



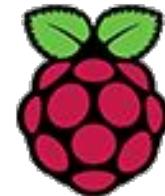
# Turtlebot3



**ROBOTIS**



# TURTLEBOT3



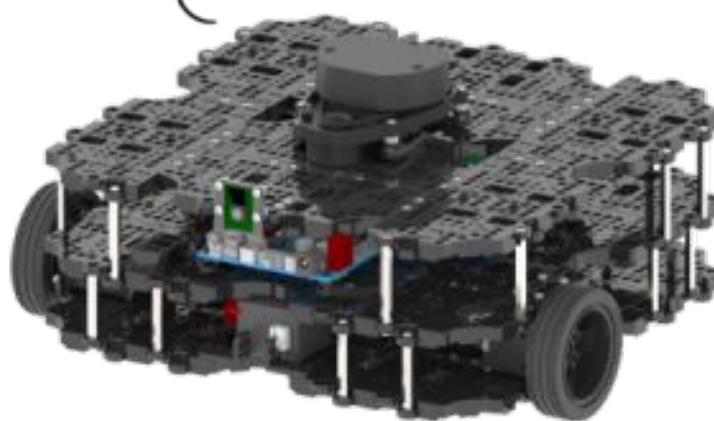
TurtleBot3

Burger



TurtleBot3

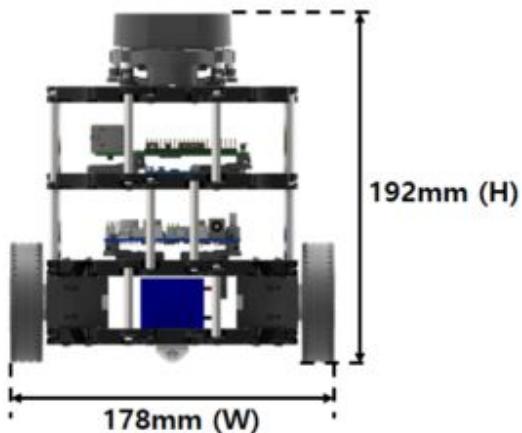
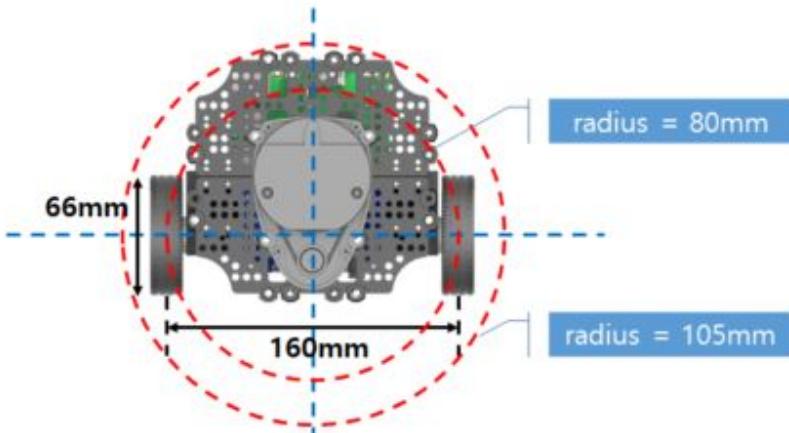
Waffle Pi



# Model

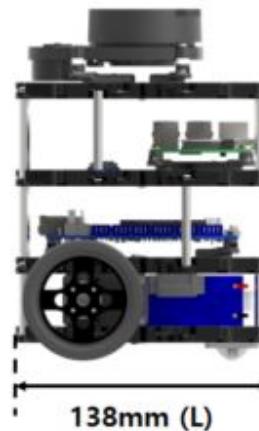
Burger

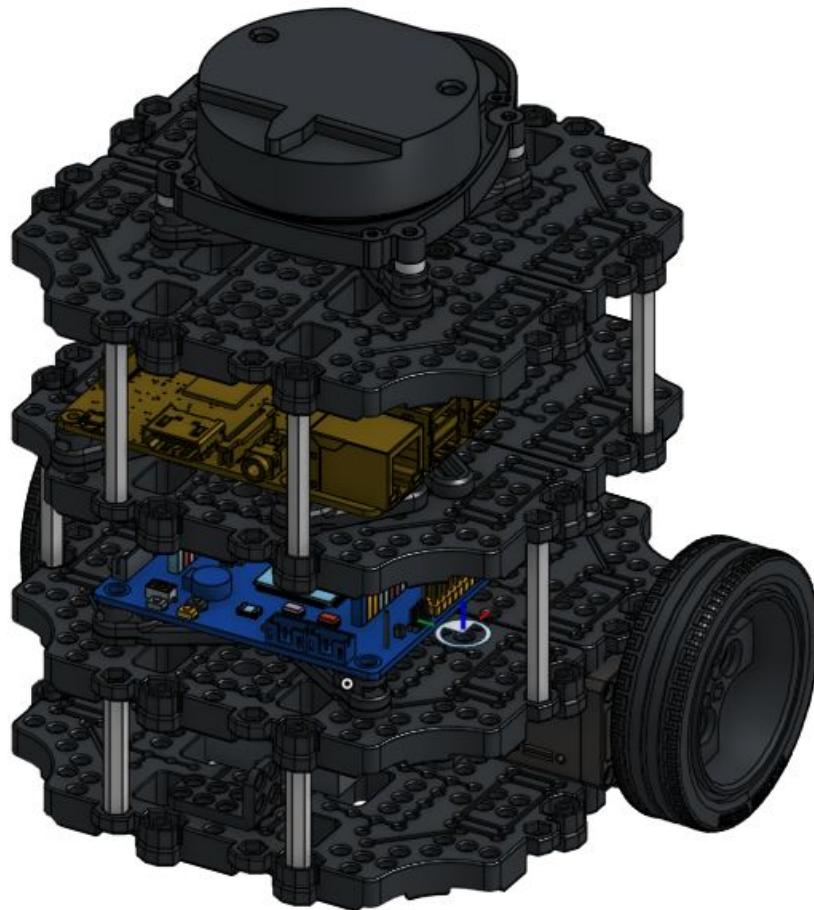
# TurtleBot3 Burger



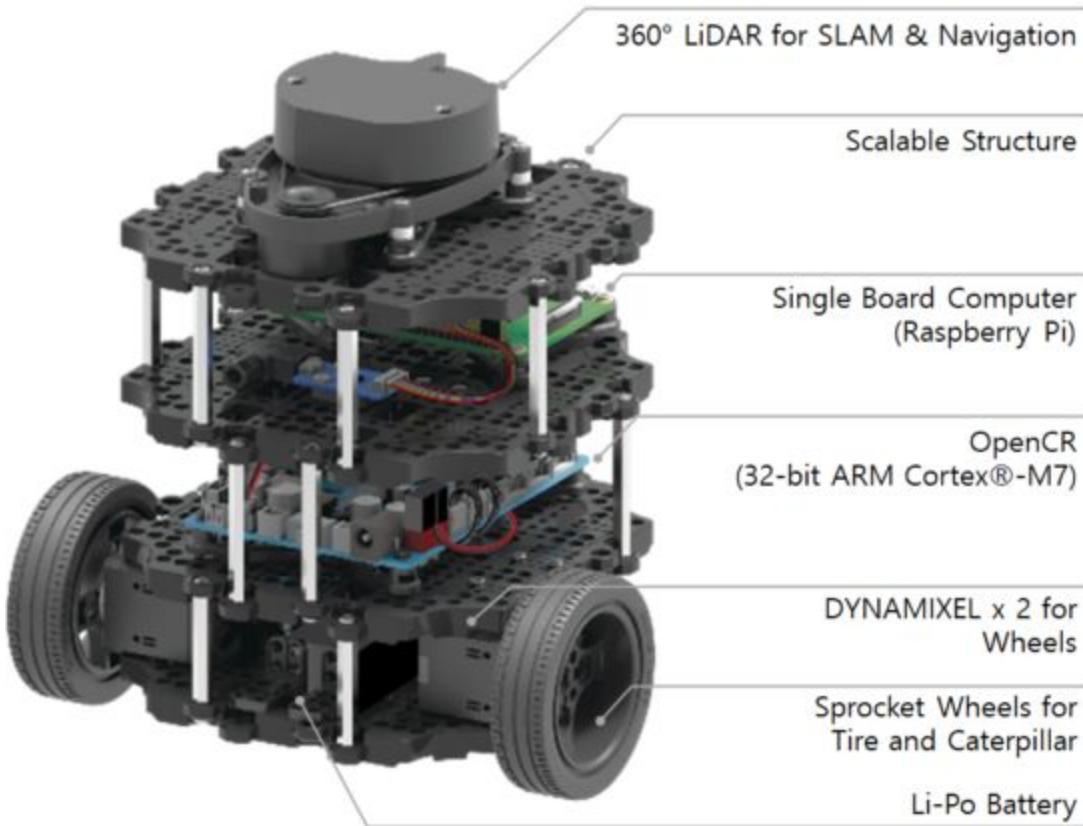
=  $138 \times 178 \times 192$   
(L x W x H, mm)

= 1 Kg

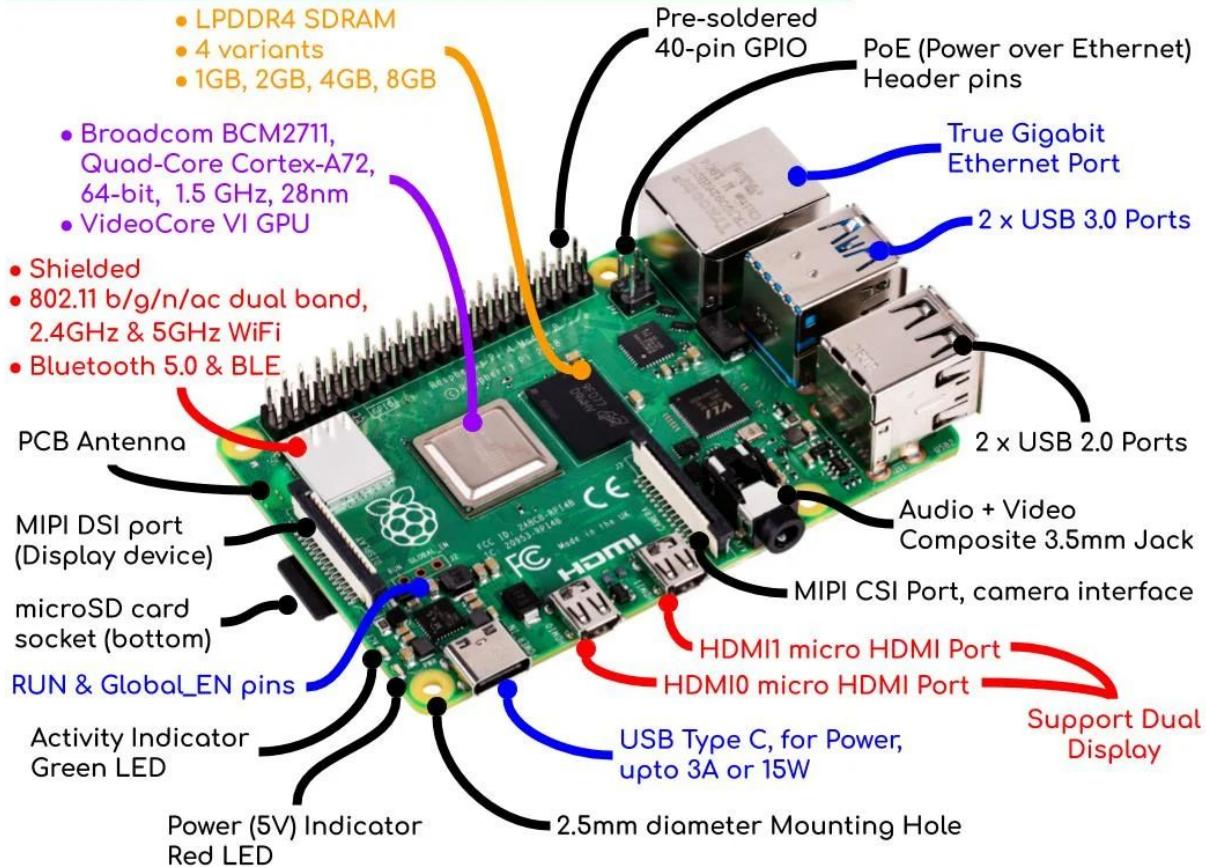




# TurtleBot3 Burger



# Raspberry Pi 4 Model B Overview



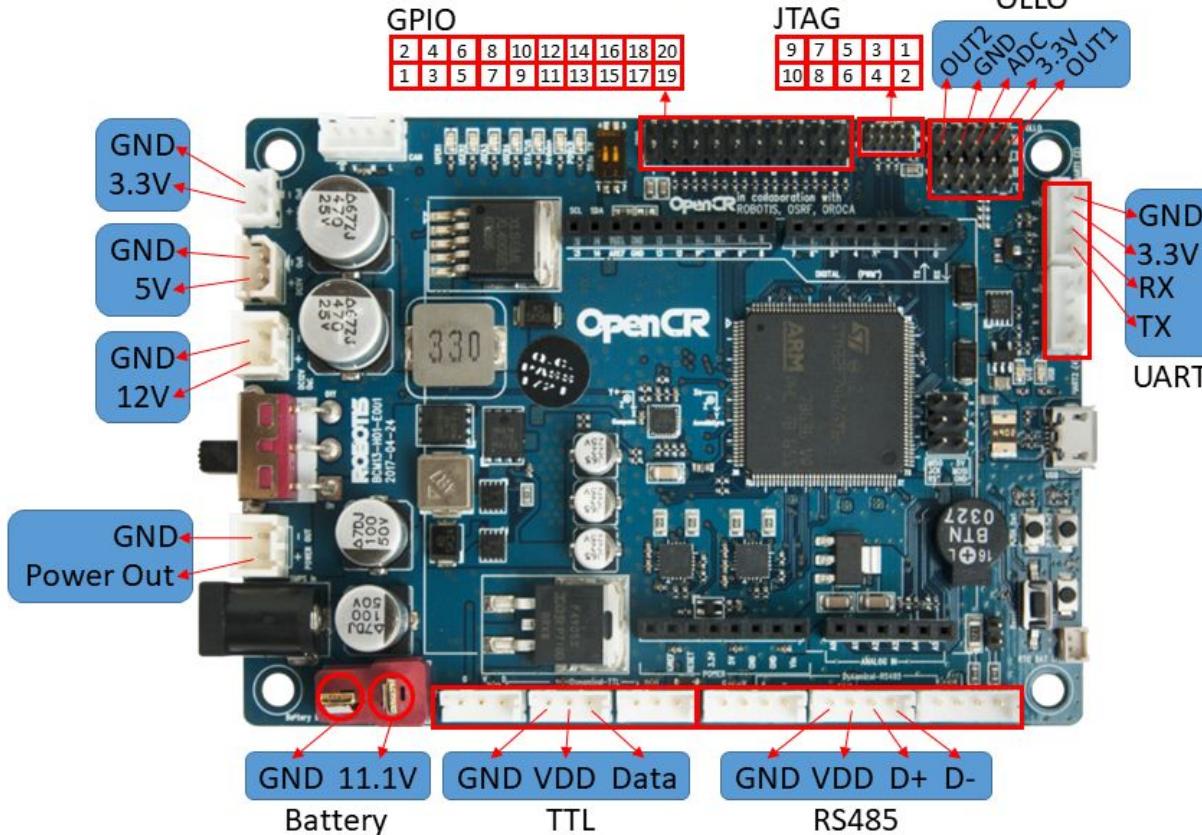
GPIO

<b>1</b>	3.3V	<b>6</b>	D53	<b>11</b>	D58	<b>16</b>	D63
<b>2</b>	GND	<b>7</b>	D54	<b>12</b>	D59	<b>17</b>	D64
<b>3</b>	D50	<b>8</b>	D55	<b>13</b>	D60	<b>18</b>	D65
<b>4</b>	D51	<b>9</b>	D56	<b>14</b>	D61	<b>19</b>	D66
<b>5</b>	D52	<b>10</b>	D57	<b>15</b>	D62	<b>20</b>	D67

JTAG

<b>1</b>	3.3V	<b>6</b>	JTDO_SWO
<b>2</b>	JTMS_SWDIO	<b>7</b>	GND
<b>3</b>	GND	<b>8</b>	JTDI
<b>4</b>	JTCK_SWCLK	<b>9</b>	GND
<b>5</b>	GND	<b>10</b>	MCU_NRESET

OLLO

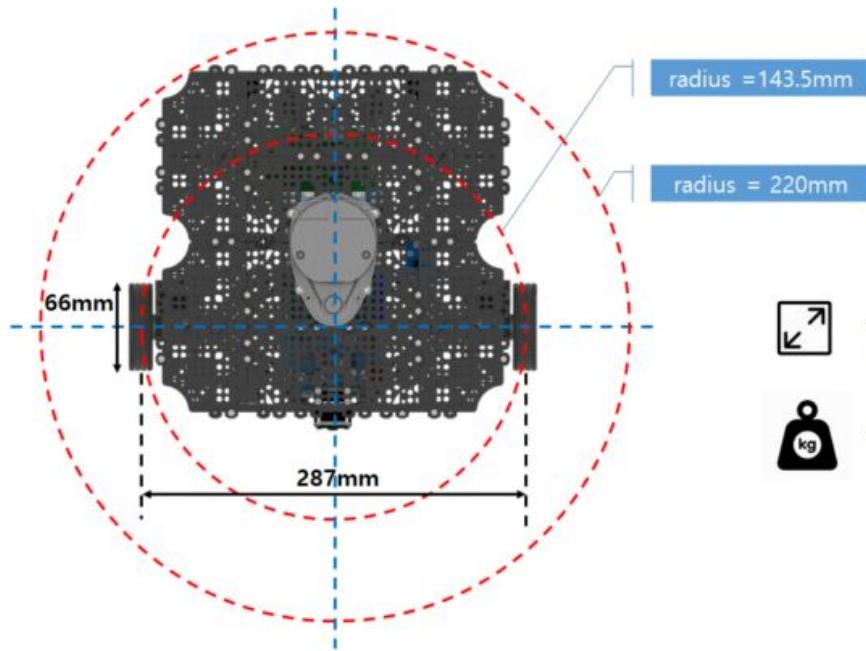


# Waffle



Waffle pi

# TurtleBot3 Waffle Pi



radius = 143.5mm

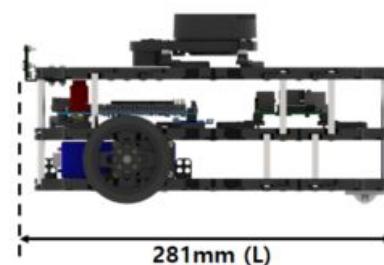
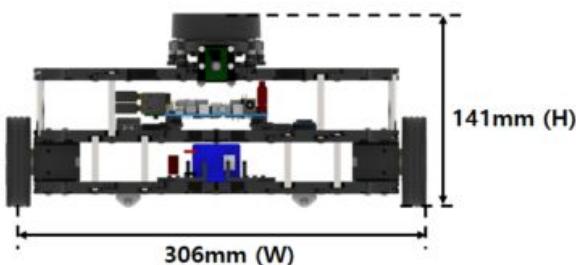
radius = 220mm

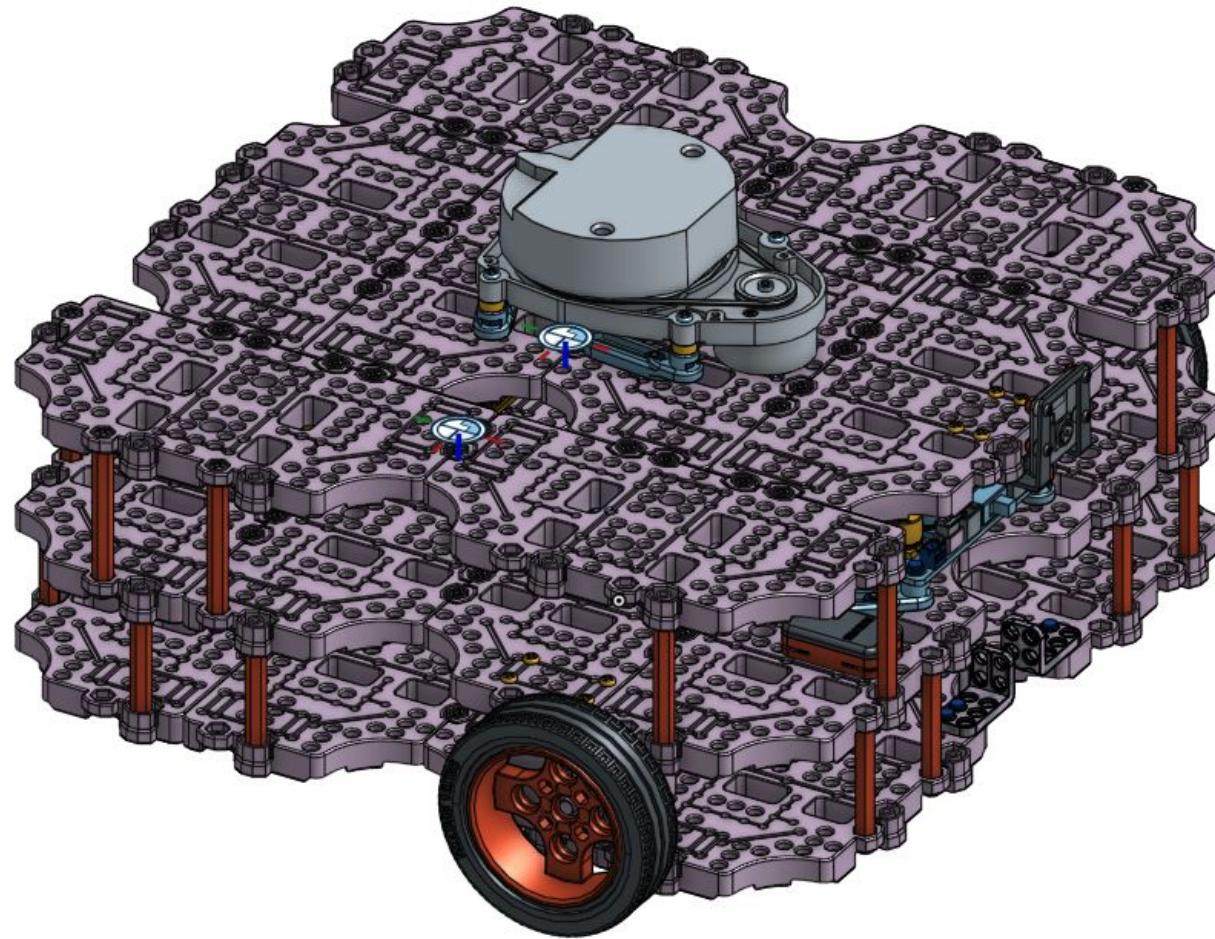


= 281 x 306 x 141  
(L x W x H, mm)

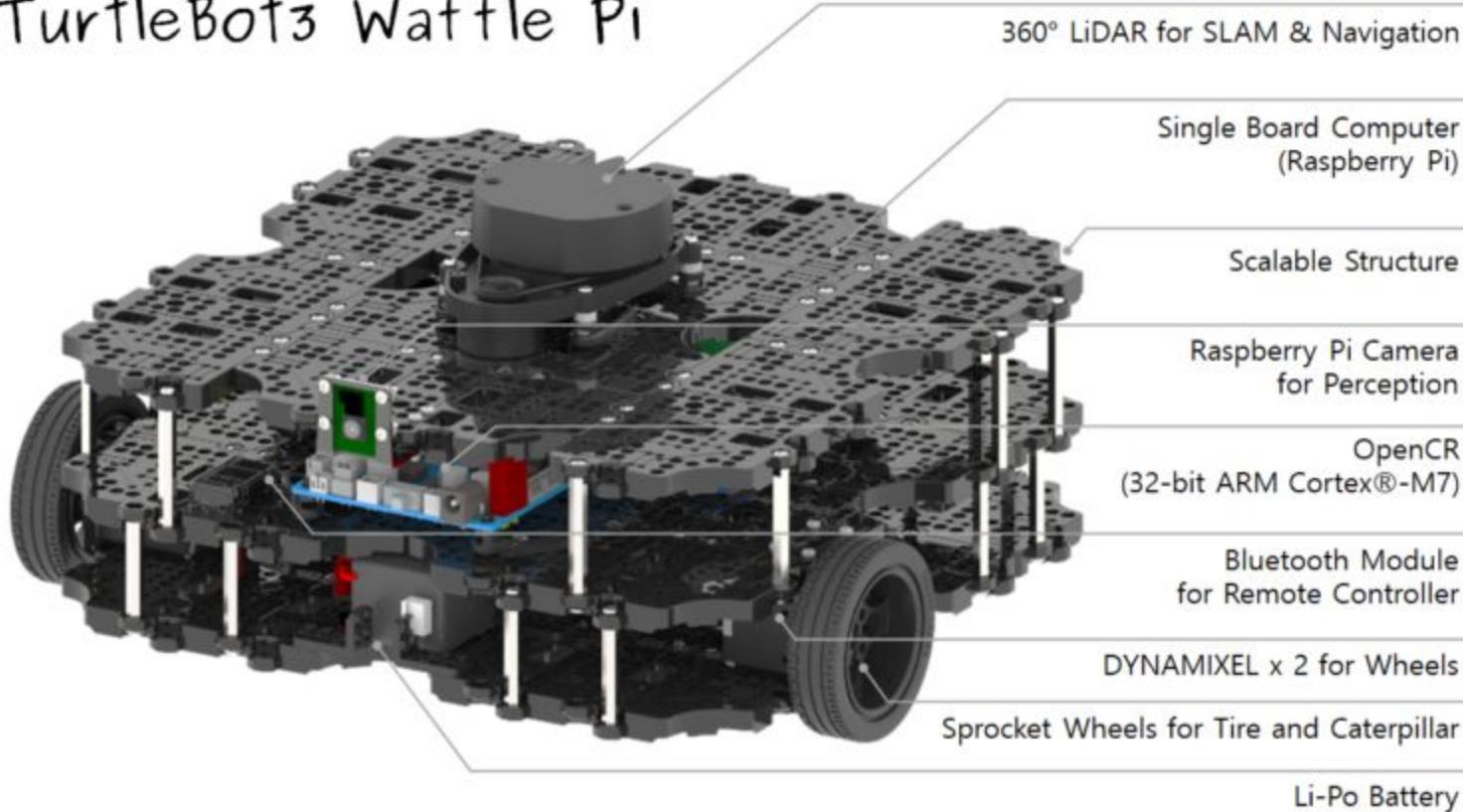


= 1.8 Kg





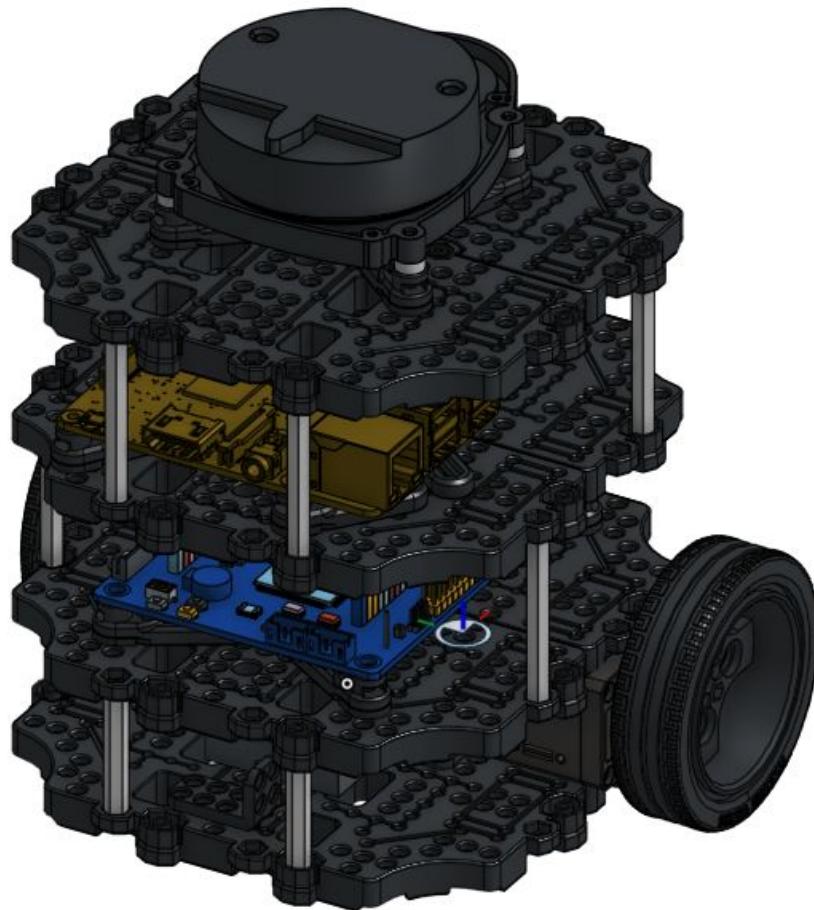
# TurtleBot3 Waffle Pi



Items	Burger	Waffle Pi
Maximum translational velocity	0.22 m/s	0.26 m/s
Maximum rotational velocity	2.84 rad/s (162.72 deg/s)	1.82 rad/s (104.27 deg/s)
Maximum payload	15kg	30kg
Size (L x W x H)	138mm x 178mm x 192mm	281mm x 306mm x 141mm
Weight (+ SBC + Battery + Sensors)	1kg	1.8kg
Threshold of climbing	10 mm or lower	10 mm or lower
Expected operating time	2h 30m	2h
Expected charging time	2h 30m	2h 30m
SBC (Single Board Computers)	Raspberry Pi	Raspberry Pi
MCU	32-bit ARM Cortex®-M7 with FPU (216 MHz, 462 DMIPS)	32-bit ARM Cortex®-M7 with FPU (216 MHz, 462 DMIPS)
Remote Controller	-	RC-100B + BT-410 Set (Bluetooth 4, BLE)
Actuator	XL430-W250	XM430-W210
LDS(Laser Distance Sensor)	360 Laser Distance Sensor <a href="#">LDS-01</a> or <a href="#">LDS-02</a>	360 Laser Distance Sensor <a href="#">LDS-01</a> or <a href="#">LDS-02</a>
Camera	-	Raspberry Pi Camera Module v2.1
IMU	Gyroscope 3 Axis Accelerometer 3 Axis	Gyroscope 3 Axis Accelerometer 3 Axis
Power connectors	3.3V / 800mA 5V / 4A 12V / 1A	3.3V / 800mA 5V / 4A 12V / 1A
Expansion pins	GPIO 18 pins Arduino 32 pin	GPIO 18 pins Arduino 32 pin
Peripheral	UART x3, CAN x1, SPI x1, I2C x1, ADC x5, 5pin OLLO x4	UART x3, CAN x1, SPI x1, I2C x1, ADC x5, 5pin OLLO x4
DYNAMIXEL ports	RS485 x 3, TTL x 3	RS485 x 3, TTL x 3
Audio	Several programmable beep sequences	Several programmable beep sequences
Programmable LEDs	User LED x 4	User LED x 4
Status LEDs	Board status LED x 1 Arduino LED x 1 Power LED x 1	Board status LED x 1 Arduino LED x 1 Power LED x 1
Buttons and Switches	Push buttons x 2, Reset button x 1, Dip switch x 2	Push buttons x 2, Reset button x 1, Dip switch x 2
Battery	Lithium polymer 11.1V 1800mAh / 19.98Wh 5C	Lithium polymer 11.1V 1800mAh / 19.98Wh 5C
PC connection	USB	USB
Firmware upgrade	via USB / via JTAG	via USB / via JTAG
Power adapter (SMPS)	Input : 100-240V, AC 50/60Hz, 1.5A @max Output : 12V DC, 5A	Input : 100-240V, AC 50/60Hz, 1.5A @max Output : 12V DC, 5A

# Turtlebot3 URDF

Burger



## **turtlebot3\_burger.urdf.xacro**

## turtlebot3\_burger.urdf.xacro

```
1  <?xml version="1.0" ?>
2  <robot name="turtlebot3_burger" xmlns:xacro="http://ros.org/wiki/xacro">
3      <xacro:include filename="$(find turtlebot3_description)/urdf/common_properties.xacro"/>
4      <xacro:include filename="$(find turtlebot3_description)/urdf/turtlebot3_burger.gazebo.xacro"/>
```

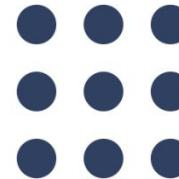
# Xacro

# Xacro

Xacro (XML Macros) Xacro is an XML macro language. With xacro, you can construct shorter and more readable XML files by using macros that expand to larger XML expressions.

## ros/xacro

Xacro is an XML macro language. With xacro, you can construct shorter and more readable XML files by using macros...



22  
Contributors

6  
Issues

46  
Stars

85  
Forks



## turtlebot3\_burger.urdf.xacro

```
1  <?xml version="1.0" ?>
2  <robot name="turtlebot3_burger" xmlns:xacro="http://ros.org/wiki/xacro">
3    <xacro:include filename="$(find turtlebot3_description)/urdf/common_properties.xacro"/>
4    <xacro:include filename="$(find turtlebot3_description)/urdf/turtlebot3_burger.gazebo.xacro"/>
```

## turtlebot3\_burger.urdf.xacro

```
6   <link name="base_footprint"/>
```

## turtlebot3\_burger.urdf.xacro

```
14  <link name="base_link">
15    <visual>
16      <origin xyz="-0.032 0 0.0" rpy="0 0 0"/>
17      <geometry>
18        <mesh filename="package://turtlebot3_description/meshes/bases/burger_base.stl" scale="0.001 0.001 0.001"/>
19      </geometry>
20      <material name="light_black"/>
21    </visual>
22
23    <collision>
24      <origin xyz="-0.032 0 0.070" rpy="0 0 0"/>
25      <geometry>
26        <box size="0.140 0.140 0.143"/>
27      </geometry>
28    </collision>
29
30    <inertial>
31      <origin xyz="0 0 0" rpy="0 0 0"/>
32      <mass value="8.2573504e-01"/>
33      <inertia ixx="2.2124416e-03" ixy="-1.2294101e-05" ixz="3.4938785e-05"
34          iyy="2.1193702e-03" iyz="-5.0120904e-06"
35          izz="2.0064271e-03" />
36    </inertial>
37  </link>
```

## turtlebot3\_burger.urdf.xacro

```
8   <joint name="base_joint" type="fixed">
9     <parent link="base_footprint"/>
10    <child link="base_link"/>
11    <origin xyz="0.0 0.0 0.010" rpy="0 0 0"/>
12  </joint>
```

## turtlebot3\_burger.urdf.xacro

```
46   <link name="wheel_left_link">
47     <visual>
48       <origin xyz="0 0 0" rpy="1.57 0 0"/>
49       <geometry>
50         <mesh filename="package://turtlebot3_description/meshes/wheels/left_tire.stl" scale="0.001 0.001 0.001"/>
51       </geometry>
52       <material name="dark"/>
53     </visual>
54
55     <collision>
56       <origin xyz="0 0 0" rpy="0 0 0"/>
57       <geometry>
58         <cylinder length="0.018" radius="0.033"/>
59       </geometry>
60     </collision>
61
62     <inertial>
63       <origin xyz="0 0 0" />
64       <mass value="2.8498940e-02" />
65       <inertia ixx="1.1175580e-05" ixy="-4.2369783e-11" ixz="-5.9381719e-09"
66           iyy="1.1192413e-05" iyz="-1.4400107e-11"
67           izz="2.0712558e-05" />
68     </inertial>
69   </link>
```

## turtlebot3\_burger.urdf.xacro

```
39    <joint name="wheel_left_joint" type="continuous">
40        <parent link="base_link"/>
41        <child link="wheel_left_link"/>
42        <origin xyz="0.0 0.08 0.023" rpy="-1.57 0 0"/>
43        <axis xyz="0 0 1"/>
44    </joint>
```

## turtlebot3\_burger.urdf.xacro

```
78  <link name="wheel_right_link">
79    <visual>
80      <origin xyz="0 0 0" rpy="1.57 0 0"/>
81      <geometry>
82        <mesh filename="package://turtlebot3_description/meshes/wheels/right_tire.stl" scale="0.001 0.001 0.001"/>
83      </geometry>
84      <material name="dark"/>
85    </visual>
86
87    <collision>
88      <origin xyz="0 0 0" rpy="0 0 0"/>
89      <geometry>
90        <cylinder length="0.018" radius="0.033"/>
91      </geometry>
92    </collision>
93
94    <inertial>
95      <origin xyz="0 0 0" />
96      <mass value="2.8498940e-02" />
97      <inertia ixx="1.1175580e-05" ixy="-4.2369783e-11" ixz="-5.9381719e-09"
98          iyy="1.1192413e-05" iyz="-1.4400107e-11"
99          izz="2.0712558e-05" />
100     </inertial>
101   </link>
```

## turtlebot3\_burger.urdf.xacro

```
71      <joint name="wheel_right_joint" type="continuous">
72          <parent link="base_link"/>
73          <child link="wheel_right_link"/>
74          <origin xyz="0.0 -0.080 0.023" rpy="-1.57 0 0"/>
75          <axis xyz="0 0 1"/>
76      </joint>
```

## turtlebot3\_burger.urdf.xacro

```
103      <joint name="caster_back_joint" type="fixed">
104        <parent link="base_link"/>
105        <child link="caster_back_link"/>
106        <origin xyz="-0.081 0 -0.004" rpy="-1.57 0 0"/>
107      </joint>
108
109      <link name="caster_back_link">
110        <collision>
111          <origin xyz="0 0.001 0" rpy="0 0 0"/>
112          <geometry>
113            <box size="0.030 0.009 0.020"/>
114          </geometry>
115        </collision>
116
117        <inertial>
118          <origin xyz="0 0 0" />
119          <mass value="0.005" />
120          <inertia ixx="0.001" ixy="0.0" ixz="0.0"
121              iyy="0.001" iyz="0.0"
122              izz="0.001" />
123        </inertial>
124      </link>
```

## turtlebot3\_burger.urdf.xacro

```
126     <joint name="imu_joint" type="fixed">
127         <parent link="base_link"/>
128         <child link="imu_link"/>
129         <origin xyz="-0.032 0 0.068" rpy="0 0 0"/>
130     </joint>
131
132     <link name="imu_link"/>
133
134     <joint name="scan_joint" type="fixed">
135         <parent link="base_link"/>
136         <child link="base_scan"/>
137         <origin xyz="-0.032 0 0.172" rpy="0 0 0"/>
138     </joint>
```

## turtlebot3\_burger.urdf.xacro

```
140   <link name="base_scan">
141     <visual>
142       <origin xyz="0 0 0.0" rpy="0 0 0"/>
143       <geometry>
144         <mesh filename="package://turtlebot3_description/meshes/sensors/lds.stl" scale="0.001 0.001 0.001"/>
145       </geometry>
146       <material name="dark"/>
147     </visual>
148
149     <collision>
150       <origin xyz="0.015 0 -0.0065" rpy="0 0 0"/>
151       <geometry>
152         <cylinder length="0.0315" radius="0.055"/>
153       </geometry>
154     </collision>
155
156     <inertial>
157       <mass value="0.114" />
158       <origin xyz="0 0 0" />
159       <inertia ixx="0.001" ixy="0.0" ixz="0.0"
160             iyy="0.001" iyz="0.0"
161             izz="0.001" />
162     </inertial>
163   </link>
```

## turtlebot3\_burger.gazebo.xacro

```
10  <gazebo reference="wheel_left_link">
11    <mu1>0.1</mu1>
12    <mu2>0.1</mu2>
13    <kp>500000.0</kp>
14    <kd>10.0</kd>
15    <minDepth>0.001</minDepth>
16    <maxVel>0.1</maxVel>
17    <fdir1>1 0 0</fdir1>
18    <material>Gazebo/FlatBlack</material>
19  </gazebo>
20
21  <gazebo reference="wheel_right_link">
22    <mu1>0.1</mu1>
23    <mu2>0.1</mu2>
24    <kp>500000.0</kp>
25    <kd>10.0</kd>
26    <minDepth>0.001</minDepth>
27    <maxVel>0.1</maxVel>
28    <fdir1>1 0 0</fdir1>
29    <material>Gazebo/FlatBlack</material>
30  </gazebo>
31
32  <gazebo reference="caster_back_link">
33    <mu1>0.1</mu1>
34    <mu2>0.1</mu2>
35    <kp>1000000.0</kp>
36    <kd>100.0</kd>
37    <minDepth>0.001</minDepth>
38    <maxVel>1.0</maxVel>
39    <material>Gazebo/FlatBlack</material>
40  </gazebo>
```

## turtlebot3\_burger.gazebo.xacro

```
42   <gazebo reference="imu_link">
43     <sensor type="imu" name="imu">
44       <always_on>true</always_on>
45       <visualize>$(arg imu_visual)</visualize>
46     </sensor>
47     <material>Gazebo/FlatBlack</material>
48   </gazebo>
```

```
73   <gazebo>
74     <plugin name="imu_plugin" filename="libgazebo_ros_imu.so">
75       <alwaysOn>true</alwaysOn>
76       <bodyName>imu_link</bodyName>
77       <frameName>imu_link</frameName>
78       <topicName>imu</topicName>
79       <serviceName>imu_service</serviceName>
80       <gaussianNoise>0.0</gaussianNoise>
81       <updateRate>0</updateRate>
82     <imu>
83       <noise>
84         <type>gaussian</type>
85         <rate>
86           <mean>0.0</mean>
87           <stddev>2e-4</stddev>
88           <bias_mean>0.0000075</bias_mean>
89           <bias_stddev>0.0000008</bias_stddev>
90         </rate>
91         <accel>
92           <mean>0.0</mean>
93           <stddev>1.7e-2</stddev>
94           <bias_mean>0.1</bias_mean>
95           <bias_stddev>0.001</bias_stddev>
96         </accel>
97       </noise>
98     </imu>
99   </plugin>
100 </gazebo>
```

## turtlebot3\_burger.gazebo.xacro

```
102    <gazebo reference="base_scan">
103        <material>Gazebo/FlatBlack</material>
104        <sensor type="ray" name="lds_lfcd_sensor">
105            <pose>0 0 0 0 0</pose>
106            <visualize>$(arg laser_visual)</visualize>
107            <update_rate>5</update_rate>
108            <ray>
109                <scan>
110                    <horizontal>
111                        <samples>360</samples>
112                        <resolution>1</resolution>
113                        <min_angle>0.0</min_angle>
114                        <max_angle>6.28319</max_angle>
115                    </horizontal>
116                </scan>
117                <range>
118                    <min>0.120</min>
119                    <max>3.5</max>
120                    <resolution>0.015</resolution>
121                </range>
122                <noise>
123                    <type>gaussian</type>
124                    <mean>0.0</mean>
125                    <stddev>0.01</stddev>
126                </noise>
127            </ray>
128            <plugin name="gazebo_ros_lds_lfcd_controller" filename="libgazebo_ros_laser.so">
129                <topicName>scan</topicName>
130                <frameName>base_scan</frameName>
131            </plugin>
132        </sensor>
133    </gazebo>
```

## turtlebot3\_burger.gazebo.xacro

```
50  <gazebo>
51    <plugin name="turtlebot3_burger_controller" filename="libgazebo_ros_diff_drive.so">
52      <commandTopic>cmd_vel</commandTopic>
53      <odometryTopic>odom</odometryTopic>
54      <odometryFrame>odom</odometryFrame>
55      <odometrySource>world</odometrySource>
56      <publishOdomTF>true</publishOdomTF>
57      <robotBaseFrame>base_footprint</robotBaseFrame>
58      <publishWheelTF>false</publishWheelTF>
59      <publishTf>true</publishTf>
60      <publishWheelJointState>true</publishWheelJointState>
61      <legacyMode>false</legacyMode>
62      <updateRate>30</updateRate>
63      <leftJoint>wheel_left_joint</leftJoint>
64      <rightJoint>wheel_right_joint</rightJoint>
65      <wheelSeparation>0.160</wheelSeparation>
66      <wheelDiameter>0.066</wheelDiameter>
67      <wheelAcceleration>1</wheelAcceleration>
68      <wheelTorque>10</wheelTorque>
69      <rosDebugLevel>na</rosDebugLevel>
70    </plugin>
71  </gazebo>
```



GAZEBO

REF: <http://gazebosim.org/>

```
$ cd ~/tutorial_ws/src/
```

```
$ git clone -b noetic-devel https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git
```

```
$ sudo apt install -y ros-noetic-turtlebot3-msgs \
ros-noetic-turtlebot3-description \
ros-noetic-xacro ros-noetic-gazebo-plugins
```

```
$ echo "export TURTLEBOT3_MODEL=burger" >> ~/.bashrc
```

```
$ cd . . /
```

```
$ catkin_make
```

```
$ rospack profile
```

World

```
$ roslaunch turtlebot3_gazebo turtlebot3_empty_world.launch
```

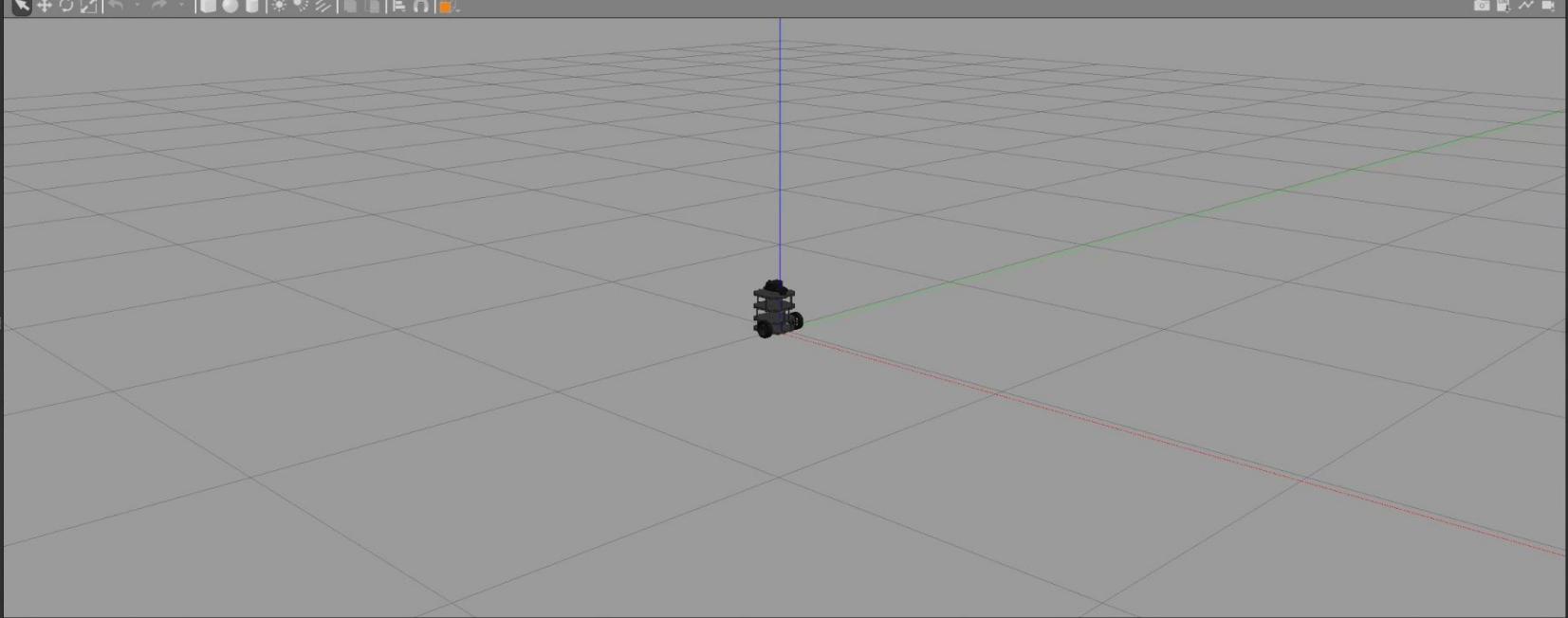
Gazebo@c065c07a68b

File Edit Camera View Window Help

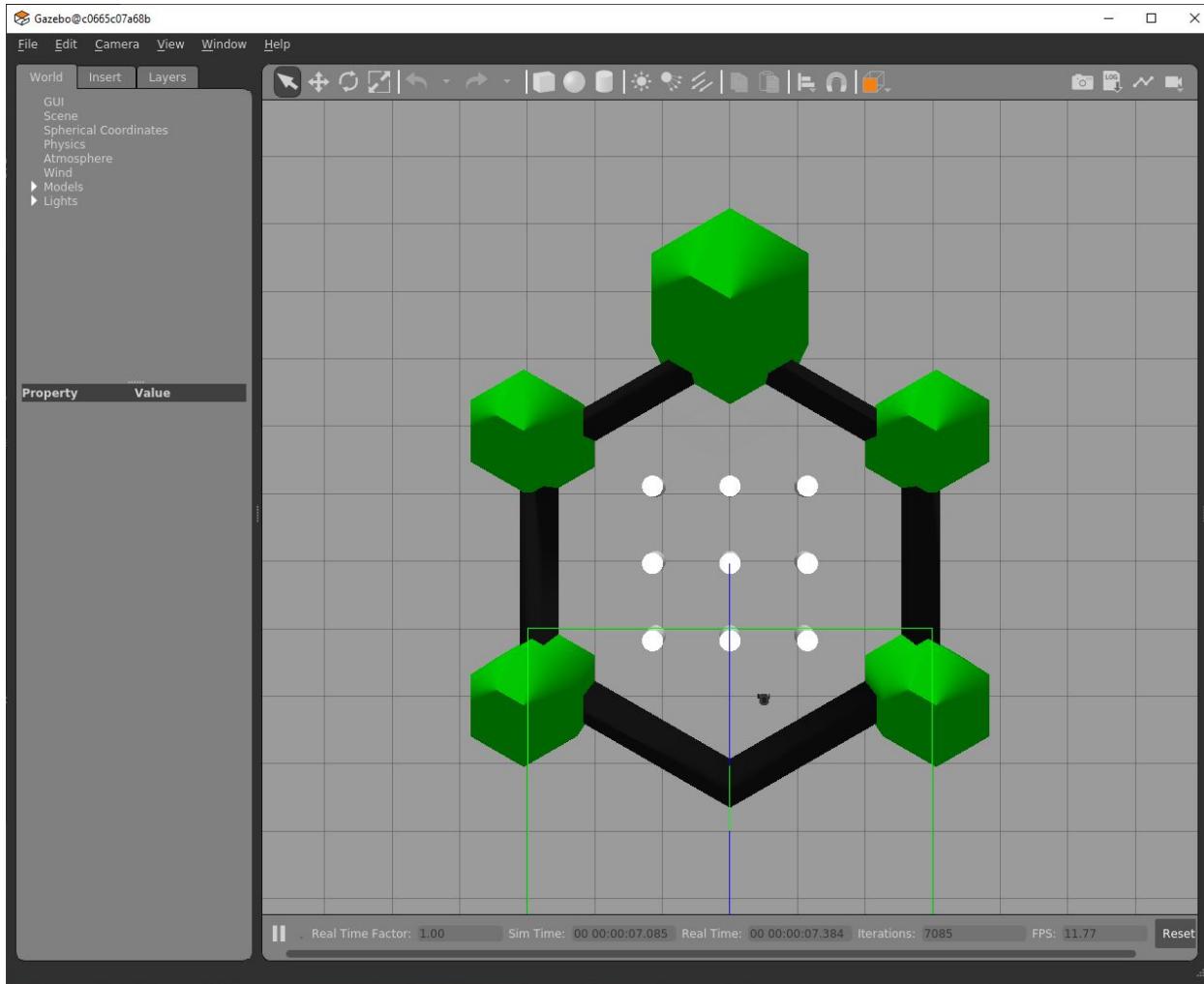
World Insert Layers

GUI  
Scene  
Spherical Coordinates  
Physics  
Atmosphere  
Wind  
Models  
Lights

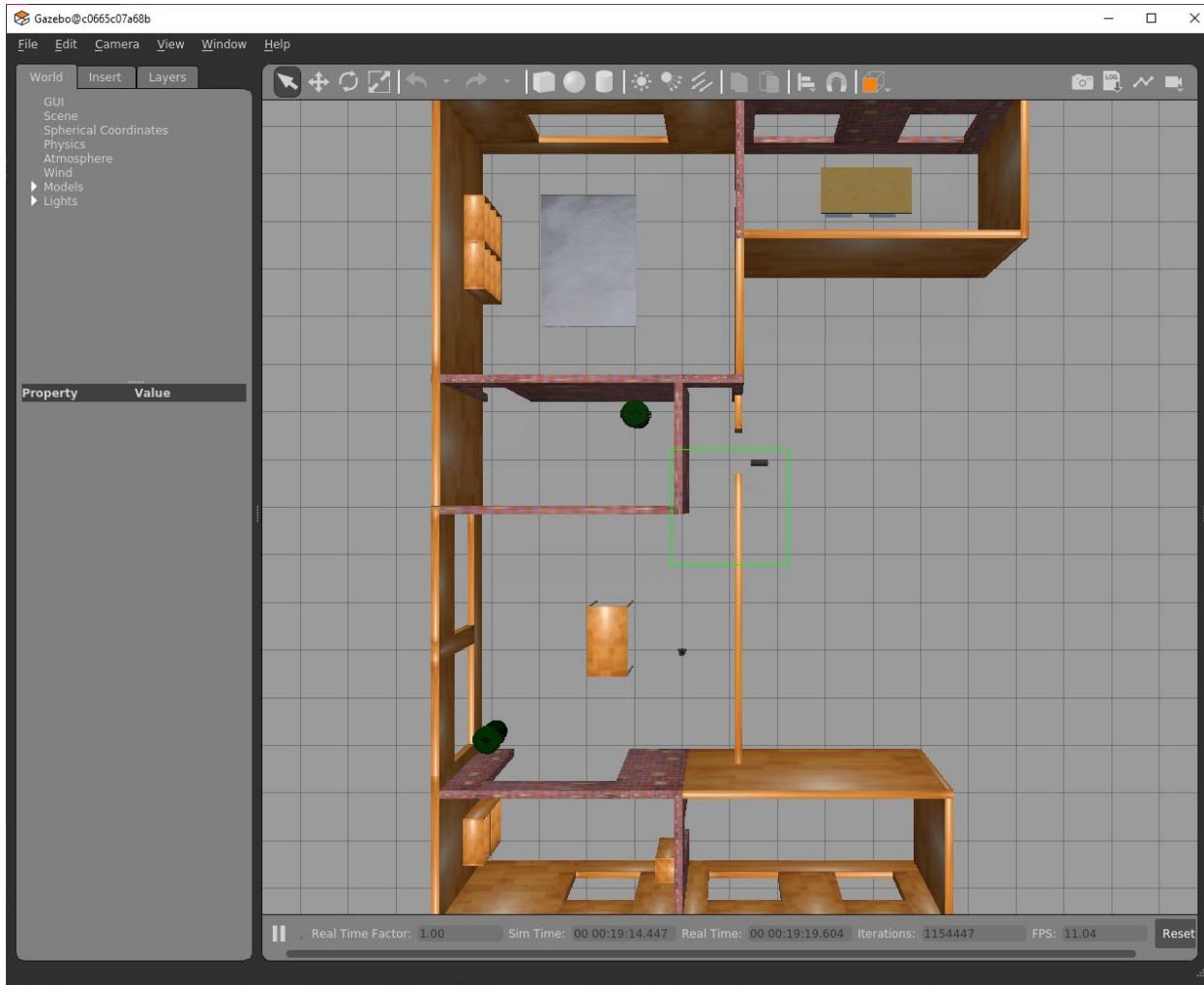
Property Value



```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



```
$ roslaunch turtlebot3_gazebo turtlebot3_house.launch
```



เปิด terminal ขึ้นมา

```
$ roscore
```

```
:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:39823/
ros_comm version 1.15.13

SUMMARY
=====
PARAMETERS
  * /rosdistro: noetic
  * /rosversion: 1.15.13

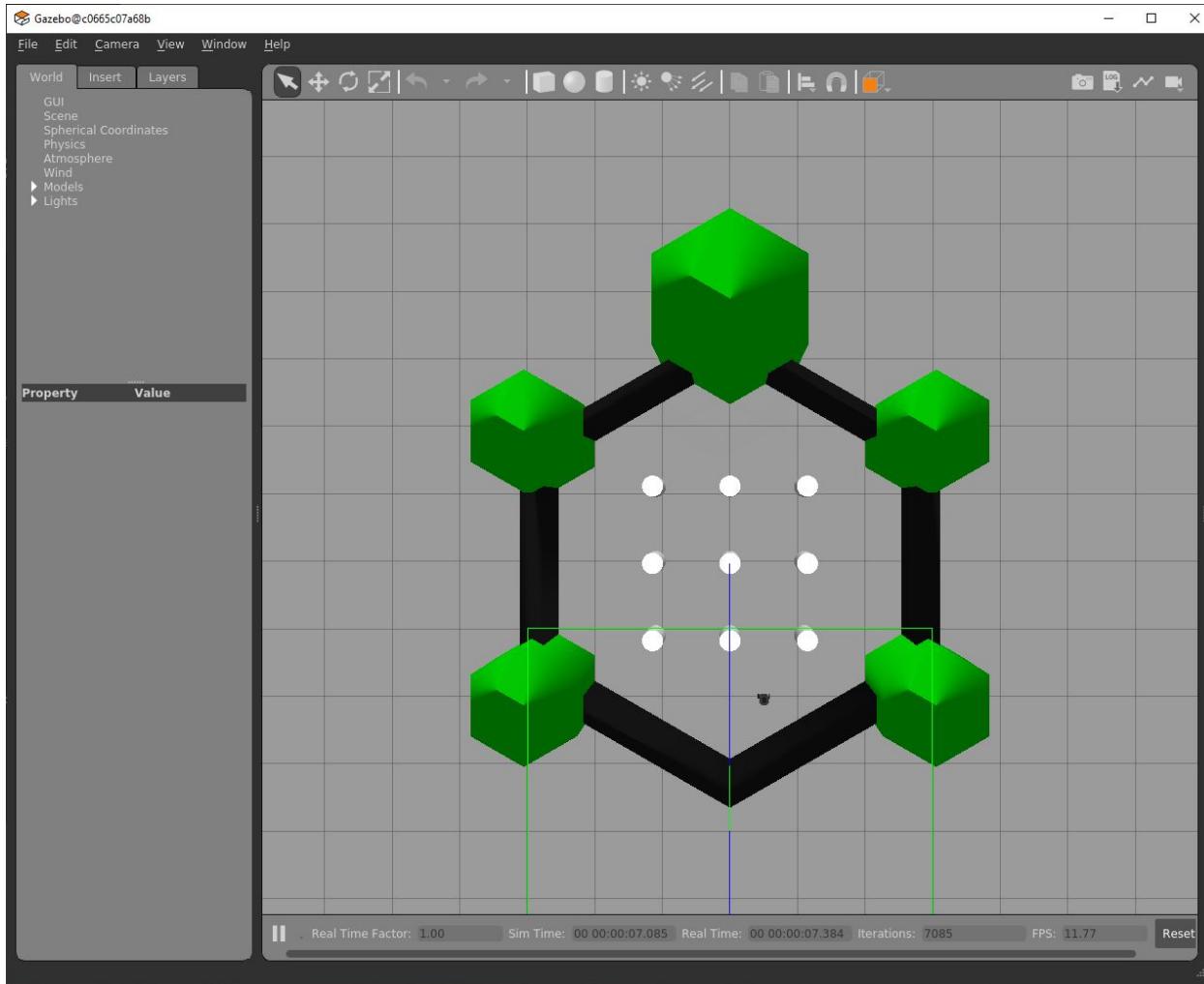
NODES

auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]
-
```

เปิดหน้าต่าง terminal ใหม่

```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



เปิดหน้าต่าง terminal ใหม่

```
$ rostopic list
```

```
:~$ rostopic list  
/clock  
/cmd_vel  
/gazebo/link_states  
/gazebo/model_states  
/gazebo/parameter_descriptions  
/gazebo/parameter_updates  
/gazebo/performance_metrics  
/gazebo/set_link_state  
/gazebo/set_model_state  
/imu  
/joint_states  
/odom  
/rosout  
/rosout_agg  
/scan  
/tf
```

```
:~$ rostopic list  
/clock  
/cmd_vel  
/gazebo/link_states  
/gazebo/model_states  
/gazebo/parameter_descriptions  
/gazebo/parameter_updates  
/gazebo/performance_metrics  
/gazebo/set_link_state  
/gazebo/set_model_state  
/imu  
/joint_states  
/odom  
/rosout  
/rosout_agg  
/scan  
/tf
```

/cmd\_vel

```
$ rostopic info /cmd_vel
```

```
:~$ rostopic info /cmd_vel
Type: geometry_msgs/Twist

Publishers: None

Subscribers:
* /gazebo (http://:36893/)
```

เปิดหน้าต่าง terminal ใหม่

```
$ rqt
```

Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

- Container
- Actions
- Configuration
- Introspection
- Logging
- Miscellaneous Tools
- Services
- Topics
- Visualization

► Message Publisher

Message Type Brow

Topic Monitor



A Python GUI plugin for publishing ROS messages.

Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic /clicked\_point

Type geometry\_msgs/PointStamped

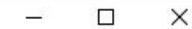
Freq. 1 Hz + -



topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help



Message Publisher



Topic /clicked\_point

Type geometry\_msgs/PointStamped

Freq. 1 Hz

expression

topic /clock

/cmd vel

/gazebo/link\_states

/gazebo/model\_states

/gazebo/parameter\_descriptions

/gazebo/parameter\_updates

/gazebo/performance\_metrics

/gazebo/set\_link\_state

/gazebo/set\_model\_state



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic /clicked\_point

Type geometry\_msgs/PointStamped

Freq.

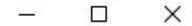
1

Hz



topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	

Default - rqt@c0665c07a68b



[File](#) [Plugins](#) [Running](#) [Perspectives](#) [Help](#)

▷ Message Publisher

D - O X

Topic /clicked\_point

Type geometry\_msgs/PointStamped

Freq.

1

Hz



topic	type	rate	expression
-------	------	------	------------

/cmd_vel	geometry_msgs/Twist	10.00	
----------	---------------------	-------	--



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

▷ Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

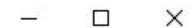
Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.5	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X



Topic /clicked\_point



Type geometry\_msgs/PointStamped



Freq. 1



Hz



topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
	float64	0.5	
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X



Topic /clicked\_point



Type geometry\_msgs/PointStamped



Freq. 1

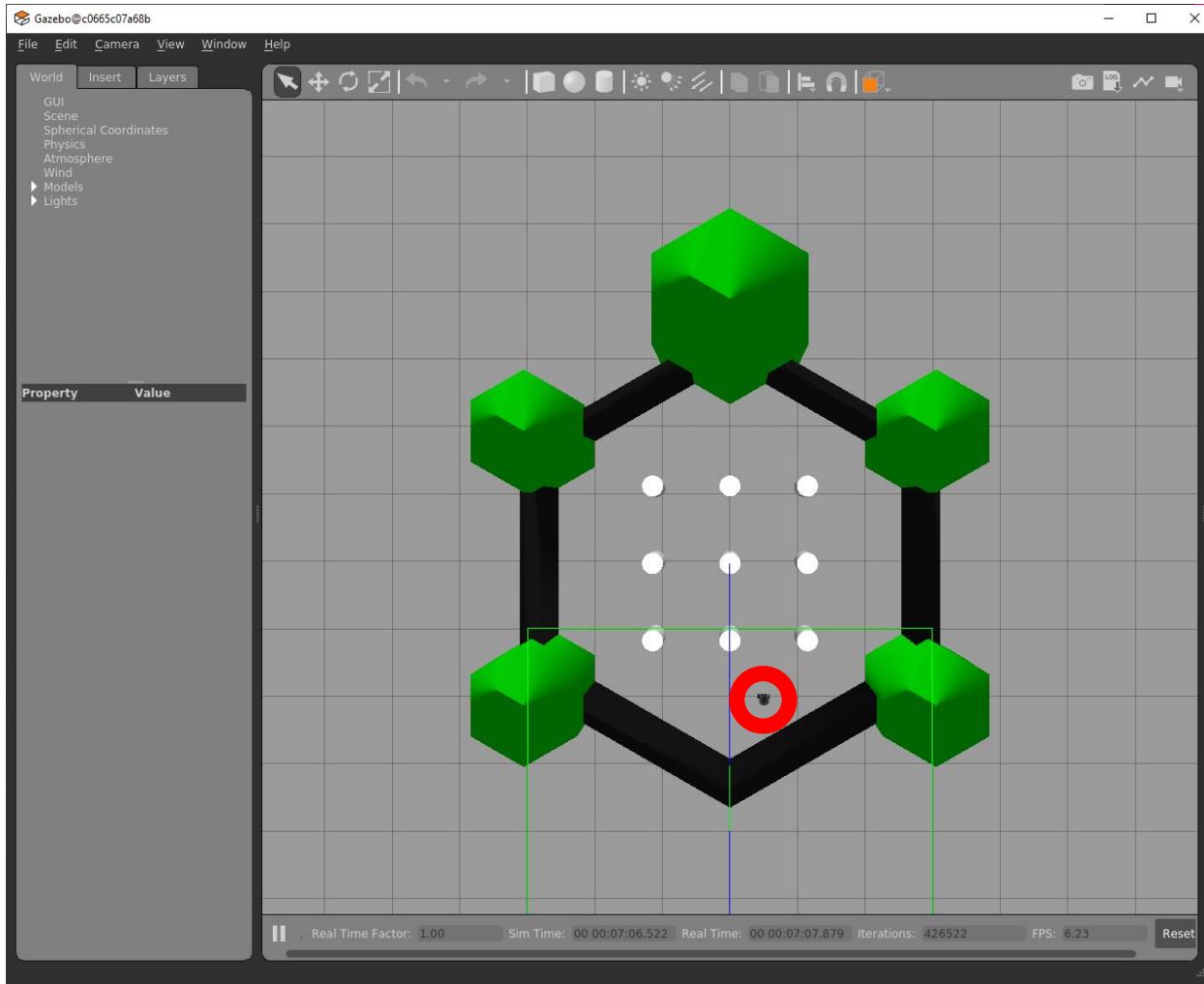


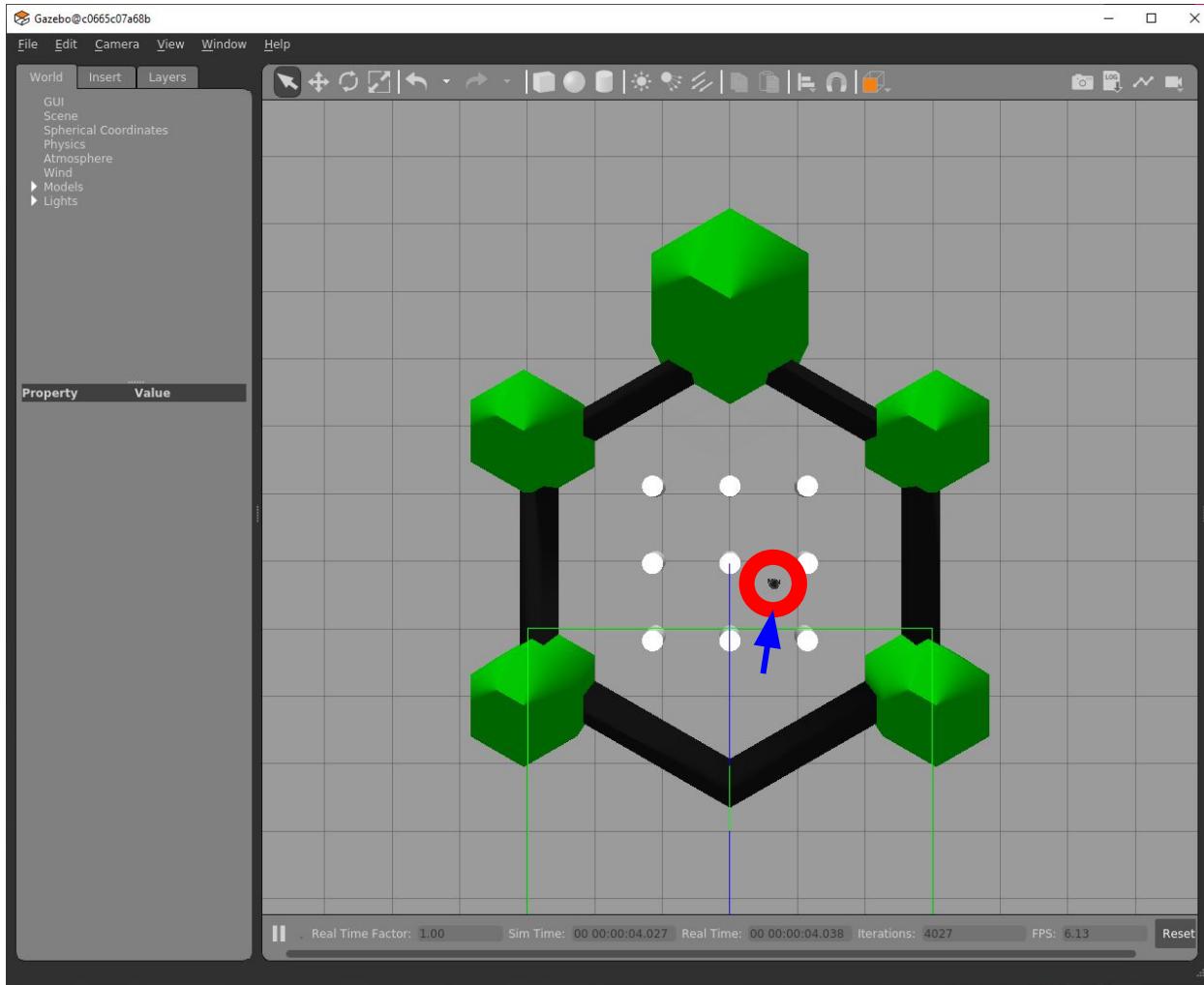
Hz



topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.5	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		







Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic /clicked\_point

Type geometry\_msgs/PointStamped

Freq.

1

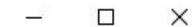
Hz



topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.5
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

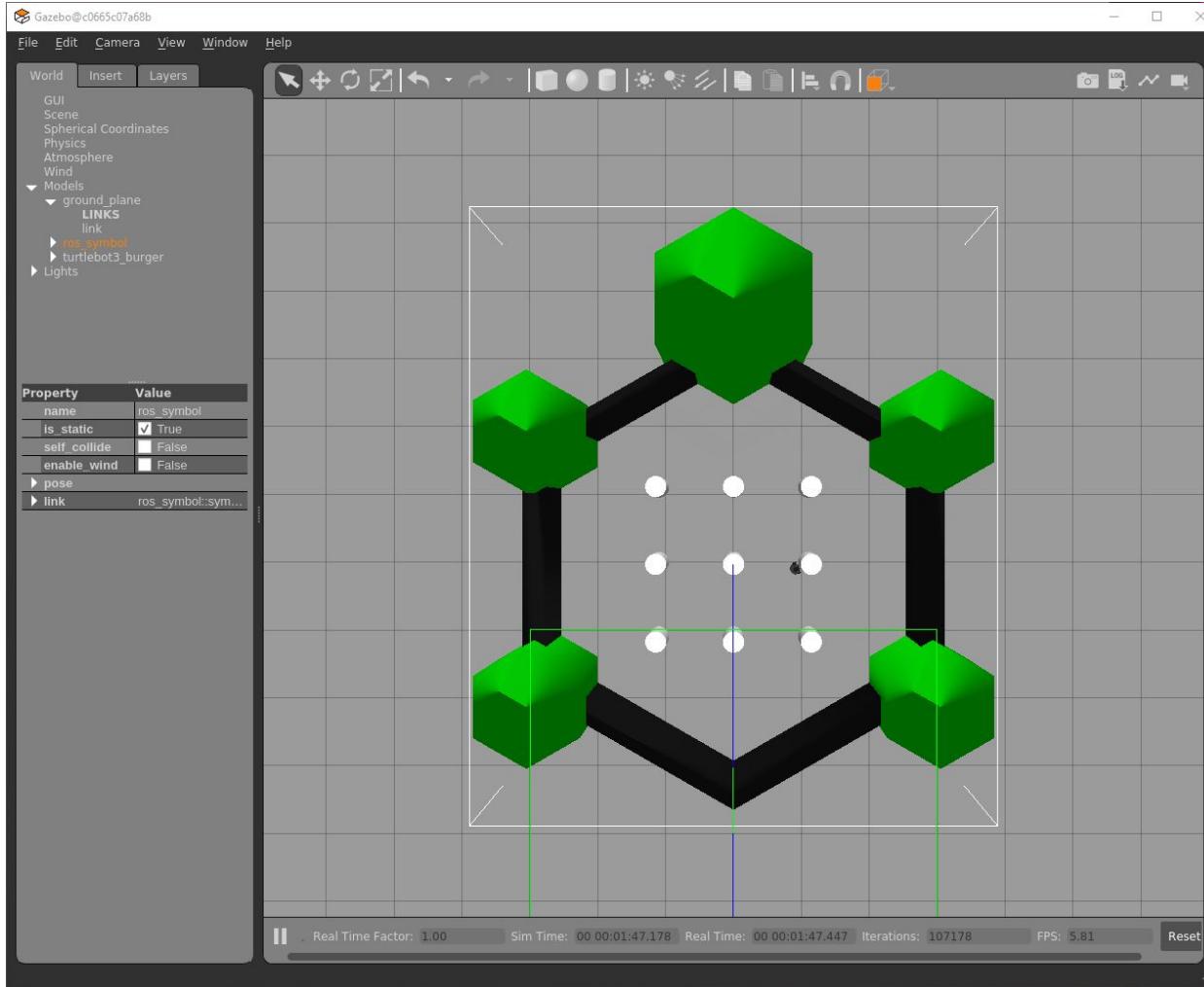


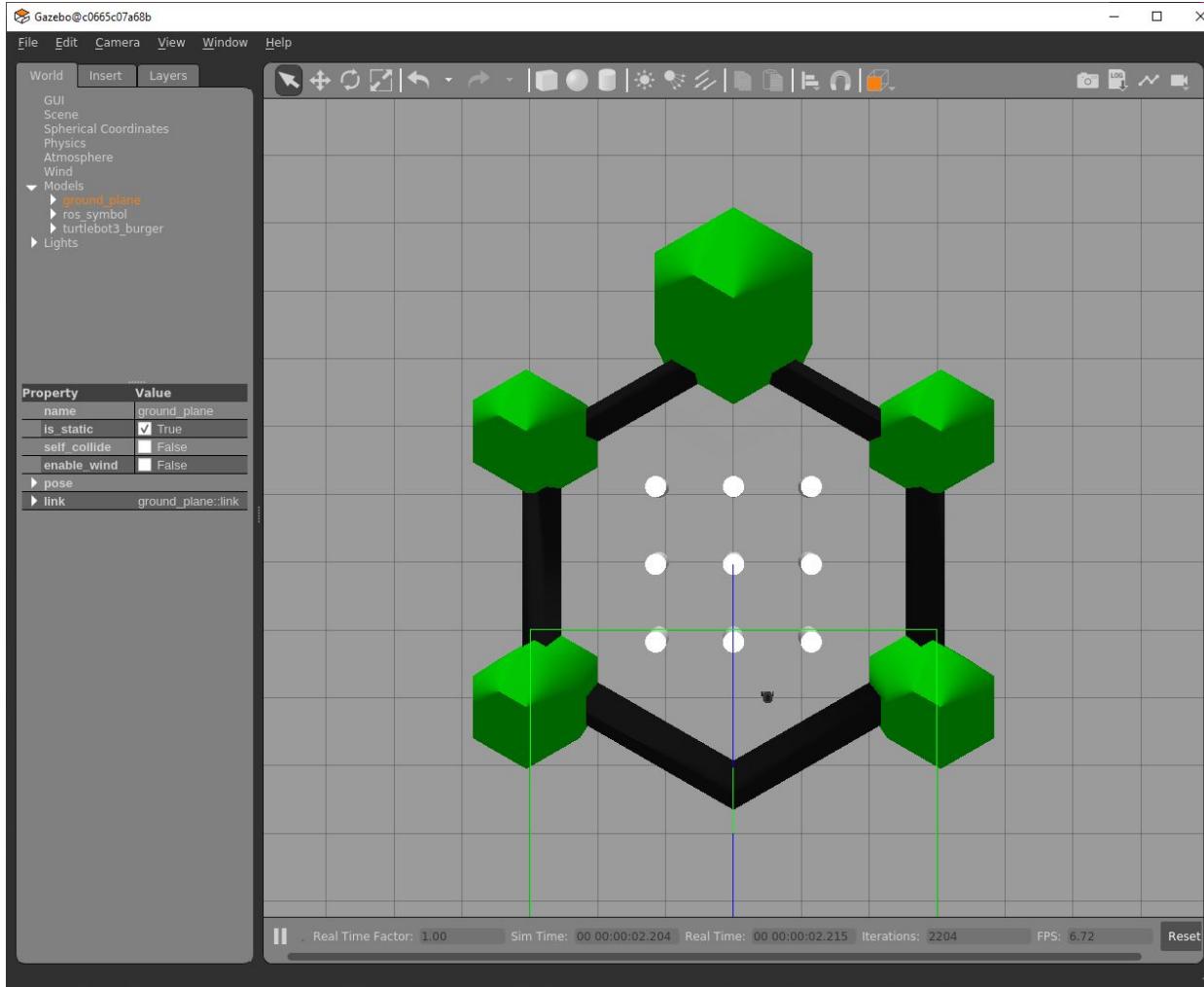
Message Publisher

topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.5
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		



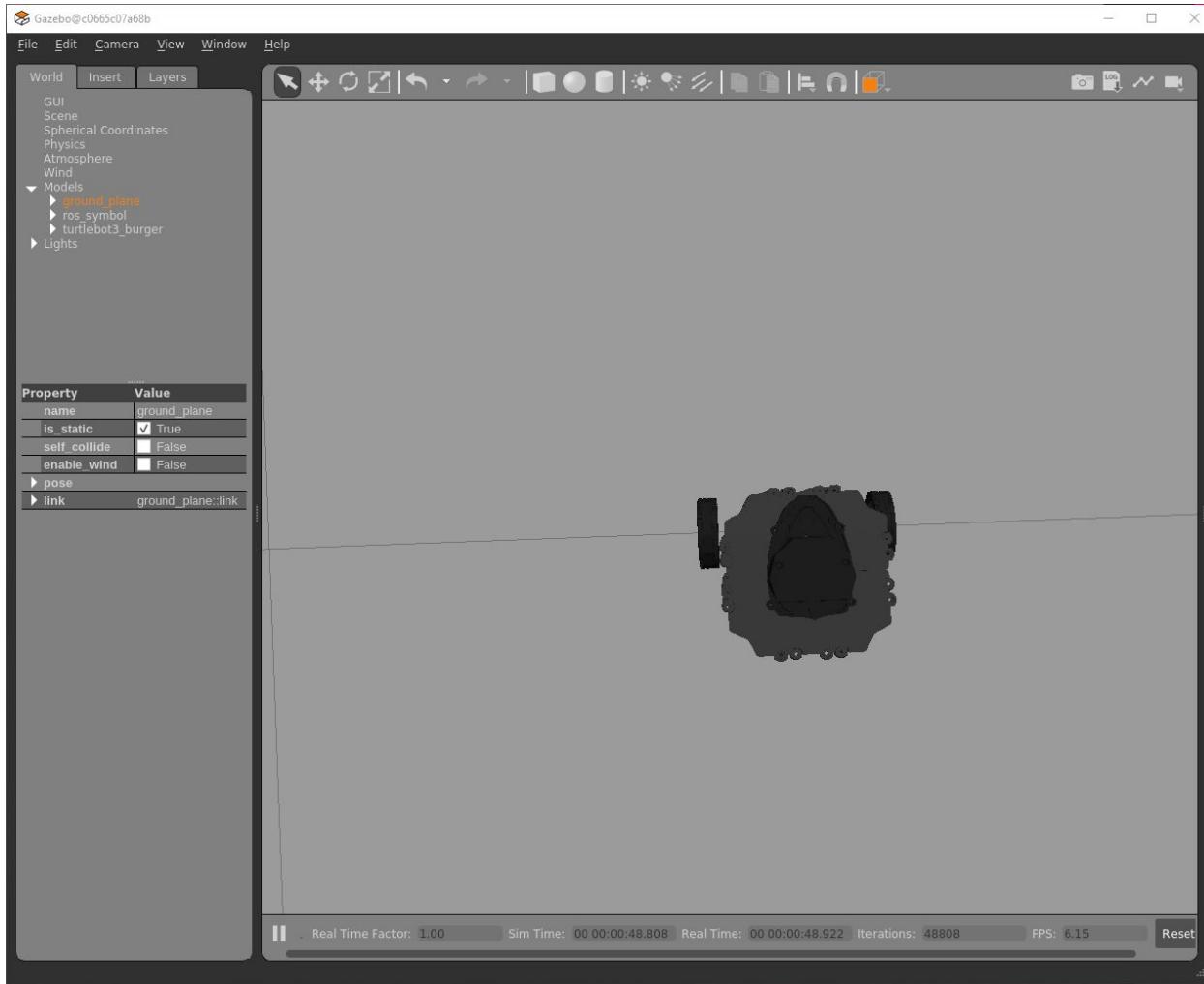
กด `ctrl+r` ที่หน้า gazebo





ZOOM IN





Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic	Type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.5
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.5	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b

- □ ×

File Plugins Running Perspectives Help

Message Publisher

D S O X

Topic	Type	Rate	Expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help



Message Publisher

topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic	Type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.5

Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

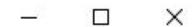
Message Publisher

D E O X

Topic	Type	Rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.5



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help



Message Publisher



Topic /clicked\_point

Type geometry\_msgs/PointStamped

Freq.

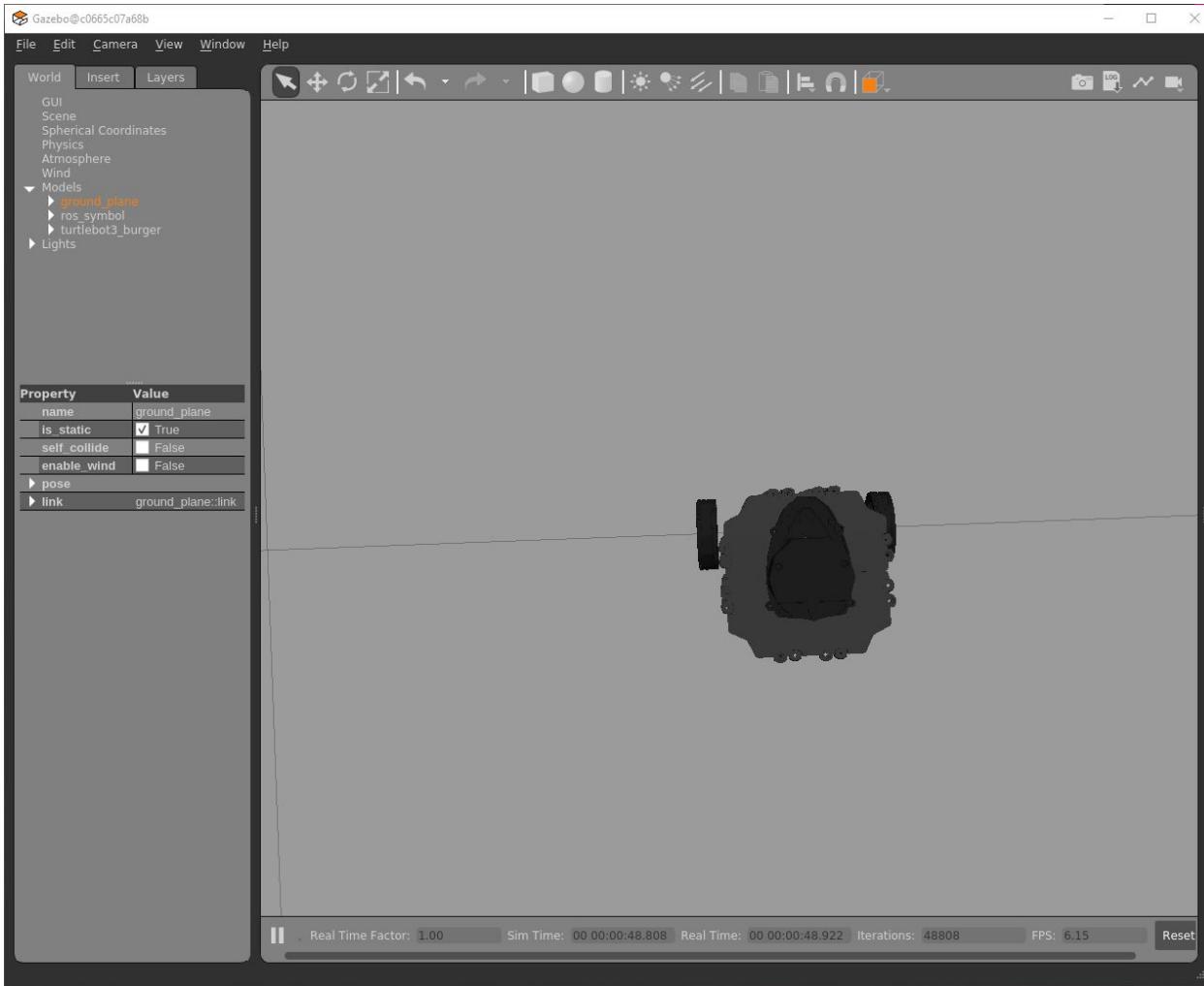
1

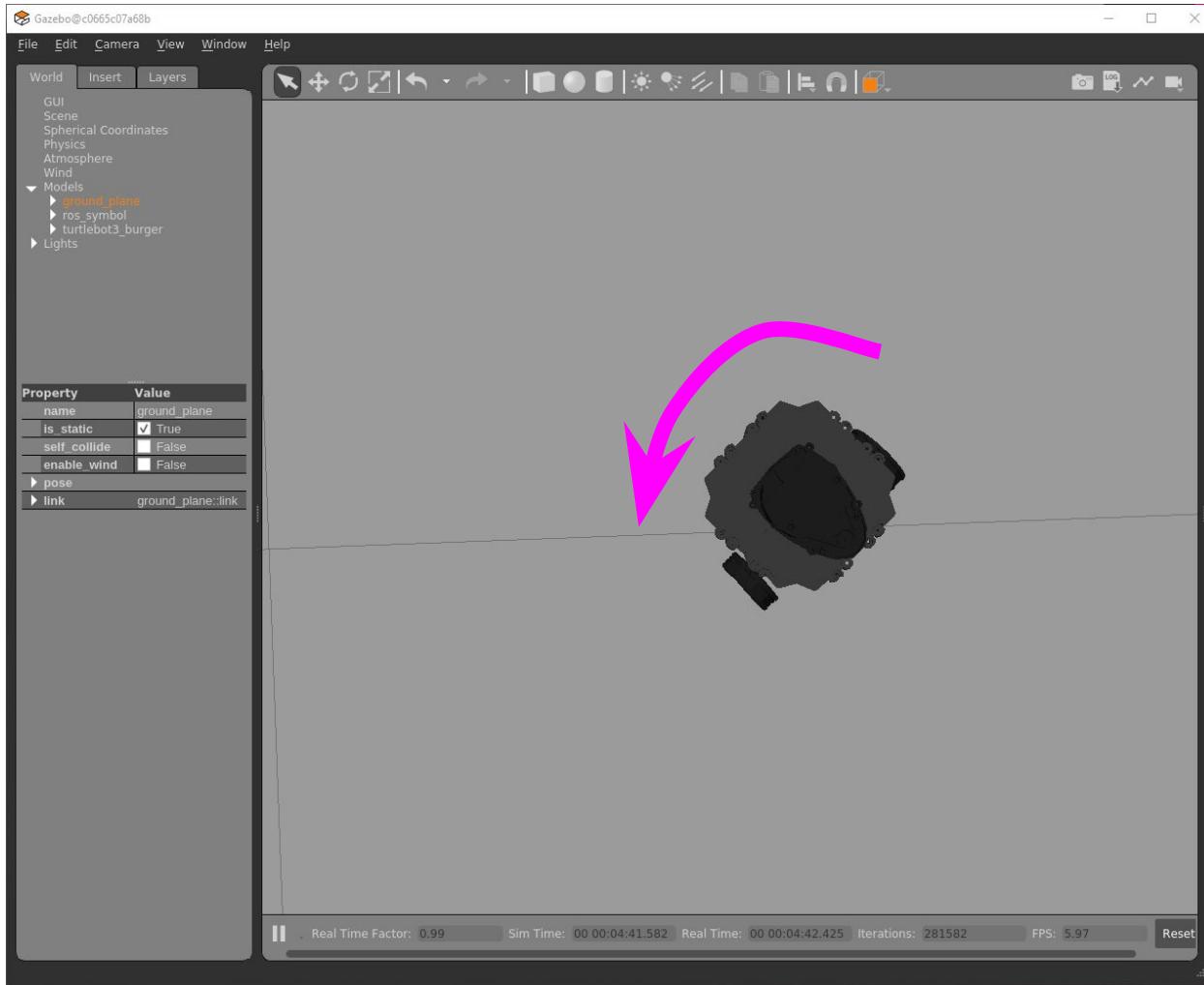
Hz

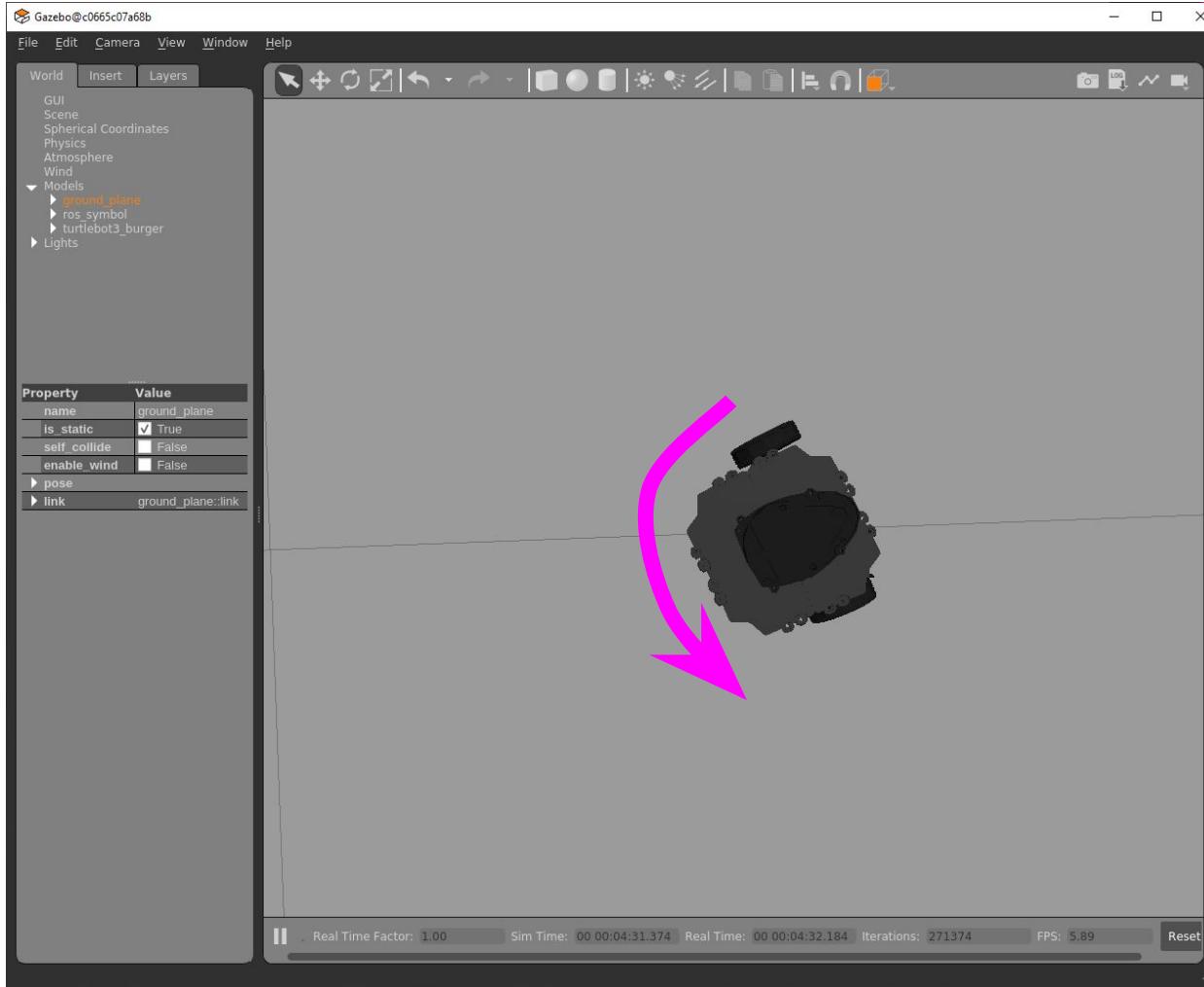


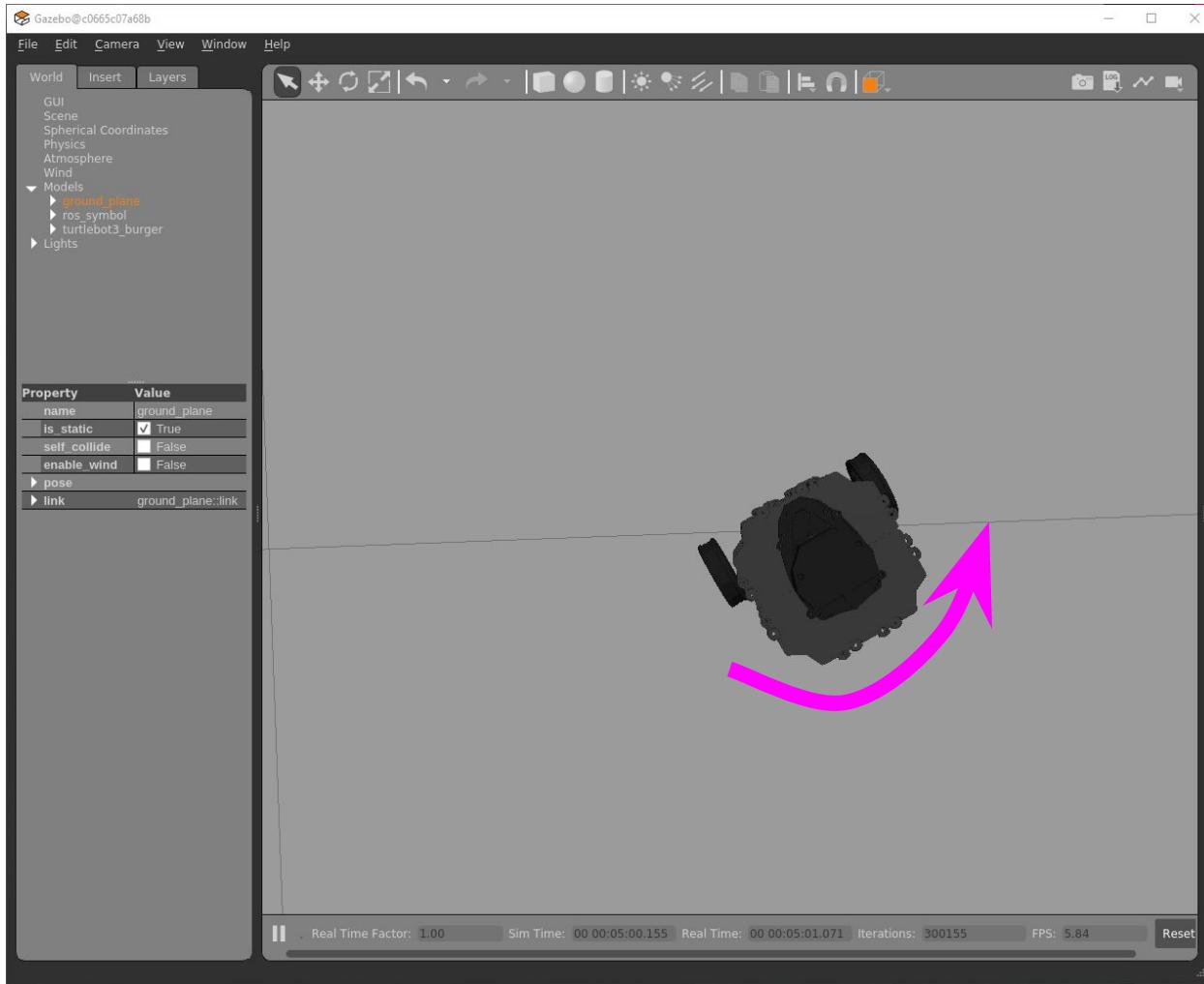
topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.5	

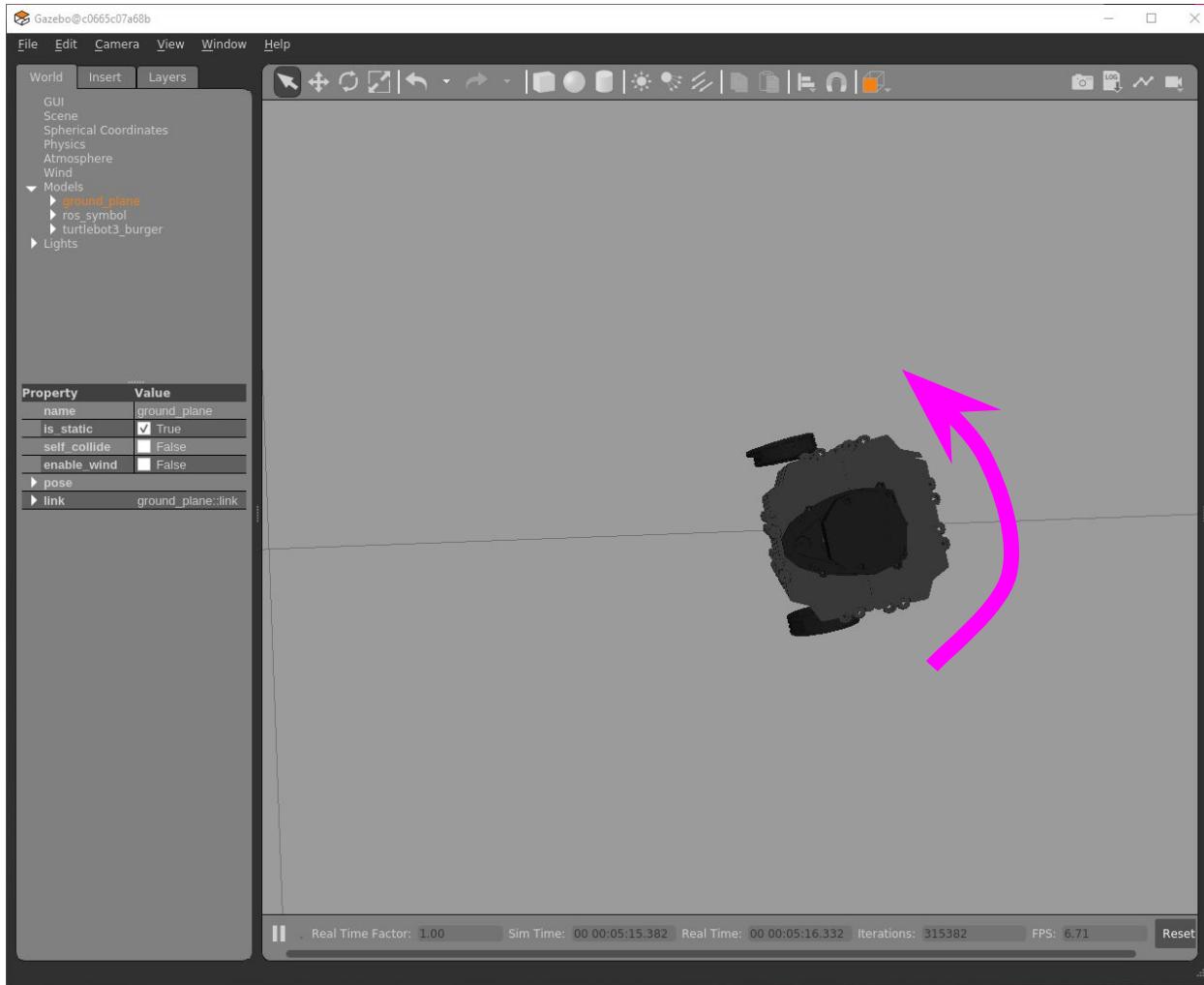












Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic /clicked\_point Type geometry\_msgs/PointStamped Freq. 1 Hz + - ⚡

topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.5	



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

Message Publisher

D E O X

Topic /clicked\_point Type geometry\_msgs/PointStamped Freq. 1 Hz + - ⚡

topic	type	rate	expression
/cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		
x	float64	0.0	
y	float64	0.0	
z	float64	0.5	



Default - rqt@c0665c07a68b



File Plugins Running Perspectives Help

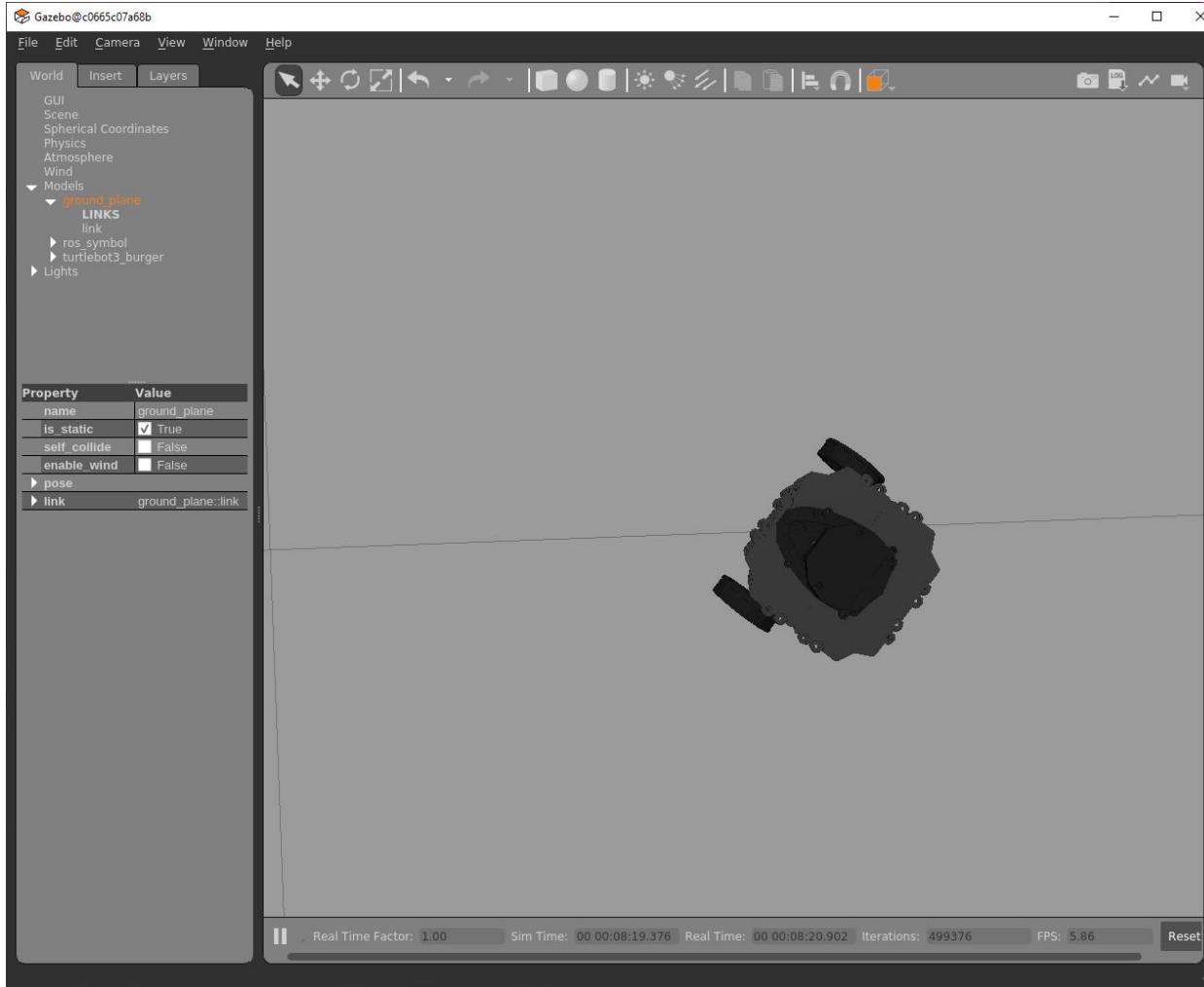
Message Publisher

D E O X

Topic /clicked\_point Type geometry\_msgs/PointStamped Freq. 1 Hz + - ⚡

topic	type	rate	expression
✓ /cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0
angular	geometry_msgs/Vector3		
x	float64		0.0
y	float64		0.0
z	float64		0.0





กด **ctrl+c** ใน ทุกๆ หน้า

เพื่อหยุดการทำงาน

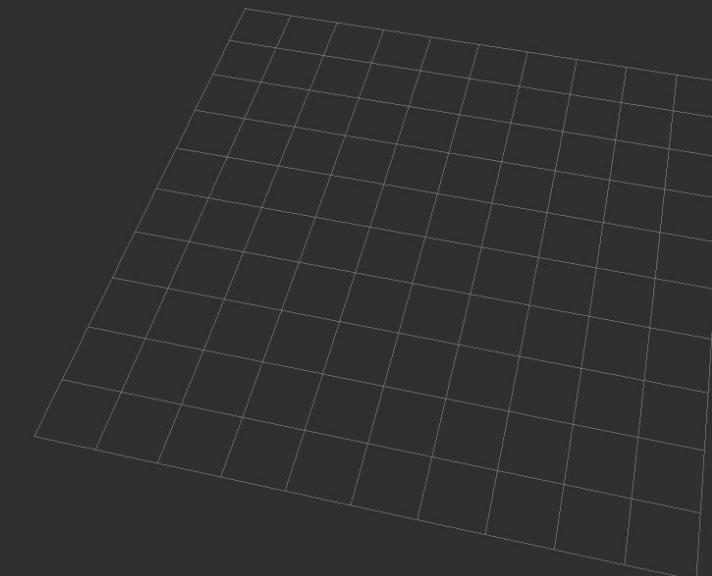
RVIZ

```
$ sudo apt install ros-noetic-rviz
```

```
$ rviz
```

[File](#) [Panels](#) [Help](#)[Interact](#) [Move Camera](#) [Select](#) [Focus Camera](#) [Measure](#) [2D Pose Estimate](#) [2D Nav Goal](#) [Publish Point](#)[+](#) [-](#) [Reset](#)**Displays**

- Global Options
  - Fixed Frame map
  - Background Color 48; 48; 48
  - Frame Rate 30
  - Default Light ✓
- Global Status: Warn
  - Fixed Frame
- No TF data ✓

**Grid****Views**

Type:	Orbit (rviz)	<a href="#">Zero</a>
Current View	Orbit (rviz)	
Near Clip Di...	0.01	
Invert Z Axis	✓	
Target Frame	<Fixed Frame>	
Distance	17.6234	
Focal Shape...	0.05	
Focal Shape...	✓	
Yaw	0.220398	
Pitch	0.935398	
Field of View	0.785398	
Focal Point	0: 9.5367e-07; 0	

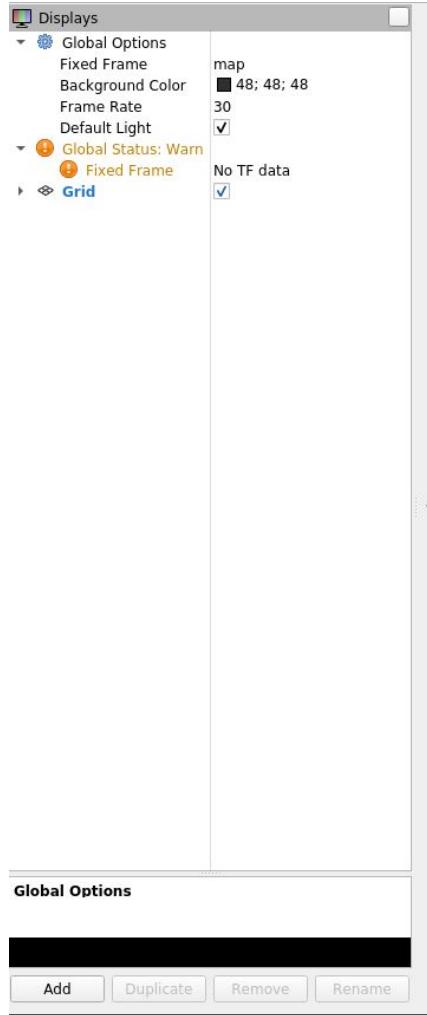
**Global Options**[Add](#) [Duplicate](#) [Remove](#) [Rename](#)

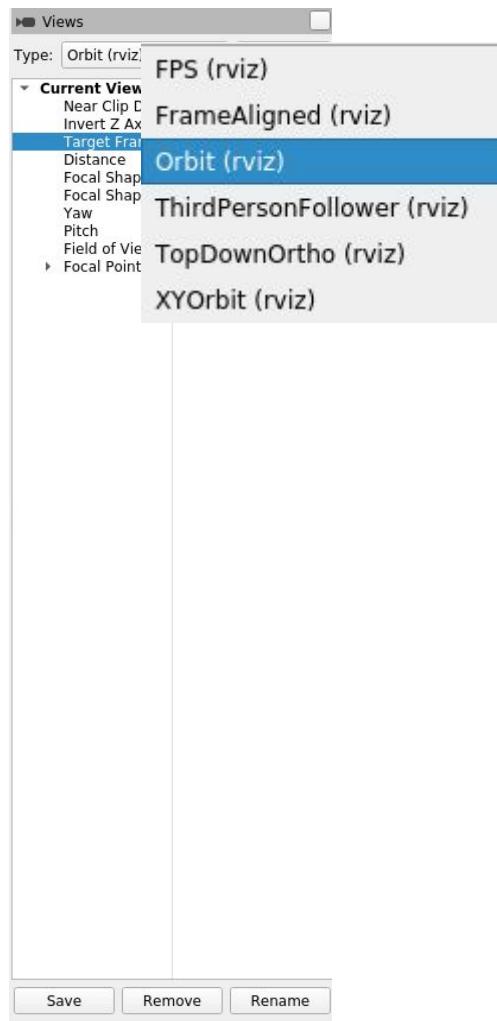
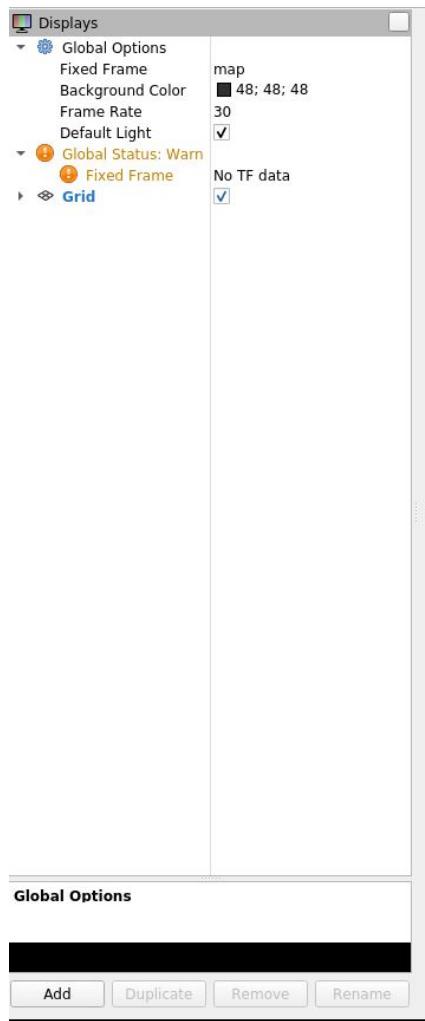
ROS Time: 1645804400.33 ROS Elapsed: 117.33 Wall Time: 1645804400.46 Wall Elapsed: 117.33

 Experimental[Reset](#)

8 fps







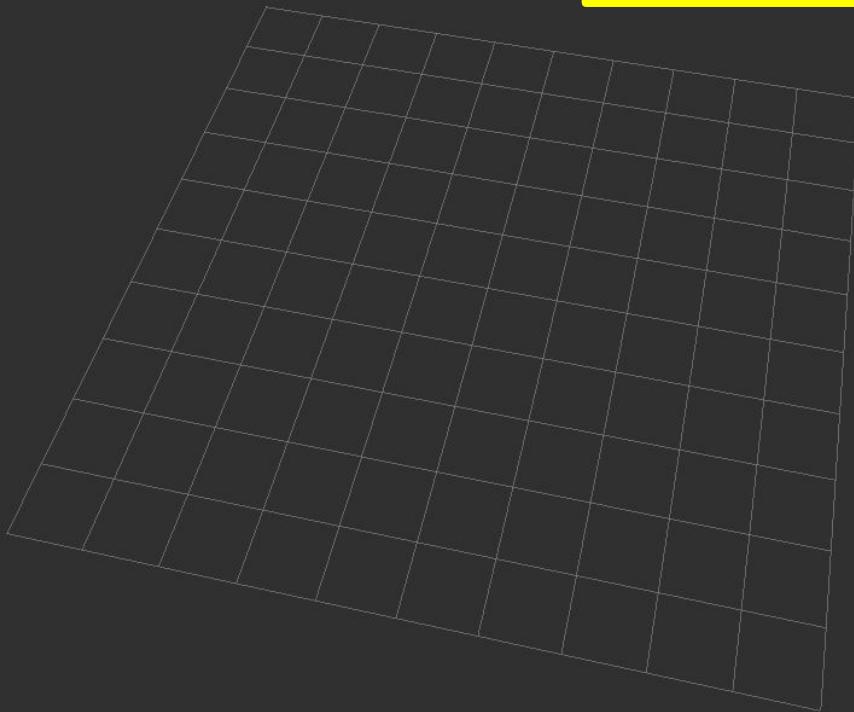
ROS Time: 1645804506.80 ROS Elapsed: 223.80 Wall Time: 1645804506.93 Wall Elapsed: 223.80

Experimental

**Left-Click:** Rotate. **Middle-Click:** Move X/Y. **Right-Click/Mouse Wheel:** Zoom. **Shift:** More options.

8 fps

SCENE



ROTATE  
(Left click)



ZOOM IN/OUT

(Right click)



MOVE  
(Scroll click)



ZOOM IN/OUT



เปิด terminal ขึ้นมา

```
$ roscore
```

```
:~# roscore
... logging to /root/.ros/log/a4938efa-7c5b-11ec-b410-0242ac110002/roslaunch-c0665c07a68b-2984.log
Checking log directory for disk usage. This may take a while.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://[REDACTED]:39823/
ros_comm version 1.15.13

SUMMARY
=====
PARAMETERS
  * /rosdistro: noetic
  * /rosversion: 1.15.13

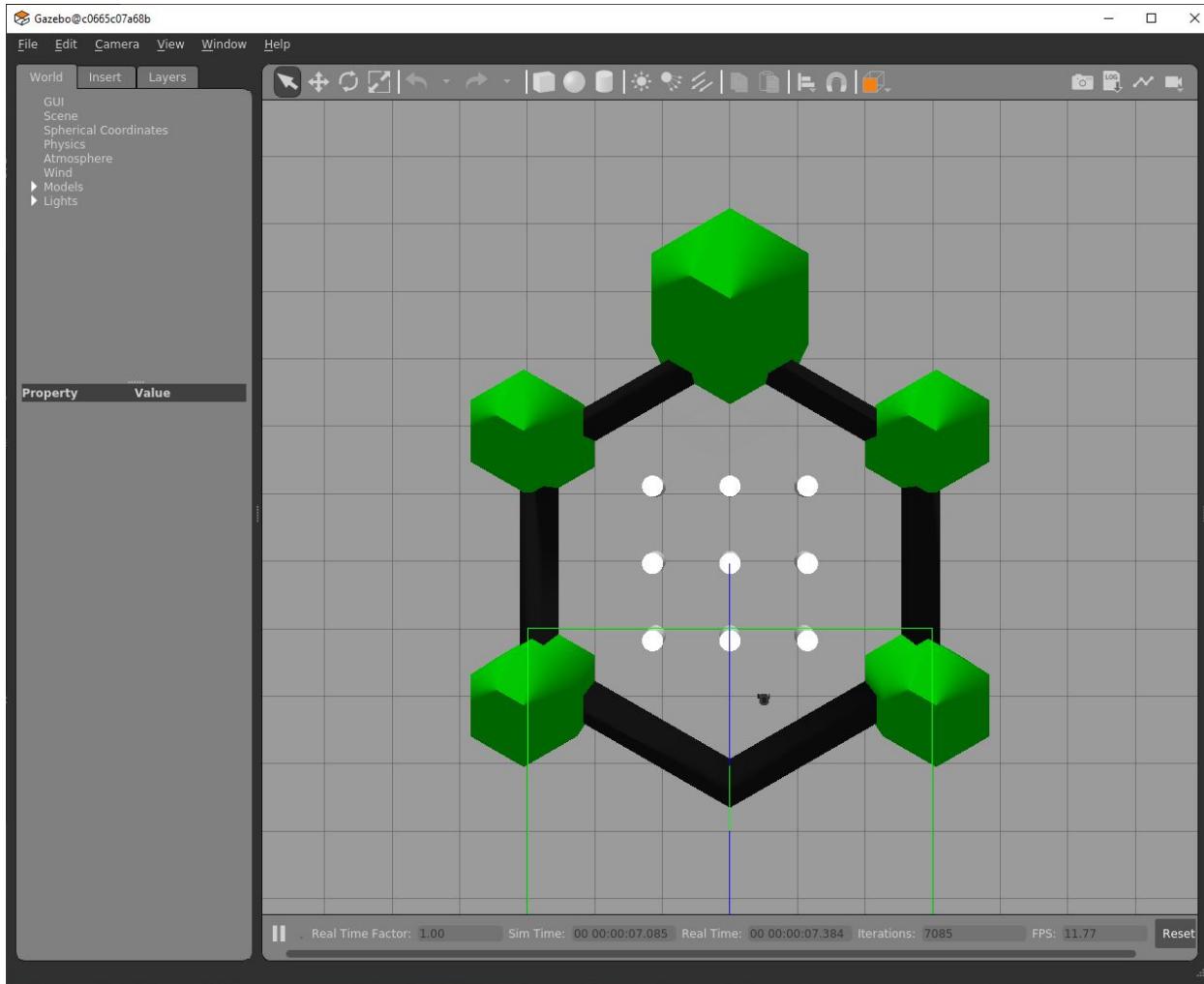
NODES

auto-starting new master
process[master]: started with pid [3008]
ROS_MASTER_URI=http://[REDACTED]:11311/

setting /run_id to [REDACTED]
process[rosout-1]: started with pid [3028]
started core service [/rosout]
-
```

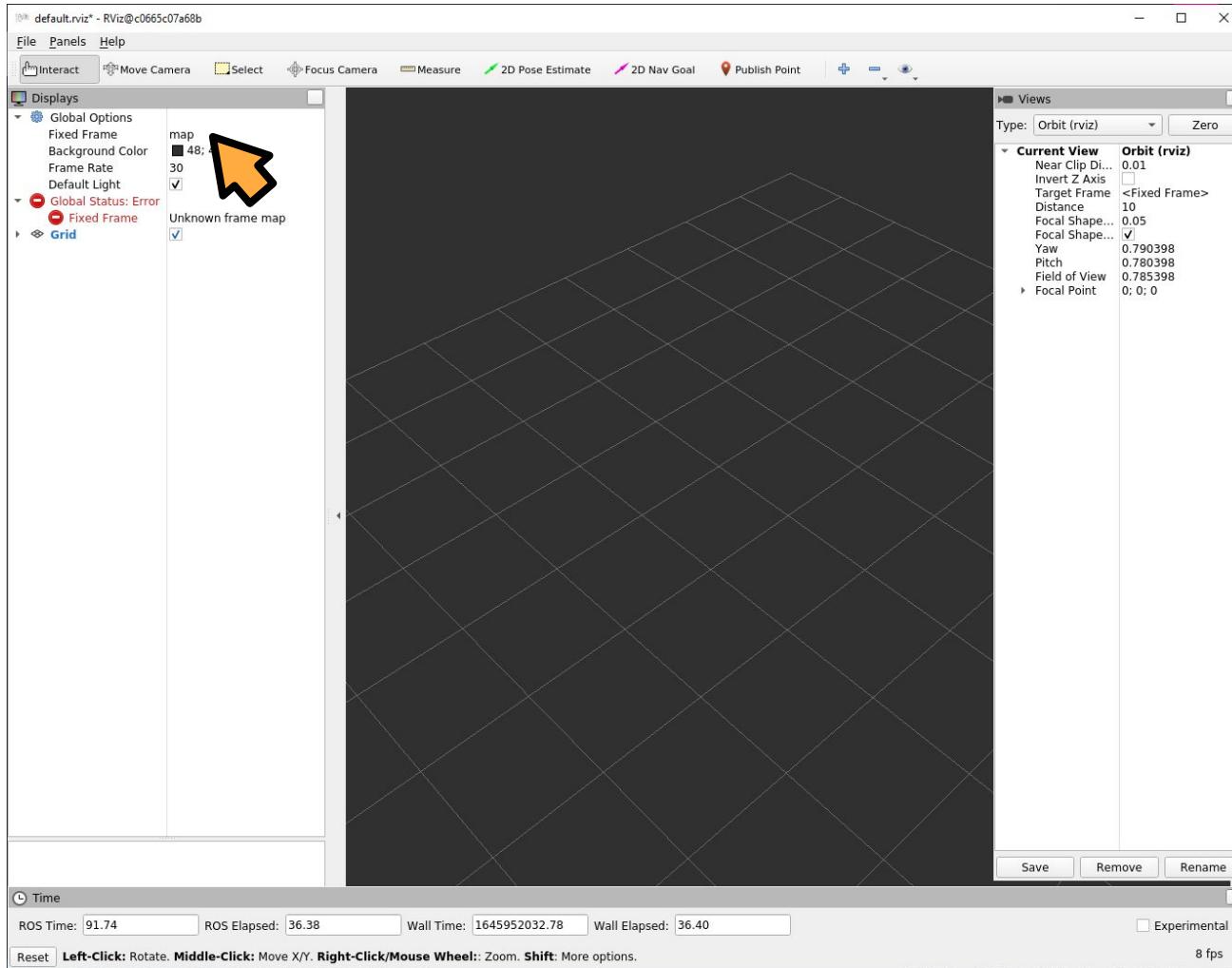
เปิดหน้าต่าง terminal ใหม่

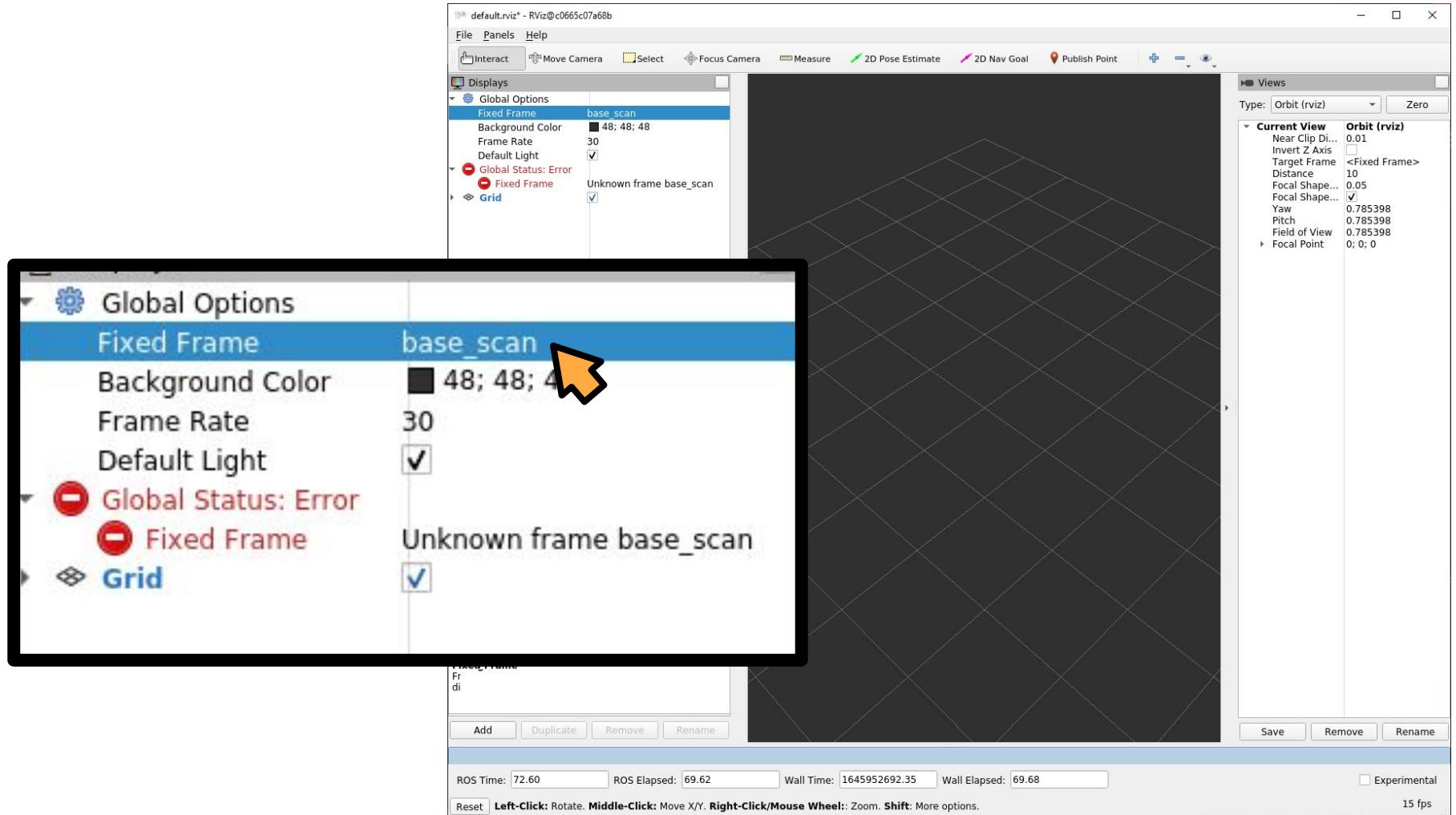
```
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

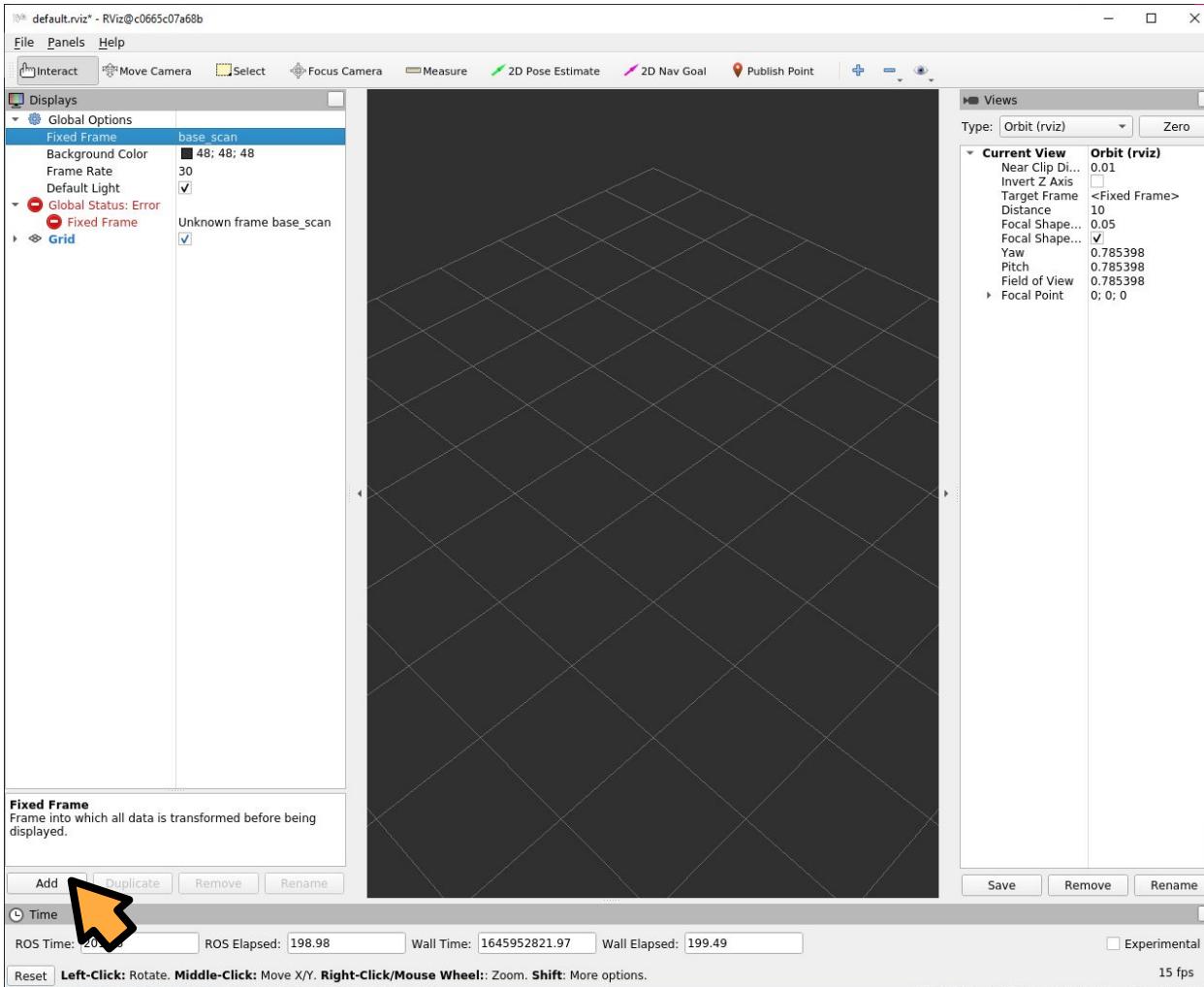


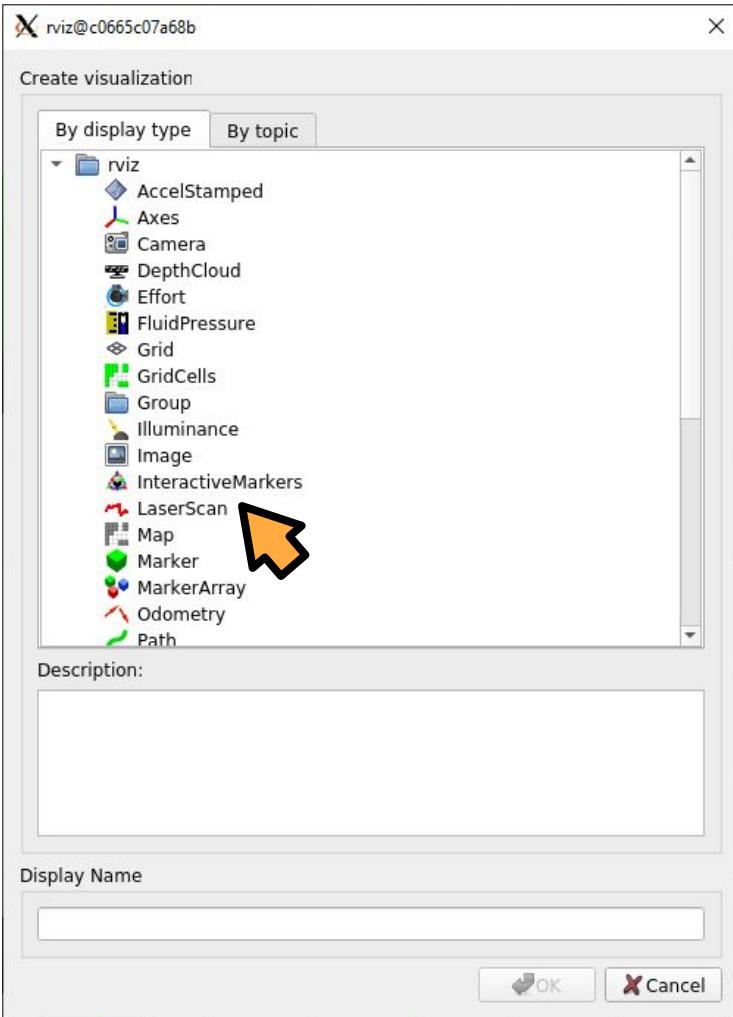
เปิดหน้าต่าง terminal ใหม่

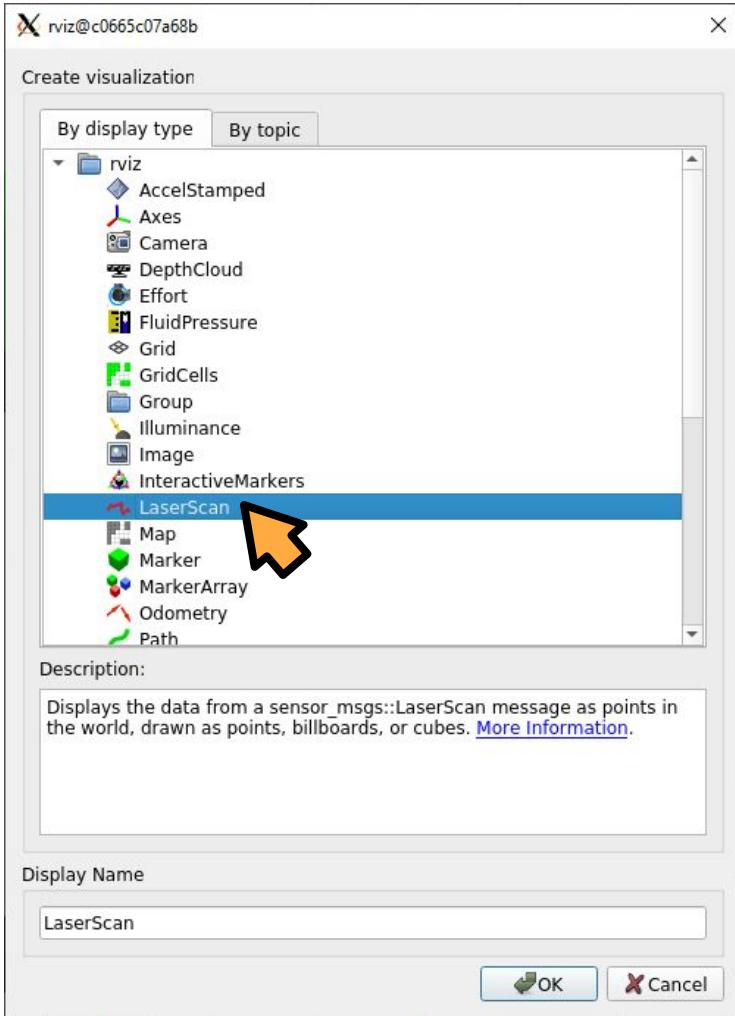
```
$ rviz
```

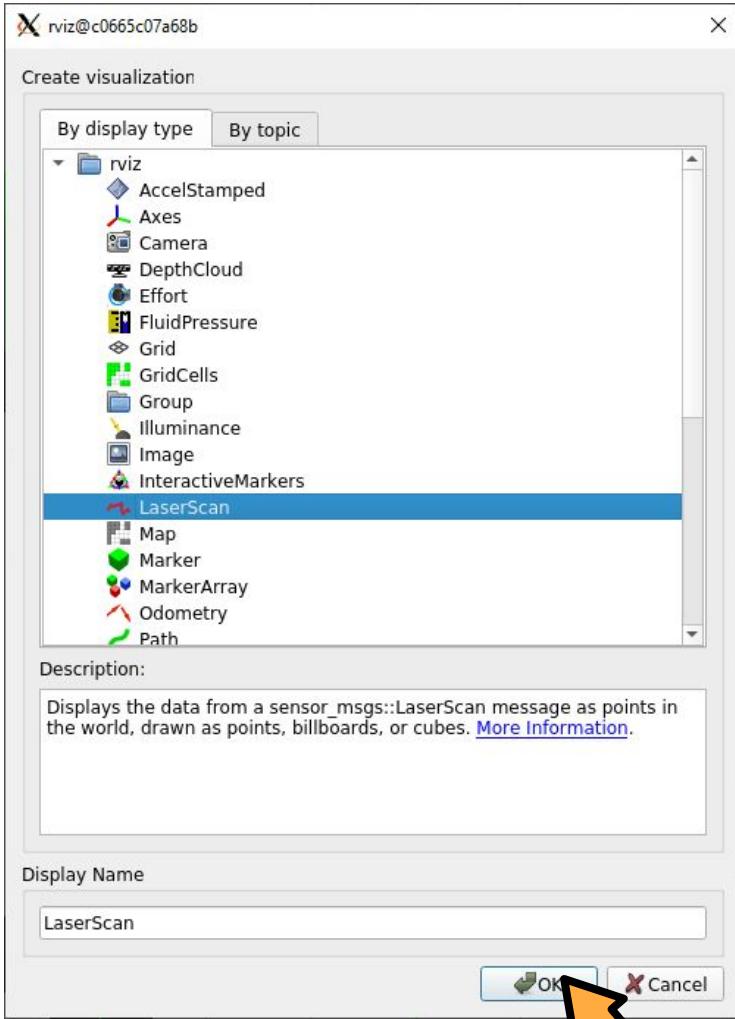


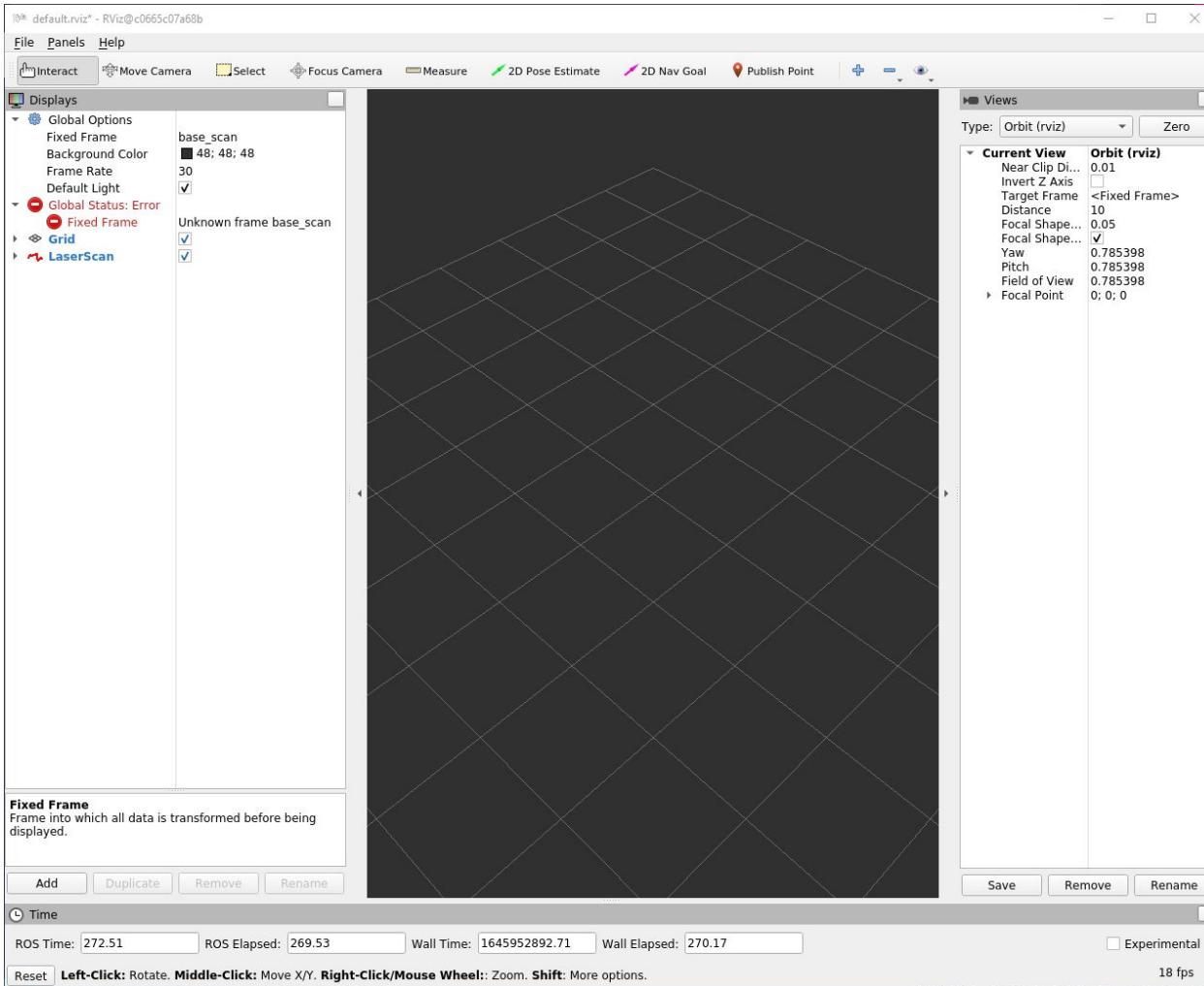


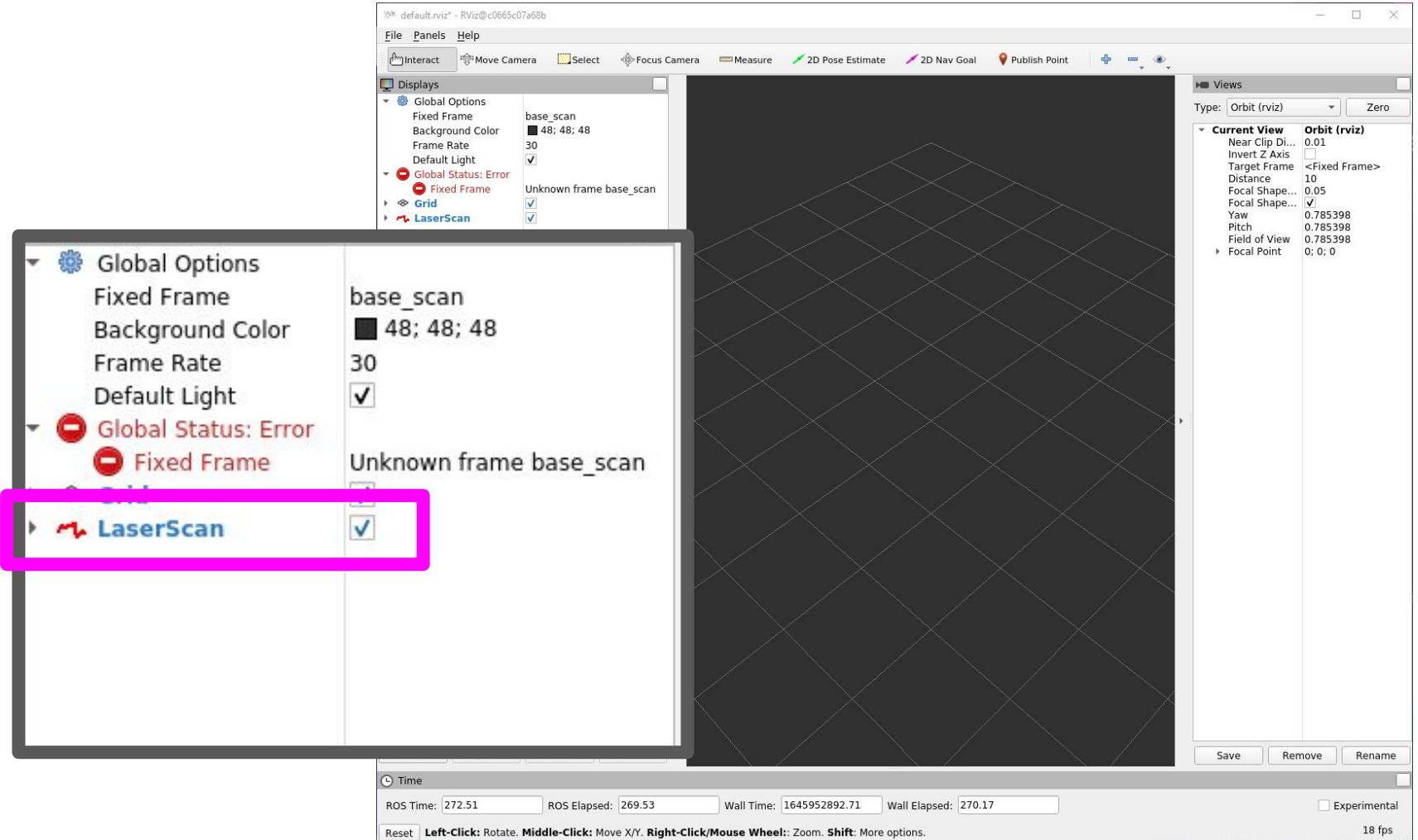


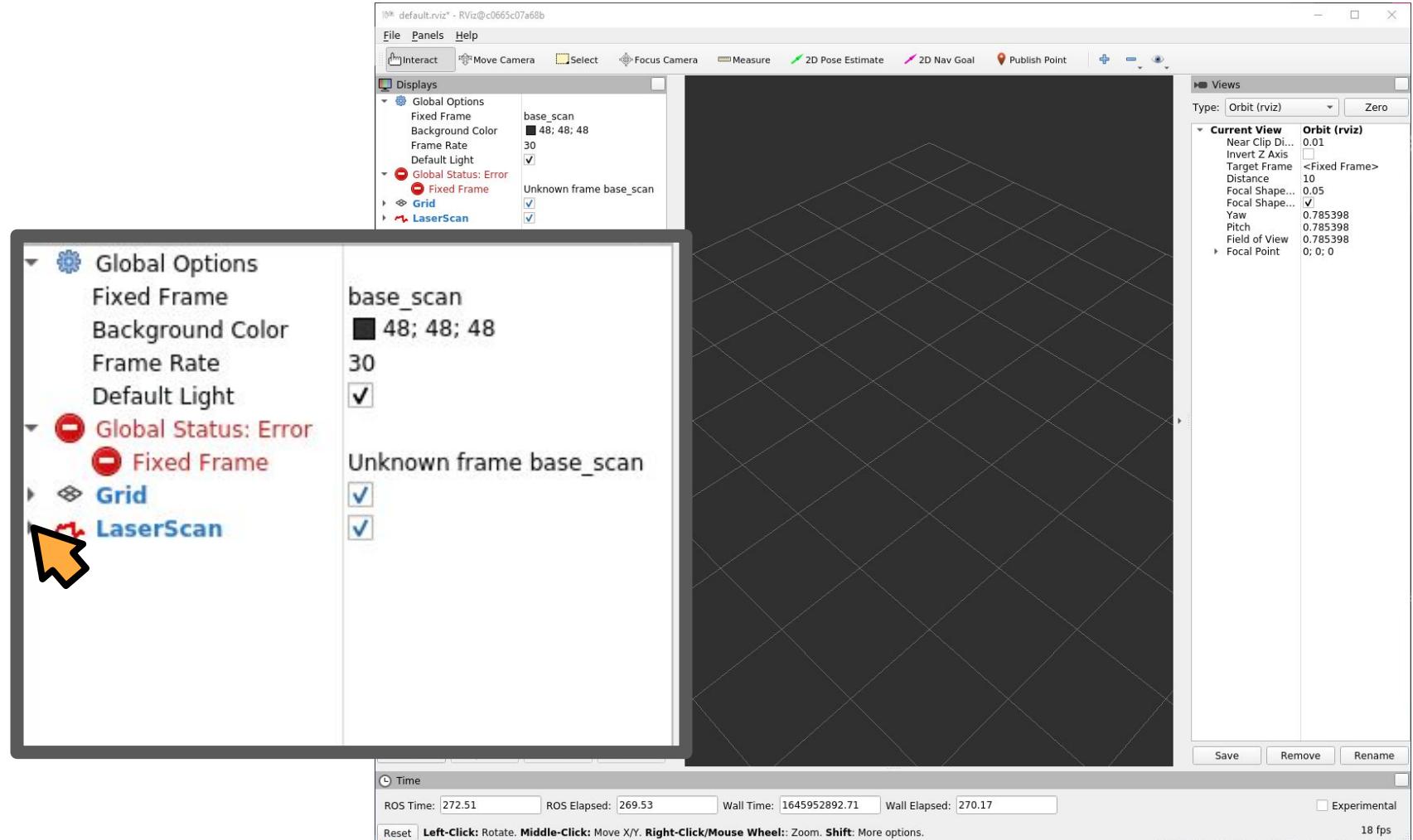


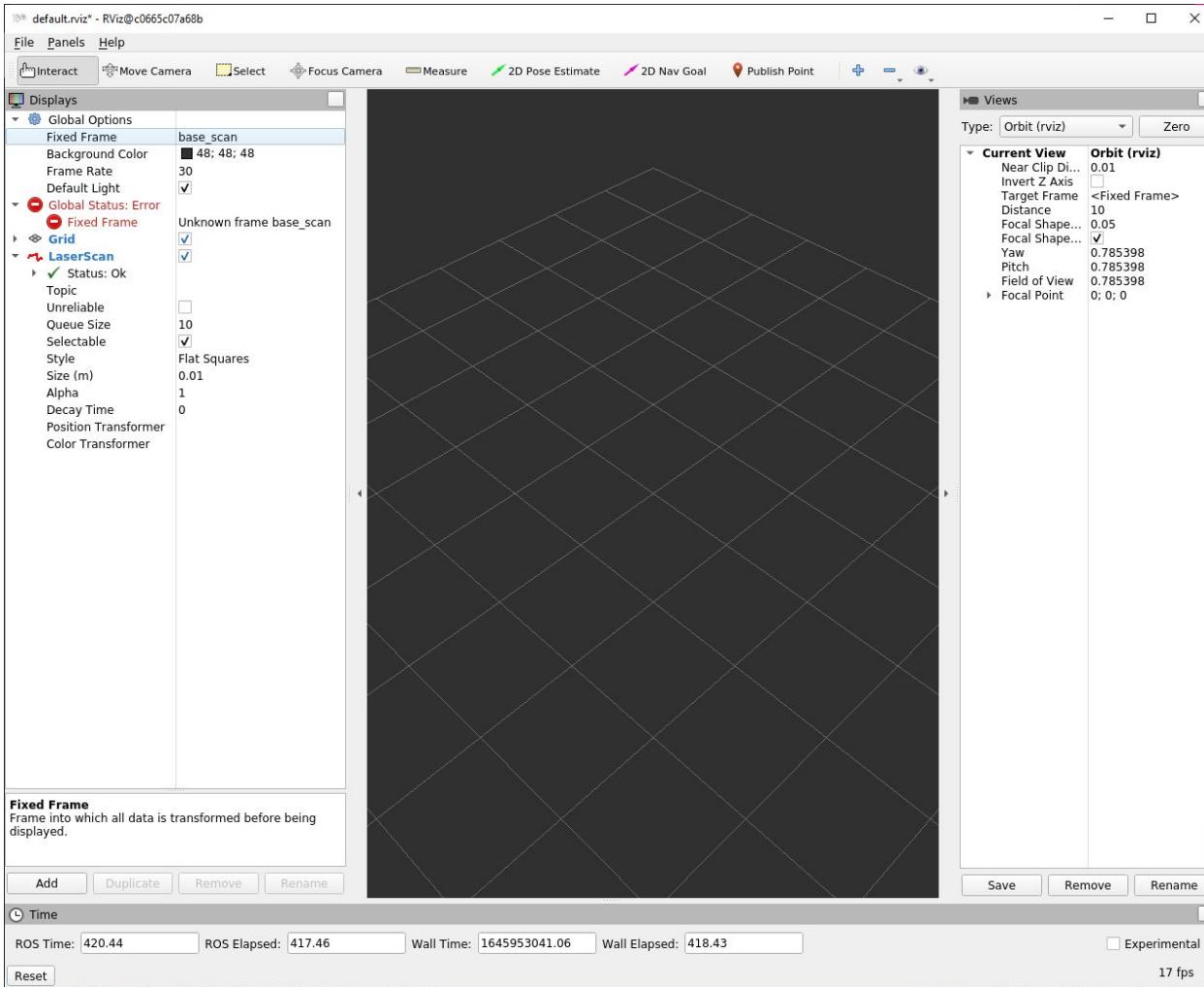


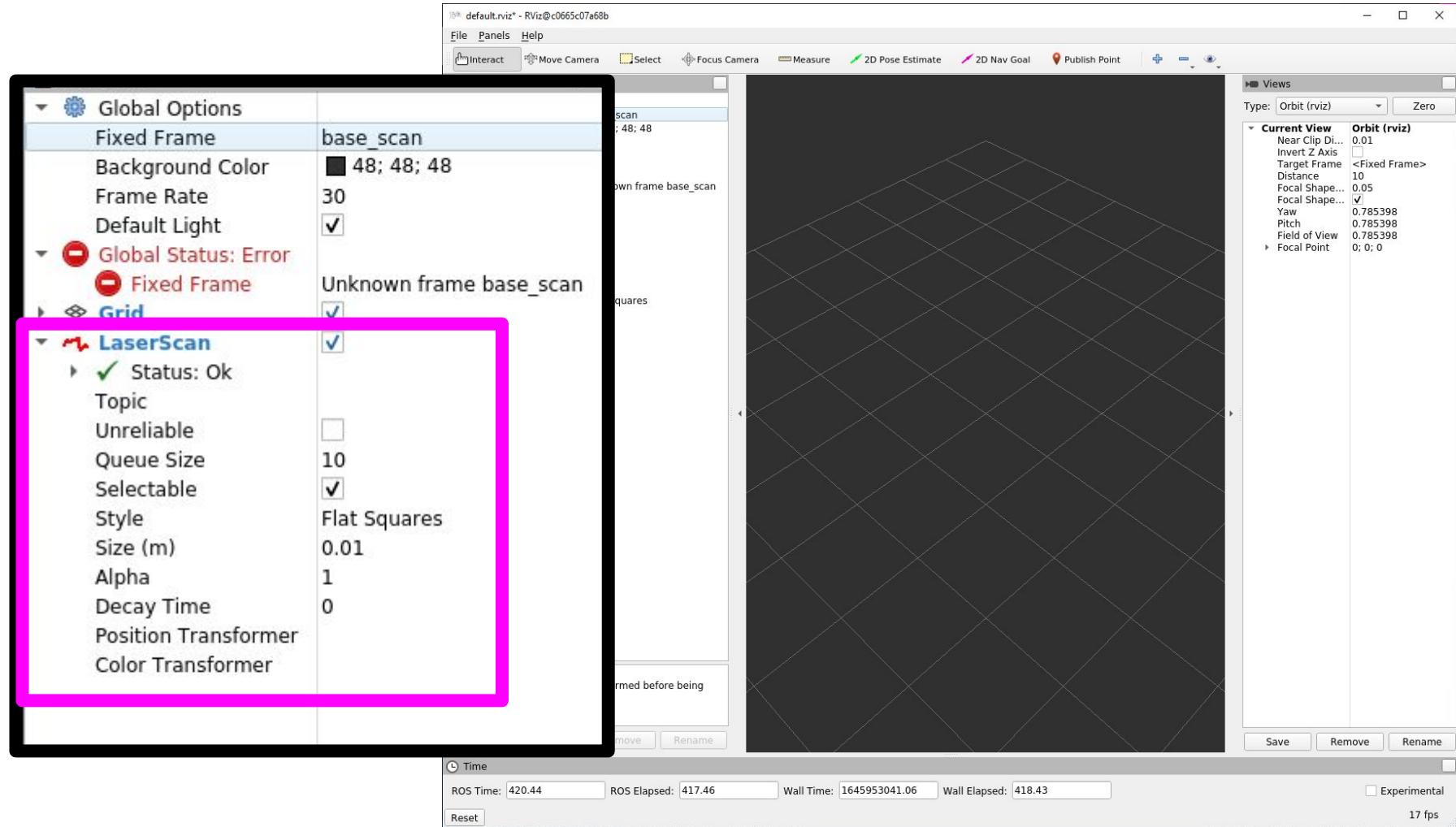


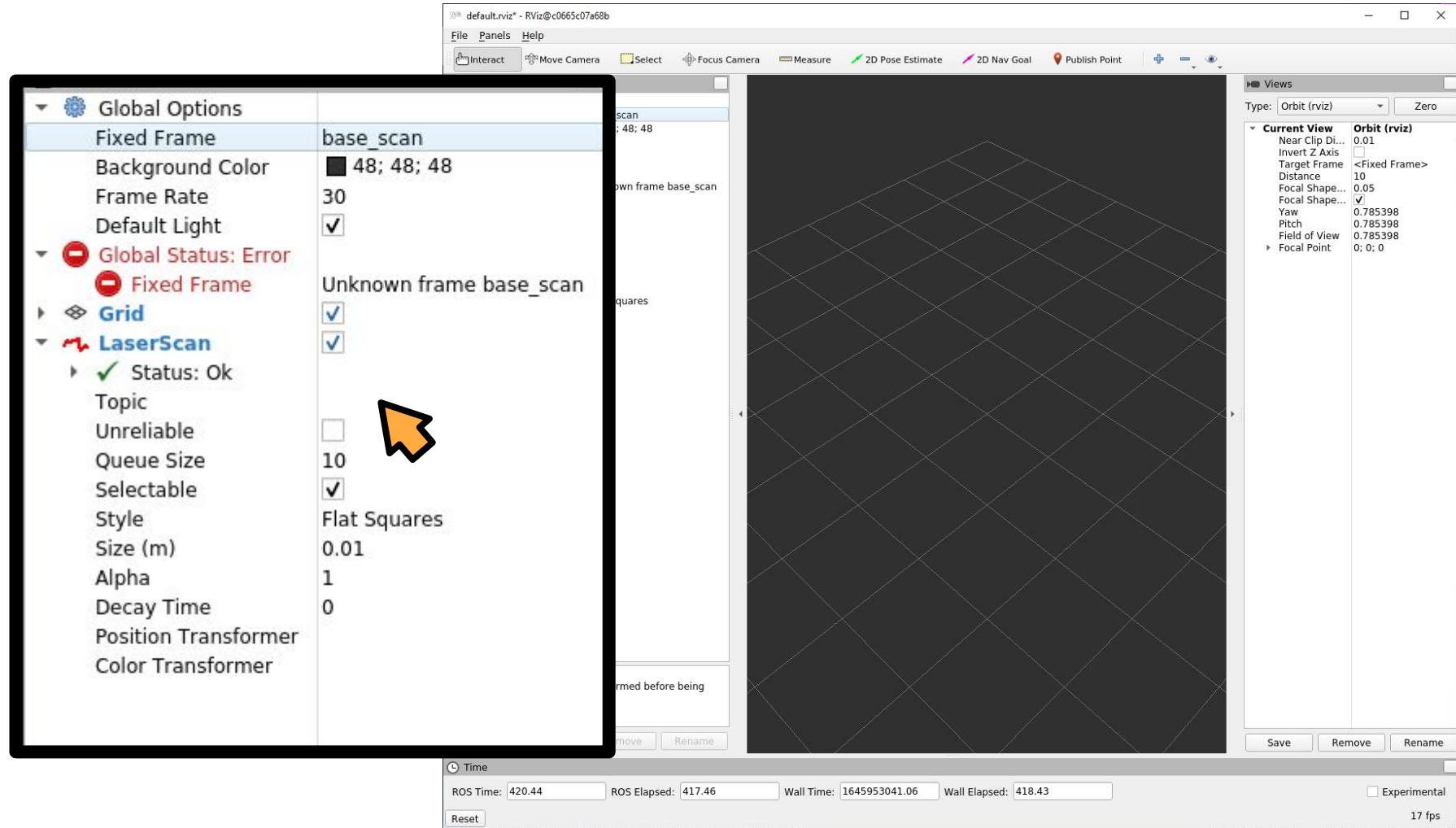


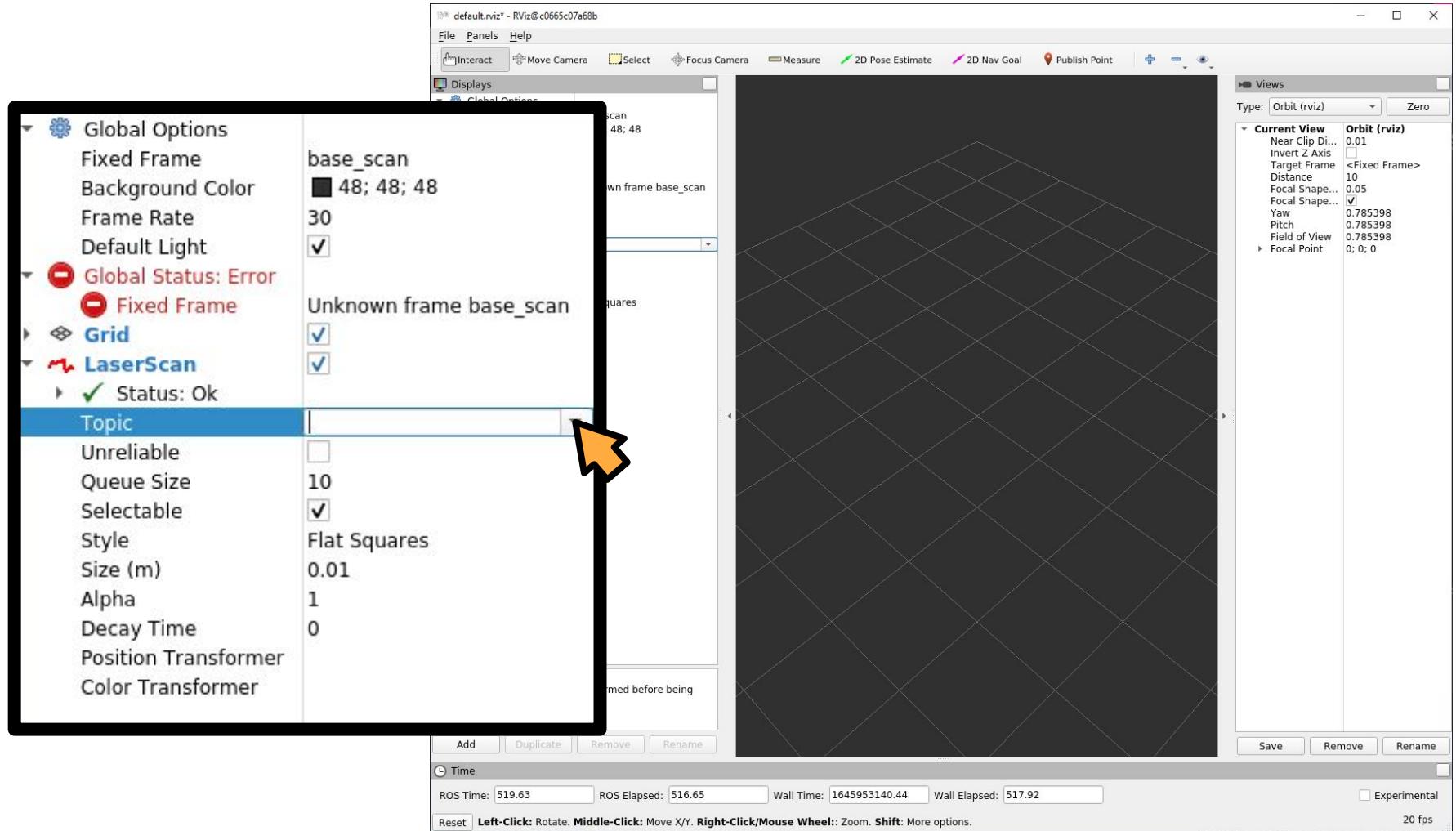


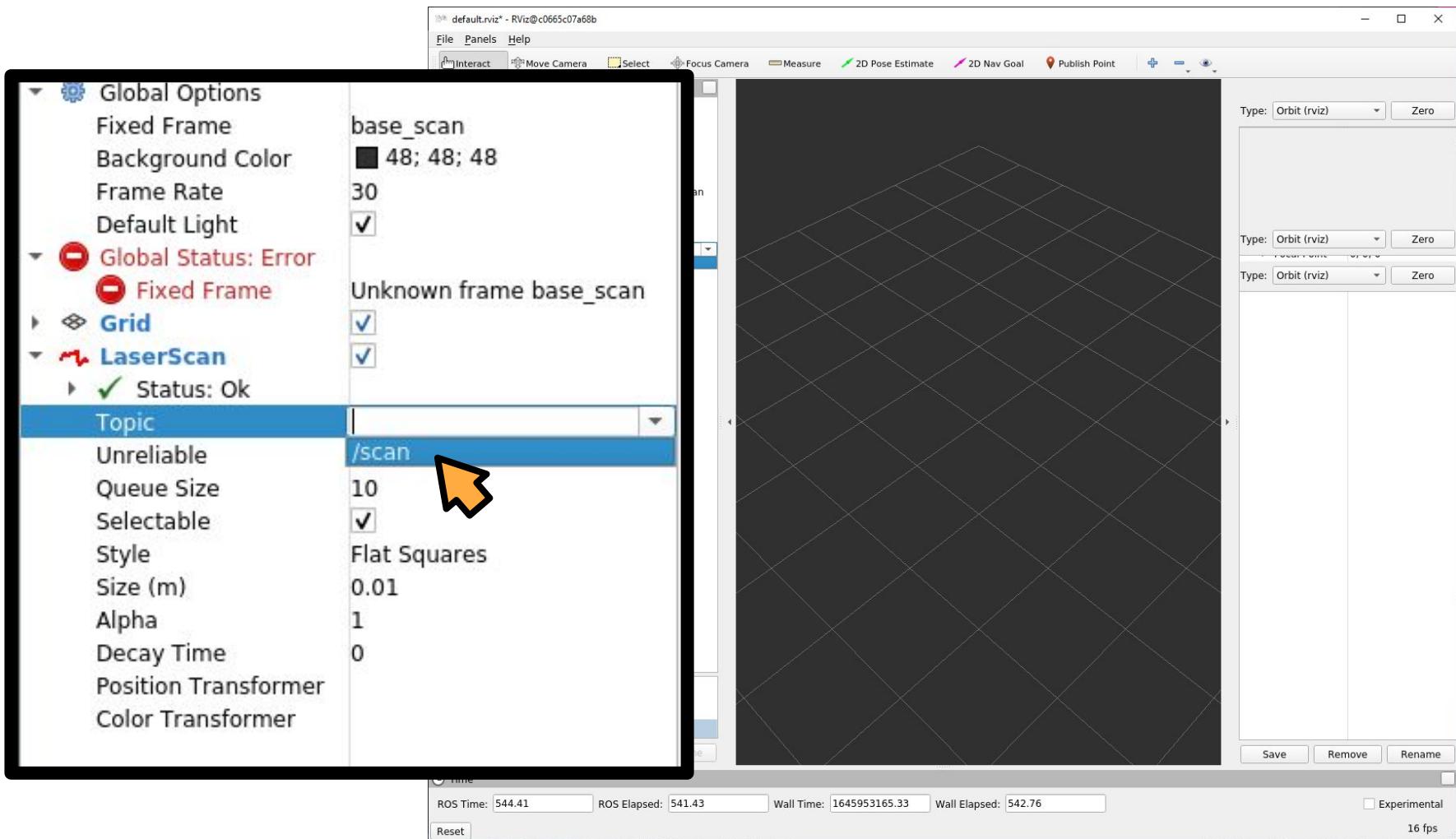


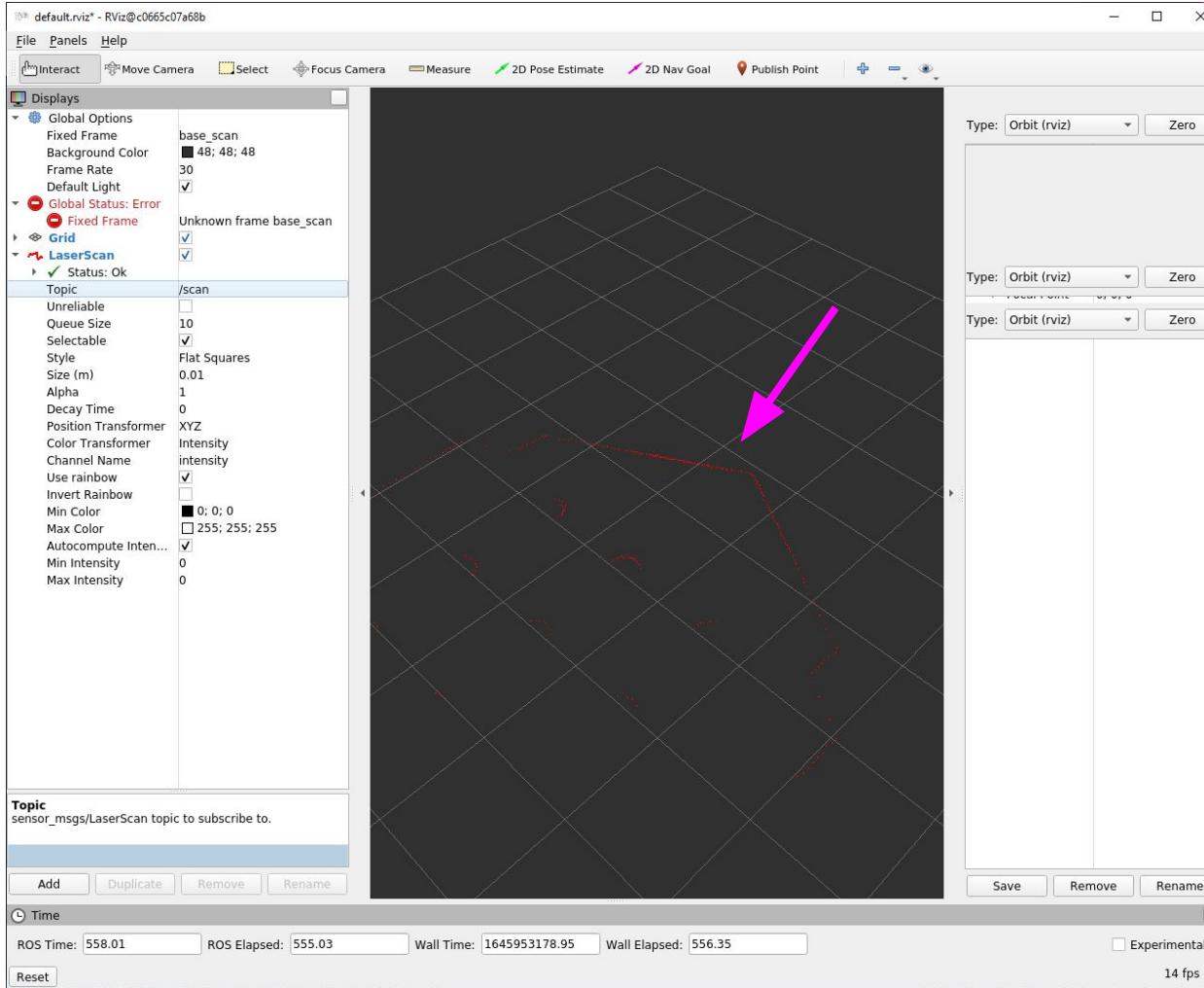






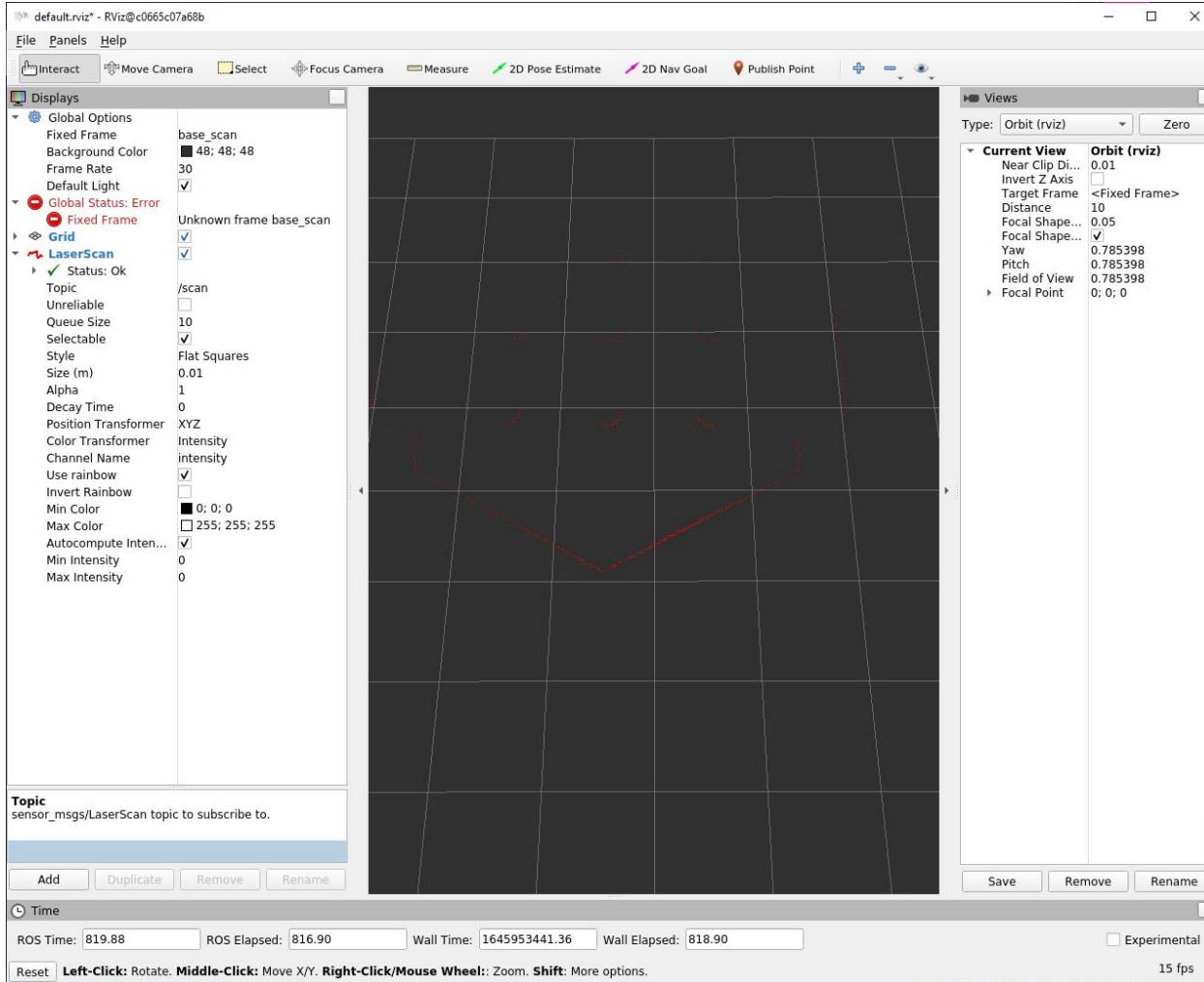


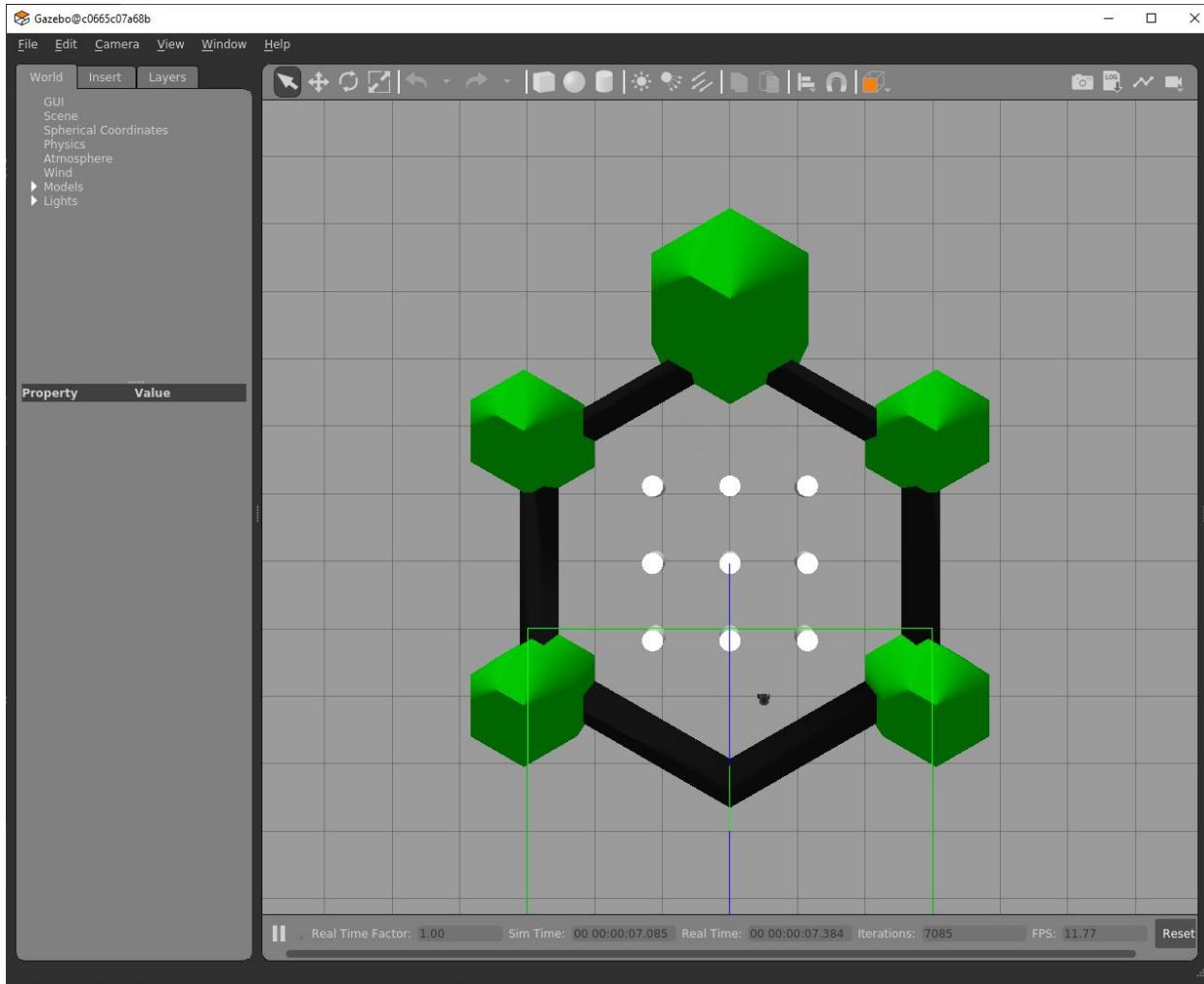




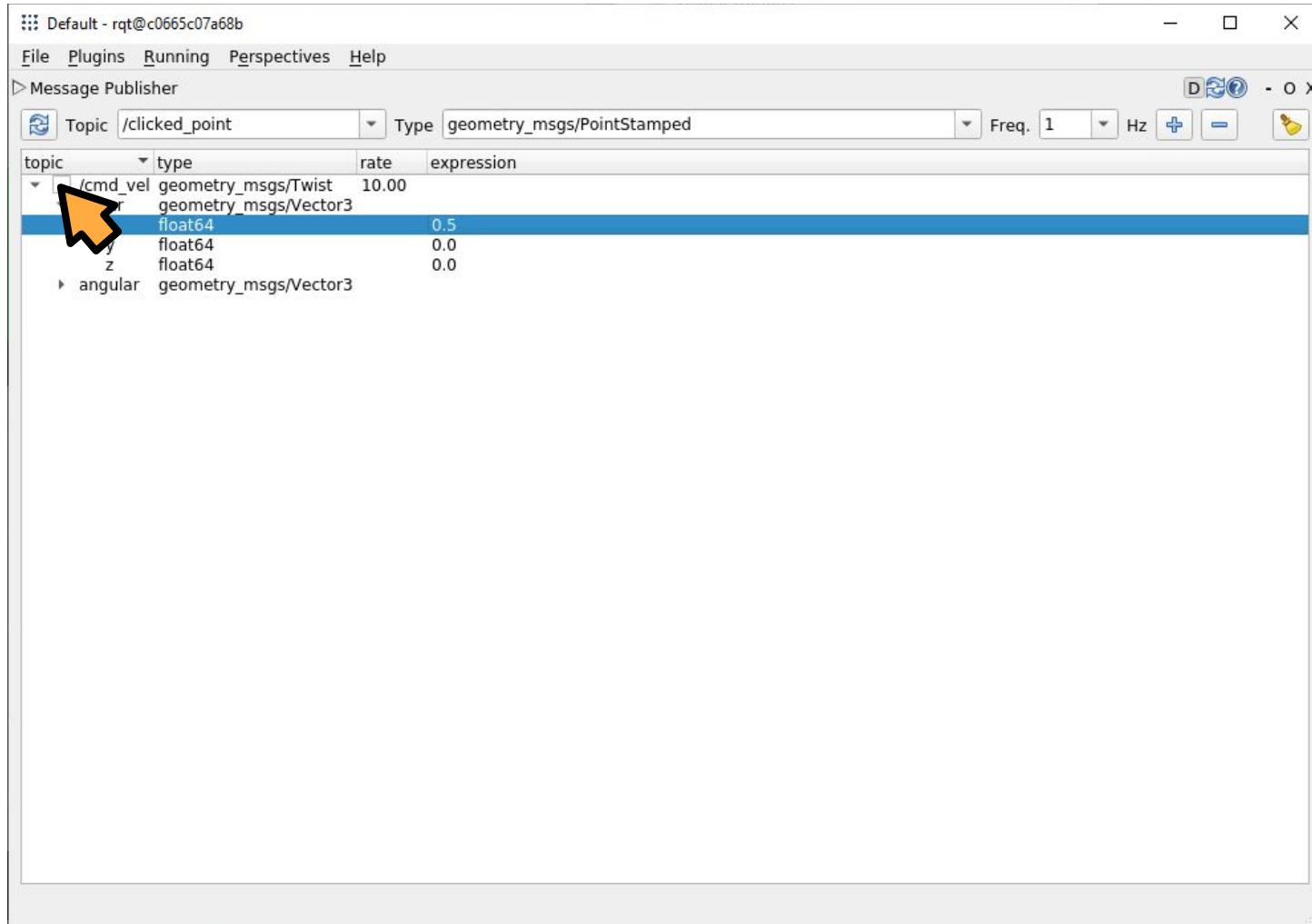
ROTATE  
(Left click)







```
$ rqt
```



Default - rqt@c0665c07a68b

- □ ×

File Plugins Running Perspectives Help

Message Publisher

D C O X



Topic /clicked\_point

Type geometry\_msgs/PointStamped

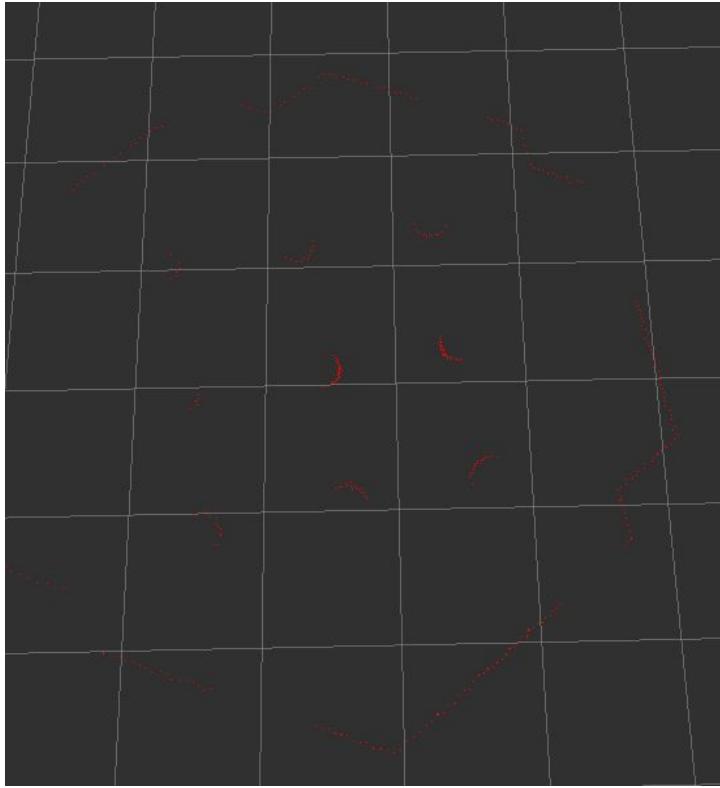
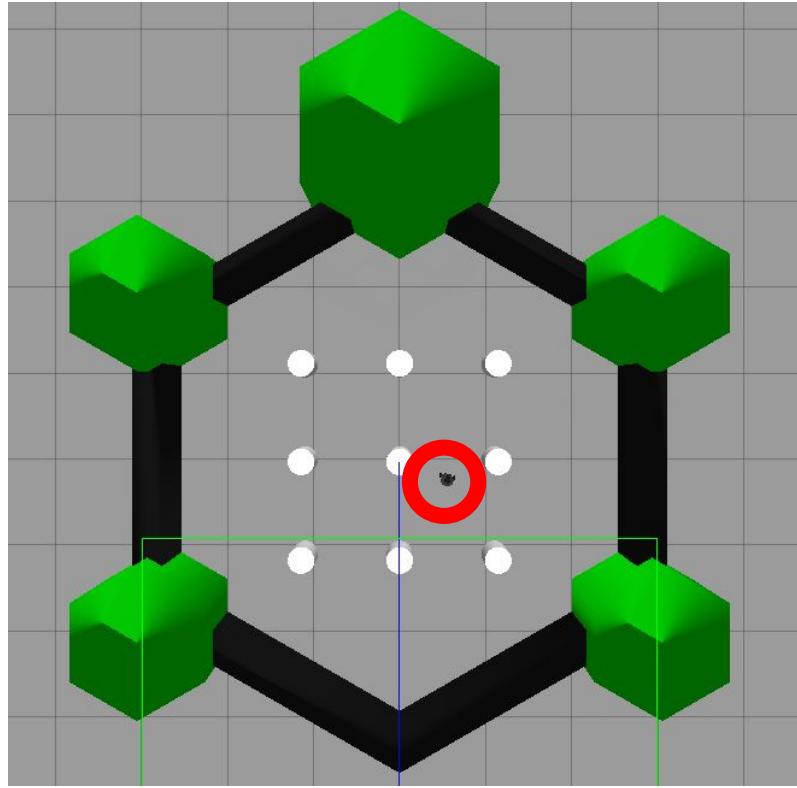
Freq.

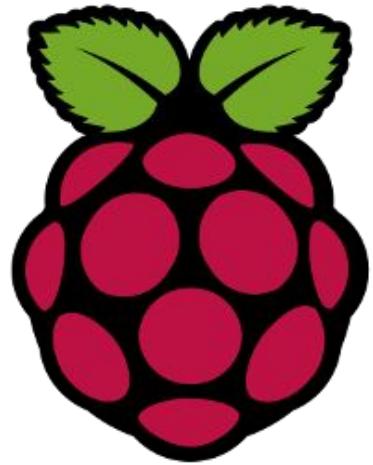
1

Hz

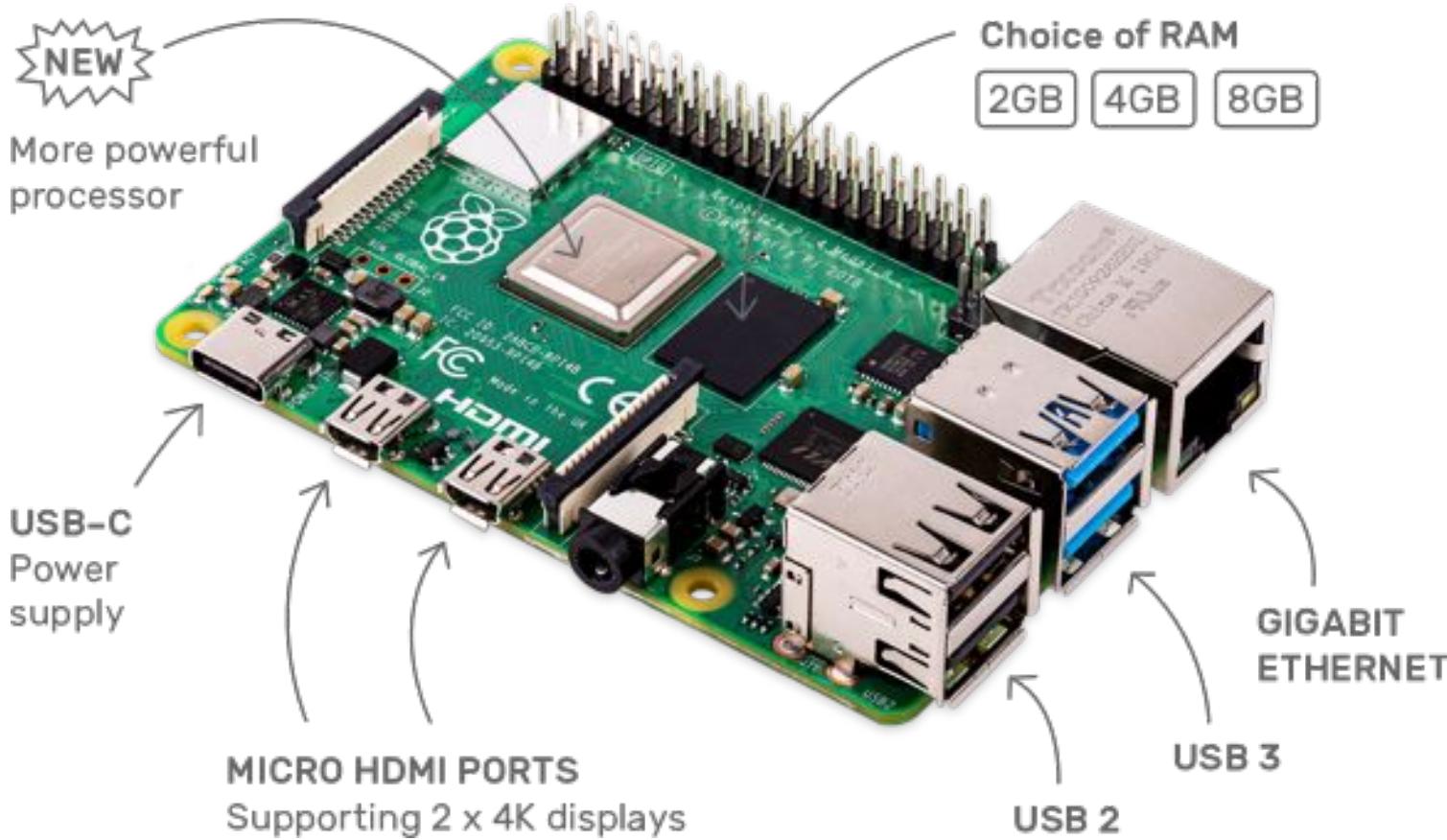


topic	type	rate	expression
✓ /cmd_vel	geometry_msgs/Twist	10.00	
linear	geometry_msgs/Vector3		
x	float64	0.5	
y	float64	0.0	
z	float64	0.0	
angular	geometry_msgs/Vector3		





Raspberry Pi



# Raspberry Pi OS

**SanDisk**  
***Extreme PRO***

**64 GB** **microSD** **V30**  
**XC I**  
**U3 A2**

REF: <https://www.aquapro.co.th/product/64-gb-extreme-pro/>

Link

We use cookies to ensure that we give you the best experience on our websites. By continuing to visit this site you agree to our use of cookies. Read our cookie policy.

Got it!



For Industry    Hardware    Software    Documentation    News    Forums    Foundation



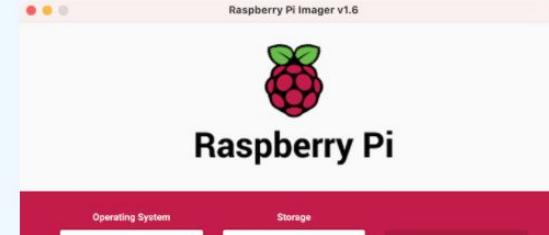
# Raspberry Pi OS

Your Raspberry Pi needs an operating system to work. This is it. Raspberry Pi OS (previously called Raspbian) is our official supported operating system.



## Install Raspberry Pi OS using Raspberry Pi Imager

Raspberry Pi Imager is the quick and easy way to install Raspberry Pi OS and other operating systems to a microSD card, ready to use with your Raspberry Pi. [Watch our 45-second video](#) to learn how to install an



## Install Raspberry Pi OS using Raspberry Pi Imager

Raspberry Pi Imager is the quick and easy way to install Raspberry Pi OS and other operating systems to a microSD card, ready to use with your Raspberry Pi. [Watch our 45-second video](#) to learn how to install an operating system using Raspberry Pi Imager.

Download and install Raspberry Pi Imager to a computer with an SD card reader. Put the SD card you'll use with your Raspberry Pi into the reader and run Raspberry Pi Imager.

[Download for Windows](#)

[Download for macOS](#)

[Download for Ubuntu for x86](#)

To install on **Raspberry Pi OS**, type  
`sudo apt install rpi-imager`  
in a Terminal window.



## Install Raspberry Pi OS using Raspberry Pi Imager

Raspberry Pi Imager is the quick and easy way to install Raspberry Pi OS and other operating systems to a microSD card, ready to use with your Raspberry Pi. [Watch our 45-second video](#) to learn how to install an operating system using Raspberry Pi Imager.

Download and install Raspberry Pi Imager to a computer with an SD card reader. Put the SD card you'll use with your Raspberry Pi into the reader and run Raspberry Pi Imager.

[Download for Windows](#)

[Download for macOS](#)

[Download for Ubuntu for x86](#)

To install on **Raspberry Pi OS**, type  
`sudo apt install rpi-imager`  
in a Terminal window.



## Install Raspberry Pi OS using Raspberry Pi Imager

Raspberry Pi Imager is the quick and easy way to install Raspberry Pi OS and other operating systems to a microSD card, ready to use with your Raspberry Pi. [Watch our 45-second video](#) to learn how to install an operating system using Raspberry Pi Imager.

Download and install Raspberry Pi Imager to a computer with an SD card reader. Put the SD card you'll use with your Raspberry Pi into the reader and run Raspberry Pi Imager.

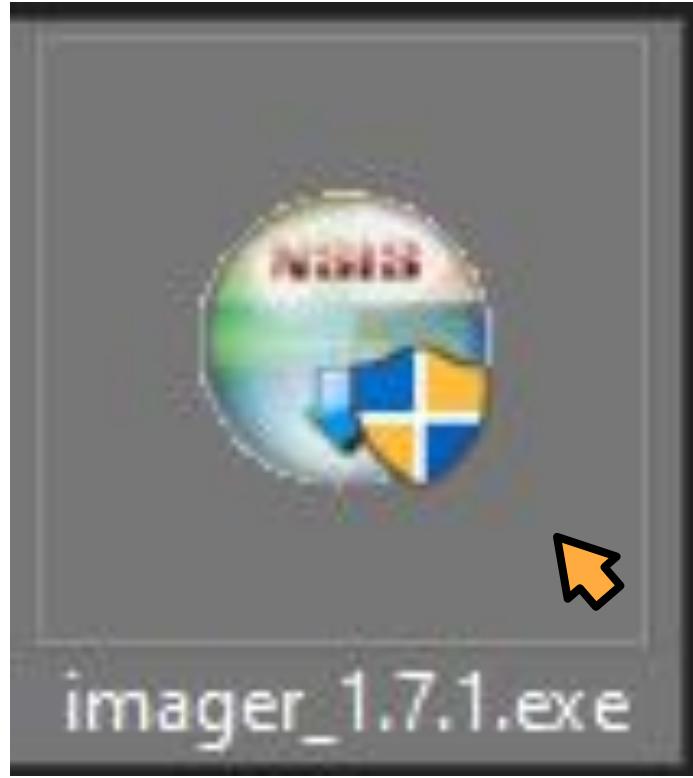
[Download for Windows](#)

[Download for macOS](#)

[Download for Ubuntu for x86](#)

To install on **Raspberry Pi OS**, type  
`sudo apt install rpi-imager`  
in a Terminal window.







Raspberry Pi Imager



## Welcome to Raspberry Pi Imager Setup

Setup will guide you through the installation of Raspberry Pi Imager.

It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.

Click Install to start the installation.

Install

Cancel



Raspberry Pi Imager



## Installing

Please wait while Raspberry Pi Imager is being installed.



Stopping Raspberry Pi Imager



Show details

Raspberry Pi Imager

< Back

Next >

Cancel



Raspberry Pi Imager



## Completing Raspberry Pi Imager Setup

Raspberry Pi Imager has been installed on your computer.

Click Finish to close Setup.

Run Raspberry Pi Imager

< Back

Finish

Cancel





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

Storage

CHOOSE OS

CHOOSE STORAGE

WRITE





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

Storage

CHOOSE OS

CHOOSE STORAGE

WRITE





Raspberry Pi Imager v1.7.1



### Operating System



#### Raspberry Pi OS (32-bit)

A port of Debian Bullseye with the Raspberry Pi Desktop (Recommended)

Released: 2022-01-28

Online - 1.2 GB download



#### Raspberry Pi OS (other)

Other Raspberry Pi OS based images



#### Other general-purpose OS

Other general-purpose operating systems



#### Media player OS

Media player operating systems



#### Emulation and game OS





## Operating System

X

**Raspberry Pi OS (32-bit)**

A port of Debian Bullseye with the Raspberry Pi Desktop (Recommended)

Released: 2022-01-28

Online - 1.2 GB download

**Raspberry Pi OS (other)**

Other Raspberry Pi OS based images

**Other general-purpose OS**

Other general-purpose operating systems

&gt;

**Media player OS**

Media player operating systems

&gt;

**Emulation and game OS**

&lt;



## Operating System

**Back**

Go back to main menu

**Raspberry Pi OS Lite (32-bit)**

A port of Debian Bullseye with no desktop environment

Released: 2022-01-28

Online - 0.5 GB download

**Raspberry Pi OS Full (32-bit)**

A port of Debian Bullseye with desktop environment and recommended applications

Released: 2022-01-28

Online - 3.2 GB download

**Raspberry Pi OS (64-bit)**

A port of Debian Bullseye with the Raspberry Pi Desktop (Compatible with Raspberry Pi 3/4/400)

Released: 2022-01-28



### Operating System



Online - 1.1 GB download

#### Raspberry Pi OS Lite (64-bit)



A port of Debian Bullseye with no desktop environment (Compatible with Raspberry Pi 3/4/400)

Released: 2022-01-28

Online - 0.4 GB download

#### Raspberry Pi OS (Legacy)



A port of Debian Buster with security updates and desktop environment

Released: 2022-01-28

Online - 1.1 GB download

#### Raspberry Pi OS Lite (Legacy)



A port of Debian Buster with security updates and no desktop environment

Released: 2022-01-28

Online - 0.4 GB download



**Operating System**

X

Online - 1.1 GB download

**Raspberry Pi OS Lite (64-bit)**

A port of Debian Bullseye with no desktop environment (Compatible with Raspberry Pi 3/4/400)

Released: 2022-01-28

Online - 0.4 GB download

**Raspberry Pi OS (Legacy)**

A port of Debian Buster with security updates and desktop environment

Released: 2022-01-28

Online - 1.1 GB download

**Raspberry Pi OS Lite (Legacy)**

A port of Debian Buster with security updates and no desktop environment

Released: 2022-01-28

Online - 0.4 GB download



Raspberry Pi Imager v1.7.1



## Operating System



Online - 1.1 GB download



### Raspberry Pi OS Lite (64-bit)

A port of Debian Bullseye with no desktop environment (Compatible with Raspberry Pi 3/4/400)

Released: 2022-01-28

Online - 0.4 GB download



### Raspberry Pi OS (Legacy)

A port of Debian Buster with security updates and desktop environment

Released: 2022-01-28

Online - 1.1 GB download



### Raspberry Pi OS Lite (Legacy)

A port of Debian Buster with security updates and no desktop environment

Released: 2022-01-28

Online - 0.4 GB download



Raspberry Pi Imager v1.7.1



# Raspberry Pi

RASPBERRY PI OS (LEGACY)

Storage

CHOOSE STORAGE

WRITE





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

RASPBERRY PI OS (LEGACY)

Storage

CHOOSE STORAGE

WRITE





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

RASPBERRY PI OS (LEGACY)

Storage

CHOOSE STORAGE

WRITE





Raspberry Pi Imager v1.7.1



Storage

X



Generic STORAGE DEVICE USB Device - 63.9 GB





Raspberry Pi Imager v1.7.1



Storage

X



Generic STORAGE DEVICE USB Device - 63.9 GB





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

RASPBERRY PI OS (LEGACY)

GENERIC STORA...

WRITE





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

RASPBERRY PI OS (LEGACY)

Storage

GENERIC STORA...

WRITE





Raspberry Pi Imager v1.7.1



Warning



All existing data on 'Generic STORAGE DEVICE USB Device' will be erased.

Are you sure you want to continue?

NO

YES





Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

RASPBERRY PI OS (LEGACY)

Storage

GENERIC STORA...

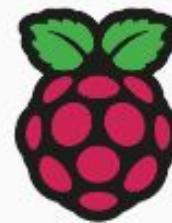
WRITE

Preparing to write... (opening drive)

CANCEL WRITE



Raspberry Pi Imager v1.7.1



# Raspberry Pi

Operating System

Storage

RASPBERRY PI OS (LEGACY)

GENERIC STORAG...

WRITE

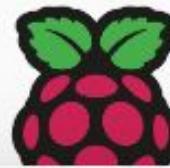
Writing... 11%



CANCEL WRITE



Raspberry Pi Imager v1.7.1



Write Successful



**Raspberry Pi OS (Legacy)** has been written to **Generic STORAGE DEVICE USB Device**

You can now remove the SD card from the reader

CONTINUE





```
$ sudo rm -f /usr/bin/python
```

```
$ sudo ln -s /usr/bin/python3 /usr/bin/python
```

```
$ sudo apt update
```

```
$ sudo apt install curl
```

```
$ sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu  
$(lsb_release -sc) main" >  
/etc/apt/sources.list.d/ros-latest.list'
```

```
$ curl -s https://raw.githubusercontent.com/ros/rosdistro/master/ros.asc |  
sudo apt-key add -
```

```
$ sudo apt update
```

```
$ sudo apt install python3-rosdep python3-rosinstall-generator  
python3-vcstool build-essential
```

```
$ sudo rosdep init
```

```
$ rosdep update
```

```
$ mkdir ~/ros_catkin_ws
```

```
$ cd ~/ros_catkin_ws
```

```
$ rosinstall_generator desktop --rosdistro noetic --deps  
--tar > noetic-desktop.rosinstall
```

```
$ mkdir ./src
```

```
$ vcs import --input noetic-desktop.rosinstall ./src
```

```
$ rosdep install --from-paths ./src  
--ignore-packages-from-source --rosdistro noetic -y
```

```
$ ./src/catkin/bin/catkin_make_isolated --install  
-DCMAKE_BUILD_TYPE=Release
```

```
$ echo "source ~/ros_catkin_ws/install_isolated/setup.bash"  
">>> ~/.bashrc
```

```
$ source ~/.bashrc
```