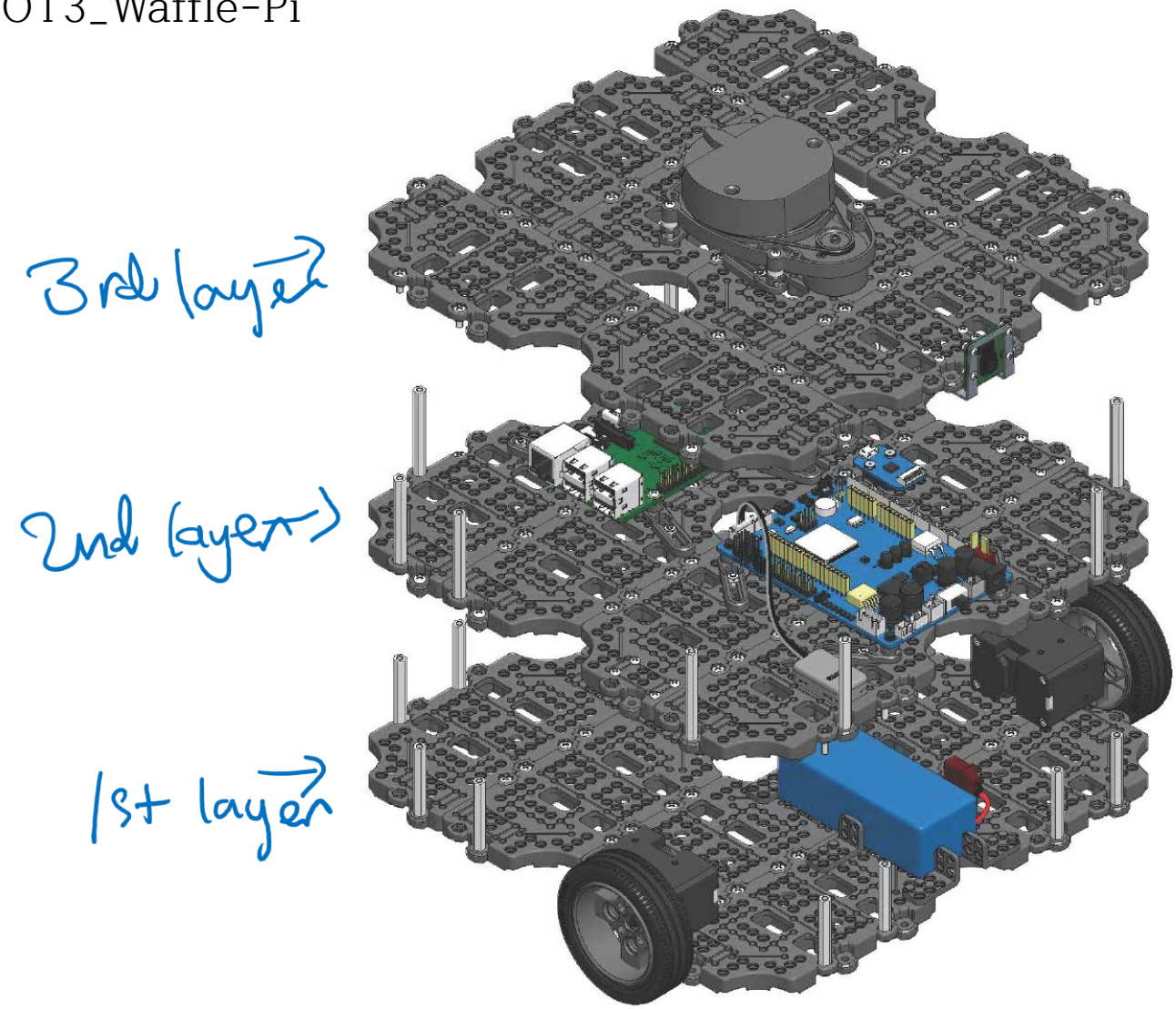
(1) Please remove the protective tape before use.
(2) After removing the tape, do not touch the sensing area to protect from stain.
(3) Do not touch the belt.
(4) Do not disassemble this LDS.
(5) Do not apply impact to this LDS.



LDS-1 : black belt
LDS-2 : Orange belt.

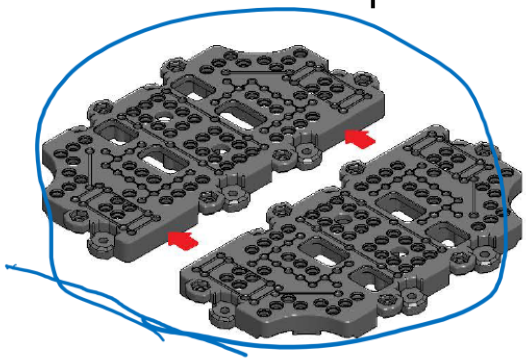
Hardware Assembly

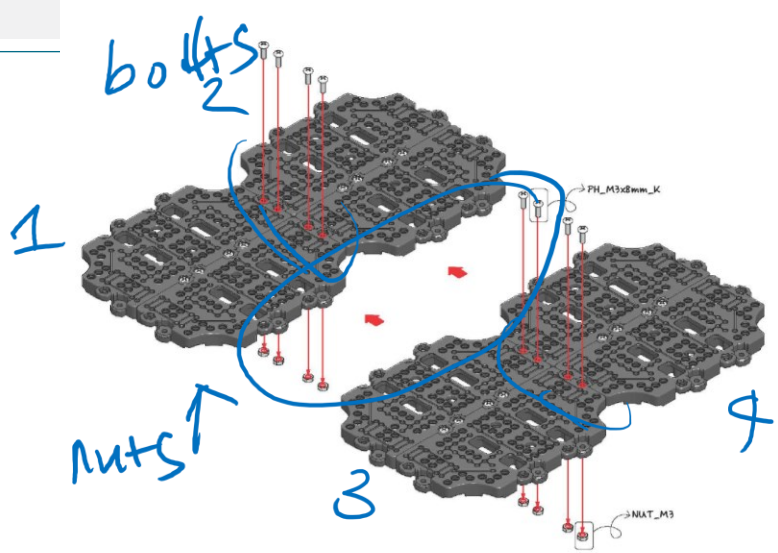
- TURTLEBOT3_Waffle-Pi



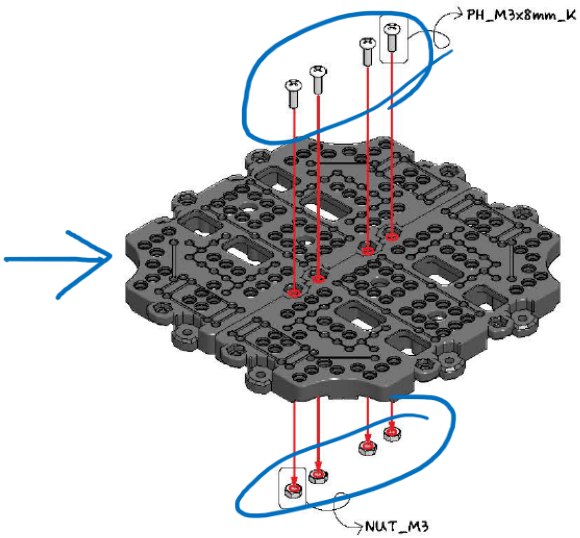
Hardware Assembly: 1st layer

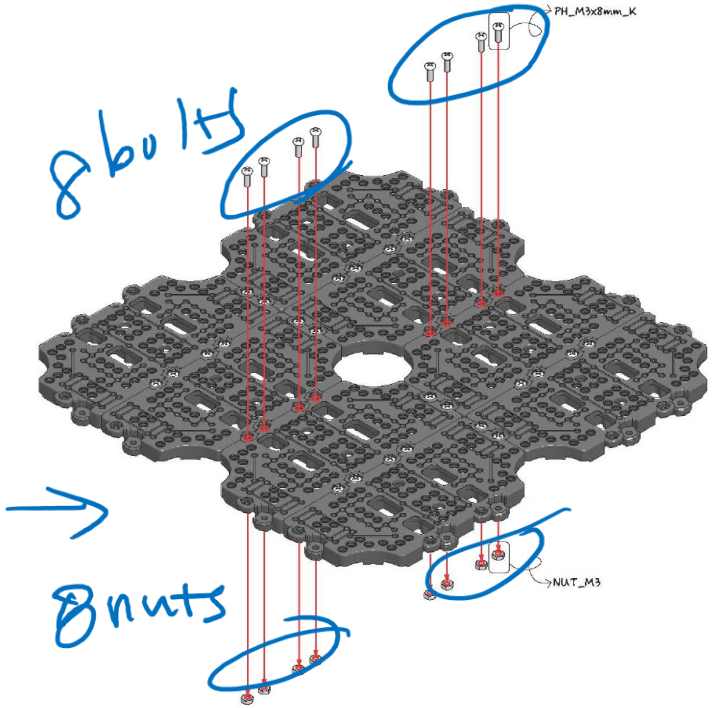
1. Assemble two waffle-plates





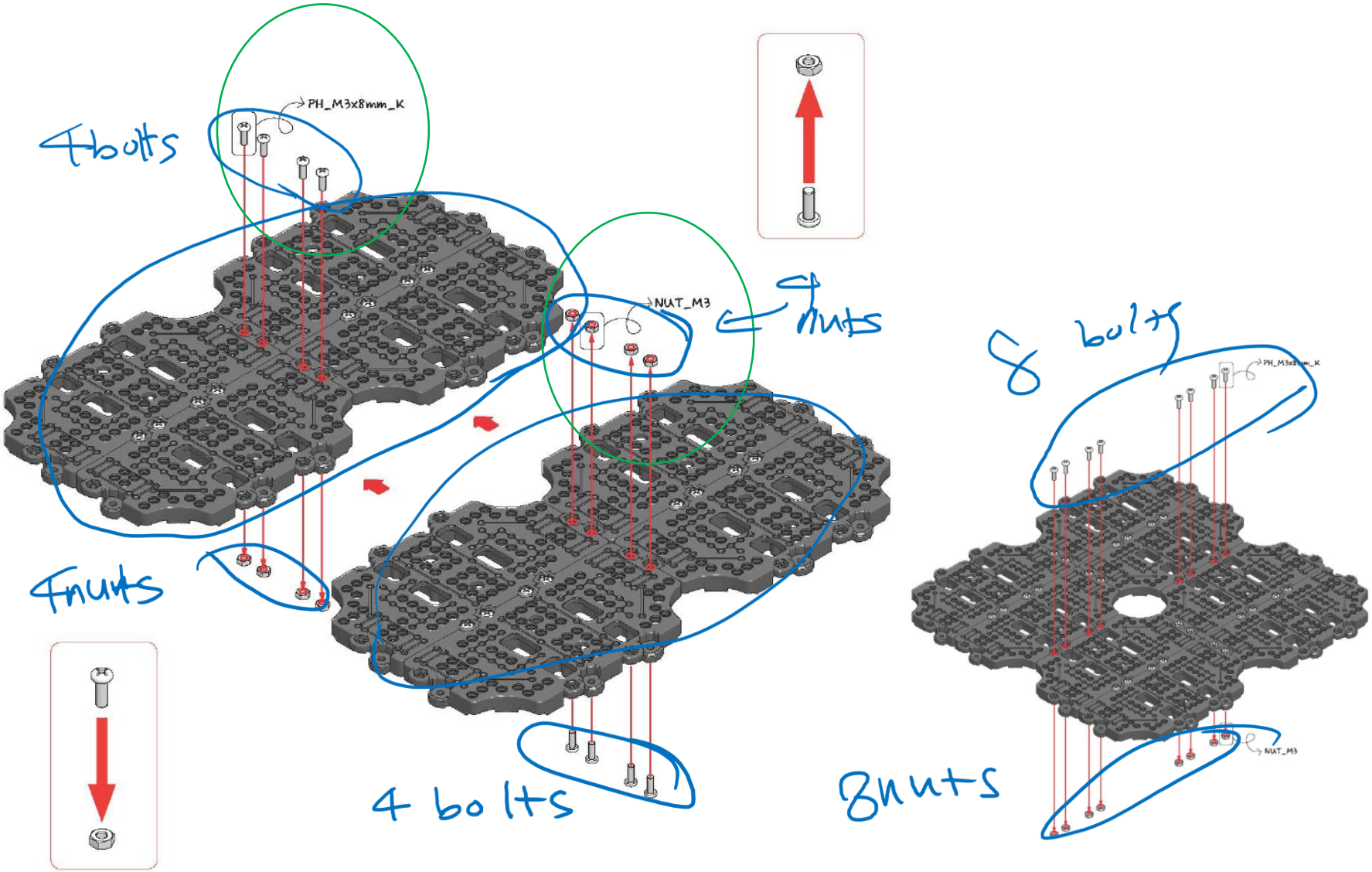
Insert **PH_M3×8mm_K** from the top of the **Waffle-Plate**





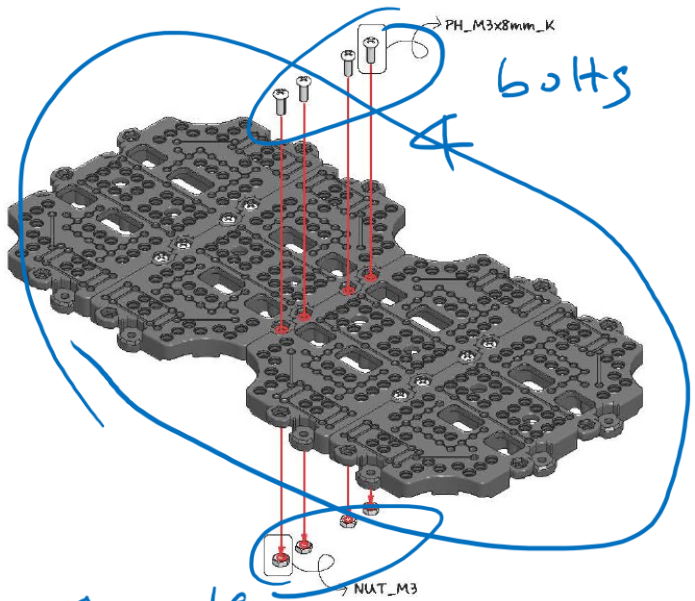
Hardware Assembly:2nd layer

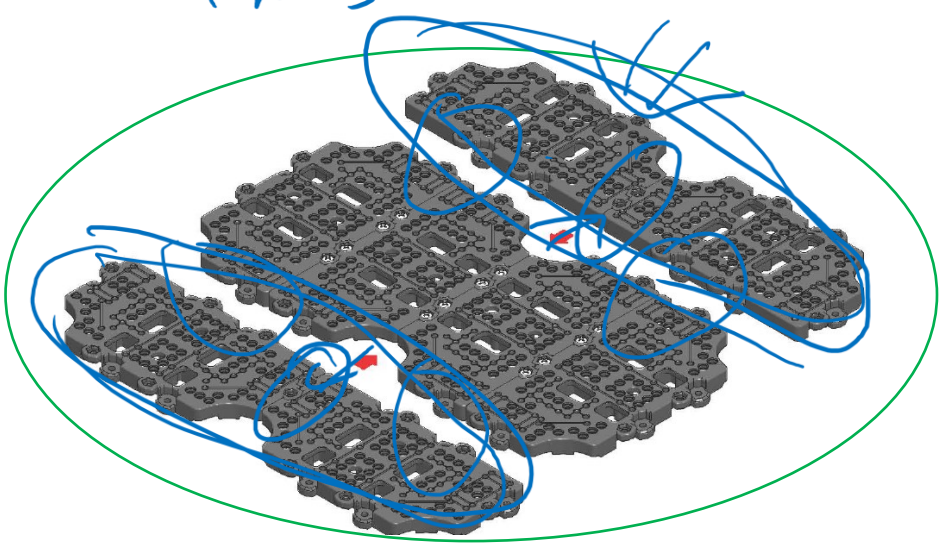
2. 2nd layer

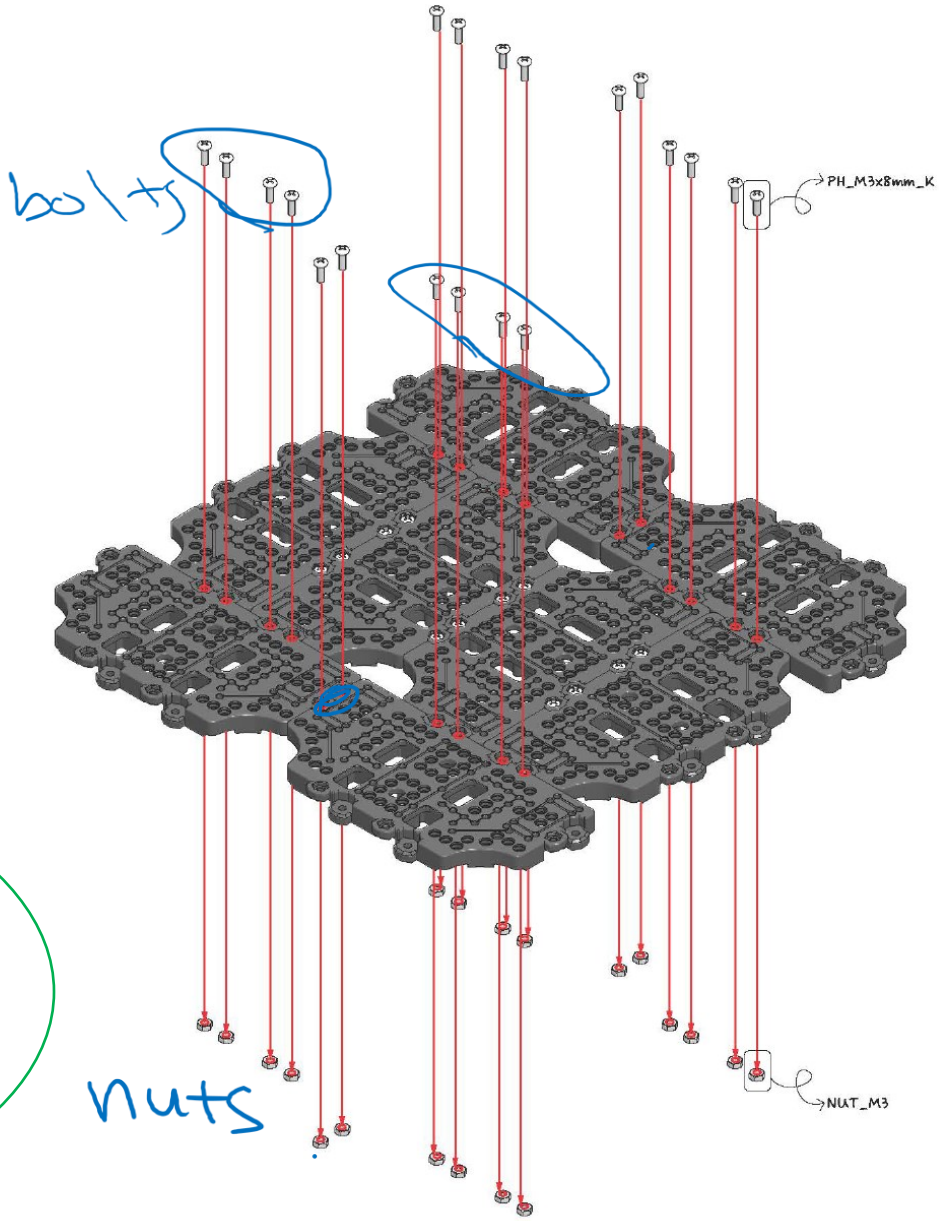


Hardware Assembly: 3rd layer

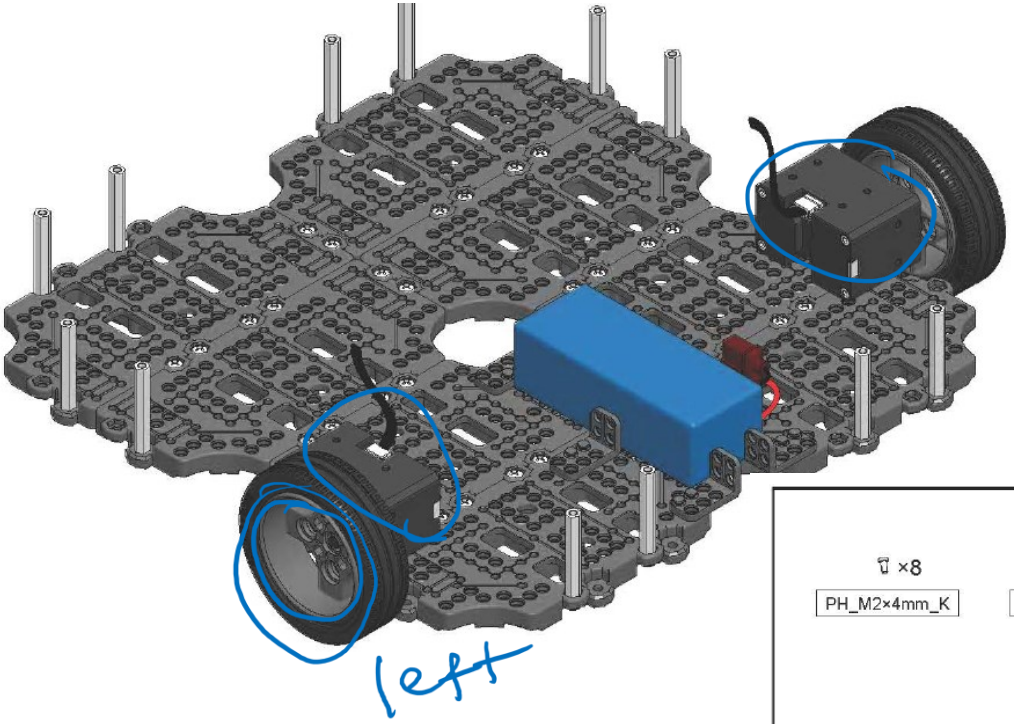
3. 3rd layer



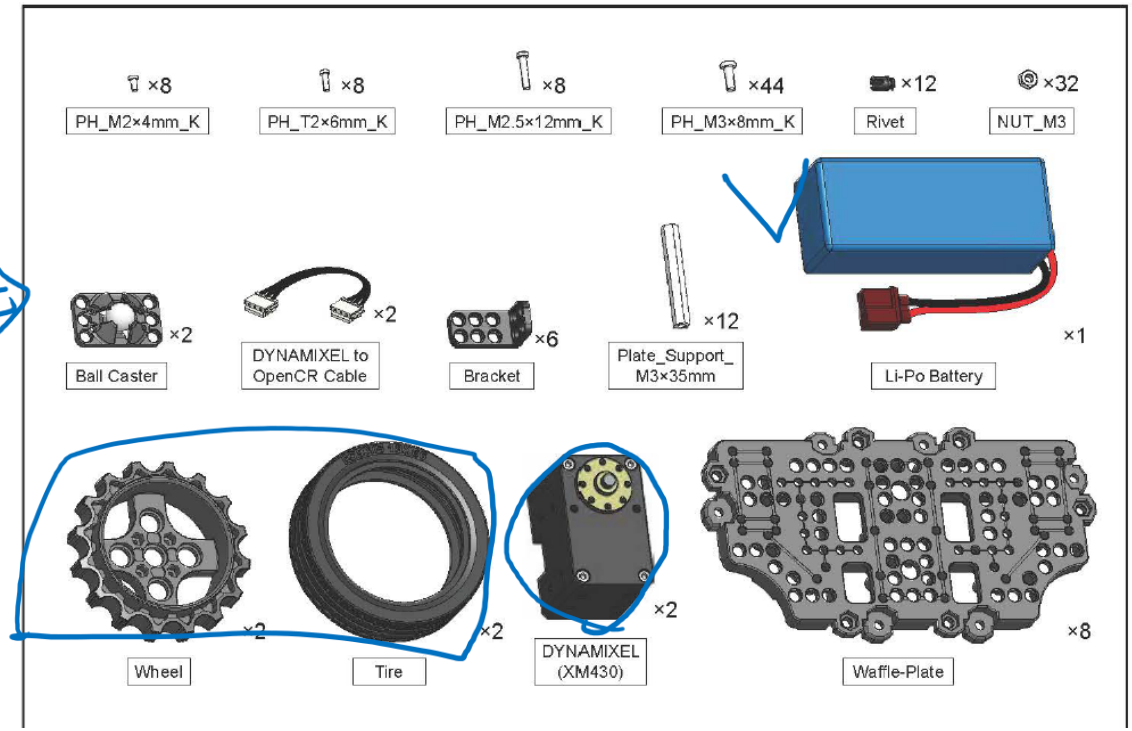




Hardware Assembly: 1st layer Assembly (1)

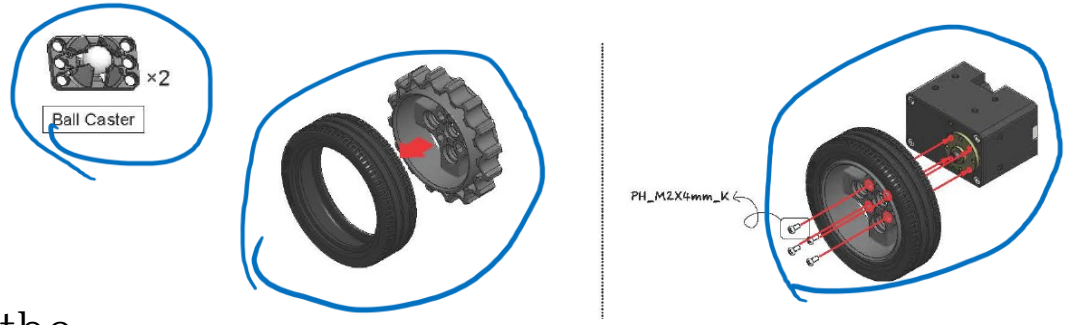


Check specific components.

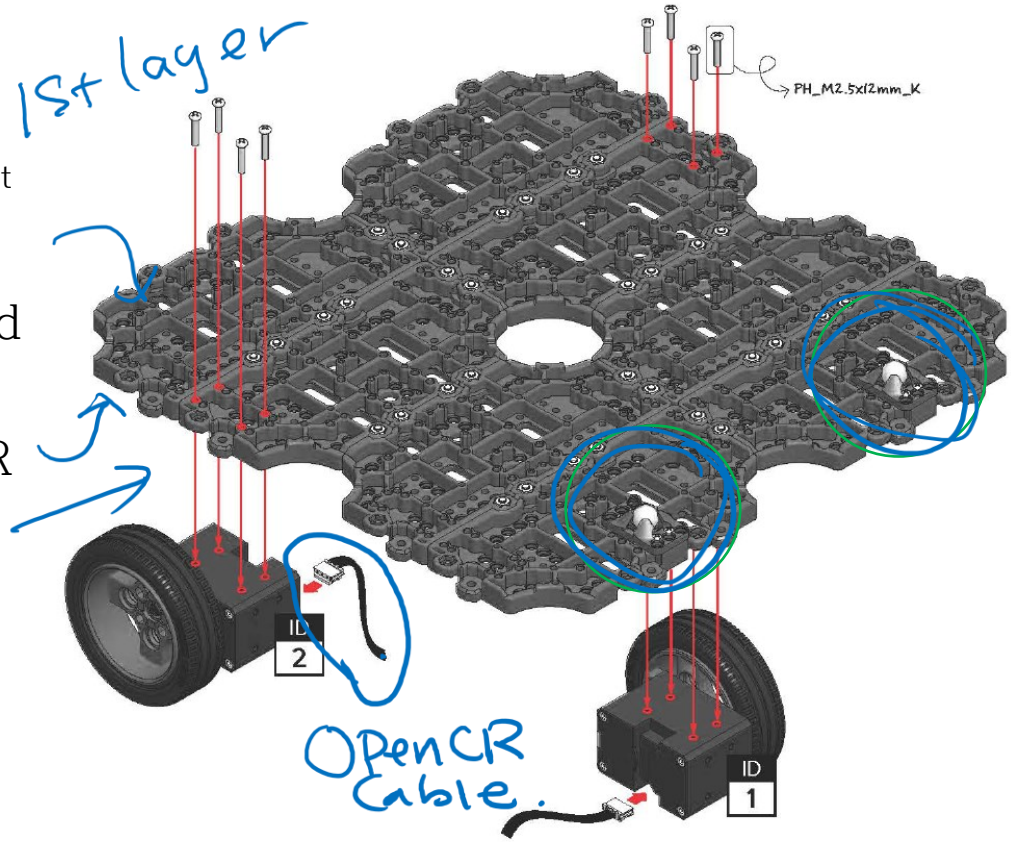


Hardware Assembly: 1st layer Assembly (2)

- Assemble Ball Casters from underneath the first layer of Waffle-Plate
- Assemble Tire on the Wheel
- Assemble the Tire+Wheel to the DYNAMIXEL

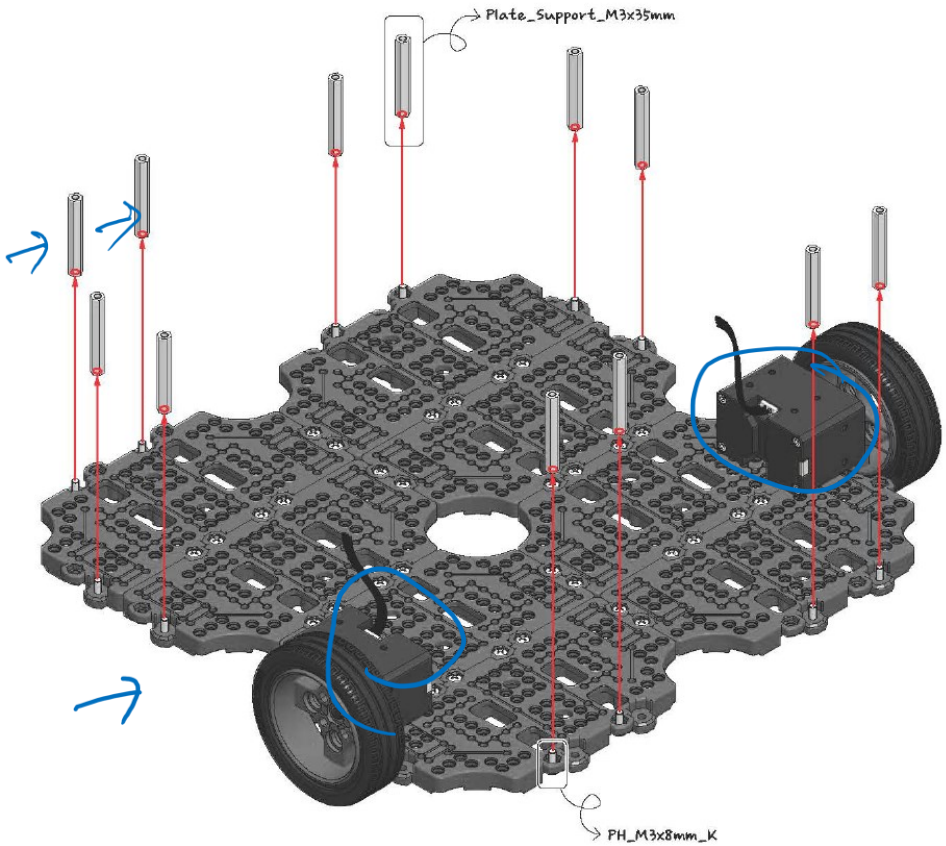


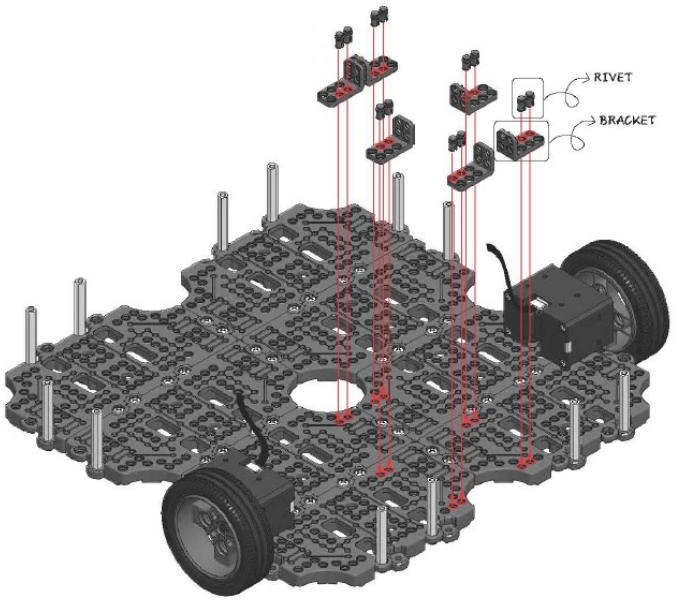
- Assemble DYNAMIXEL on the 1st Layer of Waffle-Plate
- Notice the ID of DYNAMIXEL and the orientation of the Wheel
- Connect DYNAMIXEL to OpenCR Cable to DYNAMIXEL

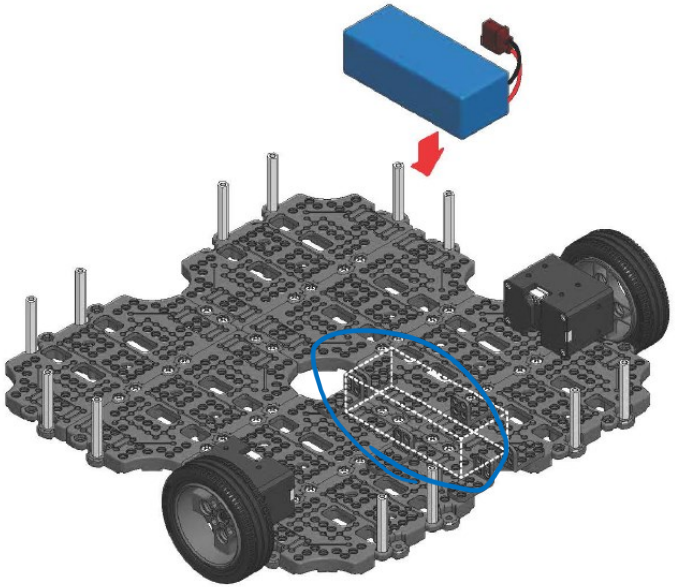


Hardware Assembly: 1st layer Assembly (3)

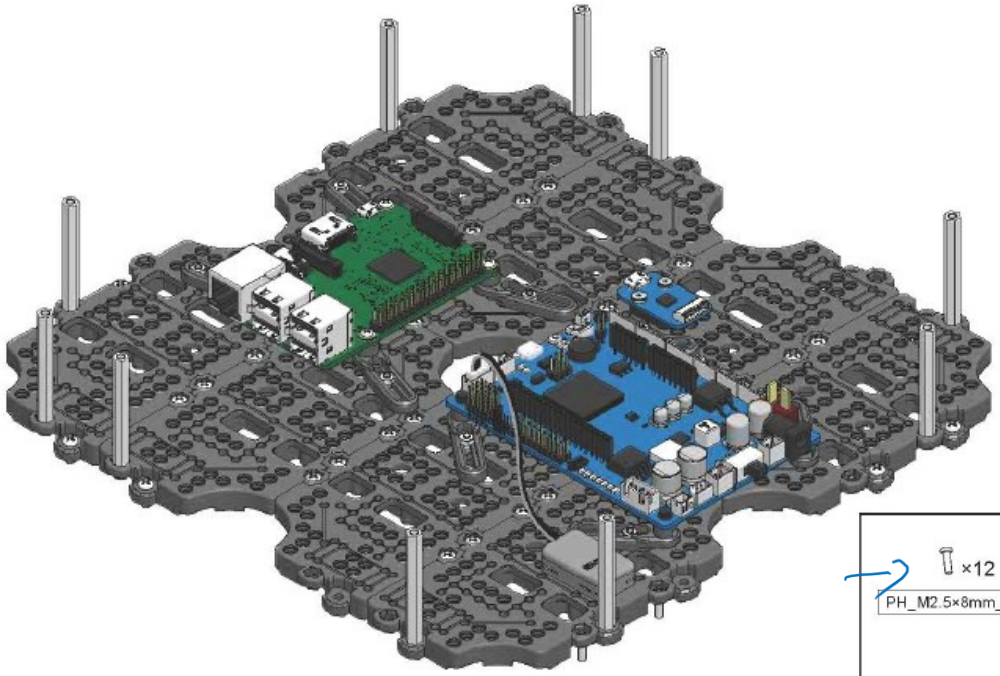
- Assemble Plate_Supports using PH screw bolts
- Place Battery in between DYNAM IXEL

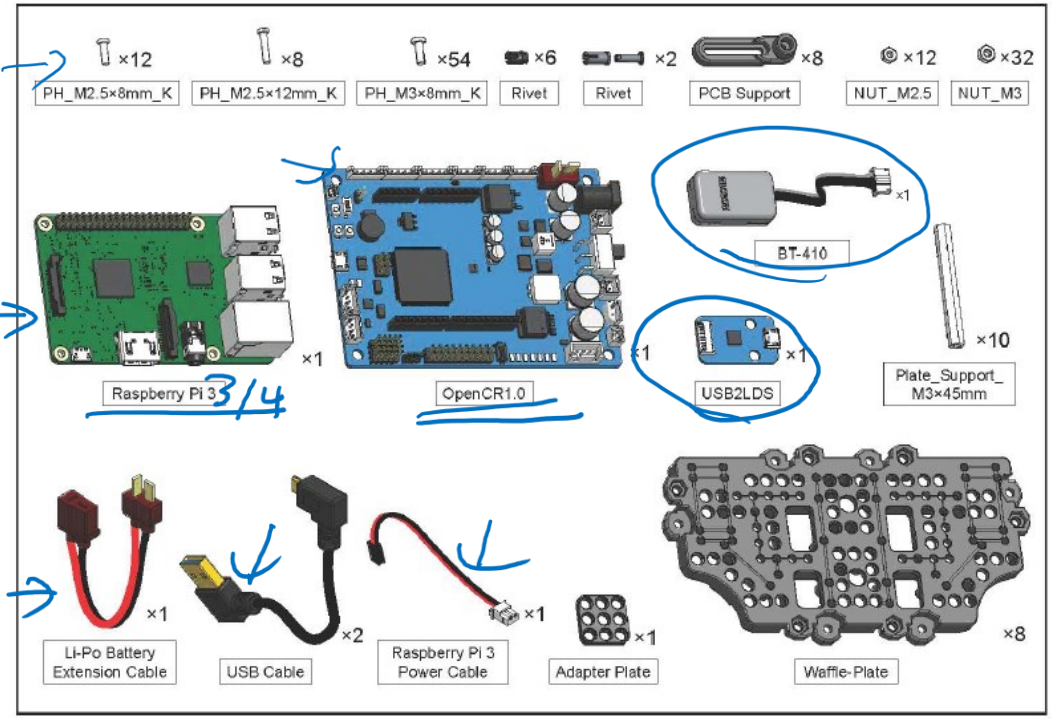






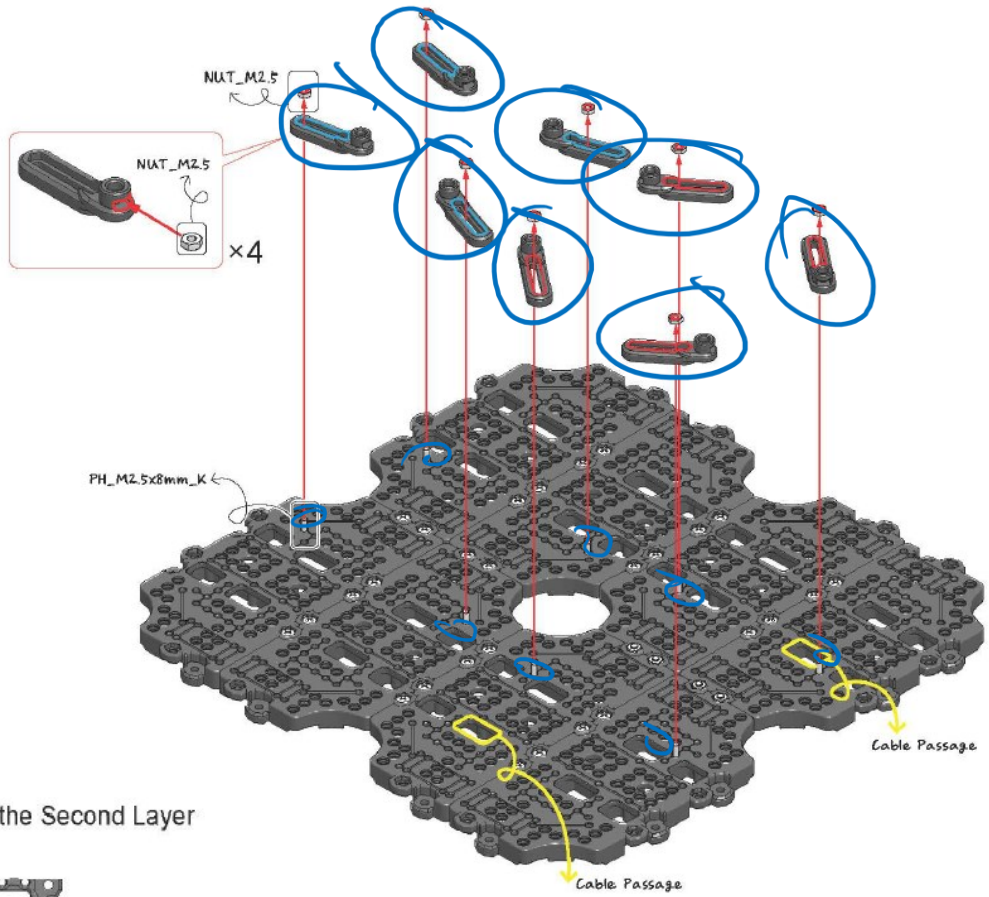
Hardware Assembly:2nd layer Assembly (1)



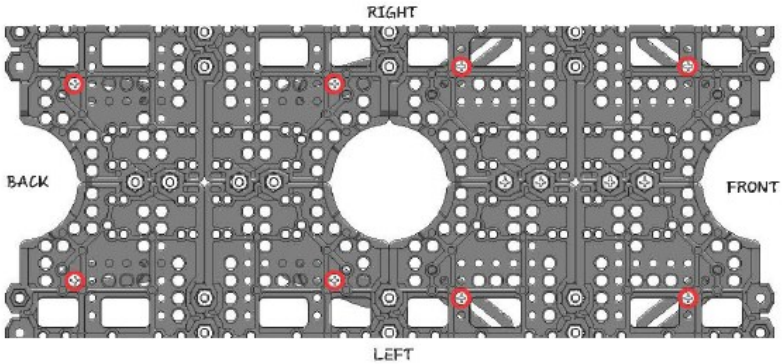


Hardware Assembly:2nd layer Assembly (2)

- NUT_M2.5: PCB Support (8) for Raspberry Pi 3
- Pass DYNAMIXEL to OpenCR Cables and Battery Extension Cable through Cable Passages



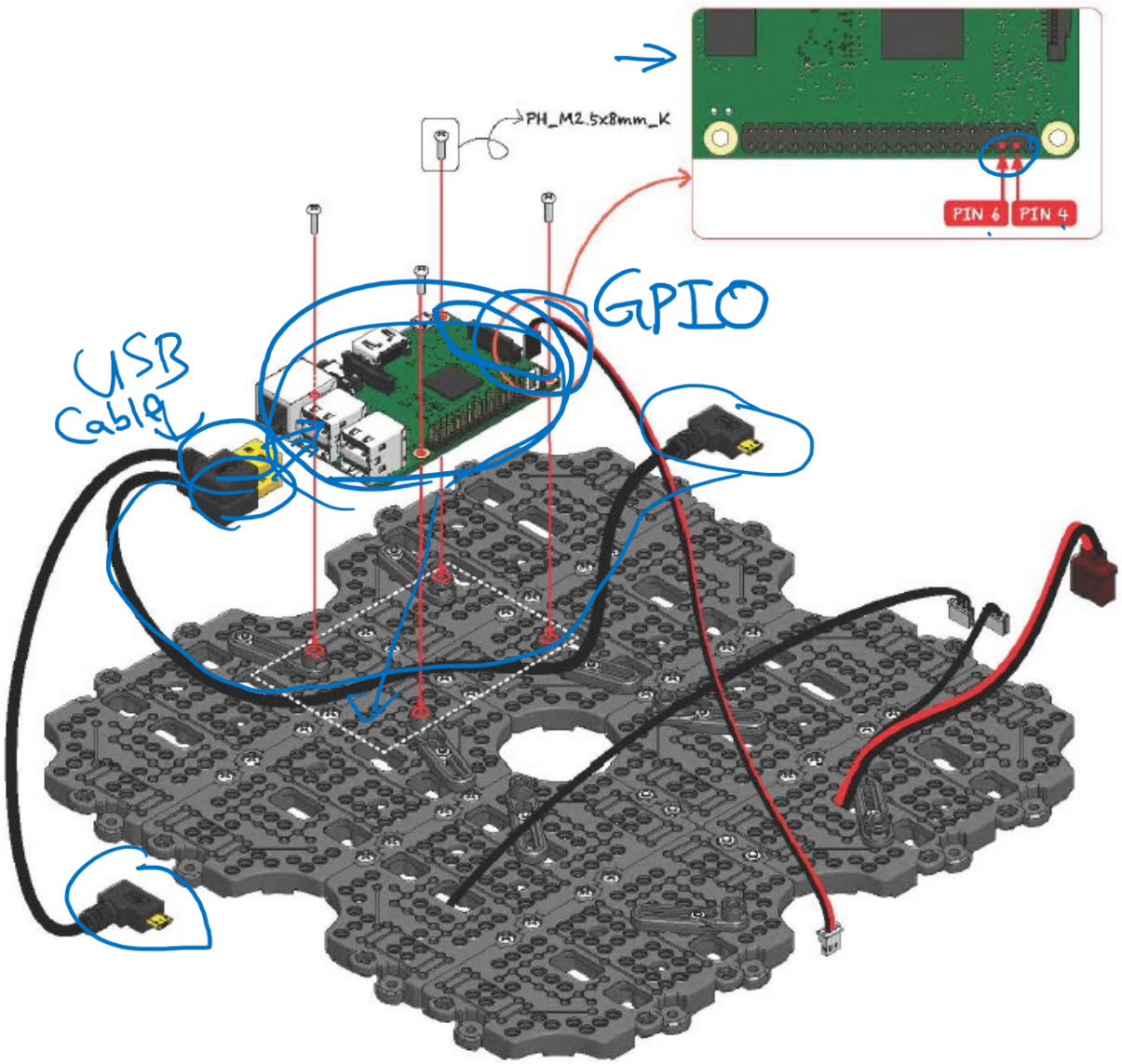
PCB Support bolts can be assembled at below locations from underneath the Second Layer



Hardware Assembly:2nd layer Assembly (3)

- Connect 2 USB Cables to R_Pi 3/4
- Connect R_Pi 3/4 Power Cable to R_Pi 3/4
- Mount R_Pi 3/4 on PCB Supports

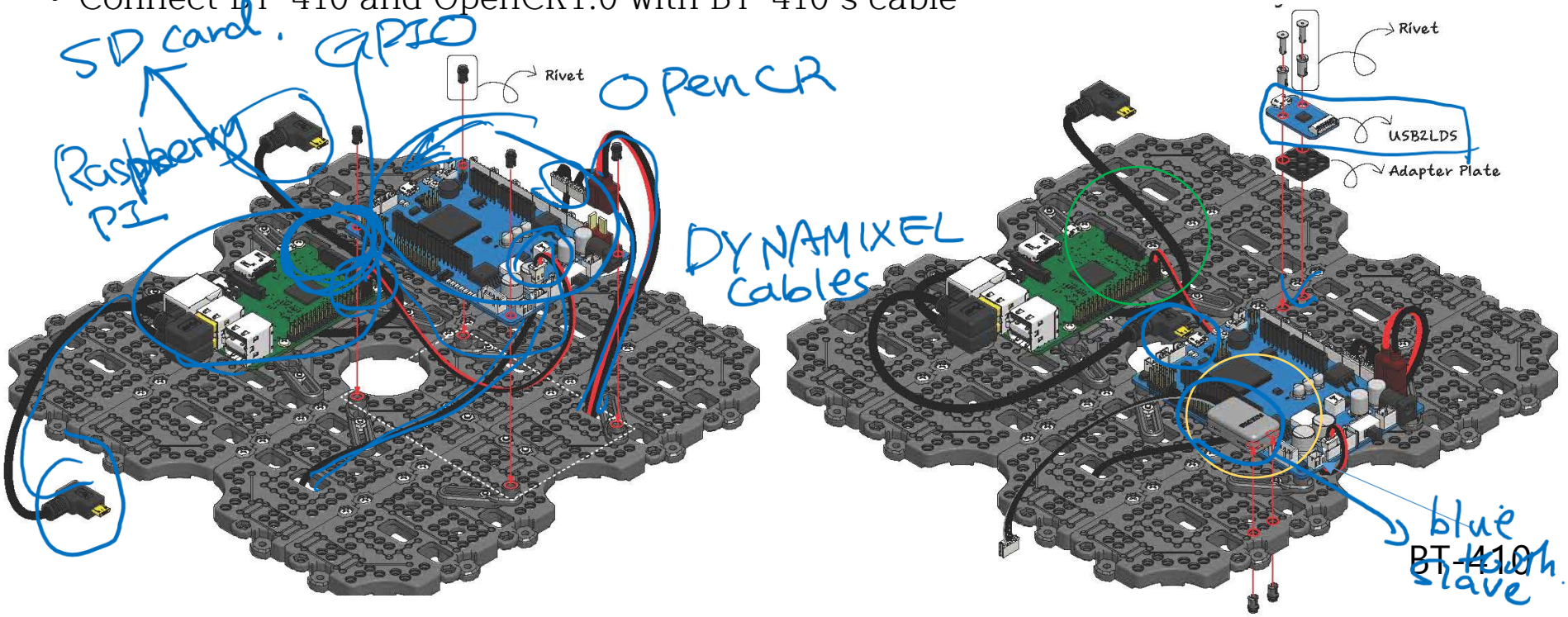
- Plug the R_Pi 3/4 Power Cable in the correct GPIO pins
  - PIN4 '+'
  - PIN6 '-'



Hardware Assembly:2nd layer Assembly (4)

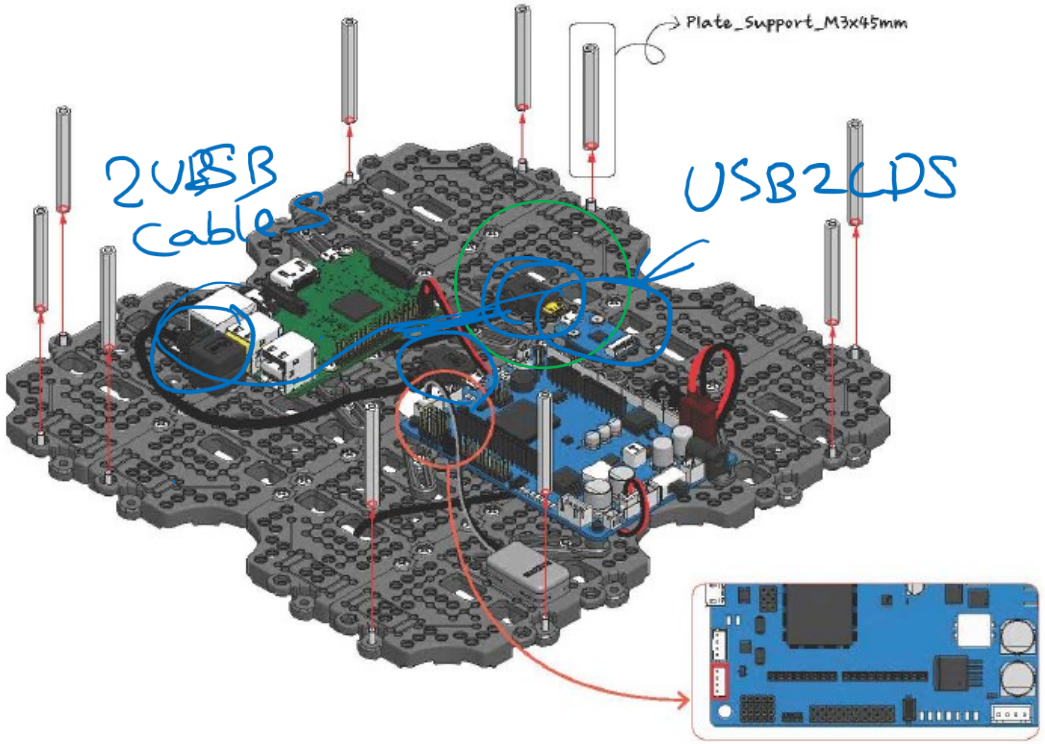
- Assemble OpenCR1.0
- Connect Battery Extension Cable, DYNAMIXEL to OpenCR Cables and R_Pi 3 Power cable

- Mount USB2LDS and Adapter Plate on Waffle-Plate using Rivets
- Connect R_Pi 3 and OpenCR1.0 with USB Cable
- Mount slave BT-410 (non-master) on Waffle-Plate using Rivets
- Connect BT-410 and OpenCR1.0 with BT-410's cable

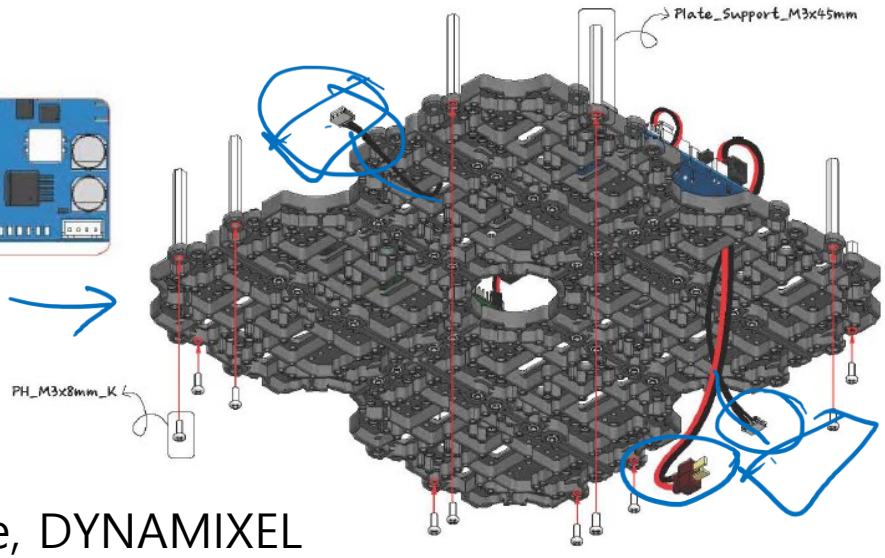


Hardware Assembly:2nd layer Assembly (5)

- Assemble Plate Supports (PH_M3x8mm_K bolts)
- Connect RPi3 and USB2LDS with USB Cable



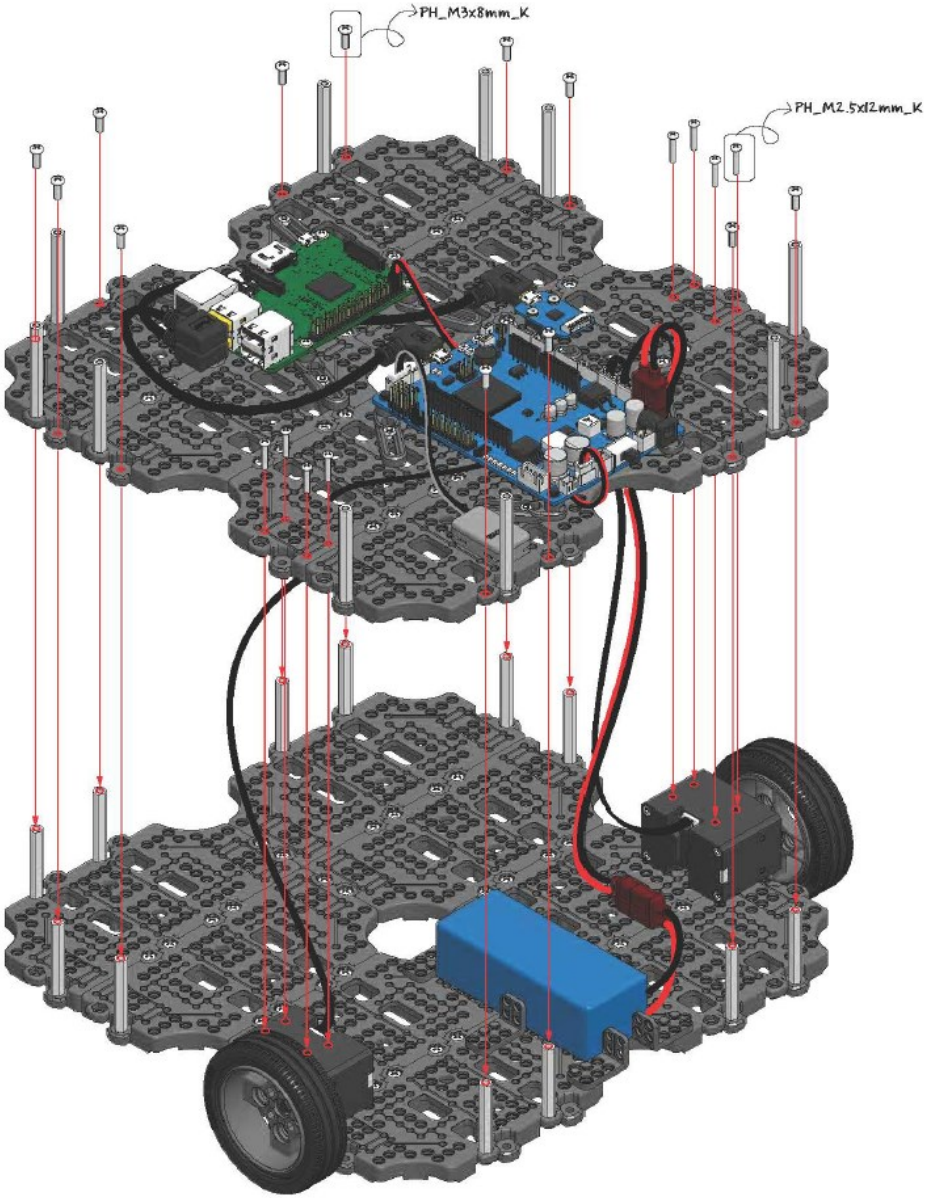
Underneath the Waffle-Plate



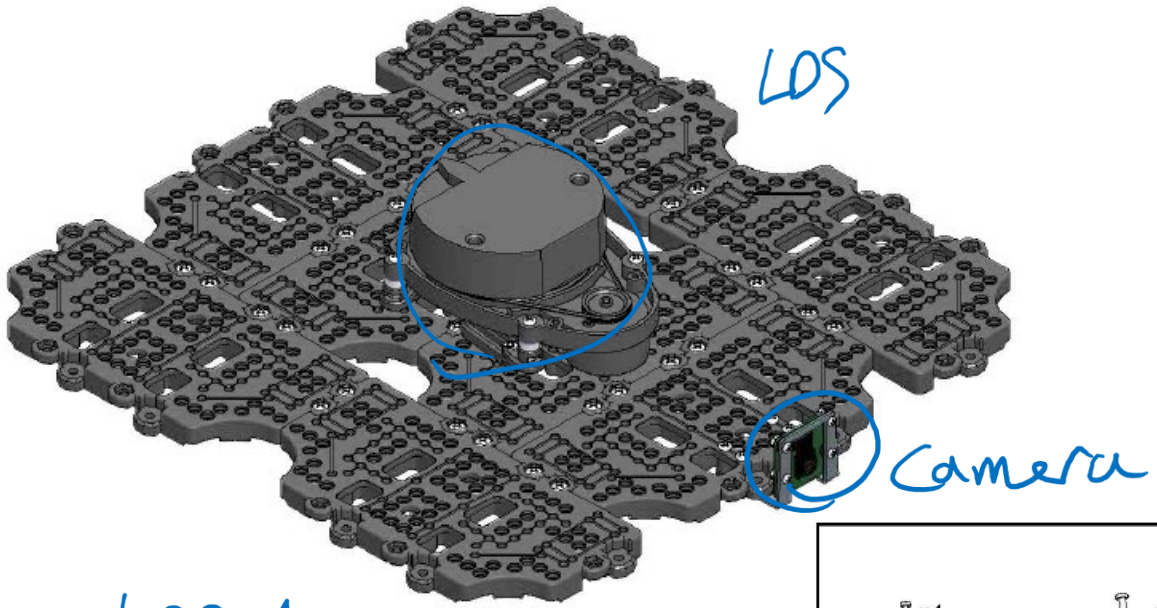
Battery Extension Cable, DYNAMIXEL

Hardware Assembly: 1st + 2nd Layer

- Assemble the 2nd layer on top of the 1st layer
- Make sure RPi3 software setup

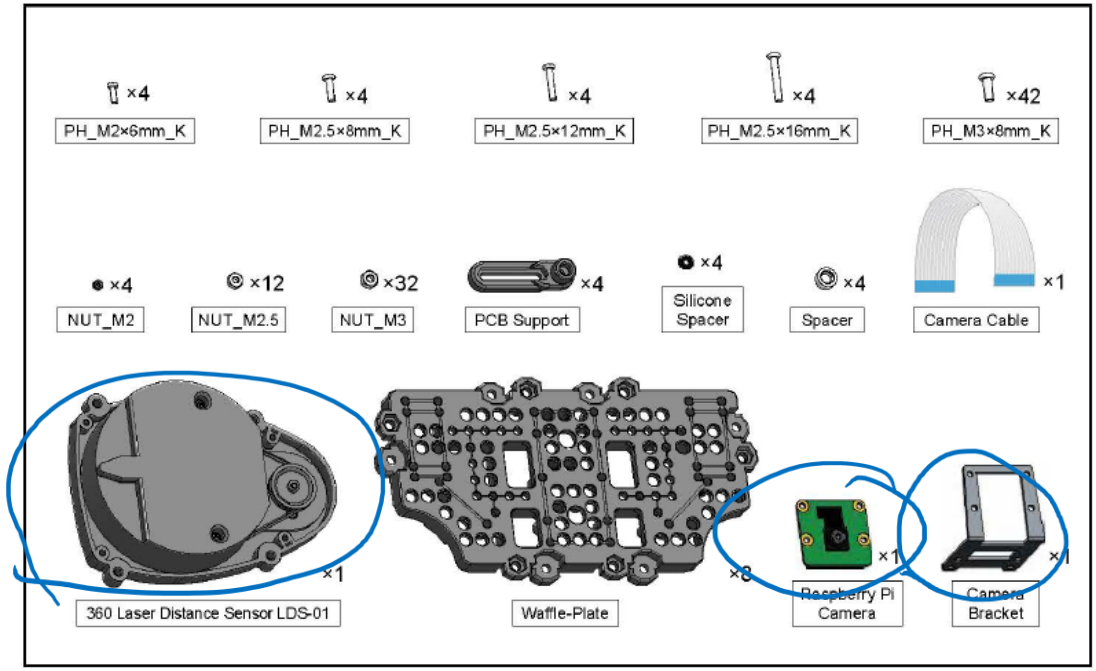


Hardware Assembly:3rd layer Assembly (1)



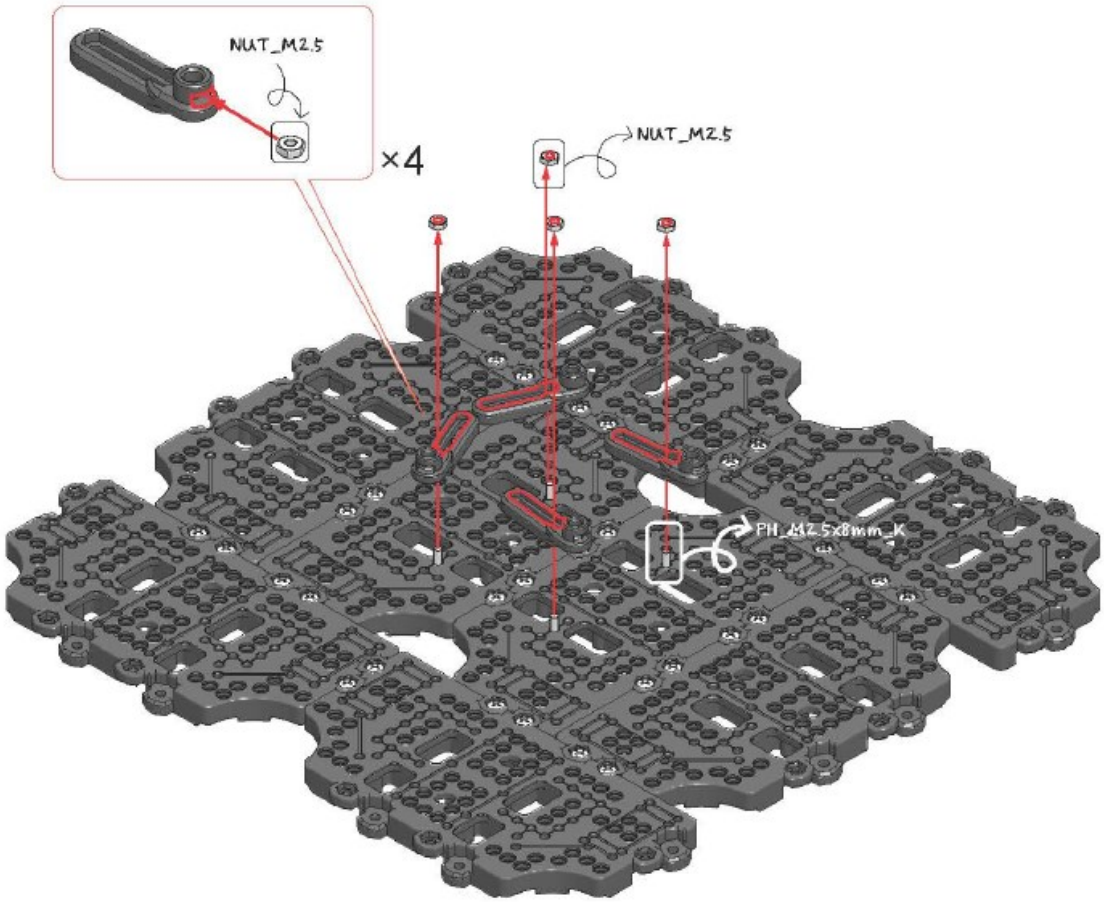
LDS-01

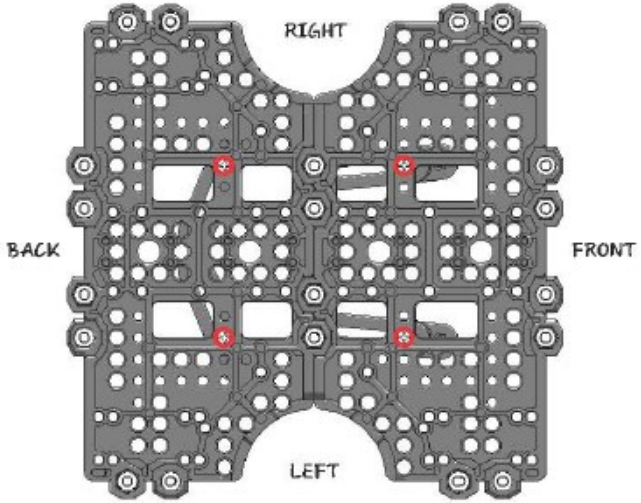
LDS-02 -



Hardware Assembly:3rd layer Assembly (2)

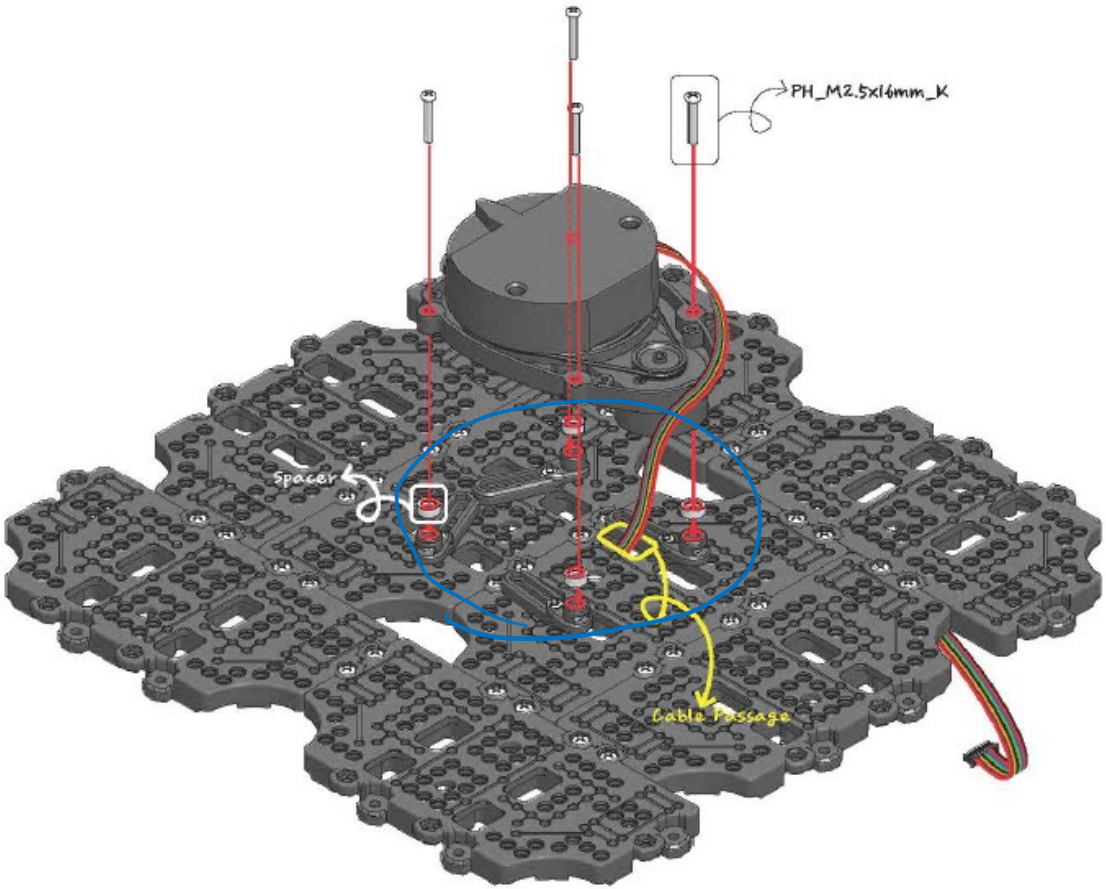
- NUT_M2.5: PCB Support (8) for 360 Laser Distance Sensor LDS-01/02

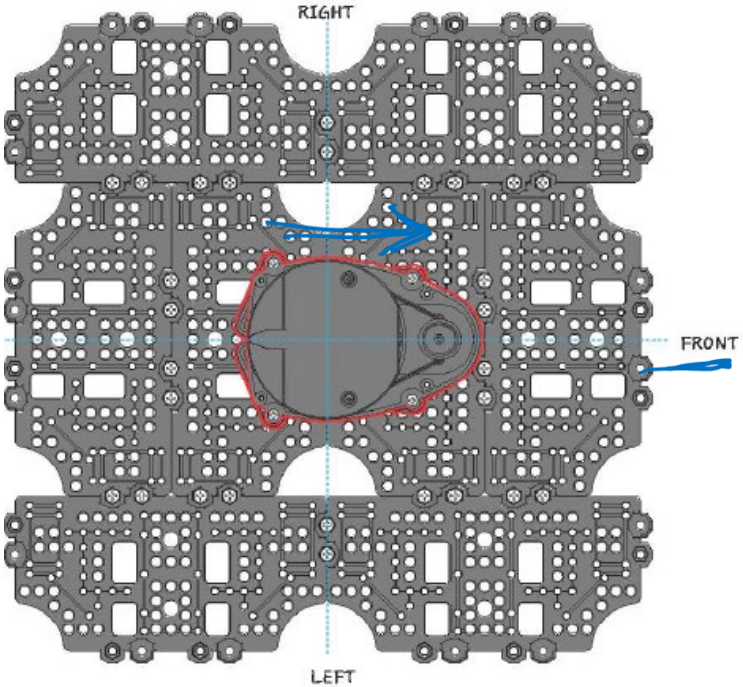




Hardware Assembly:3rd layer Assembly (3)

- Place Spacers on PCB Supports
- Assemble LDS-01/02 on top of Spacers

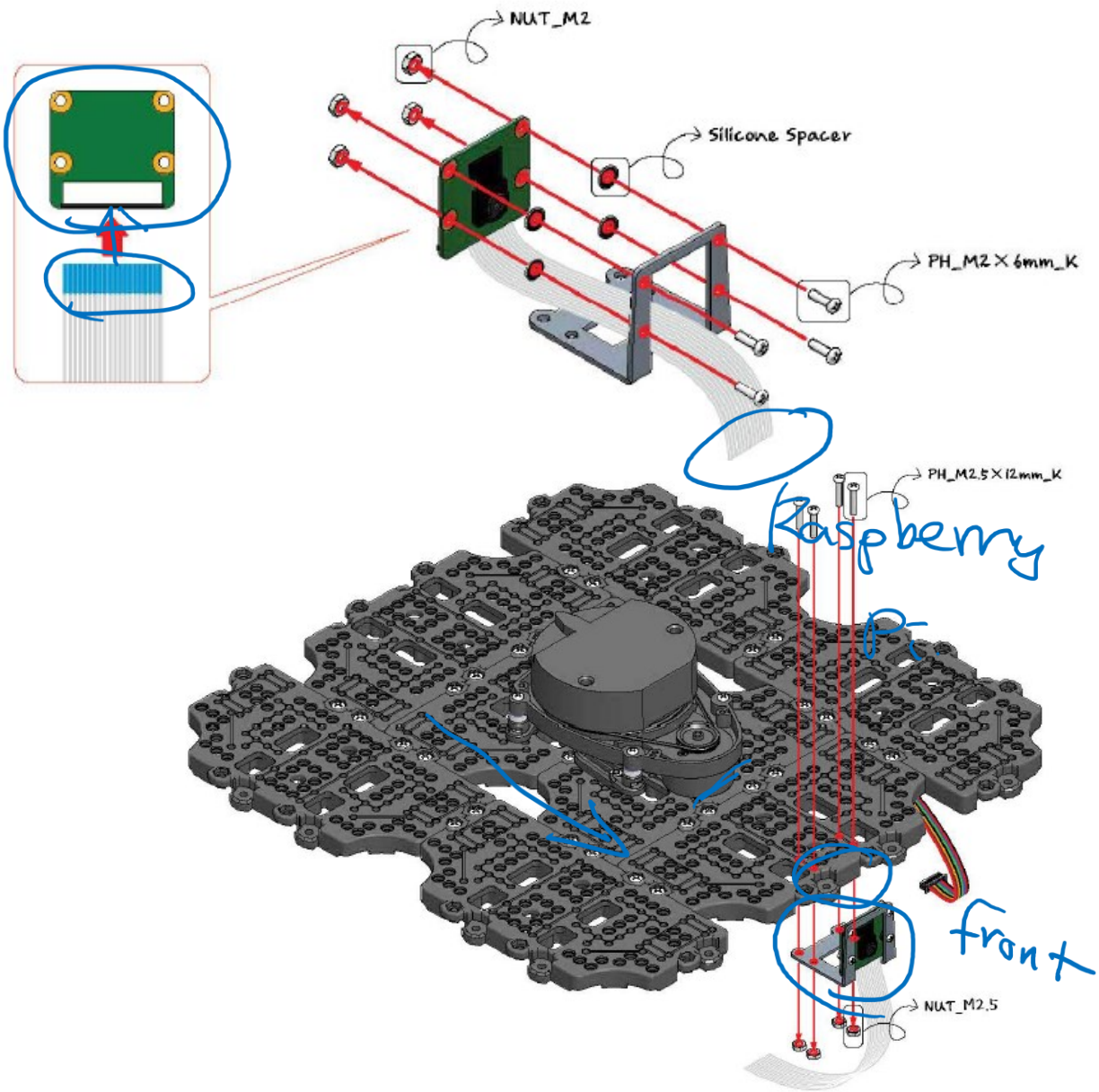




Hardware Assembly:3rd layer Assembly (4)

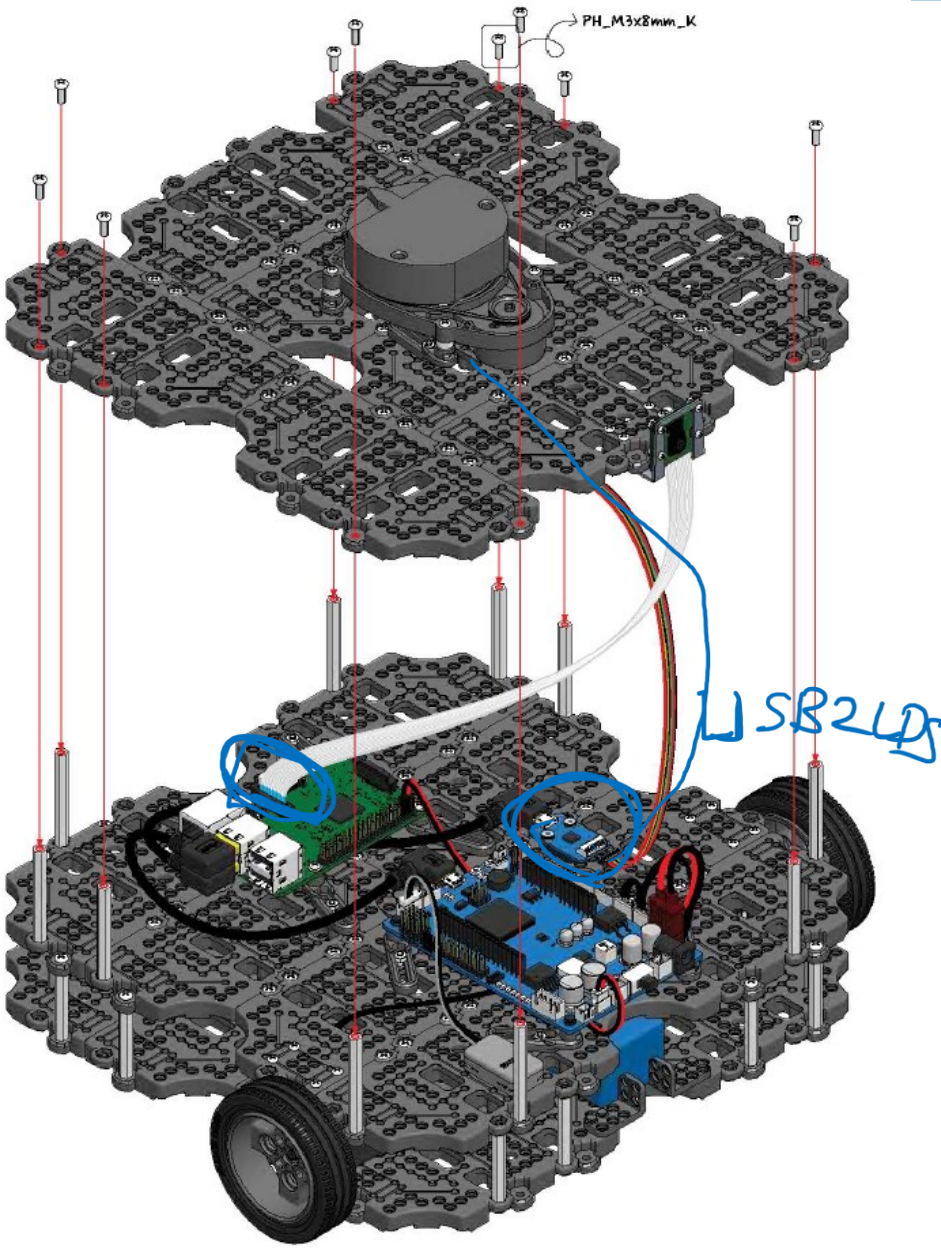
- Connect Camera Cable to RPi Camera
- Replace previously connected cable with Camera Cable (300mm) → check direction!!
- Assemble RPi Camera to Camera Bracket

- Mount RPI Camera on Waffle-Plate



Hardware Assembly: 1st + 2nd + 3rd layer

- Connect LDS-01 to USB2LDS
- Connect RPI Camera to RPi3/4 with Camera Cable
- Assemble the 3rd layer on top of the 2nd layer



Quick start

- Link: https://emanual.robotis.com/docs/en/platform/turtlebot3/quick-start/

(VMware)

- PC setup → ubuntu 20.04
  - Install ROS on remote PC (Foxy)
  - Install dependent ROS2 packages (Gazebo, Cartographer, Navigation2)
  - Install Turtlebot3 packages
  - Configuration → ROS_DOMAIN_ID=3x

.bashrc

- SBC setup
- OpenCR setup
- Bringup
- Basic operation

30
31
32

1 31
2 32

Pre-requisite

- Recharge the battery: connect your power supply
- 1 computer with ubuntu 20.04 (22.04 for humble)
- 1 USB keyboard
- Portable LCD monitor for your Raspberry pi
- Check your LDS (LiDAR) type (version 1 or 2)

Starting with your Turtlebot3

참고: https://emanual.robotis.com/docs/en/platform/turtlebot3/quick-start/#pc-setup

1. PC setup
   - Install Ubuntu 20.04 → ROS2 Foxy
   - Install ROS2 & dependent packages
   - Install turtlebot3 packages
   - Environment configuration → ROS_DOMAIN_ID=3x
2. SBC setup (Raspberry pi 4)
   - Configure the wifi network setting → /etc/netplan/50-cloud-init.yaml
   - Login ID: ubuntu, PASSWD: turtlebot
   - LDS-02 configuration (Check your LDS type!!)
3. OpenCR setup (control board) →follow the direction
   - Set the parameters: OPENCR_PORT, OPENCR_MODEL (waffle)
   - Firmware 확인, motor (DYNAMIXEL) 확인
4. If you haven't finish assembling all parts yet, finish assembling them.
5. Bringup
6. Try your remote controller !!

Ajou: password: 8766

```
wifis:
  wlan0:
    dhcp4: yes
    dhcp6: yes
    access-points:
      WIFI_SSID:
        password: WIFI_PASSWORD
```

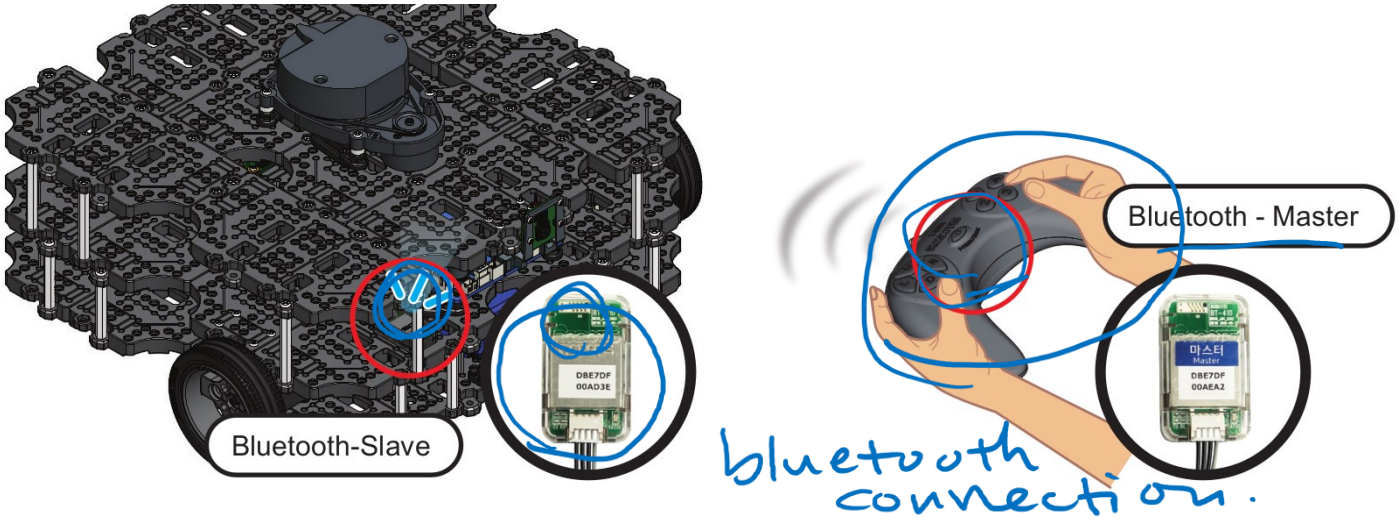
Vi editor (linux)

nano

Bringup Turtlebot3

- Each team should connect to each robot through SSH from its local computer
  - After connecting through SSH, do as the followings:
    - set the parameter TURTLEBOT3_MODEL (waffle_pi)
    - launch turtlebot3_bringup
    - Check your topic list
    - Check your service list
- Now you're all set
- Test your remote controller (RC-100)

"SSH"



Summary

- Turtlebot3 features & components
- Hardware assembly
- Quick start
  - PC setup
  - Bringup