BIT **ROS**

ROS

Robot Operating System

Agenda

1. O zajęciach
2. Wprowadzenie do ROSa
3. Roboty mobilne
4. Sprzęt
5. Demo
6. Praca z ROSem

O mnie

KOŁO NAUKOWE

AGH space systems

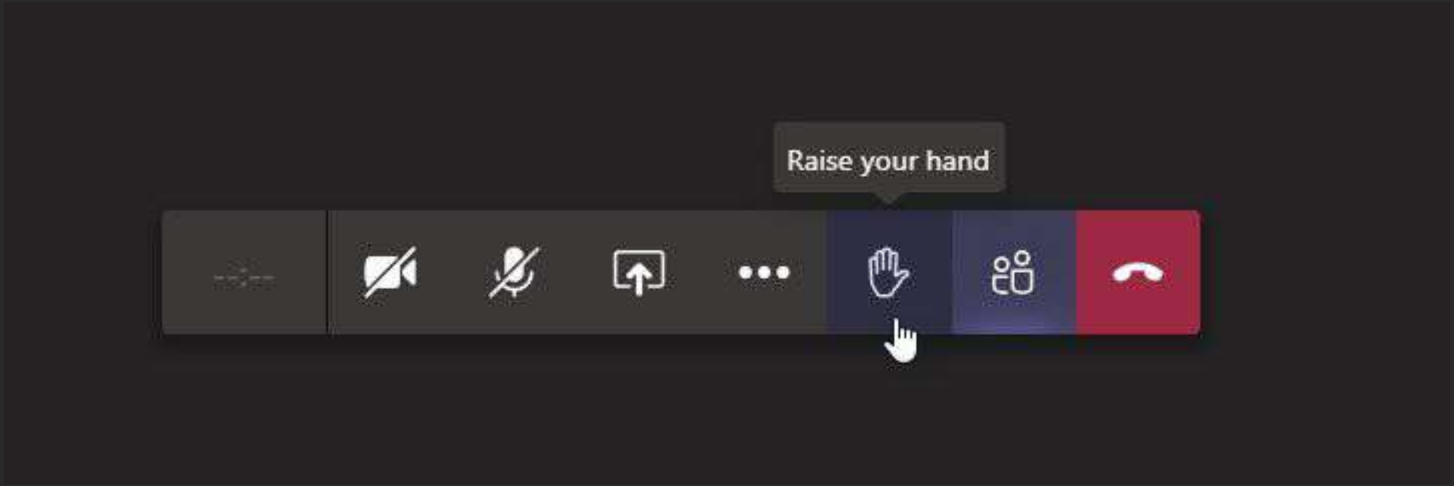
KNEI

O zajęciach

O zajęciach

Zajęcia (prawie) co tydzień

O zajęciach



Po zajęciach

Wprowadzenie

Robot do podawania piwa

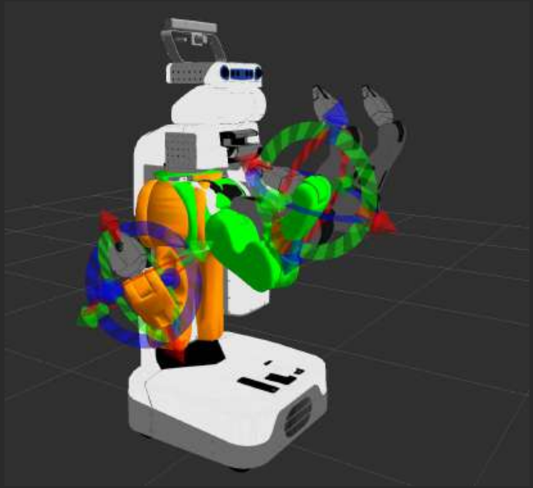
Podproblemy:

- Interfejs do komunikacji z robotem
- Nawigowanie po budynku
- Przeszukiwanie półek, lodówki
- Podnoszenie obiektu
- Znalezienie drogi powrotnej
- Podanie obiektu

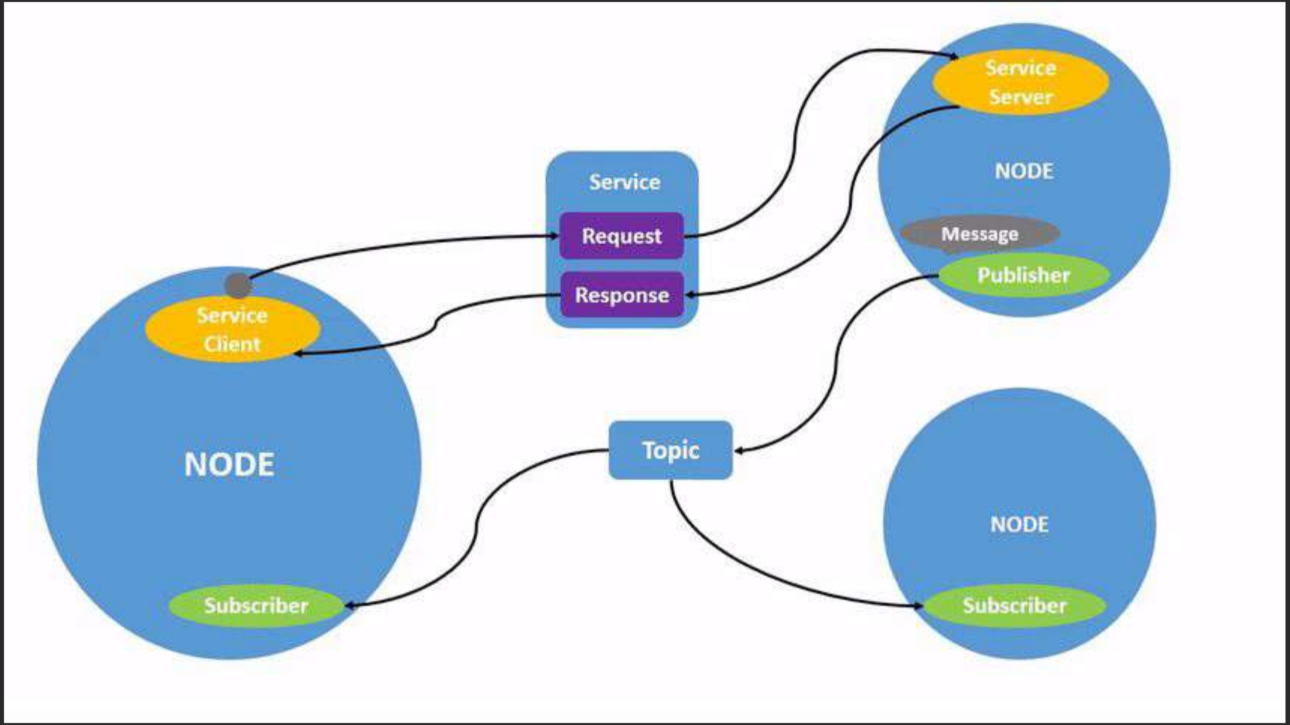
Czym jest ROS?

tl;dr zbiór frameworków i narzędzi do rozwijania oprogramowania robotycznego.

- warstwa abstrakcji
- architektura peer-to-peer
- wiele narzędzi
- wsparcie dla wielu języków
- społeczność
- open source



Architektura peer-to-peer



Client libraries

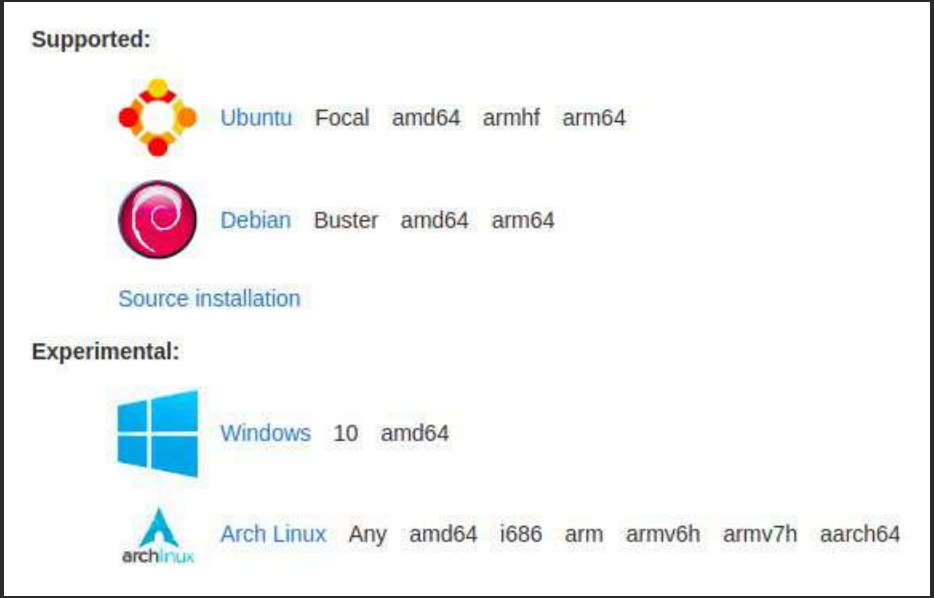
Experimental client libraries

ROS R

MATLAB®

UNREAL
ENGINE

Wspierane systemy operacyjne



Supported:

Ubuntu Focal amd64 armhf arm64

Debian Buster amd64 arm64

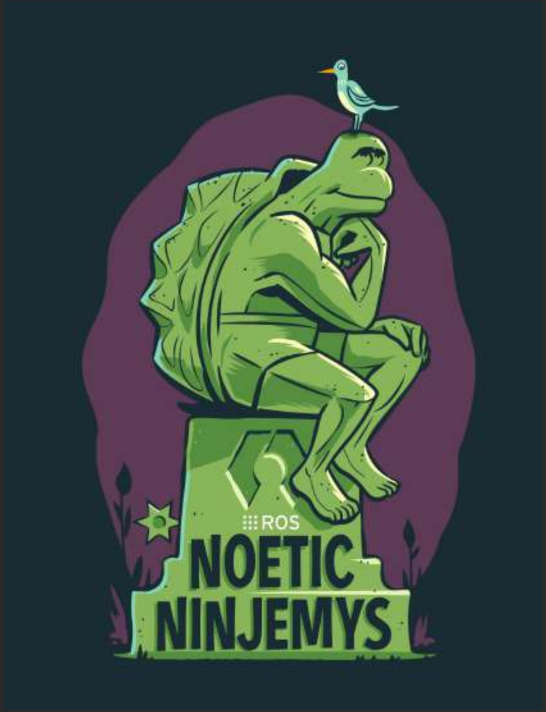
Source installation

Experimental:

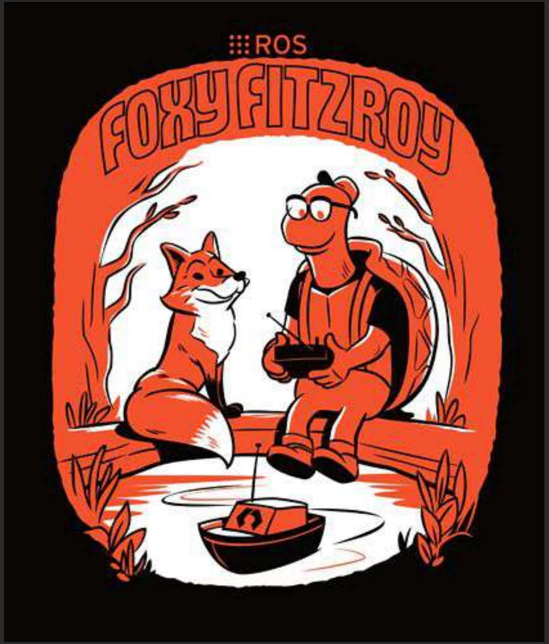
Windows 10 amd64

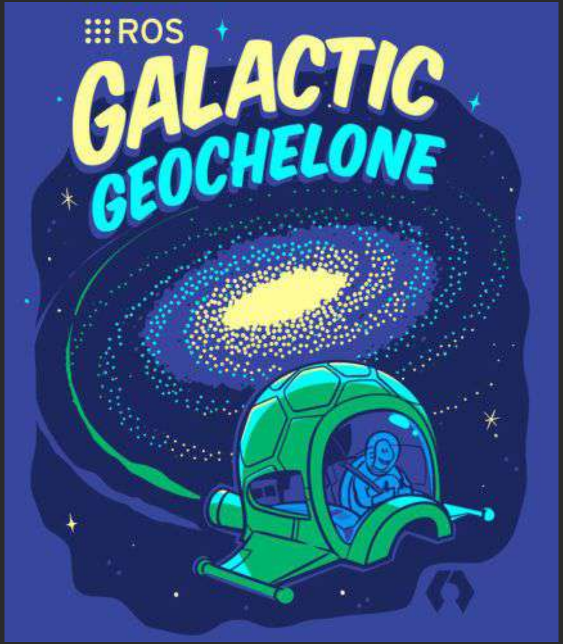
Arch Linux Any amd64 i686 arm armv6h armv7h aarch64

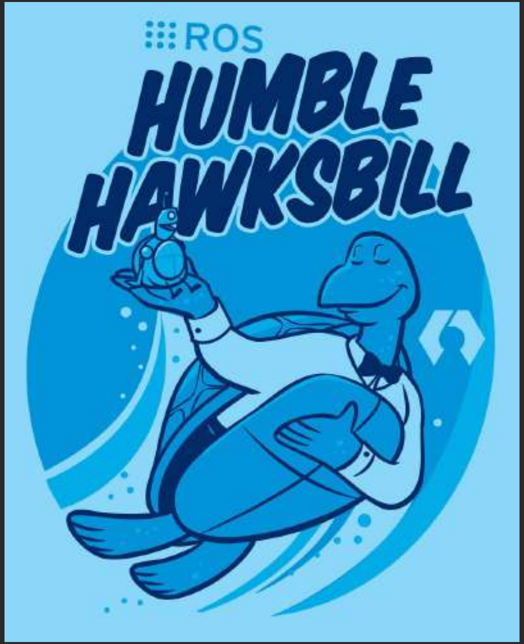
Dystrybucje



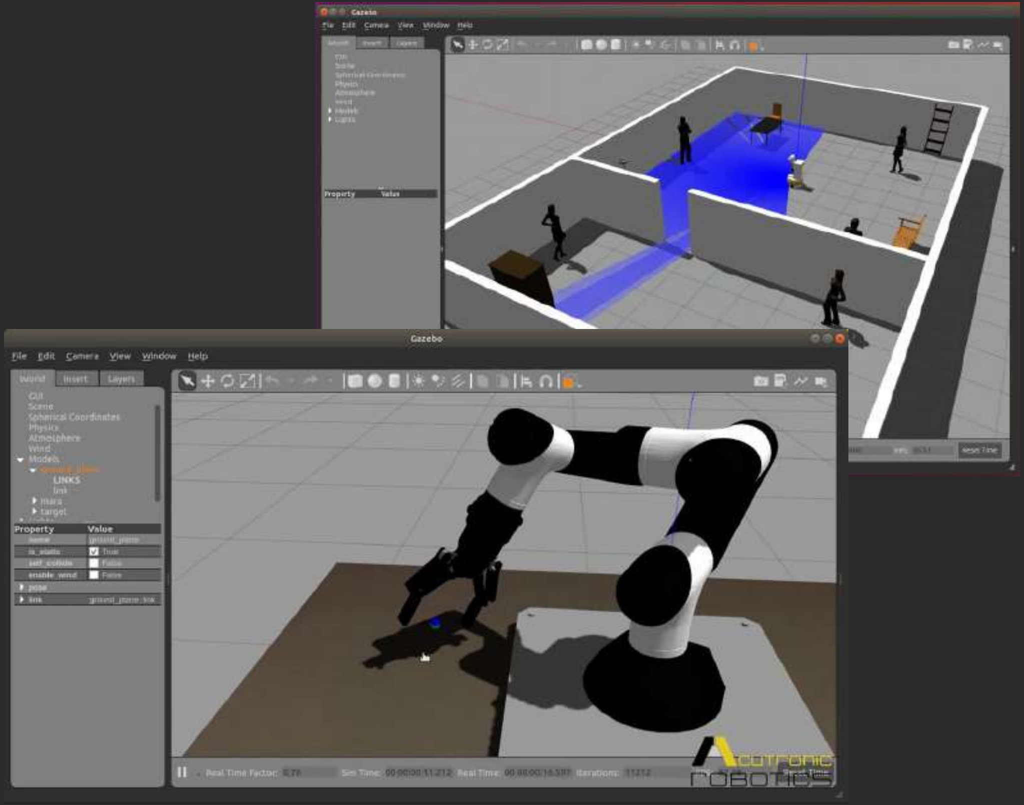
ROS 2


ROS
FOXY FITZROY


ROS
GALACTIC
GEOCHELONE


ROS
HUMBLE
HAWKSBILL

Gazebo


Gazebo
File Edit Camera View Window Help
World Insert Layers
GUI
Scene
Spherical Coordinates
Physics
Atmosphere
Wind
Models
LINKS
link
mara
target
Property Value
is_static True
self_collide False
enable_wind False
pose
link
Lights
Real Time Factor:
Sim Time:
Real Time:
Iterations:
Reset Time
Acutronic Robotics

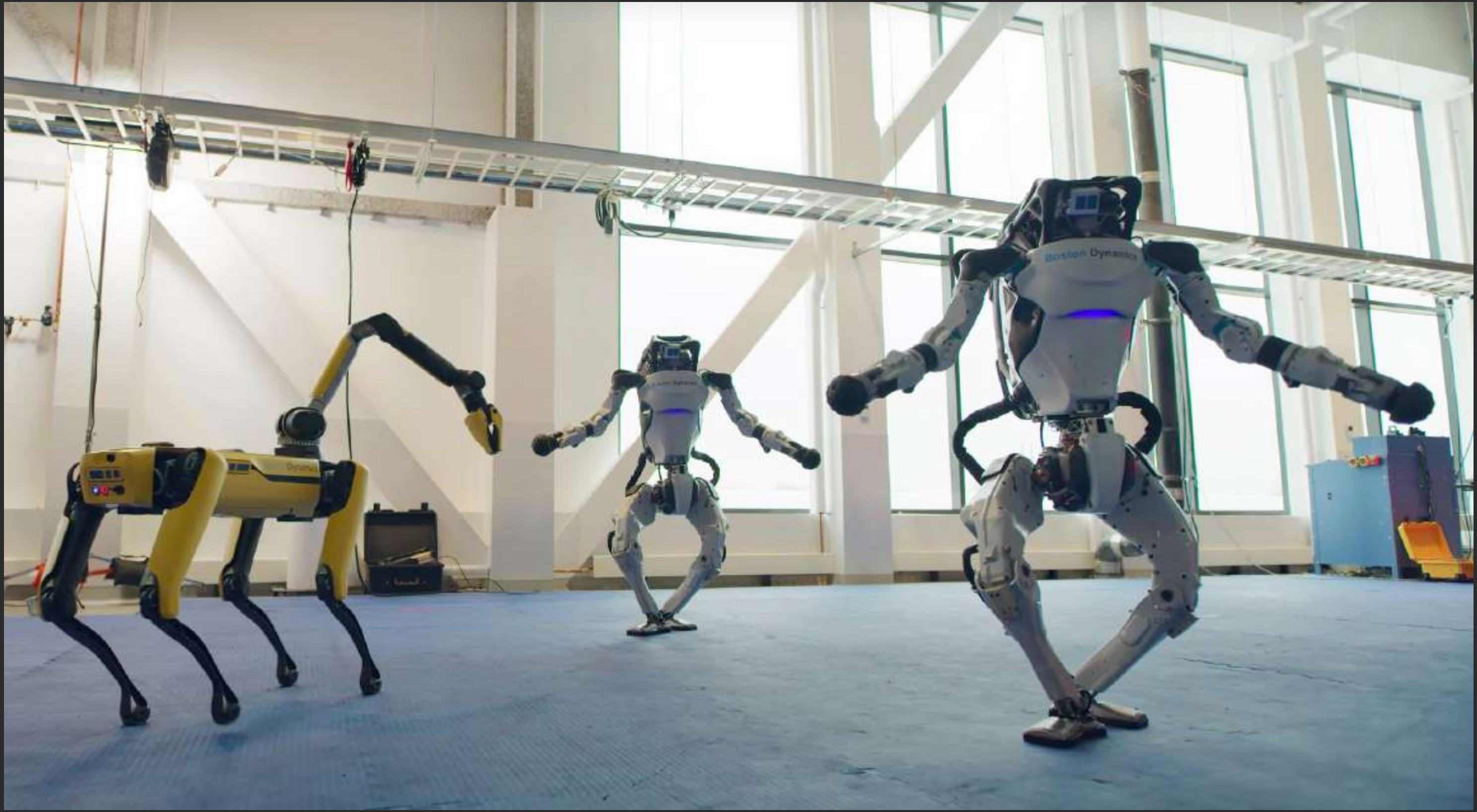
Roboty mobilne

Roboty do zastosowań przemysłowych

Roboty do zastosowań szpitalnych

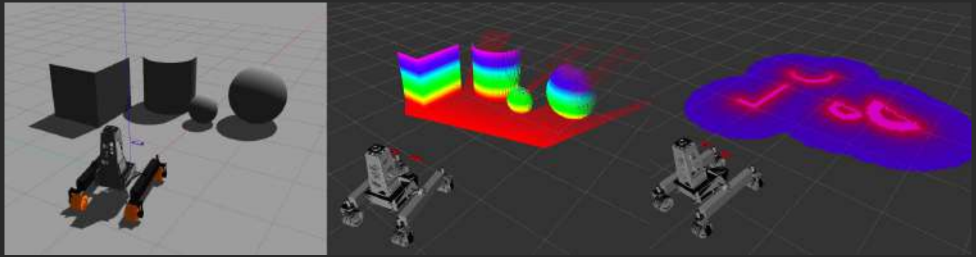
Kerfusie

BostonDynamics

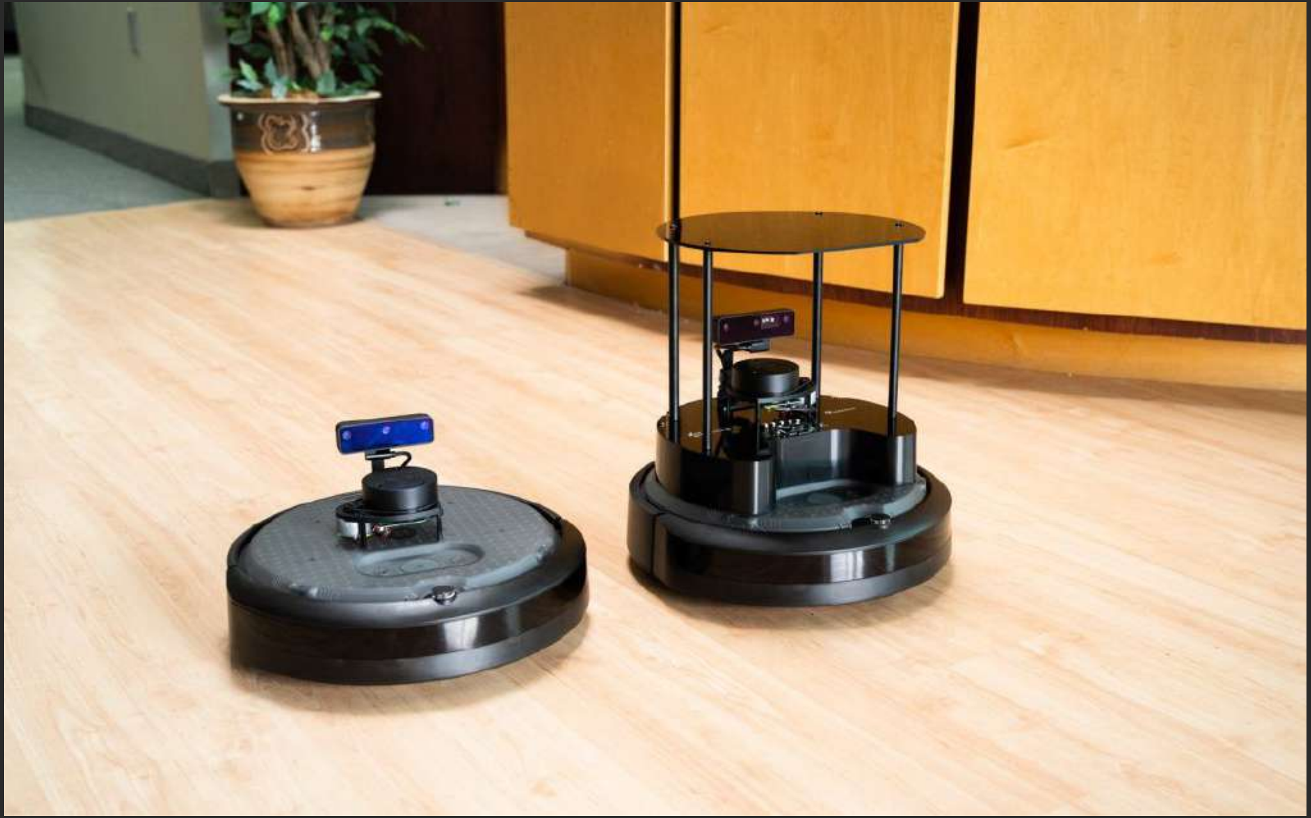


Unitree

Kalman



Turtlebot



ROSbot

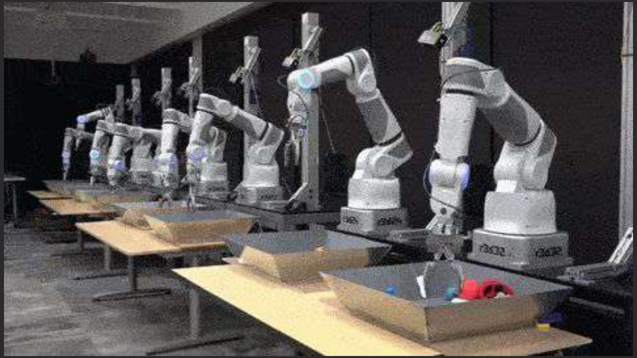
Rozwiązania

Lokomocja

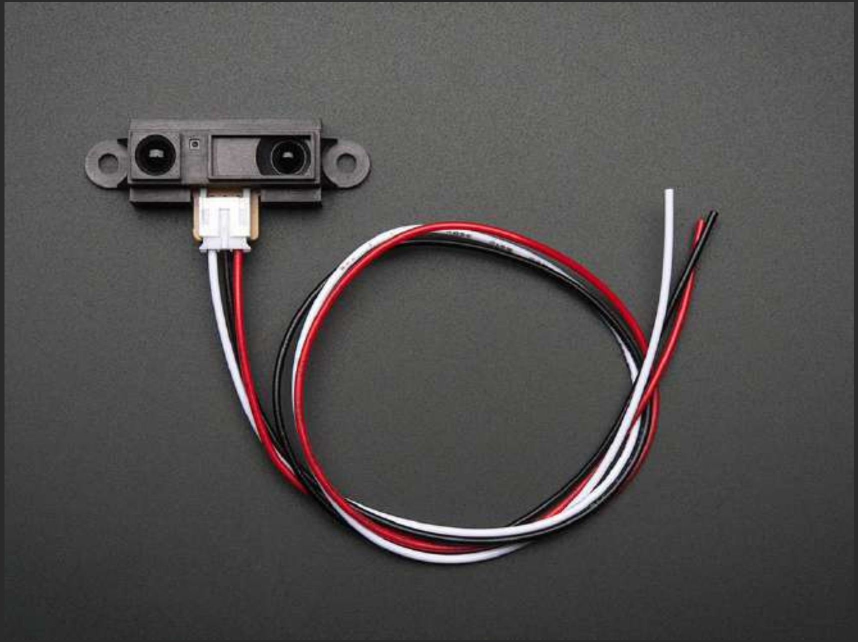
×0.25
Unitree Robotics 宇树科技

Stagehandspace.com
NDER
gifs.com

Manipulatory

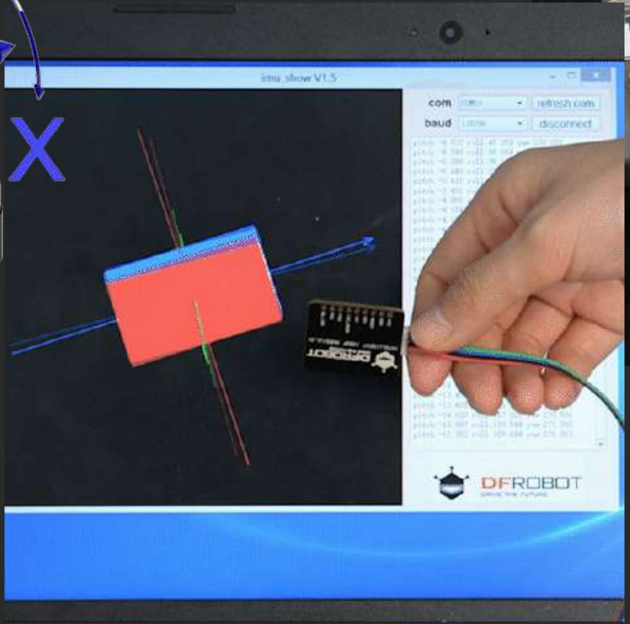


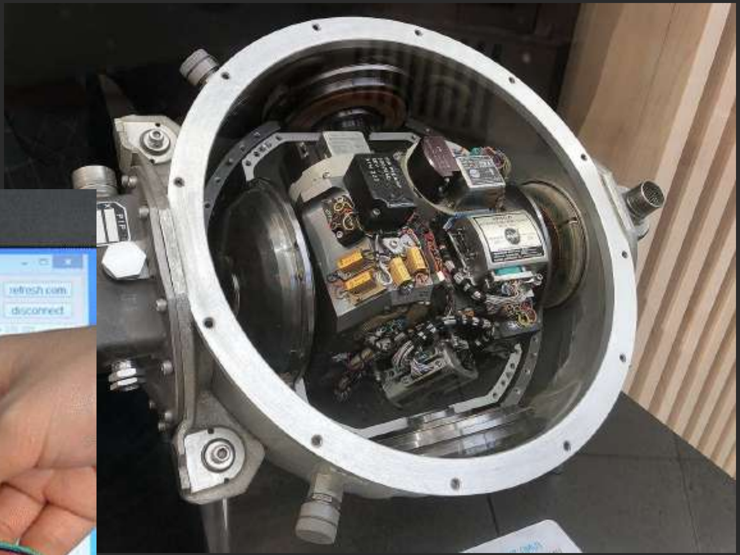
Czujniki odległości



IMU - Inertial measurement unit

Y
Z
X
MEMSENSE
IMU
3025





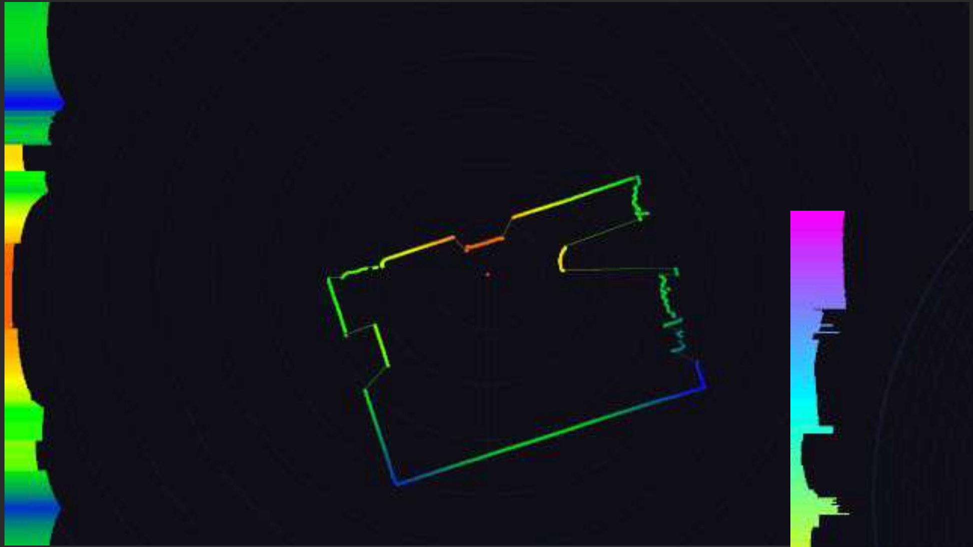
GPS/GNSS

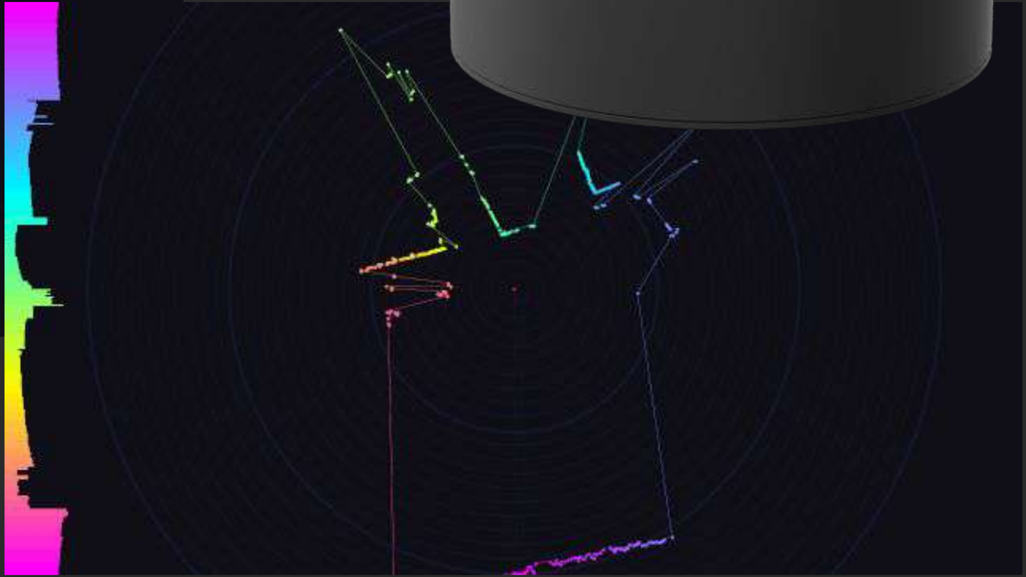
QUECTEL
L80
L80-M39
L80GR01A07S

GY-GPS6MV2
VCC RX TX GND

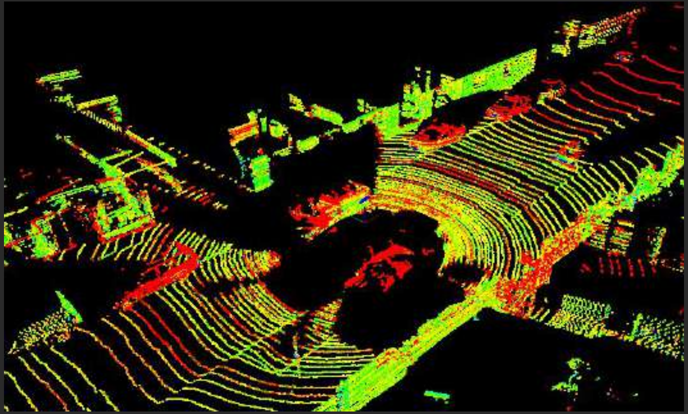
V.KEL
TTL
VK2828U7G5LF
S/N:1603G00586

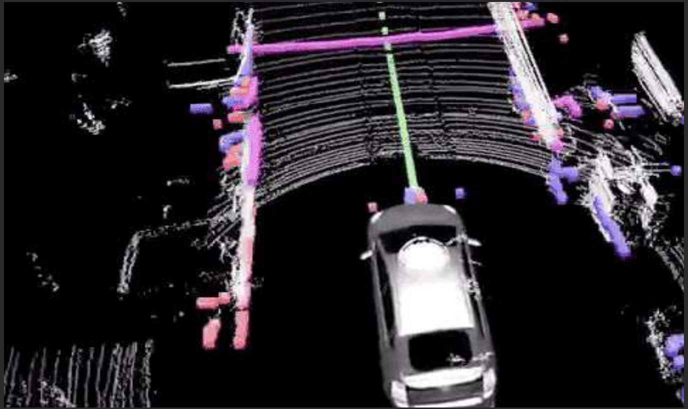
Lidary 2D





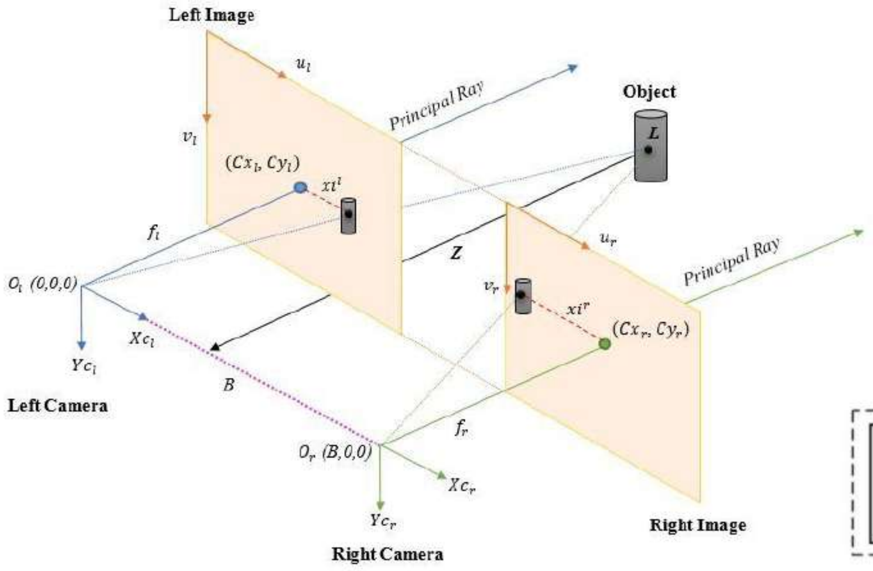
Lidary 3D

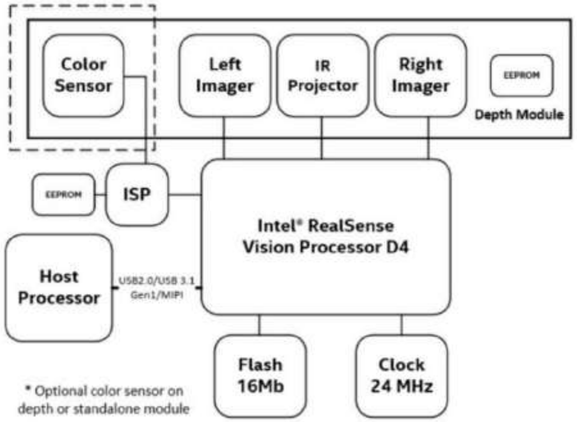




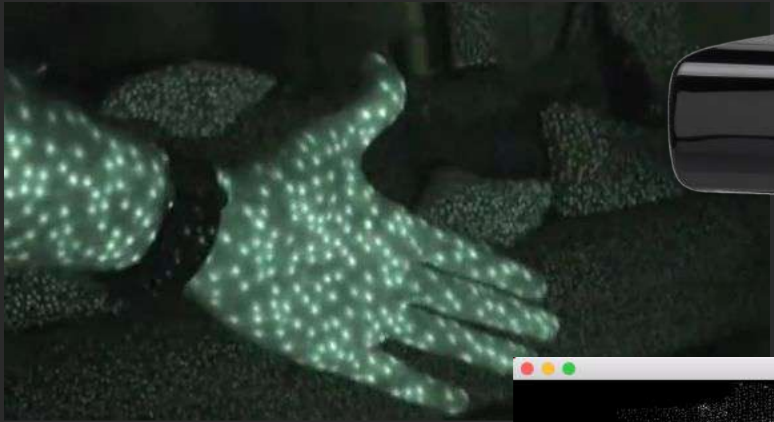
Kamery głębi

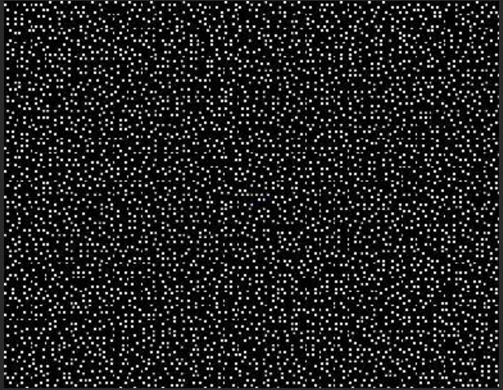
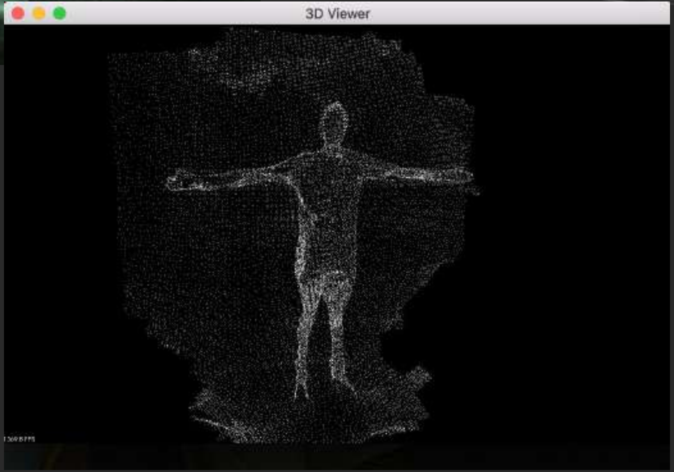
Kamery głębi - Intel Realsense



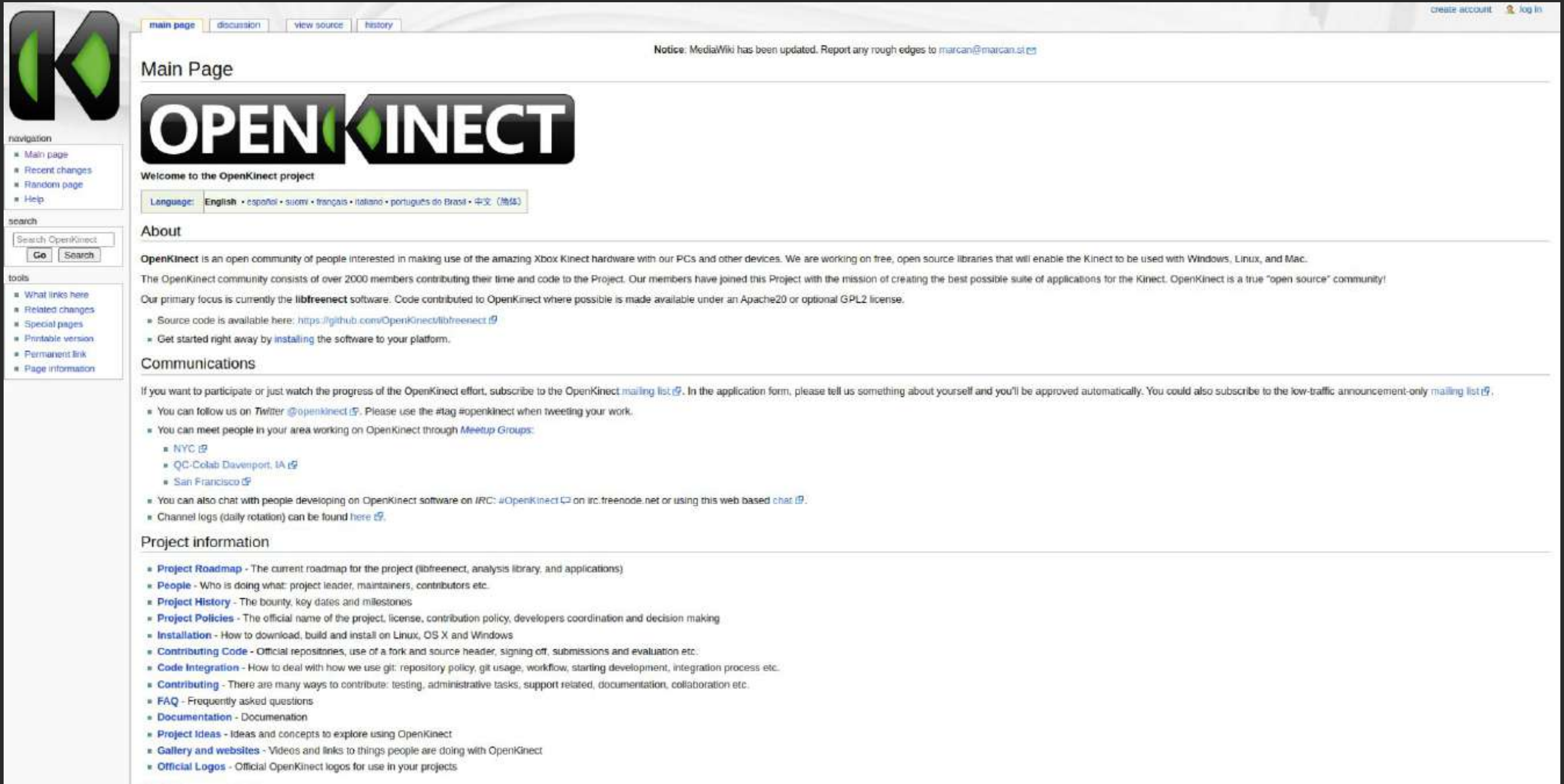


Kamery głębi - Kinect



Kamery głębi - Kinect



Notice: MediaWiki has been updated. Report any rough edges to marcan@marcan.st

Main Page

Welcome to the OpenKinect project

Language: **English** • español • suomi • français • italiano • português do Brasil • 中文（简体）

About

OpenKinect is an open community of people interested in making use of the amazing Xbox Kinect hardware with our PCs and other devices. We are working on free, open source libraries that will enable the Kinect to be used with Windows, Linux, and Mac.

The OpenKinect community consists of over 2000 members contributing their time and code to the Project. Our members have joined this Project with the mission of creating the best possible suite of applications for the Kinect. OpenKinect is a true "open source" community!

Our primary focus is currently the **libfreenect** software. Code contributed to OpenKinect where possible is made available under an Apache20 or optional GPL2 license.

- Source code is available here: https://github.com/OpenKinect/libfreenect
- Get started right away by installing the software to your platform.

Communications

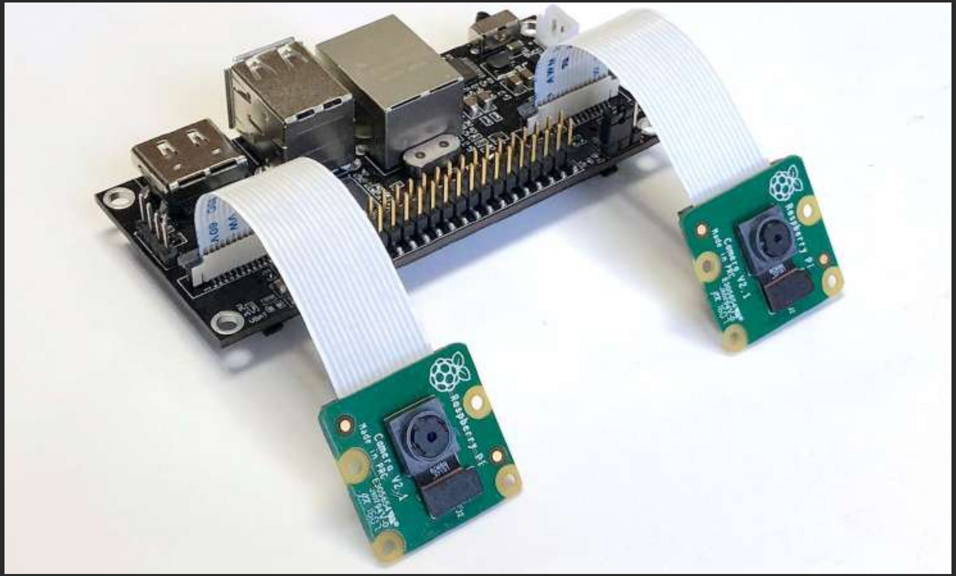
If you want to participate or just watch the progress of the OpenKinect effort, subscribe to the OpenKinect mailing list. In the application form, please tell us something about yourself and you'll be approved automatically. You could also subscribe to the low-traffic announcement-only mailing list.

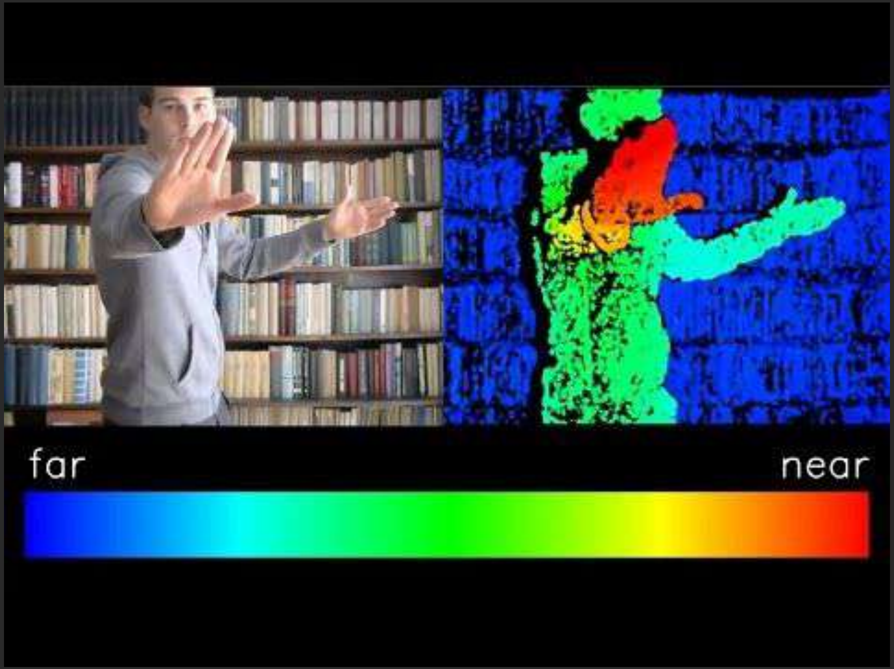
- You can follow us on *Twitter* @openkinect. Please use the #tag #openkinect when tweeting your work.
- You can meet people in your area working on OpenKinect through *Meetup Groups*:
  - NYC
  - QC-Colab Davenport, IA
  - San Francisco
- You can also chat with people developing on OpenKinect software on *IRC*: #OpenKinect on irc.freenode.net or using this web based chat.
- Channel logs (daily rotation) can be found here.

Project information

- **Project Roadmap** - The current roadmap for the project (libfreenect, analysis library, and applications)
- **People** - Who is doing what: project leader, maintainers, contributors etc.
- **Project History** - The bounty, key dates and milestones
- **Project Policies** - The official name of the project, license, contribution policy, developers coordination and decision making
- **Installation** - How to download, build and install on Linux, OS X and Windows
- **Contributing Code** - Official repositories, use of a fork and source header, signing off, submissions and evaluation etc.
- **Code Integration** - How to deal with how we use git: repository policy, git usage, workflow, starting development, integration process etc.
- **Contributing** - There are many ways to contribute: testing, administrative tasks, support related, documentation, collaboration etc.
- **FAQ** - Frequently asked questions
- **Documentation** - Documenation
- **Project Ideas** - Ideas and concepts to explore using OpenKinect
- **Gallery and websites** - Videos and links to things people are doing with OpenKinect
- **Official Logos** - Official OpenKinect logos for use in your projects

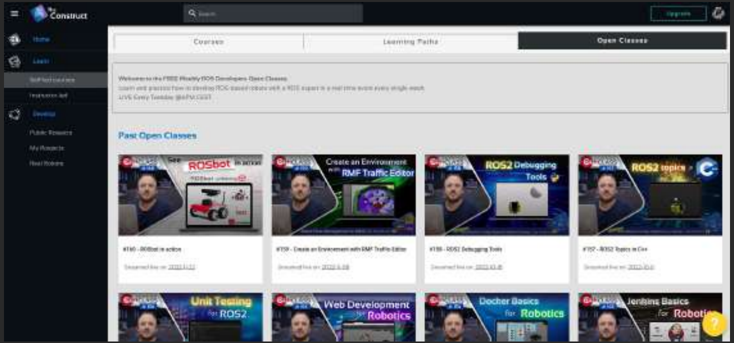
Kamery stereo

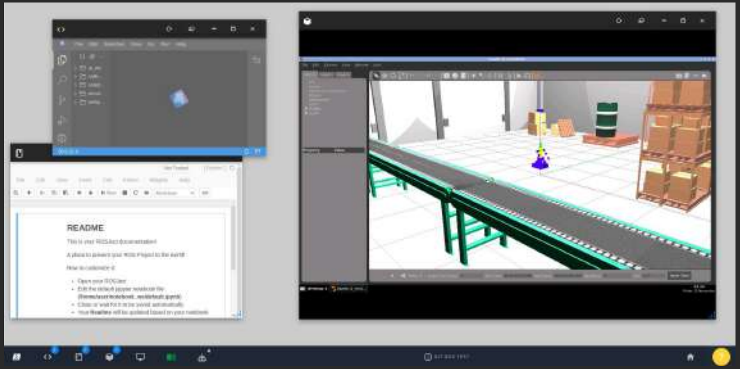




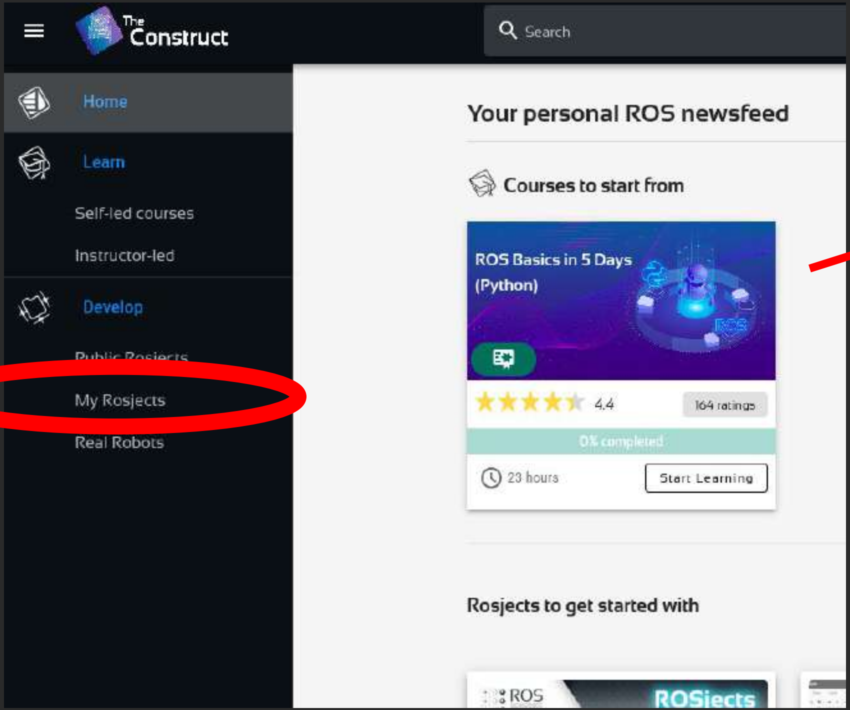
Przygotowanie środowiska

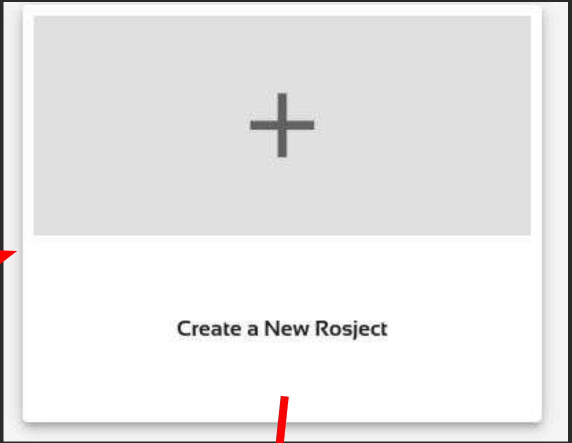
The Construct

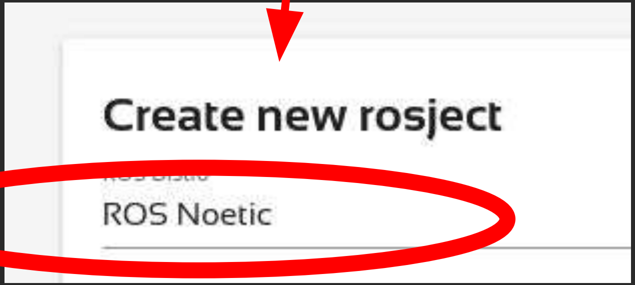




The Construct

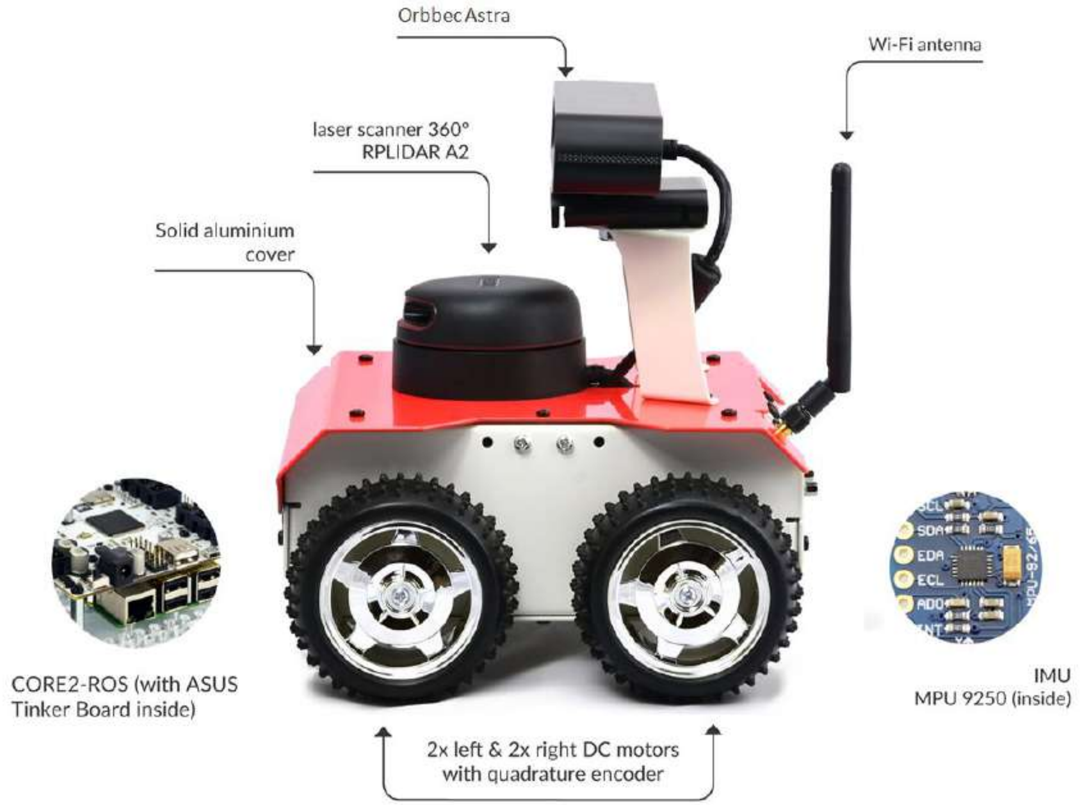




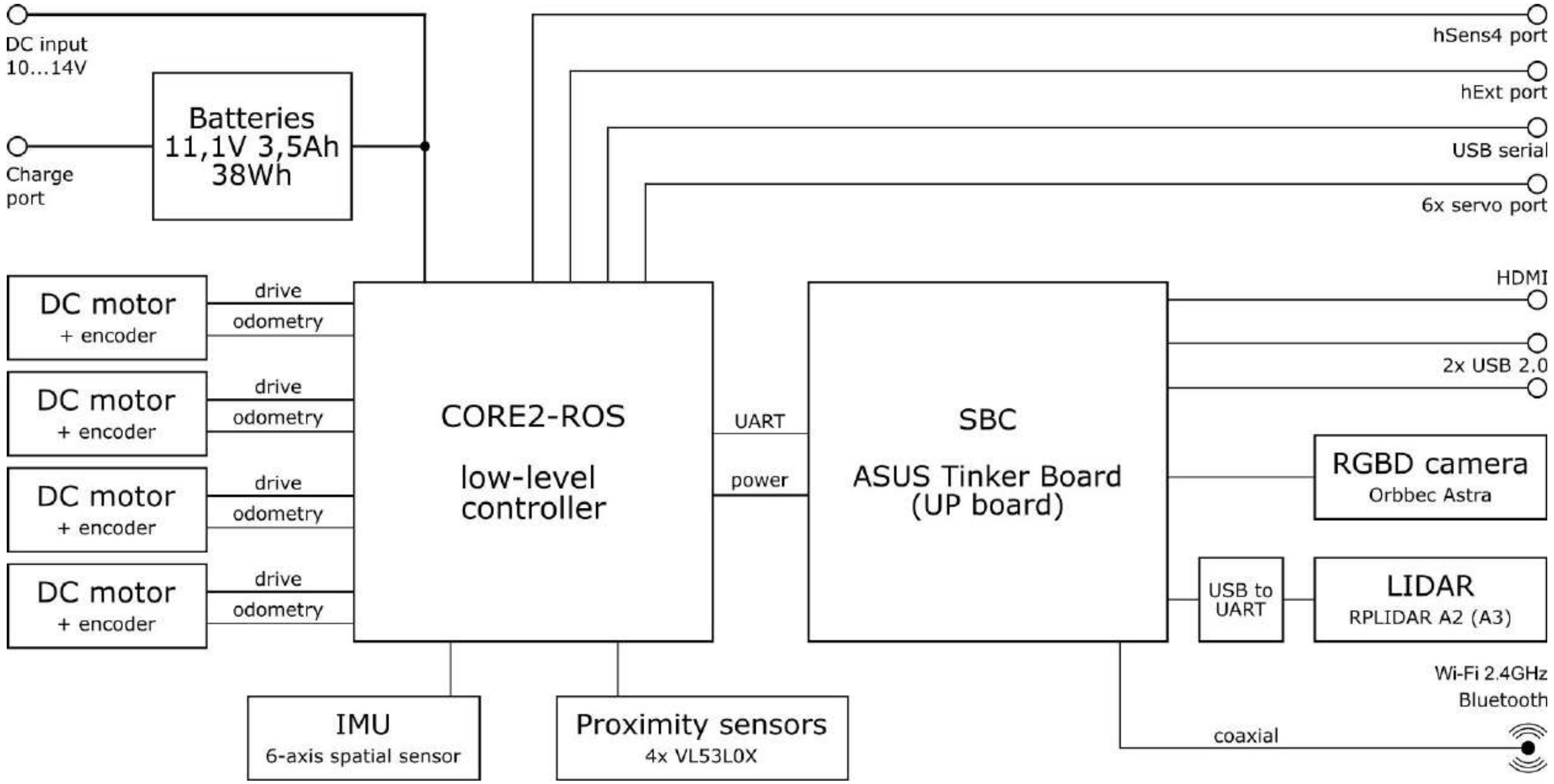


Demo

ROSbot

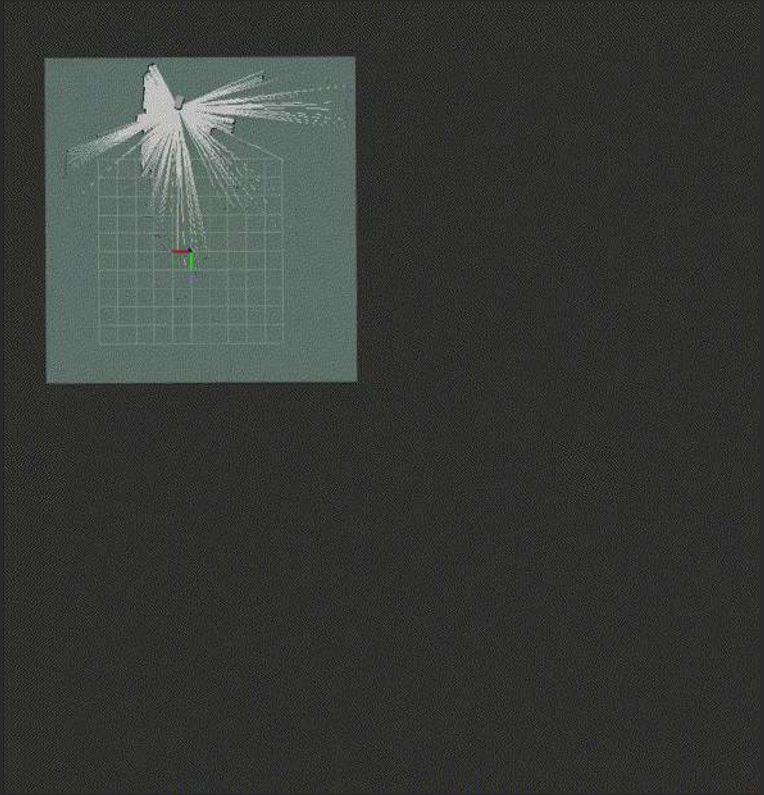

Orbbec Astra
Wi-Fi antenna
laser scanner 360° RPLIDAR A2
Solid aluminium cover
CORE2-ROS (with ASUS Tinker Board inside)
IMU MPU 9250 (inside)
2x left & 2x right DC motors with quadrature encoder

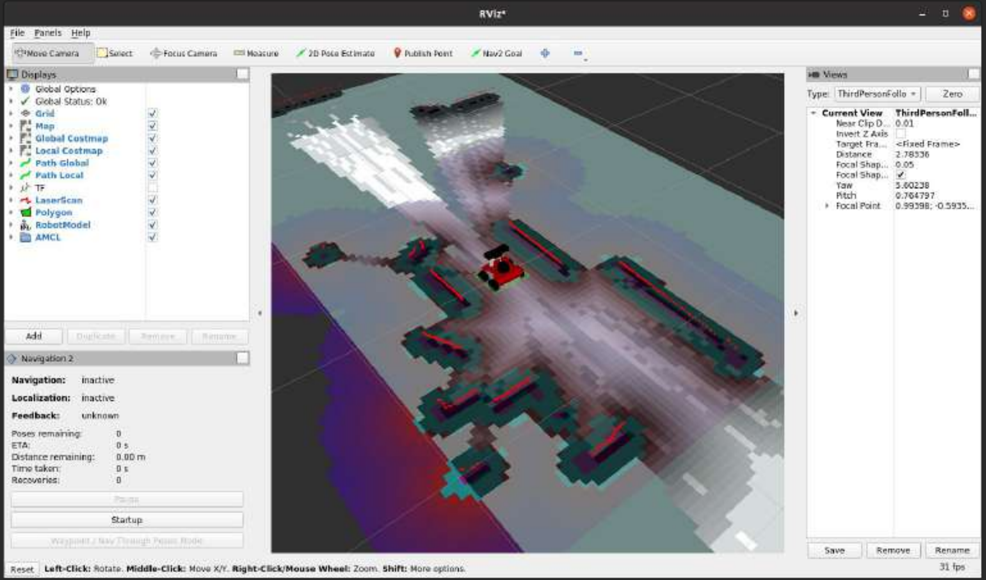
Hardware


DC input
10...14V
Charge port
Batteries
11,1V 3,5Ah
38Wh
hSens4 port
hExt port
USB serial
6x servo port
DC motor
+ encoder
drive
odometry
DC motor
+ encoder
drive
odometry
DC motor
+ encoder
drive
odometry
DC motor
+ encoder
drive
odometry
CORE2-ROS
low-level
controller
UART
power
SBC
ASUS Tinker Board
(UP board)
HDMI
2x USB 2.0
RGBD camera
Orbbec Astra
USB to UART
LIDAR
RPLIDAR A2 (A3)
Wi-Fi 2.4GHz
Bluetooth
coaxial
IMU
6-axis spatial sensor
Proximity sensors
4x VL53L0X

Software

Demo - SLAM





Global Options
Global Status: Ok
Grid ✓
Map ✓
Global Costmap ✓
Local Costmap ✓
Path Global ✓
Path Local ✓
TF ☐
LaserScan ✓
Polygon ✓
RobotModel ✓
AMCL ✓

Navigation 2

Navigation: inactive
Localization: inactive
Feedback: unknown

Poses remaining:	0
ETA:	0 s
Distance remaining:	0.00 m
Time taken:	0 s
Recoveries:	0

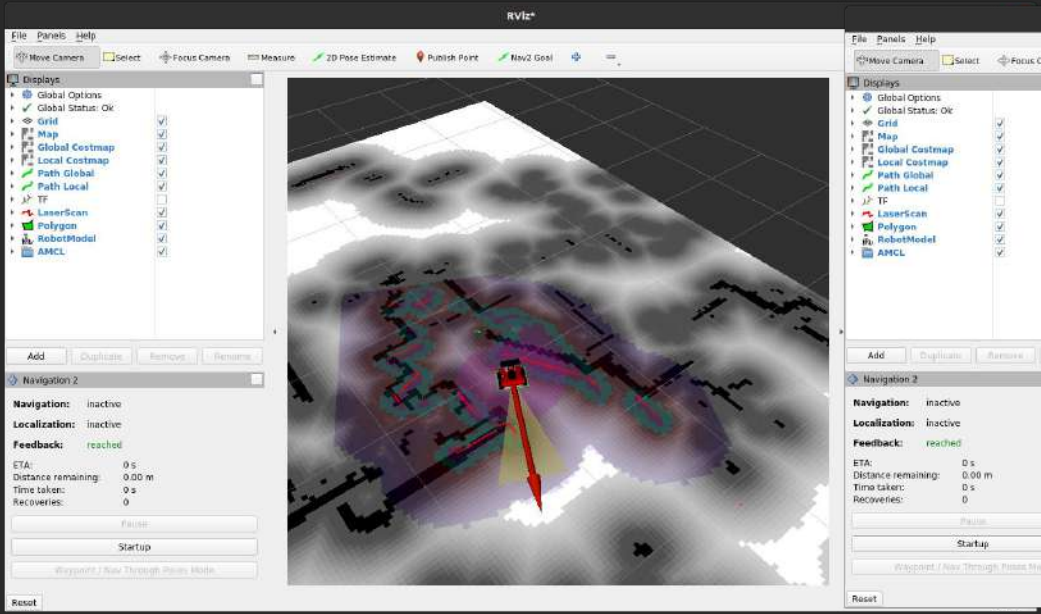
Type: ThirdPersonFollo

Current View	**ThirdPersonFoll...**
Near Clip D...	0.01
Invert Z Axis	☐
Target Fra...	<Fixed Frame>
Distance	2.78536
Focal Shap...	0.05
Focal Shap...	✓
Yaw	5.60238
Pitch	0.764797
Focal Point	0.99398; -0.5935...

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

31 fps

Demo - SLAM

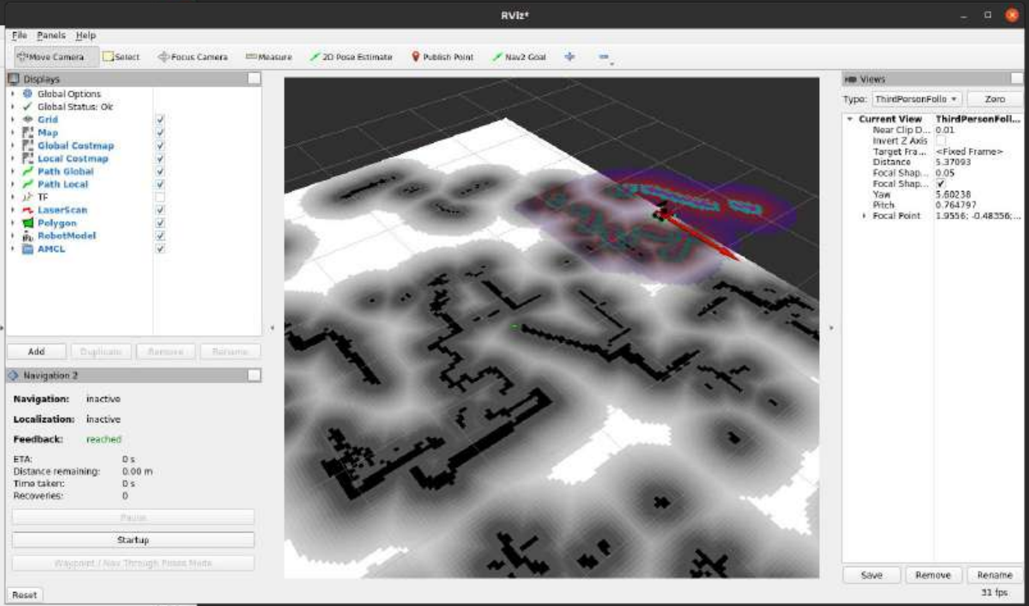

RViz*
File Panels Help
Move Camera Select Focus Camera Measure 2D Pose Estimate Publish Point Nav2 Goal
Add Duplicate Remove Rename
Pause
Startup
Waypoint / Nav Through Poses Mode
Reset

Displays
- Global Options
- Global Status: Ok
- Grid ✓
- Map ✓
- Global Costmap ✓
- Local Costmap ✓
- Path Global ✓
- Path Local ✓
- TF
- LaserScan ✓
- Polygon ✓
- RobotModel ✓
- AMCL ✓

Navigation 2

Navigation: inactive
Localization: inactive
Feedback: reached

ETA:	0 s
Distance remaining:	0.00 m
Time taken:	0 s
Recoveries:	0


RViz*
File Panels Help
Move Camera Select Focus Camera Measure 2D Pose Estimate Publish Point Nav2 Goal
Add Duplicate Remove Rename
Pause
Startup
Waypoint / Nav Through Poses Mode
Reset
Save Remove Rename
31 fps

Displays
- Global Options
- Global Status: Ok
- Grid ✓
- Map ✓
- Global Costmap ✓
- Local Costmap ✓
- Path Global ✓
- Path Local ✓
- TF
- LaserScan ✓
- Polygon ✓
- RobotModel ✓
- AMCL ✓

Navigation 2

Navigation: inactive
Localization: inactive
Feedback: reached

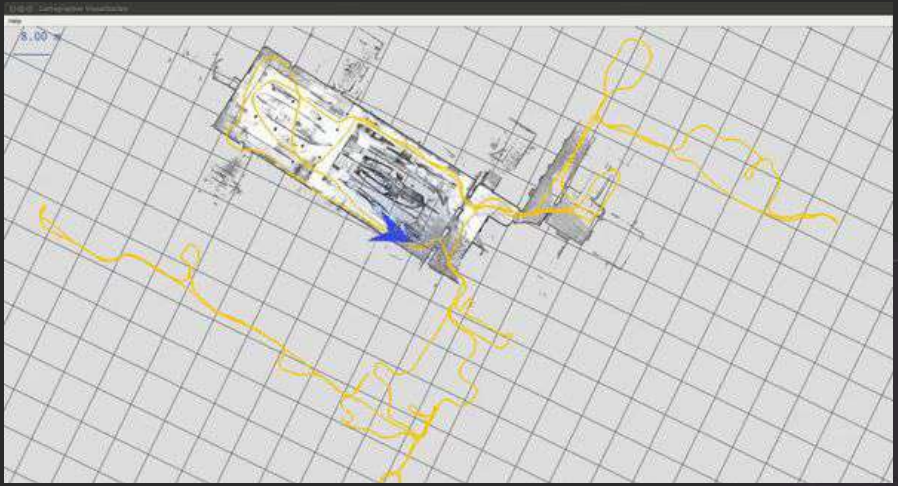
ETA:	0 s
Distance remaining:	0.00 m
Time taken:	0 s
Recoveries:	0

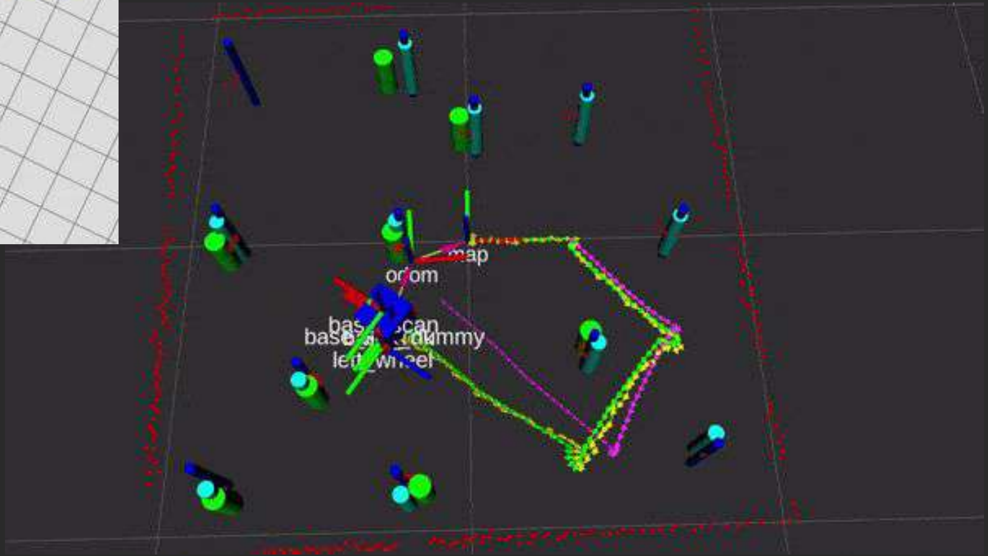
Views

Type: ThirdPersonFollo Zero

Current View	**ThirdPersonFoll...**
Near Clip D...	0.01
Invert Z Axis	
Target Fra...	<Fixed Frame>
Distance	5.37093
Focal Shap...	0.05
Focal Shap...	✓
Yaw	5.60238
Pitch	0.764797
Focal Point	1.9556; -0.48356; ...

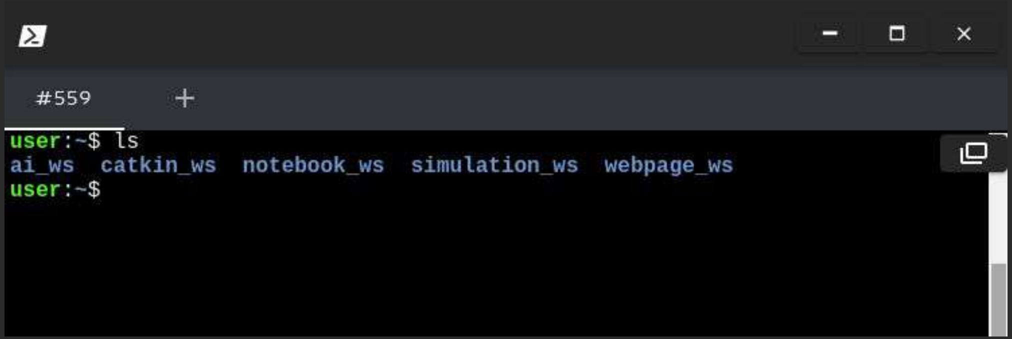
SLAM - Simultaneous Localization and Mapping



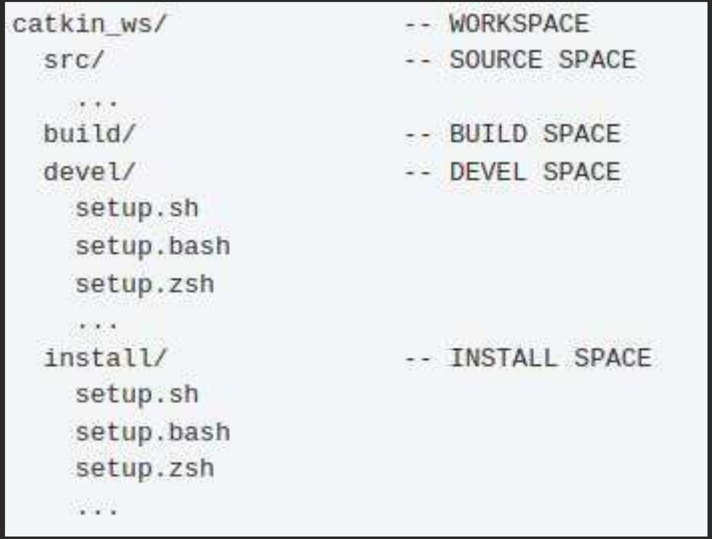


Koncepty

Workspace, Catkin

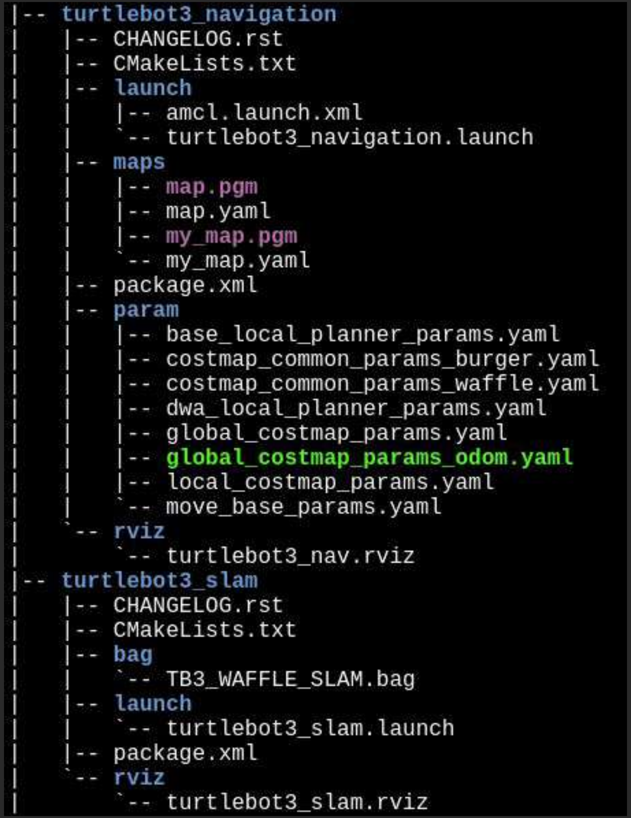


```
#559
user:~$ ls
ai_ws   catkin_ws   notebook_ws   simulation_ws   webpage_ws
user:~$
```

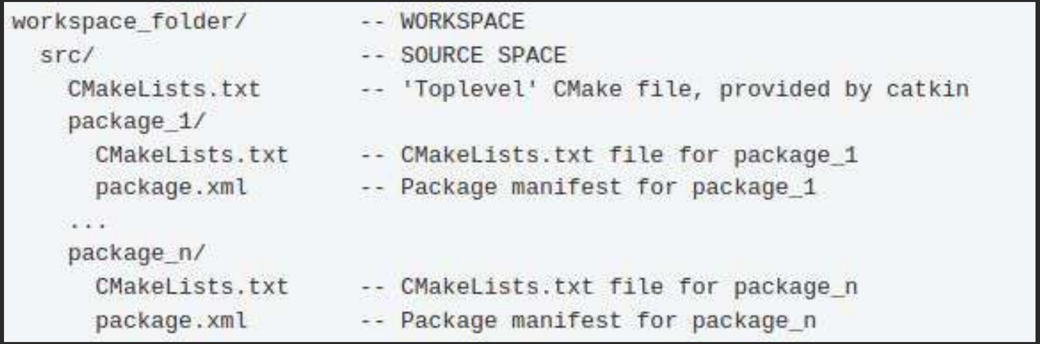


```
catkin_ws/                    -- WORKSPACE
  src/                        -- SOURCE SPACE
    ...
  build/                      -- BUILD SPACE
  devel/                      -- DEVEL SPACE
    setup.sh
    setup.bash
    setup.zsh
    ...
  install/                    -- INSTALL SPACE
    setup.sh
    setup.bash
    setup.zsh
    ...
```

Package

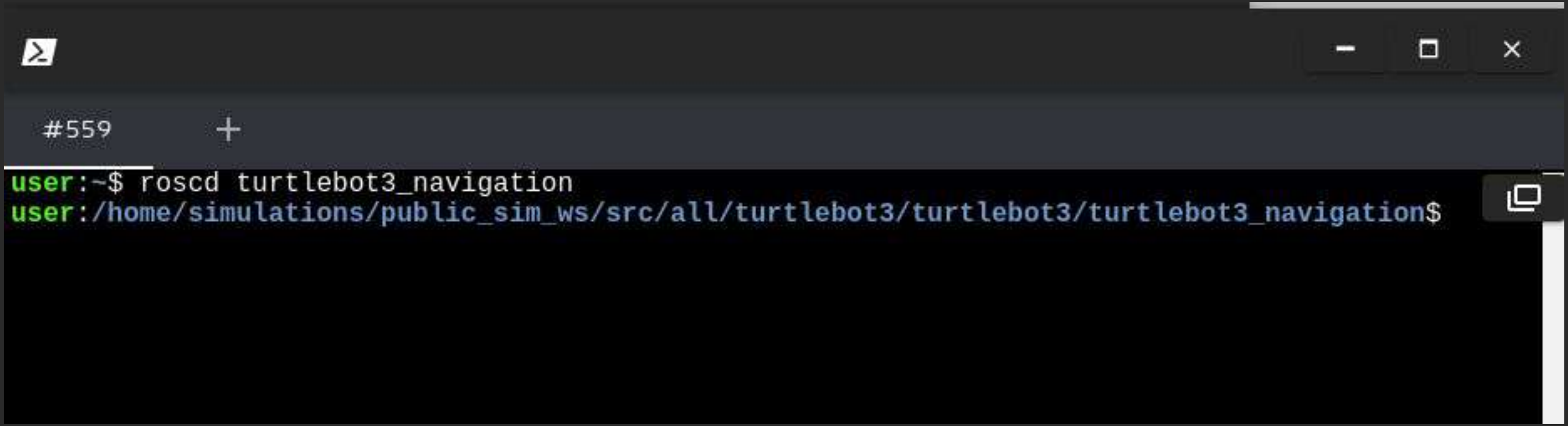


```
|-- turtlebot3_navigation
|    |-- CHANGELOG.rst
|    |-- CMakeLists.txt
|    |-- launch
|    |    |-- amcl.launch.xml
|    |    `-- turtlebot3_navigation.launch
|    |-- maps
|    |    |-- map.pgm
|    |    |-- map.yaml
|    |    |-- my_map.pgm
|    |    `-- my_map.yaml
|    |-- package.xml
|    |-- param
|    |    |-- base_local_planner_params.yaml
|    |    |-- costmap_common_params_burger.yaml
|    |    |-- costmap_common_params_waffle.yaml
|    |    |-- dwa_local_planner_params.yaml
|    |    |-- global_costmap_params.yaml
|    |    |-- global_costmap_params_odom.yaml
|    |    |-- local_costmap_params.yaml
|    |    `-- move_base_params.yaml
|    `-- rviz
|         `-- turtlebot3_nav.rviz
|-- turtlebot3_slam
|    |-- CHANGELOG.rst
|    |-- CMakeLists.txt
|    |-- bag
|    |    `-- TB3_WAFFLE_SLAM.bag
|    |-- launch
|    |    `-- turtlebot3_slam.launch
|    |-- package.xml
|    `-- rviz
|         `-- turtlebot3_slam.rviz
```

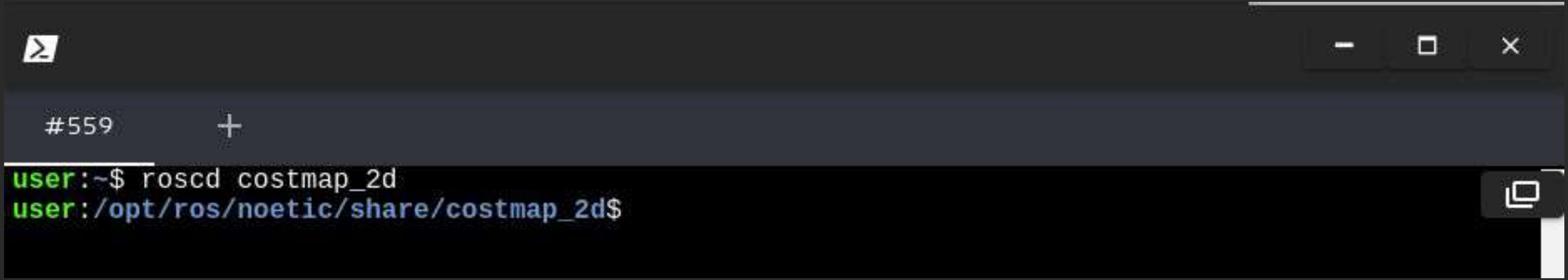


```
workspace_folder/         -- WORKSPACE
  src/                    -- SOURCE SPACE
    CMakeLists.txt        -- 'Toplevel' CMake file, provided by catkin
    package_1/
      CMakeLists.txt      -- CMakeLists.txt file for package_1
      package.xml         -- Package manifest for package_1
    ...
    package_n/
      CMakeLists.txt      -- CMakeLists.txt file for package_n
      package.xml         -- Package manifest for package_n
```

roscd

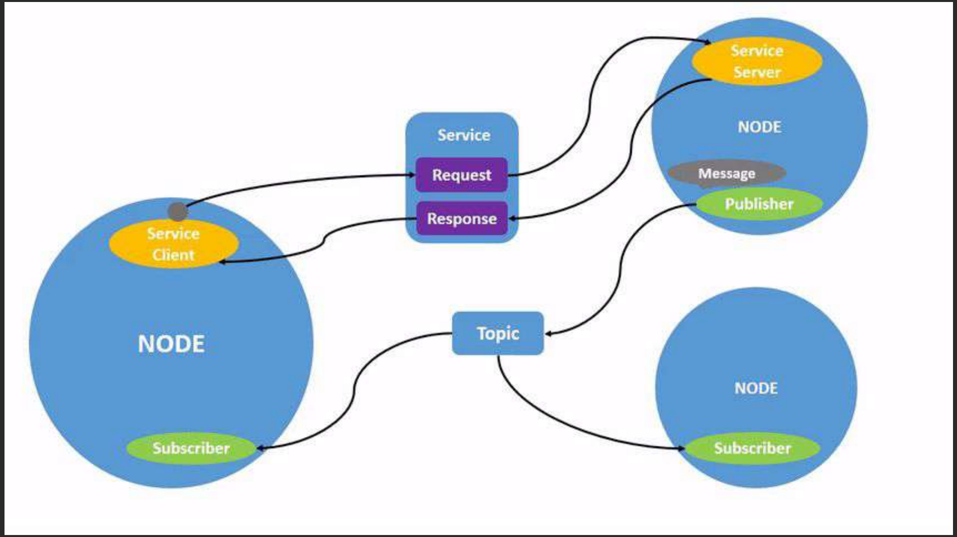


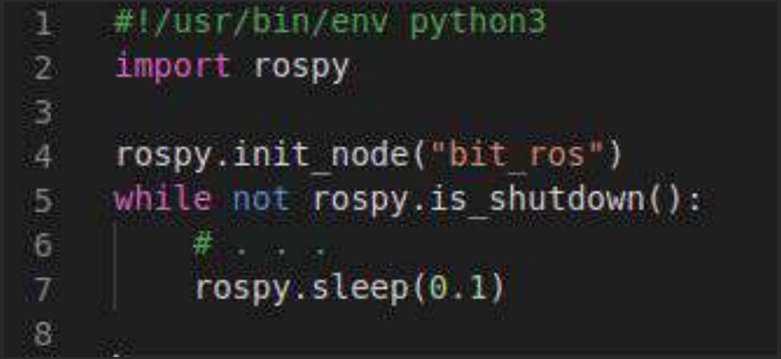
```
user:~$ roscd turtlebot3_navigation
user:/home/simulations/public_sim_ws/src/all/turtlebot3/turtlebot3/turtlebot3_navigation$
```



```
user:~$ roscd costmap_2d
user:/opt/ros/noetic/share/costmap_2d$
```

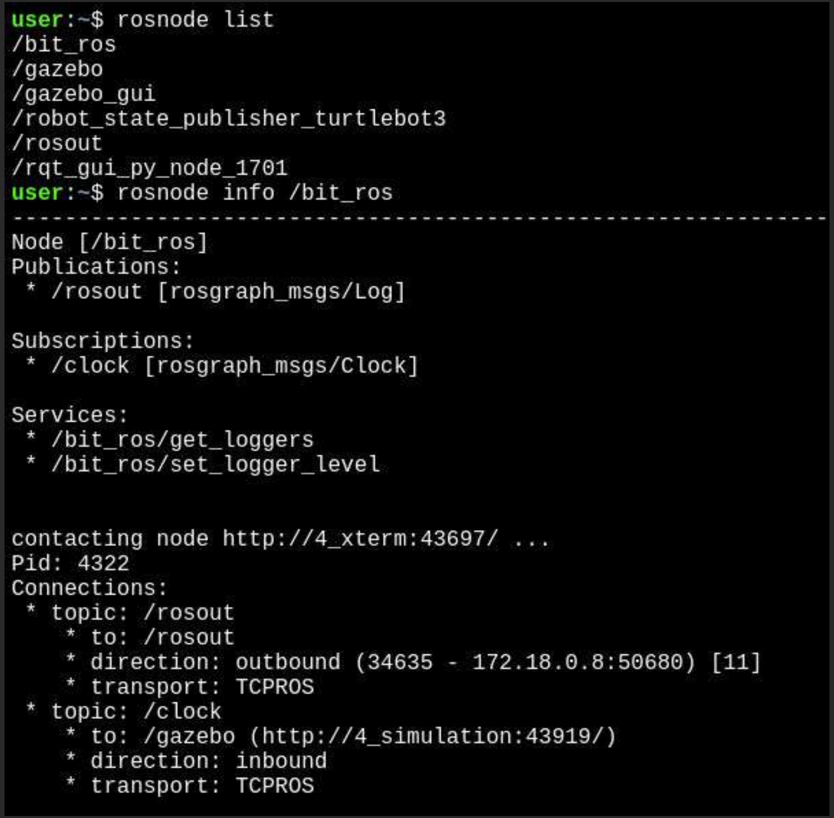
Node



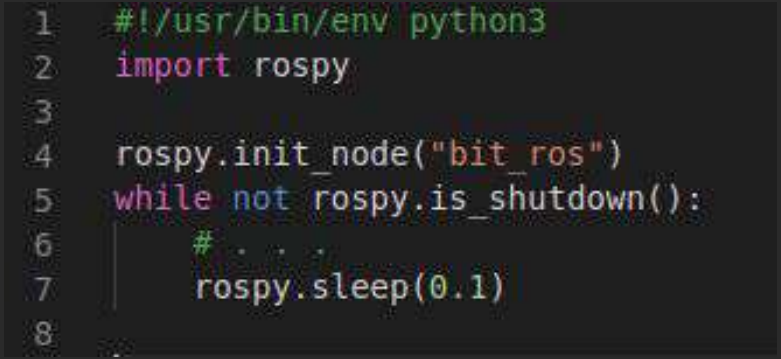


```python
#!/usr/bin/env python3
import rospy

rospy.init_node("bit_ros")
while not rospy.is_shutdown():
    # . . .
    rospy.sleep(0.1)
```

rosnode

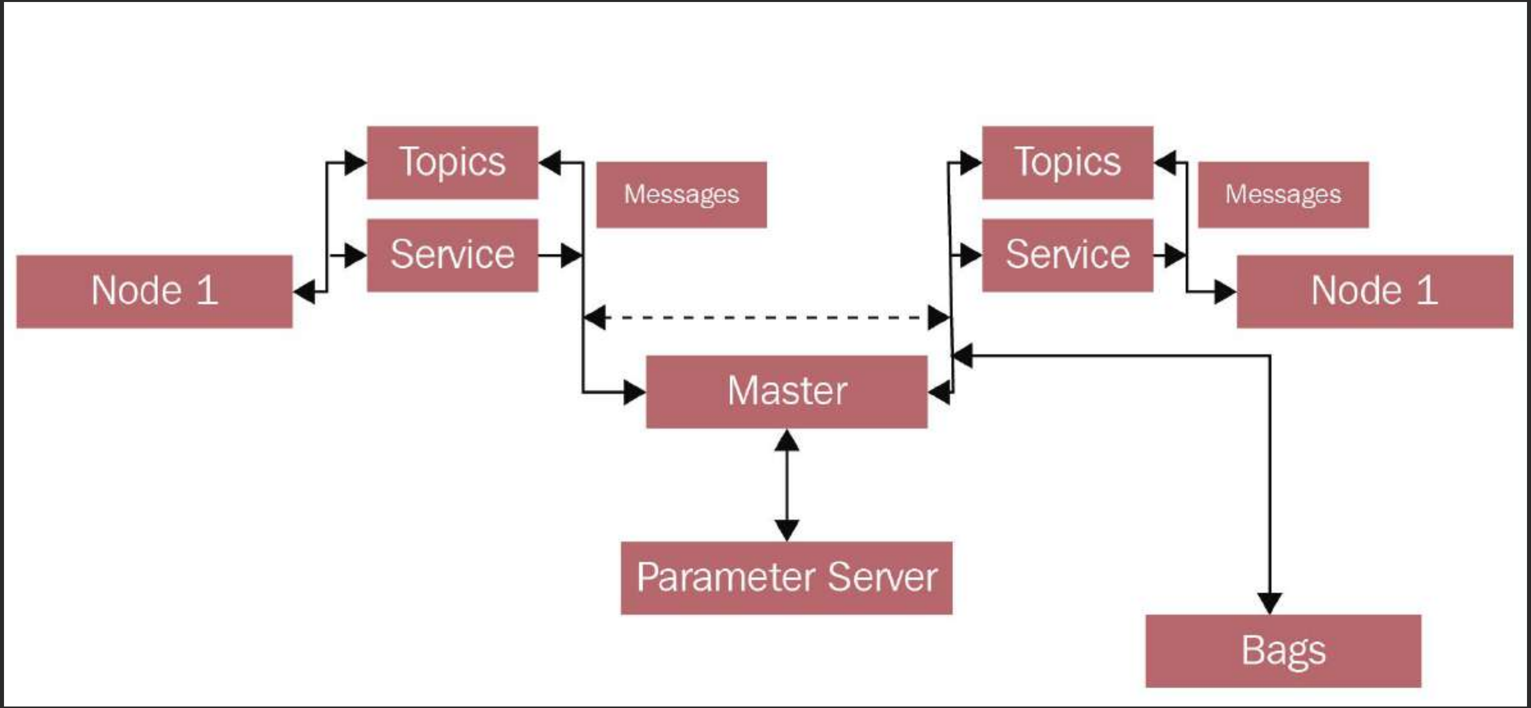


```
user:~$ rosnode list
/bit_ros
/gazebo
/gazebo_gui
/robot_state_publisher_turtlebot3
/rosout
/rqt_gui_py_node_1701
user:~$ rosnode info /bit_ros
--------------------------------------------------------------
Node [/bit_ros]
Publications:
 * /rosout [rosgraph_msgs/Log]

Subscriptions:
 * /clock [rosgraph_msgs/Clock]

Services:
 * /bit_ros/get_loggers
 * /bit_ros/set_logger_level


contacting node http://4_xterm:43697/ ...
Pid: 4322
Connections:
 * topic: /rosout
    * to: /rosout
    * direction: outbound (34635 - 172.18.0.8:50680) [11]
    * transport: TCPROS
 * topic: /clock
    * to: /gazebo (http://4_simulation:43919/)
    * direction: inbound
    * transport: TCPROS
```

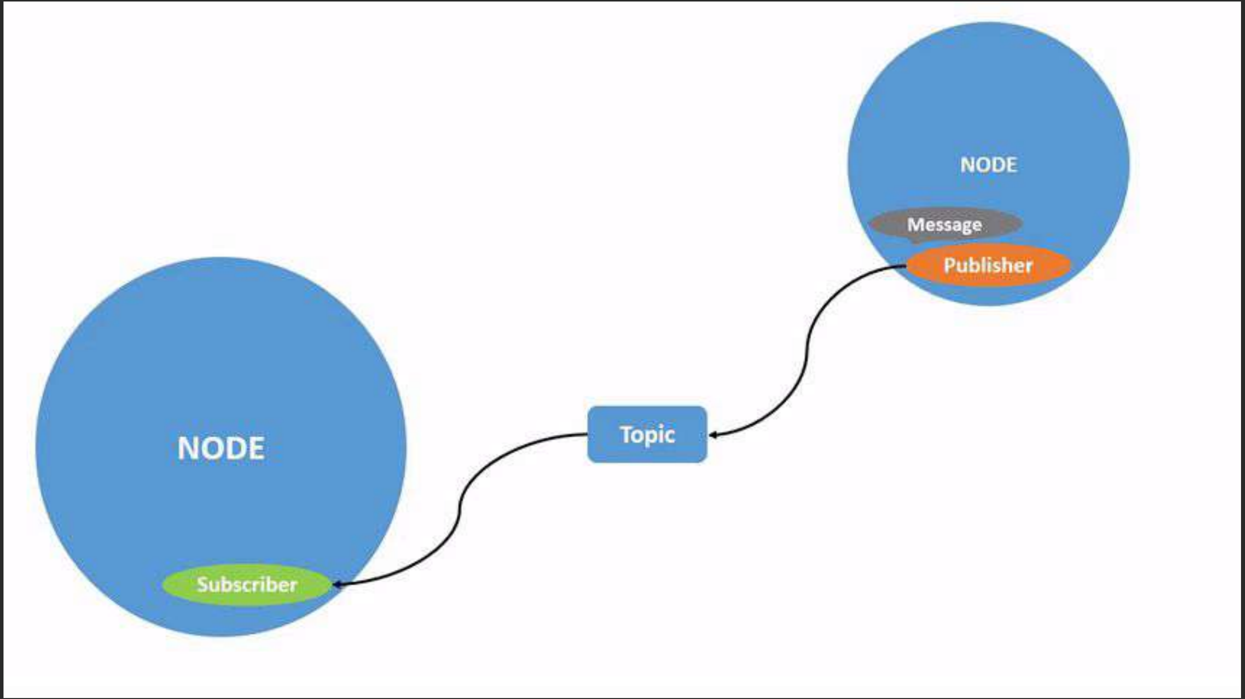


```python
#!/usr/bin/env python3
import rospy

rospy.init_node("bit_ros")
while not rospy.is_shutdown():
      # . . .
      rospy.sleep(0.1)

```

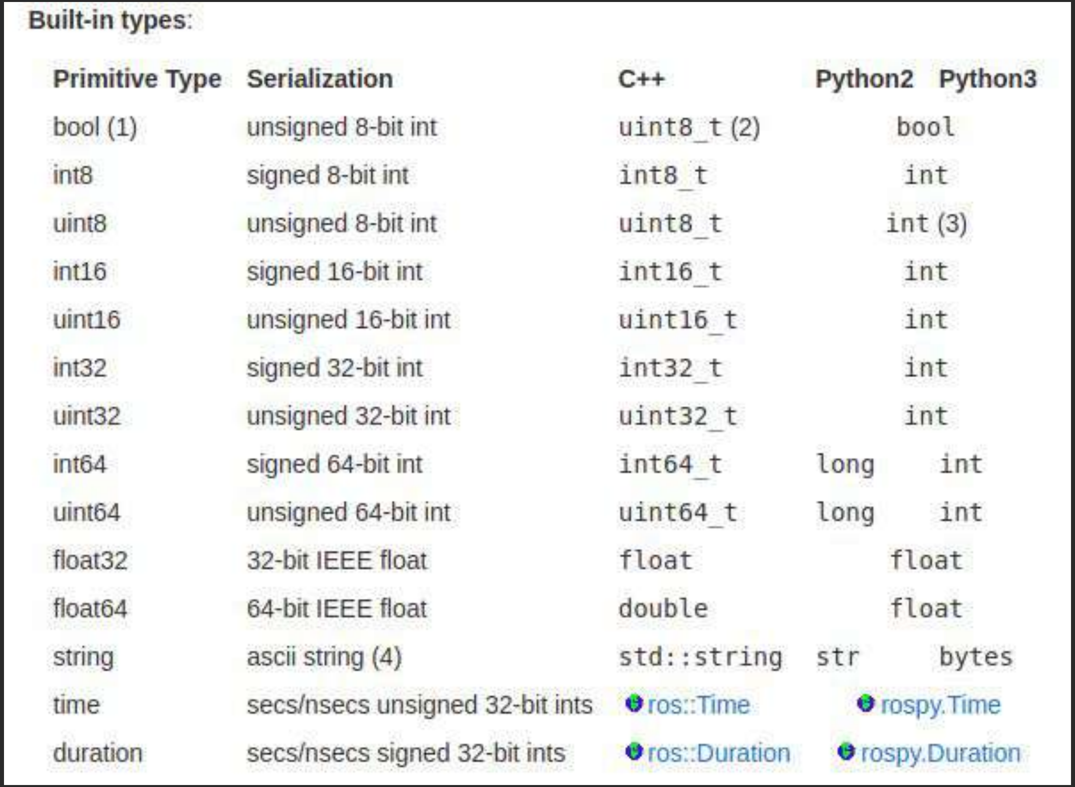
Master


Topics
Service
Messages
Node 1
Topics
Service
Messages
Node 1
Master
Parameter Server
Bags

Topic



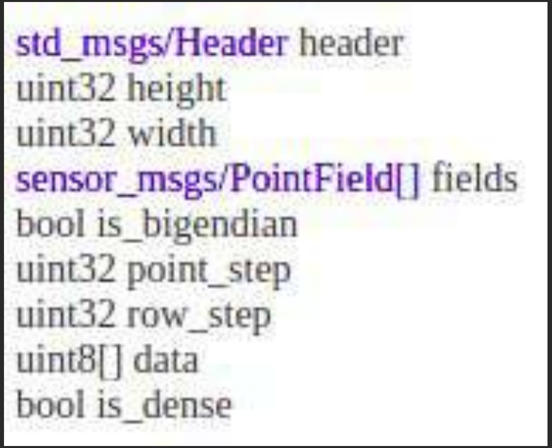
Message



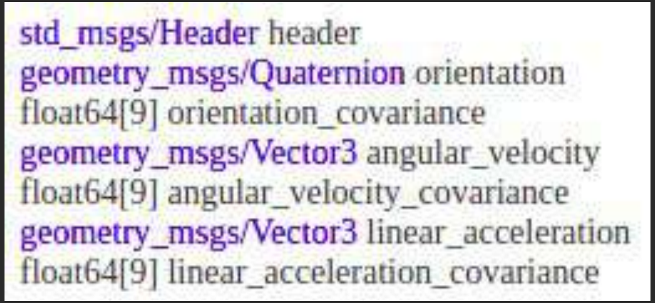
Built-in types:

Primitive Type	Serialization	C++	Python2	Python3
bool (1)	unsigned 8-bit int	`uint8_t` (2)	`bool`	
int8	signed 8-bit int	`int8_t`	`int`	
uint8	unsigned 8-bit int	`uint8_t`	`int` (3)	
int16	signed 16-bit int	`int16_t`	`int`	
uint16	unsigned 16-bit int	`uint16_t`	`int`	
int32	signed 32-bit int	`int32_t`	`int`	
uint32	unsigned 32-bit int	`uint32_t`	`int`	
int64	signed 64-bit int	`int64_t`	`long`	`int`
uint64	unsigned 64-bit int	`uint64_t`	`long`	`int`
float32	32-bit IEEE float	`float`	`float`	
float64	64-bit IEEE float	`double`	`float`	
string	ascii string (4)	`std::string`	`str`	`bytes`
time	secs/nsecs unsigned 32-bit ints	ros::Time	rospy.Time	
duration	secs/nsecs signed 32-bit ints	ros::Duration	rospy.Duration	

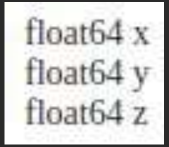
Message



```
std_msgs/Header header
uint32 height
uint32 width
sensor_msgs/PointField[] fields
bool is_bigendian
uint32 point_step
uint32 row_step
uint8[] data
bool is_dense
```



```
std_msgs/Header header
geometry_msgs/Quaternion orientation
float64[9] orientation_covariance
geometry_msgs/Vector3 angular_velocity
float64[9] angular_velocity_covariance
geometry_msgs/Vector3 linear_acceleration
float64[9] linear_acceleration_covariance
```



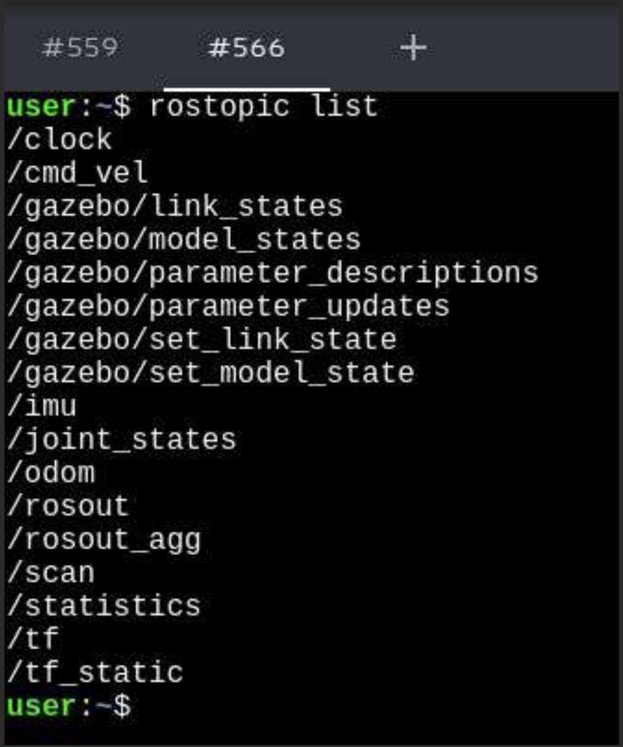
```
float64 x
float64 y
float64 z
```

sensor_msgs/PointCloud2

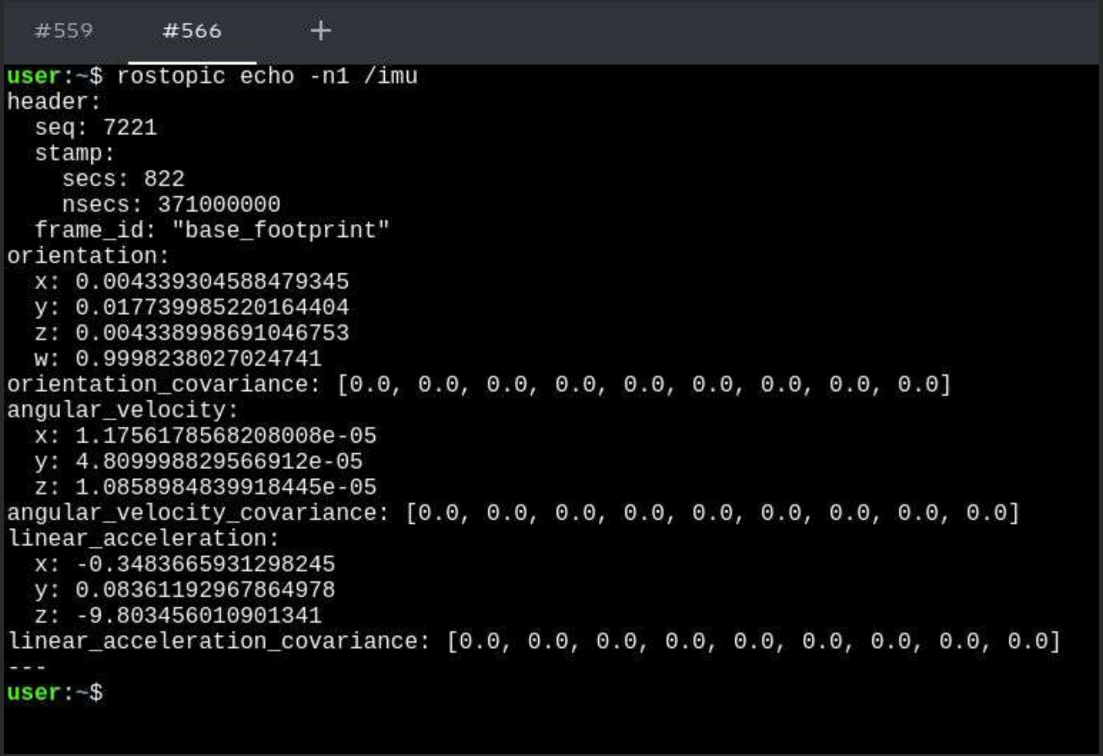
sensor_msgs/IMU

geometry_msgs/Vector3

rostopic

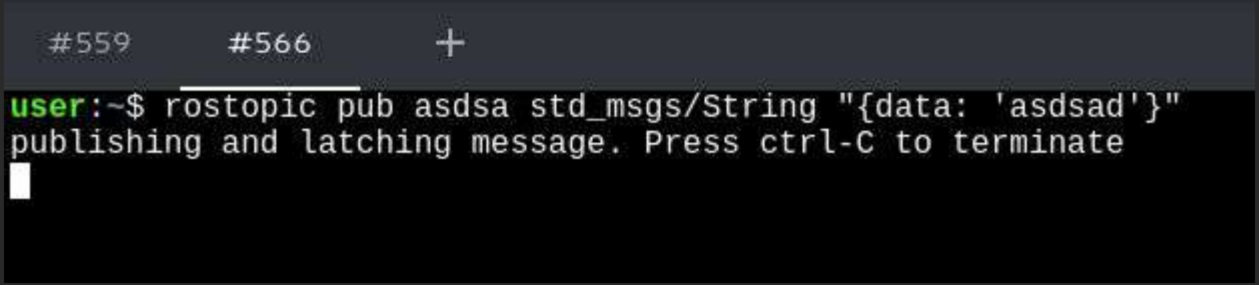


```
user:~$ rostopic list
/clock
/cmd_vel
/gazebo/link_states
/gazebo/model_states
/gazebo/parameter_descriptions
/gazebo/parameter_updates
/gazebo/set_link_state
/gazebo/set_model_state
/imu
/joint_states
/odom
/rosout
/rosout_agg
/scan
/statistics
/tf
/tf_static
user:~$
```

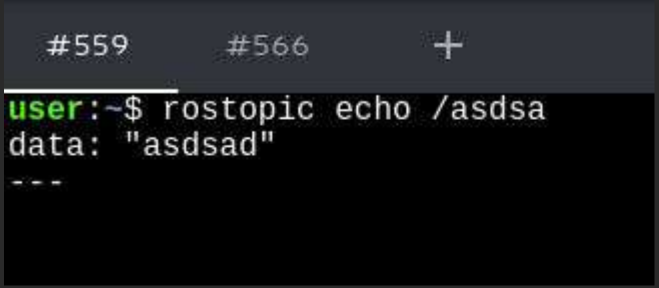


```
user:~$ rostopic echo -n1 /imu
header:
  seq: 7221
  stamp:
    secs: 822
    nsecs: 371000000
  frame_id: "base_footprint"
orientation:
  x: 0.004339304588479345
  y: 0.017739985220164404
  z: 0.004338998691046753
  w: 0.9998238027024741
orientation_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
angular_velocity:
  x: 1.1756178568208008e-05
  y: 4.809998829566912e-05
  z: 1.0858984839918445e-05
angular_velocity_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
linear_acceleration:
  x: -0.3483665931298245
  y: 0.08361192967864978
  z: -9.803456010901341
linear_acceleration_covariance: [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
---
user:~$
```

rostopic

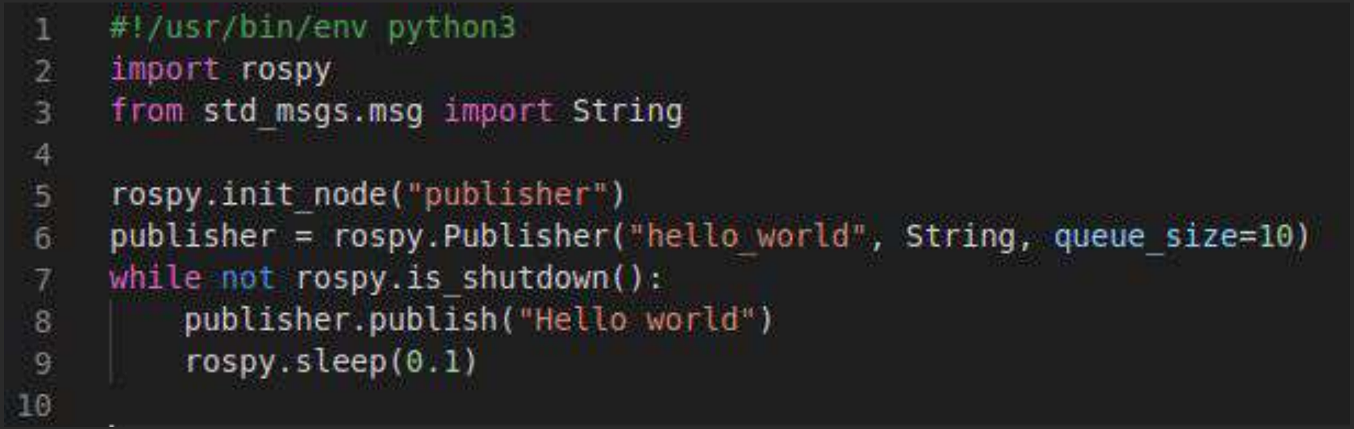


```
user:~$ rostopic pub asdsa std_msgs/String "{data: 'asdsad'}"
publishing and latching message. Press ctrl-C to terminate
```



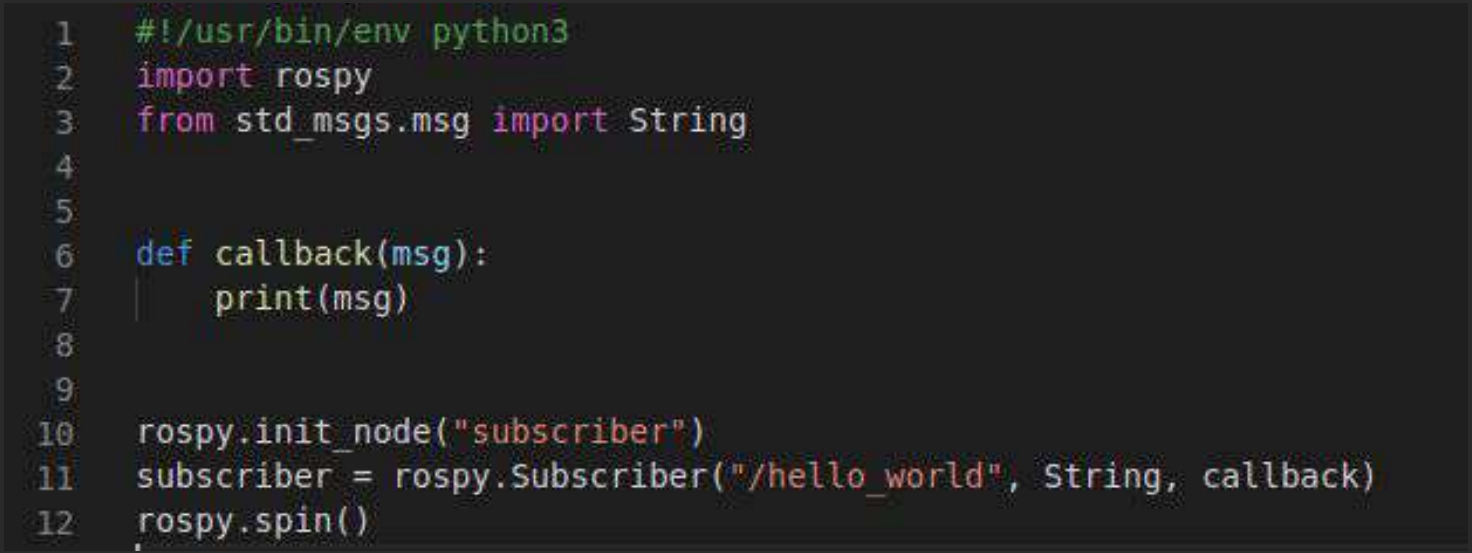
```
user:~$ rostopic echo /asdsa
data: "asdsad"
---
```

Topic publisher



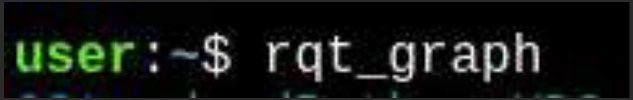
```python
#!/usr/bin/env python3
import rospy
from std_msgs.msg import String

rospy.init_node("publisher")
publisher = rospy.Publisher("hello_world", String, queue_size=10)
while not rospy.is_shutdown():
    publisher.publish("Hello world")
    rospy.sleep(0.1)
```

Topic subscriber

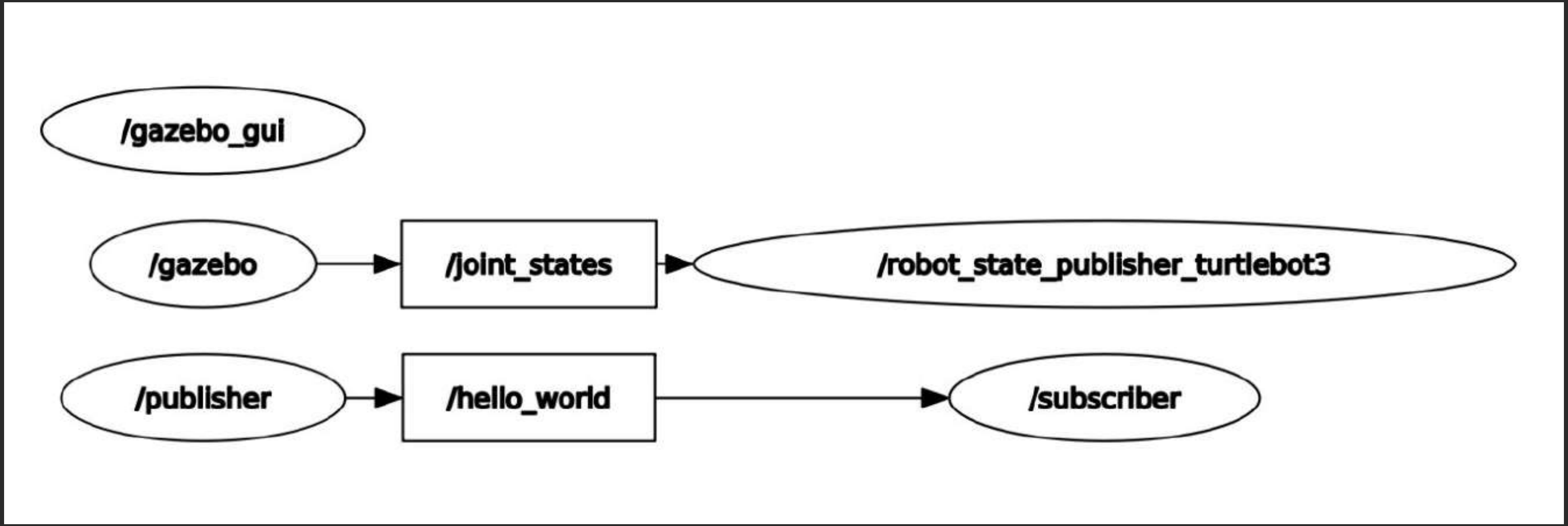


```python
#!/usr/bin/env python3
import rospy
from std_msgs.msg import String


def callback(msg):
    print(msg)


rospy.init_node("subscriber")
subscriber = rospy.Subscriber("/hello_world", String, callback)
rospy.spin()
```

rqt_graph



```
user:~$ rqt_graph
```



Dzięki za uwagę

Źródła

- **The 5 Generations of Robotics**
  automatismosmundo.com/en/the-5-generations-of-robotics
- **ROS Introduction Video**
  vimeo.com/osrfoundation/ros
- **ROS Website**
  www.ros.org
- **ROS Wiki**
  wiki.ros.org
- **Kinect Pattern Uncovered**
  azttm.wordpress.com/2011/04/03/kinect-pattern-uncovered/
- **Open Kinect**
  openkinect.org/wiki/Main_Page
- **The Basics of Stereo Depth Vision**
  www.intelrealsense.com/stereo-depth-vision-basics/
- **Comparing Depth Cameras: iToF Versus Active Stereo**
  medium.com/chronoptics-time-of-flight/comparing-depth-cameras-itof-versus-active-stereo-e163811f3ac8
- **ROSbot 2R About**
  husarion.com/manuals/rosbot/
- **ROSbot 2 Demo**
  github.com/husarion/rosbot-docker/tree/ros2/demo

Źródła

- **slam_toolbox GitHub**
  github.com/SteveMacenski/slam_toolbox
- **ROS Robot Programming**, 2017, Yoonseok Pyo, Hancheol Cho, Leon Jung, Darby Lim
  community.robotsource.org/t/download-the-ros-robot-programming-book-for-free/51
- **Programming Robots with ROS A Practical Introduction to the Robot Operating System**, 2015, Morgan Quigley, Brian Gerkey. William D. Smart - O'Reilly
- **Mobile Robots**
  https://en.wikipedia.org/wiki/Mobile_robot
- **Mecanum Wheels**
  https://en.wikipedia.org/wiki/Mecanum_wheel

bit