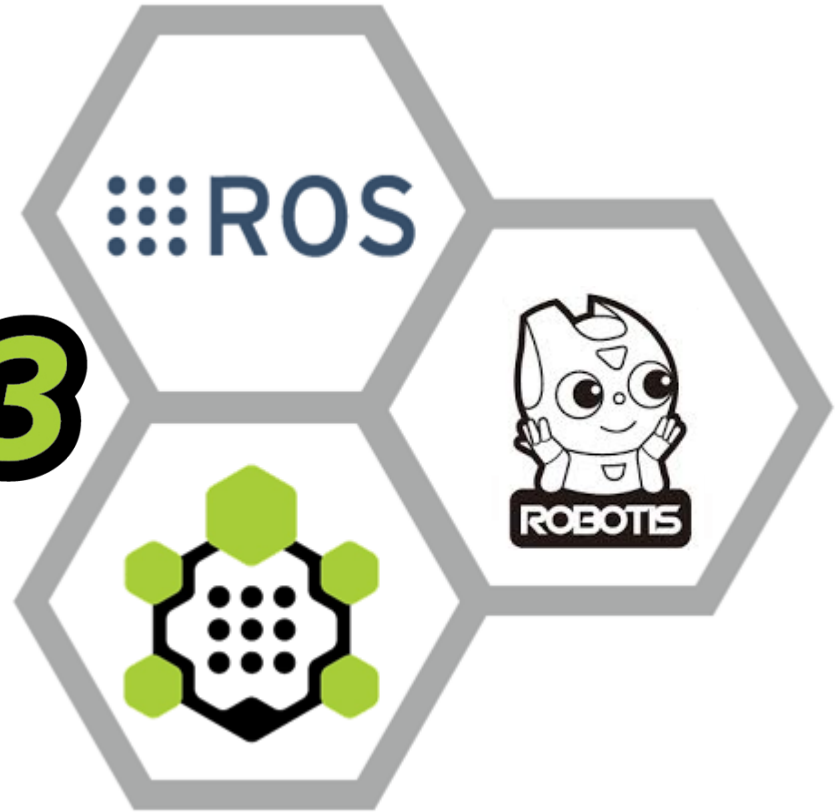


# TURTLEBOT3



# Speakers



Yoonseok Pyo

Leon Jung

# Look-back Demonstration of DRC Finals

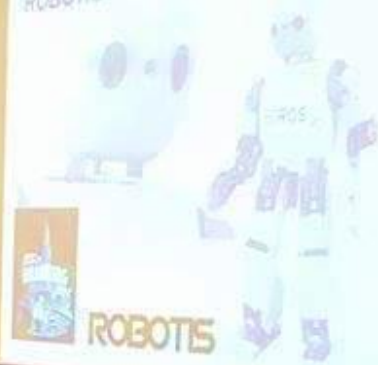


<https://youtu.be/rFV-9PVDzC8>

# ROSCon 2015

ROBOTIS Framework with ROS...

ROBOTIS Framework supporting ROS



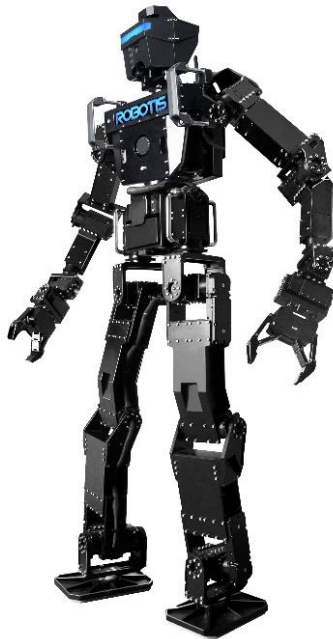


almost of all line-ups  
dived into

 ROS

with over 60 ROS packages

<http://wiki.ros.org/ROBOTIS>



THORMANG3



DYNAMIXEL

DYNAMIXEL X

DYNAMIXEL PRO



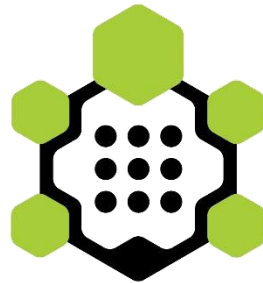
ROBOTIS Manipulator



ROBOTIS OP  
MAX Collaboration with ROS/ARM Project by ROS



# TURTLEBOT3



Yoonseok Pyo, Yoshihiro Shibata, Leon Jung, Darby Lim  
10/08/2016 ROSCon2016

# ROBOTIS



# We had a meeting with OSRF





# Index



## 1. Previous Turtlebot Series

- Needs & Requirements from Users

## 2. Turtlebot3

- Features and Components

## 3. Demos

- SLAM / Navigation / Visual SLAM / Manipulation

## 4. Details

- More Information of Turtlebot3





# Previous versions



## Turtlebot1, Turtlebot2





# Previous versions

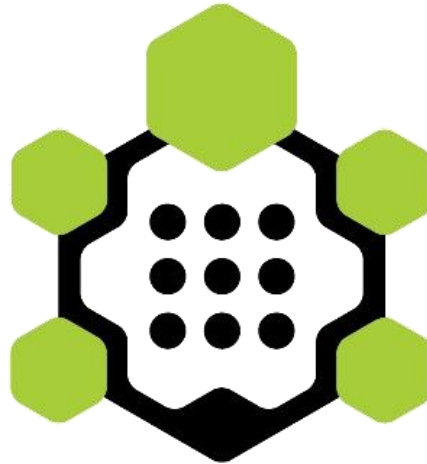


## Needs & Requirements

- **Small**
- **Low-cost**
- **Fully programmable**
- **Extensible**
- **ROS based open robot platform**



# Turtlebot3



**TURTLEBOT3**



# Turtlebot3



\* Prototype 2.4

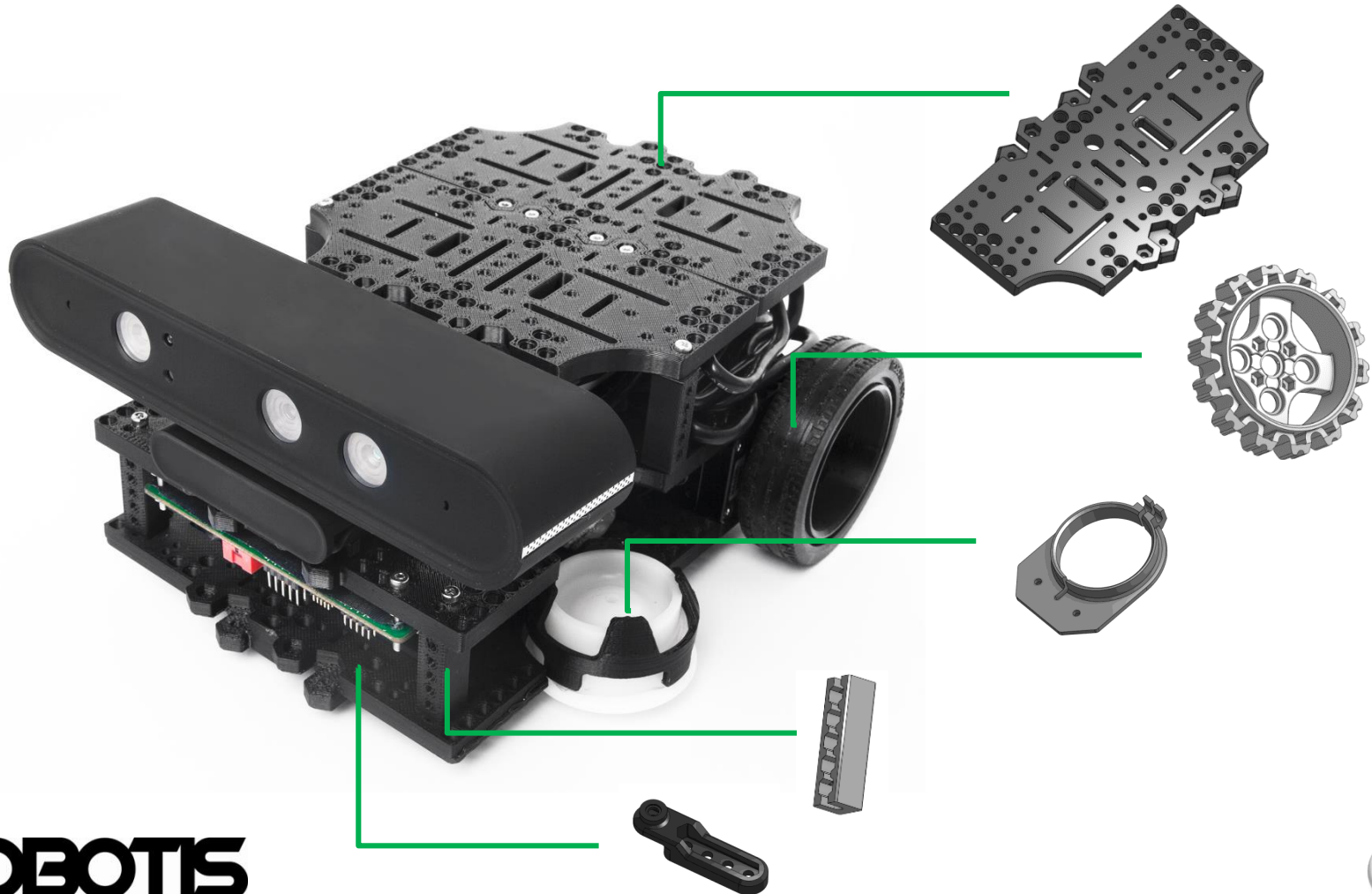




# Turtlebot3



\* Prototype 2.4





# Turtlebot3



\* Prototype 2.4

## Sensor(s)

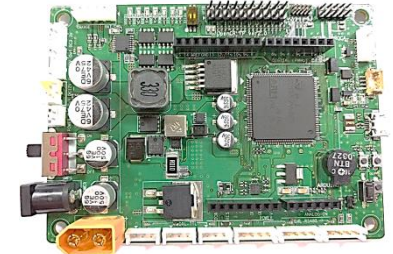
(Realsense, Astra, RPLIDAR, Hokuyo, SICK, etc.)

Battery (11.1v)

Octa-plate x 8

OpenCR for ROS embedded

Motor x 2  
(Dynamixel-X)



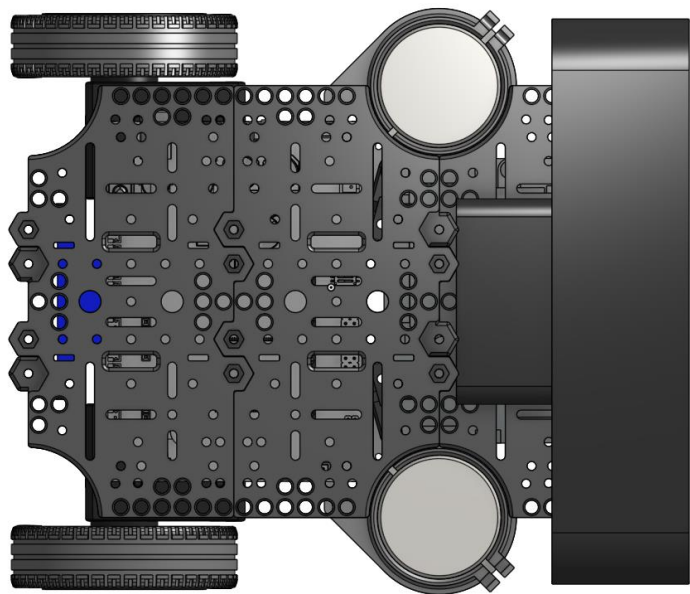
Wheel and rubber tire x 2

Ball caster x 2

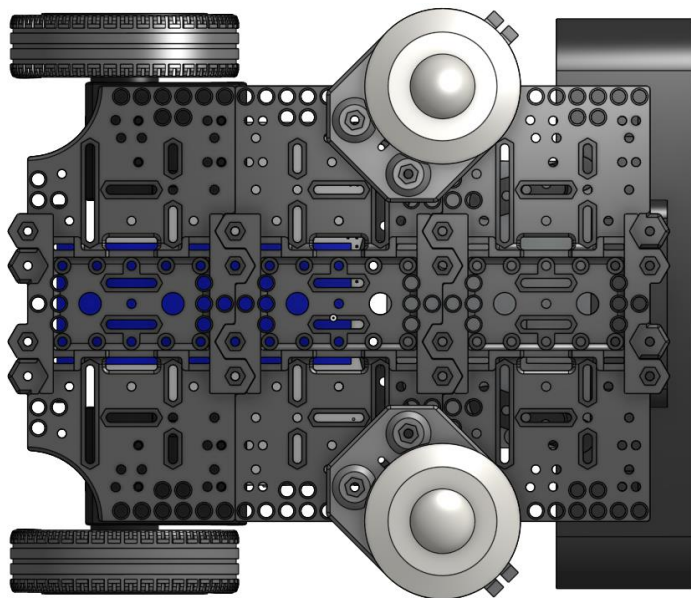
SBC

(ODROID, Intel Joule, Upboard, Raspberry Pi 3, etc.)

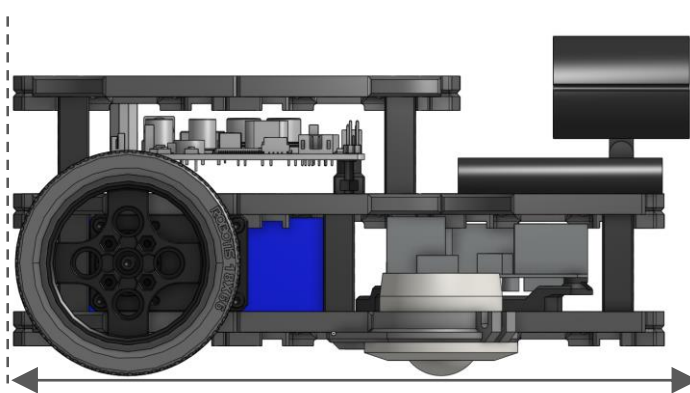
[ Top ]



[ Bottom ]

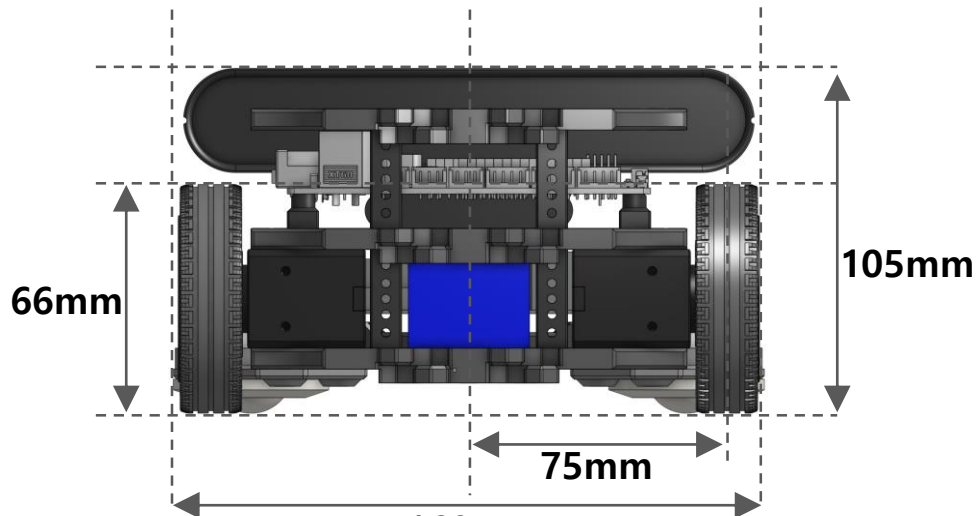


[ Right ]



190mm

[ Back ]



66mm

105mm

75mm

168mm



# Turtlebot3



## Components of Turtlebot3 (Default)

- **Chassis:** plate, post, pcb base, ball caster, caster holder
- **Motor:** Dynamixel-X series (XL430 or XM430) x 2
- **Wheel:** multi purpose wheel (18x66) x 2
- **Embedded board:** OpenCR x 1
- **Computer:** SBC x 1
- **Sensor:** Distance Sensor x 1
- **Battery:** Lithium-polymer 11.1V 1800 mAh x 1



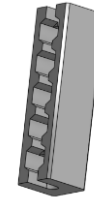
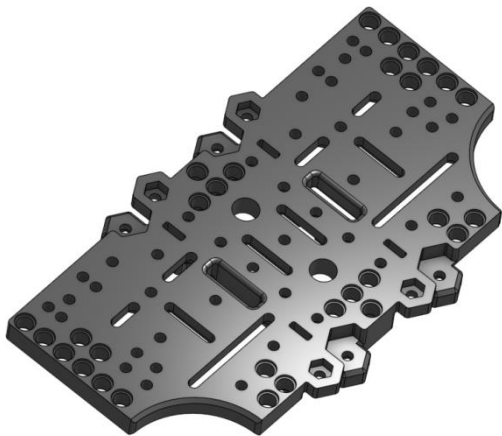


# Locomotion layer



## Chassis of Turtlebot3

- Small size (ex: octa-plate is smaller than your hand)
- Injection molded plates (for low-cost)  
+ CAD data for 3D printing are opened.
- Two-wheeled differential drive, **but** we will provide various examples of mechanical customization.





# Locomotion layer



## Motors of Turtlebot3

- **ROBOTIS Dynamixel X series**
- 3 ways for cabling
- 6 operating modes: **velocity** (for wheels), **torque**, **position**, extended position, current-based position, and PWM.
- Networks: **daisy-chained RS-485 / TTL**





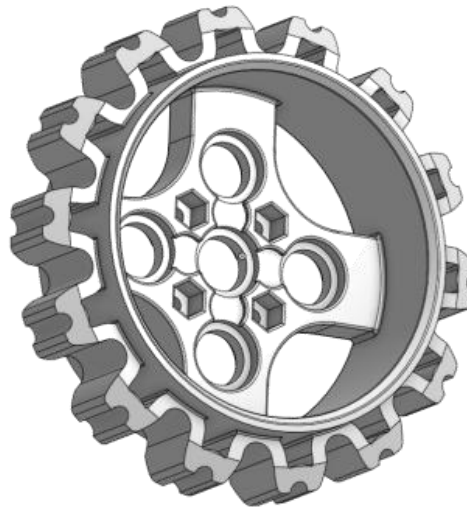
# Locomotion layer



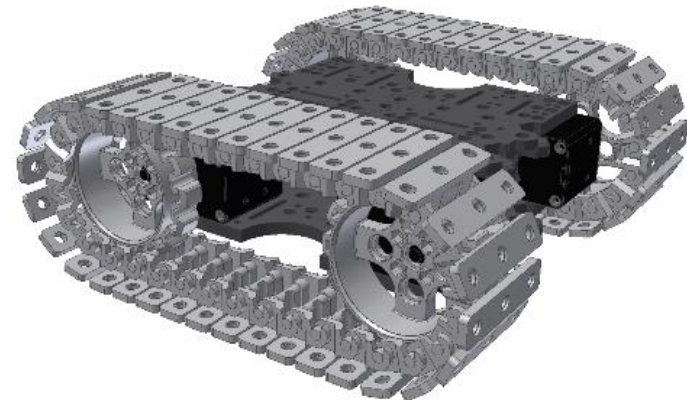
## Wheels of Turtlebot3

- Use as rubber wheel or caterpillar wheel

For rubber wheel



For caterpillar wheel





# Locomotion layer



## OpenCR of Turtlebot3

IMU(MPU9250: Gyroscope, Accelerometer, Magnetometer)

Battery charger

LEDs

GPIO x 18

JTAG

ROBOTIS Sensor pins

Output: 3.3V@0.8A

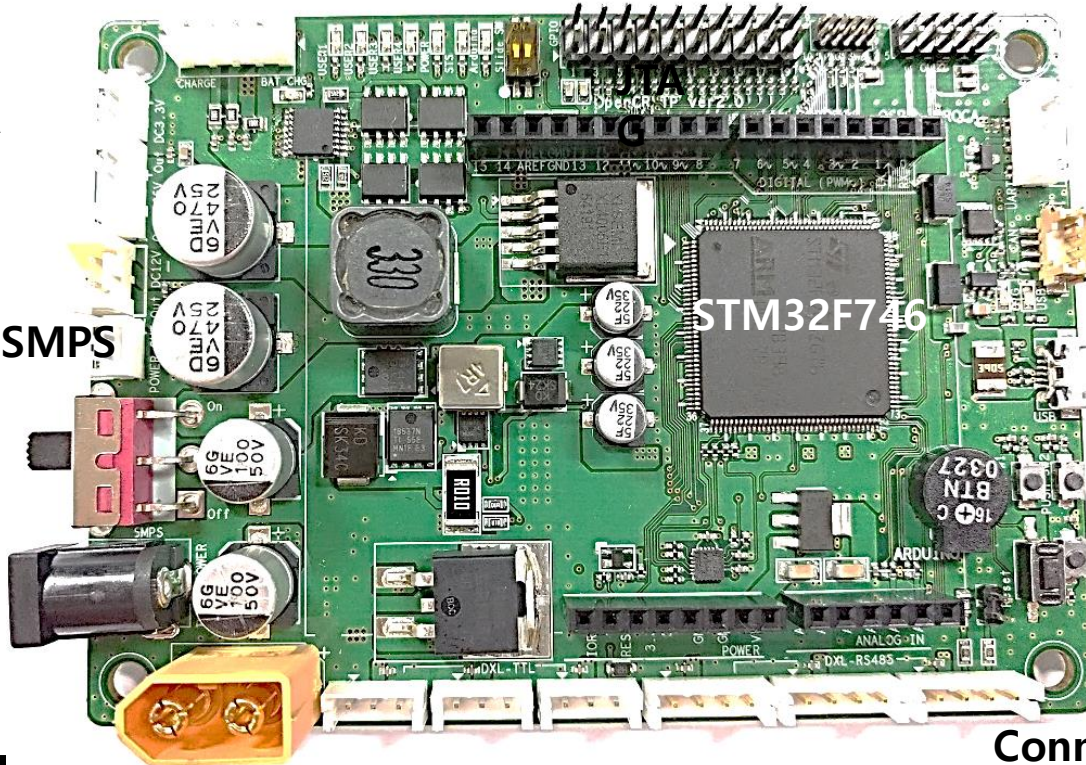
Output: 5V@4A

Output: 12V@1A

Output: Battery or SMPS

Power switch

SMPS input jack



UART

CAN

USB

User Button x 3

Reset Button x 1

Arduino

Connectivity Pins x 32

Battery input jack

TTL x 3

RS485 x 2

(GPIO, ADC, I2C, SPI, UART)





# Perception Layer



## Computer of Turtlebot3

: Single board computers (SBCs), or PC Modules

### [SBCs]

- **Hardkenel ODROID XU4**
- **Intel Joule**
- Up board
- Raspberry Pi 3 Model B
- DragonBoard 410c
- Beagle Bone Black

### [PC Modules]

- Intel NUC
- NVIDIA TK1 dev board



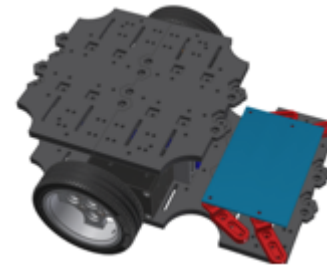
ODROID XU4



Up board



Raspberry Pi



Dragon Board 410C



Intel Joule



# Perception Layer



## Sensor(s) of Turtlebot3

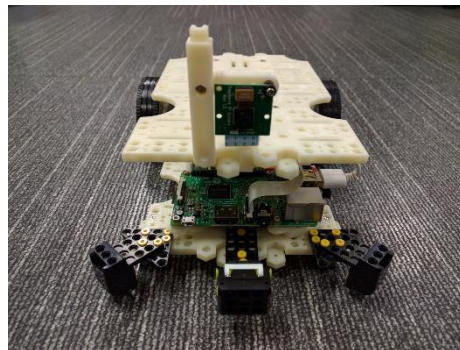
: 3D RGBD cameras, 2D laser rangefinders, USB webcams  
(\*we will challenge the Visual SLAM using a Turtlebot3 and a camera)

### [Distance sensors]

- Orbbec Astra
- Intel Realsense R200
- RPLIDAR
- SICK TIM LRF
- Hokuyo LRF
- Occipital Structure
- USB Webcams
- IR (PSD or ST VL6180x)
- Ultrasonic

### [Other sensors]

- Cliff sensor
- Bumper sensor
- MICs
- Speaker
- USB Camera





# Perception Layer



## ROBOTIS Sensors of Turtlebot3



Ultrasonics Sensor



Humidity & Temperature Sensor



Distance Sensor



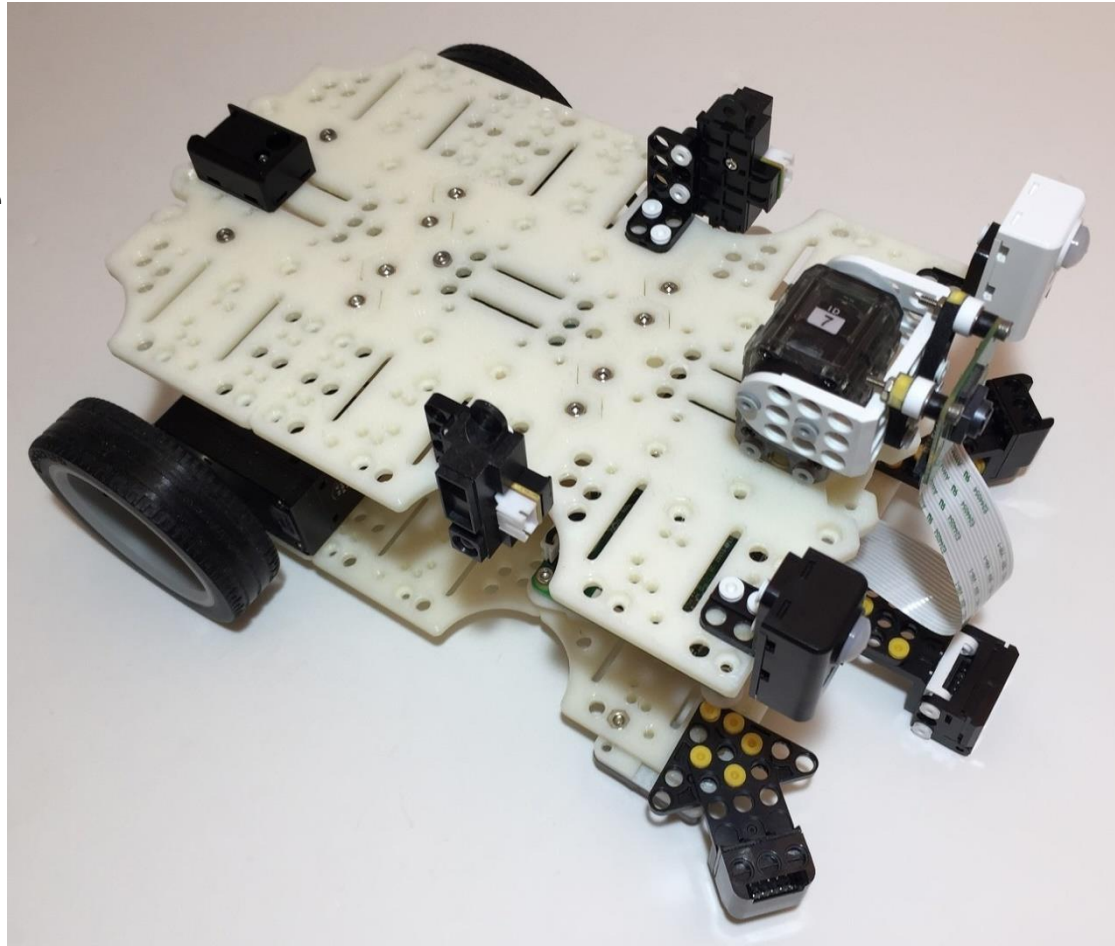
Touch Sensor



Gyro Sensor



Temperature Sensor



IR Sensor



Magnetic Sensor



Color Sensor



Illumination Sensor



Passive IR Sensor



# Manipulation layer



## Manipulation-X for Turtlebot3 (Option)

- Turtlebot +1 layer for Manipulator
- for Moveit! users
- low-cost manipulator
- Gravity compensation
- Position, velocity, torque control
- 4DOF + 1Gripper model
- 6DOF + 1Gripper model





# Demos

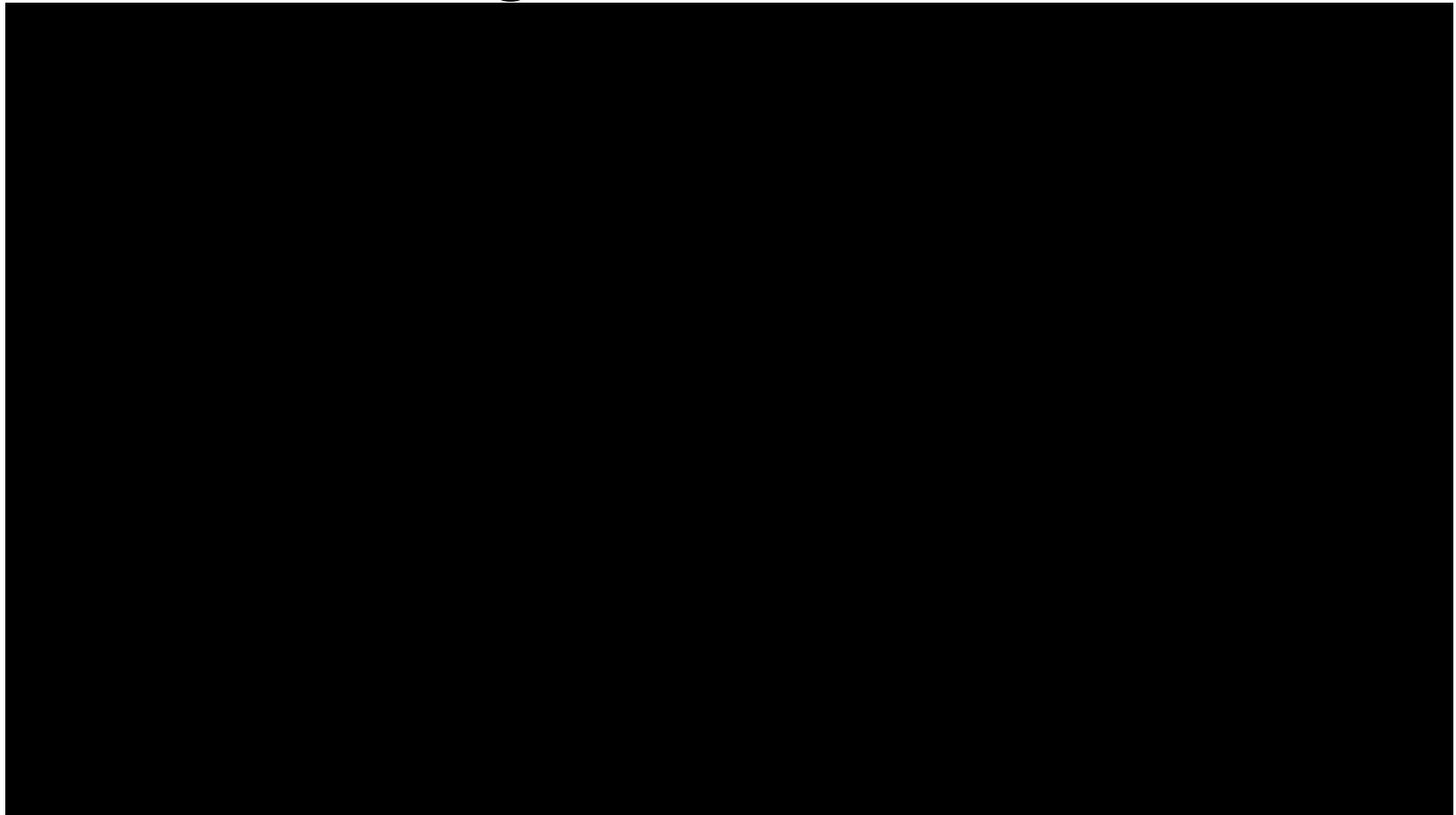


# Demos



**SLAM** and Navigation / Visual SLAM

X 10



<https://youtu.be/hX6pFcfr29c>

<http://wiki.ros.org/gmapping>

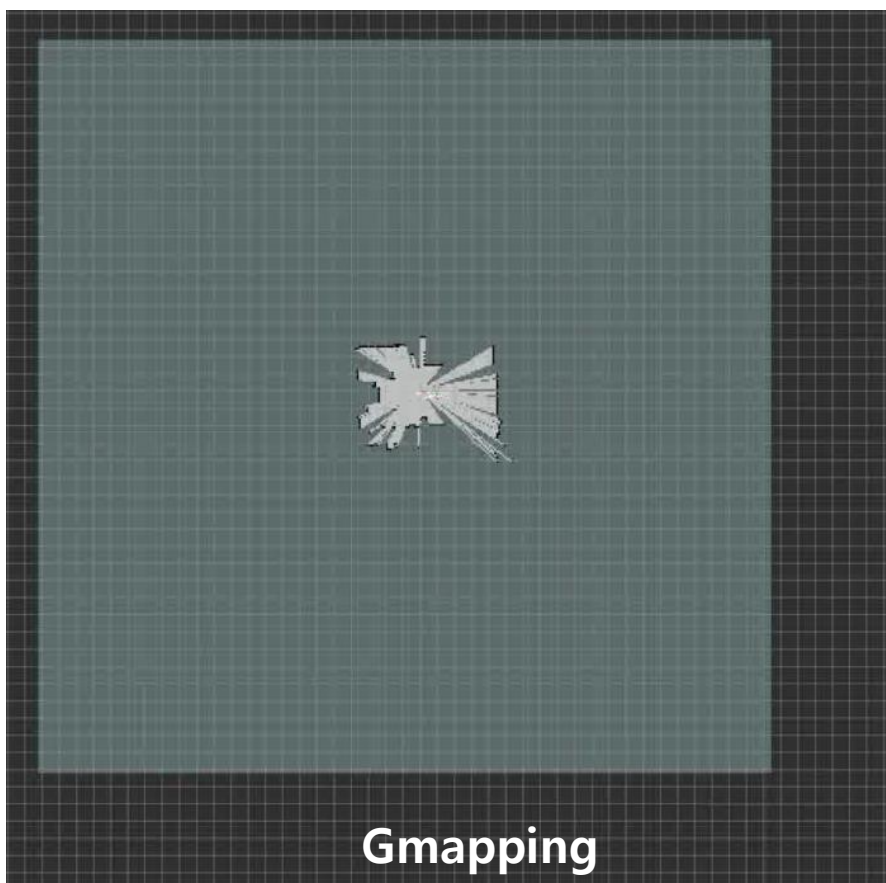


# Demos

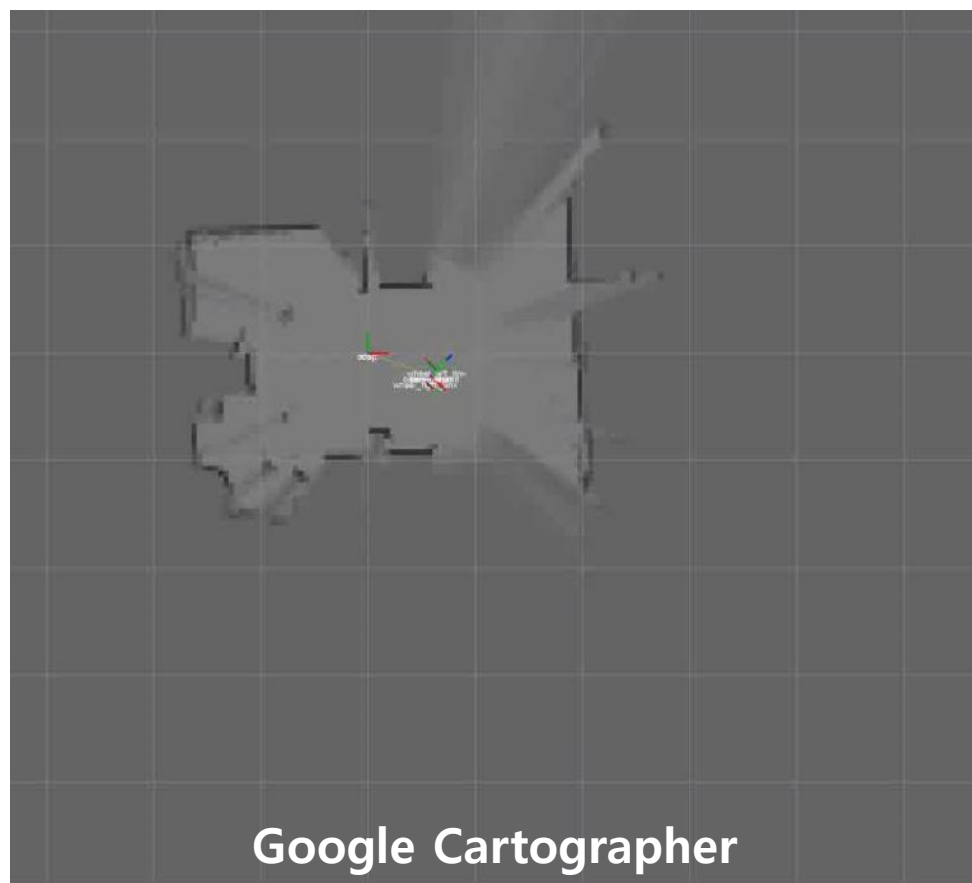


## SLAM and Navigation / Visual SLAM

X 10



Gmapping



Google Cartographer

[https://youtu.be/ZoEyCSL\\_edg](https://youtu.be/ZoEyCSL_edg)



# Demos



## SLAM and Navigation / Visual SLAM

X 1



<https://youtu.be/IOZmFC79S6A>

<http://wiki.ros.org/navigation>



# Demos



## SLAM and Navigation / Visual SLAM



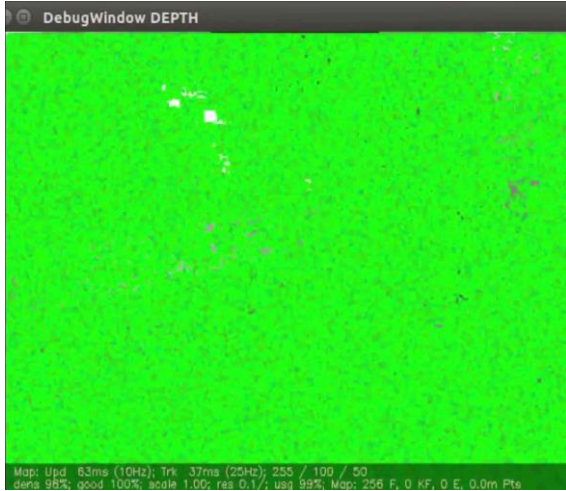


# Demos

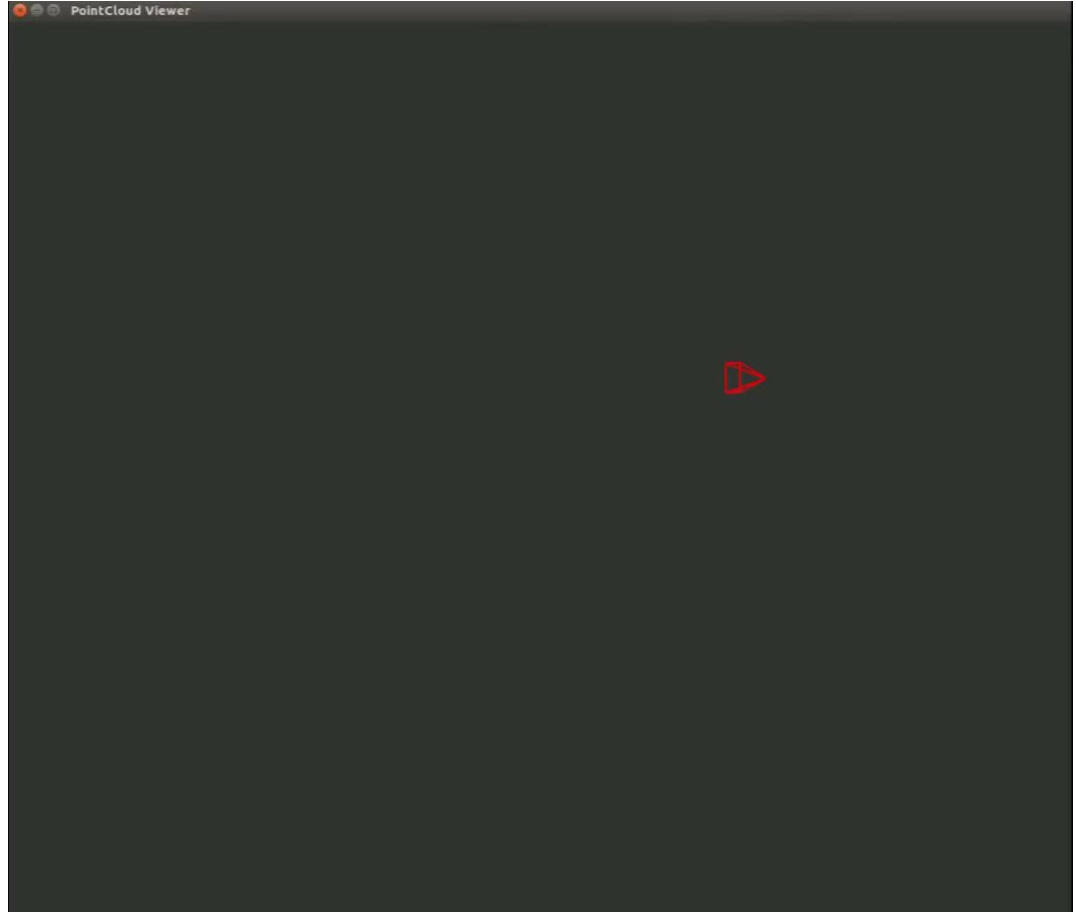


## SLAM and Navigation / Visual SLAM

X 4



<https://youtu.be/s98e0T3V8Cg>



<https://youtu.be/BfFXNnRpbMw>

LSD-SLAM / J. Engel et al. - TUM (Technische Universität München)



# Demos



The screenshot displays a ROS 2 visualization interface. The top toolbar includes buttons for 'Interact', 'Move Camera', 'Select', 'Focus Camera', 'Measure', '2D Pose Estimate', '2D Nav Goal', and 'Publish Point'. The main 3D view shows a robot model with a gripper, rendered in a grey and blue color scheme. The left sidebar contains a 'Displays' panel with the following settings:

- Plane: XY
- Offset: 0; 0; -0.12
- RobotModel:
- Status: Ok
- Visual Enabled:
- Collision Enabled:
- Update Interval: 0
- Alpha: 1
- Robot Description: robot\_description
- TF Prefix: (empty)
- Links:
  - Link Tree Style: Links in Alphabetic...
  - Expand Link Det...:
  - All Links Enabled:
  - base:
  - grip\_link:
  - grip\_link\_sub:
  - link1:
  - link2:
  - link3:
  - link4:
  - link5:
  - link6:
  - link7:
  - world:
- TF:
- Status: Ok
- Show Names:
- Show Axes:
- Show Arrows:
- Marker Scale: 0.1
- Update Interval: 0
- Frame Timeout: 15
- Frames:
  - All Enabled:
  - base:
  - grip\_link:
  - grip\_link\_sub:
  - link1:
  - link2:
  - link3:

Below the sidebar, there is an 'Offset' section with the text: 'Allows you to offset the grid from the origin of the reference frame. In meters.' At the bottom of the sidebar are buttons for 'Add', 'Duplicate', 'Remove', and 'Rename'.

<https://youtu.be/d-1737xFPUA>

# Details

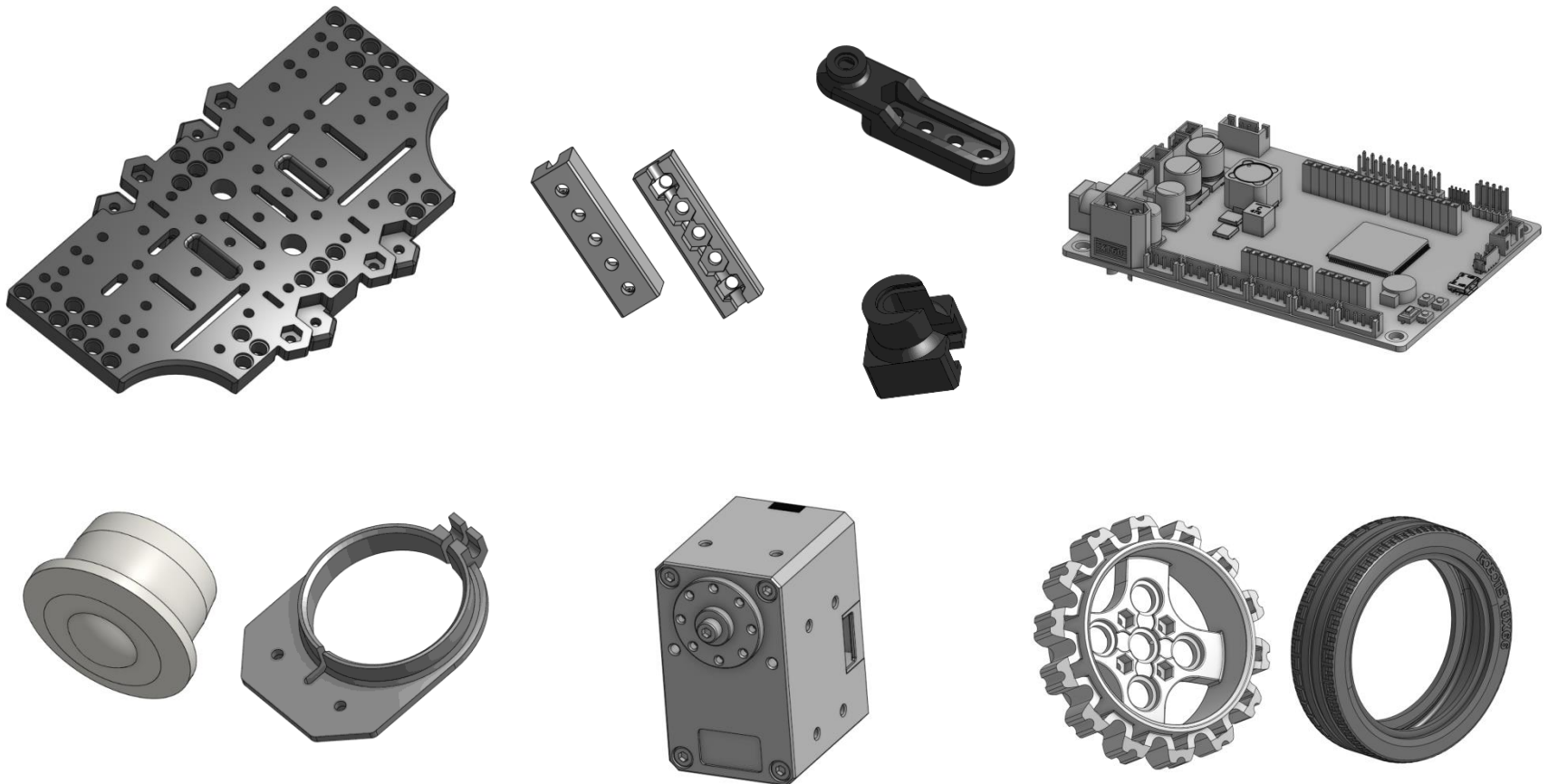




# Details



## Module based model & Assembling film

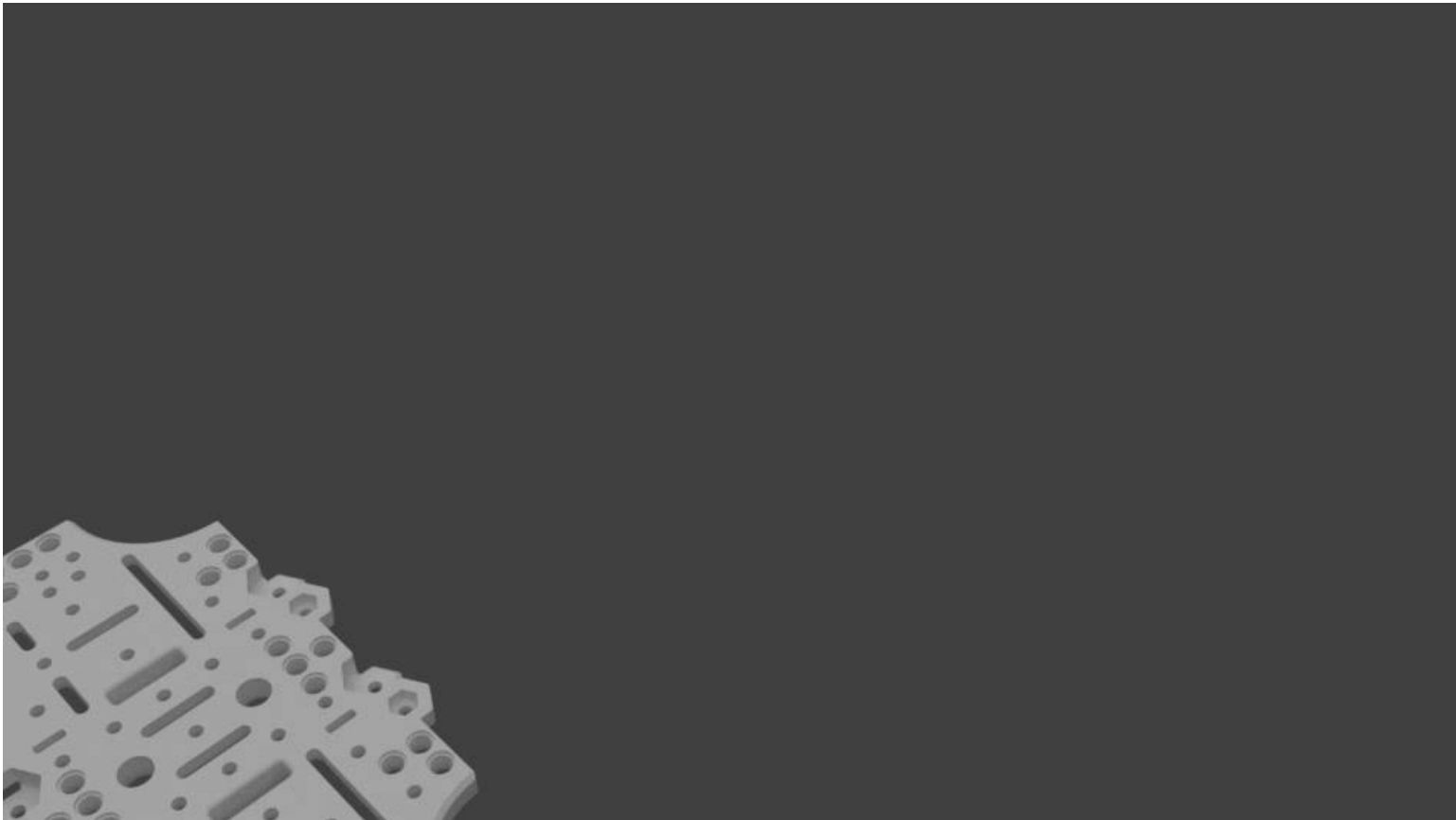




# Details



## Module based model & **Assembling film**



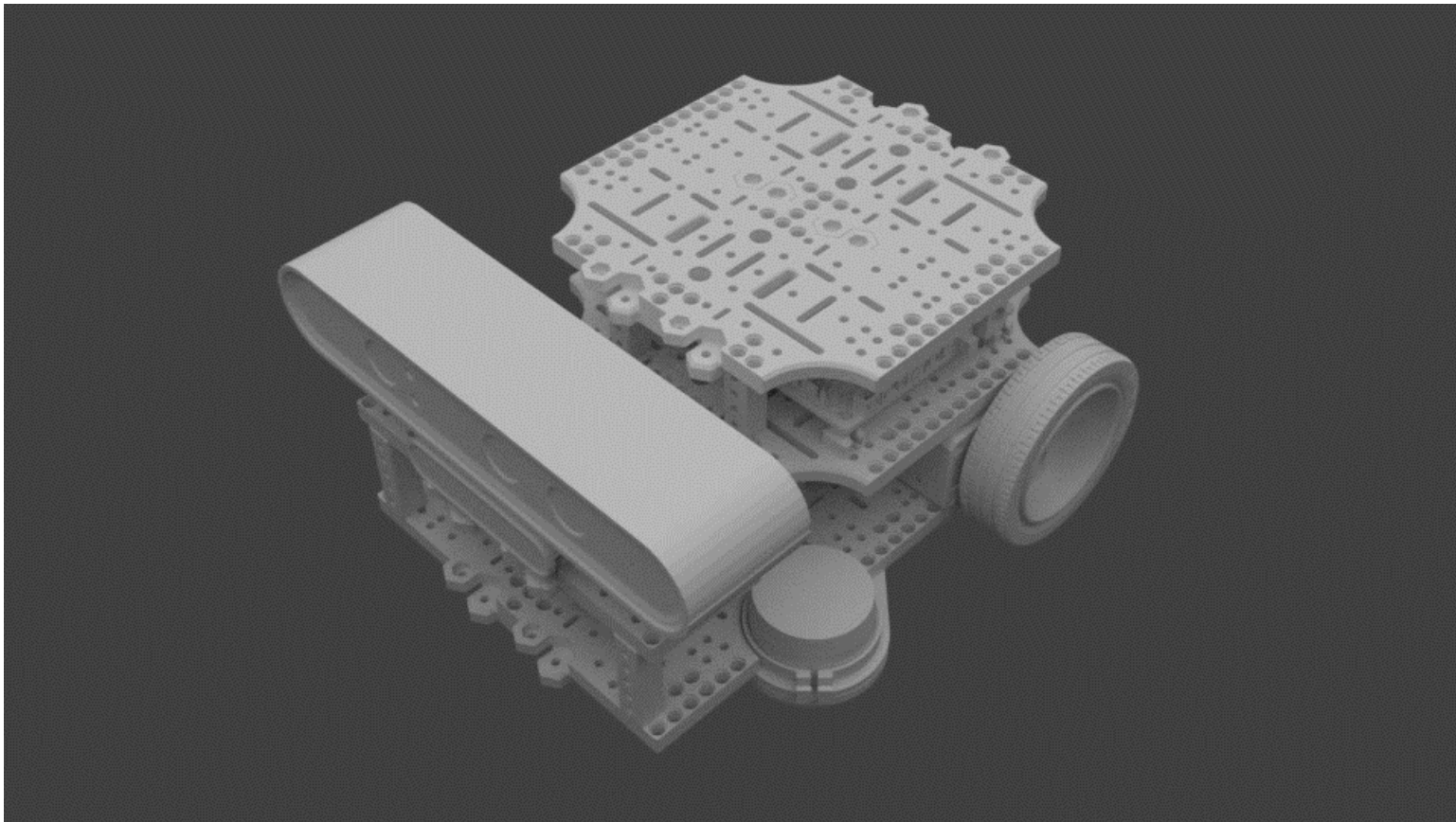
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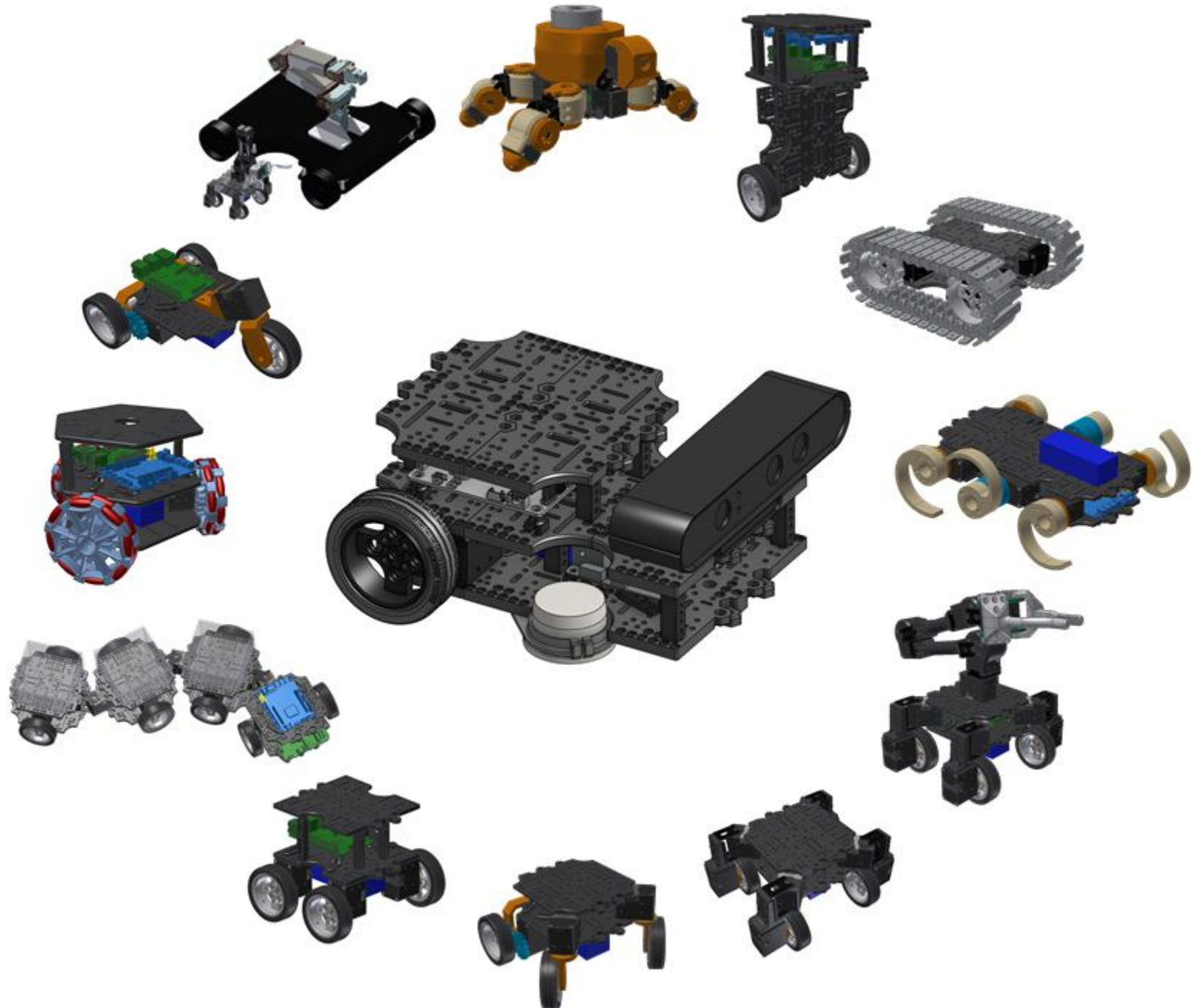
# Details



## Module based model & **Assembling film**



<https://youtu.be/r3oNIWex8a0>

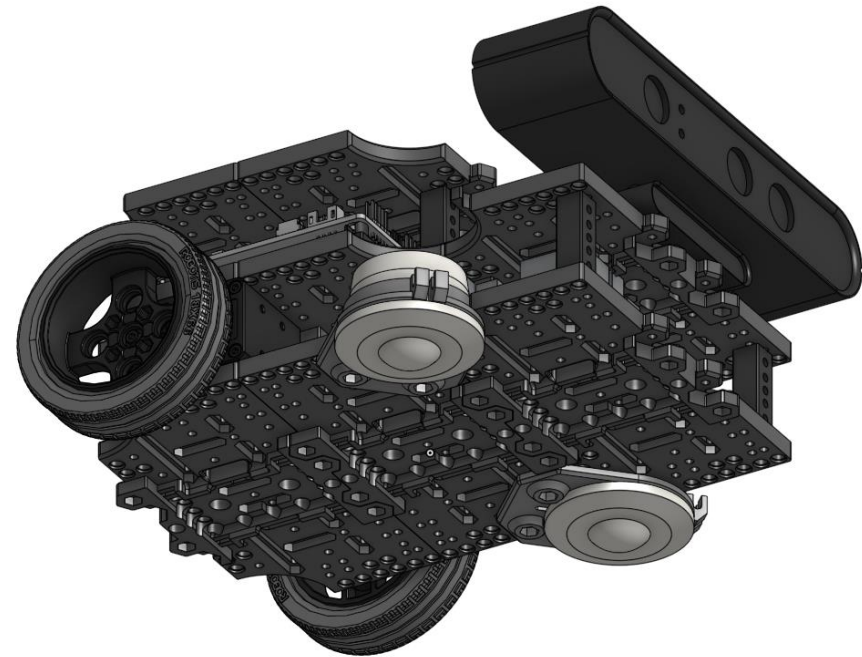
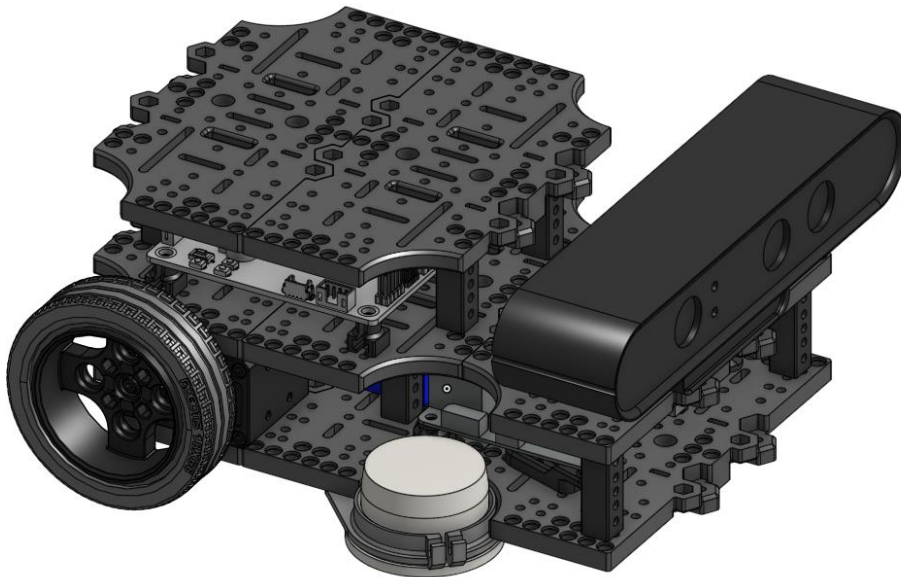




# Details



Default) 2 Wheels + 2 ball casters

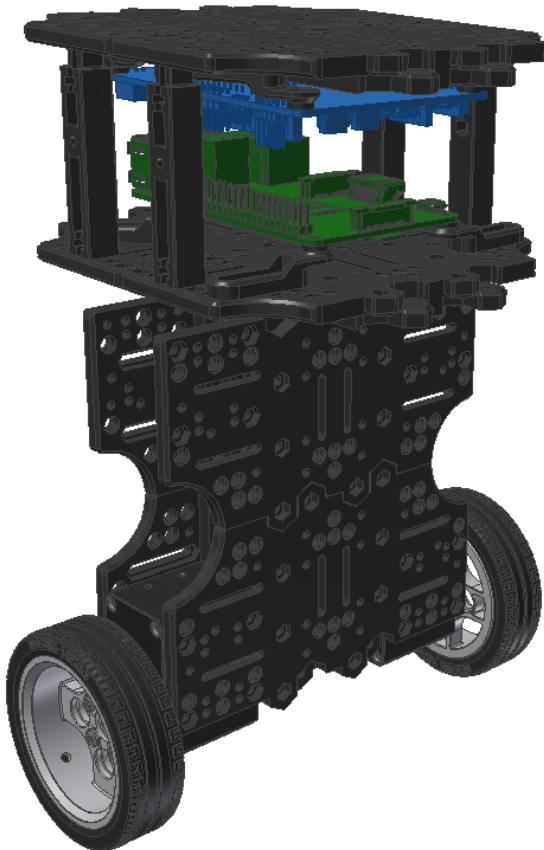




# Details



## Ex 1). 2 Wheels + Segway



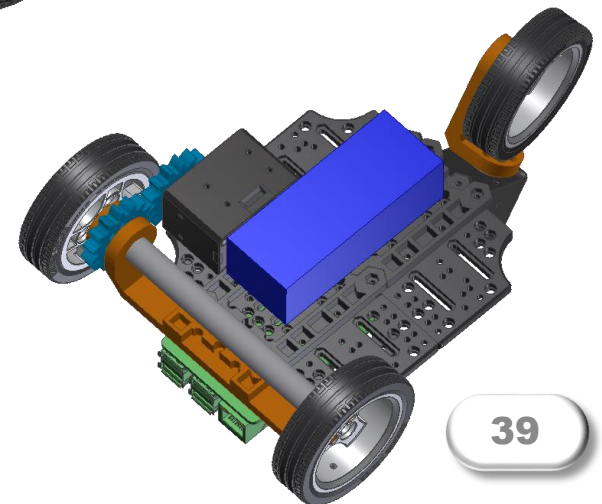
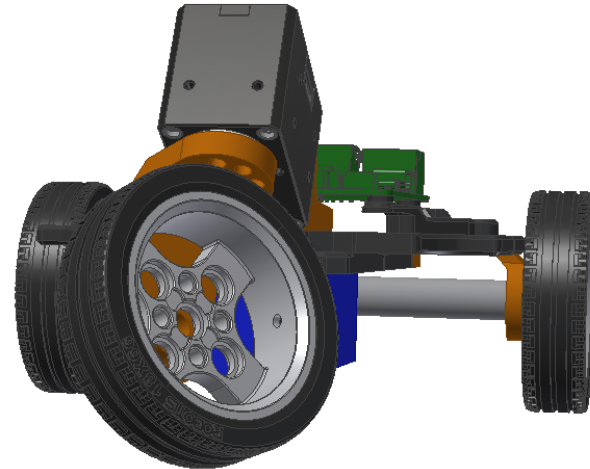
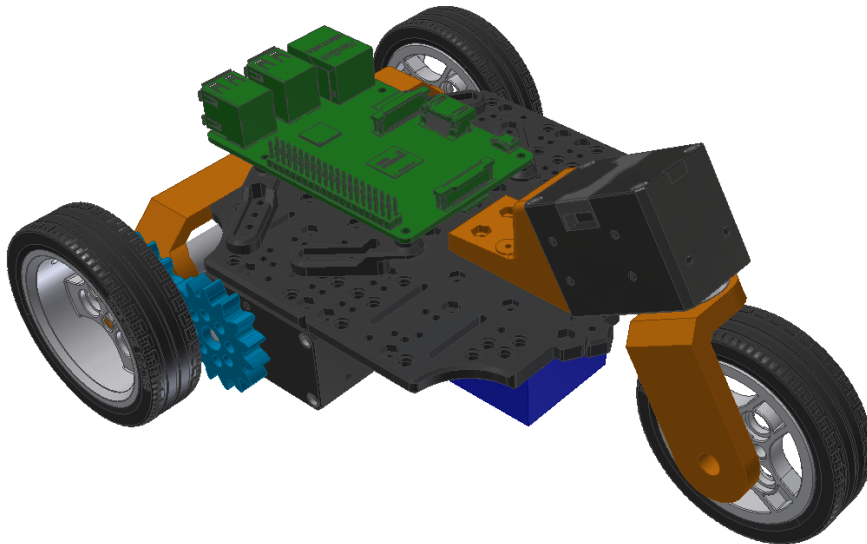
<http://www.segway.com/products/consumer-lifestyle/minipro>



# Details



Ex 2). 3 Wheels (steer motor 1ea + drive motor 1ea)

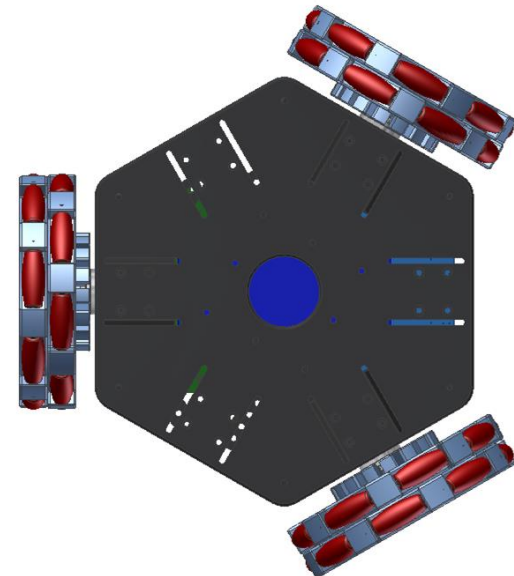
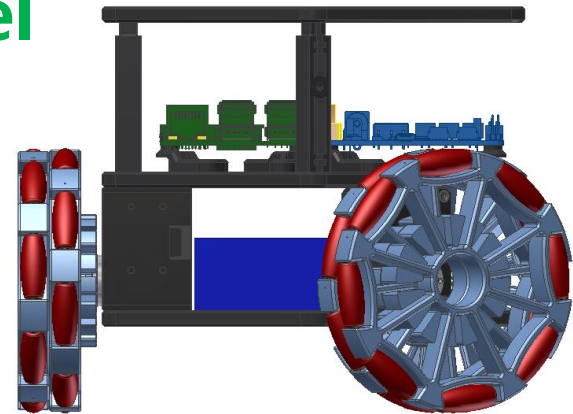
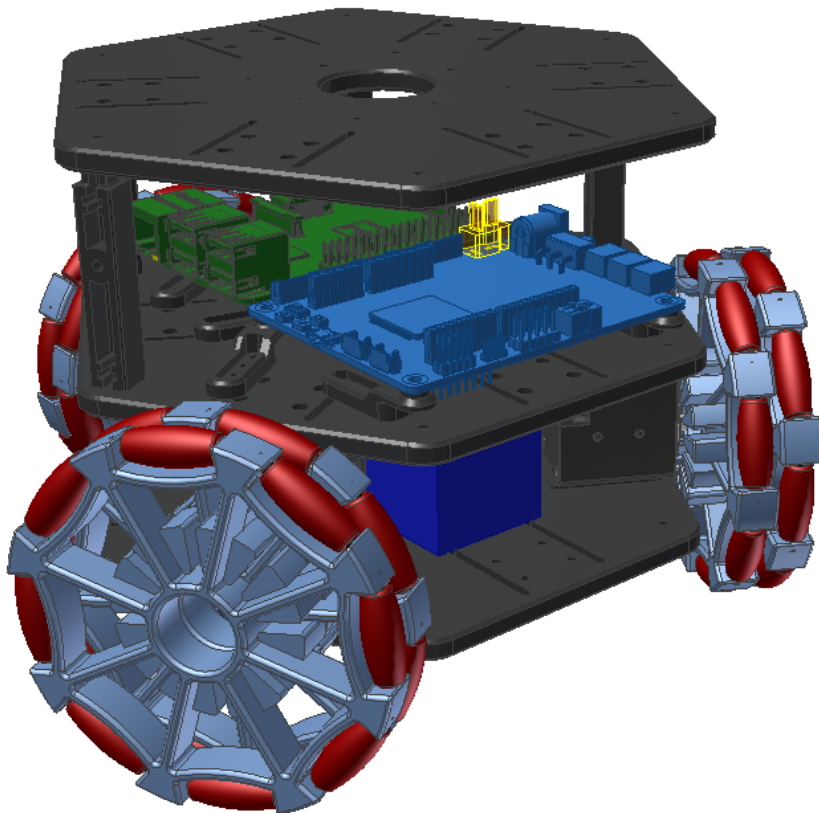




# Details



## Ex 3). 3 Wheels + omni-wheel



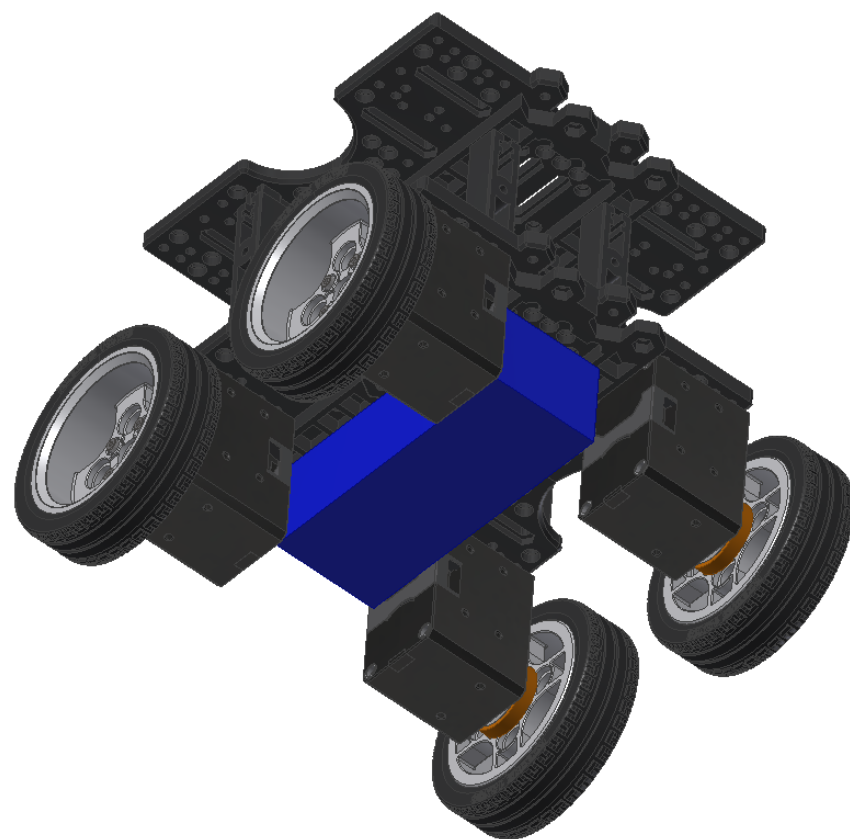
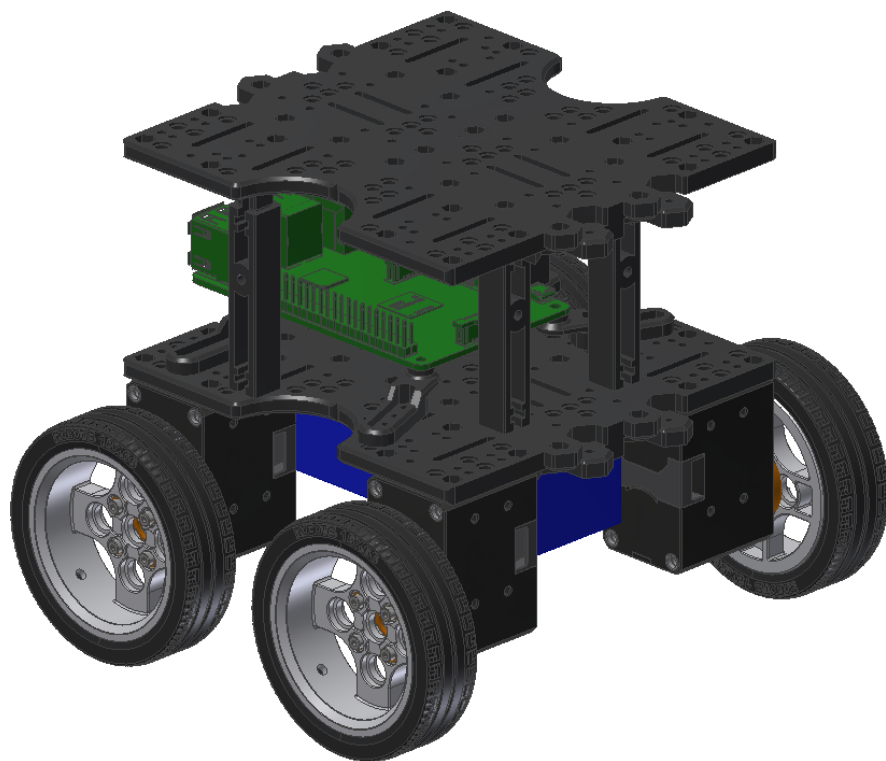




# Details



## Ex 4). 4 Wheels



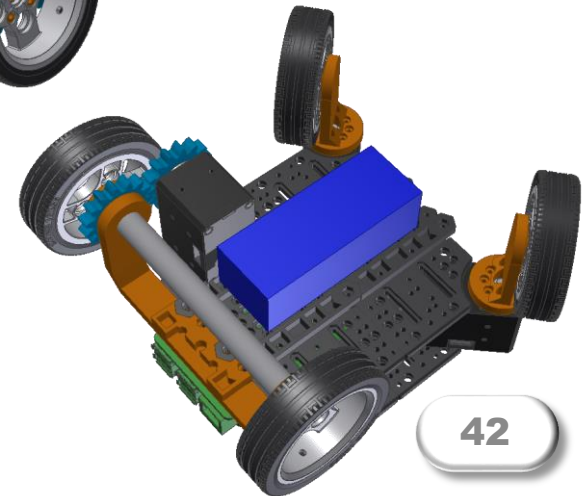
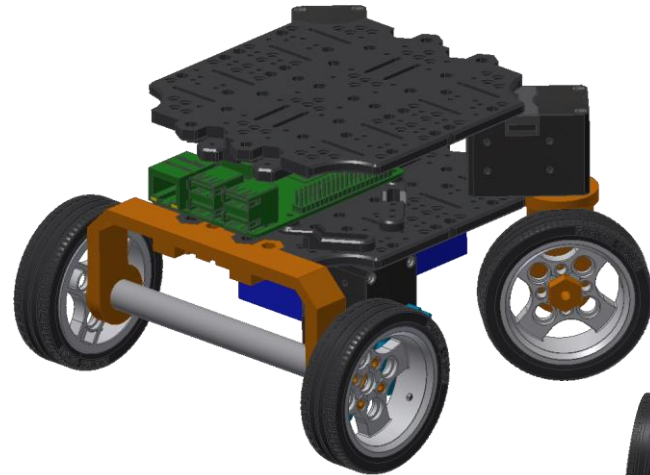
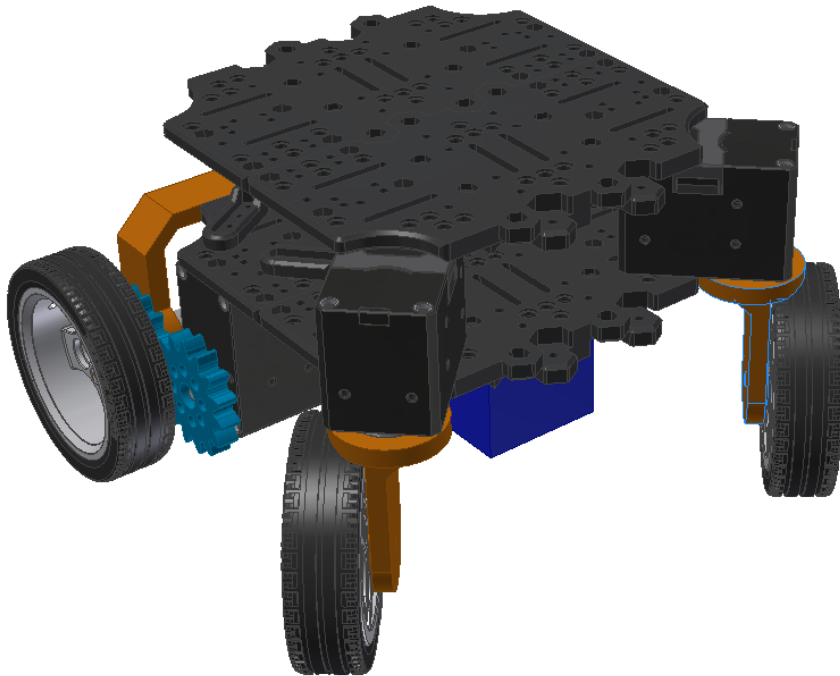


# Details



Ex 5). 4 Wheels

(front-steer-motor 2ea + drive motor 1ea)

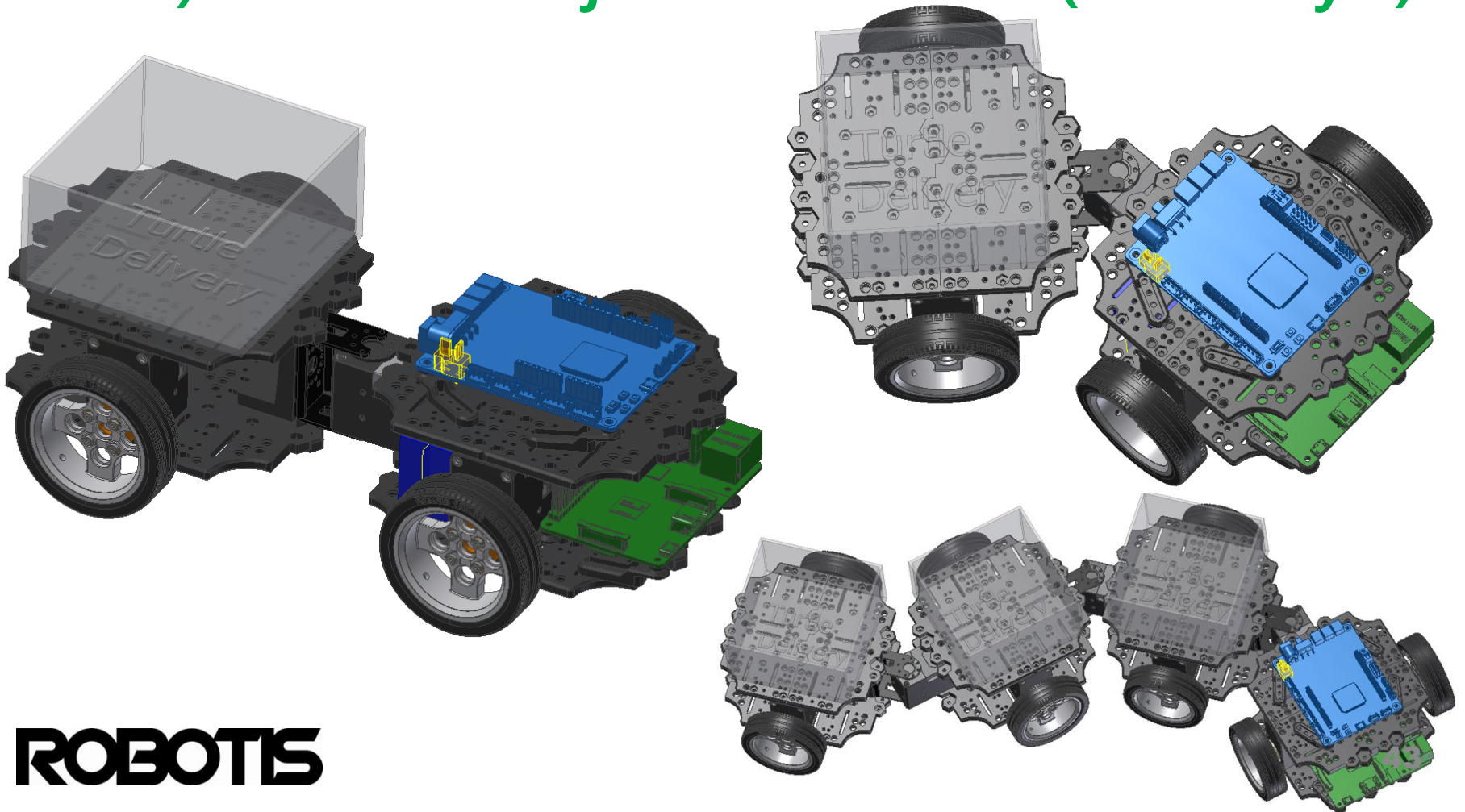




# Details



Ex 6). 4 Wheels + joint motor 1ea (snake style)

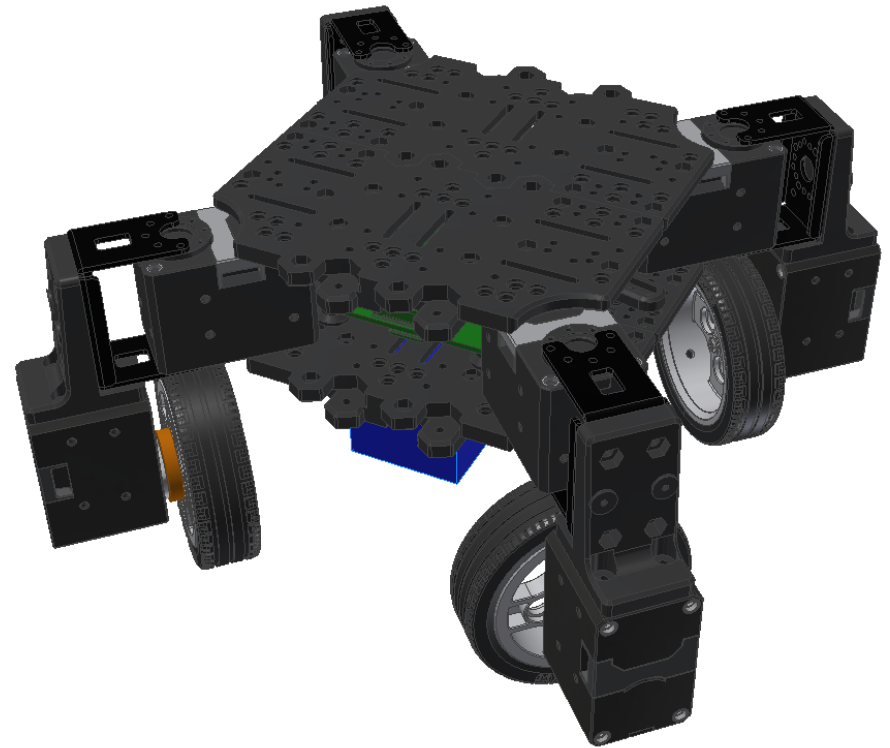
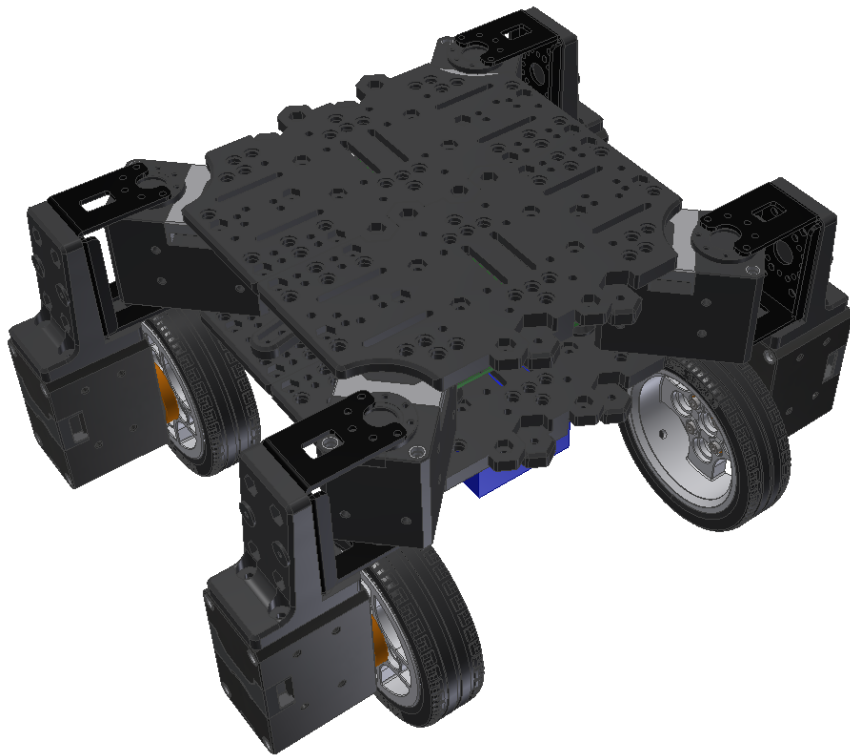




# Details



## Ex 7). 4 Wheels + omni-drive

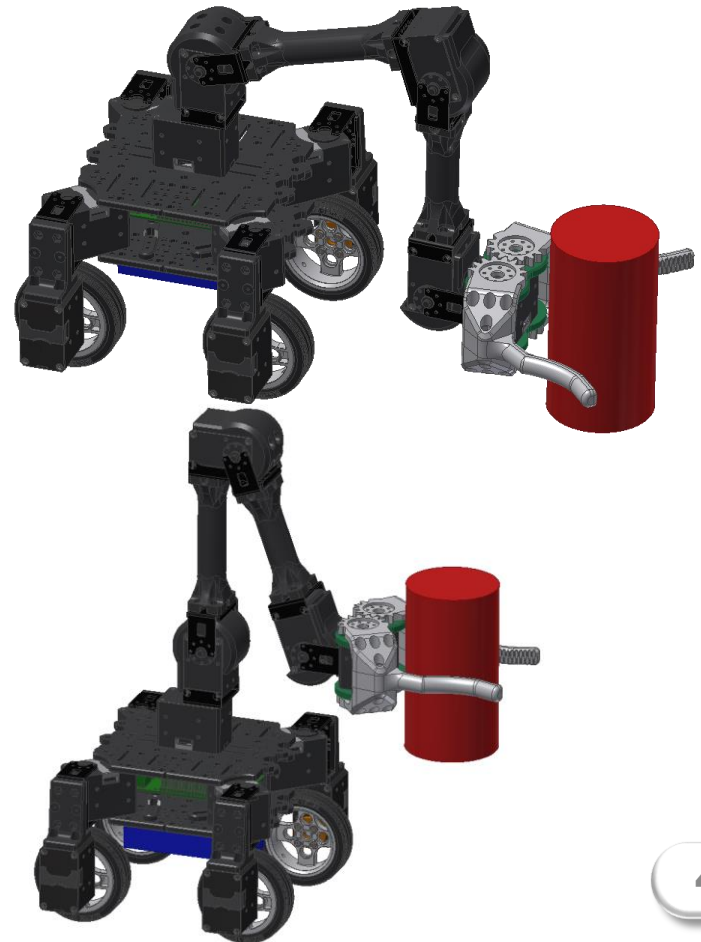
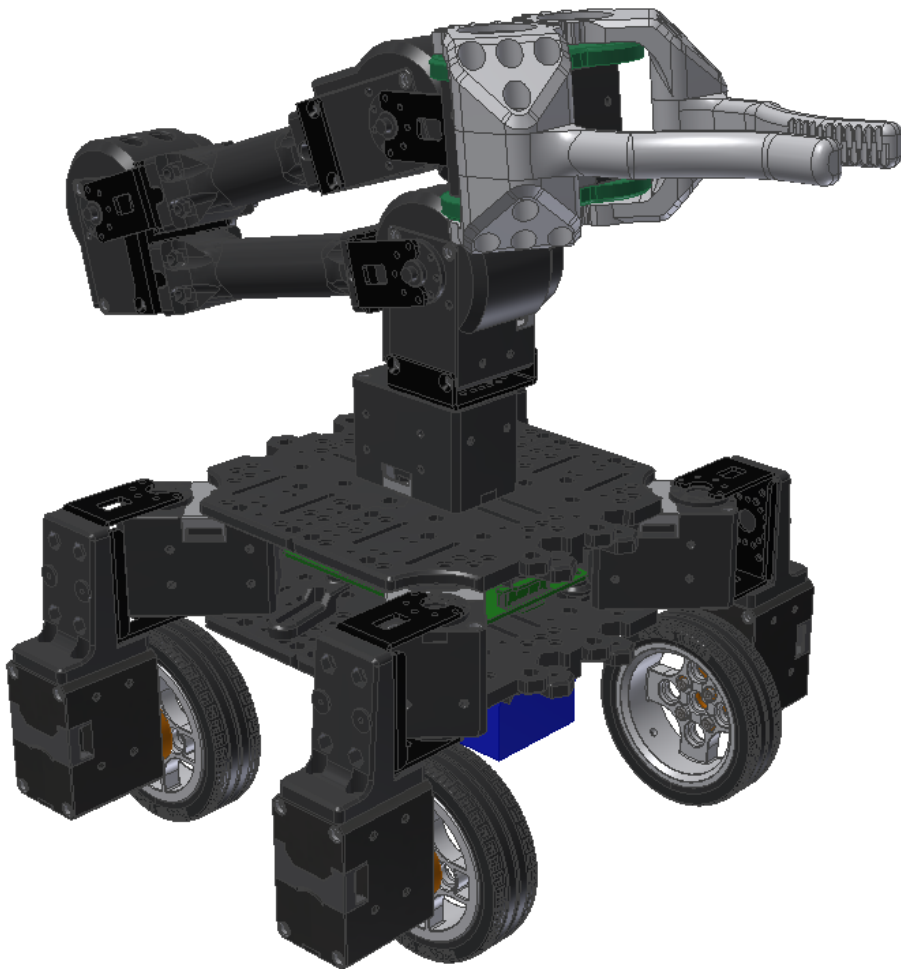




# Details



Ex 8 a). 4 Wheels + omni-drive + manipulator-x

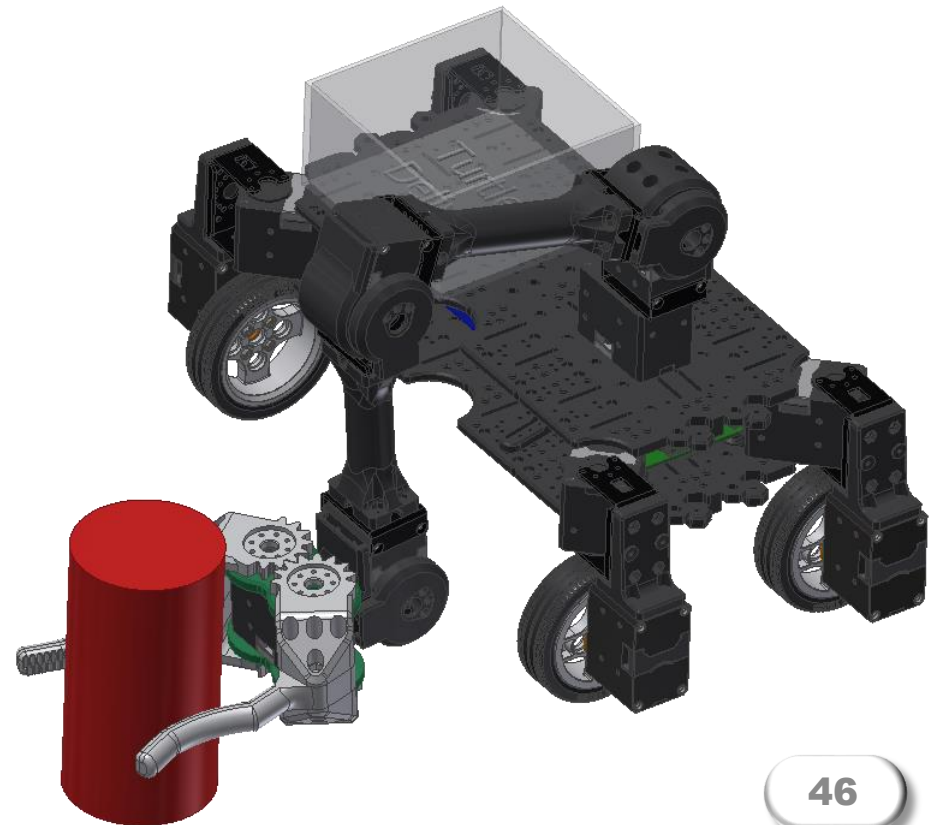




# Details



Ex 8 b). 4 Wheels + omni-drive + manipulator-x

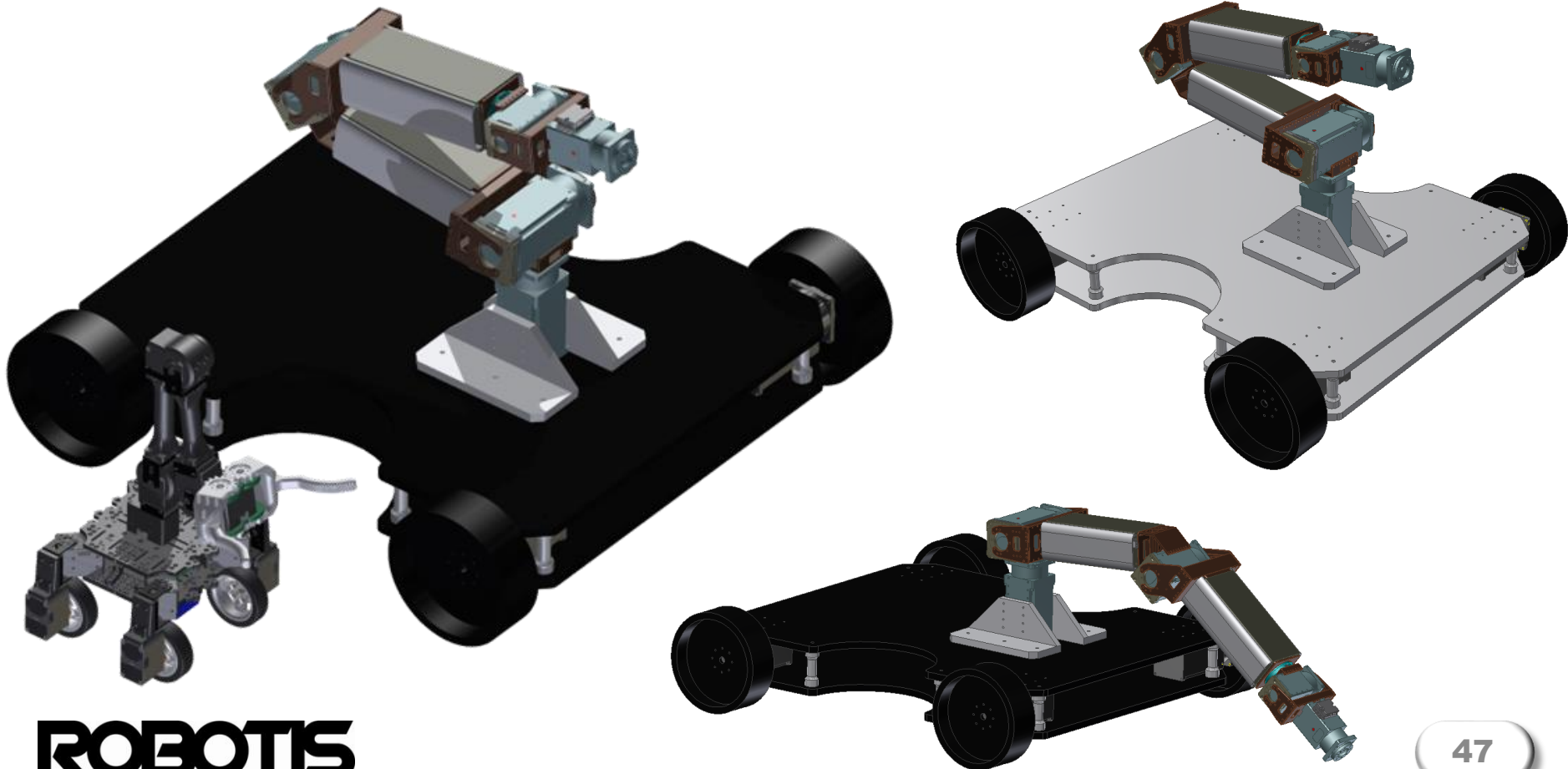




# Details



## Ex 9). 4 Wheels with Dynamixel PRO (scale up version)

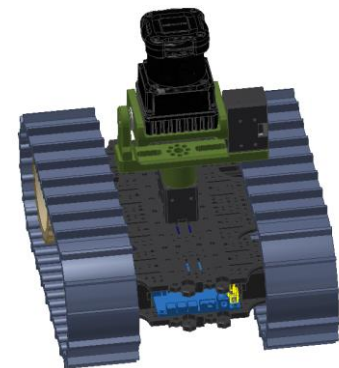
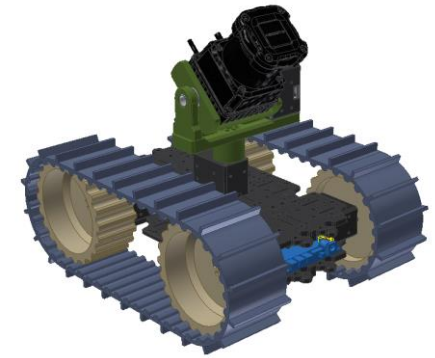
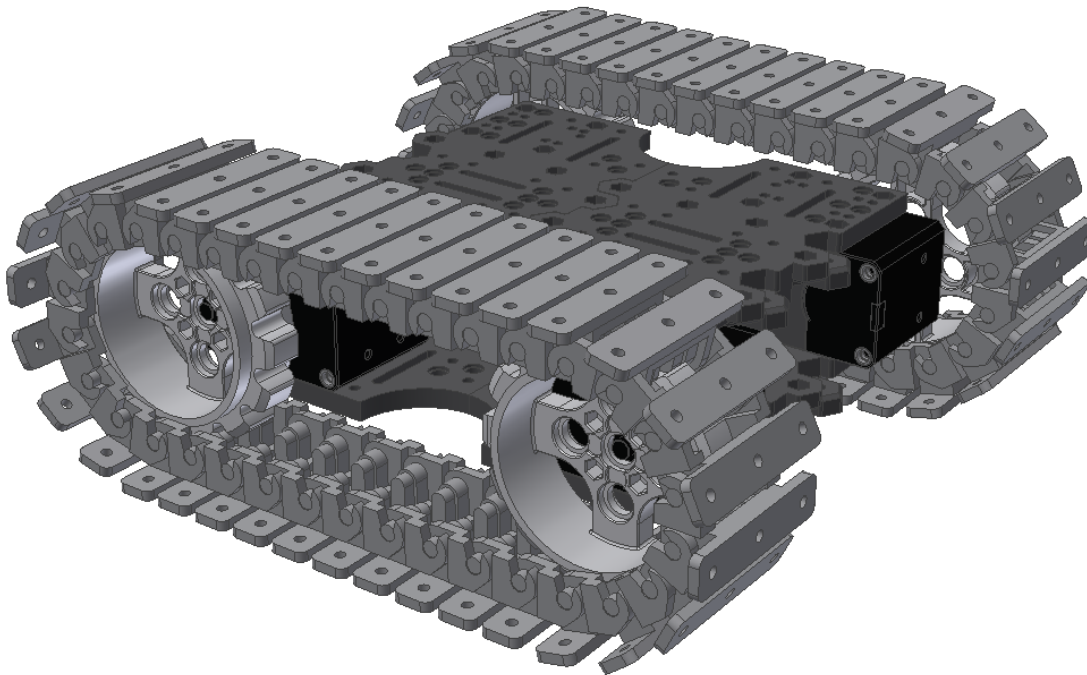




# Details



## Ex 10). 4 Wheels (caterpillar)



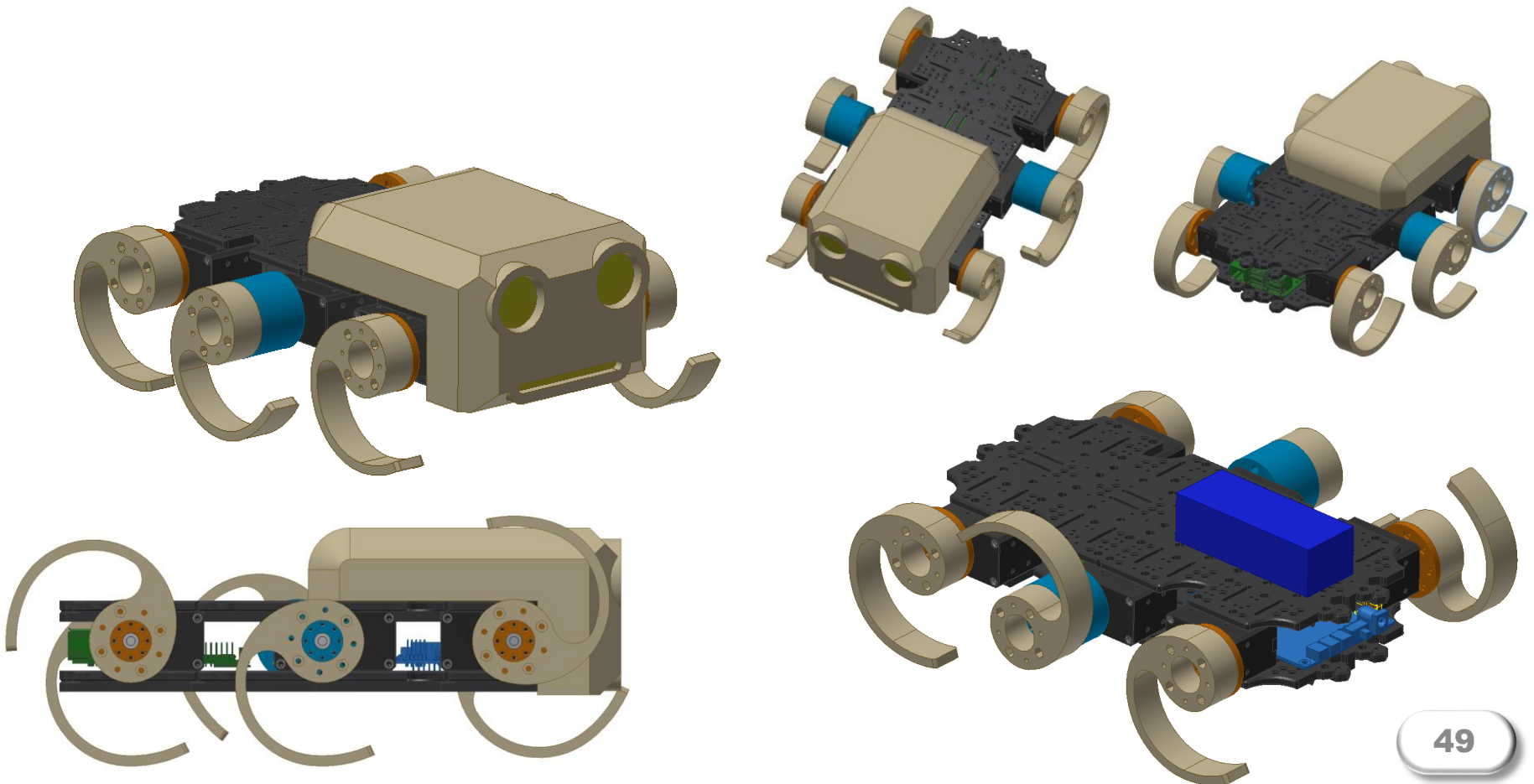




# Details



## Ex 11). 6 Wheels (special wheels)

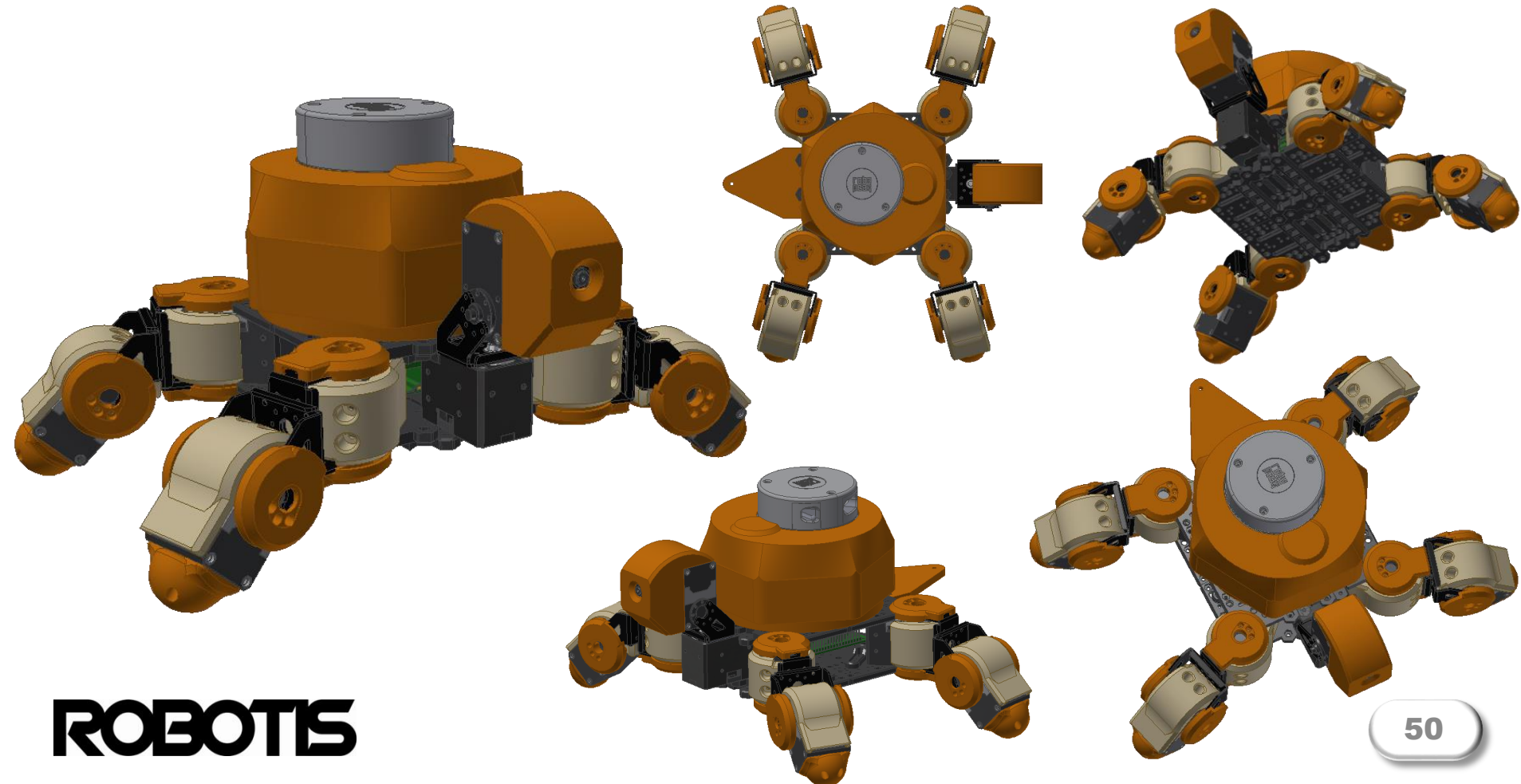




# Details



## Ex 12). 4 Legs (real turtlebot style)

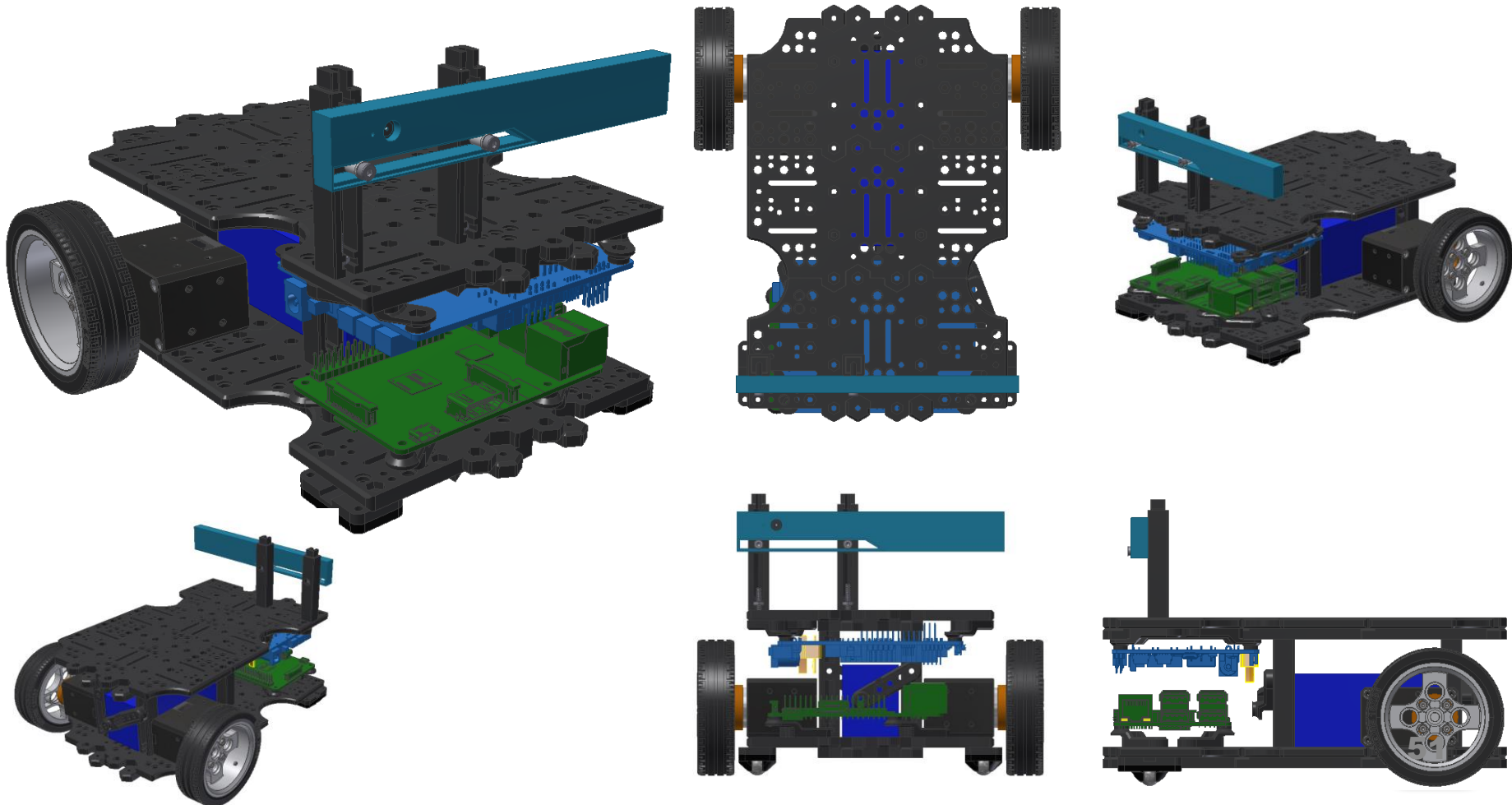




# Details



## Intel Joule + RealSense version

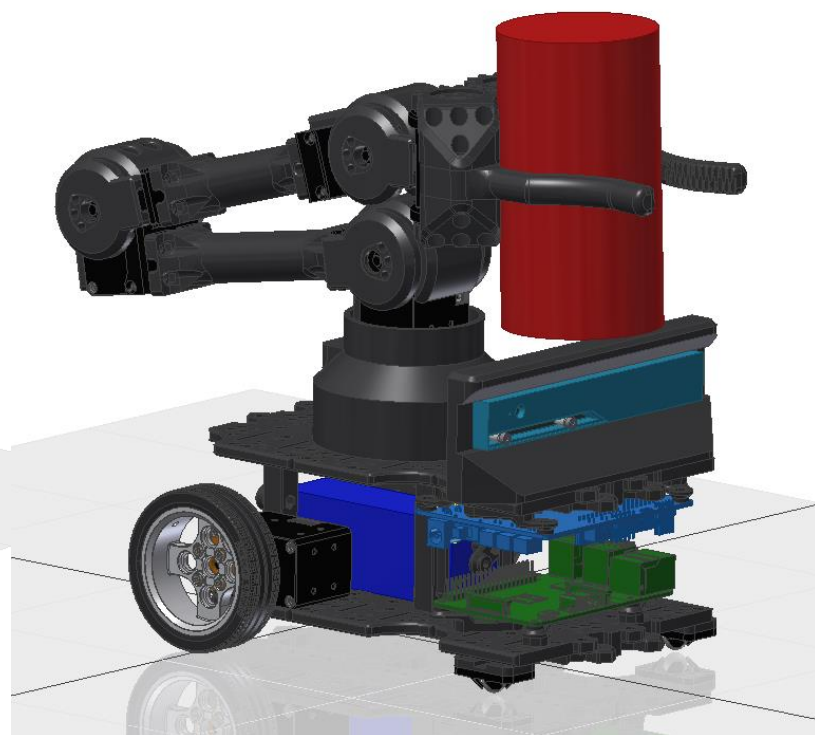
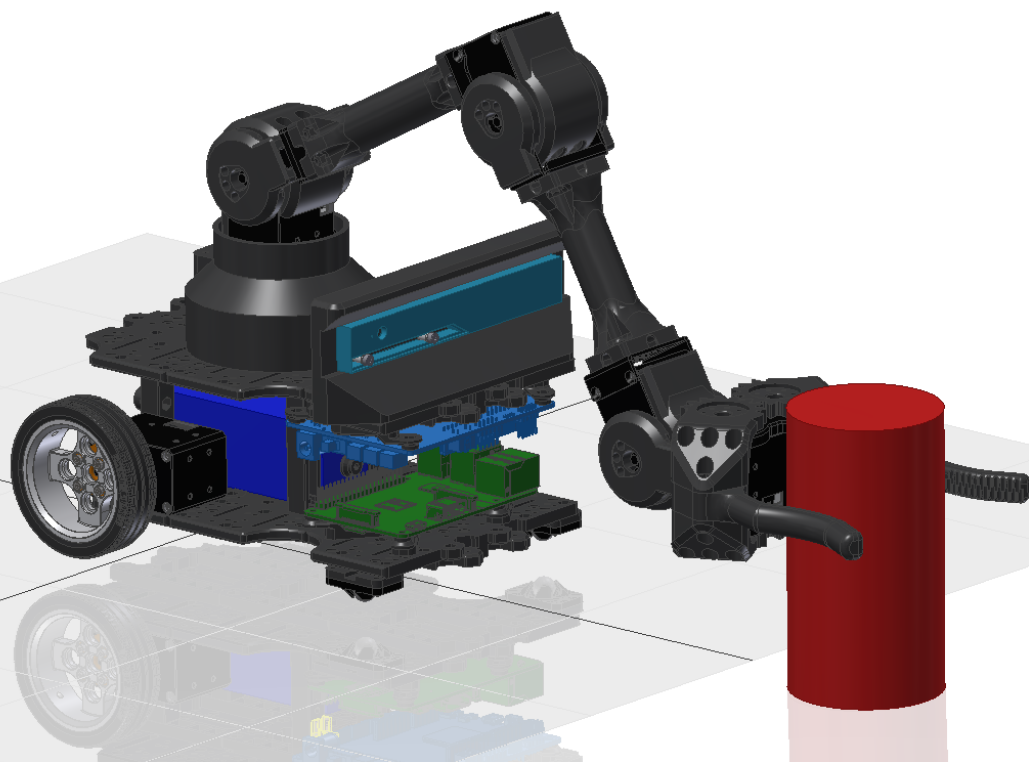




# Details



## Manipulator-X





# Details



## 3D Printability

Onshape  App Store Invite friends Share ? ROBOTIS

Your subscription: **Free** [Learn more](#) 0 of 10 Private documents 0 bytes of 100 MB Private storage 0 bytes of 5.00 GB Total storage

- Create
- Recently opened
- My documents
  - Created by me
  - Shared with me
  - New Label...
- Public**
- Tutorials & Samples
- Trash

### 29 Results for ROBOTIS in Public

Search in my documents

|  | Name  | Workspace | Modified       | Owned by               | Likes | Links | Copies |
|--|---|-----------|----------------|------------------------|-------|-------|--------|
|  | ROBOTIS Turtlebot3 ver3.0                               | Main      | 7:30 PM Today  | ROBOTIS CO., LTD.      | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel AX-12A / AX-18A / AX-12W / MX-12W ... |           | 3:47 PM Aug 25 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel Pro H42-20-S300-R                     | Main      | 9:43 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel Pro L42-10-S300-R                     | Main      | 9:25 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel MX-28T / MX-28R                       | Main      | 9:26 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel EX-106+                               | Main      | 9:33 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel DX-117                                | Main      | 9:48 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel Pro L54-30-S500-R                     | Main      | 9:24 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel MX-64T                                | Main      | 8:53 AM Jun 22 | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |
|  | ROBOTIS Dynamixel XM430                                 | Main      | 12:02 PM Today | ROBOTIS OpenSourceTeam | 0     | 1     | 0      |
|  | ROBOTIS Manipulator-X (6DOF+1Gripper)                   | Main      | 5:10 PM Today  | ROBOTIS OpenSourceTeam | 0     | 0     | 0      |

Upgrade to Professional

**ROBOTIS Dynamixel Pro H54-200-S500-R**

**Owner**  
ROBOTIS OpenSourceTeam

**Description**  
No description

**Labels**  
No labels

**Sharing**  
Public to all users  
👍 0 🔗 0 📄 0

**Created by**  
ROBOTIS OpenSourceTeam  
3:55 PM Jun 20

**Last modified by**  
Darby Lim  
4:55 PM Today

**Size**  
728 KB

**Default workspace**  
Main



# Details



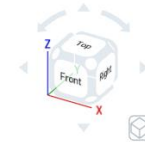
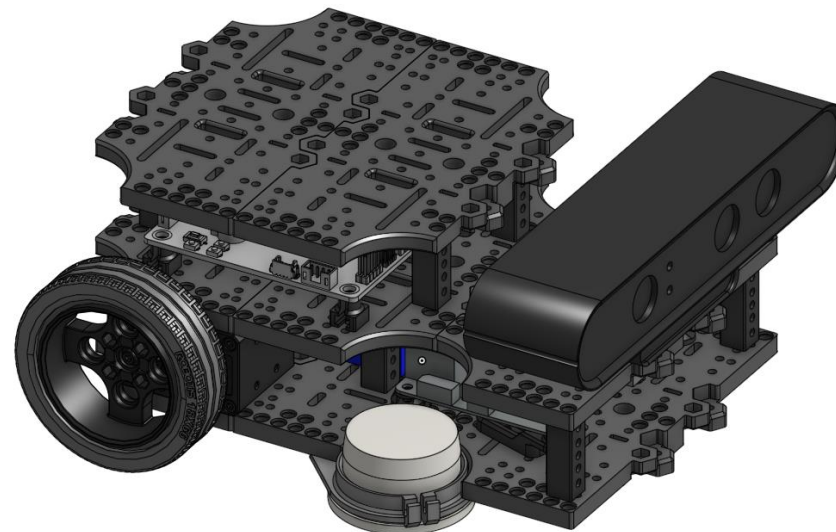
## 3D Printability

Onshape **ROBOTIS Turtlebot3 ver3.0** Main 0 0 0 App Store Share ROBO TIS ▾

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Instances (30)

- Origin
- tb3-v300-0...
- tb3-v300-01\_plat...
- tb3-v300-01\_plat...
- dummy\_battery\_L
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-01\_plat...
- tb3-v300-01\_plat...
- tb3-v300-01\_plat...
- tb3-v300-01\_plat...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-03\_post...
- tb3-v300-01\_plat...
- tb3-v300-01\_plat...
- Part 1 <1>
- tb3-v300-04\_pcb...
- tb3-v300-04\_pcb...
- tb3-v300-04\_pcb...
- tb3-v300-04\_pcb...
- > Motor Wheel <1>
- > Motor Wheel <2>
- > Ball caster <1>
- > Ball caster <2>
- > OpenCR <1>
- > Astra Camera <1>



Assembly | Turtlebot3 | Motor Wheel | Ball caster | Astra Camera | OpenCR



# Details



## 3D Printability

Onshape **ROBOTIS Turtlebot3 ver3.0** Main 0 0 0

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Features (5)

*Filter by name or type*

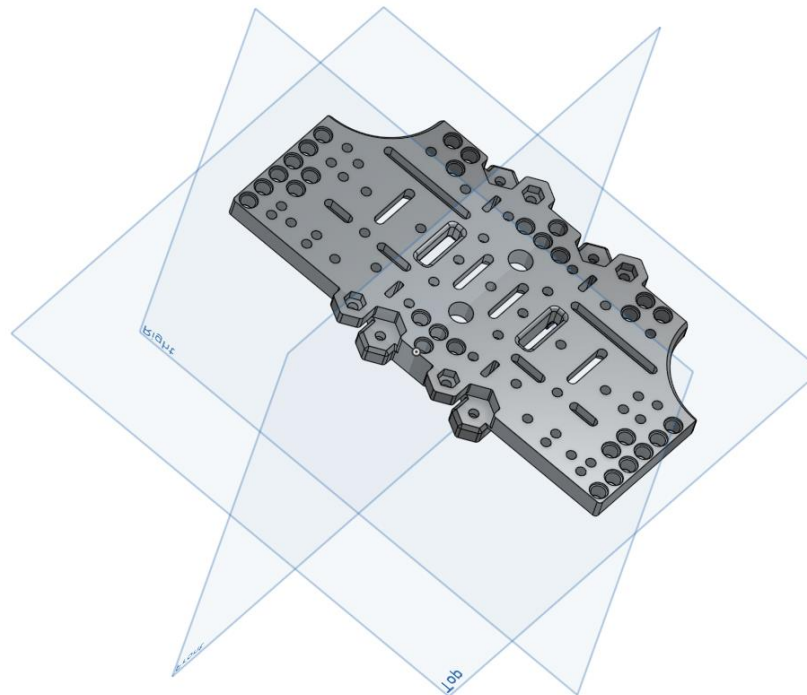
▼ Default geometry

- Origin
- ▣ Top
- ▣ Front
- ▣ Right

Import 1

Parts (1)

tb3-v300-01\_plate



Parts st\_mid tb3-v300-08\_post\_open... tb3-v300-04\_pcb\_base tb3-v300-03\_post\_short tb3-v300-02\_post\_long tb3-v300-01\_plate Dynamixel\_XM430 dummy\_battery\_1b-012 BB\_522\_B180\_POM\_1 Odroid XU4



# Details



## Full Open-source

### Hardware

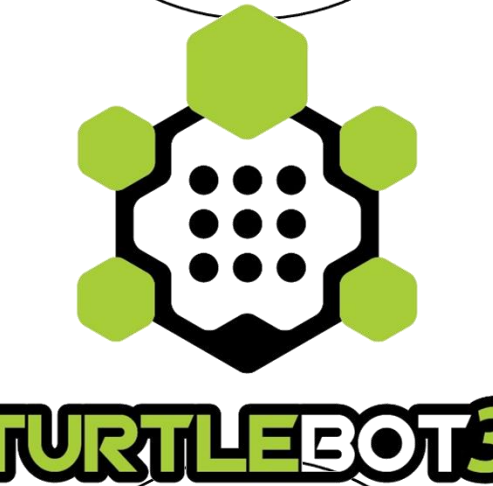
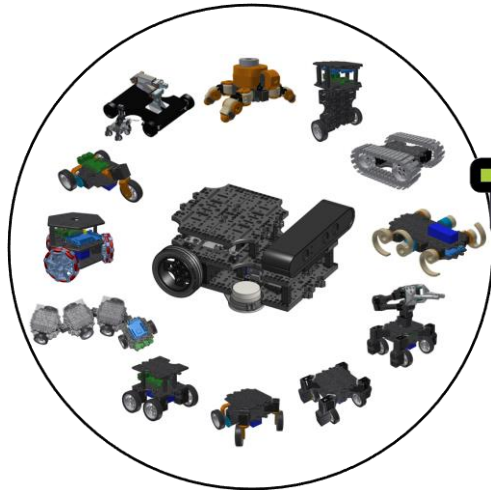
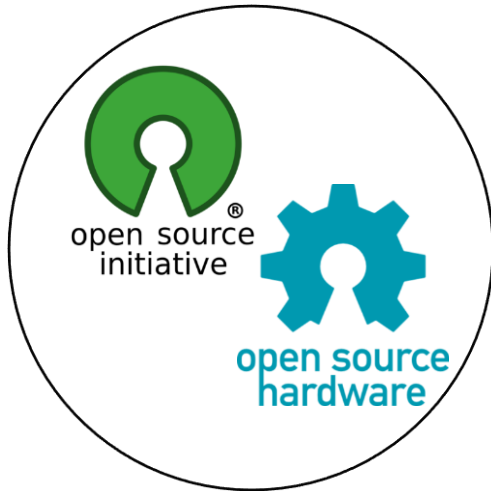
- CAD Data : **Onshape** (<https://www.onshape.com/>)
  - Search "ROBOTIS" or "Turtlebot" (ex: <https://goo.gl/Om7f9O>)
- Circuit Gerber files
  - <https://github.com/ROBOTIS-GIT/OpenCR>

### Software

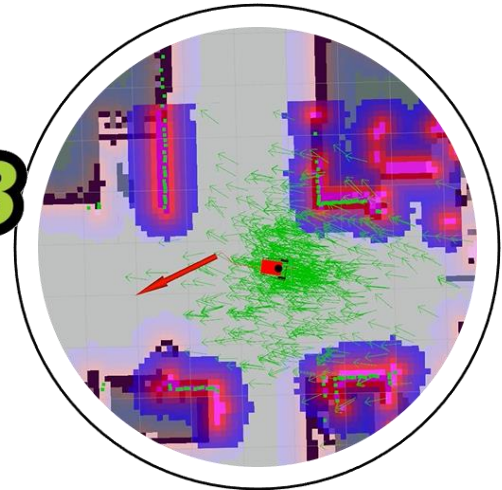
- Firmware & ROS packages
  - <https://github.com/ROBOTIS-GIT/OpenCR>
  - <https://github.com/ROBOTIS-GIT/turtlebot3>

**Welcome to TB3 open-source and your contribution!**





**TURTLEBOT3**



# TURTLEBOT3

