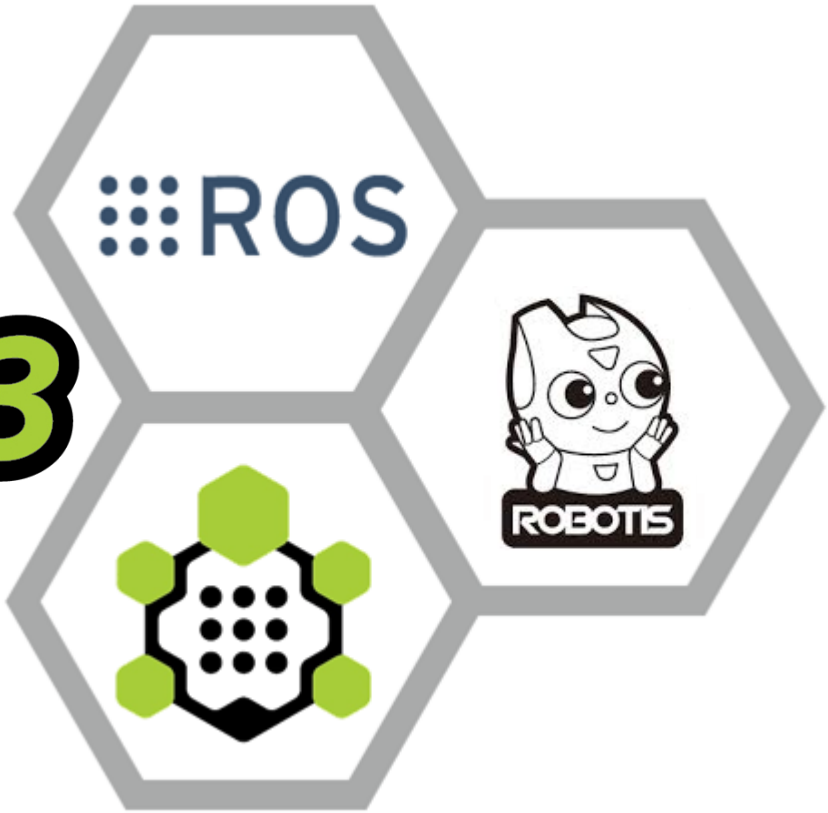
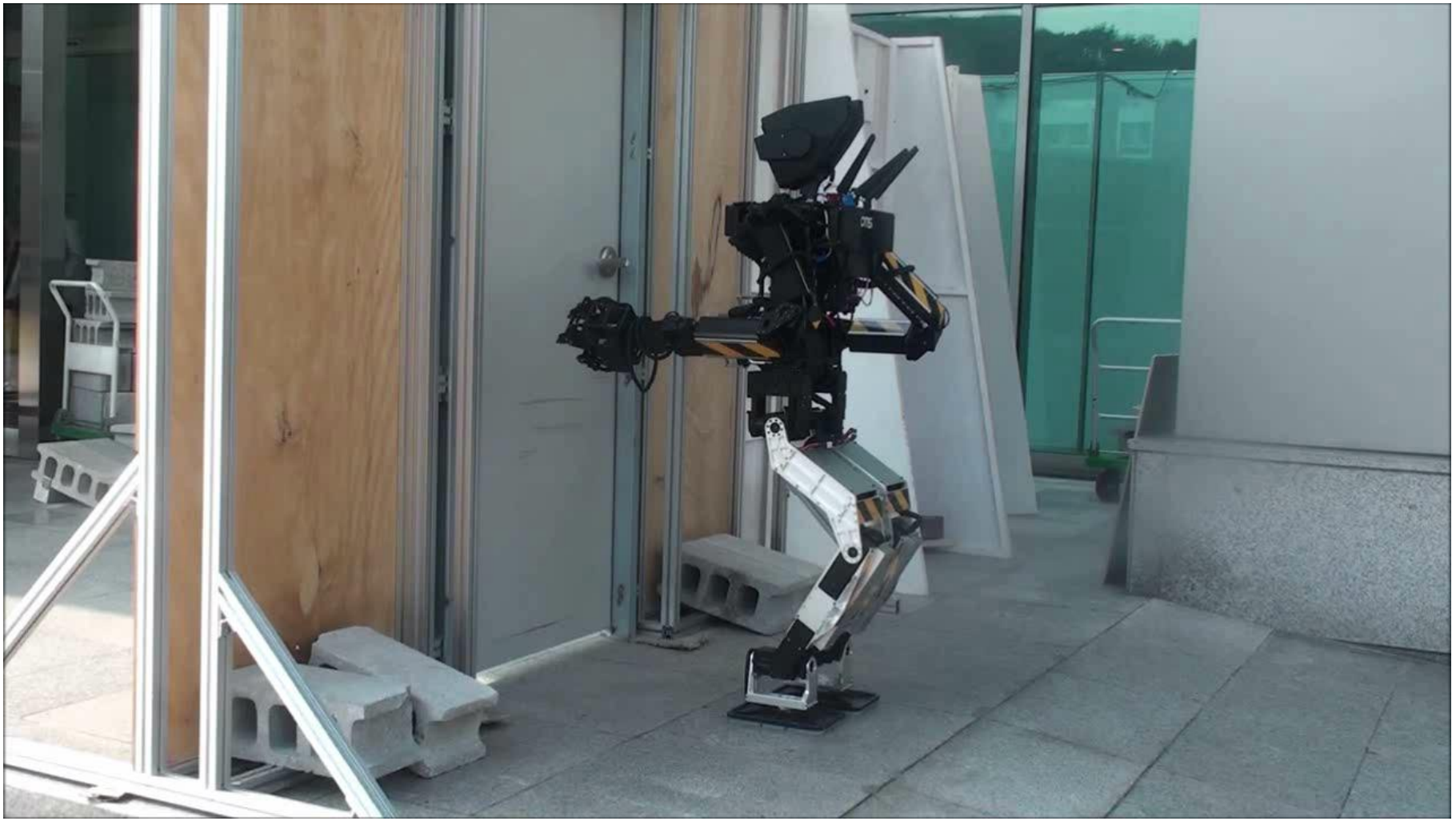
TURTLEBOT3



Speakers


#DARPADRC
FAIRPLEX
ROBOTS OF THE
DARPA ROBOTICS CHALLENGE
FINALS 2015
ESCHER
Team VALOR
Leo
Team TROOPER
WALK-MAN
Team WALK-MAN
Florian
Team VIGIR
Yoonseok Pyo
Leon Jung
ROBOTIS

Look-back Demonstration of DRC Finals



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

ROSCon 2015

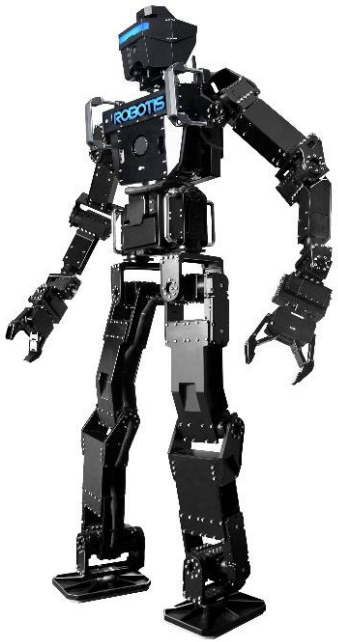

ROBOTIS Framework with ROS...
ROBOTIS Framework supporting ROS
ROBOTIS

NOW!

almost of all line-ups dived into ROS

with over 60 ROS packages

http://wiki.ros.org/ROBOTIS

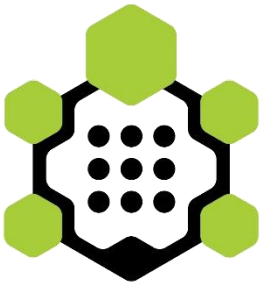


THORMANG3

ROBOTIS Manipulator

ROBOTIS OP

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

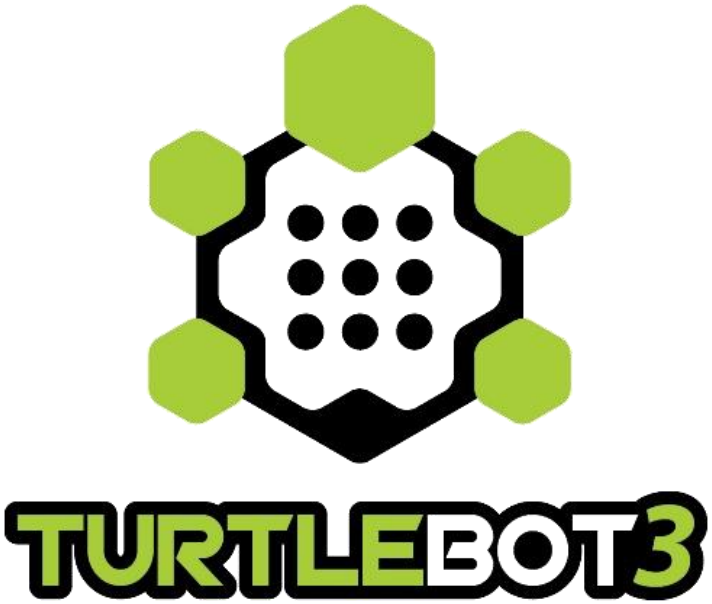
Turtlebot1, Turtlebot2

Previous versions

Needs & Requirements

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

Turtlebot3

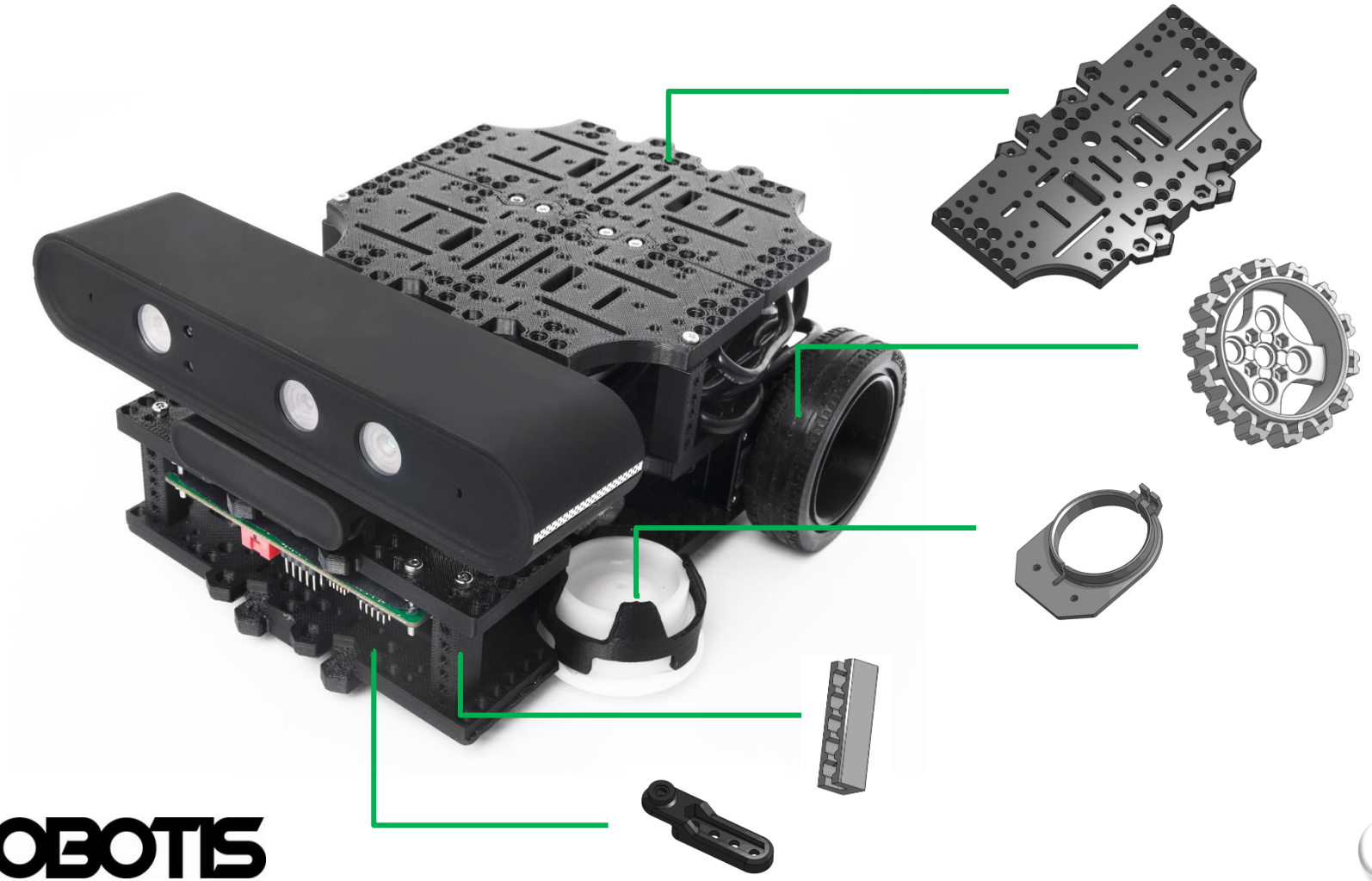


Turtlebot3

* Prototype 2.4

Turtlebot3

* Prototype 2.4



Turtlebot3

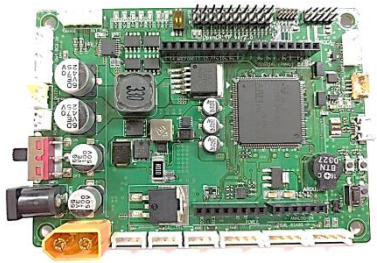
* Prototype 2.4

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

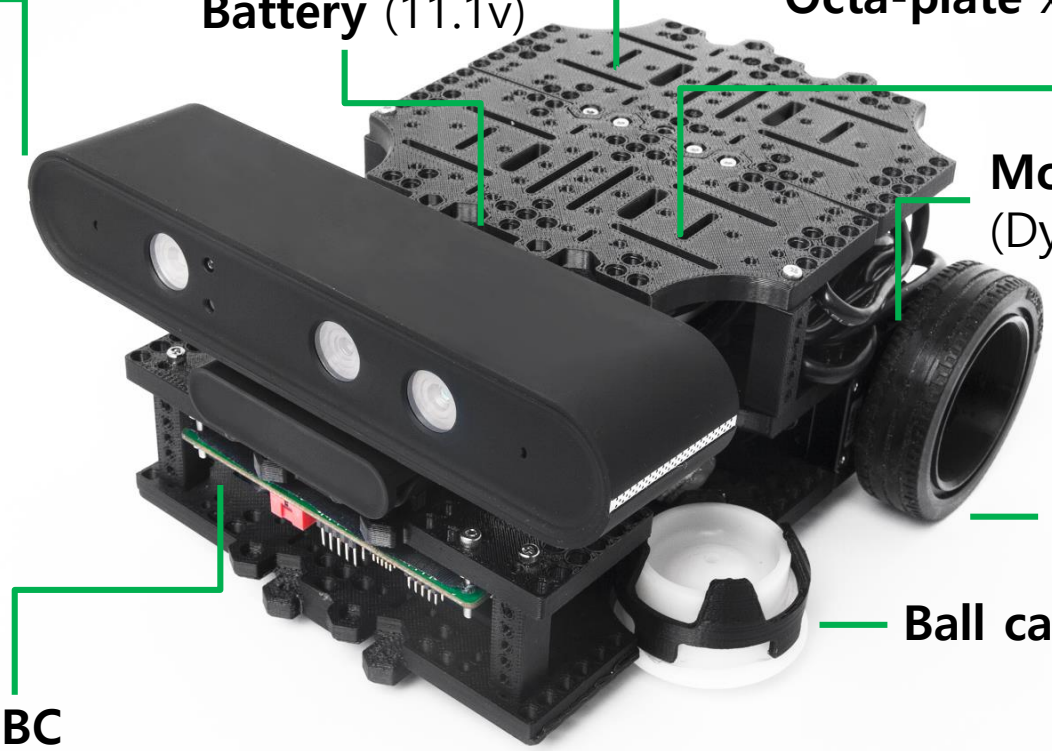
Battery (11.1v)

Octa-plate x 8

OpenCR for ROS embedded



Motor x 2
(Dynamixel-X)



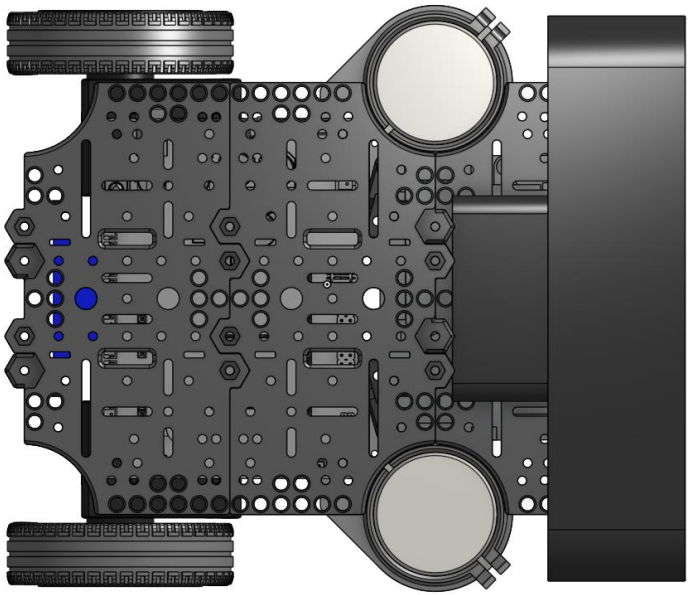
Wheel and **rubber tire** x 2

Ball caster x 2

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

ROBOTIS

[Top]



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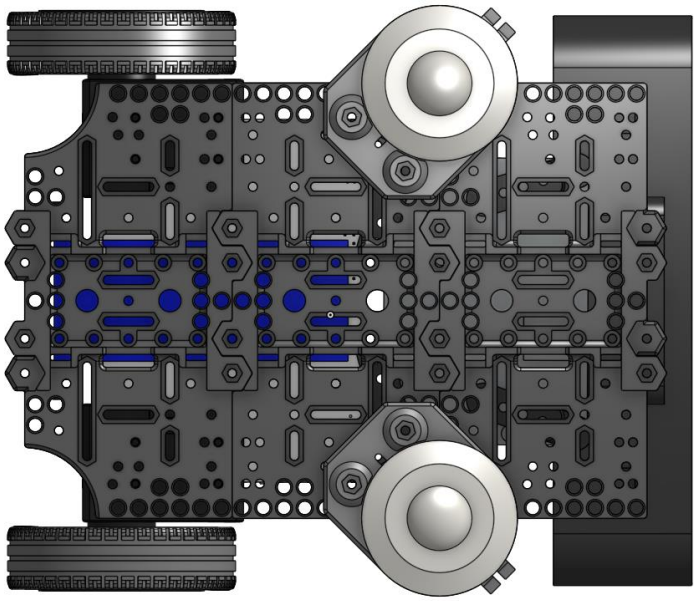

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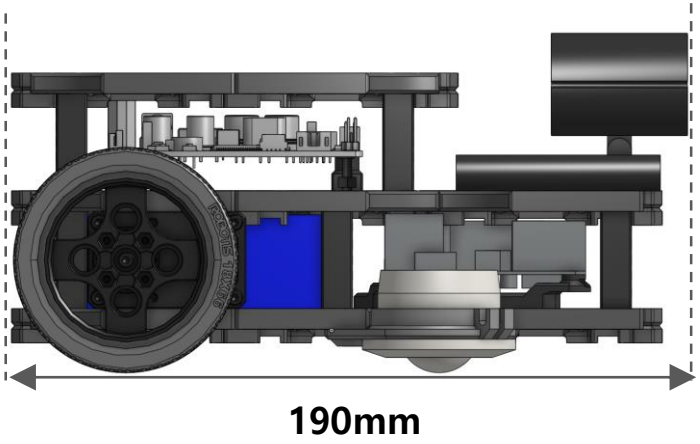

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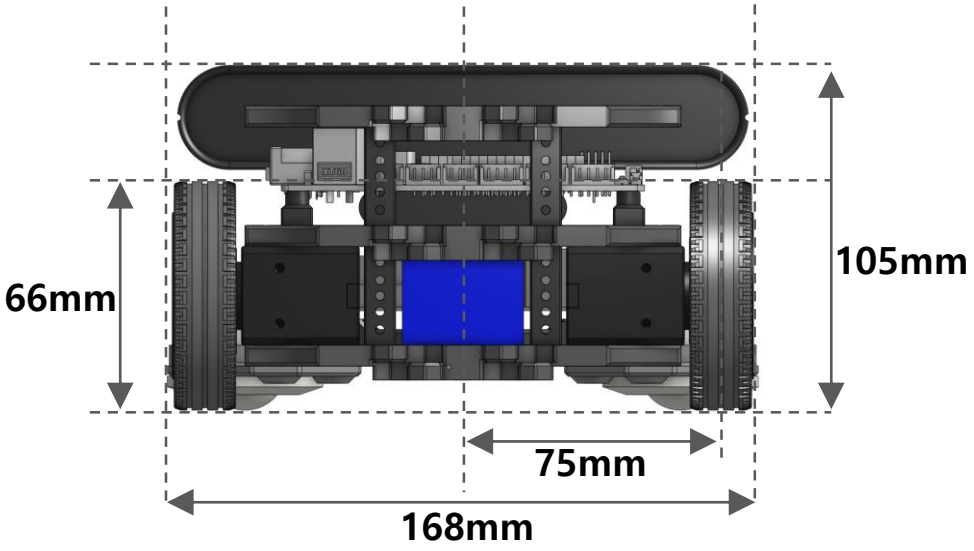


Turtlebot3

Components of Turtlebot3 (Default)

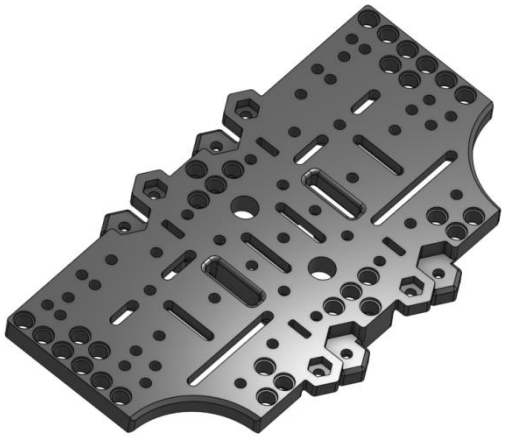
- **Chassis**: plate, post, pcb base, ball caster, caster holder
- **Motor**: Dynamixel-X series (XL430 or XM430) x 2
- **Wheel**: multi purpose wheel (18x66) x 2
- **Embedded board**: OpenCR x 1
- **Computer**: SBC x 1
- **Sensor**: Distance Sensor x 1
- **Battery**: Lithium-polymer 11.1V 1800 mAh x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

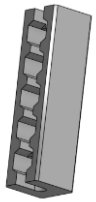
Locomotion layer

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

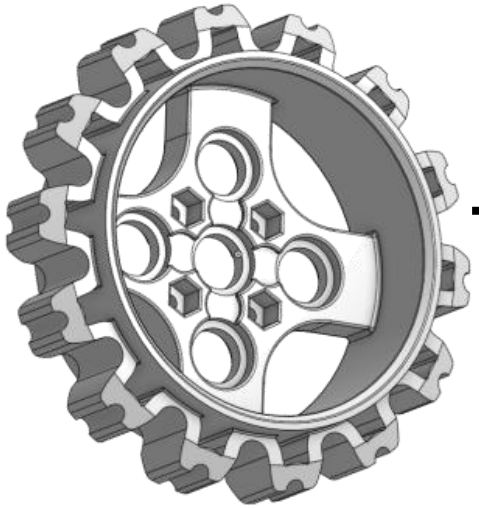
- **ROBOTIS Dynamixel X series**
- 3 ways for cabling
- 6 operating modes: **velocity** (for wheels), **torque**, **position**, extended position, current-based position, and PWM.
- Networks: **daisy-chained RS-485 / TTL**

Locomotion layer

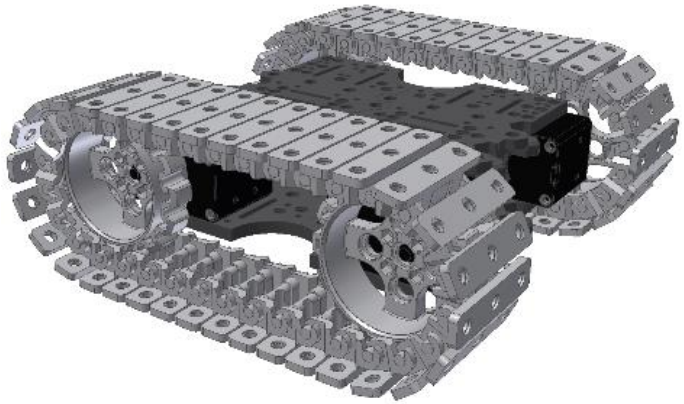
Wheels of Turtlebot3

- Use as rubber wheel or caterpillar wheel

For rubber wheel



For caterpillar wheel

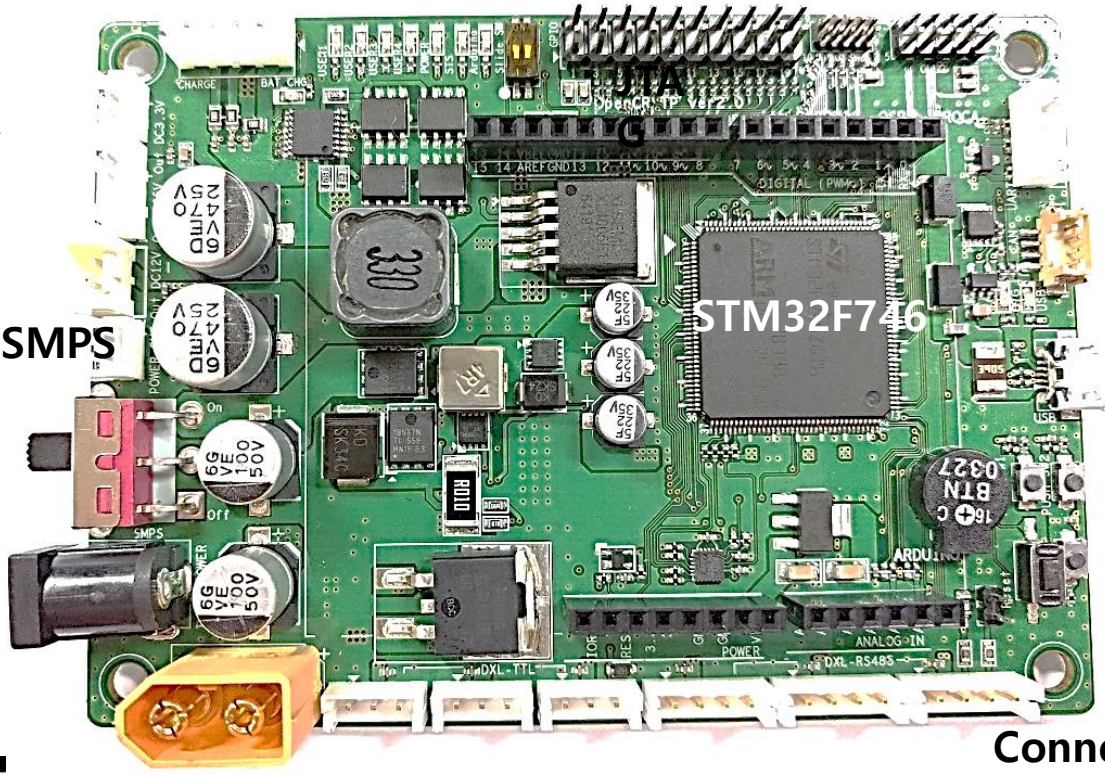


Locomotion layer

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 (GPIO, ADC, I2C, SPI, UART)

Battery input jack TTL x 3 RS485 x 2

ROBOTIS

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

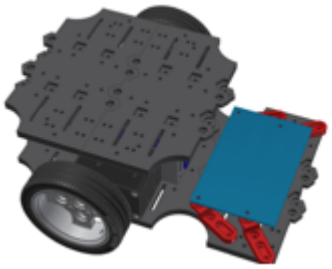
[PC Modules]

- Intel NUC
- NVIDIA TK1 dev board

ODROID XU4

Up board

Raspberry Pi



Dragon Board 410C

Intel Joule

ROBOTIS

Perception Layer

Sensor(s) of Turtlebot3

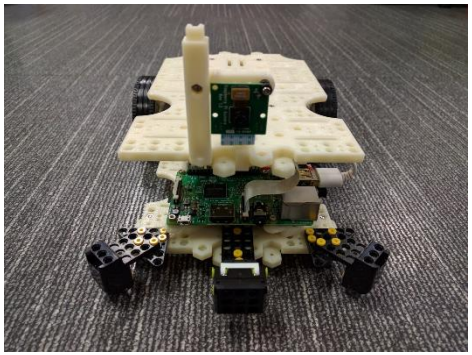
: 3D RGBD cameras, 2D laser rangefinders, USB webcams
(*we will challenge the Visual SLAM using a Turtlebot3 and a camera)

[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]

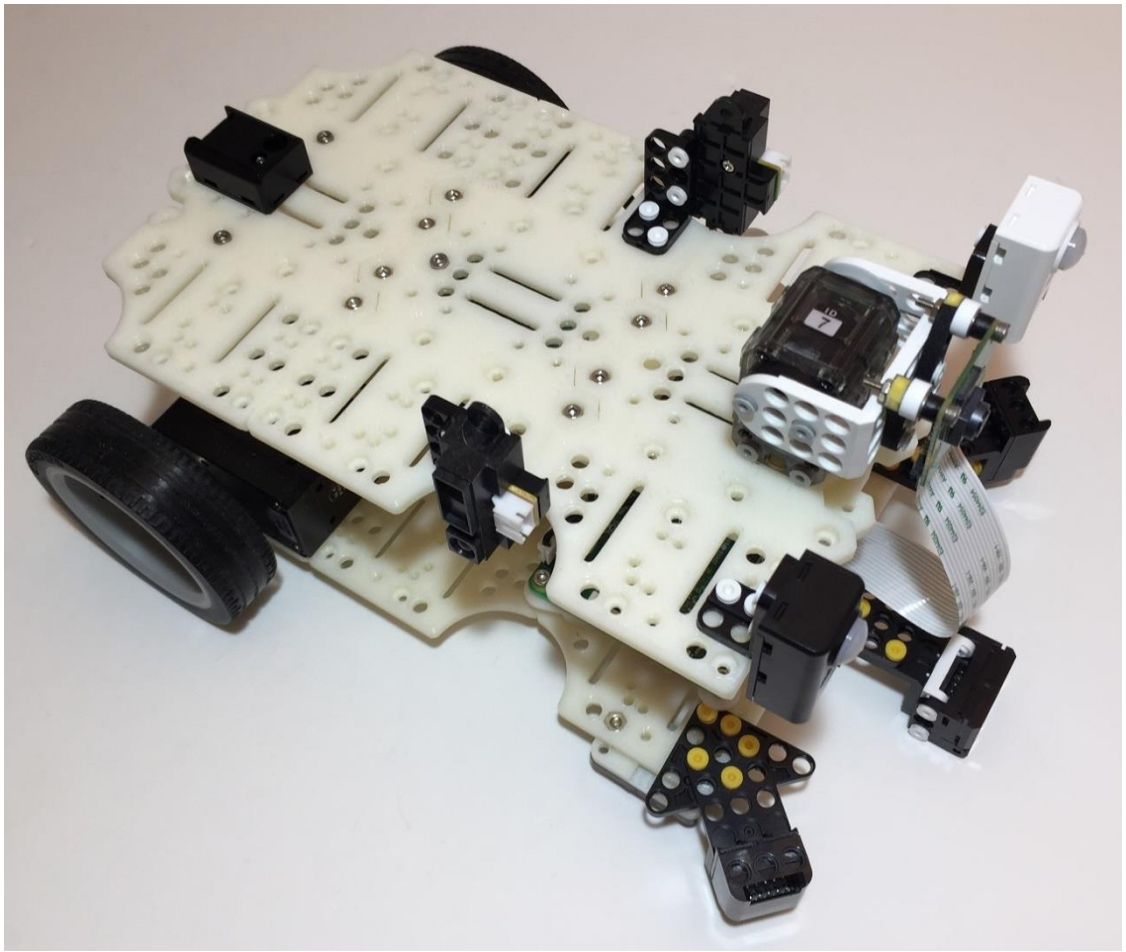
- Cliff sensor
- Bumper sensor
- MICs
- Speaker
- USB Camera



ROBOTIS

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

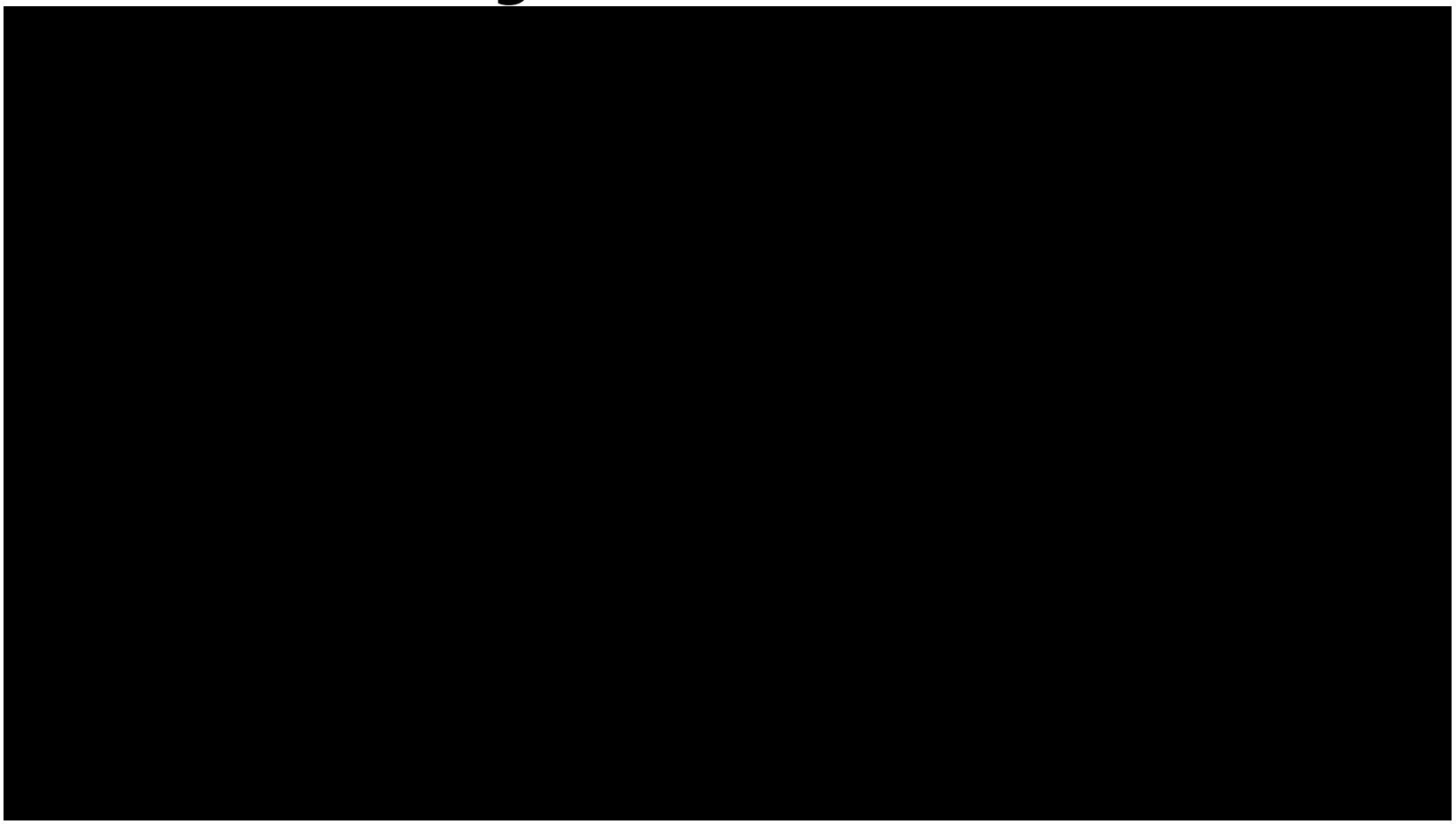
Manipulation-X for Turtlebot3 (Option)

- 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



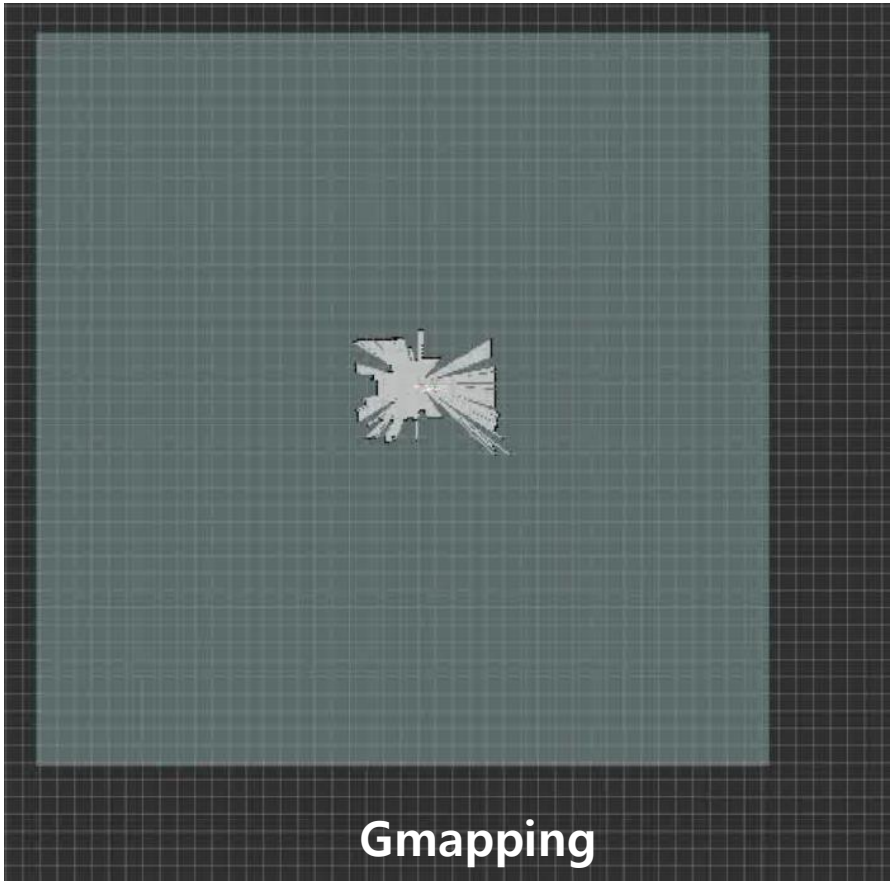
https://youtu.be/hX6pFcfr29c

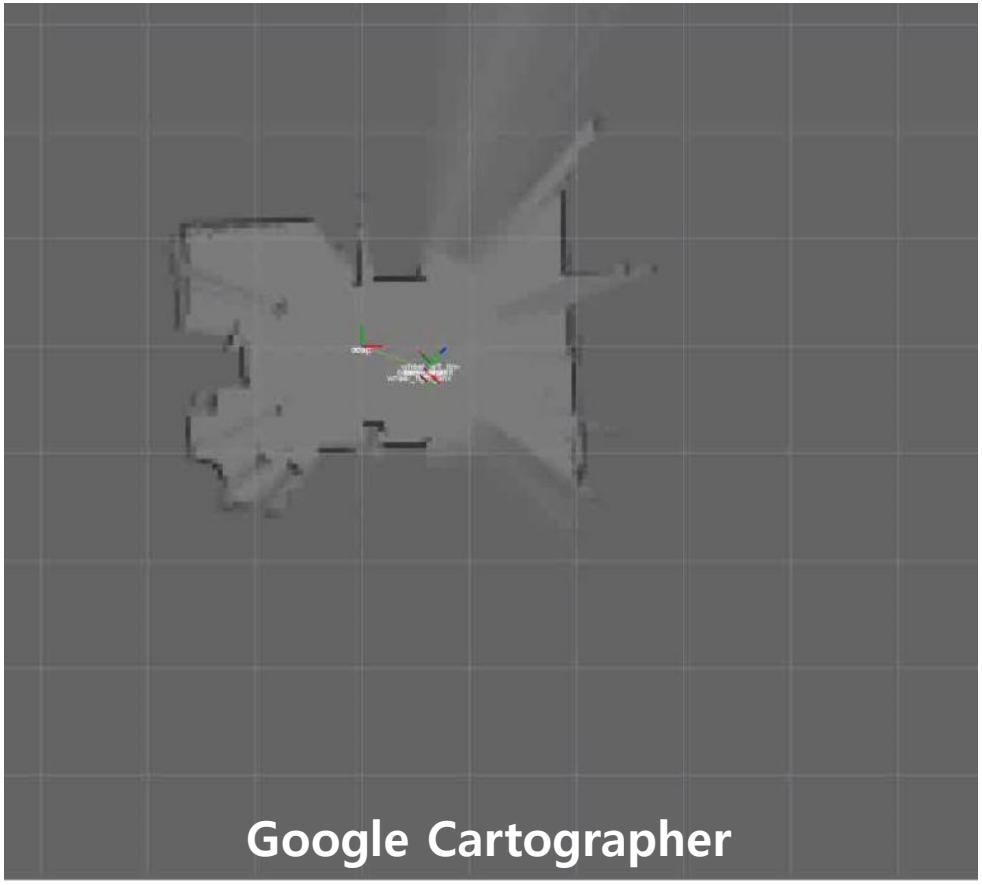
http://wiki.ros.org/gmapping

Demos

SLAM and Navigation / Visual SLAM

X 10





https://youtu.be/ZoEyCSL_edg

Demos

SLAM and Navigation / Visual SLAM X 1

https://youtu.be/lOZmFC79S6A

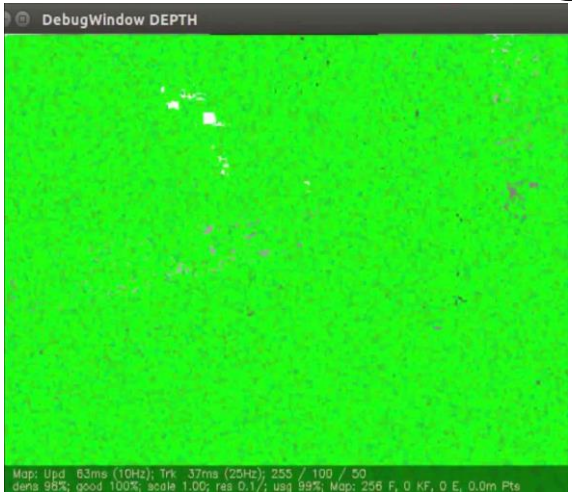
http://wiki.ros.org/navigation

Demos

SLAM and Navigation / Visual SLAM

Demos

SLAM and Navigation / Visual SLAM X 4



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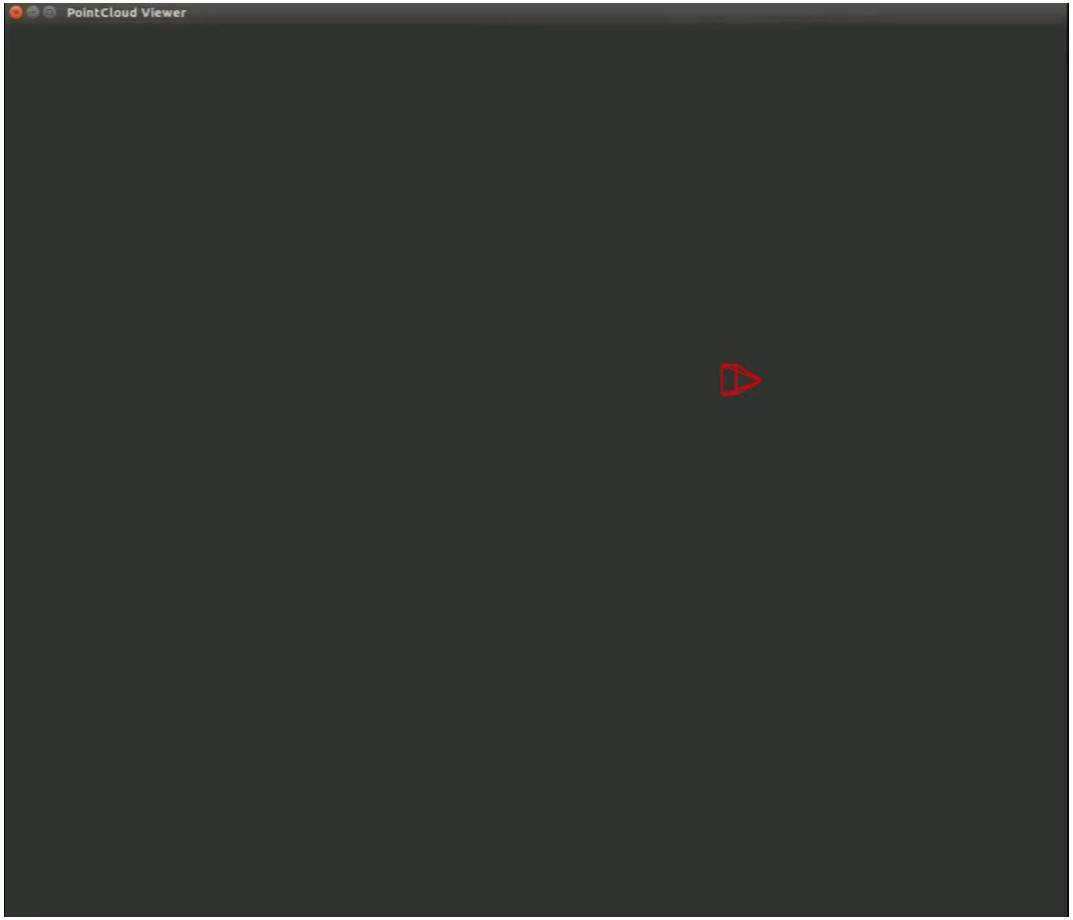
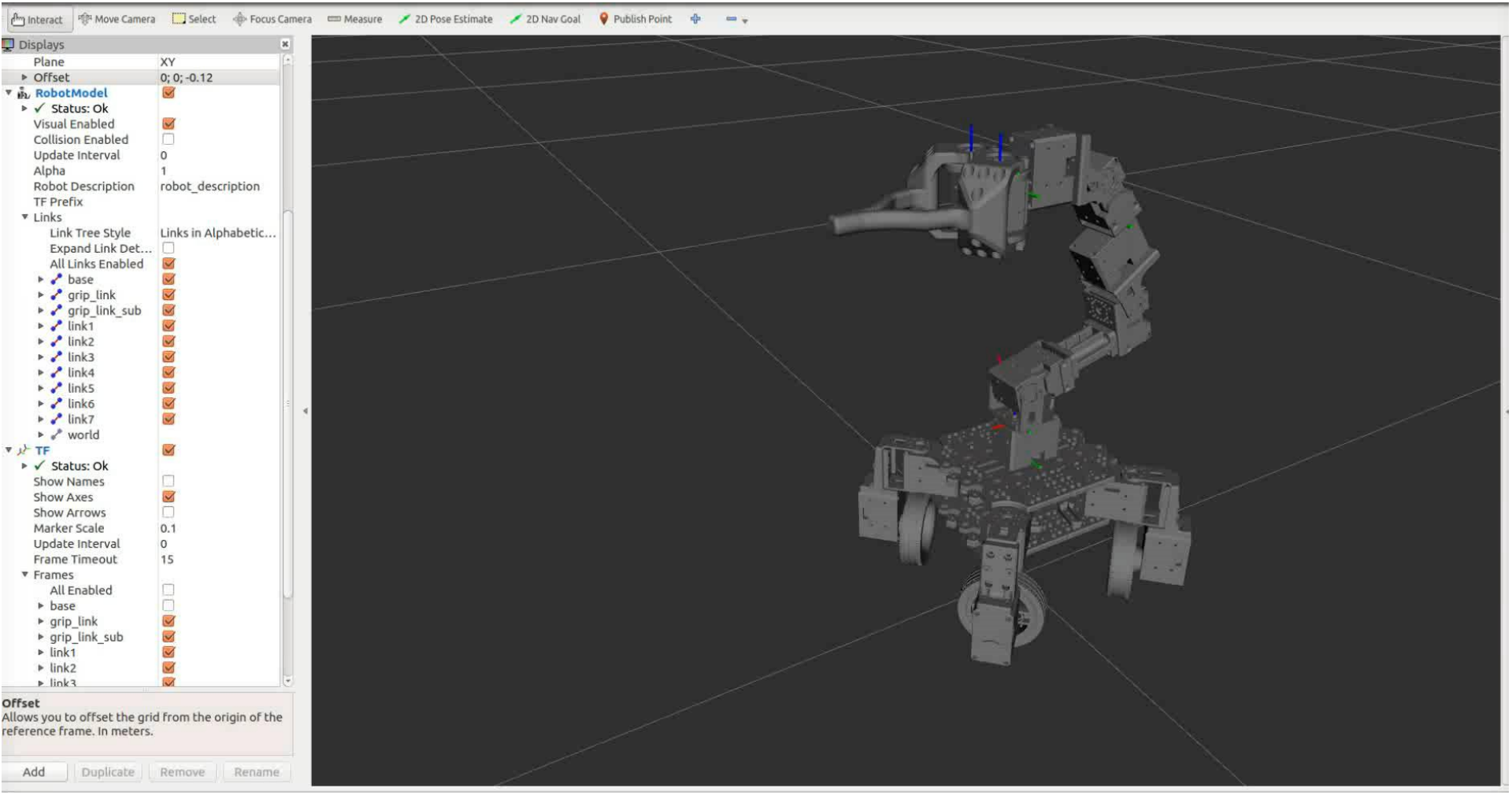


https://youtu.be/BfFXNnRpbMw

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

Demos



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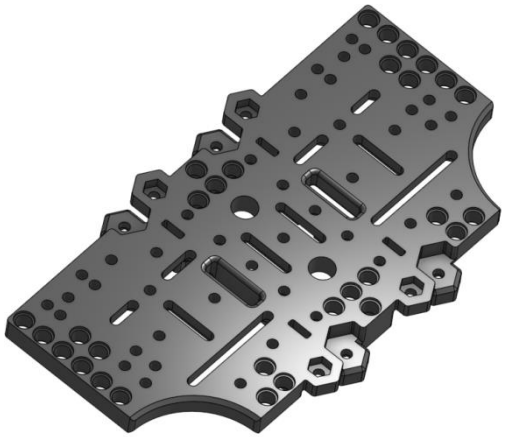
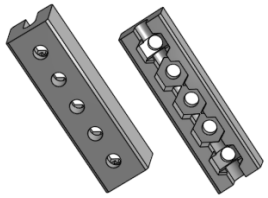
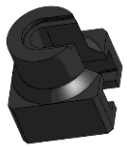
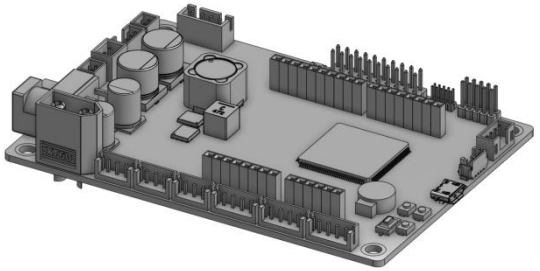
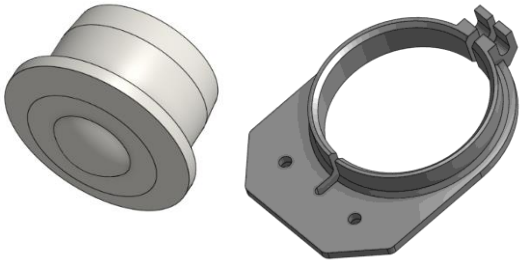
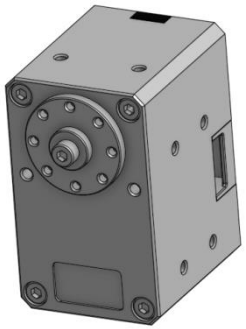
Details

Details

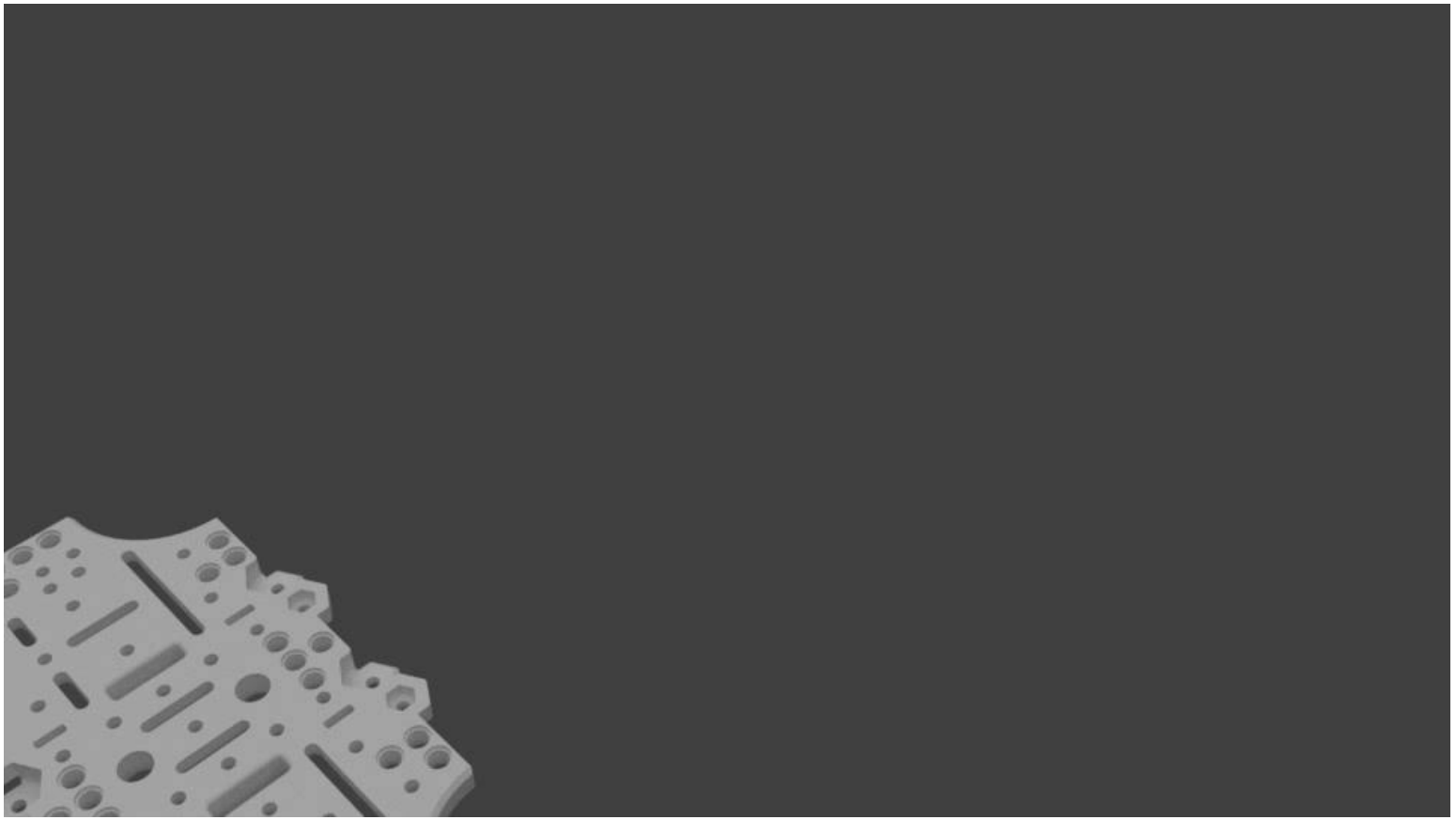
Module based model & Assembling film


Details

Module based model & Assembling film



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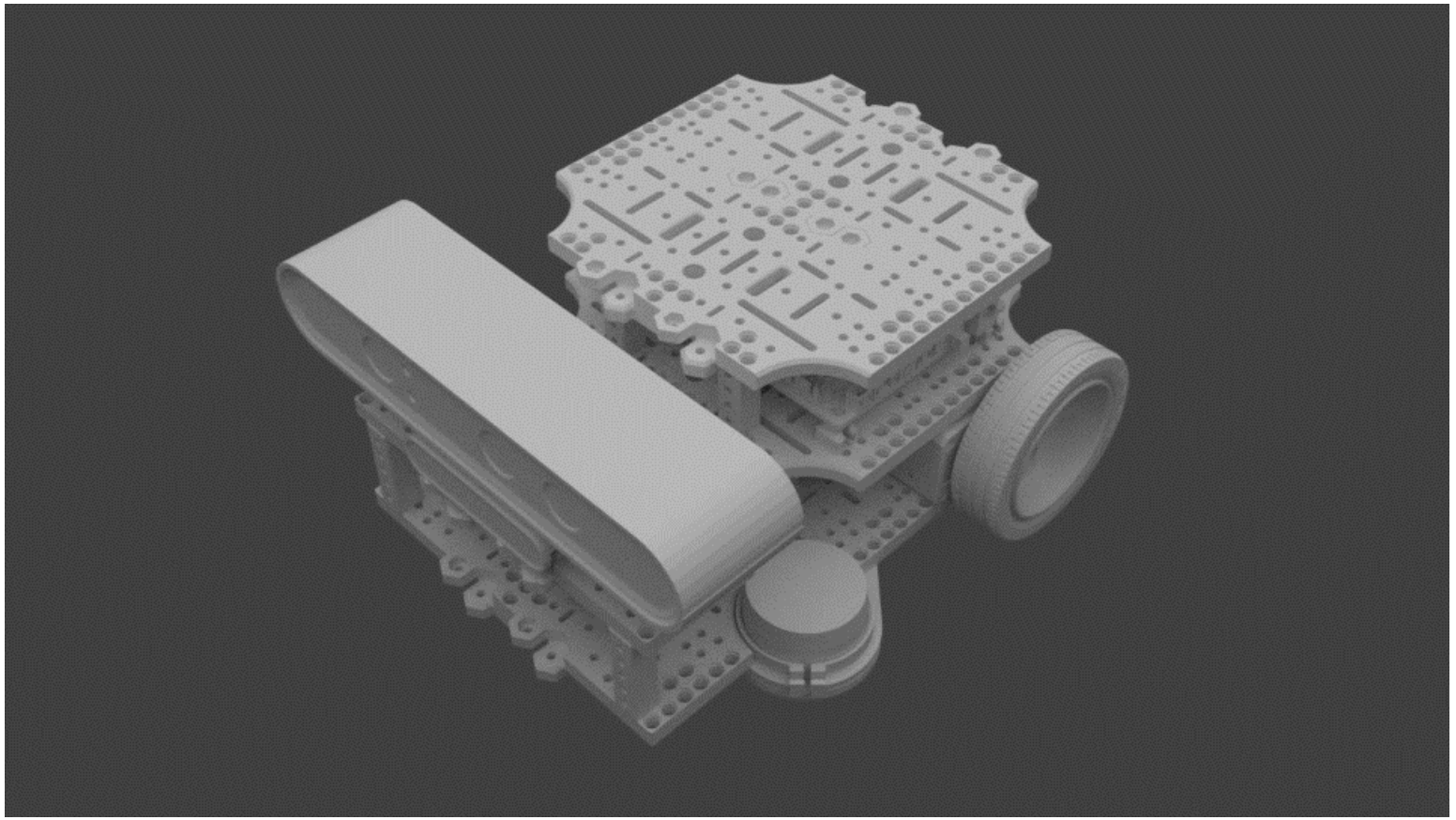
Details

Module based model & Assembling film



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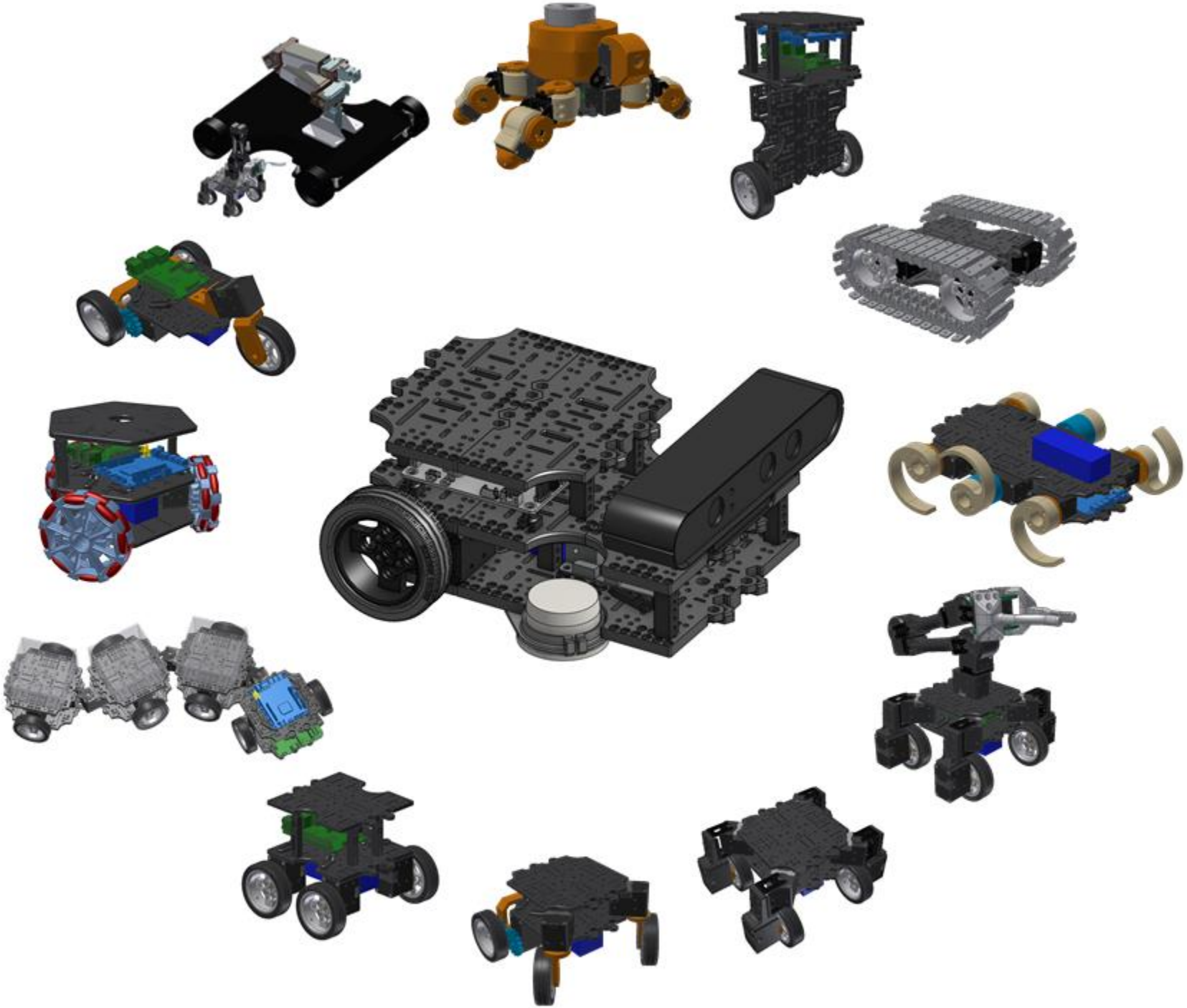
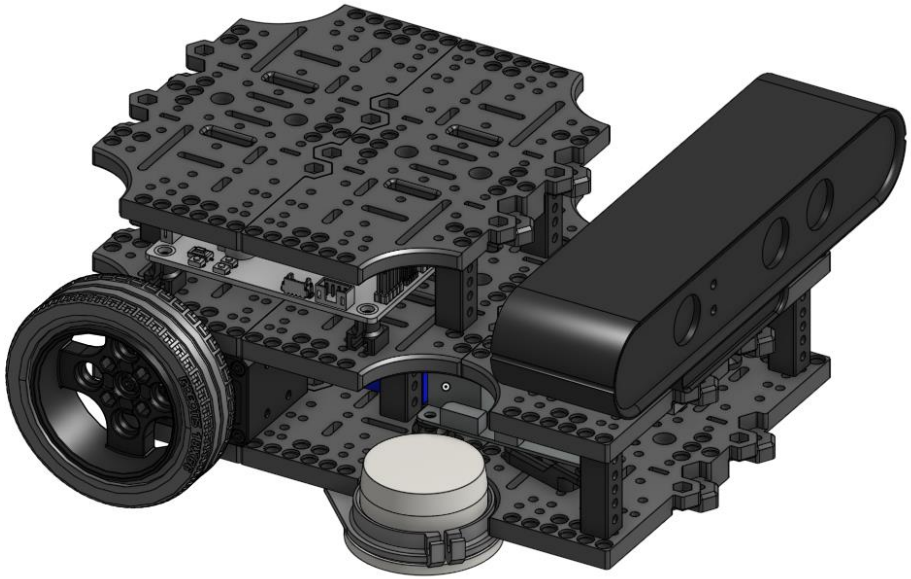
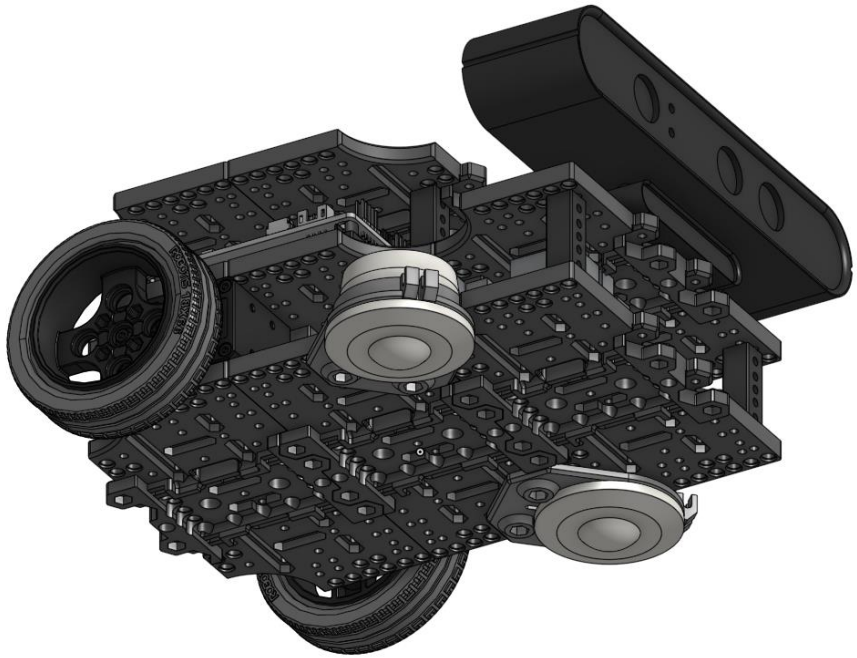


Details

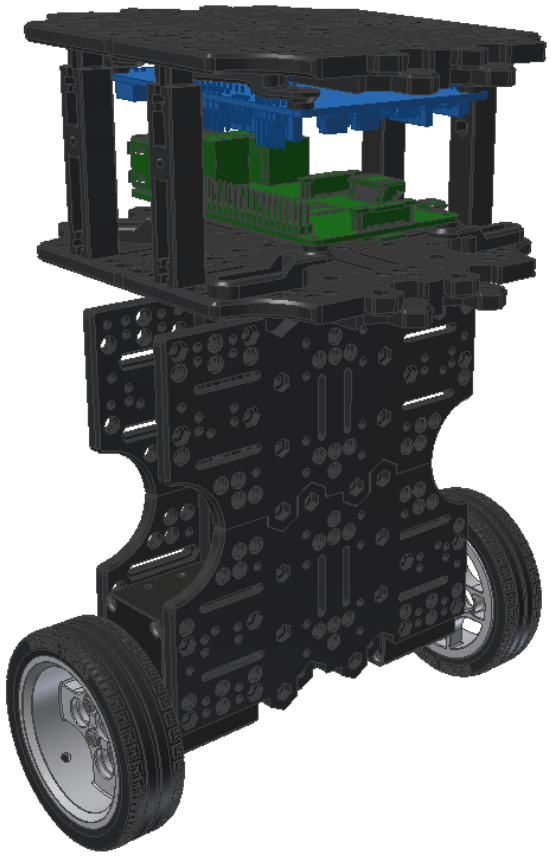
Default) 2 Wheels + 2 ball casters





Details

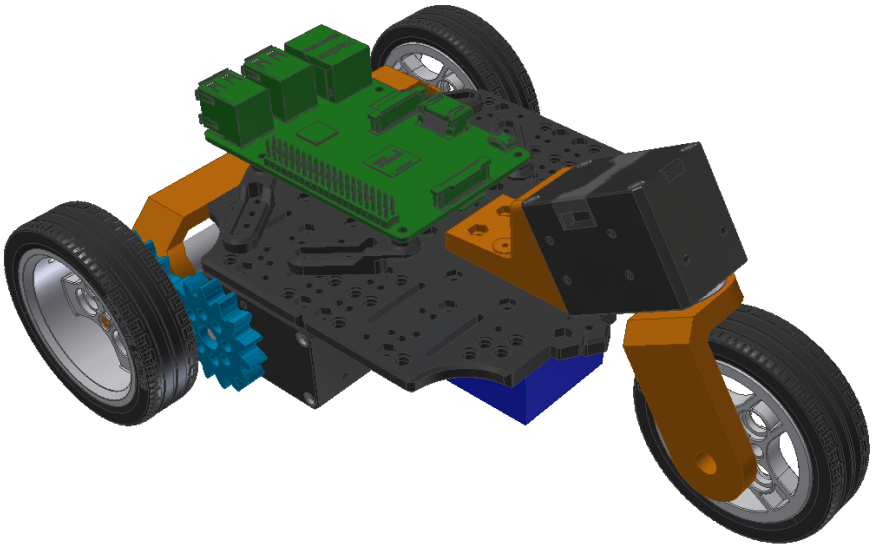
Ex 1). 2 Wheels + Segway

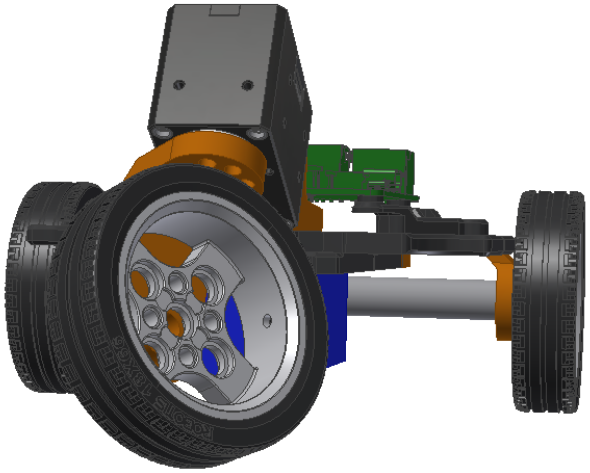


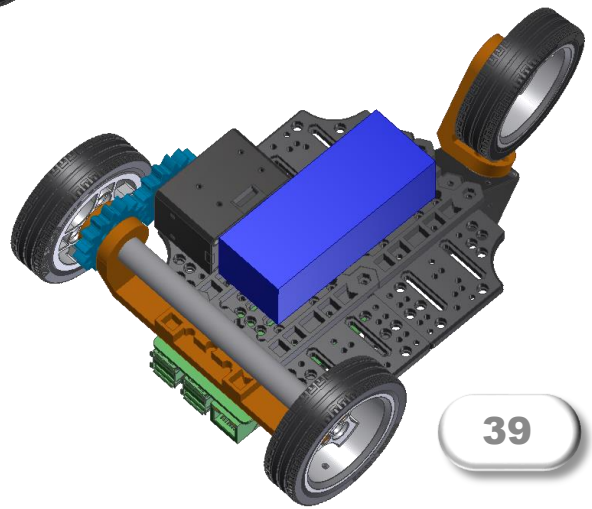
http://www.segway.com/products/consumer-lifestyle/minipro

Details

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

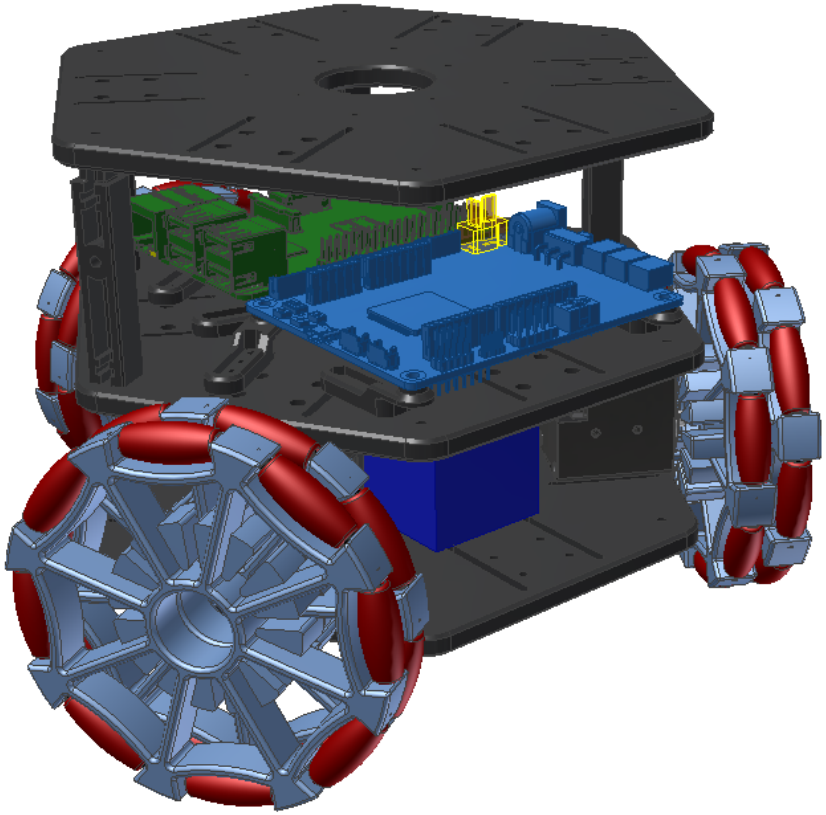


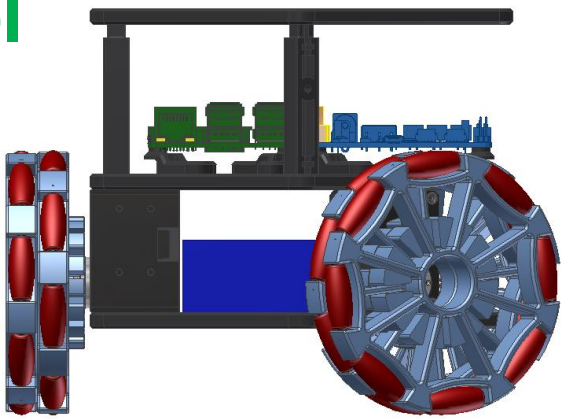


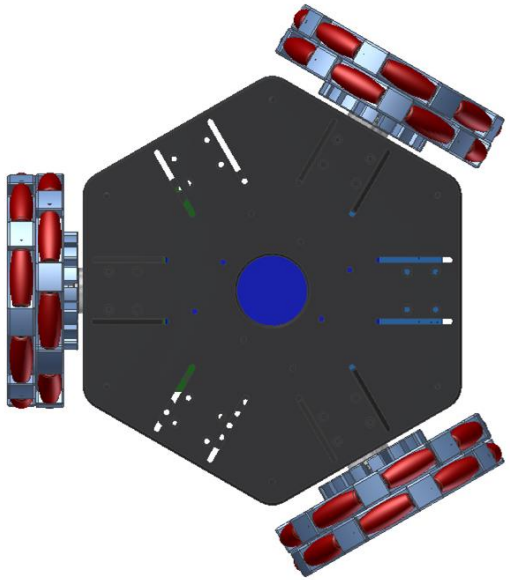


Details

Ex 3). 3 Wheels + omni-wheel

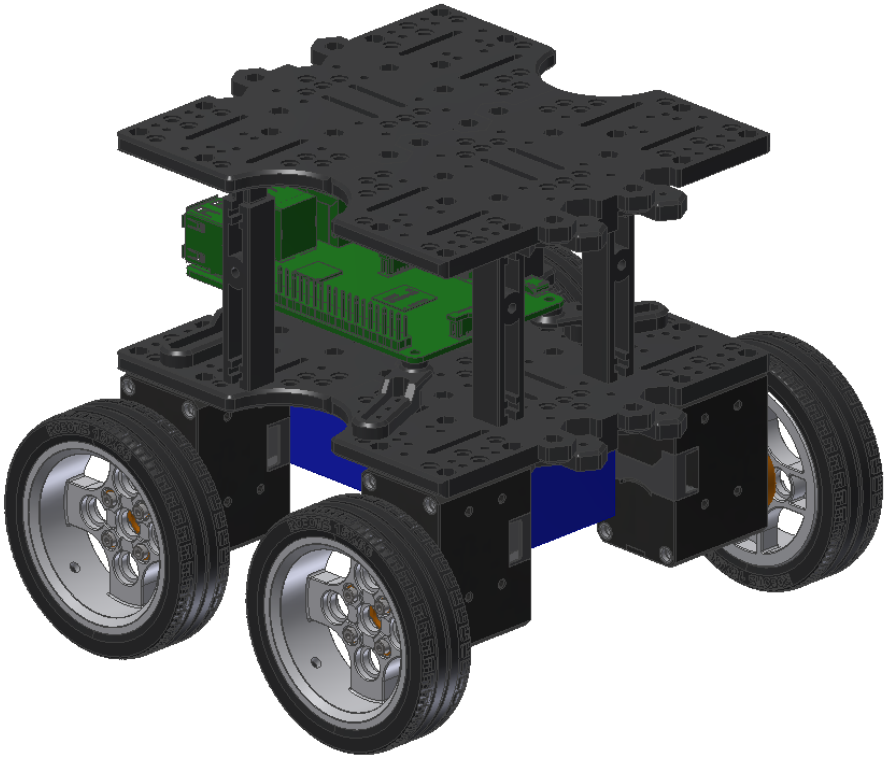


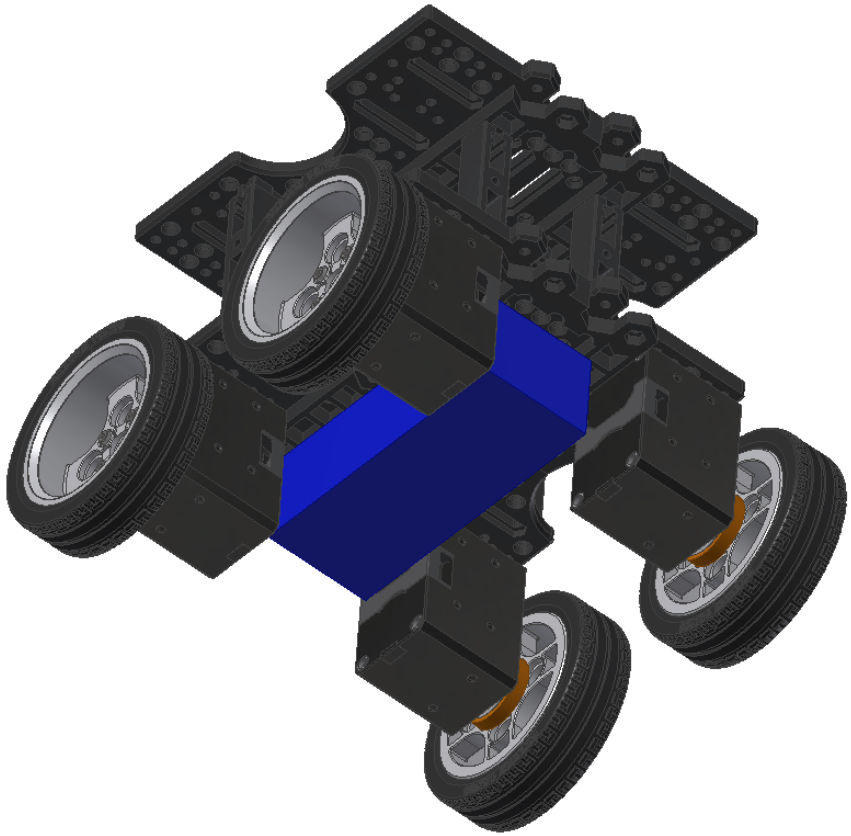




Details

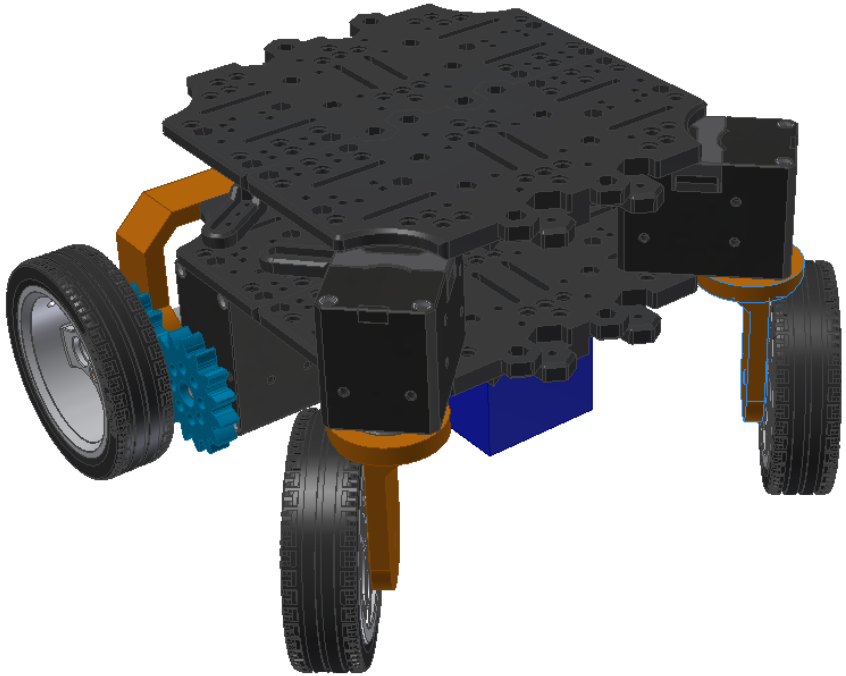
Ex 4). 4 Wheels

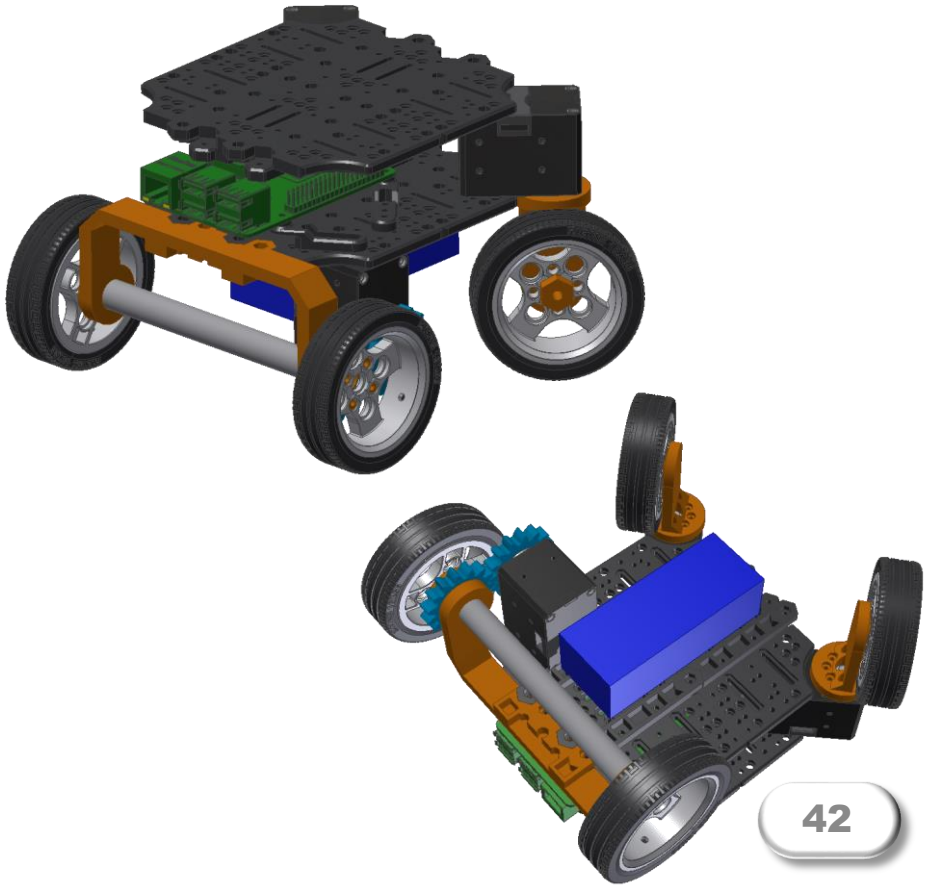




Details

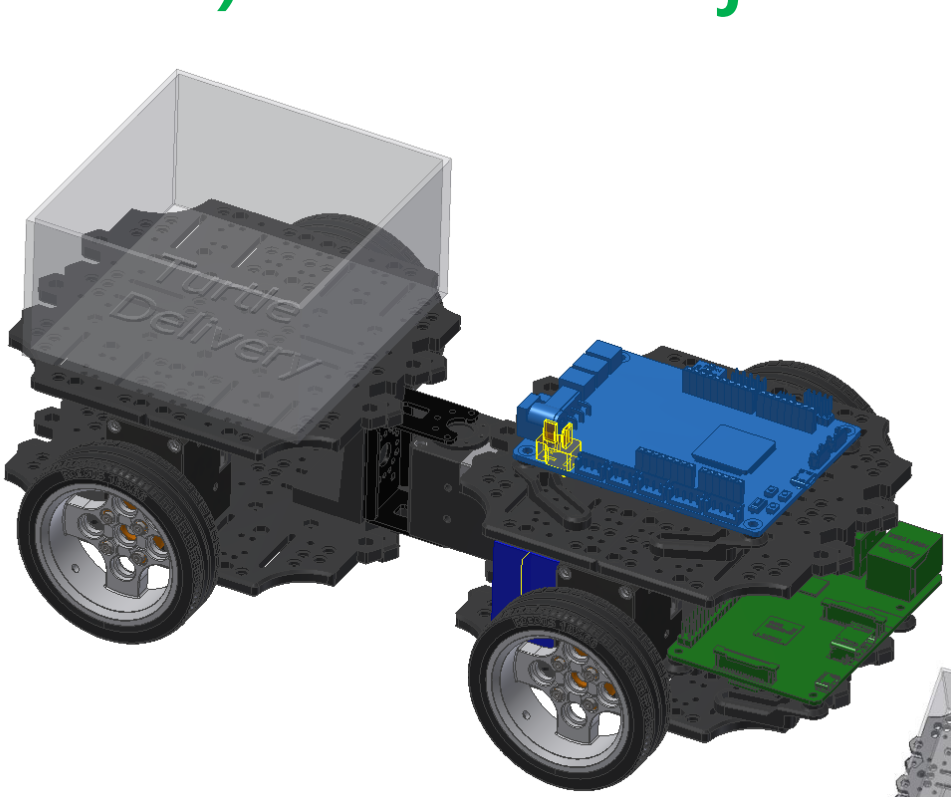
Ex 5). 4 Wheels
(front-steer-motor 2ea + drive motor 1ea)

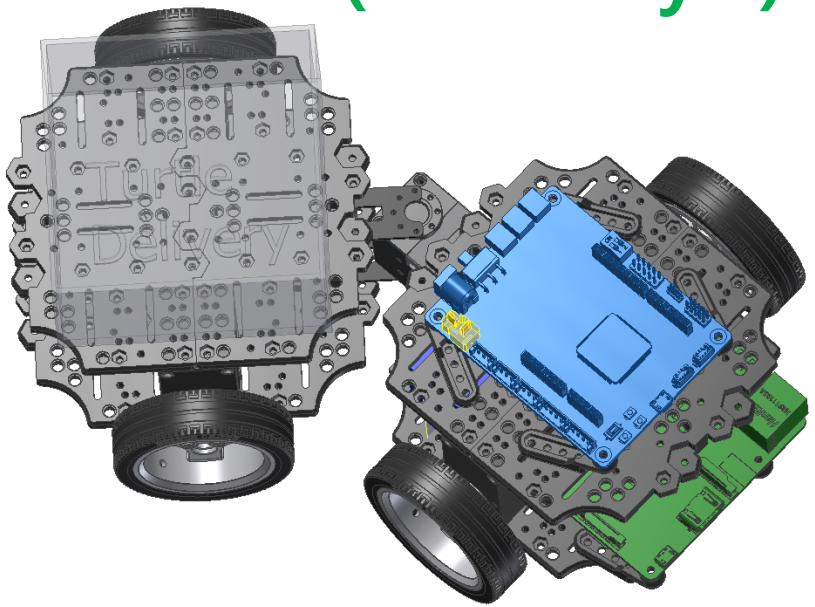




Details

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

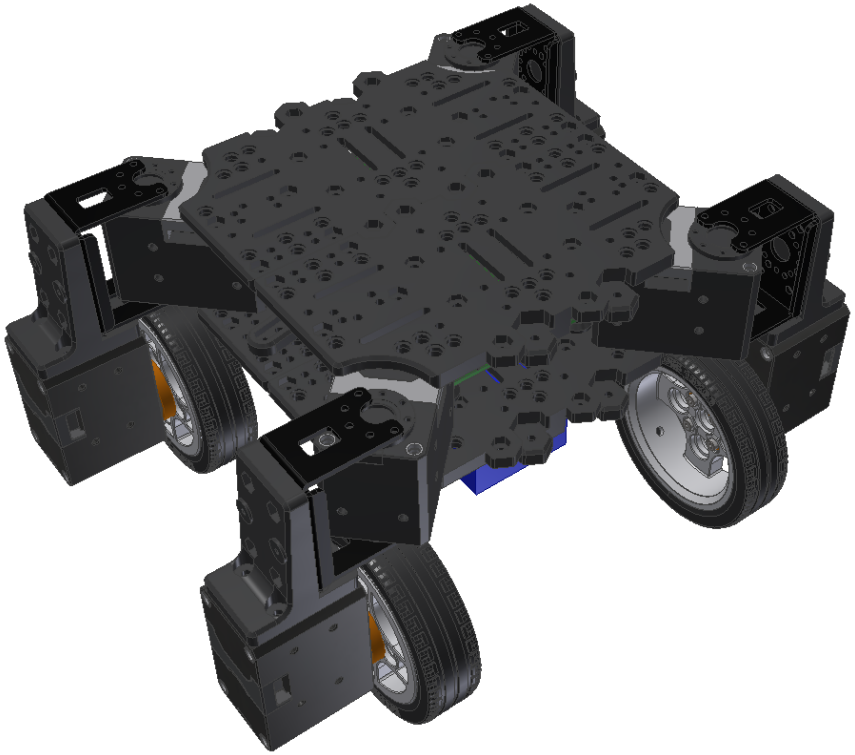


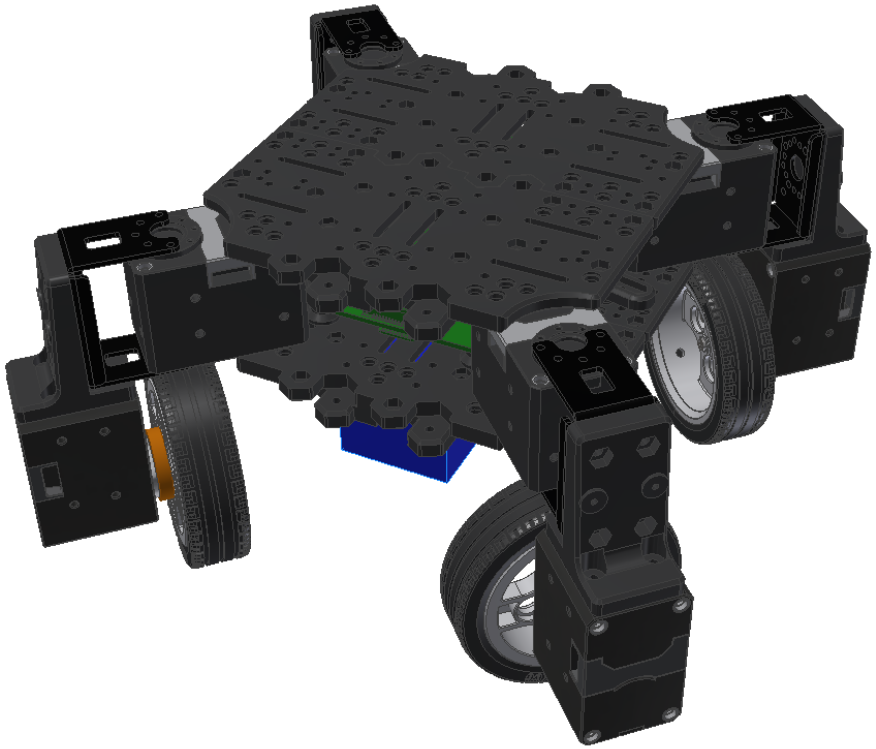


ROBOTIS

Details

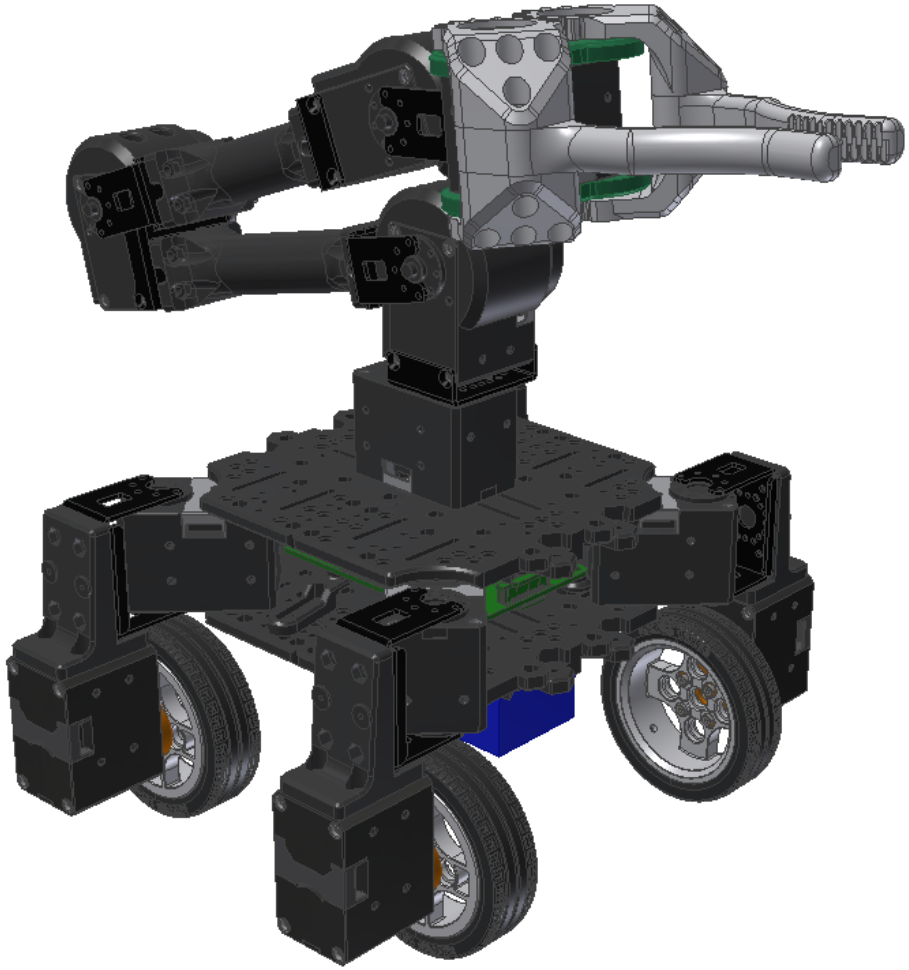
Ex 7). 4 Wheels + omni-drive

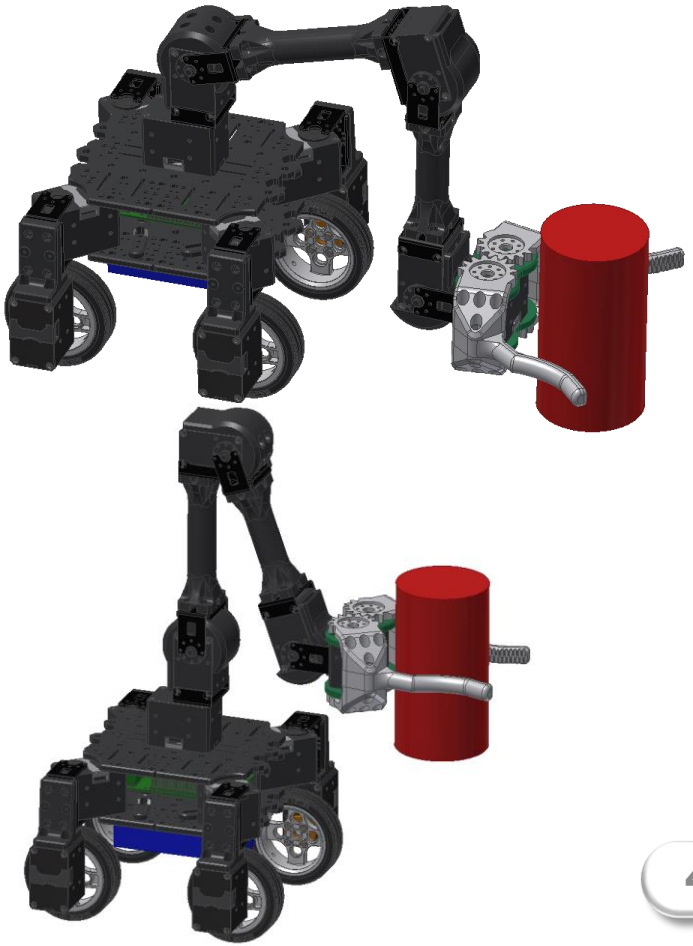




Details

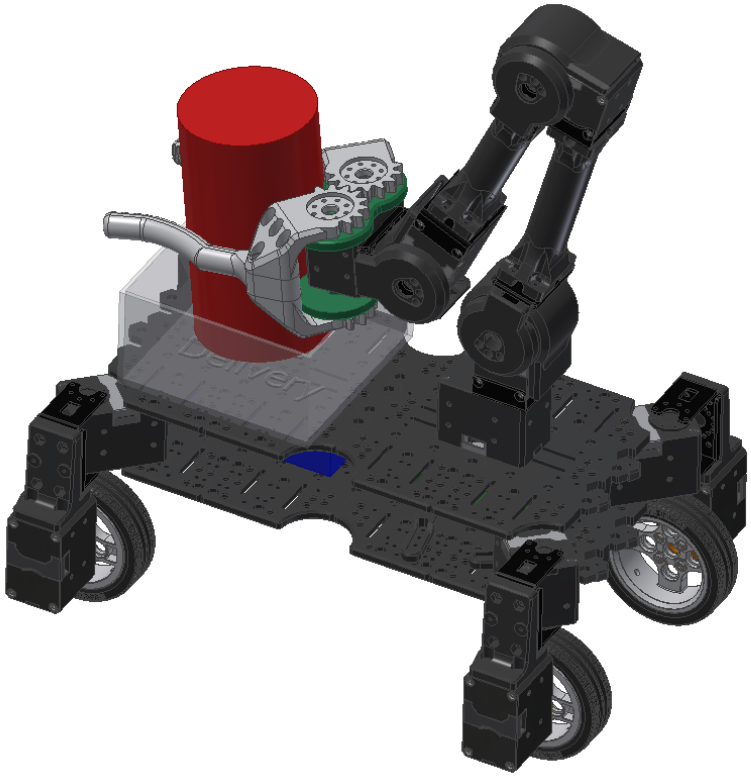
Ex 8 a). 4 Wheels + omni-drive + manipulator-x

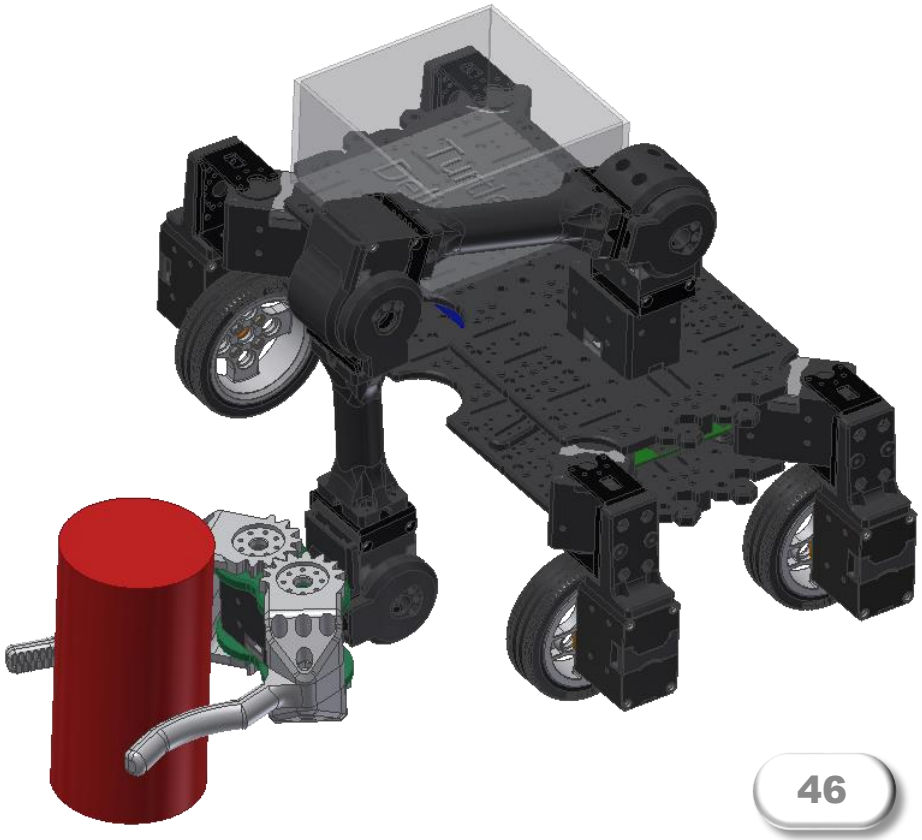




Details

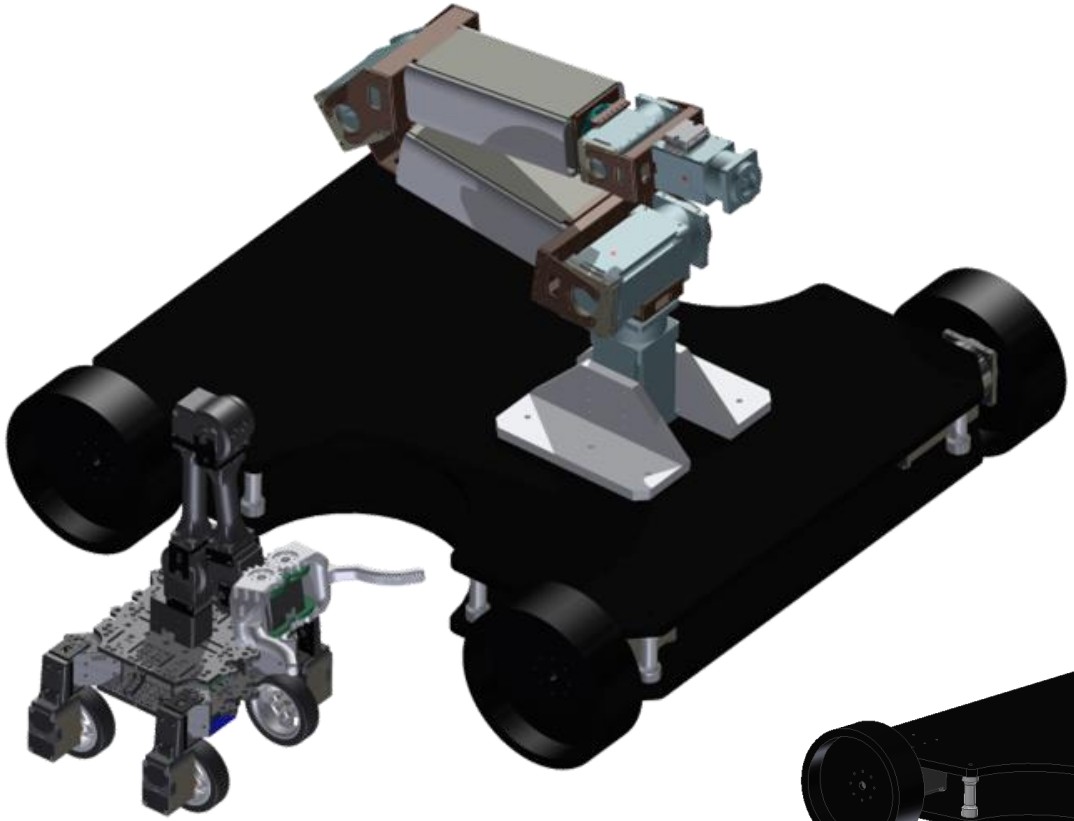
Ex 8 b). 4 Wheels + omni-drive + manipulator-x

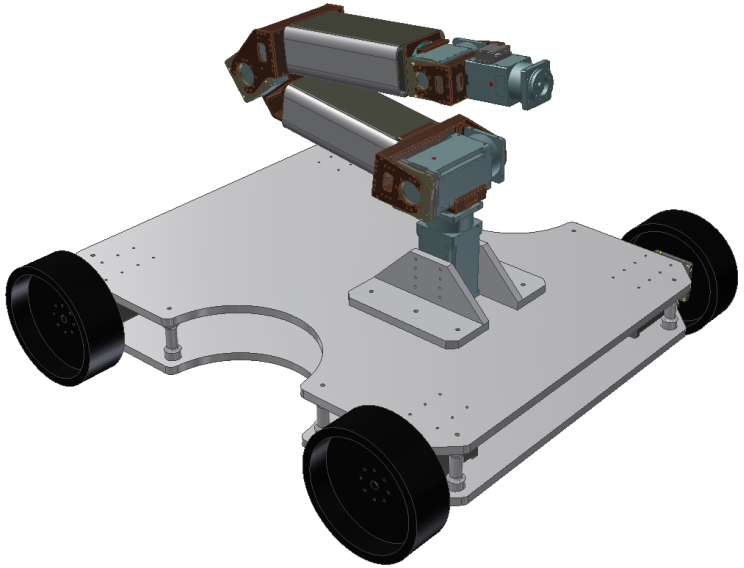


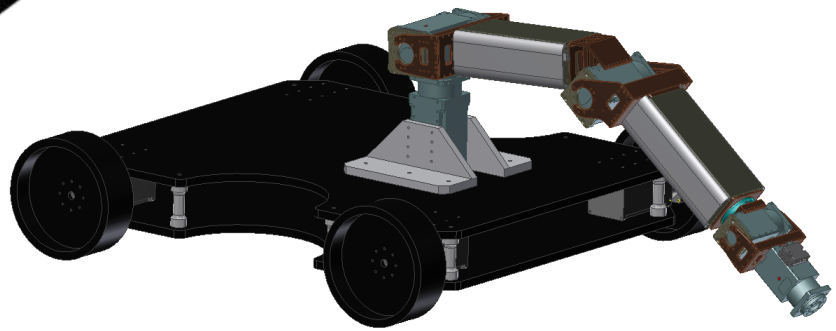


Details

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



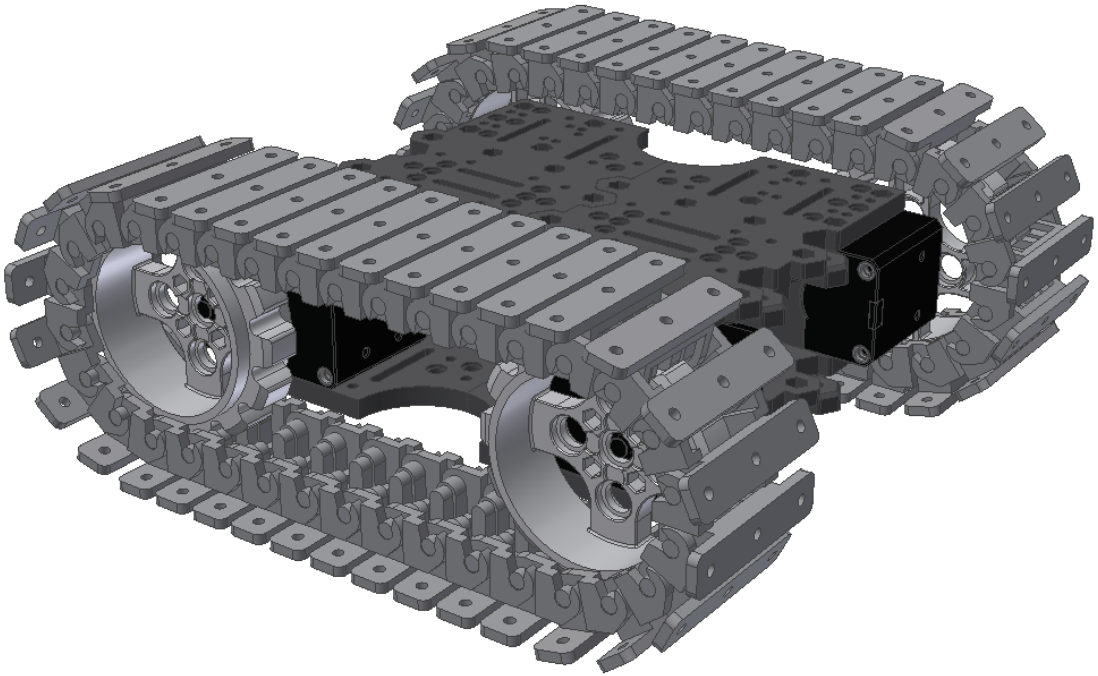


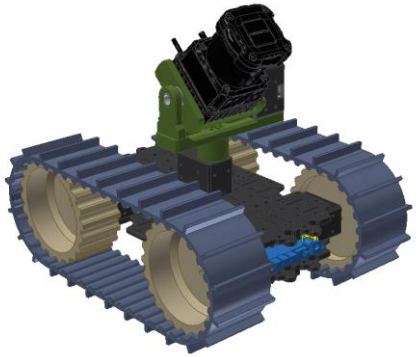


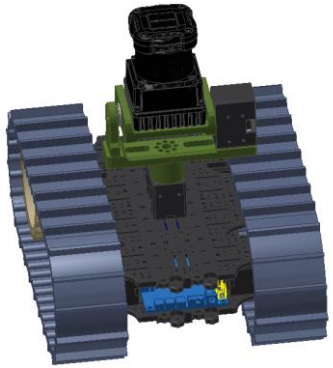
ROBOTIS

Details

Ex 10). 4 Wheels (caterpillar)

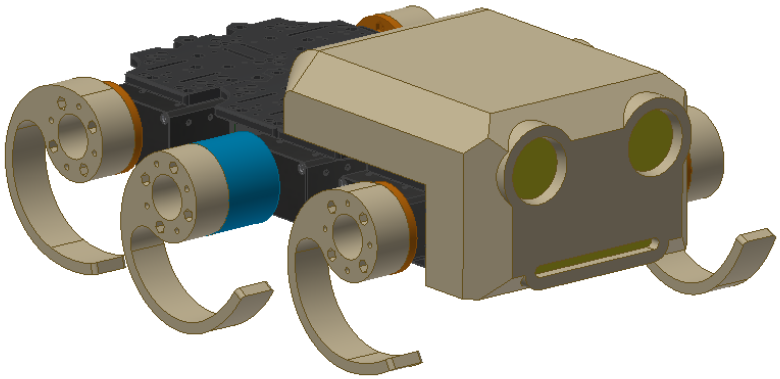


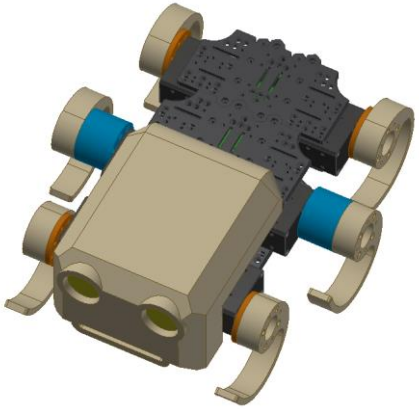


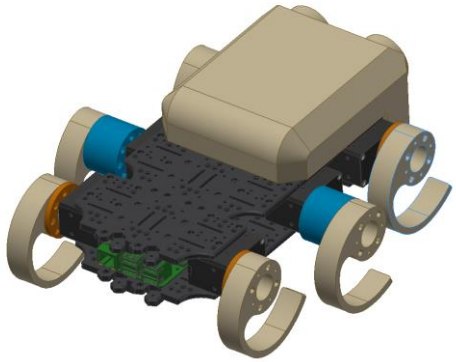


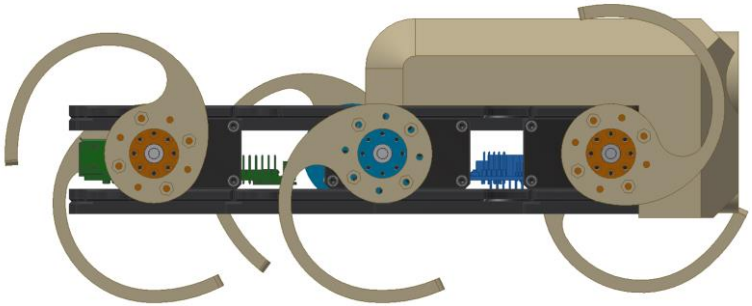
Details

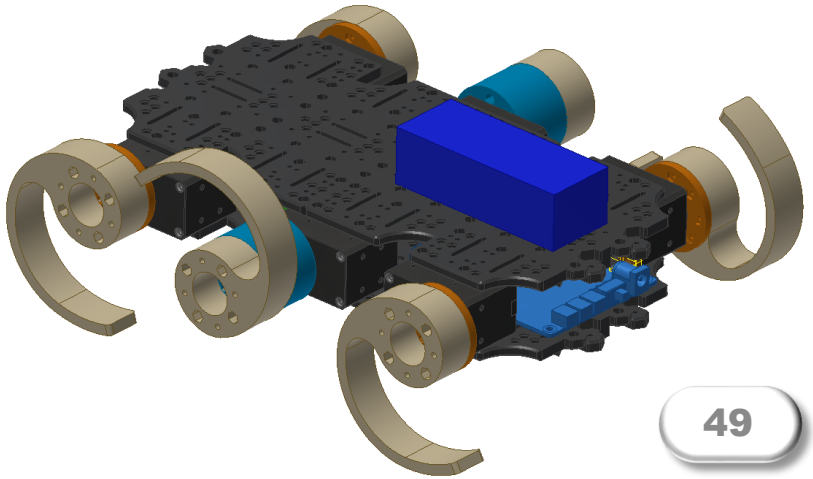
Ex 11). 6 Wheels (special wheels)





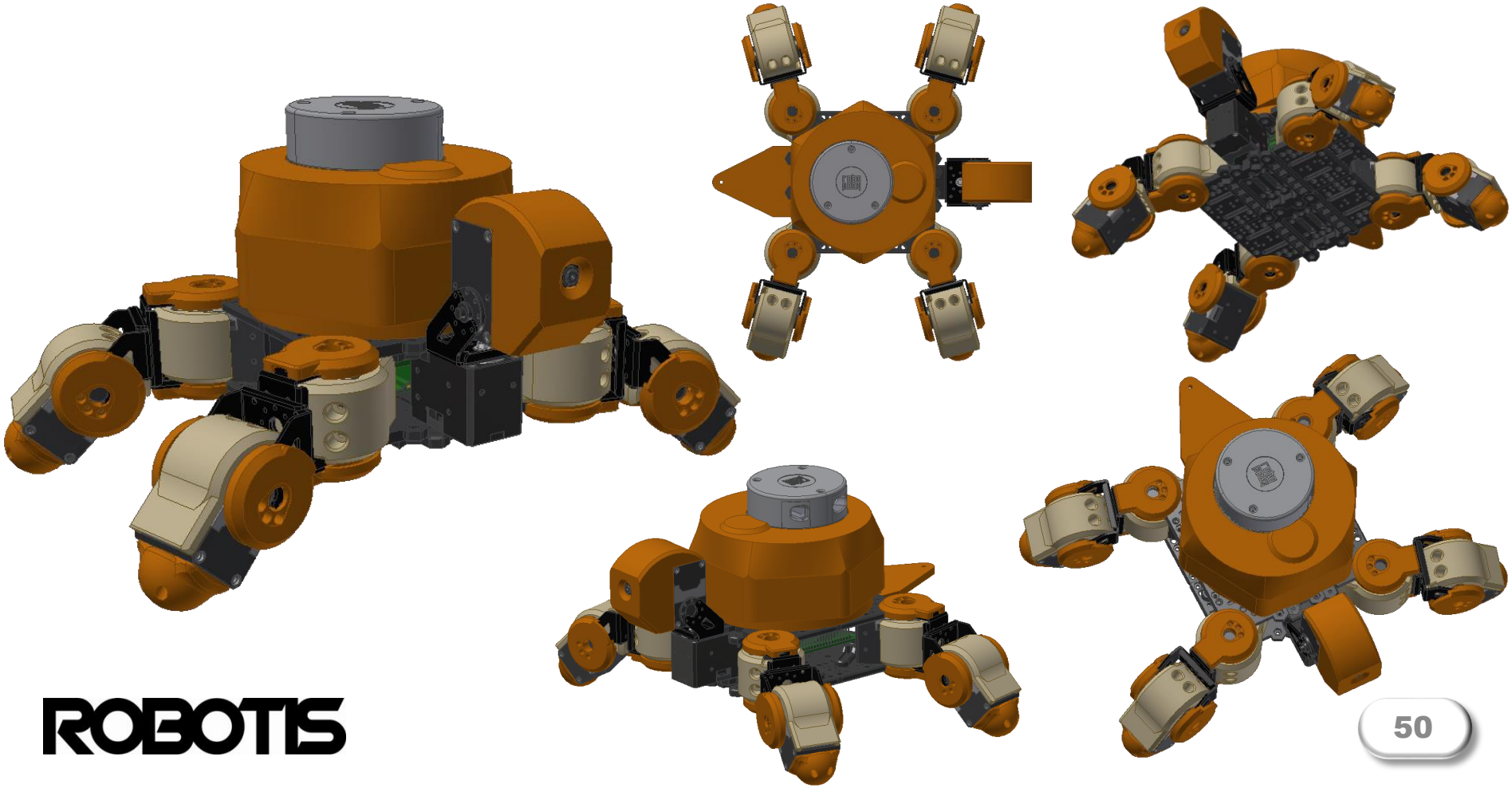






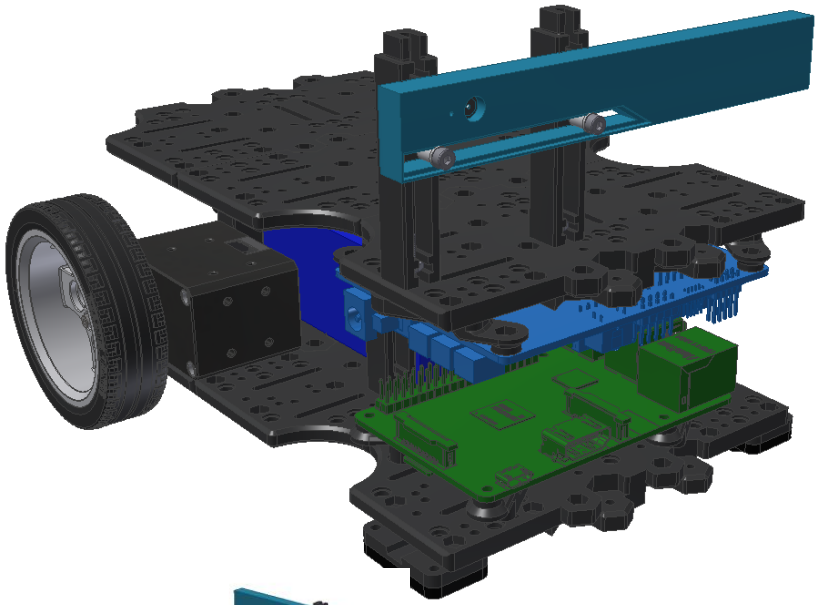
Details

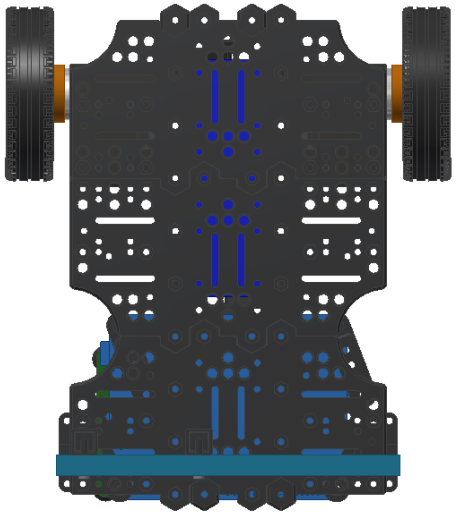
Ex 12). 4 Legs (real turtlebot style)

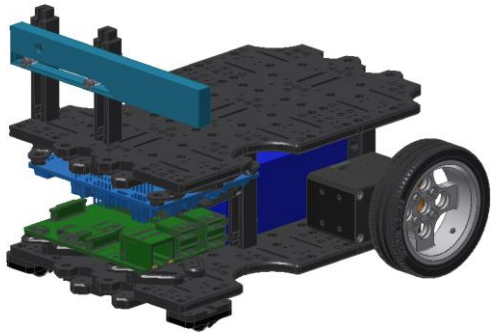


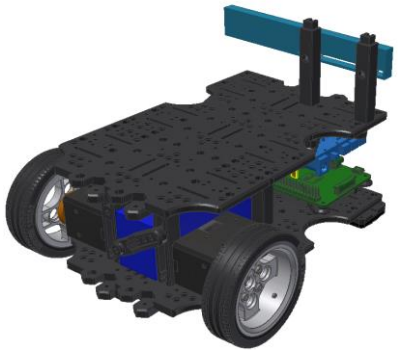
Details

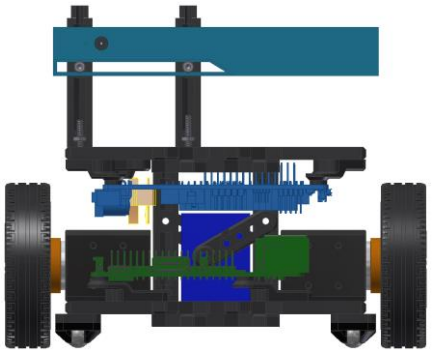
Intel Joule + RealSense version

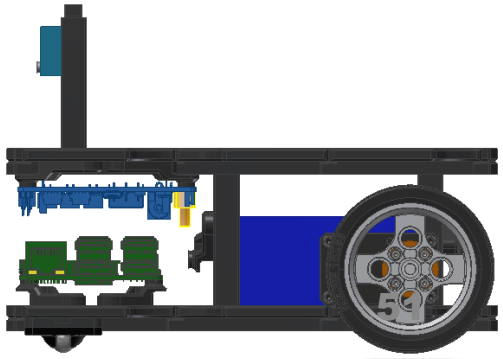






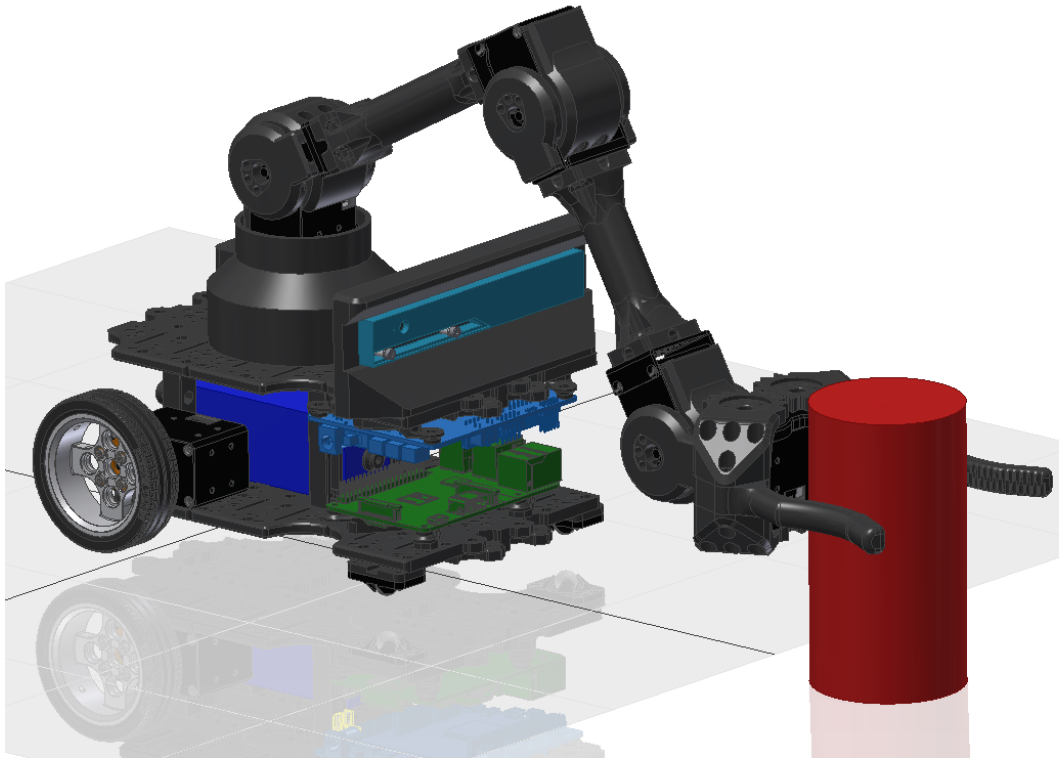


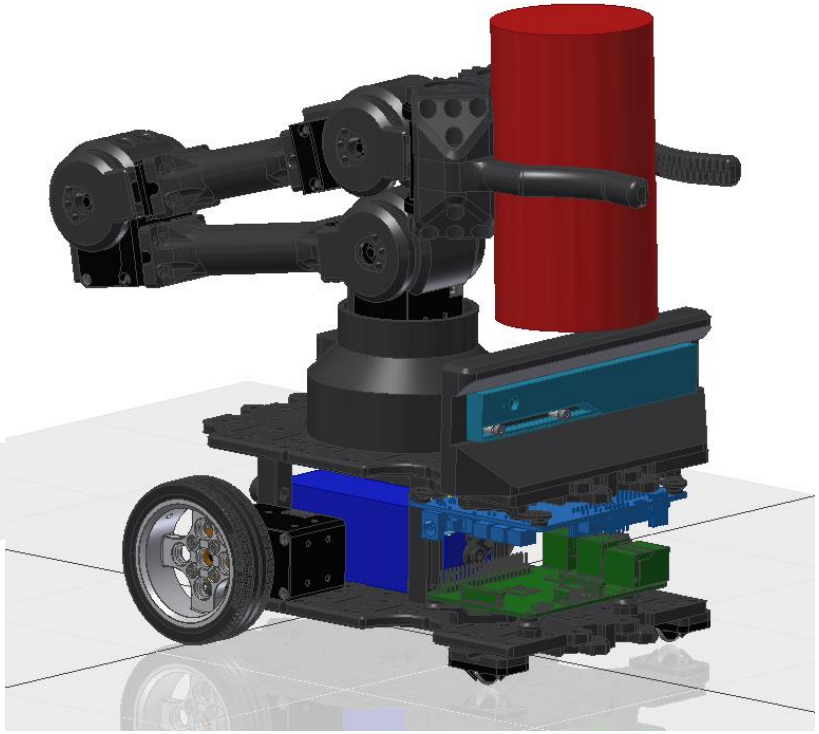




Details

Manipulator-X





Details

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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
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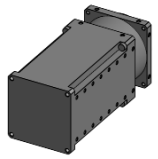

Owner
ROBOTIS OpenSourceTeam

Description
No description

Labels
No labels

Sharing
Public to all users

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Created by
ROBOTIS OpenSourceTeam
3:55 PM Jun 20

Last modified by
Darby Lim
4:55 PM Today

Size
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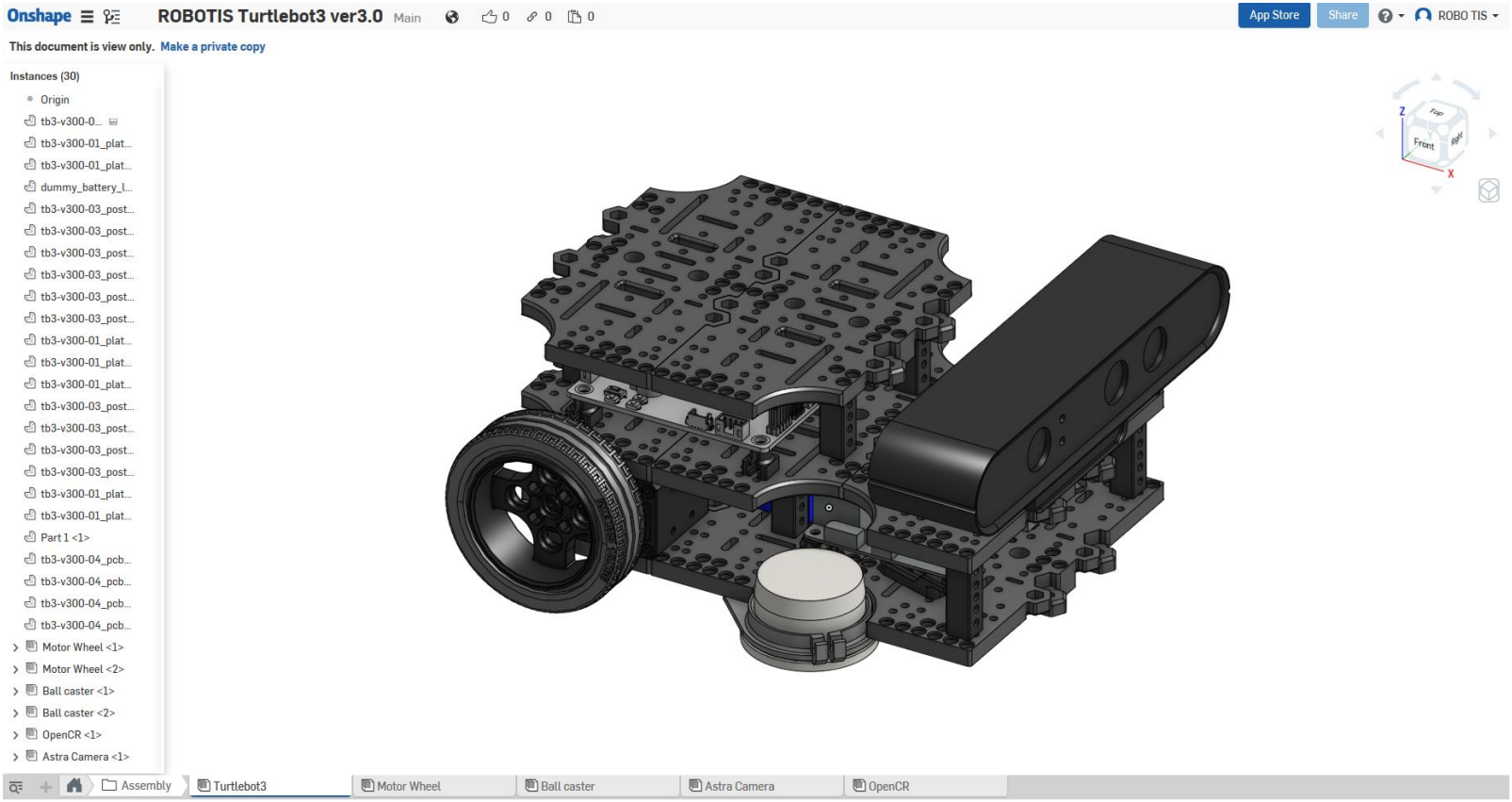
Default workspace
Main

Details

3D Printability



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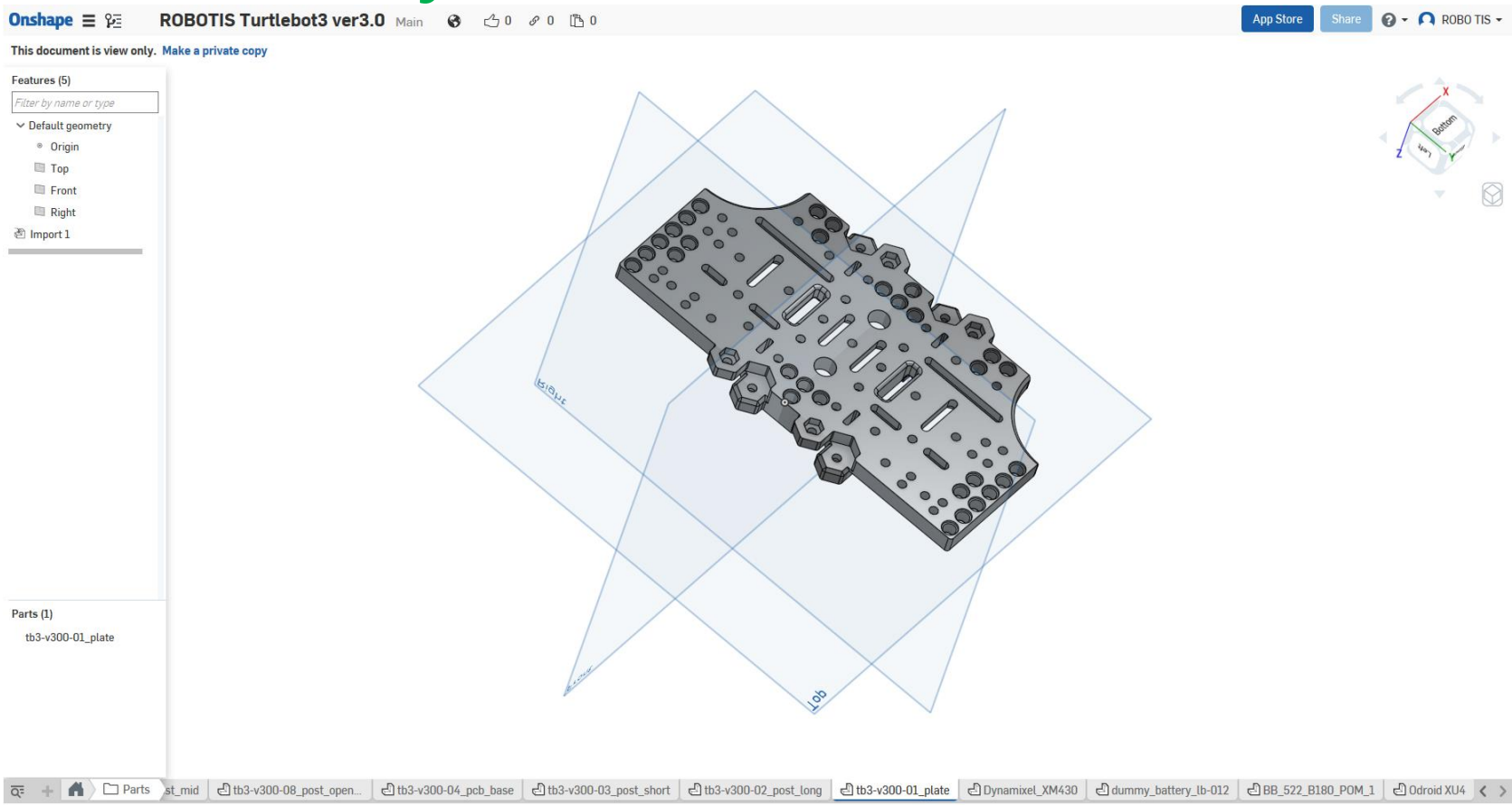


Details

Full Open-source

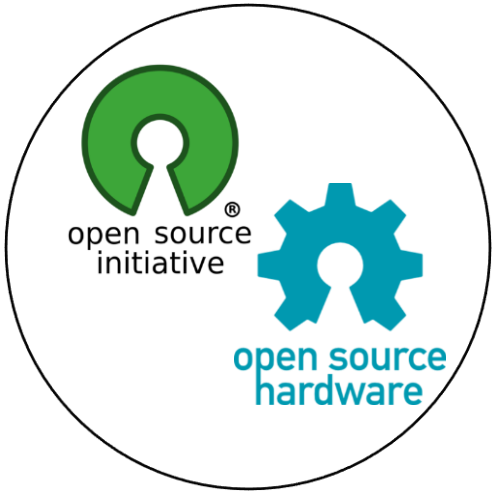
Hardware

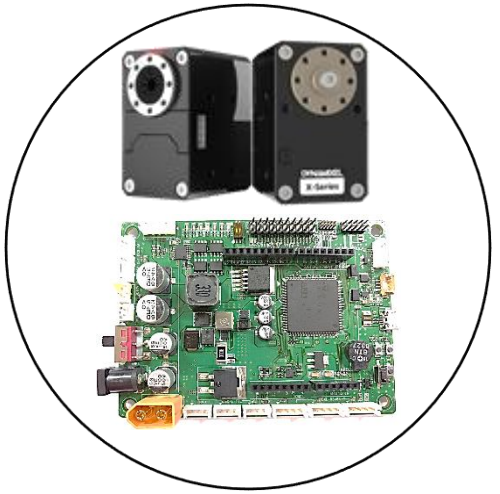
- **CAD Data** : Onshape (https://www.onshape.com/)
  - **Search "ROBOTIS" or "Turtlebot" (ex:** https://goo.gl/Om7f9O**)**
- **Circuit Gerber files**
  - https://github.com/ROBOTIS-GIT/OpenCR

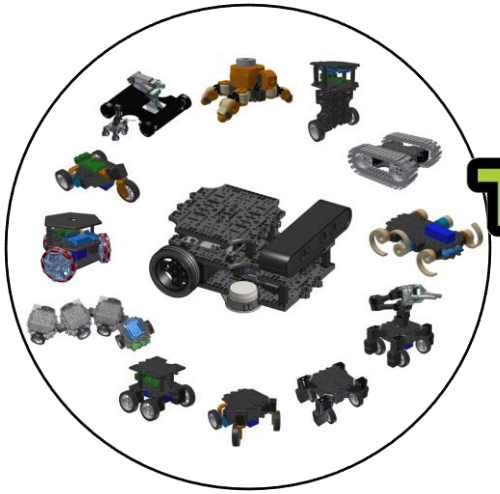
Software

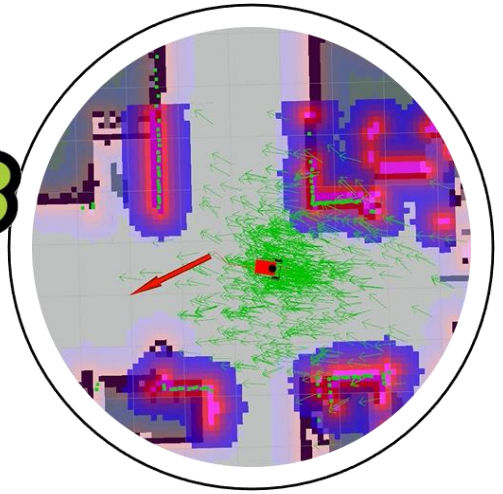
- **Firmware** & **ROS packages**
  - https://github.com/ROBOTIS-GIT/OpenCR
  - https://github.com/ROBOTIS-GIT/turtlebot3

Welcome to TB3 open-source and your contribution!









TURTLEBOT3

TURTLEBOT3