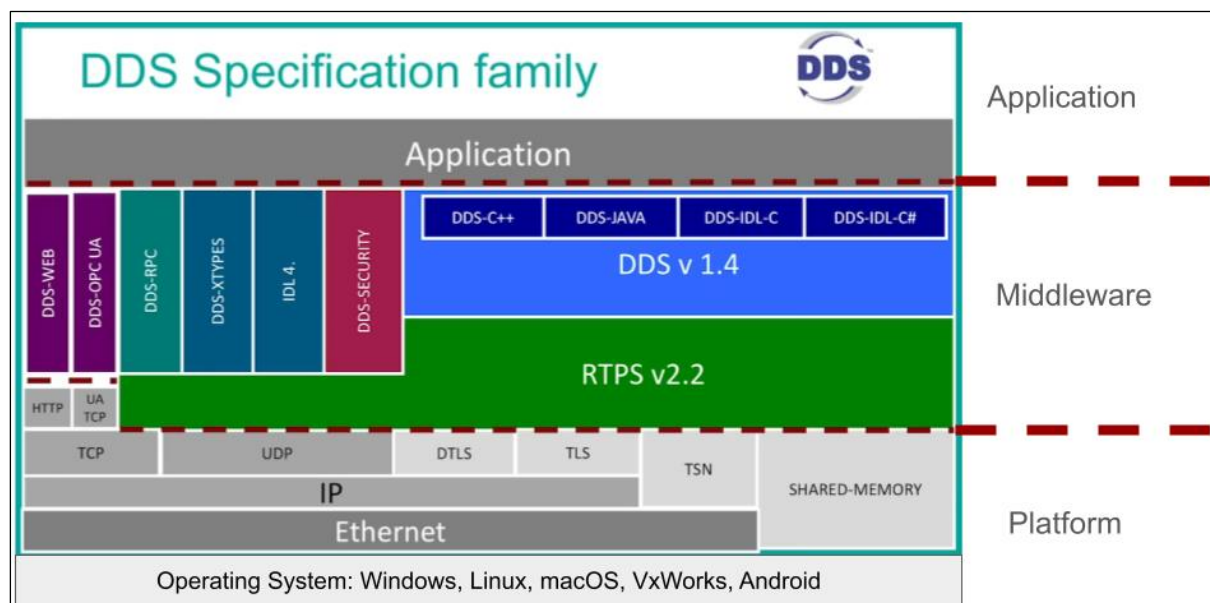
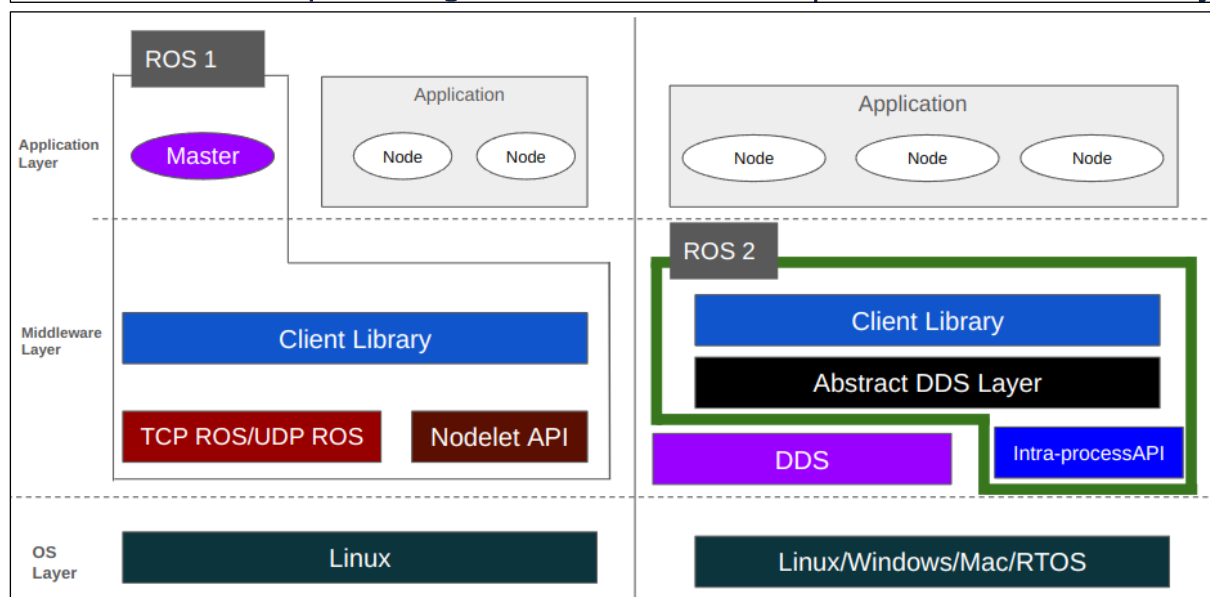
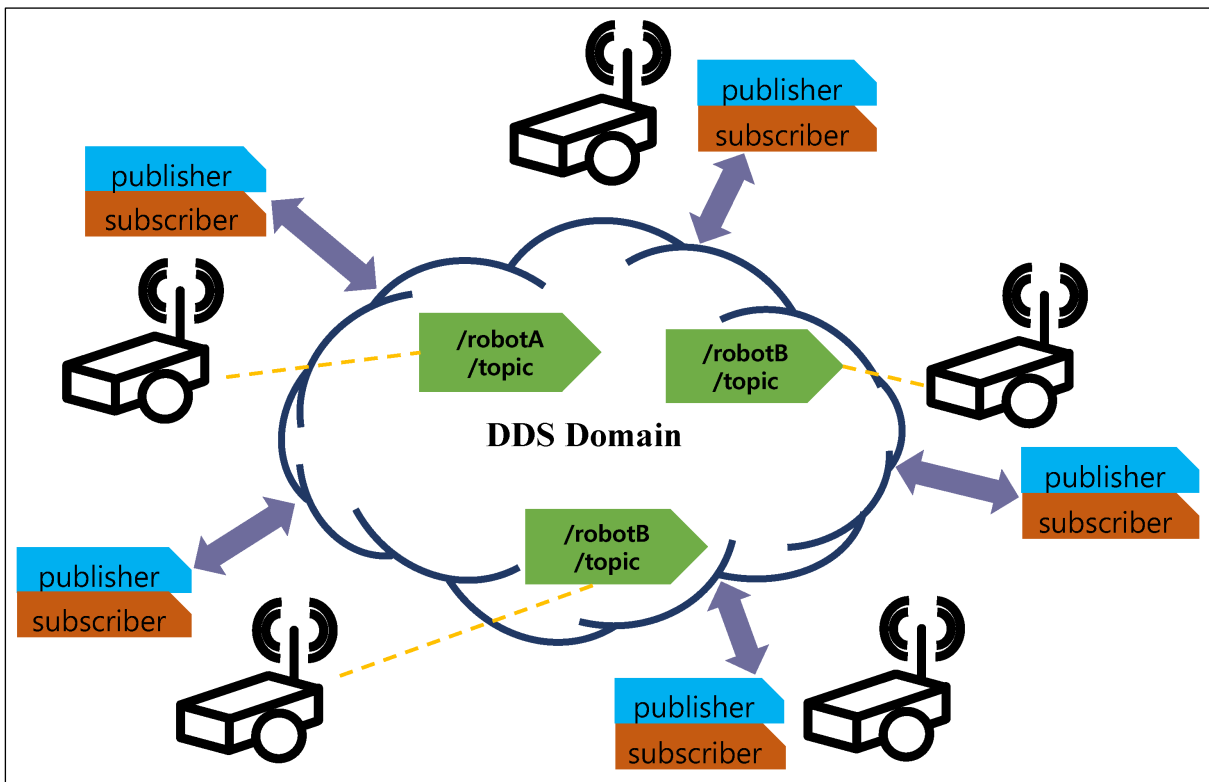
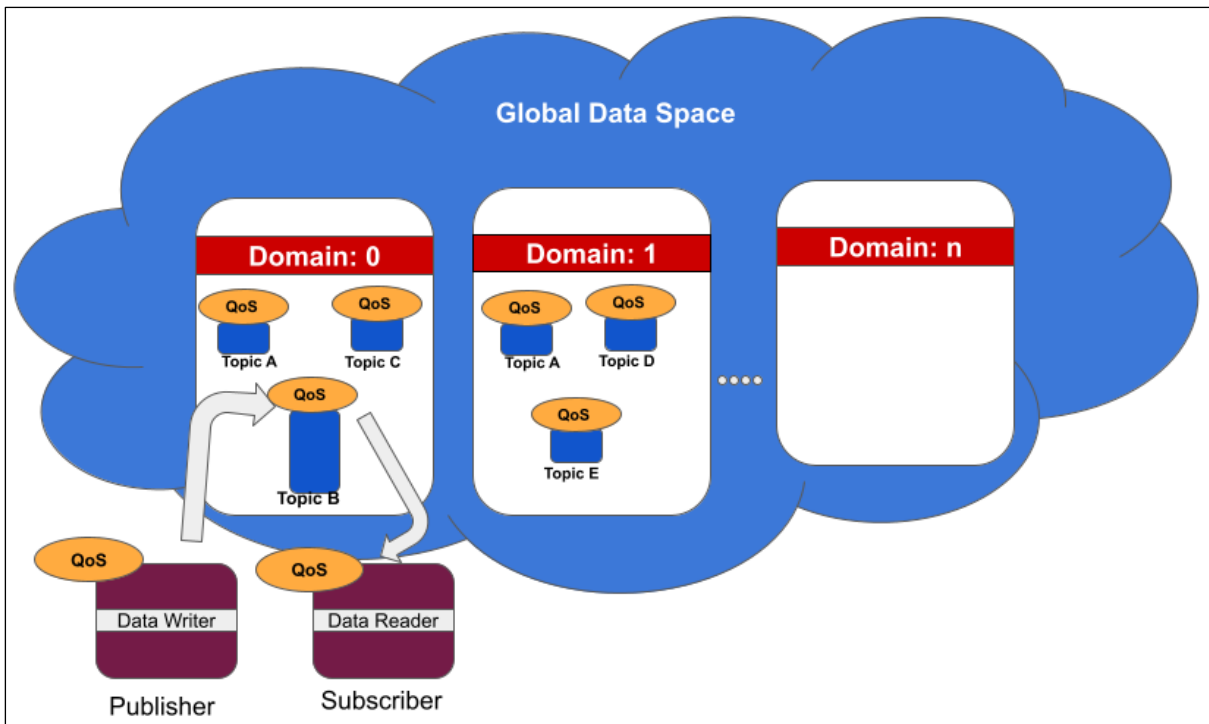
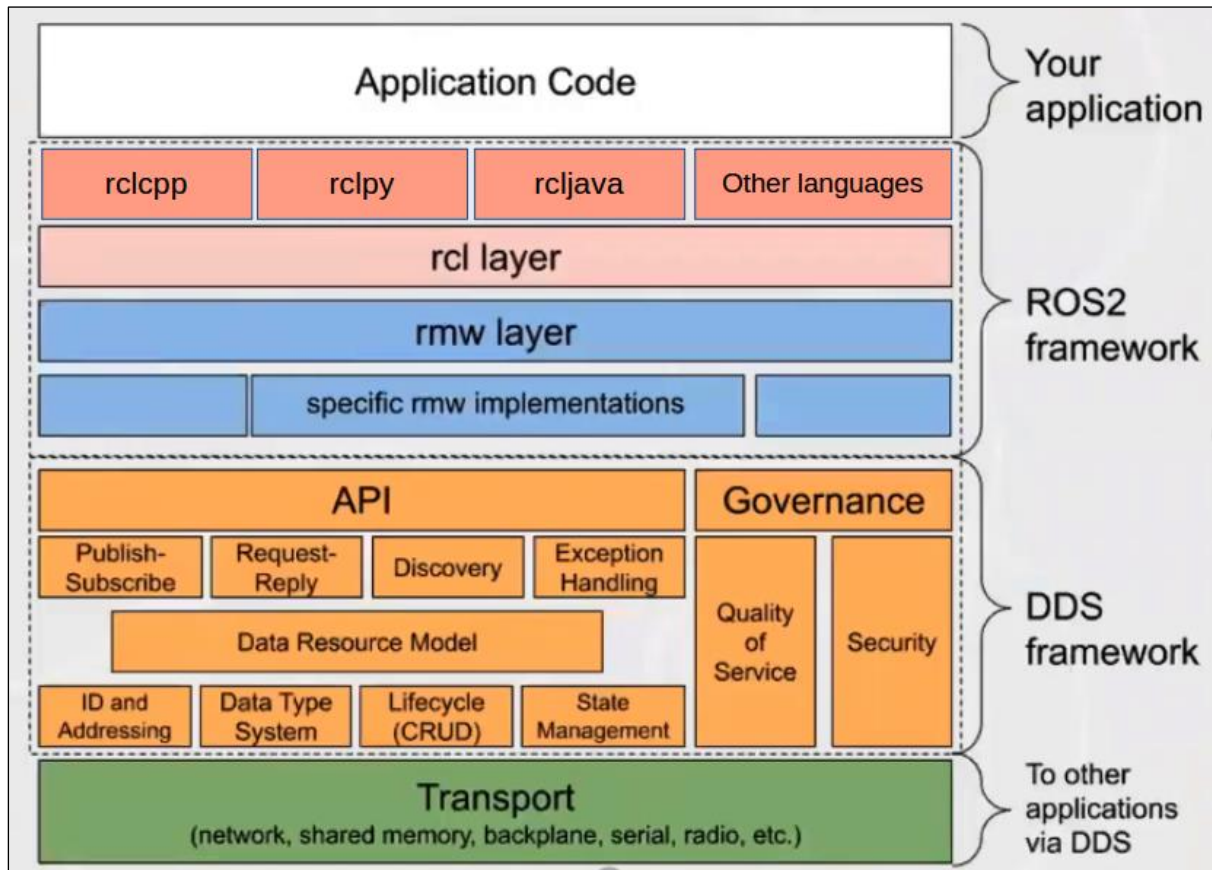
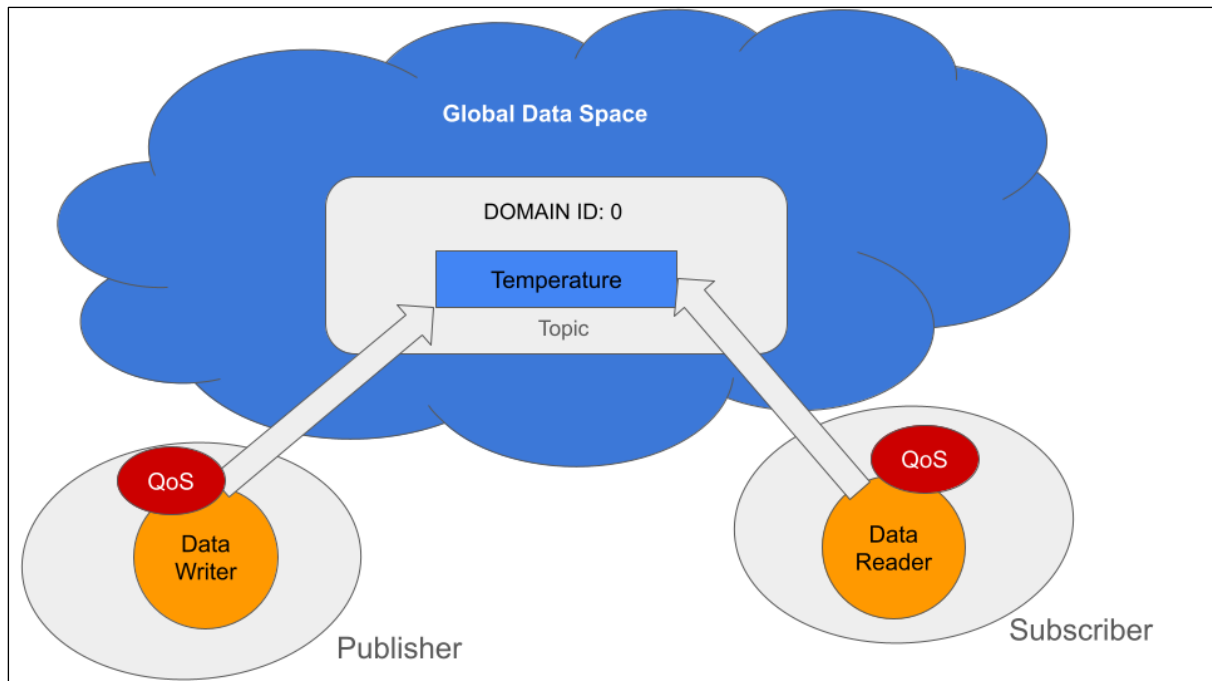
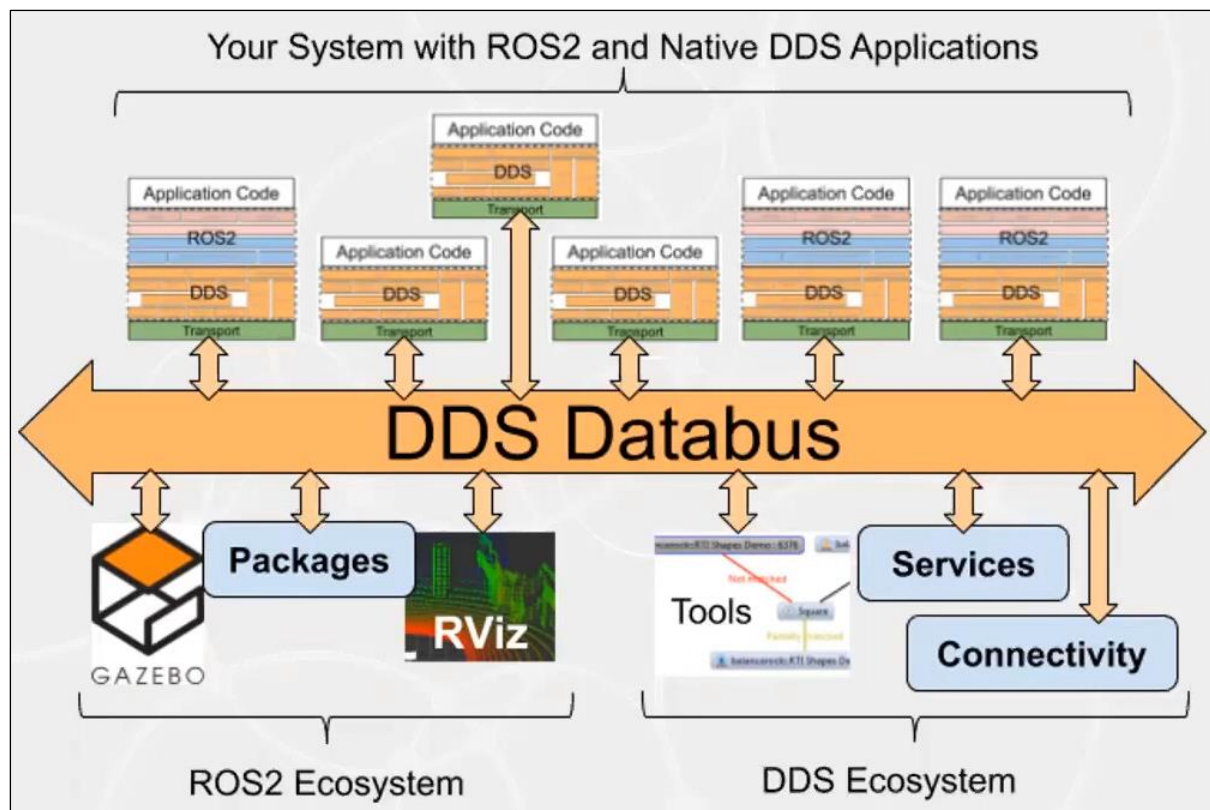


Chapter 1: Introduction to ROS 2

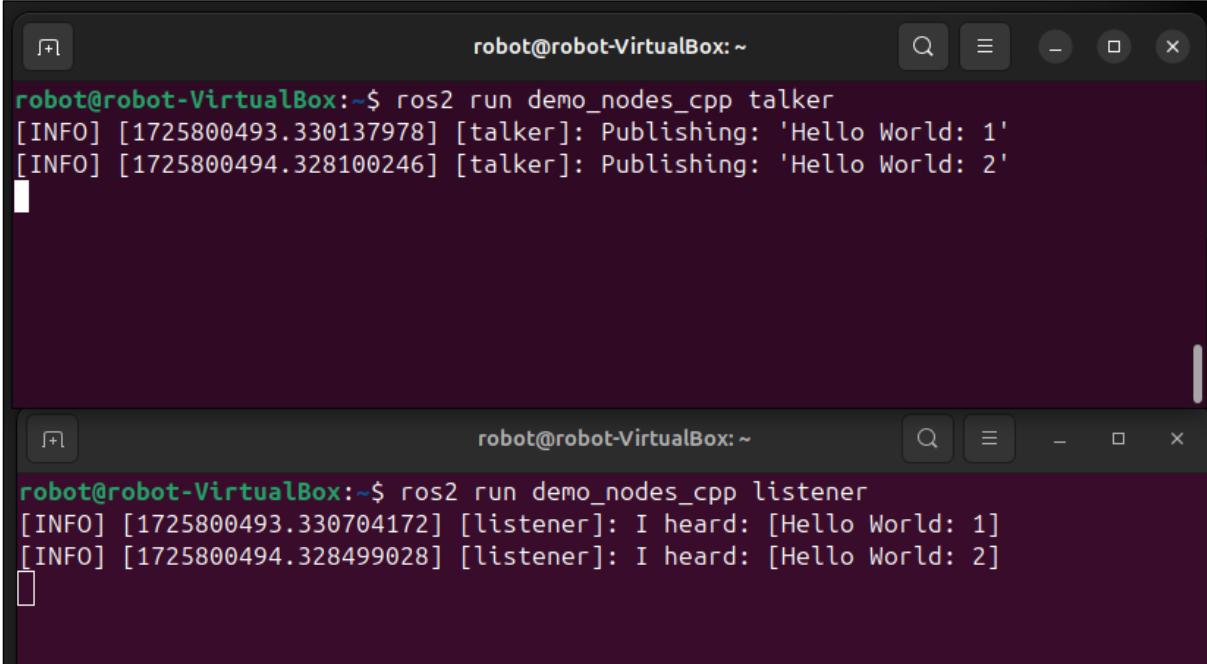






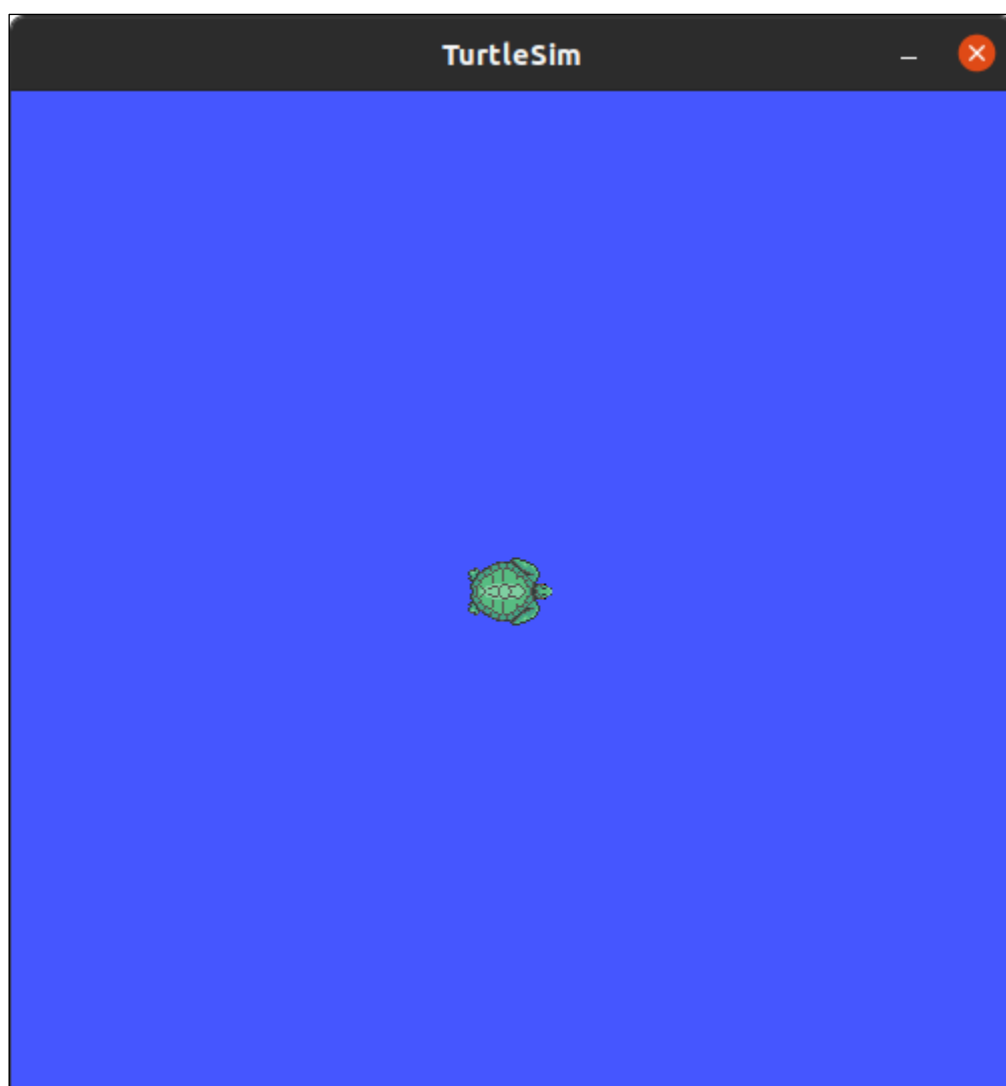


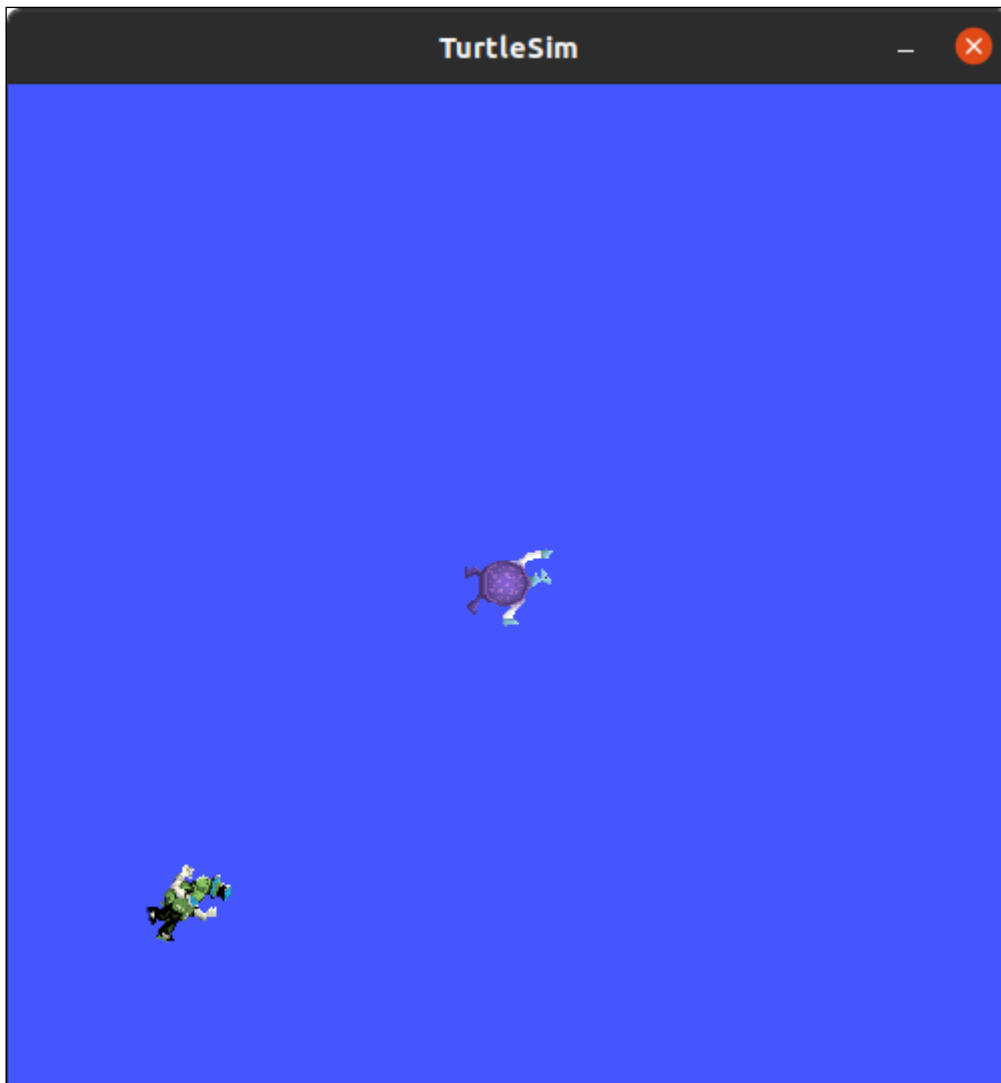
Chapter 2: Getting Started with ROS 2 Programming



The image shows two terminal windows from a ROS 2 environment. The top window shows the execution of the 'talker' node, which publishes two messages: 'Hello World: 1' and 'Hello World: 2'. The bottom window shows the execution of the 'listener' node, which receives and prints these two messages.

```
robot@robot-VirtualBox: ~  
robot@robot-VirtualBox:~$ ros2 run demo_nodes_cpp talker  
[INFO] [1725800493.330137978] [talker]: Publishing: 'Hello World: 1'  
[INFO] [1725800494.328100246] [talker]: Publishing: 'Hello World: 2'  
  
robot@robot-VirtualBox:~$ ros2 run demo_nodes_cpp listener  
[INFO] [1725800493.330704172] [listener]: I heard: [Hello World: 1]  
[INFO] [1725800494.328499028] [listener]: I heard: [Hello World: 2]
```



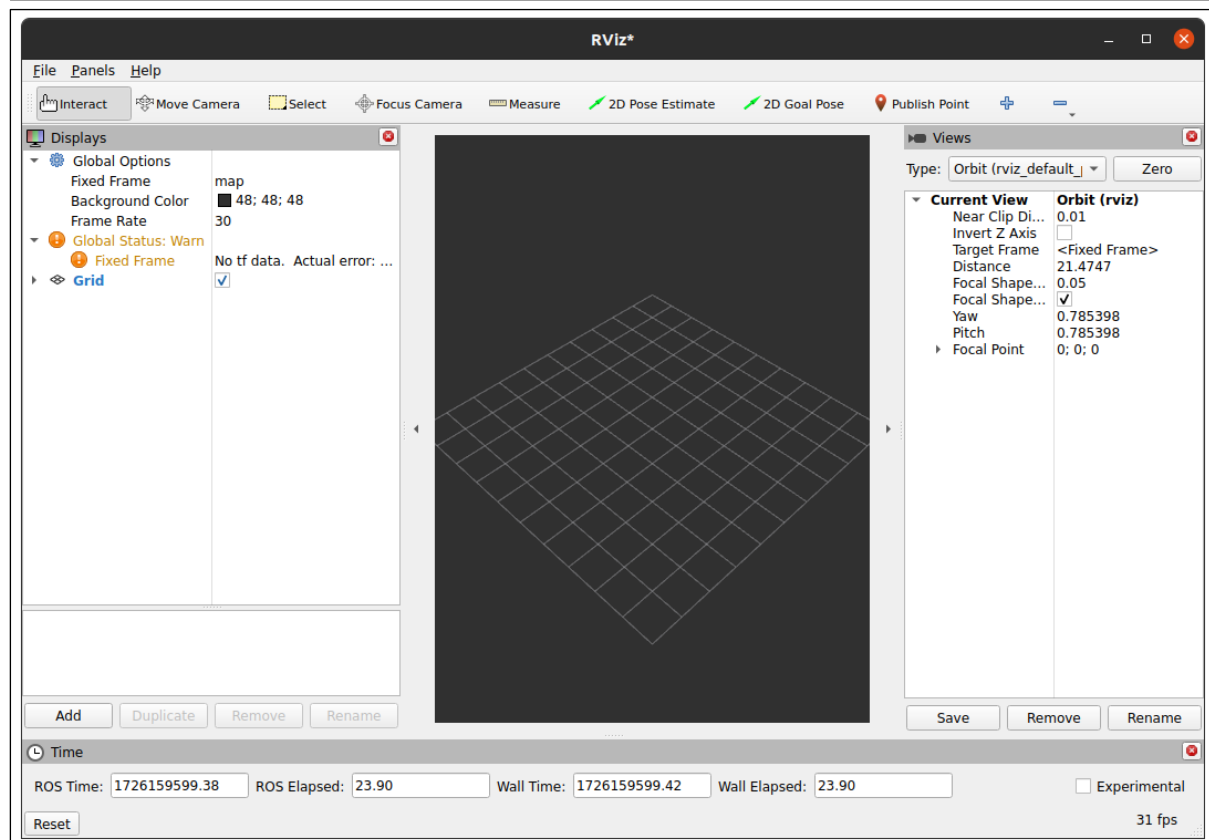


```
robot@robot-pc: ~/Mastering_R...
robot@robot-pc: ~/Mastering_RO...
robot@robot-pc:~/Mastering_ROS2_Book/Chapter02/ros2_jazzy_docker$ systemctl status docker
● docker.service - Docker Application Container Engine
   Loaded: loaded (/lib/systemd/system/docker.service; enabled; vendor preset: enabled)
   Active: active (running) since Tue 2024-09-10 11:18:53 IST; 9h ago
 TriggeredBy: ● docker.socket
           Docs: https://docs.docker.com
   Main PID: 2446 (dockerd)
     Tasks: 17
    Memory: 22.8M
    CGroup: /system.slice/docker.service
            └─2446 /usr/bin/dockerd -H fd:// --containerd=/run/containerd/containerd.sock

Sep 10 11:18:52 robot-pc dockerd[2446]: time="2024-09-10T11:18:52.873390046+05:30" level=info msg="S
Sep 10 11:18:52 robot-pc dockerd[2446]: time="2024-09-10T11:18:52.873904002+05:30" level=info msg="d
Sep 10 11:18:52 robot-pc dockerd[2446]: time="2024-09-10T11:18:52.915379231+05:30" level=info msg="[
Sep 10 11:18:52 robot-pc dockerd[2446]: time="2024-09-10T11:18:52.917028971+05:30" level=info msg="L
Sep 10 11:18:53 robot-pc dockerd[2446]: time="2024-09-10T11:18:53.055565119+05:30" level=info msg="D
Sep 10 11:18:53 robot-pc dockerd[2446]: time="2024-09-10T11:18:53.107178817+05:30" level=info msg="L
Sep 10 11:18:53 robot-pc dockerd[2446]: time="2024-09-10T11:18:53.116362502+05:30" level=info msg="D
Sep 10 11:18:53 robot-pc dockerd[2446]: time="2024-09-10T11:18:53.116492817+05:30" level=info msg="D
Sep 10 11:18:53 robot-pc dockerd[2446]: time="2024-09-10T11:18:53.140985497+05:30" level=info msg="A
Sep 10 11:18:53 robot-pc systemd[1]: Started Docker Application Container Engine.
```

```
robot@robot-pc:~$ docker info
Client: Docker Engine - Community
Version:      27.2.0
Context:      rootless
Debug Mode:  false
Plugins:
  buildx: Docker Buildx (Docker Inc.)
    Version:  v0.16.2
    Path:      /usr/libexec/docker/cli-plugins/docker-buildx
  compose: Docker Compose (Docker Inc.)
    Version:  v2.29.2
    Path:      /usr/libexec/docker/cli-plugins/docker-compose
```

```
[+] Building 0.0s (7/7) FINISHED
=> [internal] load build definition from Dockerfile
=> => transferring dockerfile: 272B
=> [internal] load metadata for docker.io/osrf/ros:jazzy-desktop-full
=> [internal] load .dockerignore
=> => transferring context: 2B
=> [1/3] FROM docker.io/osrf/ros:jazzy-desktop-full
=> CACHED [2/3] RUN apt update && apt upgrade -y
=> CACHED [3/3] RUN apt install -y python3-pip
=> exporting to image
=> => exporting layers
=> => writing image sha256:7f8d1636c4adaf6a64d36291dbc3eeae9c3bd251549
=> => naming to docker.io/library/test_ros2:v0.1
```

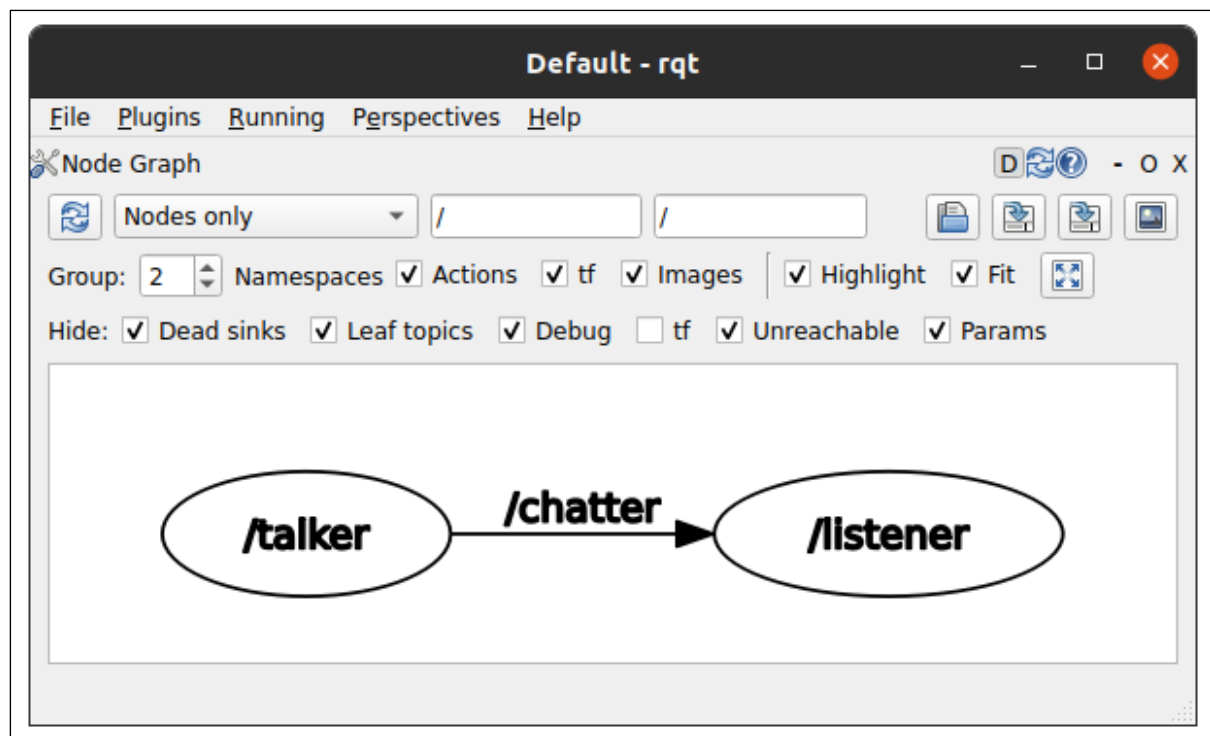


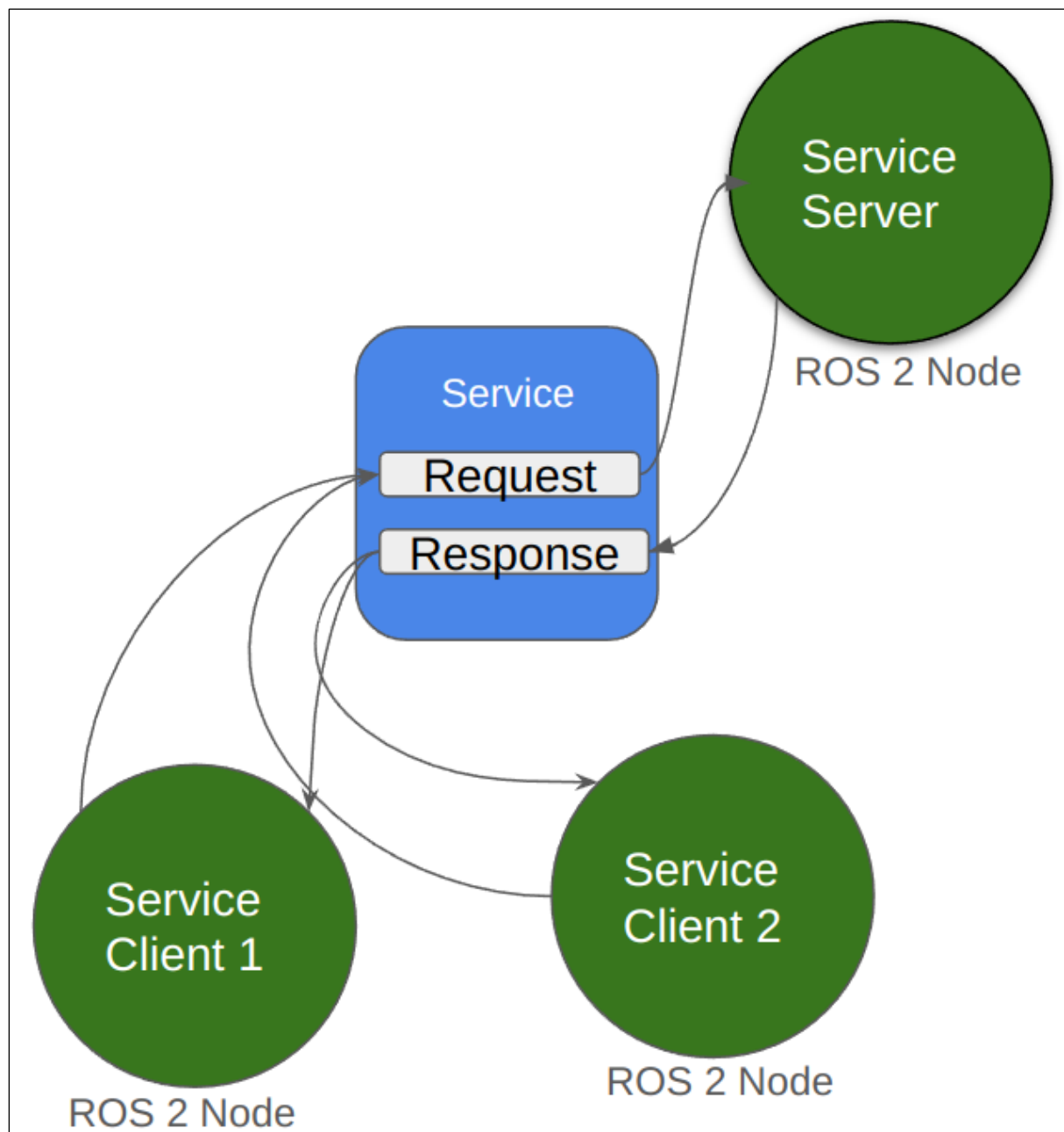
```
robot@robot-pc:~/Mastering_ROS2_Book/Chapter02/ros2_jazzy_docker/docker_compose$ docker compose up
WARN[0000] /home/robot/Mastering_ROS2_Book/Chapter02/ros2_jazzy_docker/docker_compose/docker-compose
, it will be ignored, please remove it to avoid potential confusion
[+] Running 2/0
 ✓ Container docker_compose-talker-1    Created
 ✓ Container docker_compose-listener-1  Created
Attaching to listener-1, talker-1
talker-1 | [INFO] [1726232967.783631905] [talker]: Publishing: 'Hello World: 1'
listener-1 | [INFO] [1726232967.784034553] [listener]: I heard: [Hello World: 1]
talker-1 | [INFO] [1726232968.783622195] [talker]: Publishing: 'Hello World: 2'
listener-1 | [INFO] [1726232968.783924203] [listener]: I heard: [Hello World: 2]
talker-1 | [INFO] [1726232969.783626150] [talker]: Publishing: 'Hello World: 3'
listener-1 | [INFO] [1726232969.783928489] [listener]: I heard: [Hello World: 3]
talker-1 | [INFO] [1726232970.783618084] [talker]: Publishing: 'Hello World: 4'
listener-1 | [INFO] [1726232970.783910354] [listener]: I heard: [Hello World: 4]
```

```
master_ros2@robot-pc:~/master_ros2_ws$ ros2
usage: ros2 [-h] [--use-python-default-buffering] Call 'ros2
ros2 is an extensible command-line tool for ROS 2.

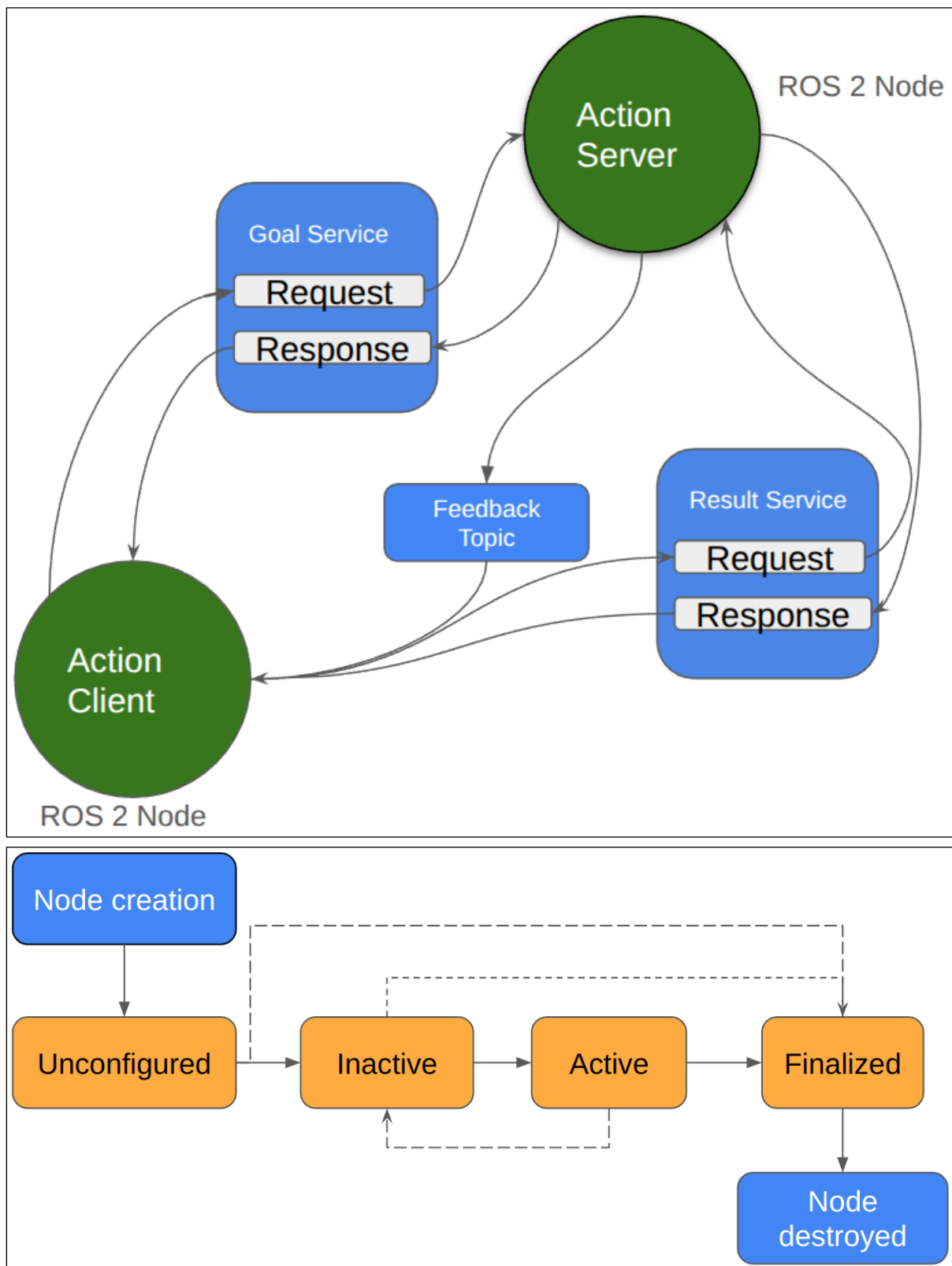
options:
  -h, --help                show this help message and exit
  --use-python-default-buffering
                           Do not force line buffering in stdout
                           not

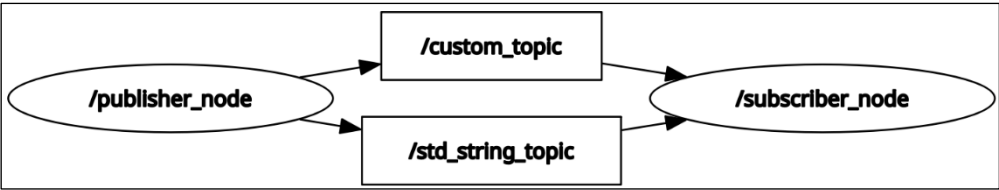
Commands:
  action                    Various action related sub-commands
  bag                      Various rosbag related sub-commands
  component                Various component related sub-commands
  daemon                   Various daemon related sub-commands
  doctor                   Check ROS setup and other potential issues
  interface                Show information about ROS interfaces
  launch                   Run a launch file
  lifecycle                Various lifecycle related sub-commands
  multicast                Various multicast related sub-commands
  node                     Various node related sub-commands
  param                    Various param related sub-commands
  pkg                      Various package related sub-commands
  run                      Run a package specific executable
  security                 Various security related sub-commands
  service                 Various service related sub-commands
  topic                   Various topic related sub-commands
  wtf                      Use 'wtf' as alias to 'doctor'
```





Chapter 3: Implementing ROS 2 Concepts





```
robot@robot-pc: ~ 59x27
robot@robot-pc:~$ ros2 run master_ros2_pkg publisher_node
[INFO] [1729007798.518502645] [publisher_node]: Publishing:
'Hello, world!'
[INFO] [1729007798.518791429] [publisher_node]: Publishing
custom message: data='Custom Hello', number=42
[INFO] [1729007799.518530814] [publisher_node]: Publishing:
'Hello, world!'
[INFO] [1729007799.518717576] [publisher_node]: Publishing
custom message: data='Custom Hello', number=42
[INFO] [1729007800.518543983] [publisher_node]: Publishing:
'Hello, world!'
[INFO] [1729007800.518717029] [publisher_node]: Publishing
custom message: data='Custom Hello', number=42
[INFO] [1729007801.518492982] [publisher_node]: Publishing:
'Hello, world!'
[INFO] [1729007801.518696385] [publisher_node]: Publishing
custom message: data='Custom Hello', number=42
[INFO] [1729007802.518484665] [publisher_node]: Publishing:
'Hello, world!'
[INFO] [1729007802.518699991] [publisher_node]: Publishing
custom message: data='Custom Hello', number=42
^C[INFO] [1729007802.903431473] [rclcpp]: signal_handler(si

robot@robot-pc: ~ 62x27
robot@robot-pc:~$ ros2 run master_ros2_pkg subscriber_node
[INFO] [1729007798.519061007] [subscriber_node]: Received: 'He
llo, world!'
[INFO] [1729007798.519229745] [subscriber_node]: Received cust
om message: data='Custom Hello', number=42
[INFO] [1729007799.518983416] [subscriber_node]: Received: 'He
llo, world!'
[INFO] [1729007799.519048950] [subscriber_node]: Received cust
om message: data='Custom Hello', number=42
[INFO] [1729007800.518988279] [subscriber_node]: Received: 'He
llo, world!'
[INFO] [1729007800.519067459] [subscriber_node]: Received cust
om message: data='Custom Hello', number=42
[INFO] [1729007801.518954481] [subscriber_node]: Received: 'He
llo, world!'
[INFO] [1729007801.519035013] [subscriber_node]: Received cust
om message: data='Custom Hello', number=42
[INFO] [1729007802.518990117] [subscriber_node]: Received: 'He
llo, world!'
[INFO] [1729007802.519071631] [subscriber_node]: Received cust
om message: data='Custom Hello', number=42
```

publisher_node_params

Publishing custom message: data='Hello String', number=42
Publishing: 'Hello, world!'
Publishing custom message: data='Hello String', number=42
Publishing: 'Hello, world!'
Publishing custom message: data='Test ', number=42
Publishing: 'Hello, world!'

subscriber_node

Received custom message: data='Hello String', number=42
Received: 'Hello, world!'
Received custom message: data='Test ', number=42
Received: 'Hello, world!'

Setting ROS 2 params

ros2 param set publisher_node_params custom_string "Test"
Set parameter successful

```
robot@robot-pc: ~/ros2_ws
robot@robot-pc: ~/ros2_ws 67x7

robot@robot-pc:~/ros2_ws$ ros2 run master_ros2_pkg simple_server
[INFO] [1729089591.254901337] [string_concat_service]: Started ROS
2 Service Server
[INFO] [1729089593.694100079] [string_concat_service]: Received: st
r1='Hello, ', str2='World!'; Responding with: 'Hello, World!'
█

robot@robot-pc: ~/ros2_ws 67x6

robot@robot-pc:~/ros2_ws$ ros2 run master_ros2_pkg simple_client
[INFO] [1729089593.692337714] [string_concat_client]: Started ROS 2
Service Client
[INFO] [1729089593.694575941] [string_concat_client]: Result: conca
tenated_str='Hello, World!'
robot@robot-pc:~/ros2_ws$ █
```

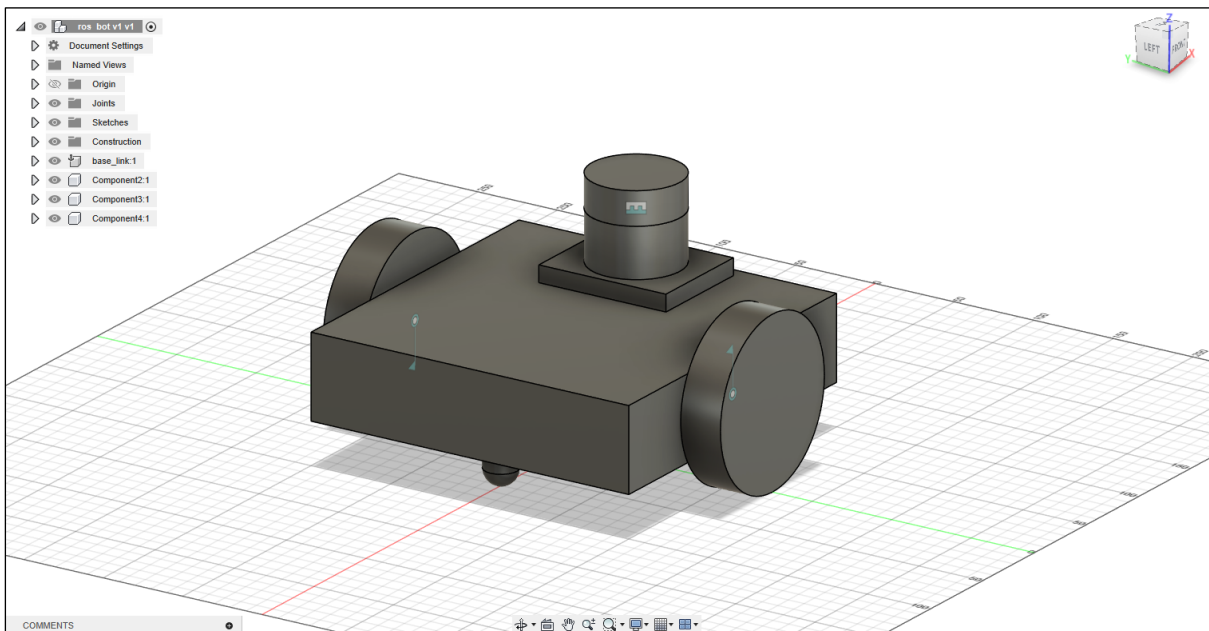
```
robot@robot-pc: ~
robot@robot-pc: ~ 62x7

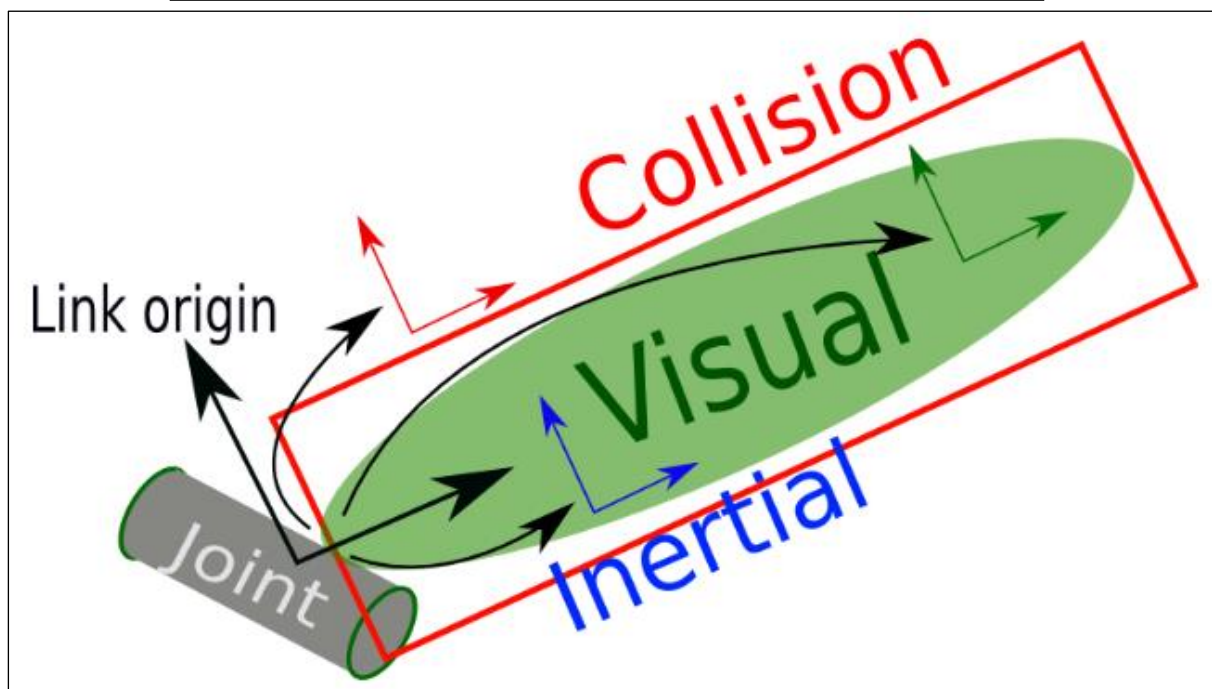
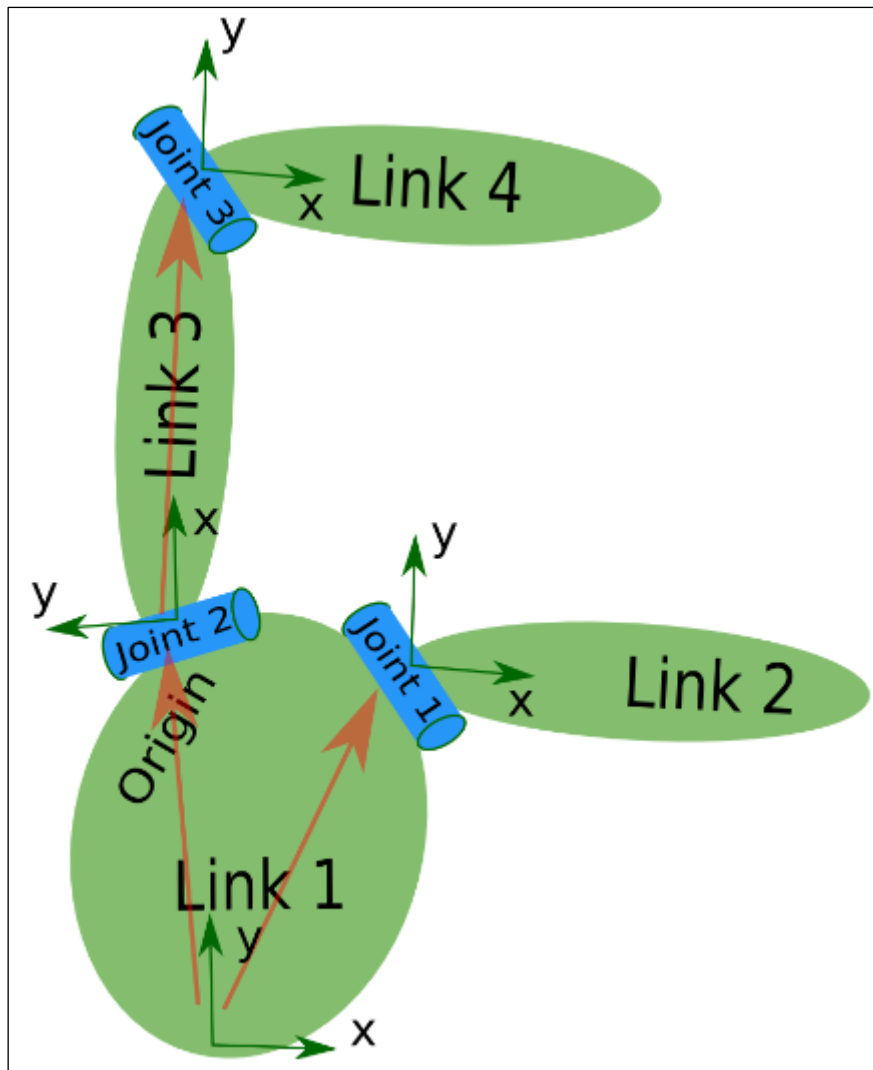
robot@robot-pc:~$ ros2 run master_ros2_pkg action_server
[INFO] [1729190191.841199020] [action_server]: Started Action
Server Node
[INFO] [1729190193.791050137] [action_server]: Received goal r
equest with value 10
[INFO] [1729190198.795818183] [action_server]: Goal succeeded
█

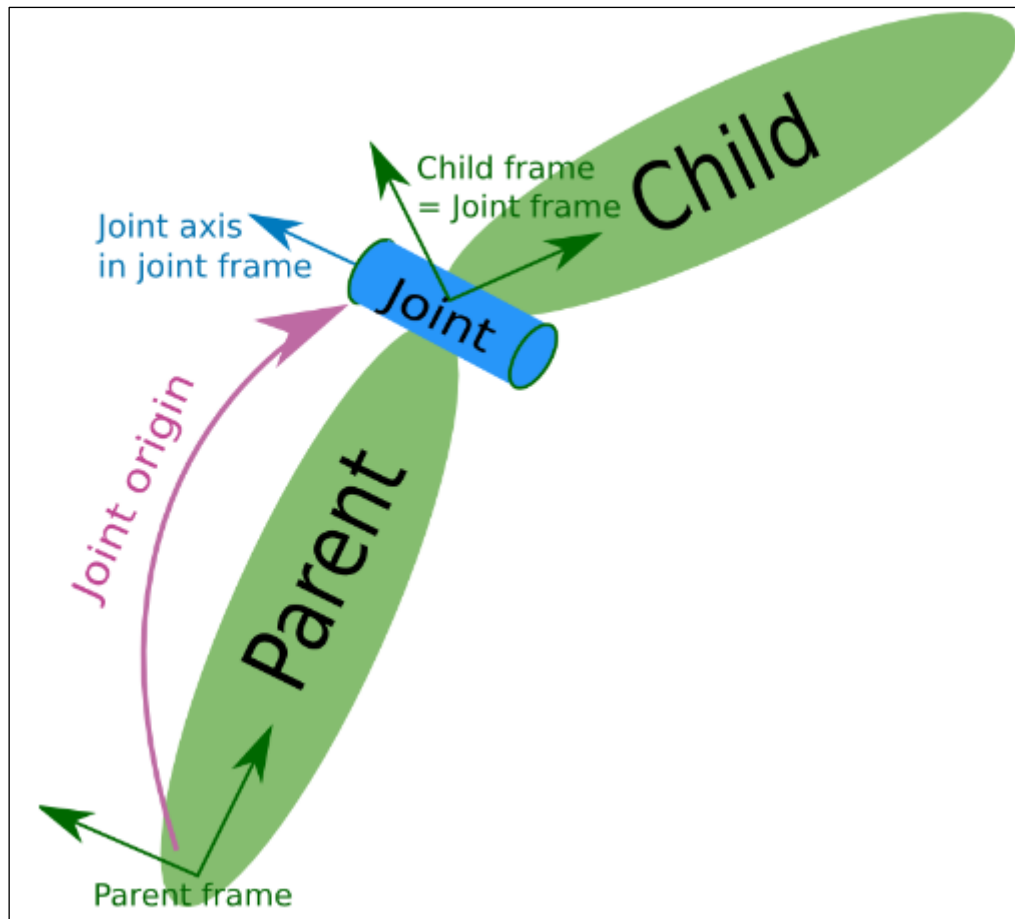
robot@robot-pc: ~/ros2_ws 68x15

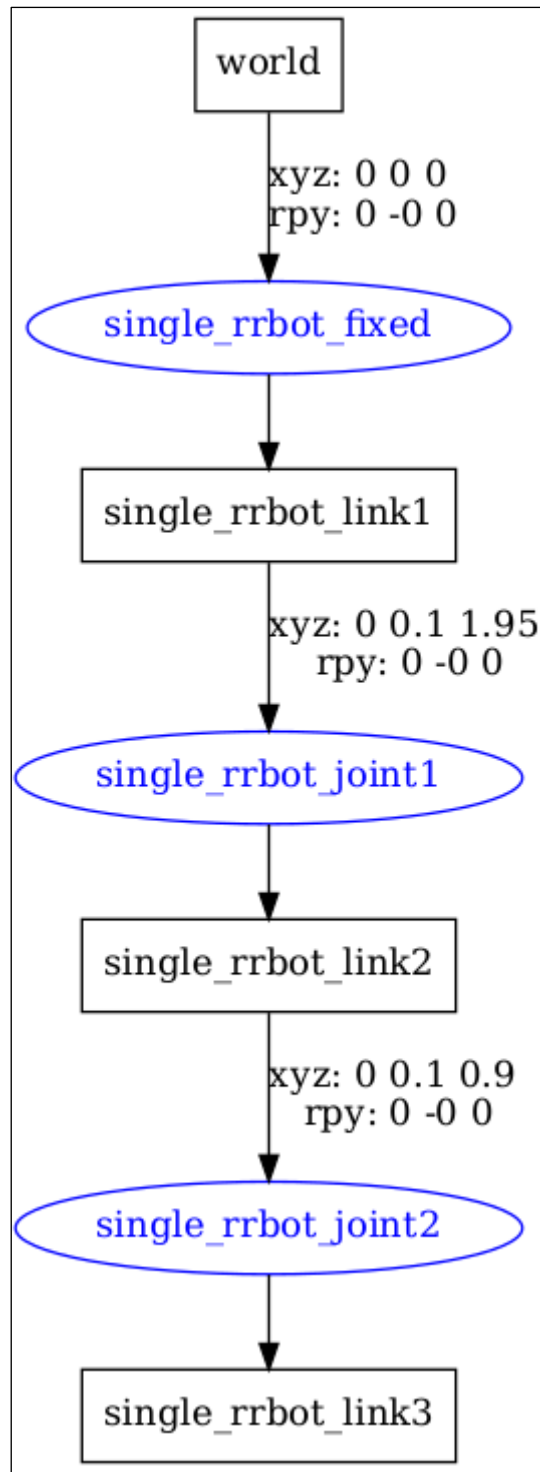
robot@robot-pc:~/ros2_ws$ ros2 run master_ros2_pkg action_client
[INFO] [1729190193.784831065] [action_client]: Started Action Client
Node
[INFO] [1729190193.791728961] [action_client]: Feedback: 1.00
[INFO] [1729190194.292407863] [action_client]: Feedback: 2.00
[INFO] [1729190194.792676118] [action_client]: Feedback: 3.00
[INFO] [1729190195.292915594] [action_client]: Feedback: 4.00
[INFO] [1729190195.793420734] [action_client]: Feedback: 5.00
[INFO] [1729190196.294299173] [action_client]: Feedback: 6.00
[INFO] [1729190196.794142231] [action_client]: Feedback: 7.00
[INFO] [1729190197.294493545] [action_client]: Feedback: 8.00
[INFO] [1729190197.794840619] [action_client]: Feedback: 9.00
[INFO] [1729190198.295442753] [action_client]: Feedback: 10.00
[INFO] [1729190198.796195931] [action_client]: Result: 10
█
```

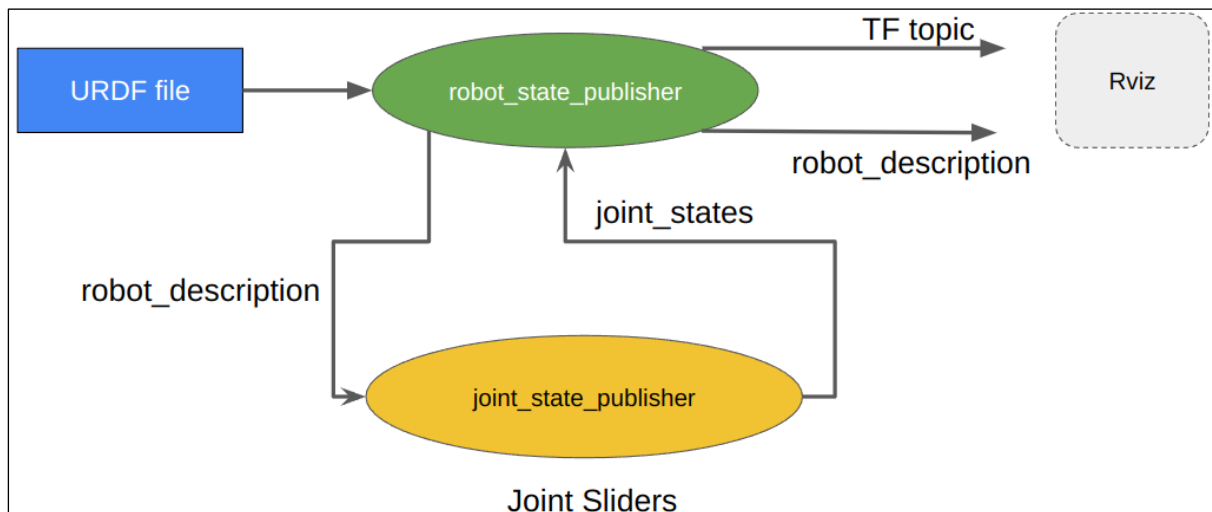
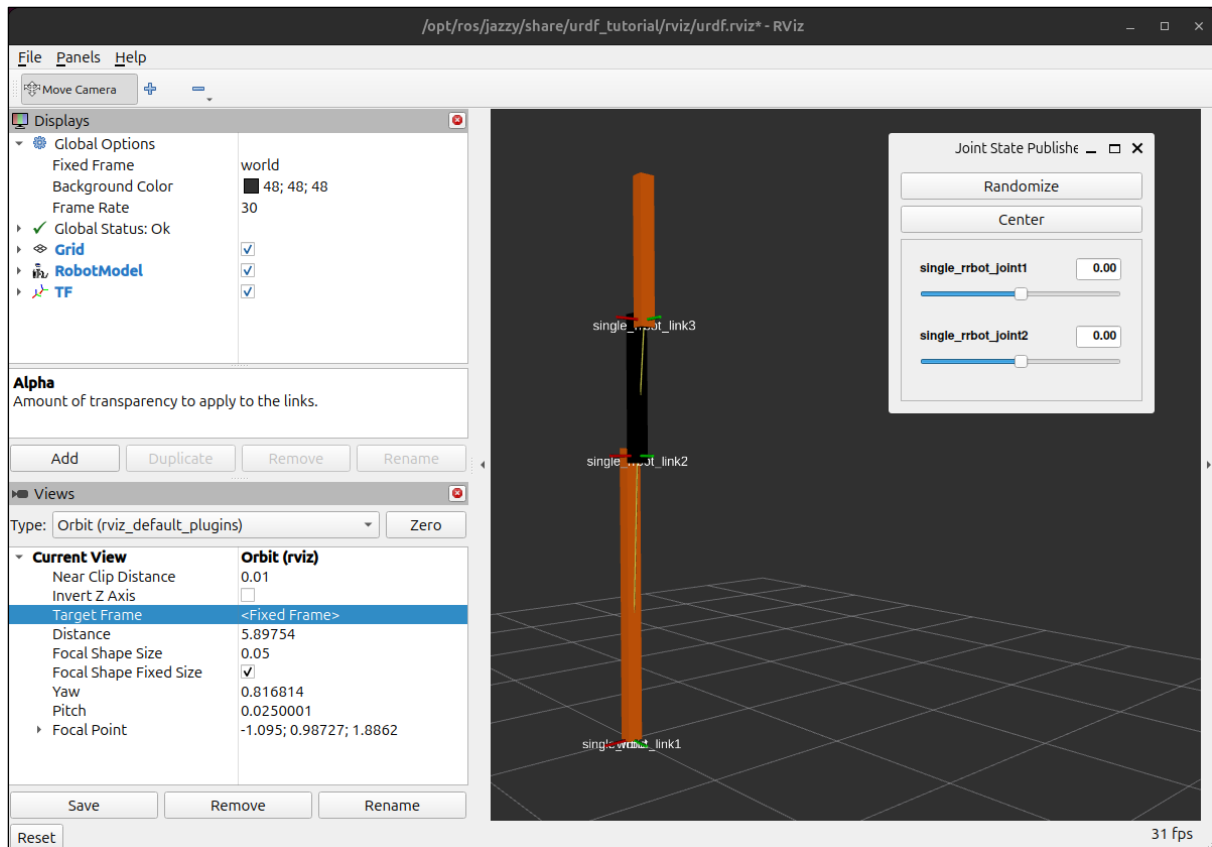
Chapter 4: Working with Robot 3D Modeling in ROS 2



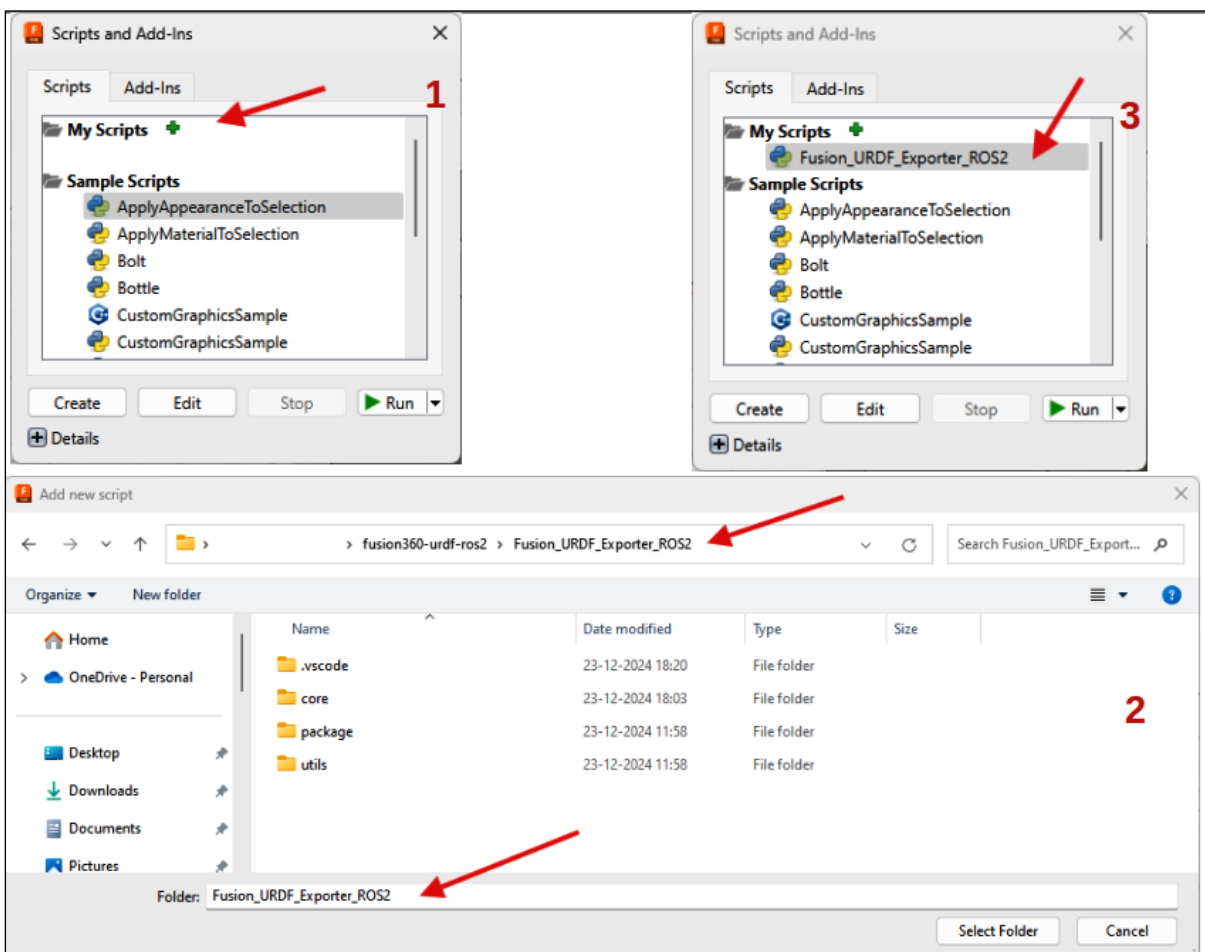


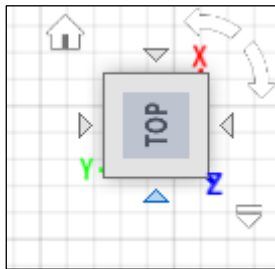
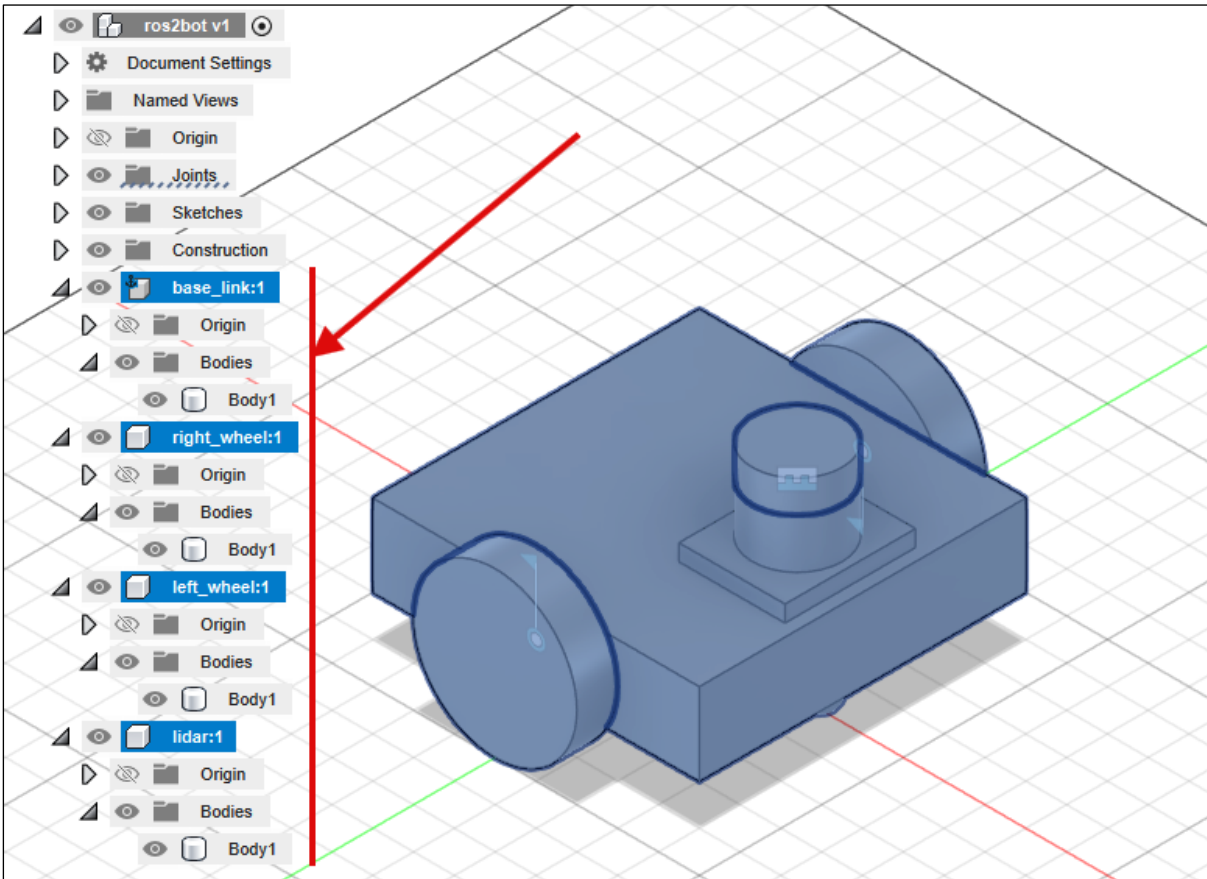
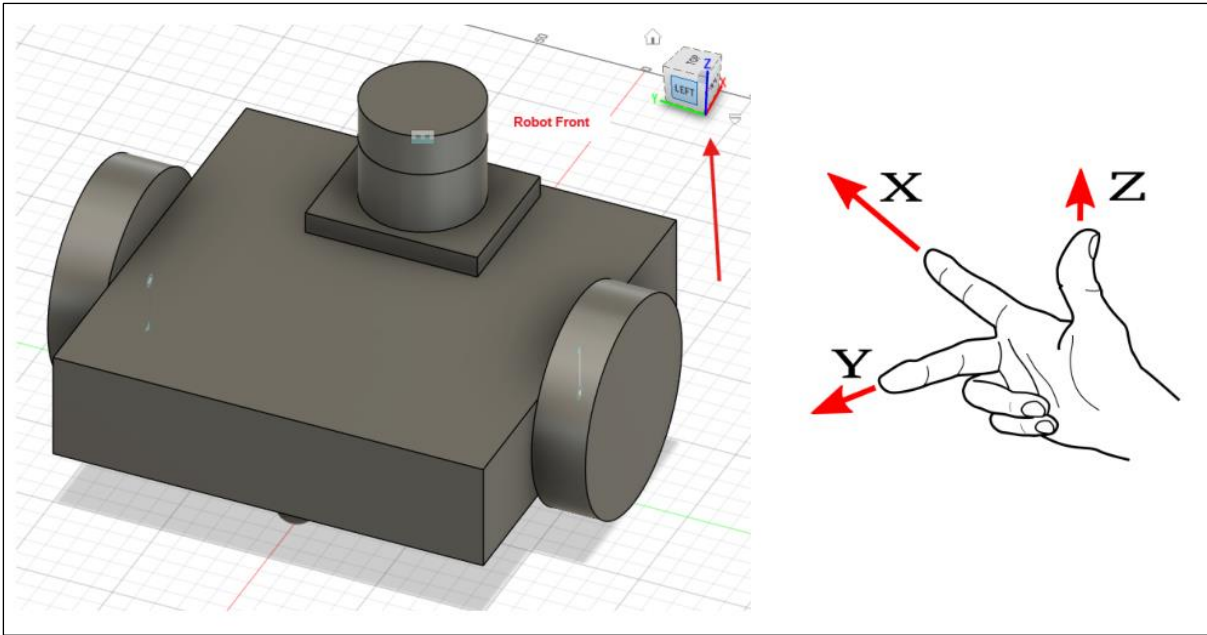


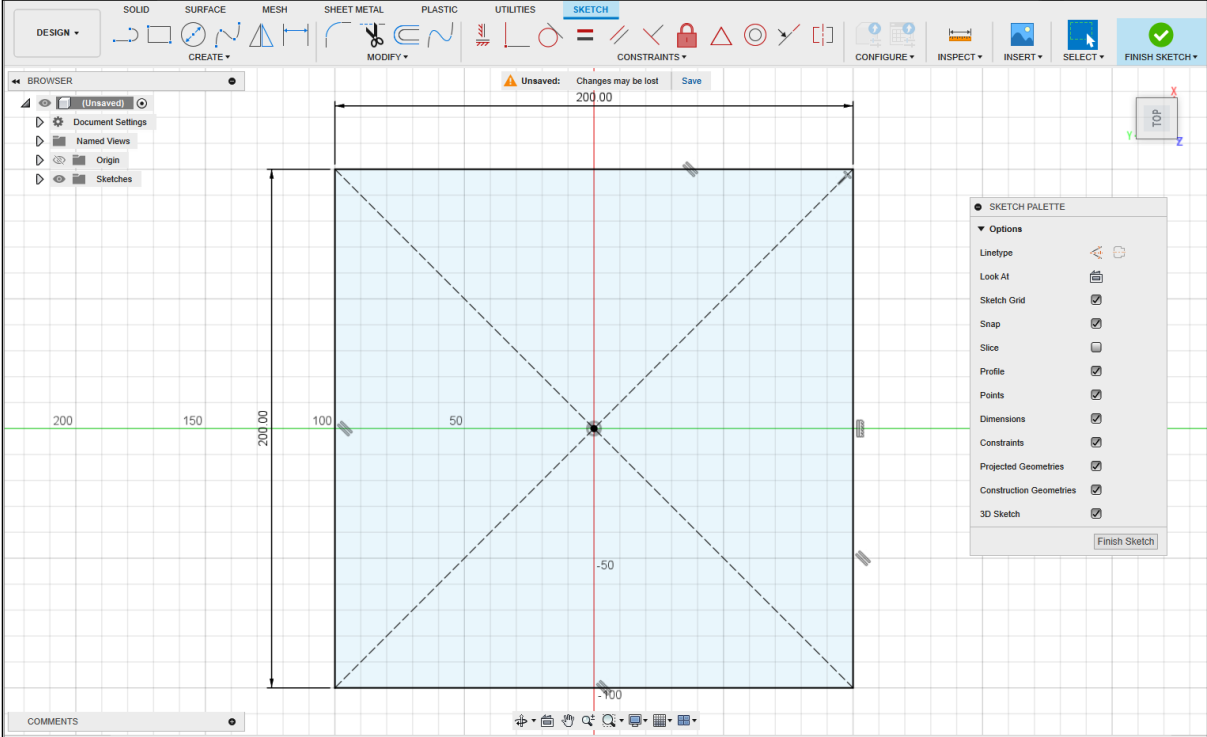
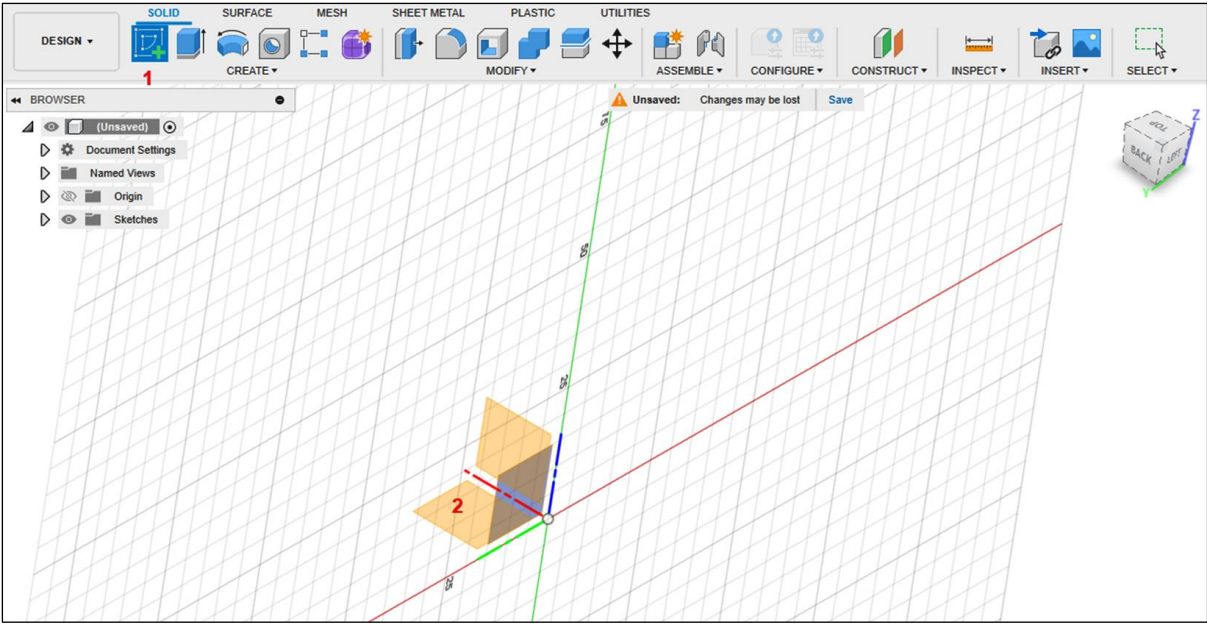


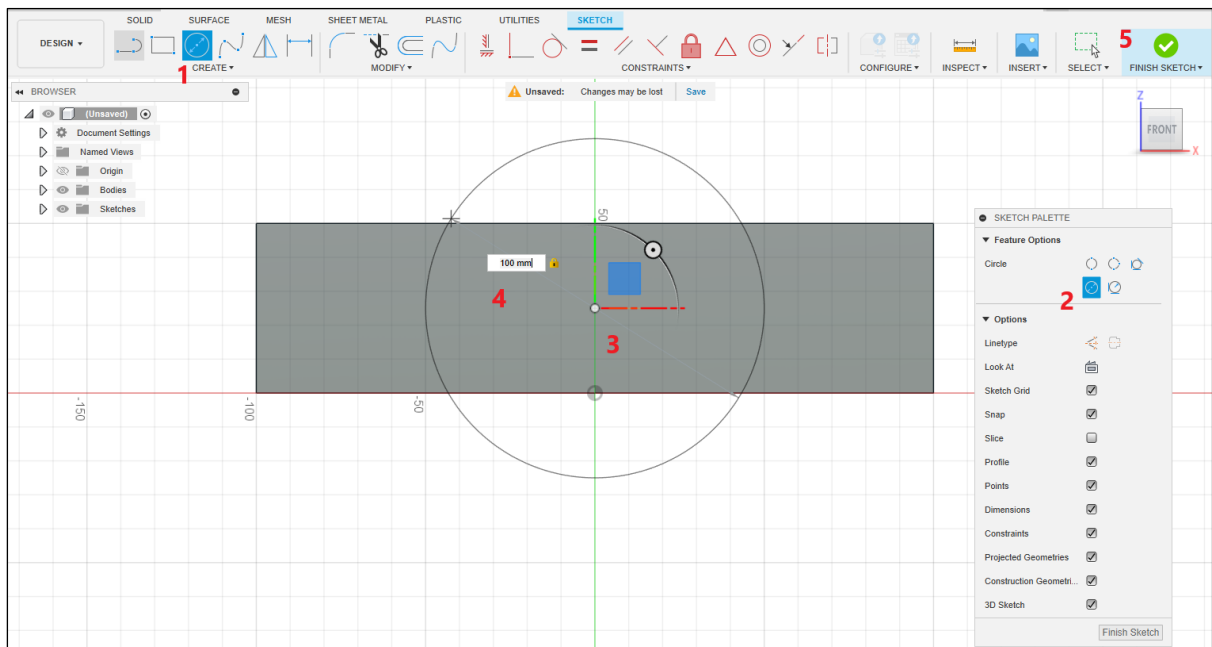
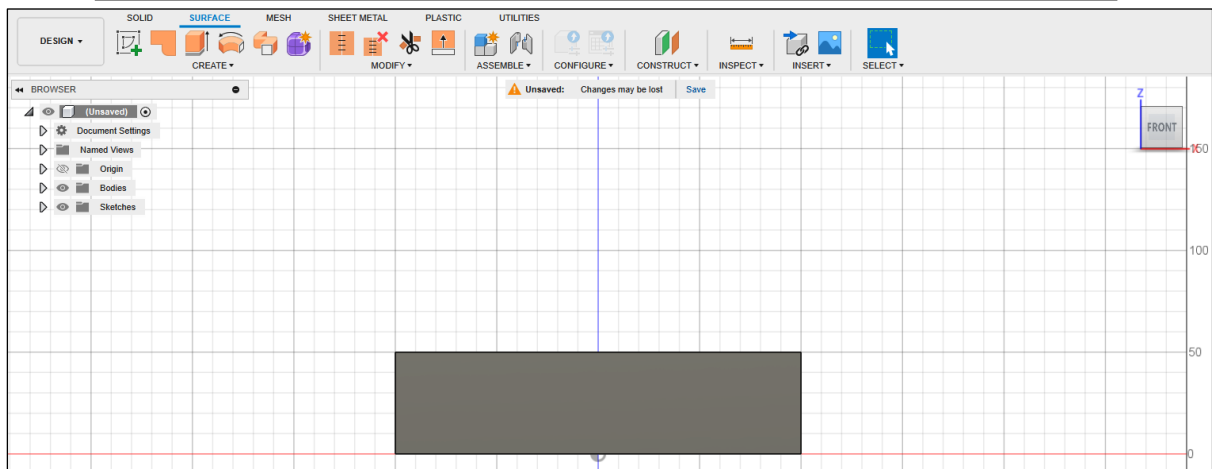
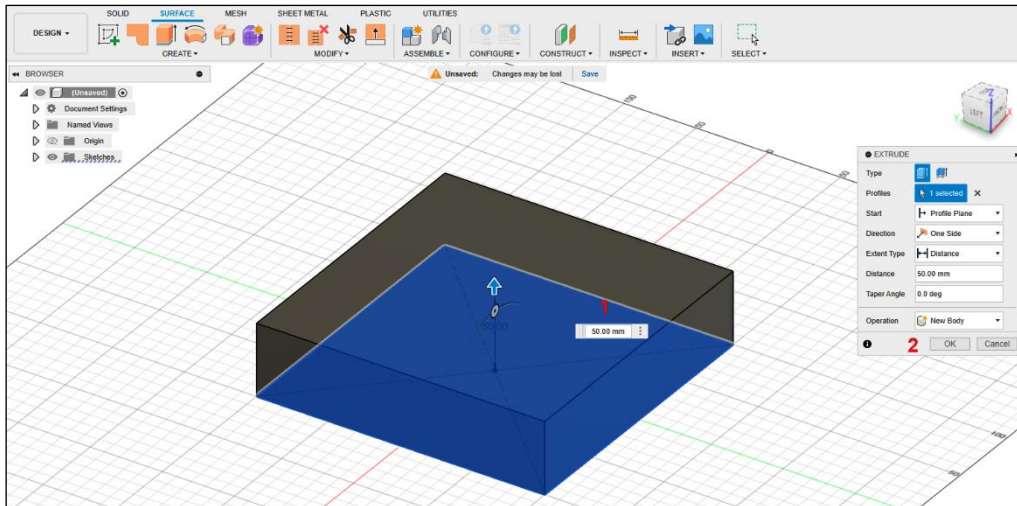


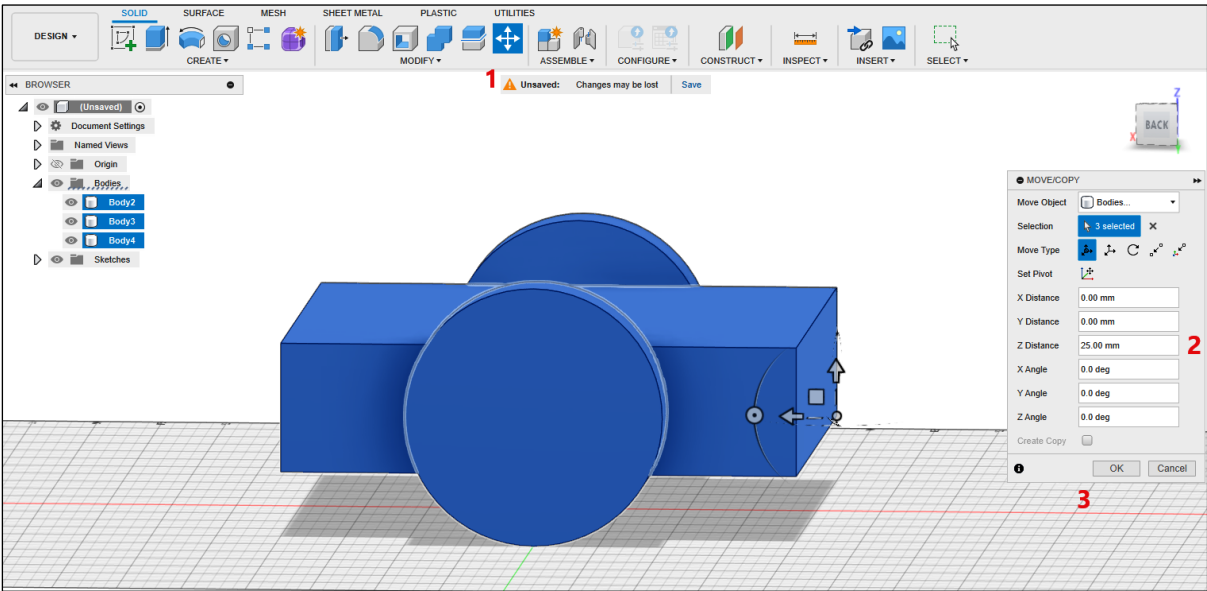
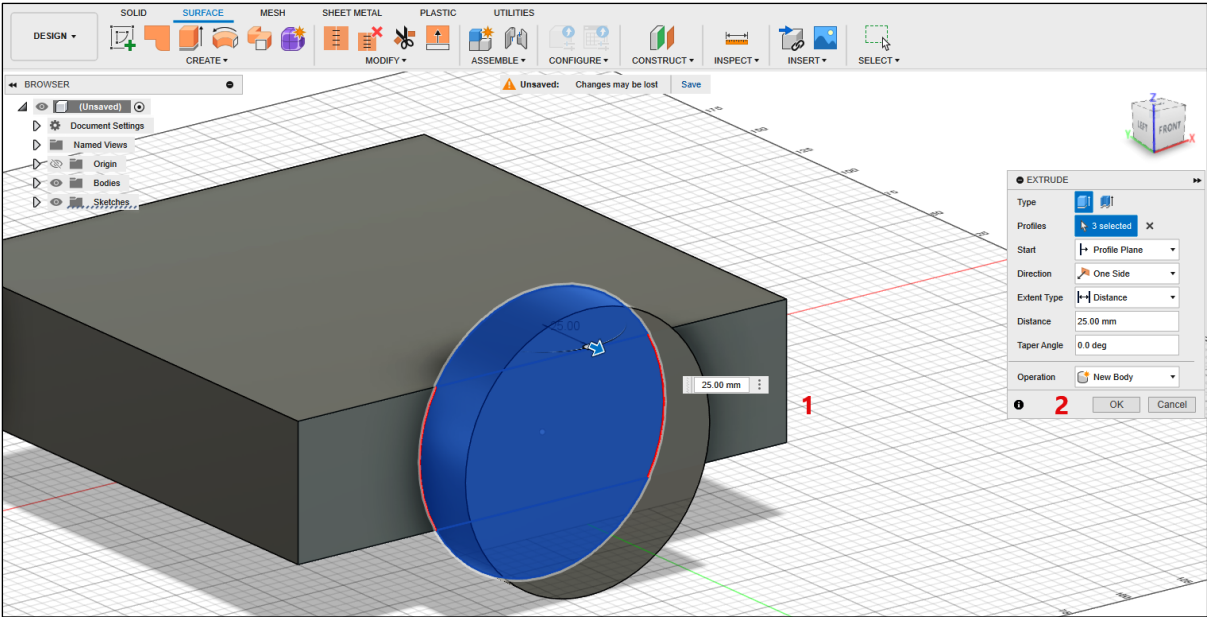
```
rrbot_description
├── CMakeLists.txt
├── launch
│   └── rrbot.launch.py
├── package.xml
├── rviz
│   └── view_robot.rviz
├── urdf
│   ├── rrbot_description.urdf.xacro
│   ├── rrbot.materials.xacro
│   └── rrbot.urdf.xacro
```

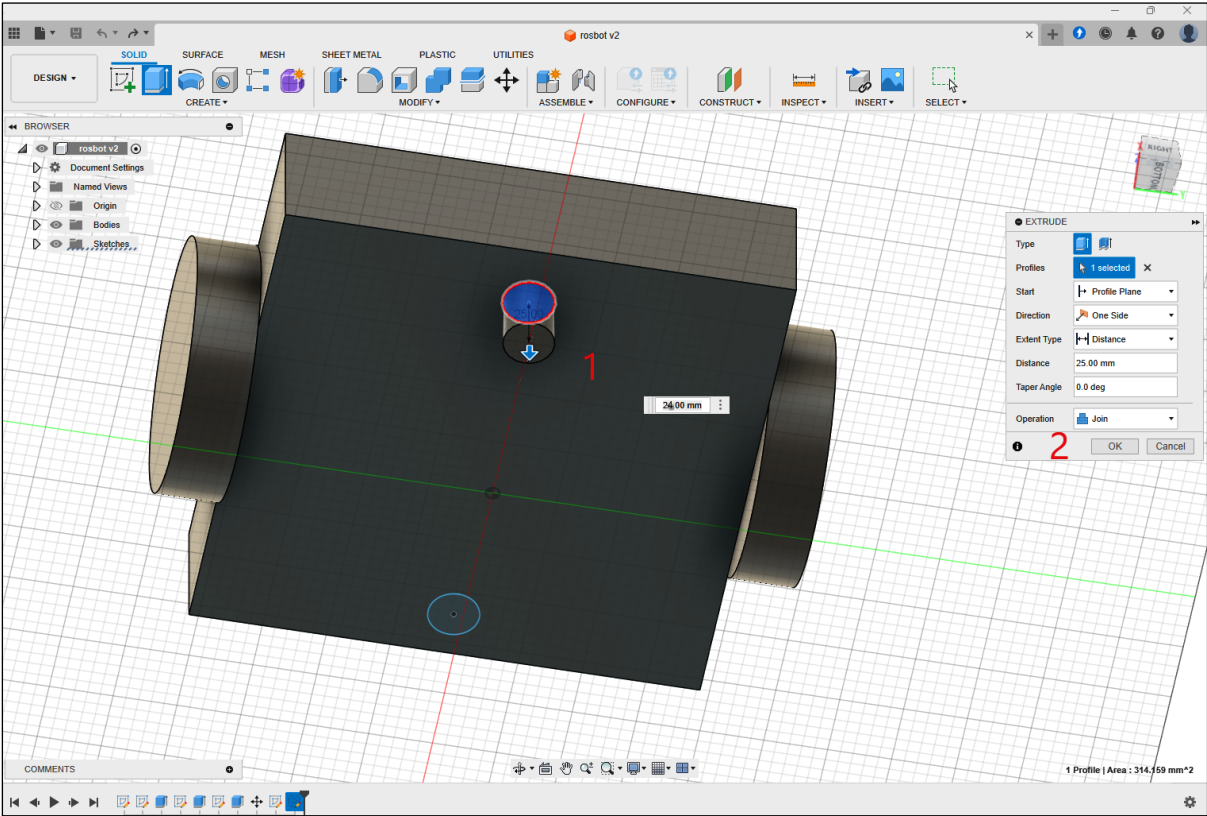
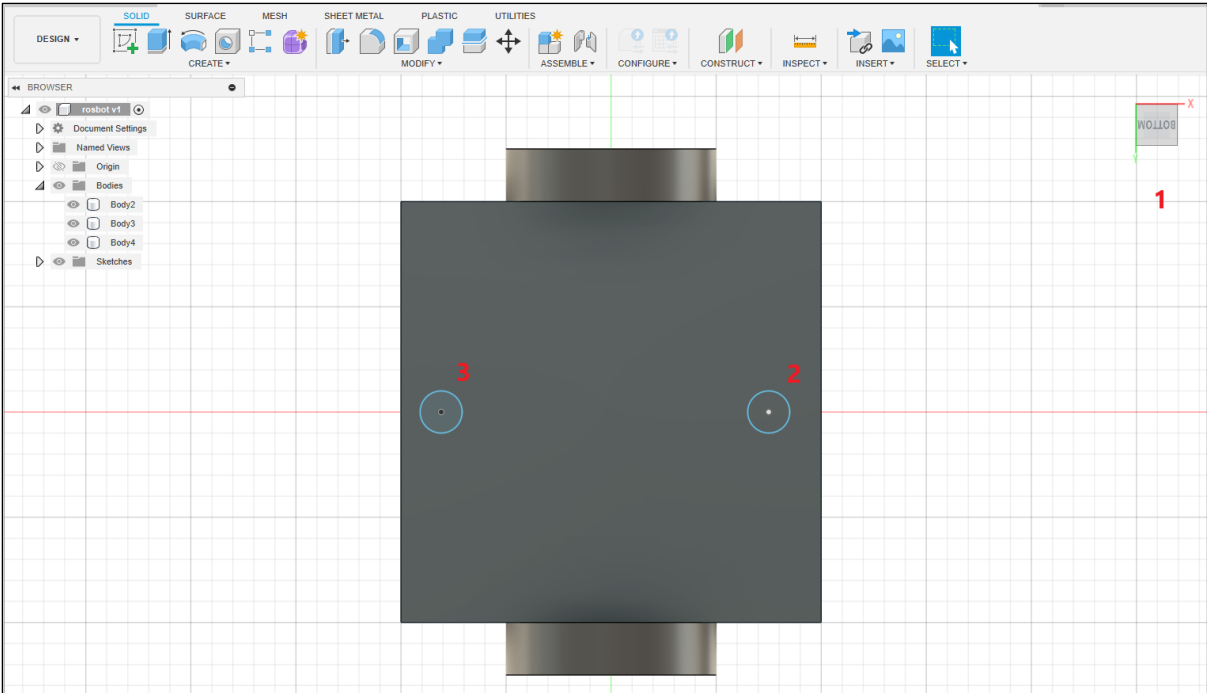


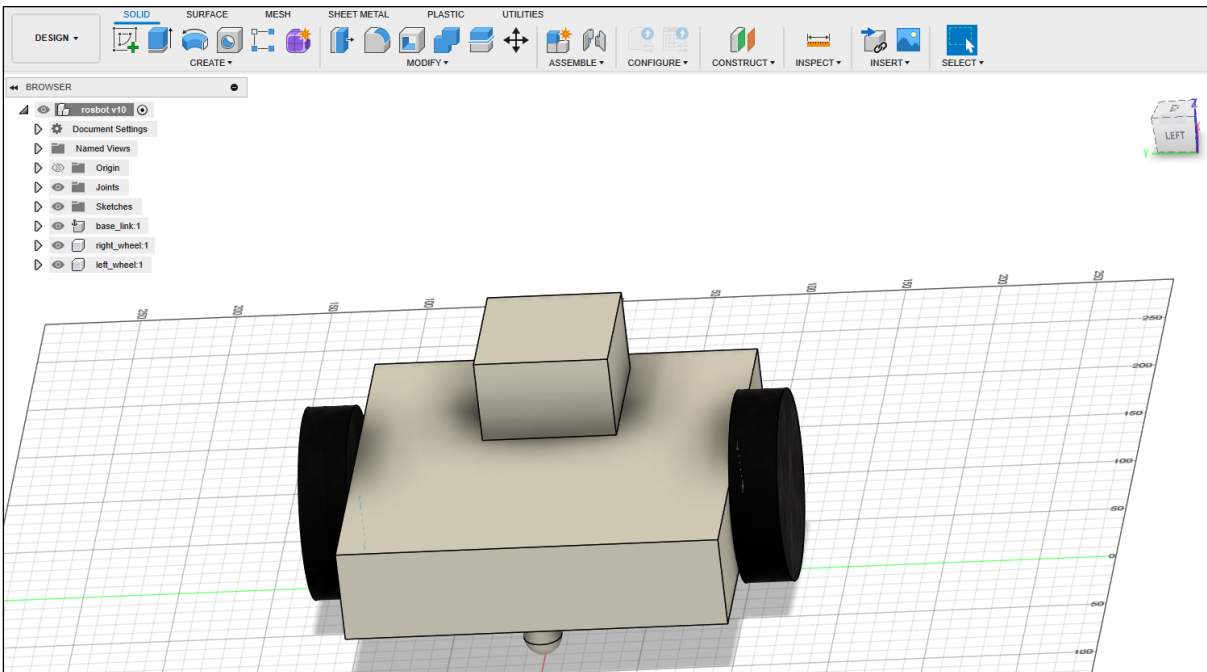
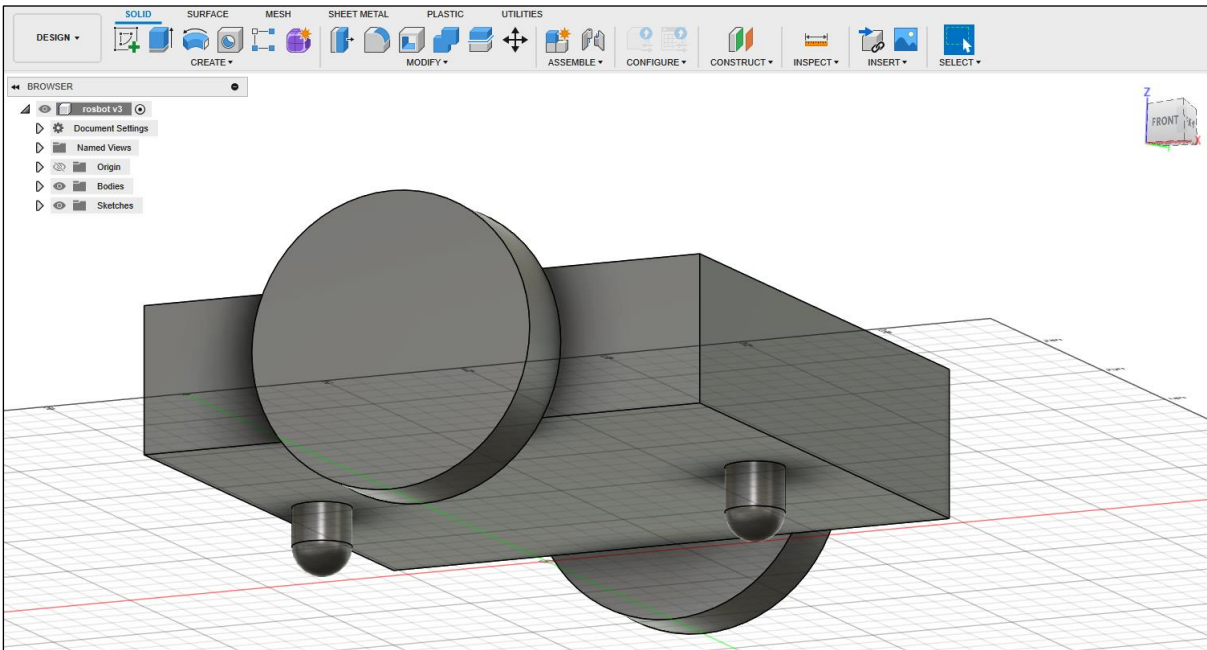
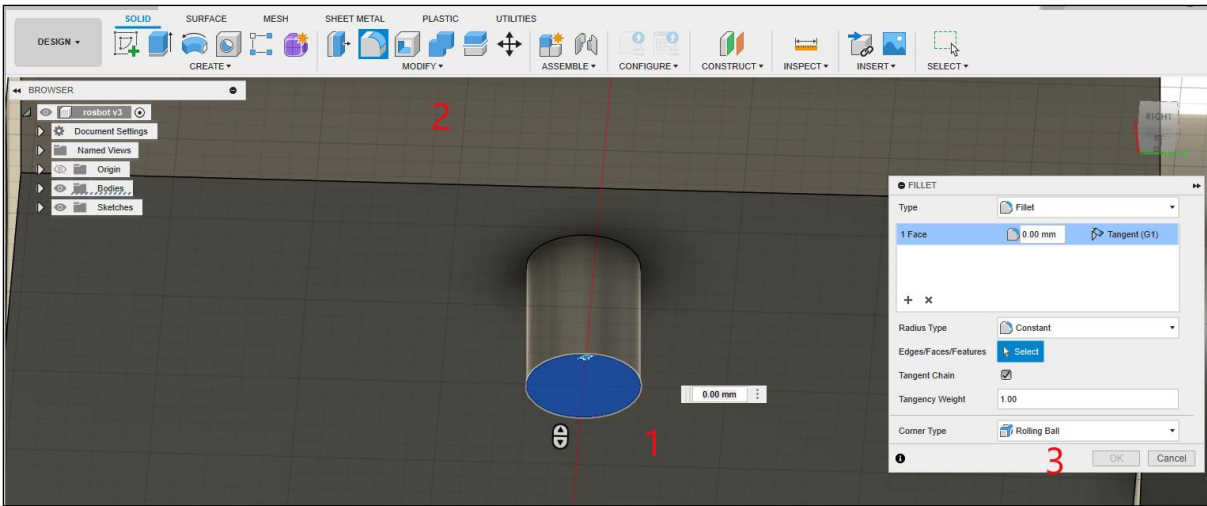


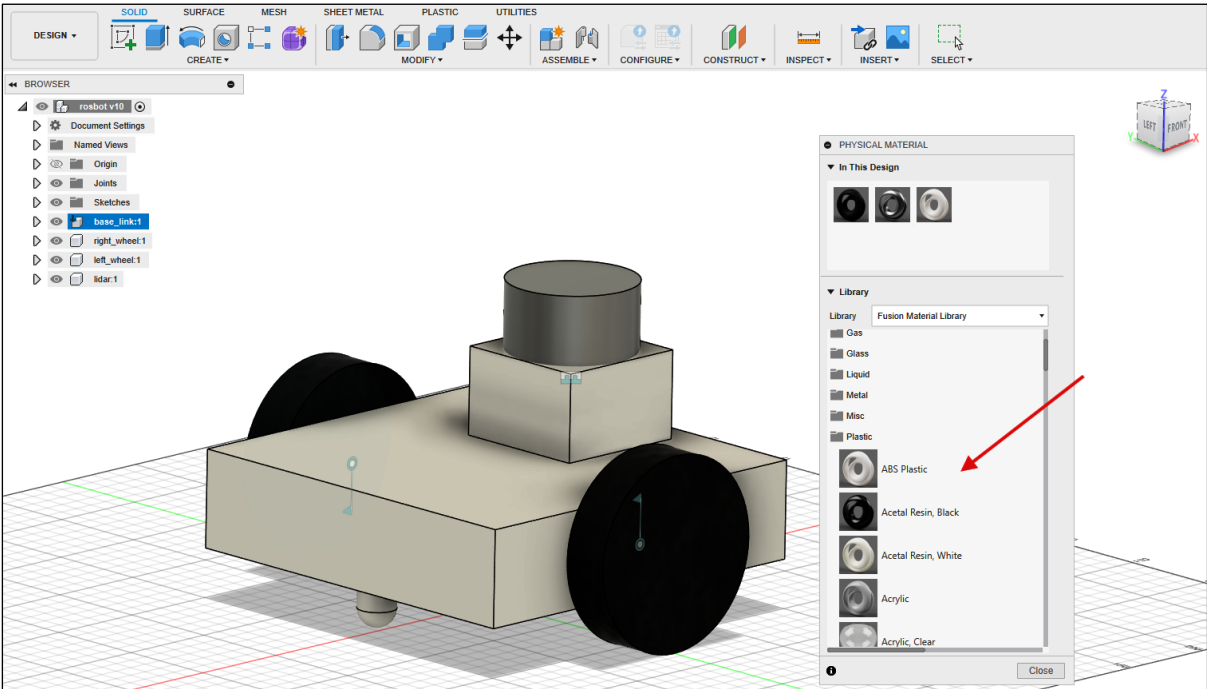
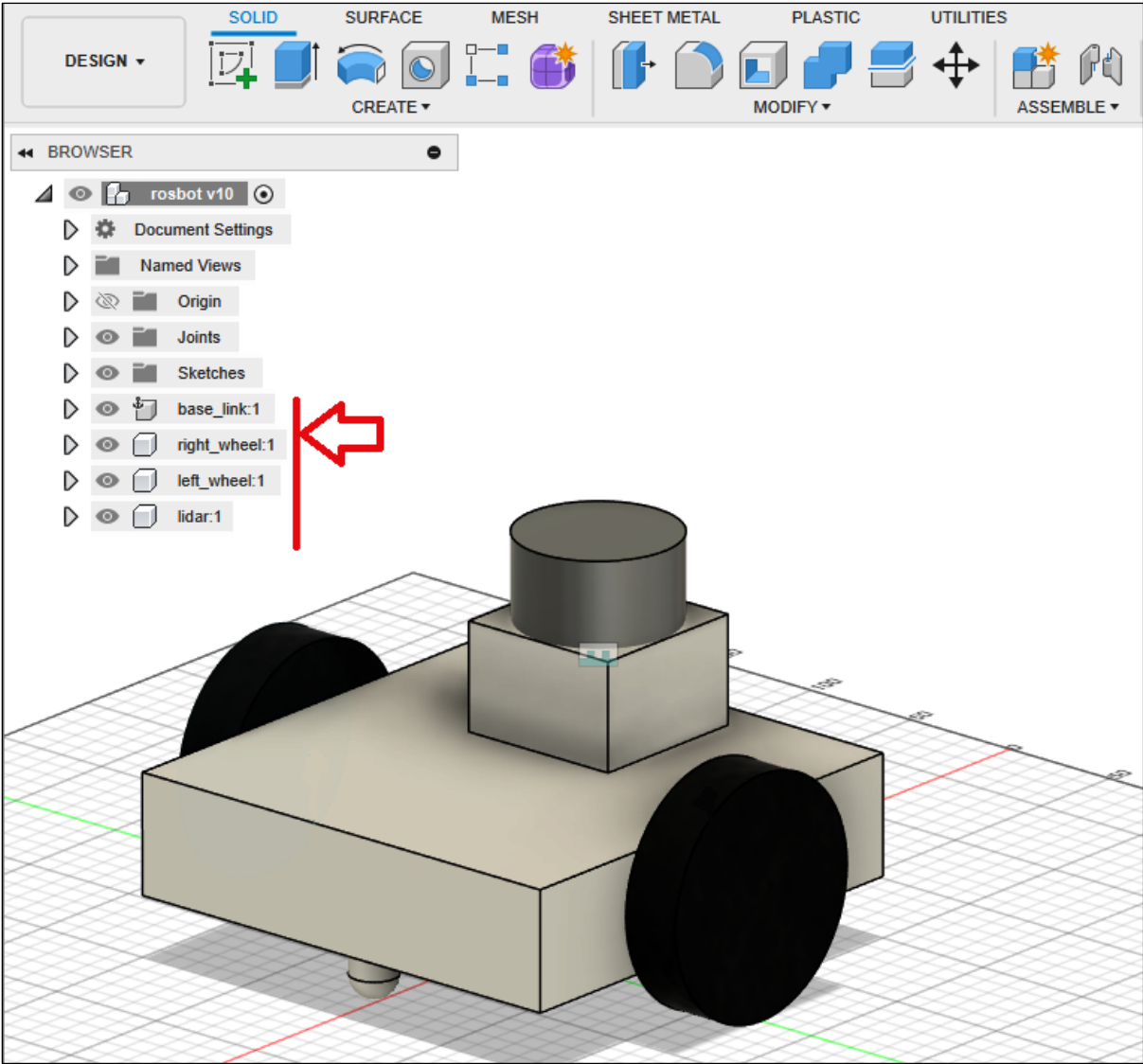


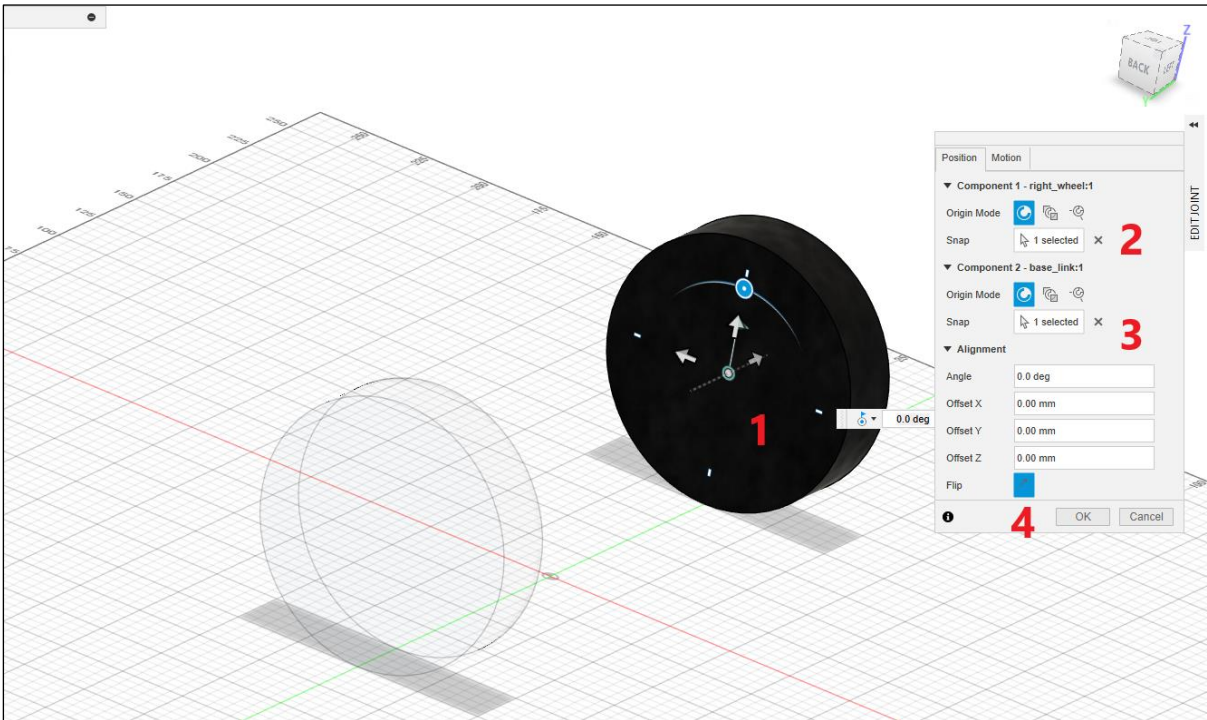
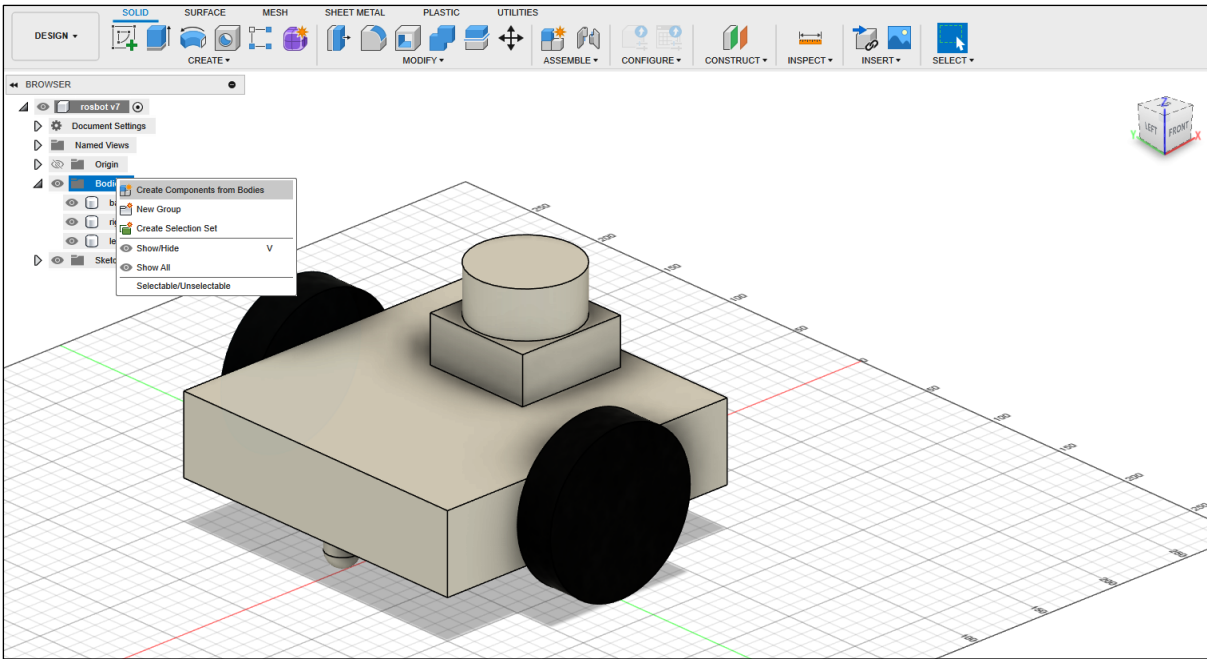


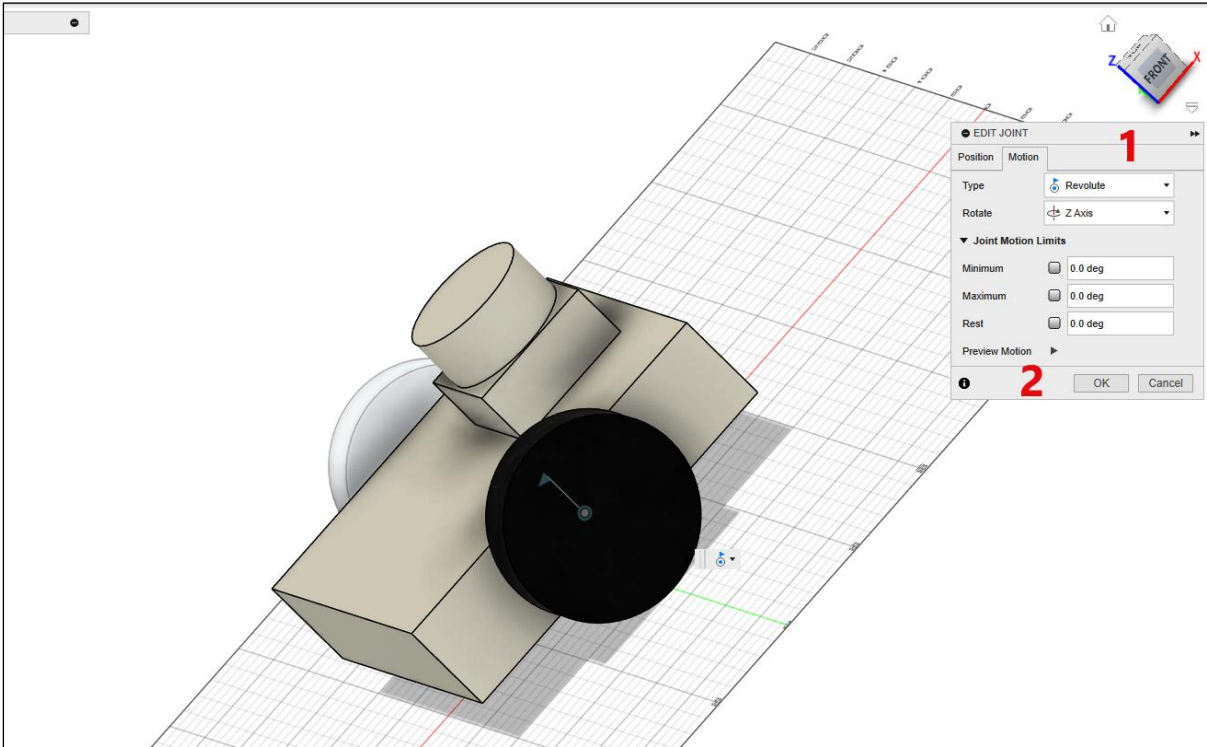
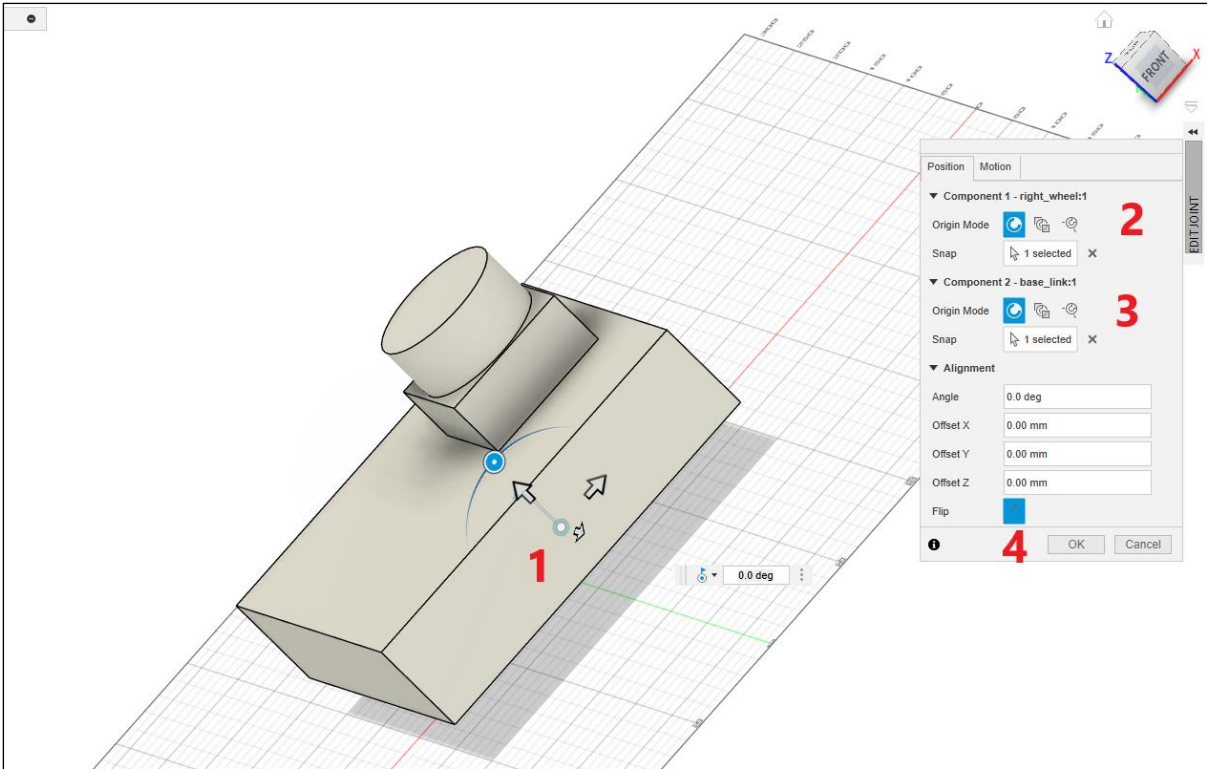


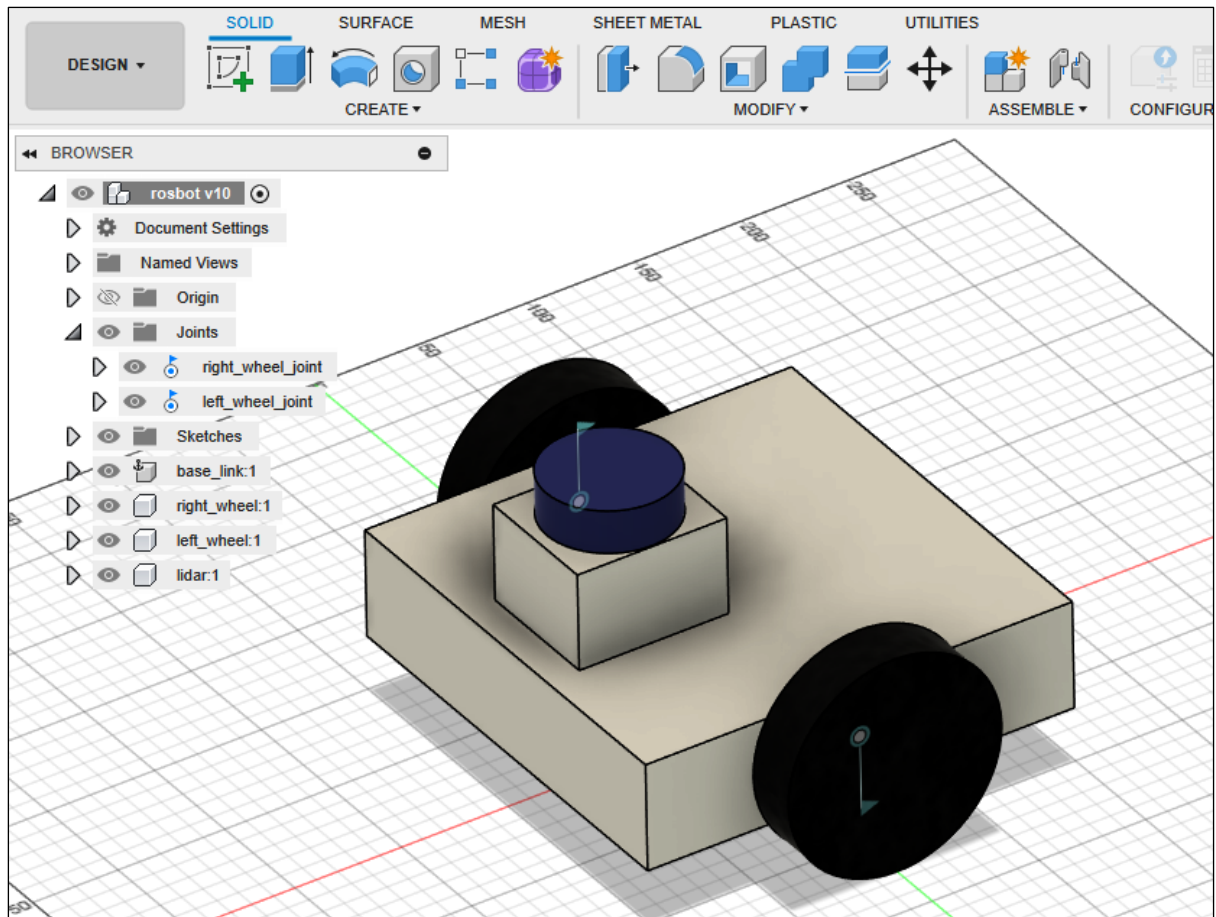












Fusion 360 -> ROS 2 URDF

1

Welcome to the Fusion 'Fusion 360 -> ROS 2 URDF' plugin.

This tool generates a robot_description package with launch files for visualizing your robot in Rviz and spawning the model in Gazebo.

It has been tested with ROS 2 Jazzy and Gazebo Harmonic, as well as ROS 2 Humble with Gazebo Classic.

Press OK to continue or Cancel to quit.

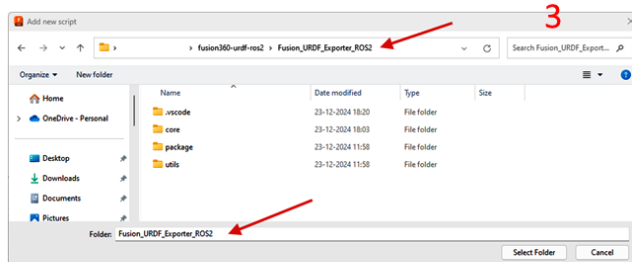
OK Cancel

Fusion 360 -> ROS 2 URDF

2

Press OK to browse the folder for saving the ROS package, cancel to quit.

OK Cancel



3

Fusion 360 -> ROS 2 URDF

4

Are you using Gazebo Harmonic? Press Yes for Gazebo Harmonic, No for Gazebo Classic (Legacy).

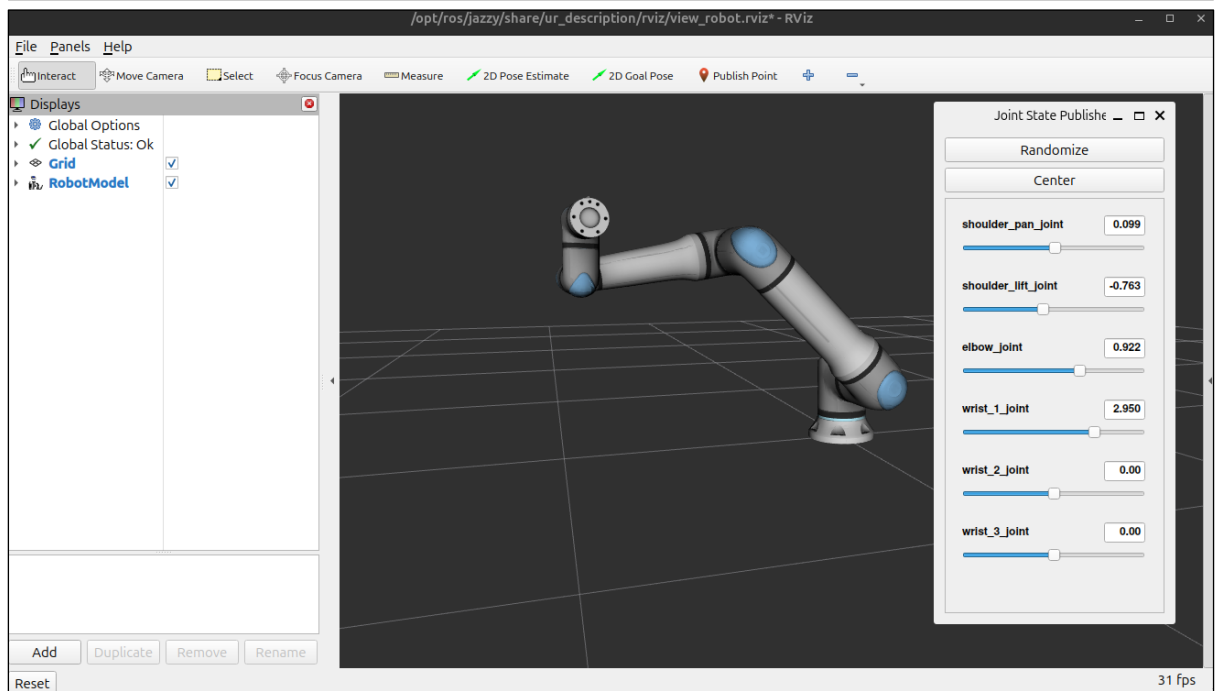
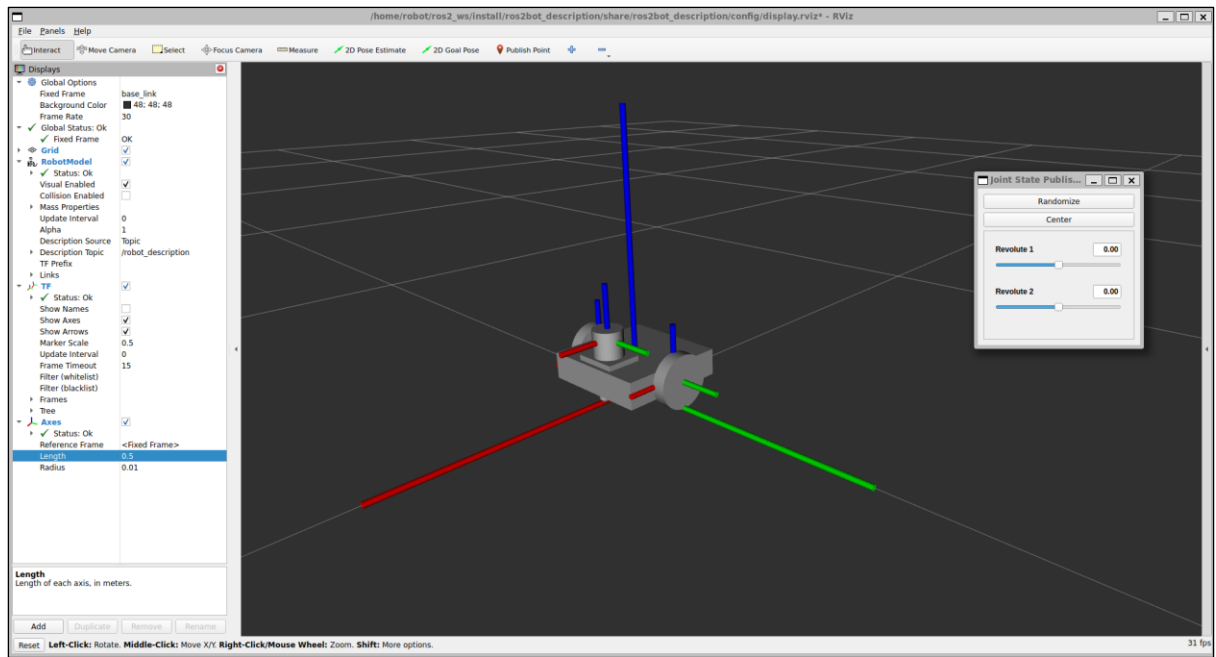
Yes No

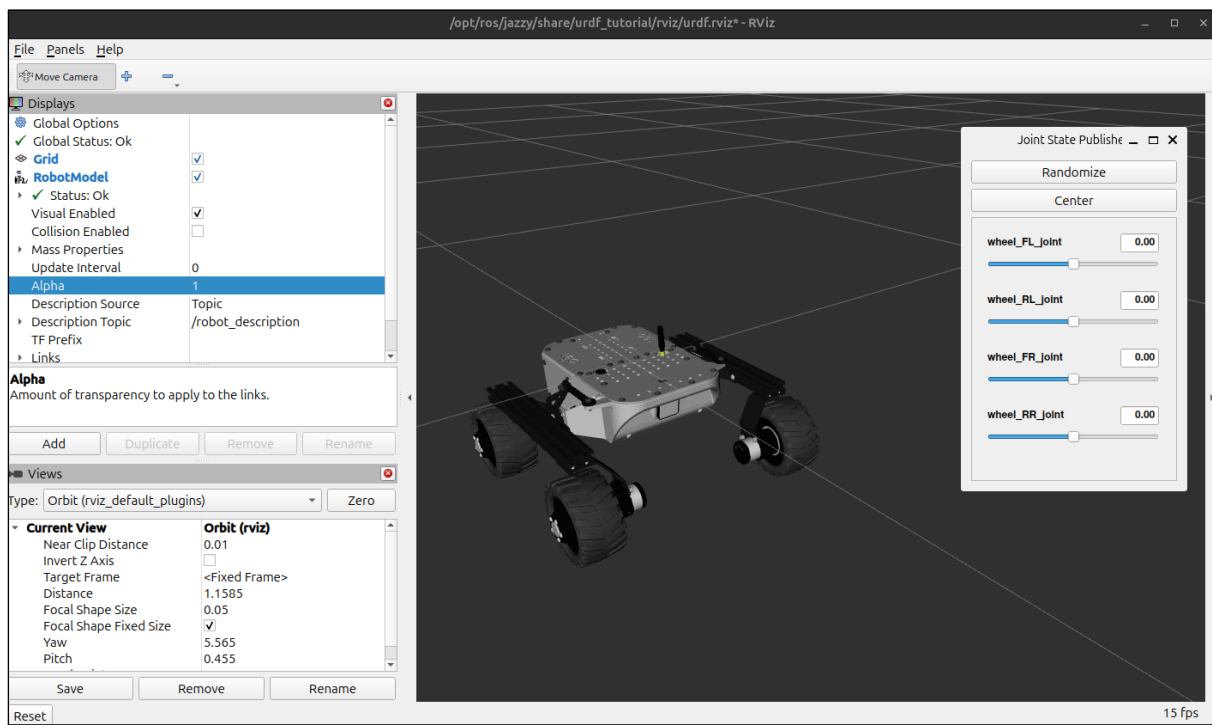
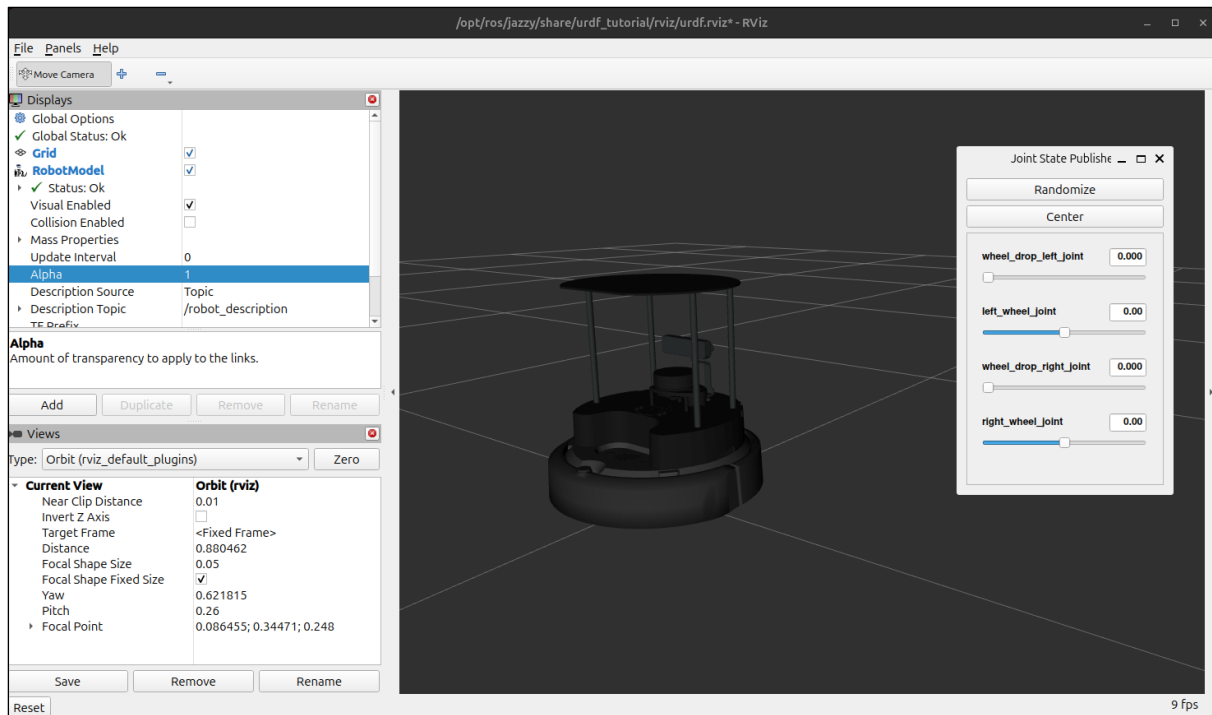
Fusion 360 -> ROS 2 URDF

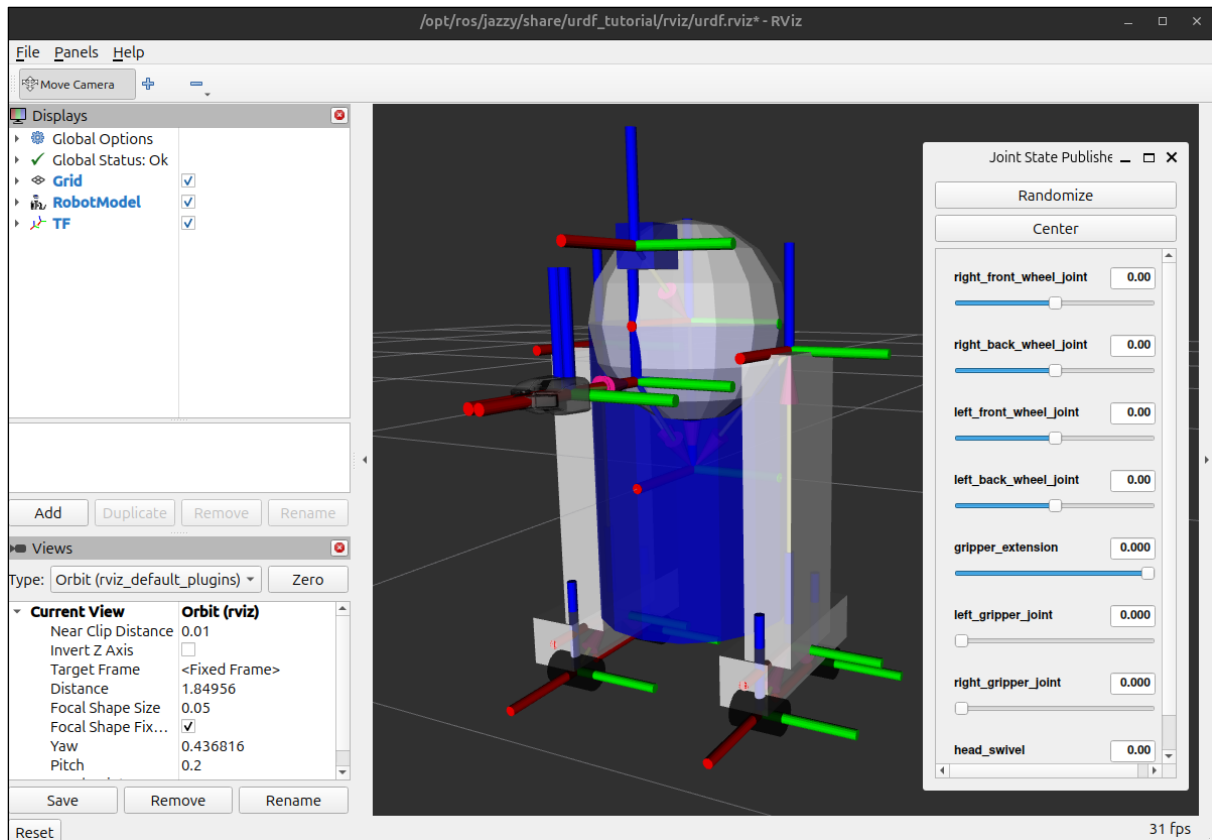
5

Successfully created URDF file and launch file for Gazebo Harmonic

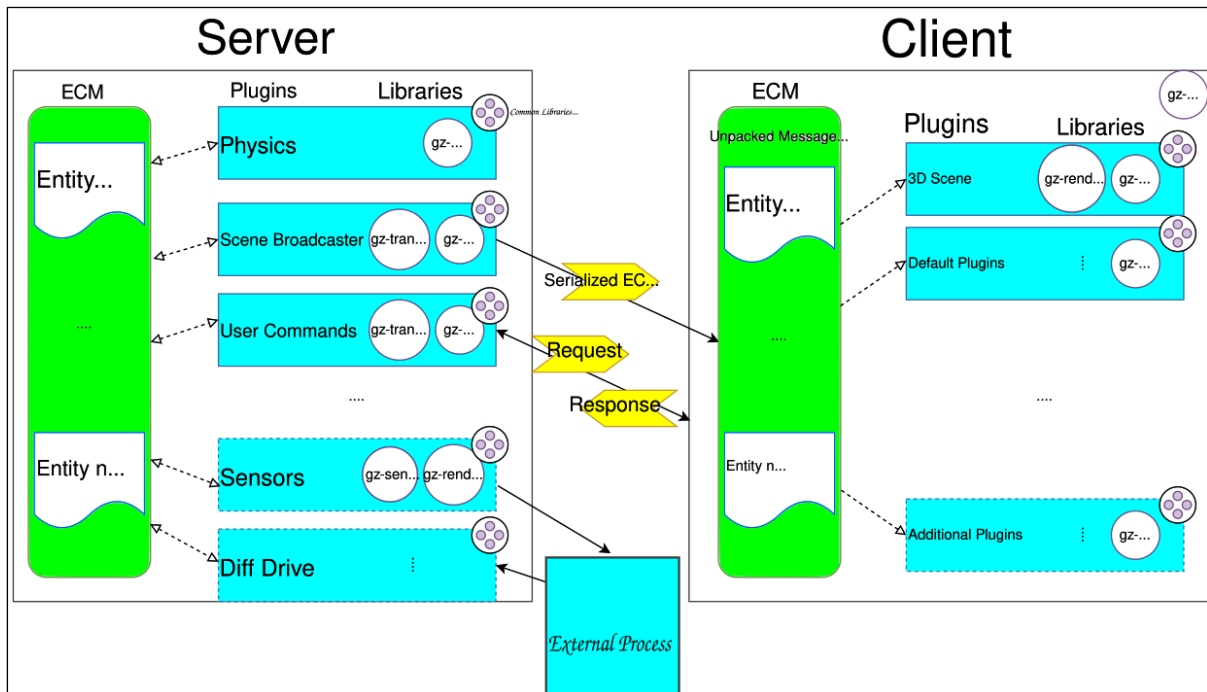
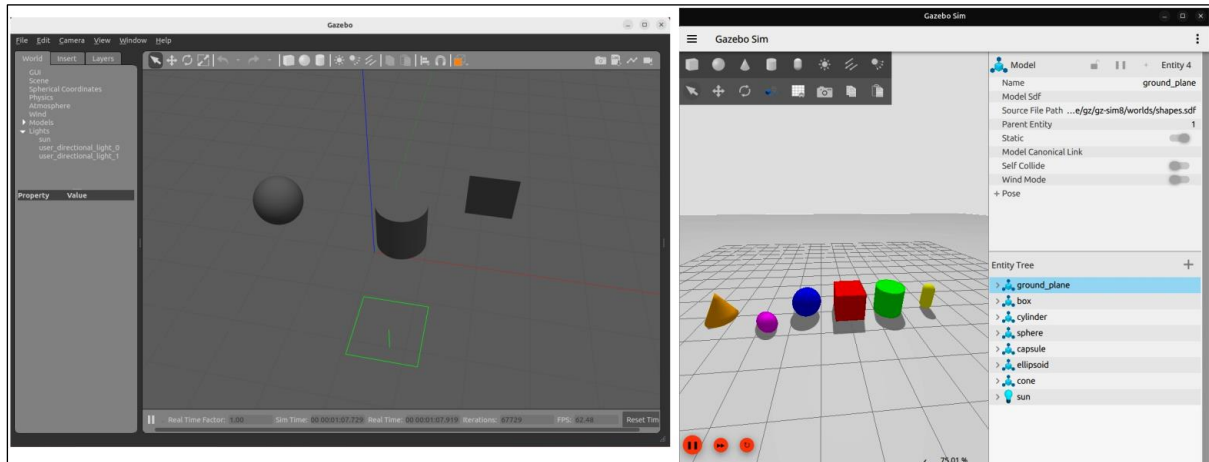
OK

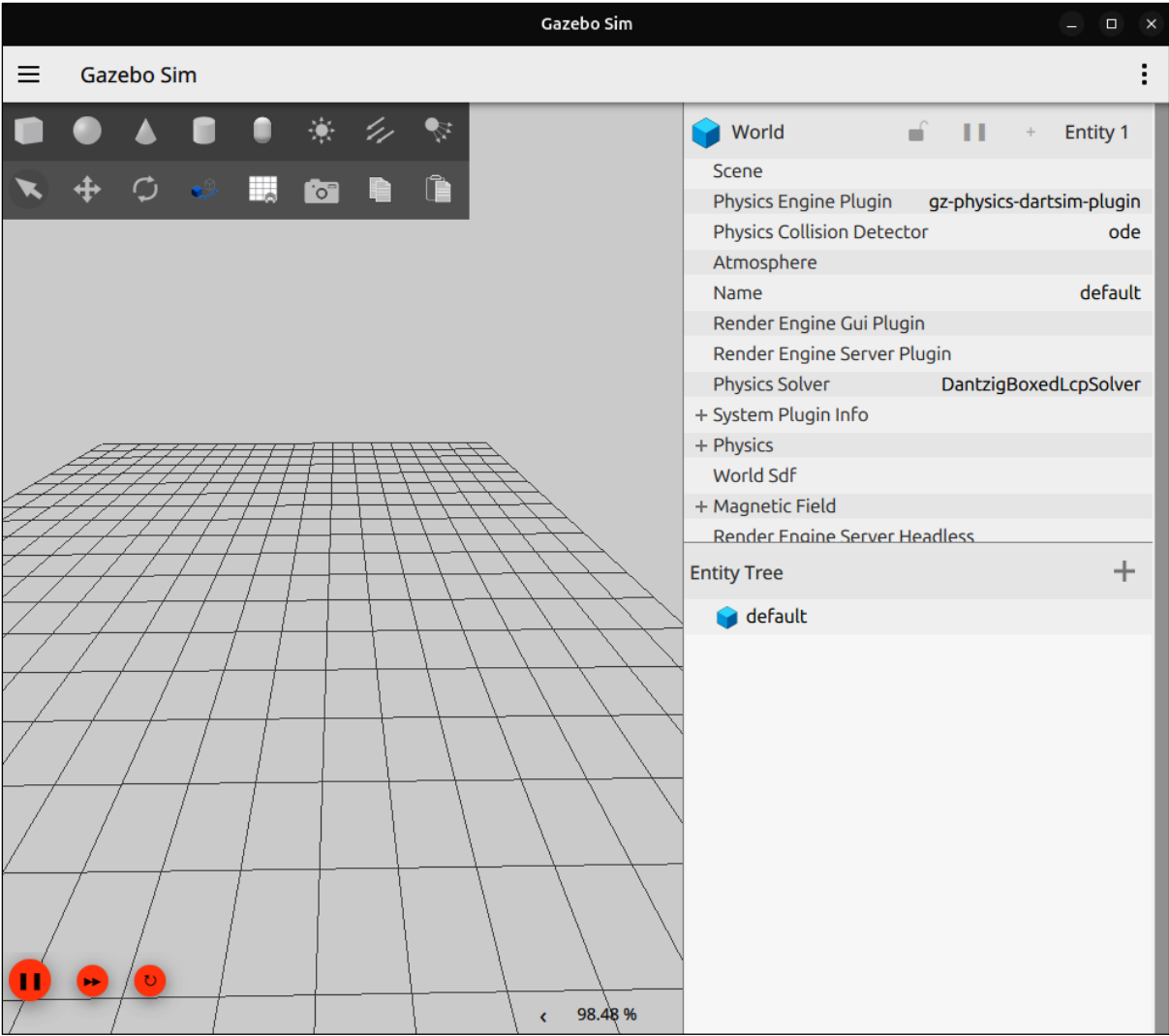






Chapter 5: Simulating Robots in a Realistic Environment





```
robot@robot-pc:~$ gz help
```

The 'gz' command provides a command line interface to the Gazebo Tools.

```
gz <command> [options]
```

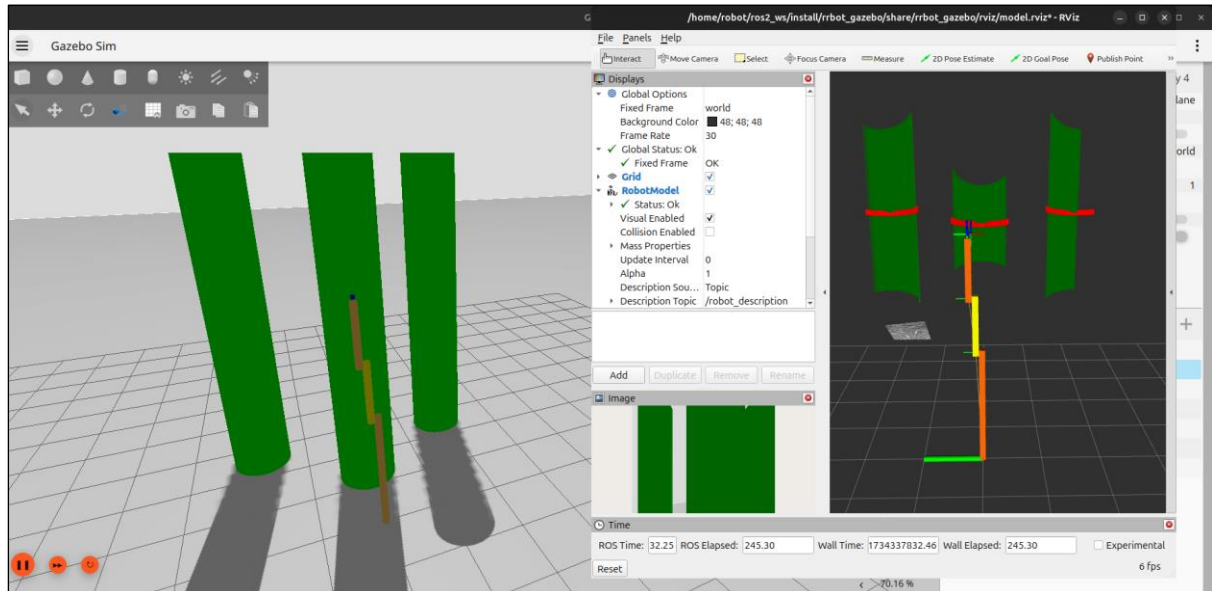
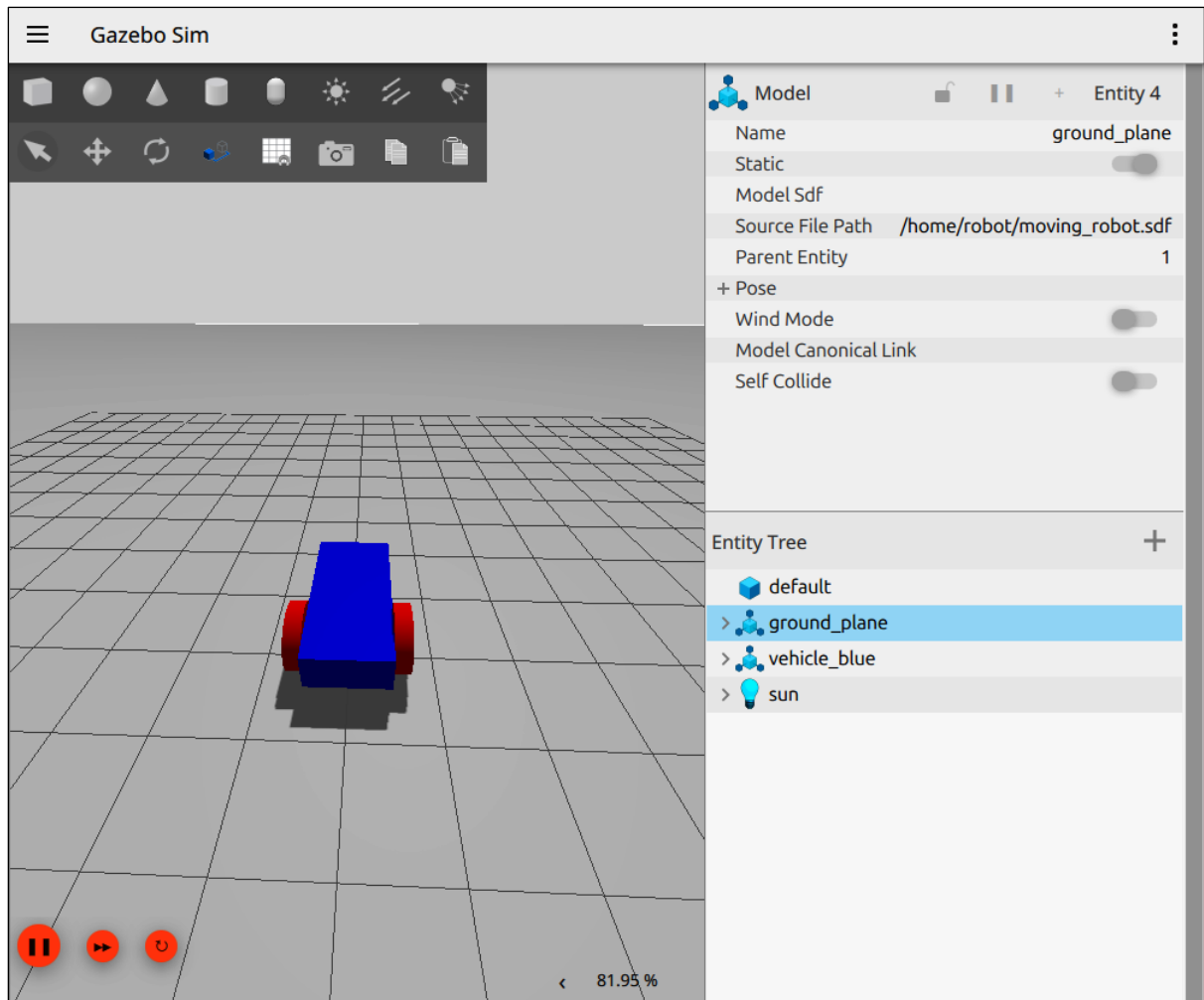
List of available commands:

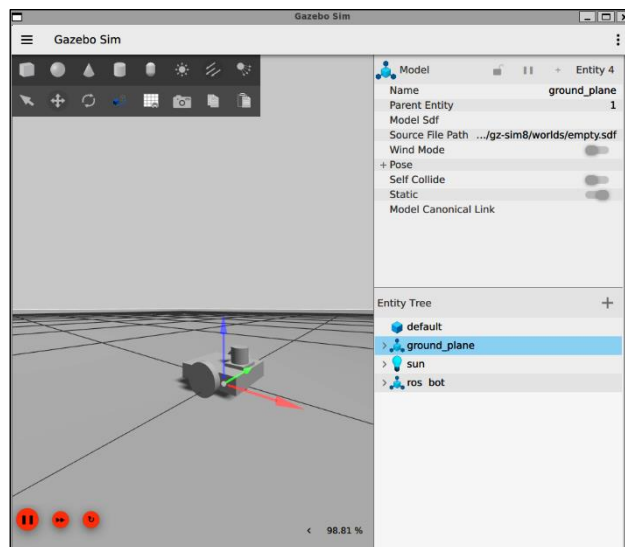
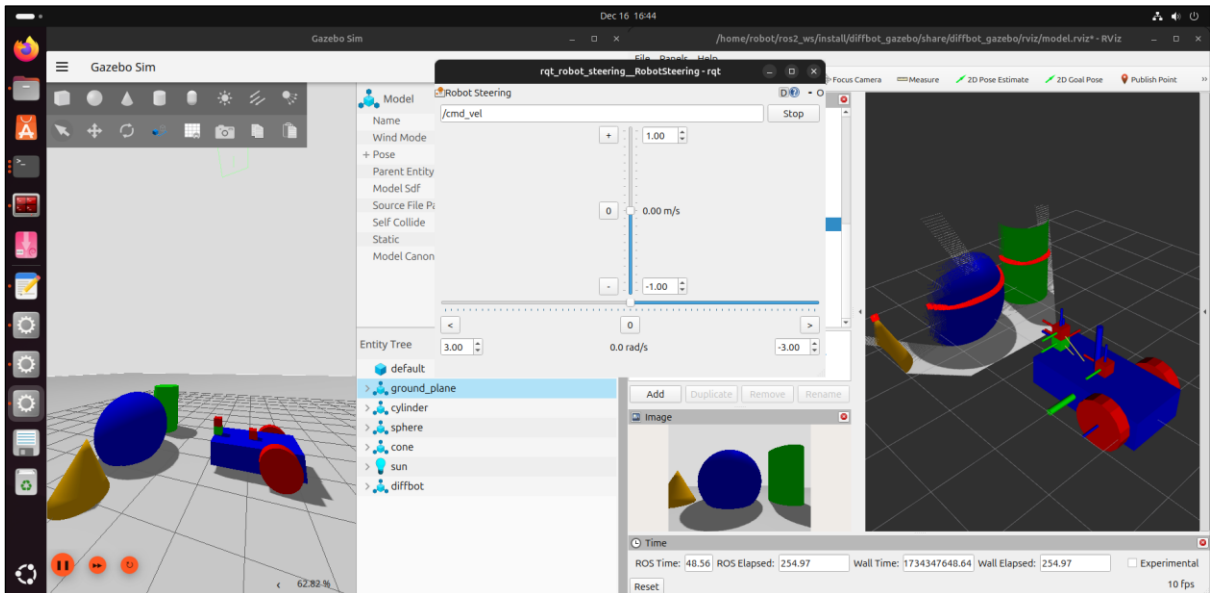
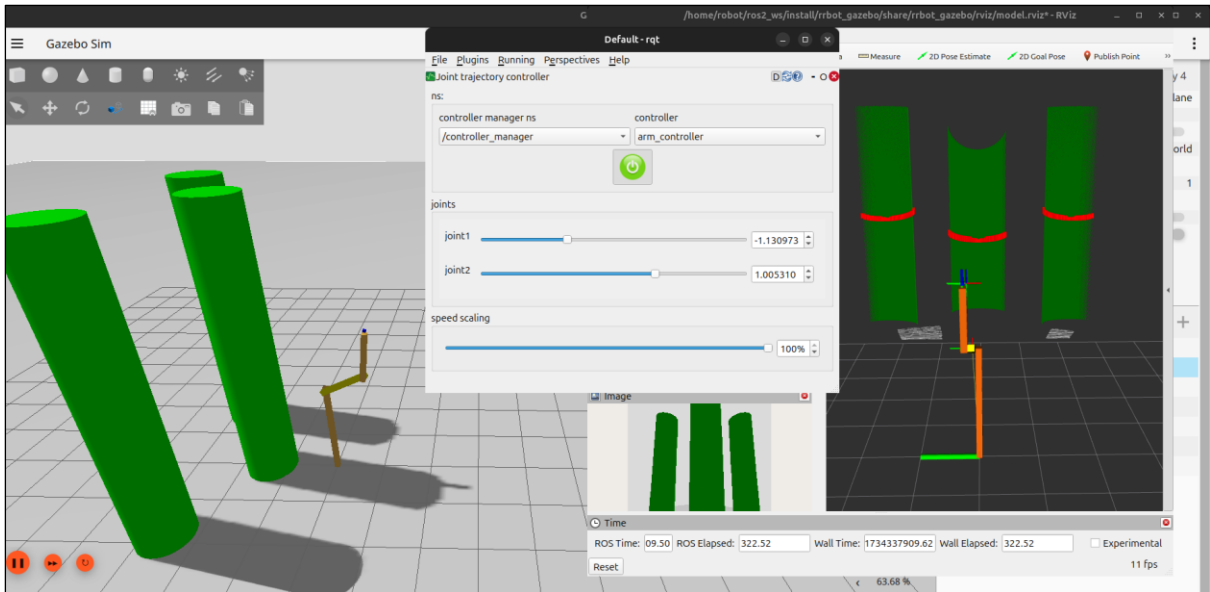
help:	Print this help text.
fuel:	Manage simulation resources.
gui:	Launch graphical interfaces.
log:	Record or playback topics.
model:	Print information about models.
msg:	Print information about messages.
param:	List, get or set parameters.
plugin:	Print information about plugins.
sdf:	Utilities for SDF files.
service:	Print information about services.
sim:	Run and manage the Gazebo Simulator.
topic:	Print information about topics.

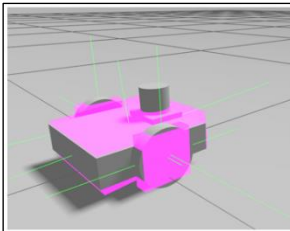
Options:

--force-version <VERSION>	Use a specific library version.
--versions	Show the available versions.
--commands	Show the available commands.

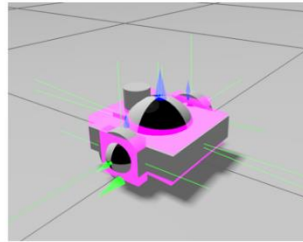
Use 'gz help <command>' to print help for a command.



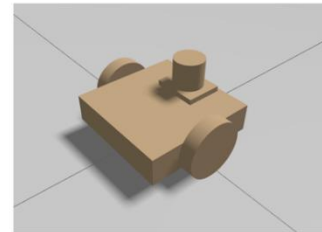




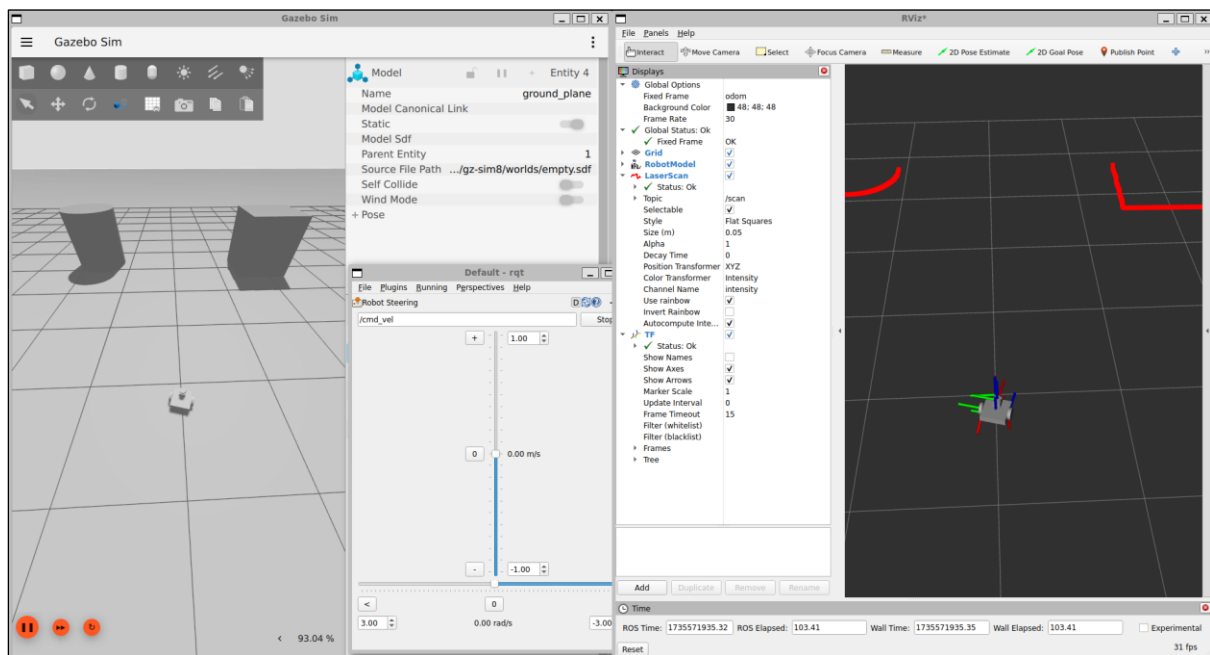
Inertia

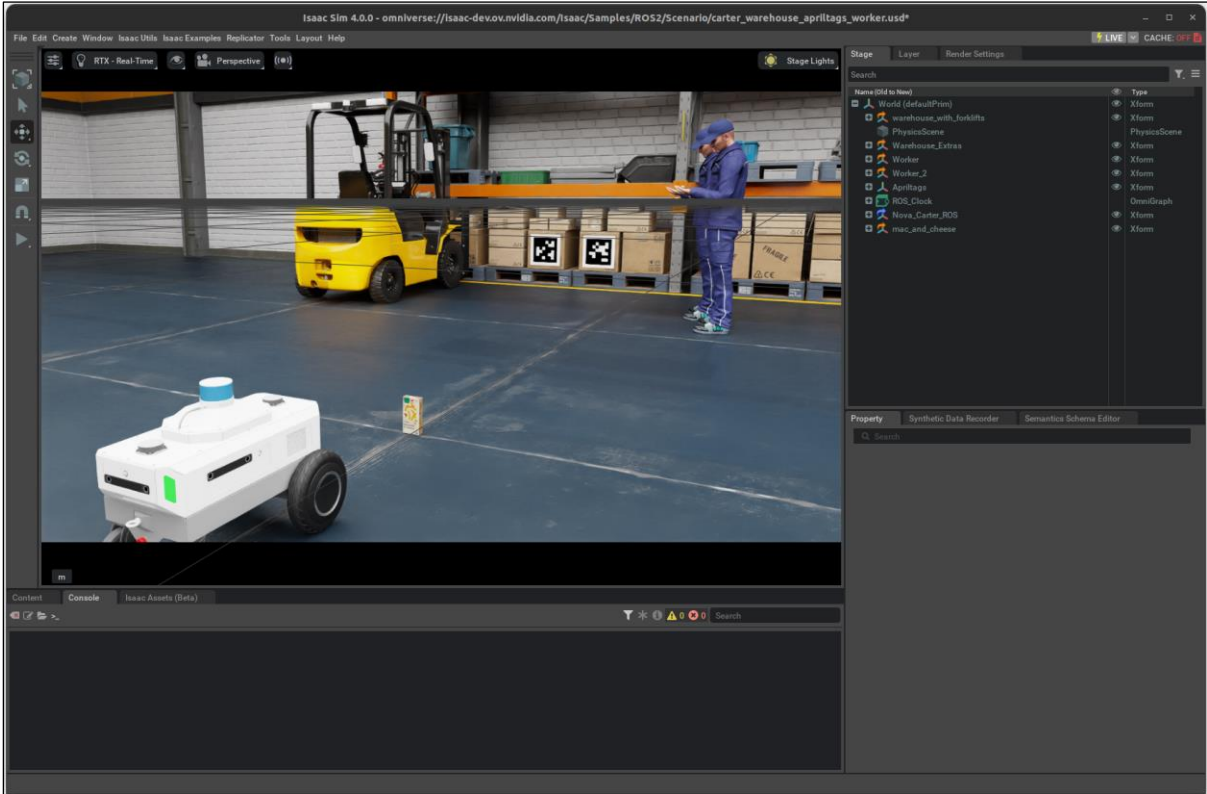
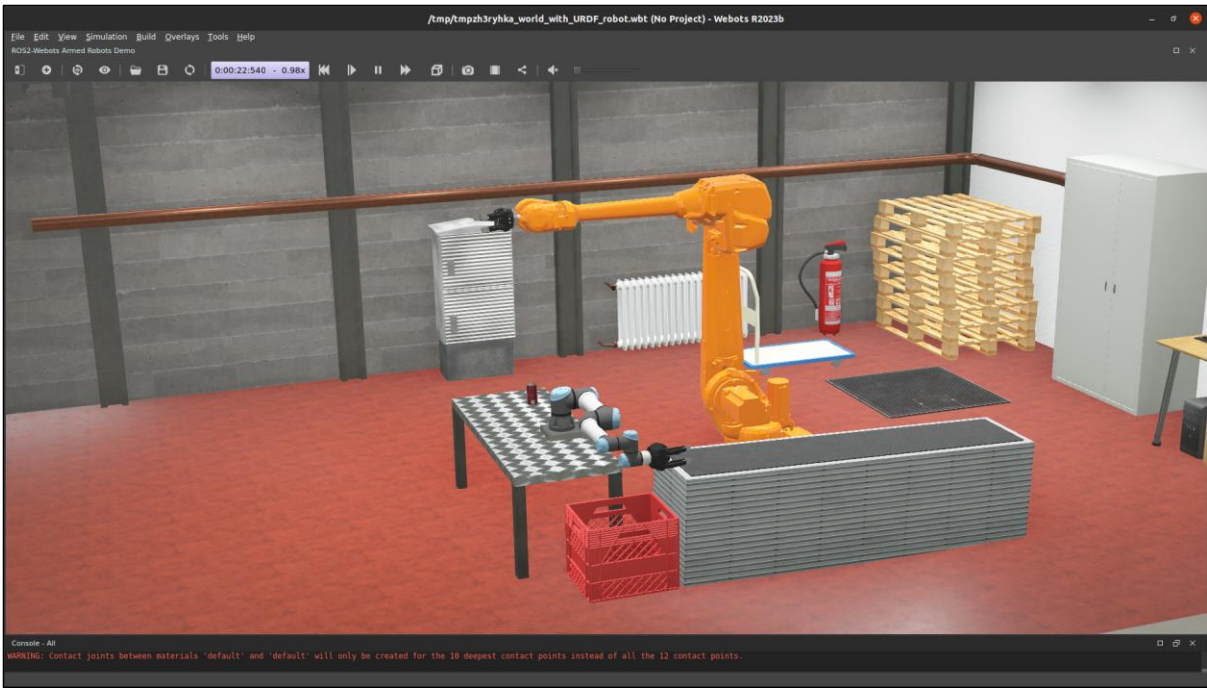


Center of mass

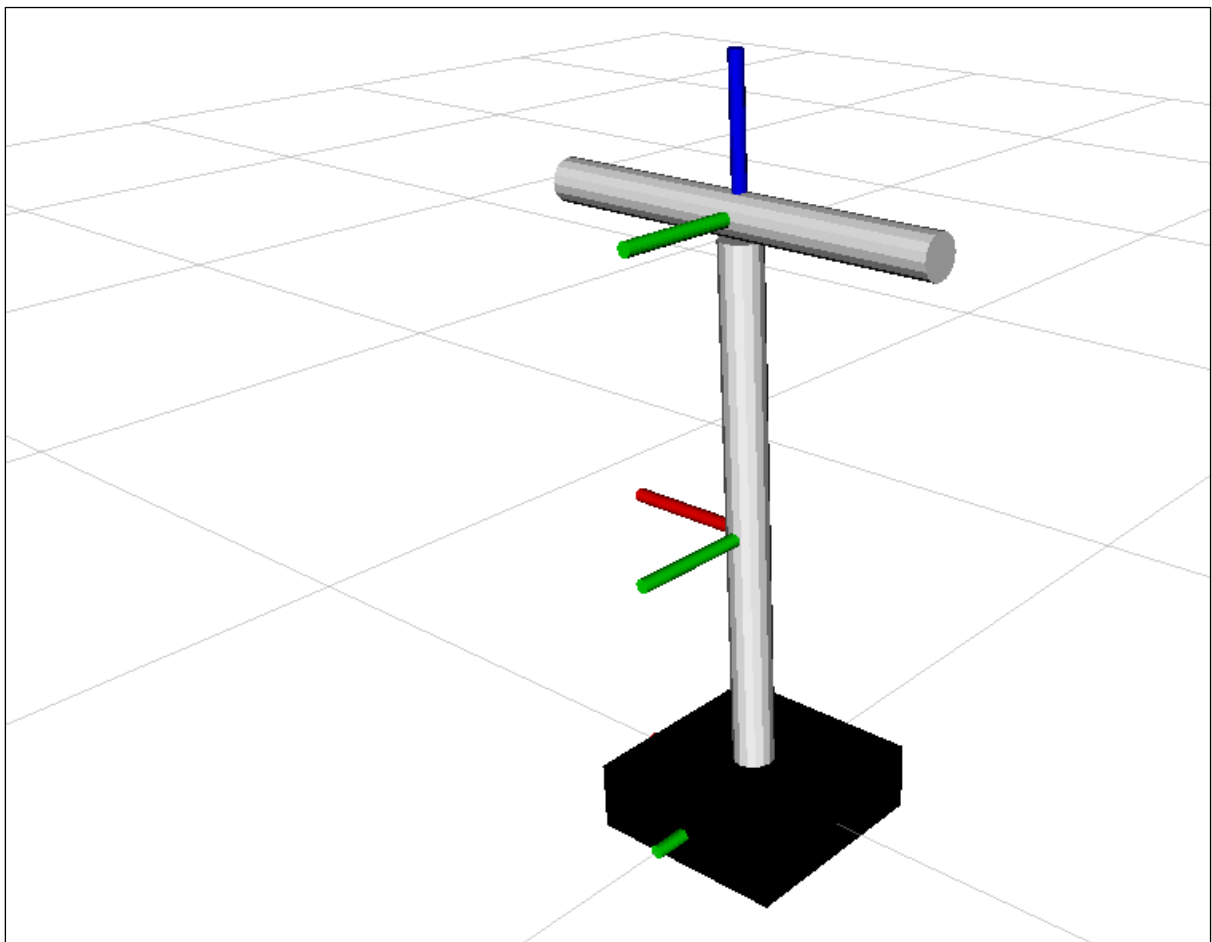
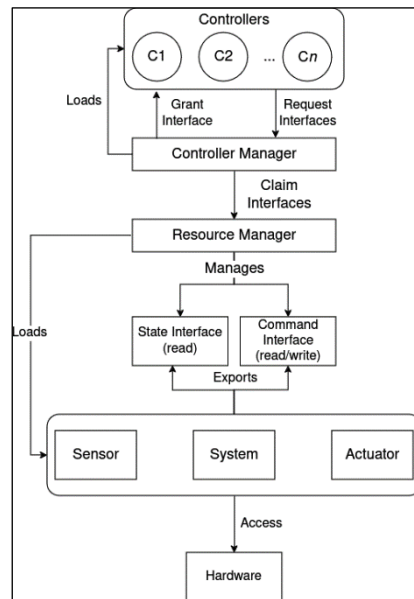


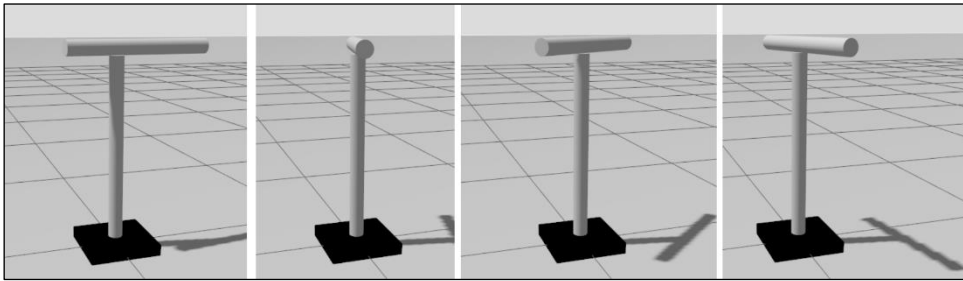
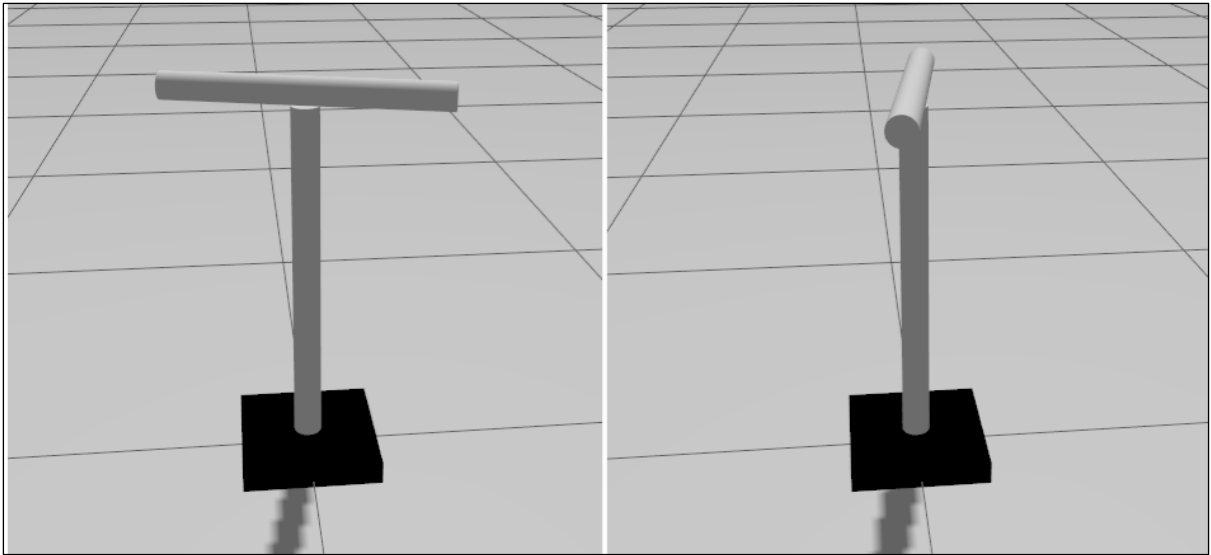
Collision



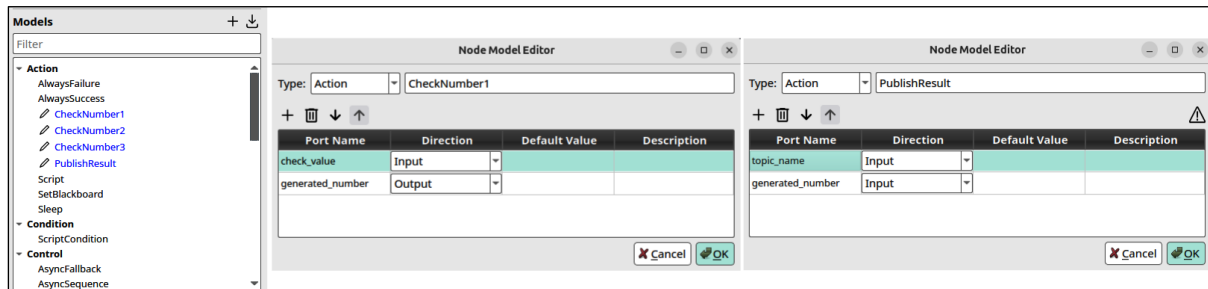
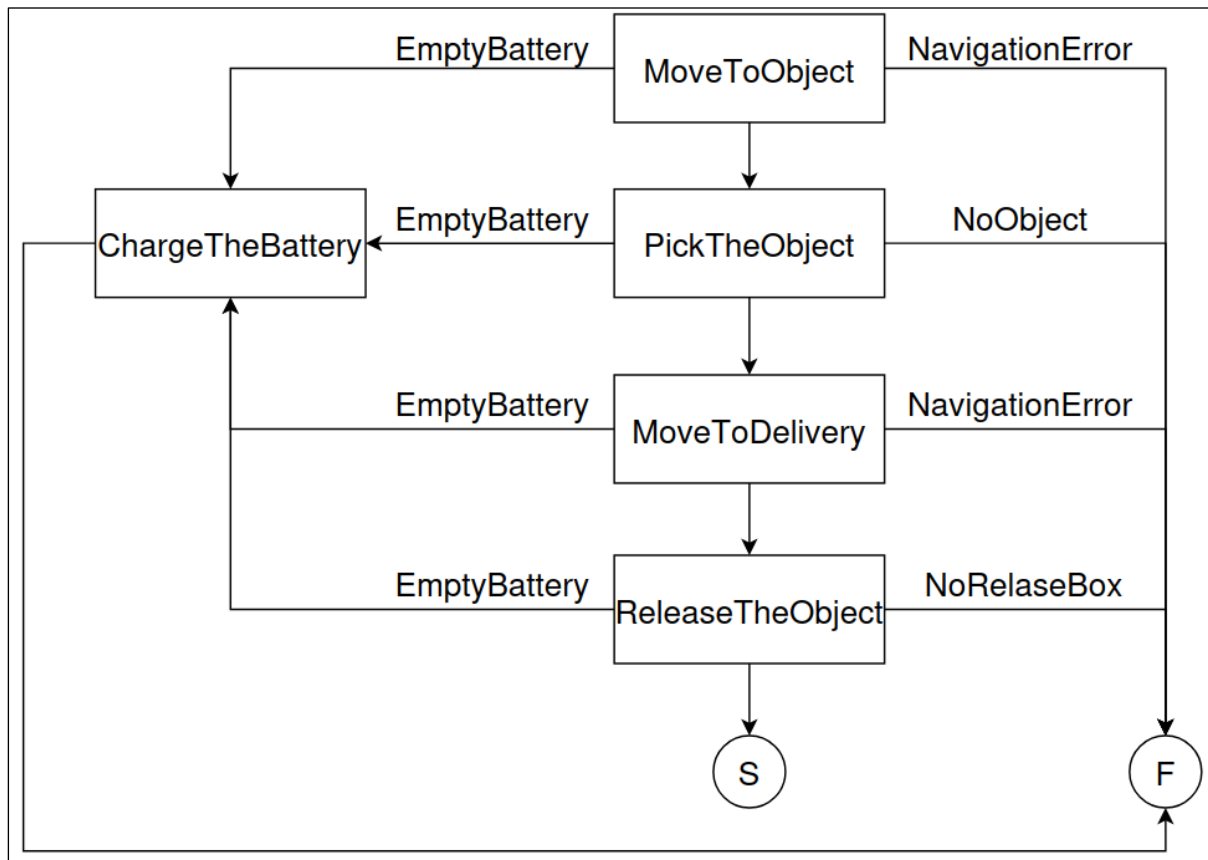


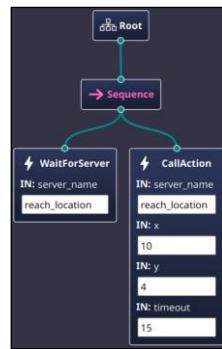
Chapter 6: Controlling Robots Using the ros2_control Package



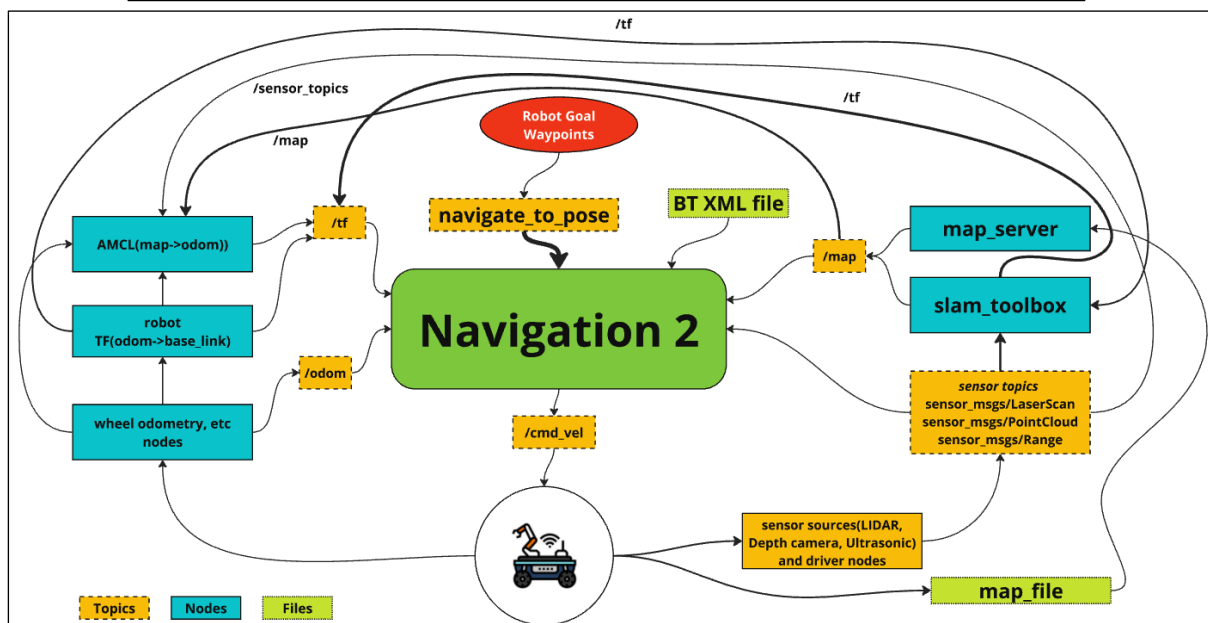
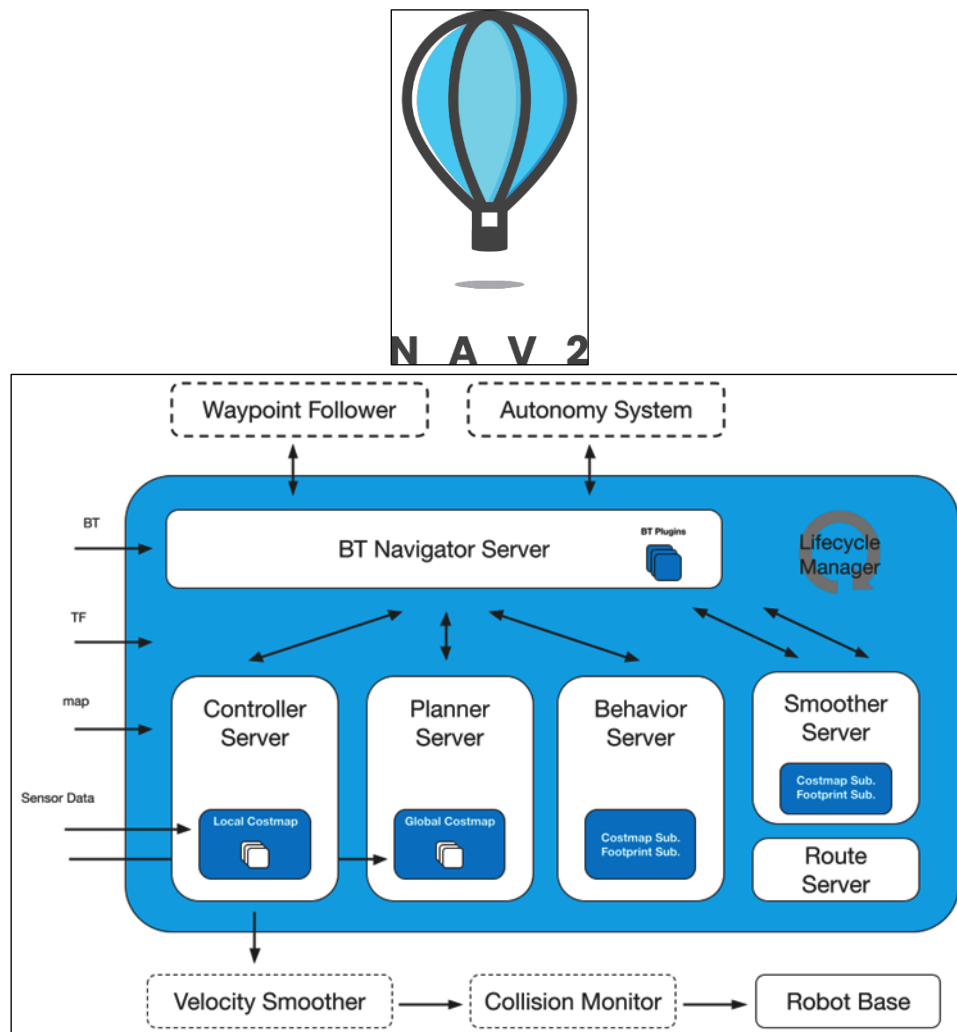


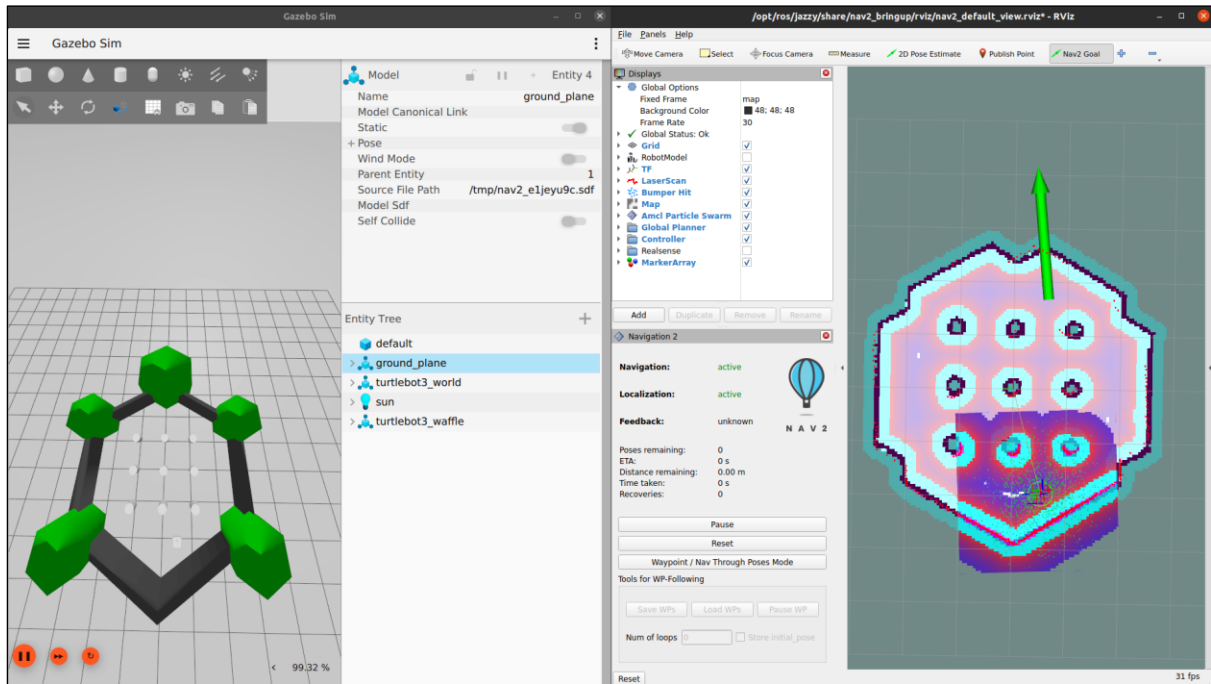
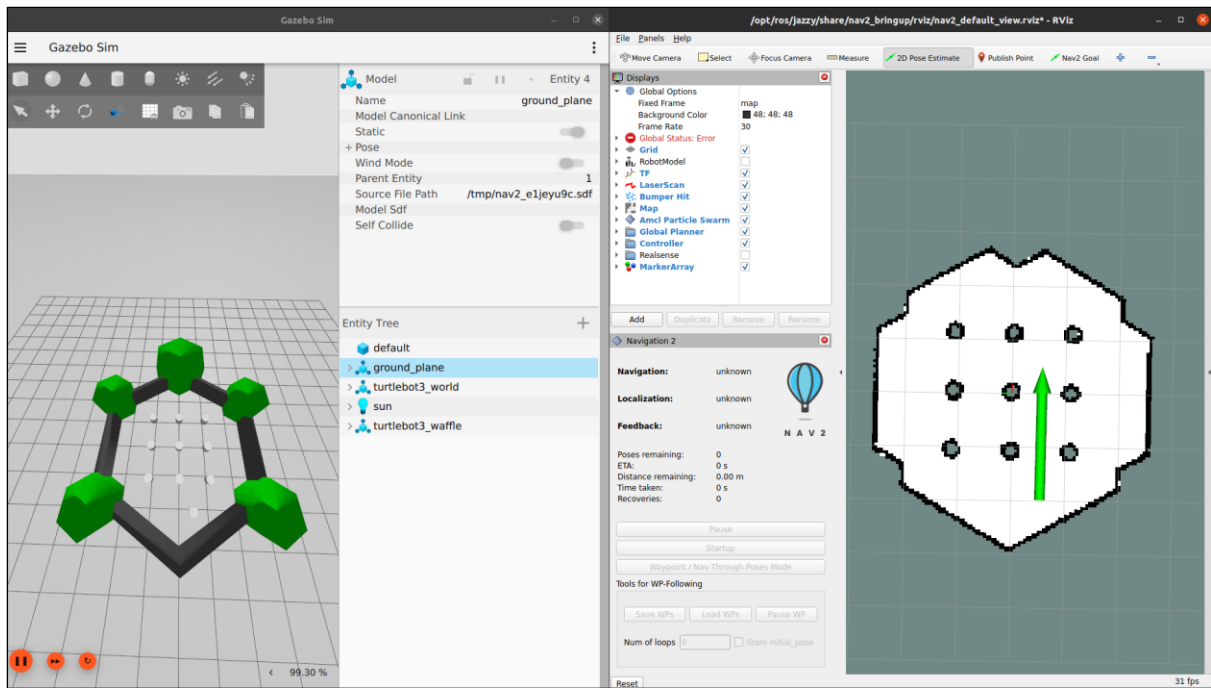
Chapter 7: Implementing ROS 2 Applications using BehaviorTree.CPP

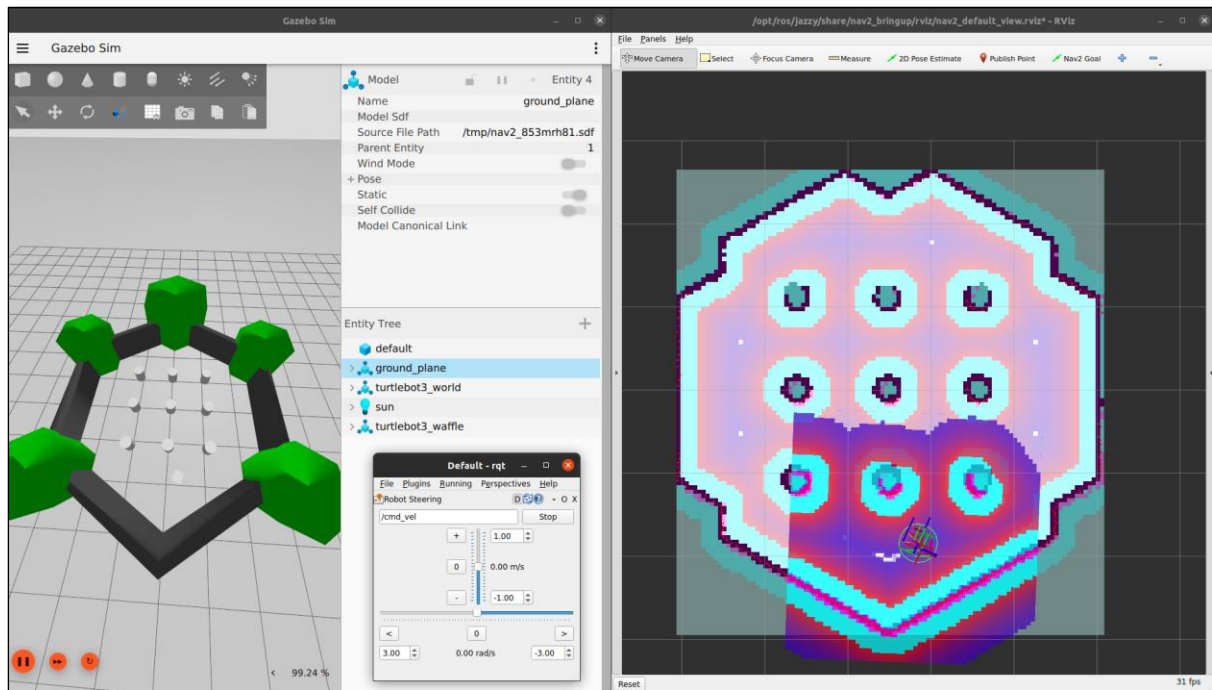




Chapter 8: ROS 2 Navigation Stack: Nav2







SlamToolboxPlugin

Create Map Tool

☐ Interactive Mode ☒ Accept New Scans ☒ Process Scans

Clear Changes Save Changes

Save Map

Serialize Map

Deserialize Map

☒ Start At Dock ☐ Start At Pose Est. ☐ Start At Curr. Odom ☐ Localize

X Y θ

Clear Measurement Queue

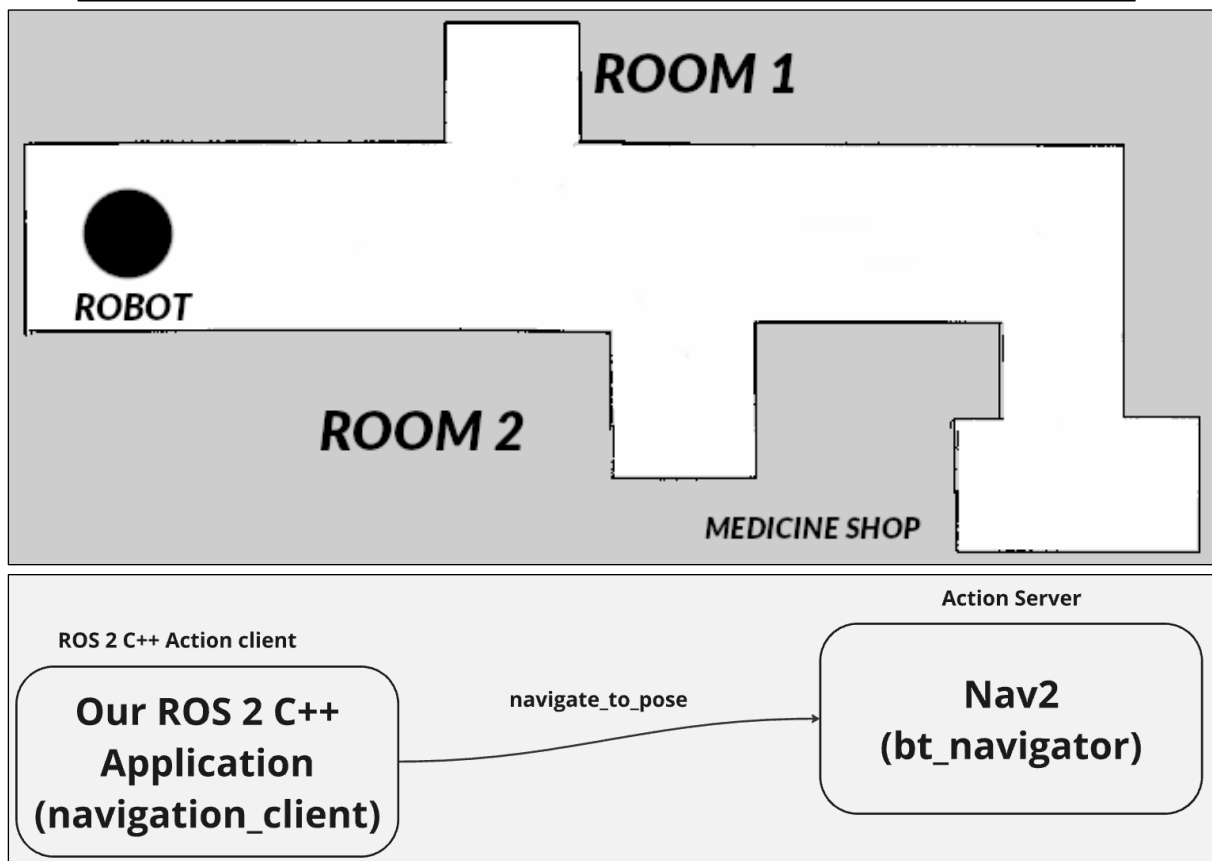
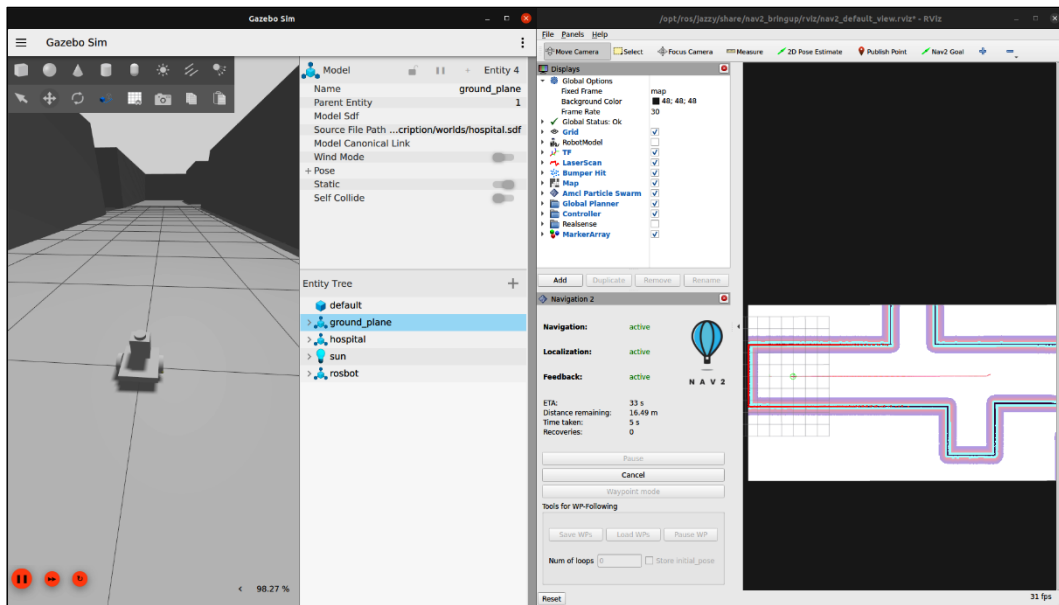
Merge Map Tool

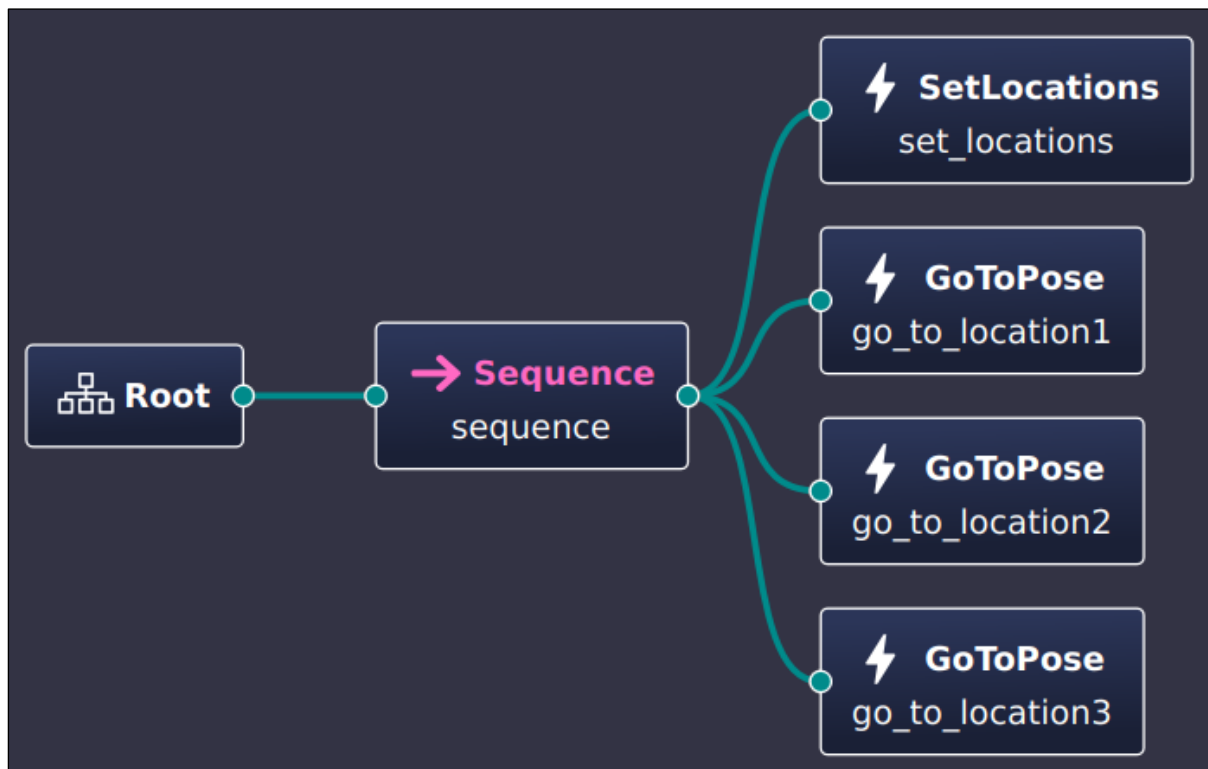
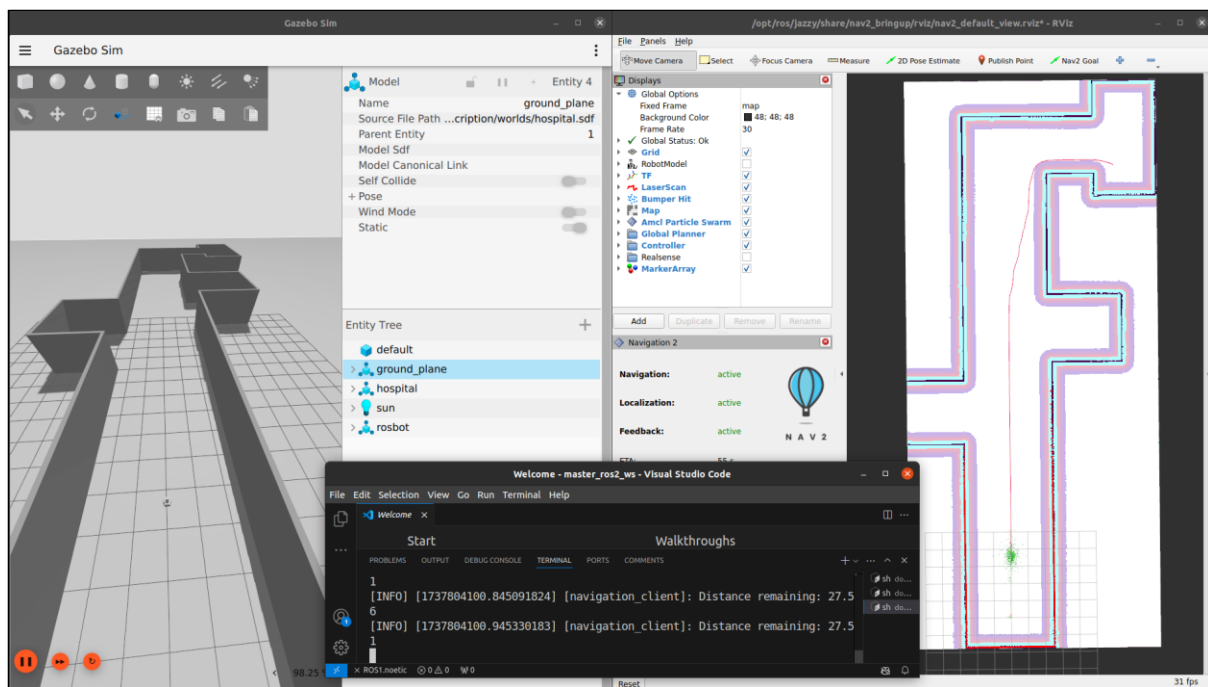
Add Submap

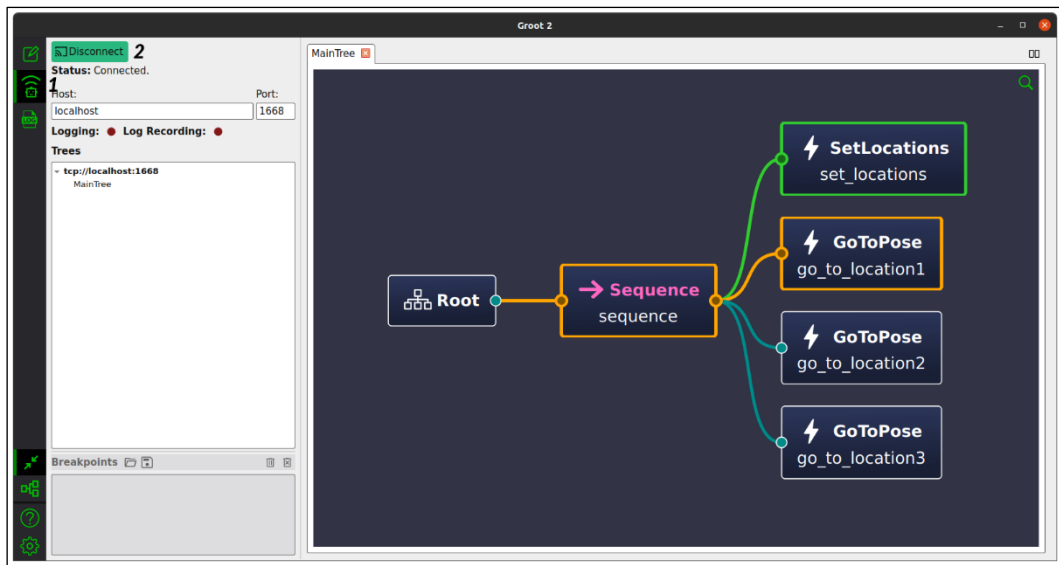
Generate Map

```
.
├── CMakeLists.txt
├── launch
│   ├── nav2.launch.py
│   ├── slam_nav2.launch.py
│   ├── slam_online_async.launch.py
│   └── slam_online_sync.launch.py
├── maps
│   ├── hospital.pgm
│   └── hospital.yaml
├── package.xml
├── params
│   ├── amcl_params.yaml
│   ├── nav2_params.yaml
│   ├── slam_toolbox_async.yaml
│   └── slam_toolbox_sync.yaml
├── README.md
├── rviz
│   └── nav2_default_view.rviz
```

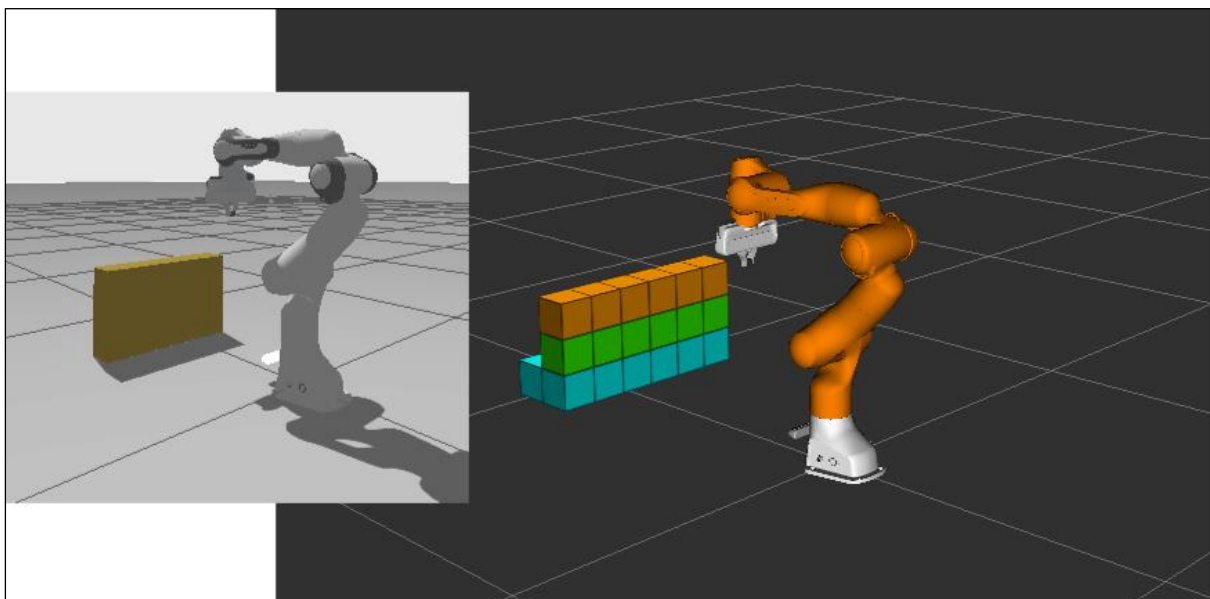
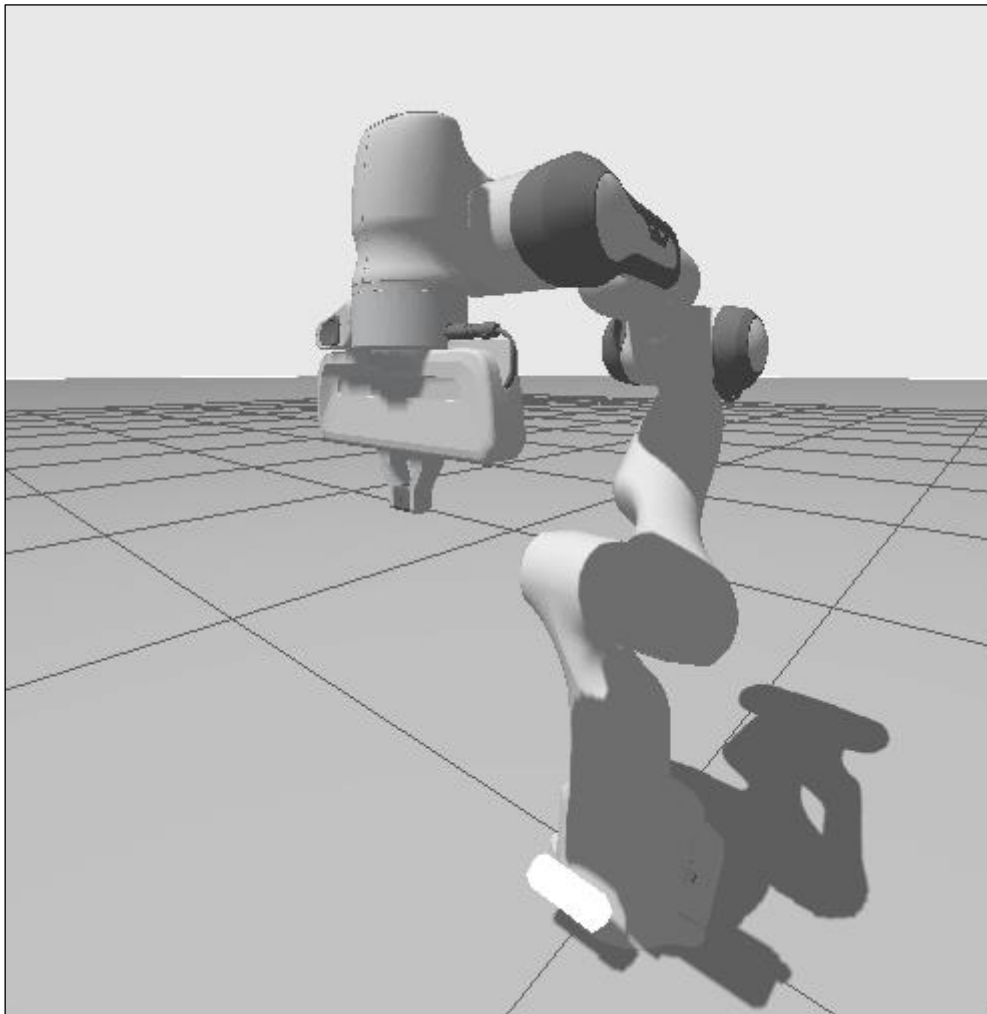
```
.
├── CMakeLists.txt
├── launch
│   ├── nav2.launch.py
│   ├── slam_nav2.launch.py
│   ├── slam_online_async.launch.py
│   └── slam_online_sync.launch.py
├── maps
│   ├── hospital.pgm
│   └── hospital.yaml
├── package.xml
├── params
│   ├── amcl_params.yaml
│   ├── nav2_params.yaml
│   ├── slam_toolbox_async.yaml
│   └── slam_toolbox_sync.yaml
├── README.md
├── rviz
│   └── nav2_default_view.rviz
```

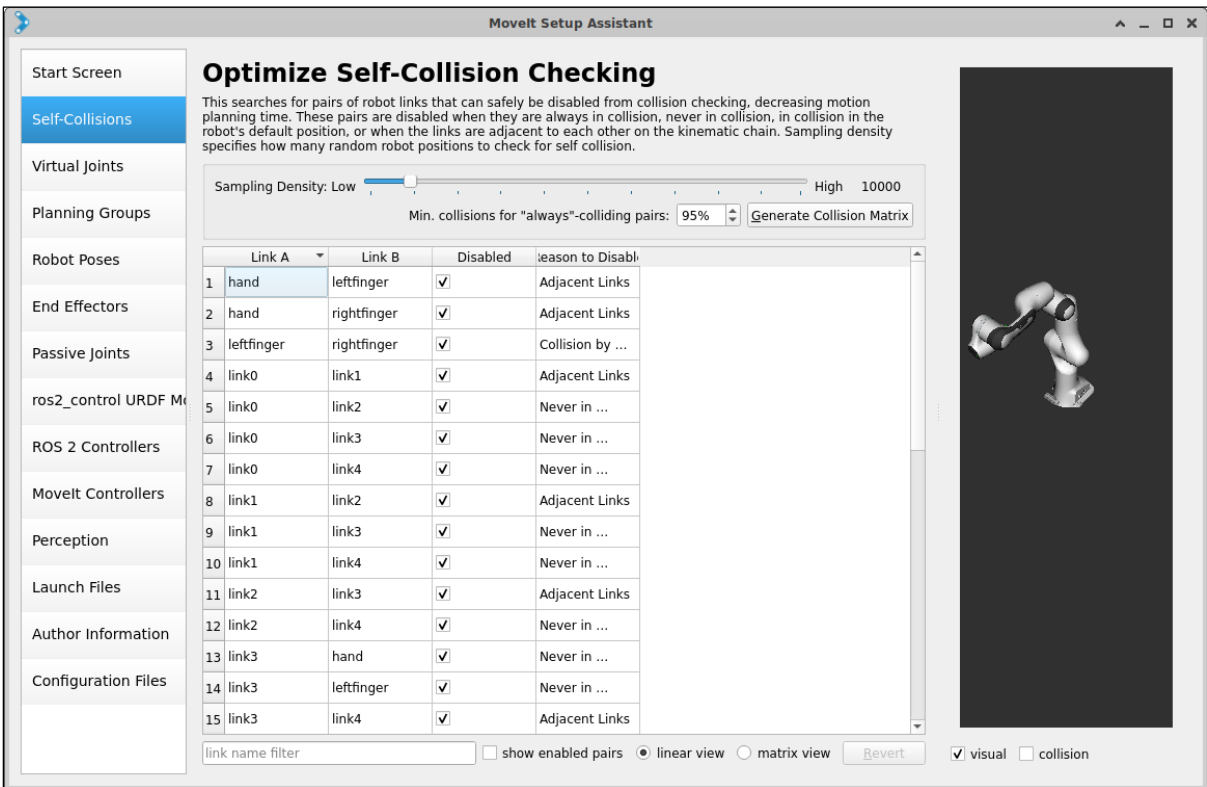
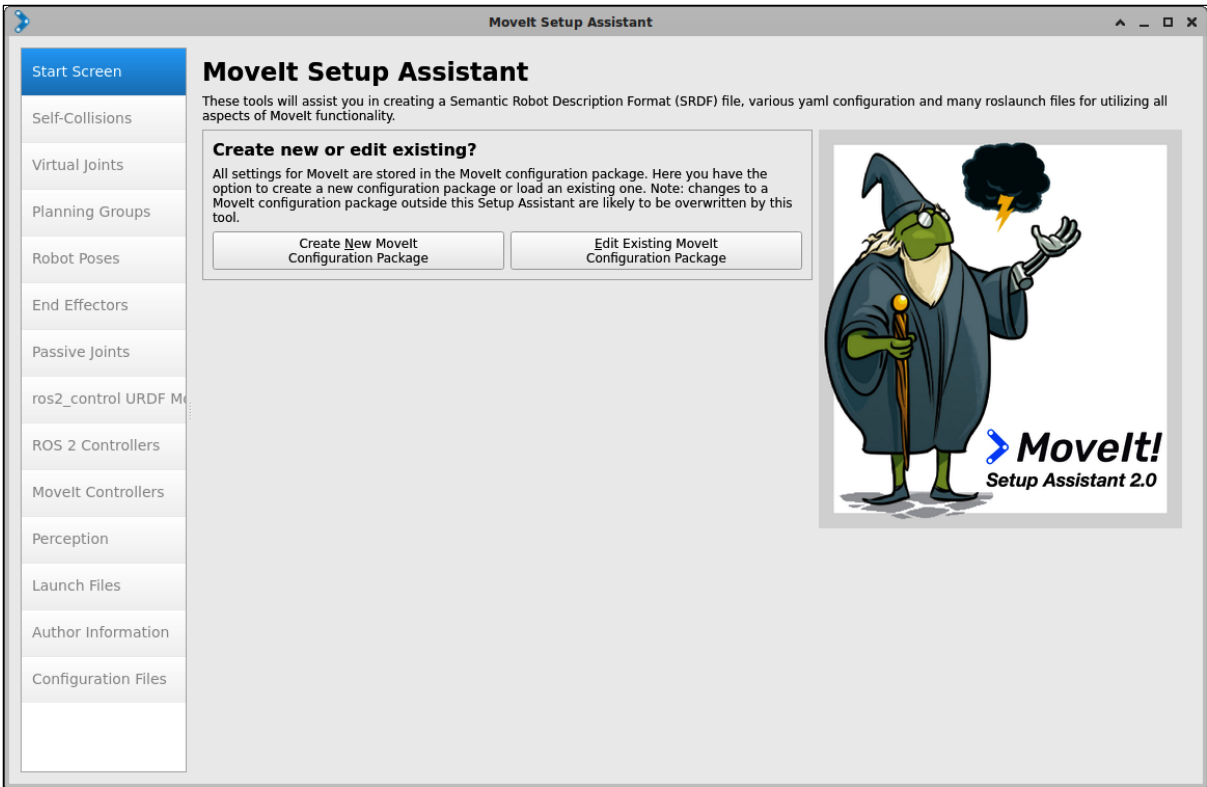


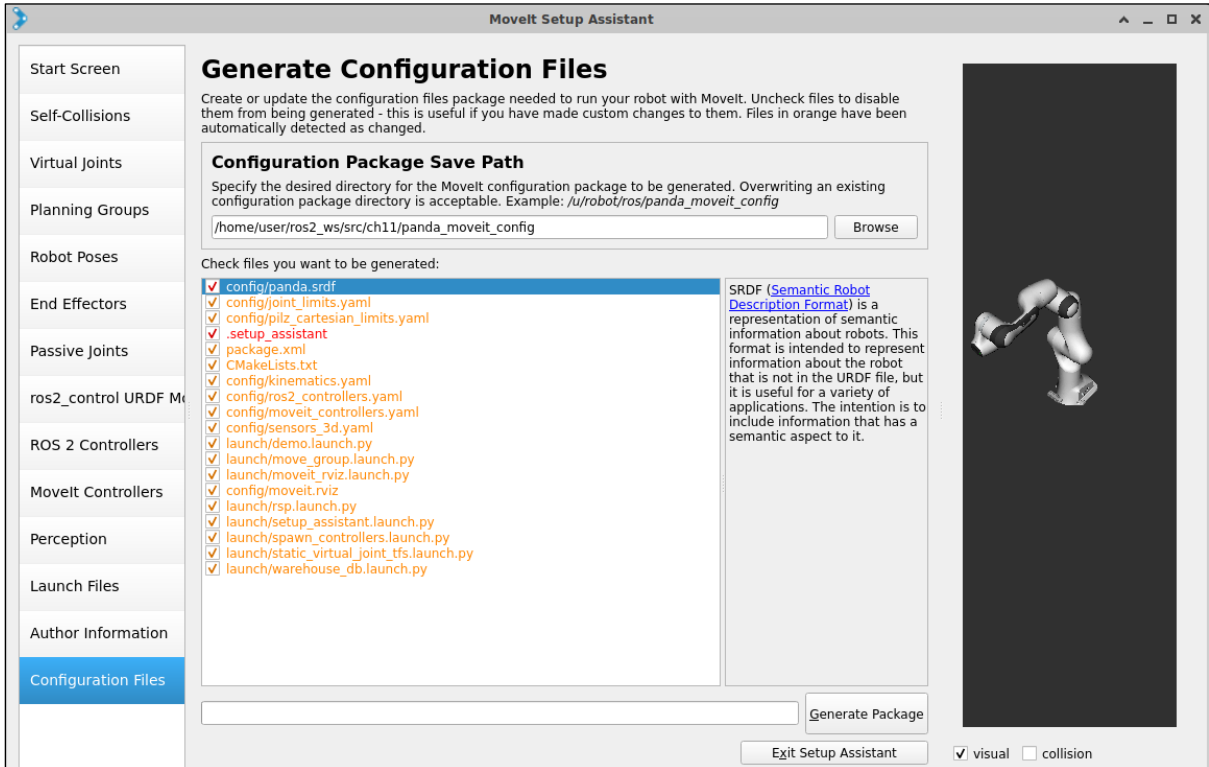
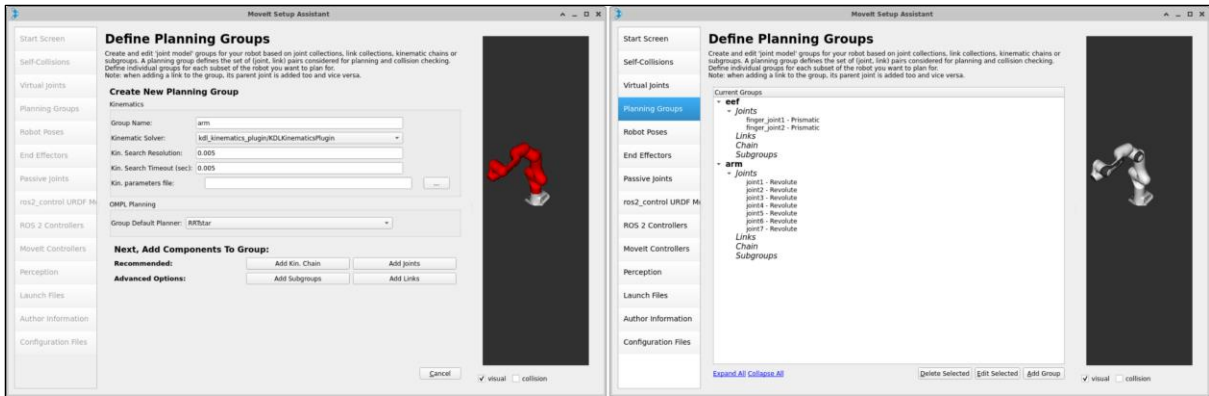


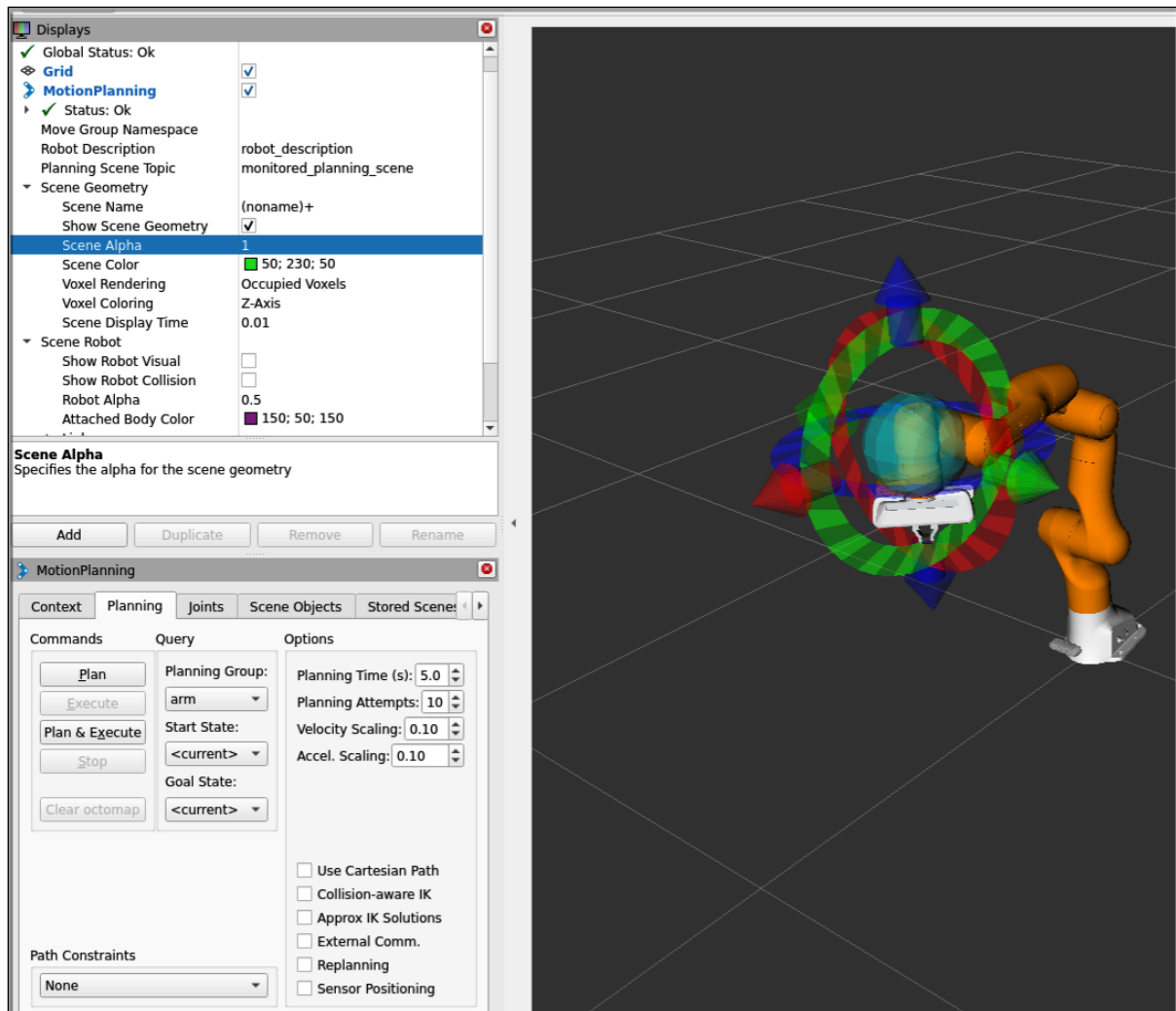


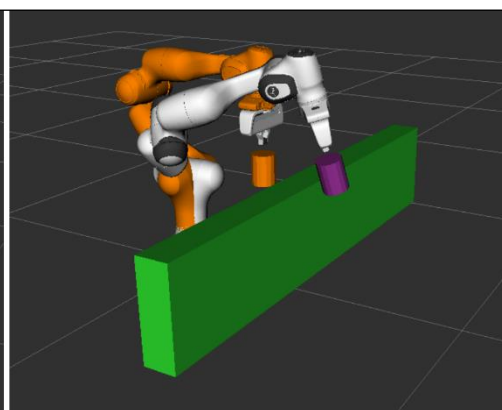
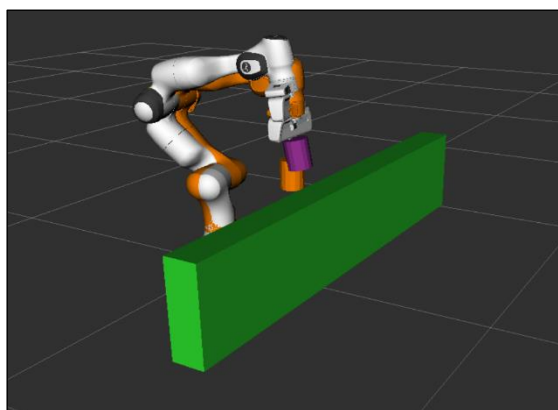
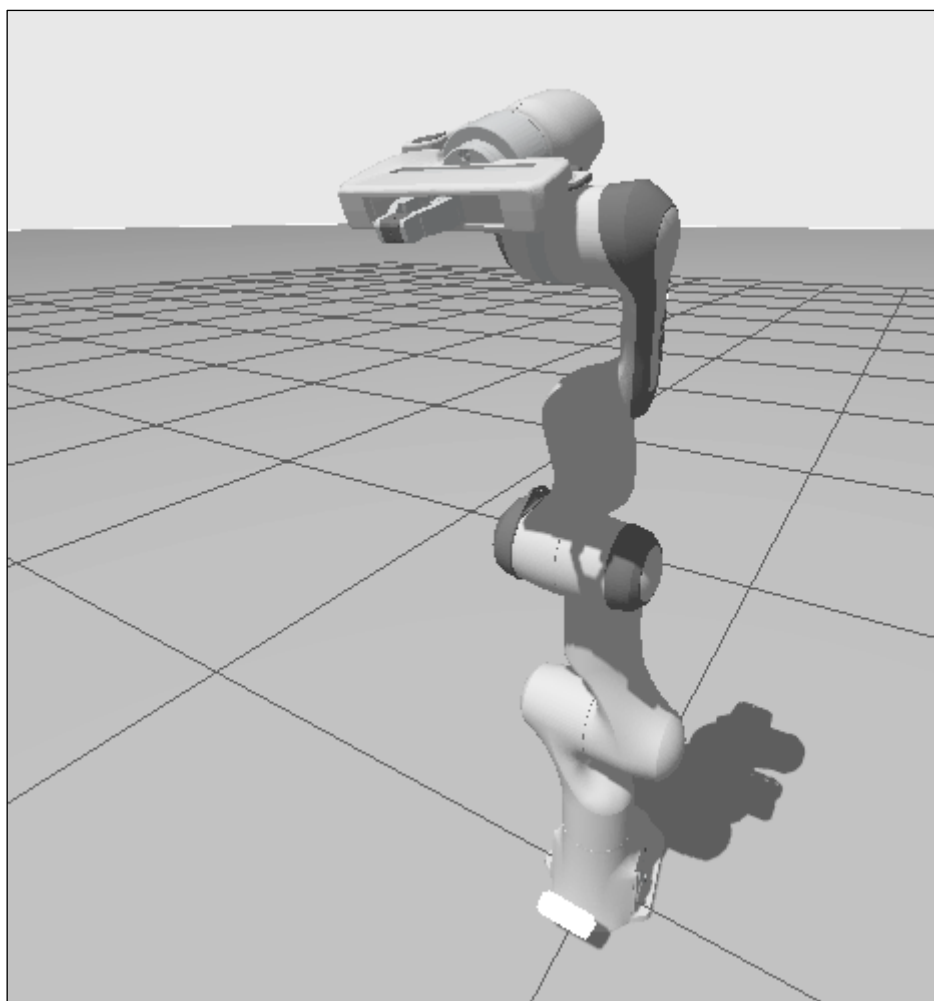
Chapter 9: Robot Manipulation Using MoveIt 2











Start Screen

Self-Collisions

Virtual Joints

Planning Groups

Robot Poses

End Effectors

Passive Joints

ros2_control URDF Model

ROS 2 Controllers

MoveIt Controllers

Perception

Launch Files

Author Information

Configuration Files

Setup 3D Perception Sensors

Configure your 3D sensors to work with MoveIt. Please see [Perception Documentation](#) for more details.

Optionally choose a type of 3D sensor plugin to configure:

Point Cloud

Point Cloud

Point Cloud Topic:

/depth_camera/points

Max Range:

5.0

Point Subsample:

1

Padding Offset:

0.1

Padding Scale:

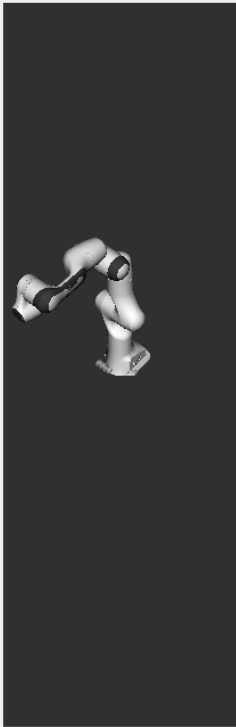
1.0

Filtered Cloud Topic:

filtered_cloud

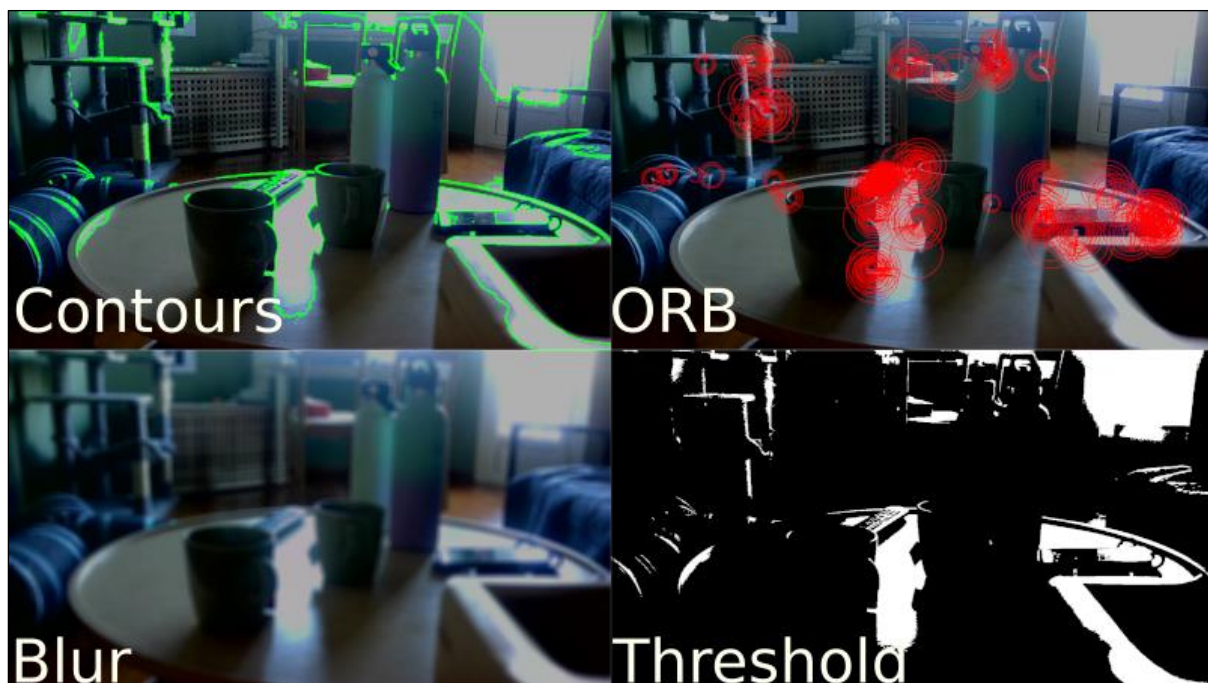
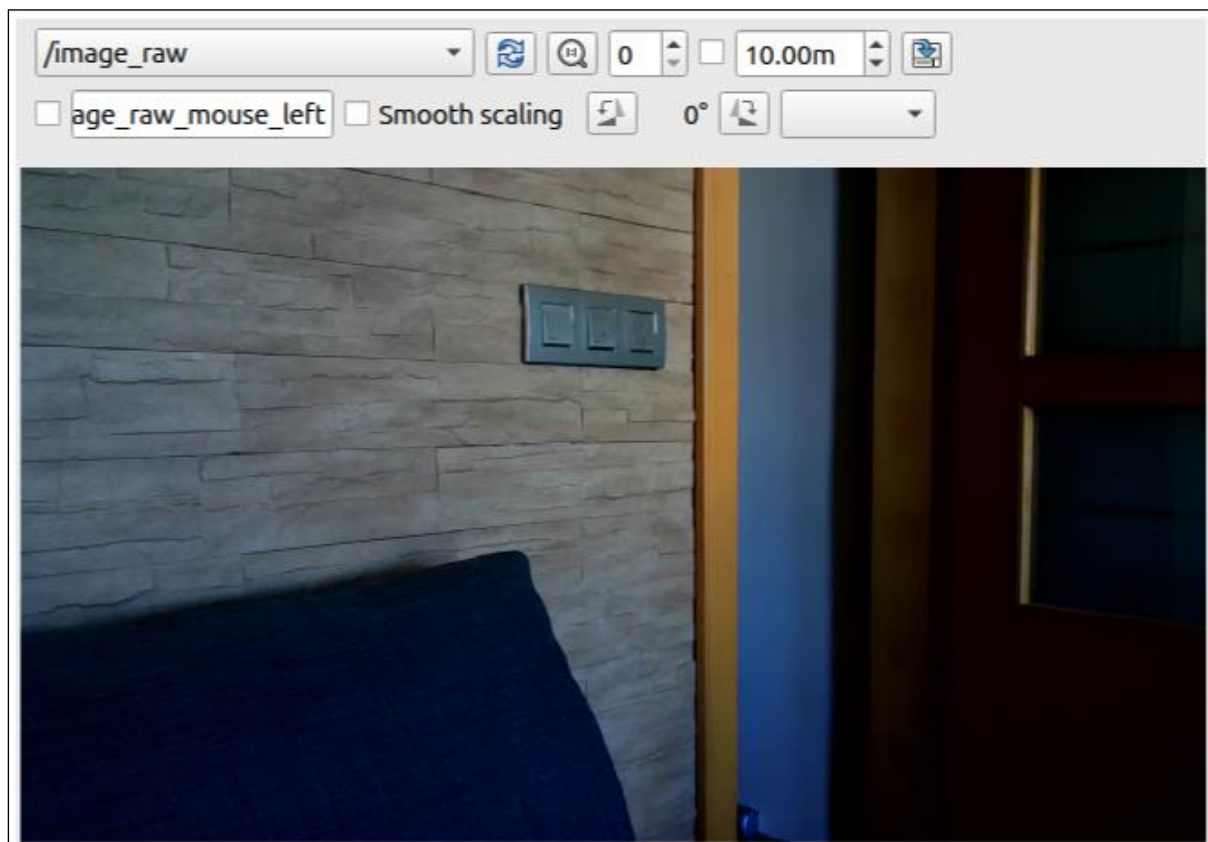
Max Update Rate:

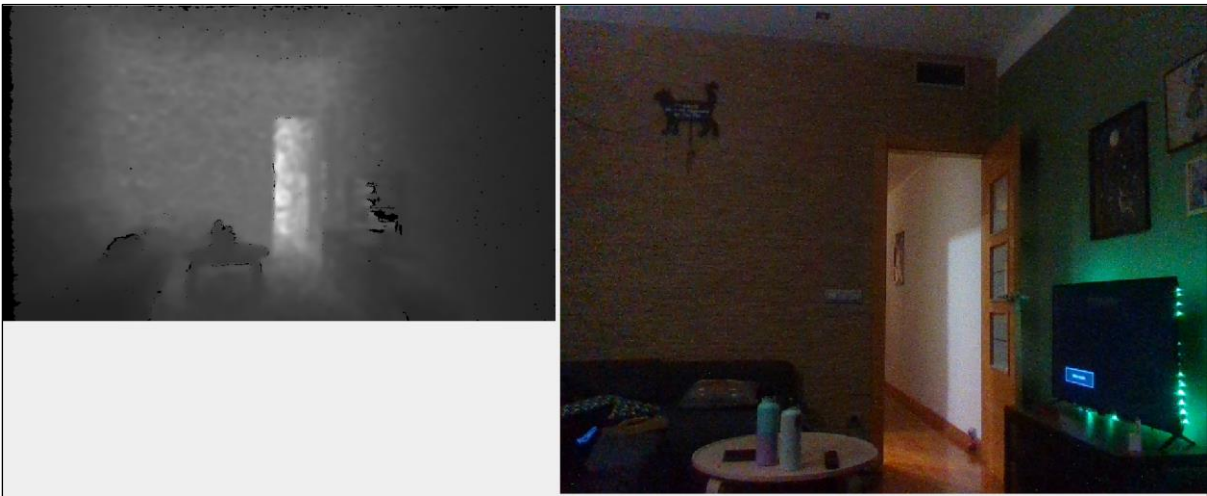
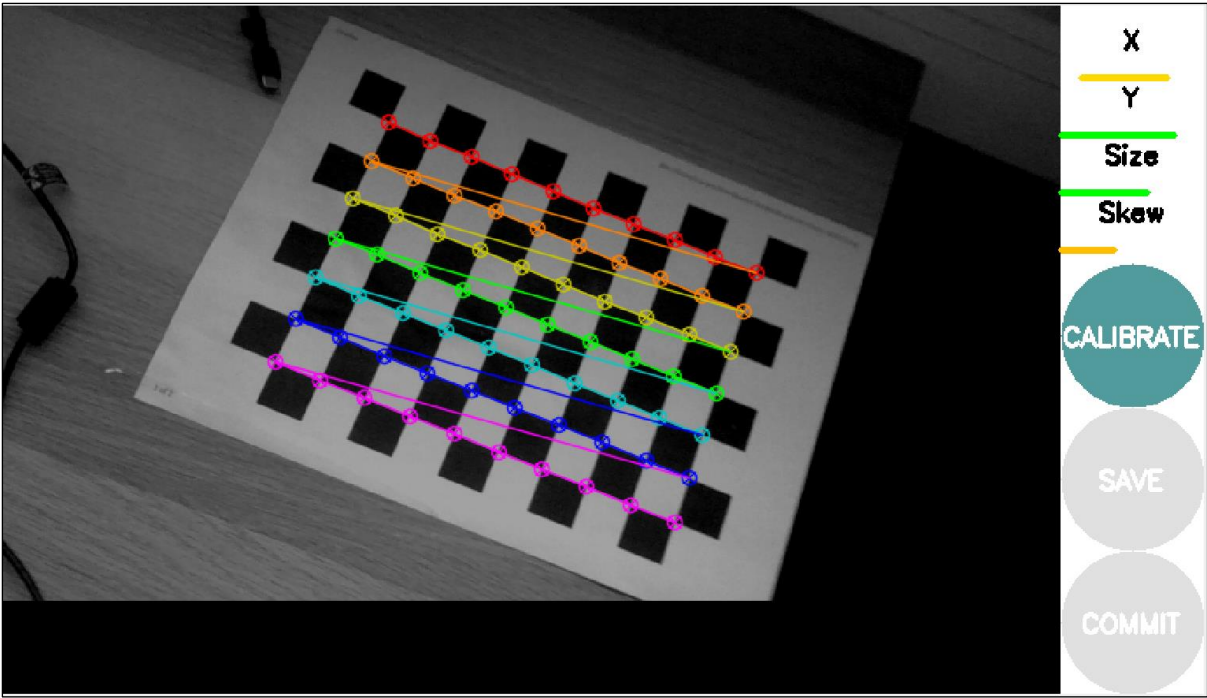
1.0

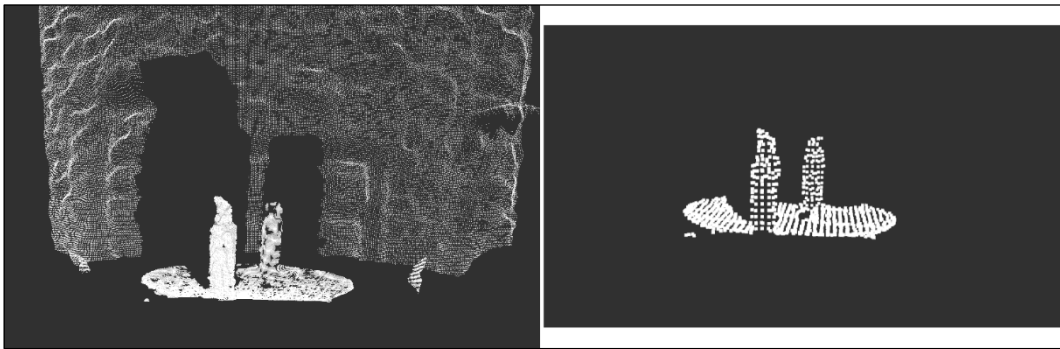
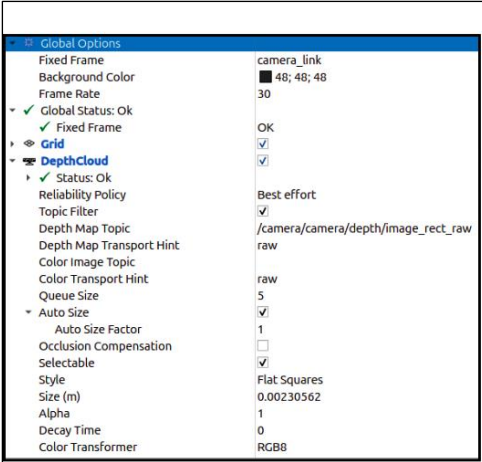


☒ visual ☐ collision

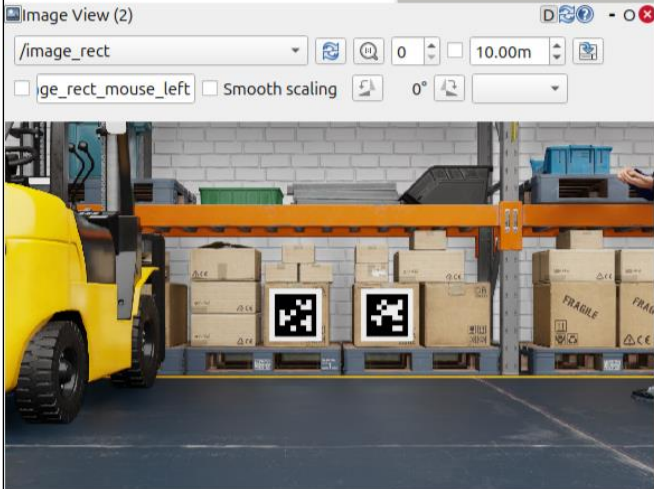
Chapter 10: Working with ROS 2 and Perception Stack





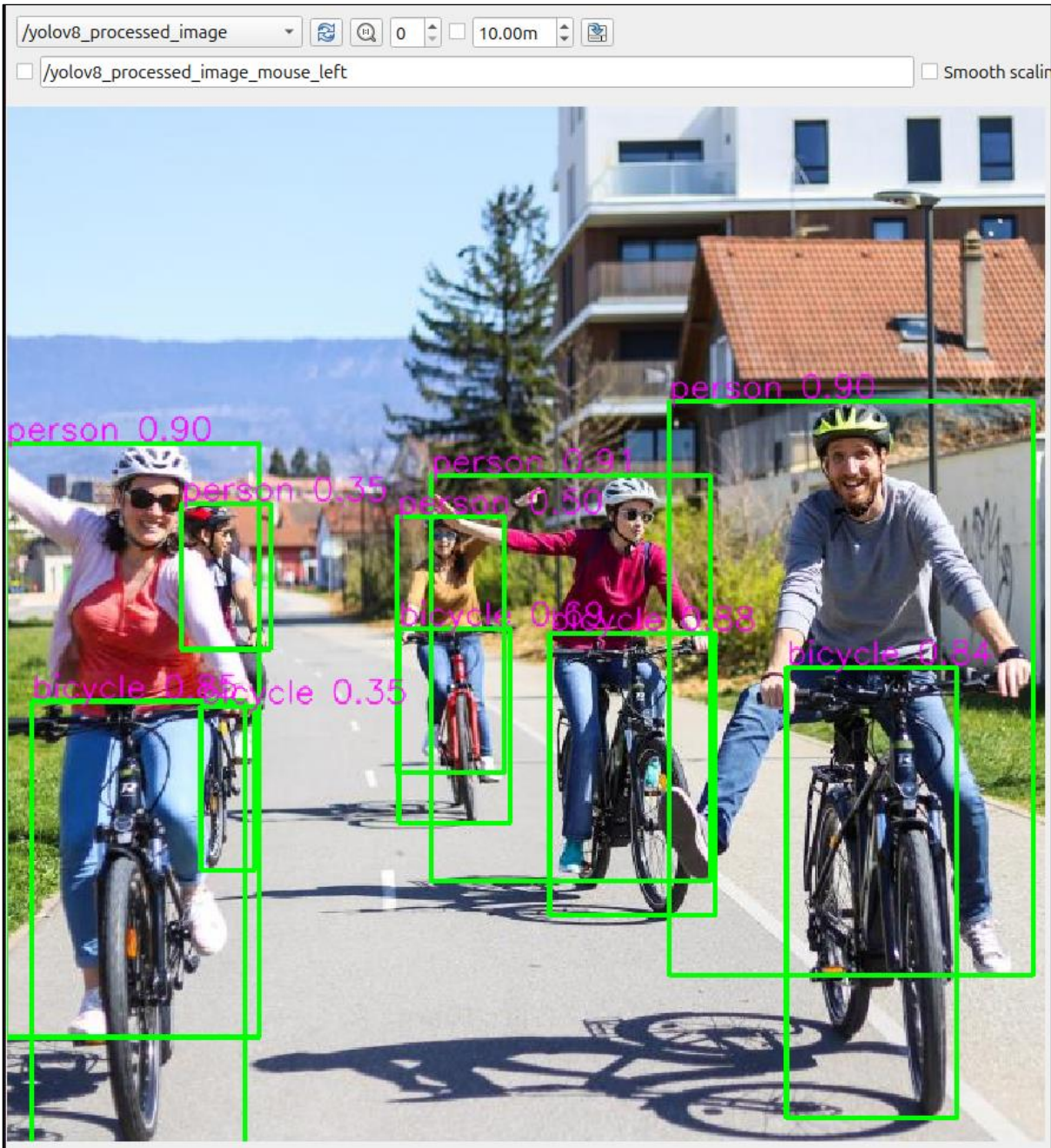


Operating System	Linux	Windows						
Architecture	x86_64	arm64-sbsa	aarch64-jetson					
Distribution	Amazon-Linux	Azure-Linux	Debian	Fedora	KylinOS	OpenSUSE	RHEL	Rocky
	SLES	Ubuntu	WSL-Ubuntu					
Version	20.04	22.04	24.04					
Installer Type	deb (local)	deb (network)	runfile (local)					

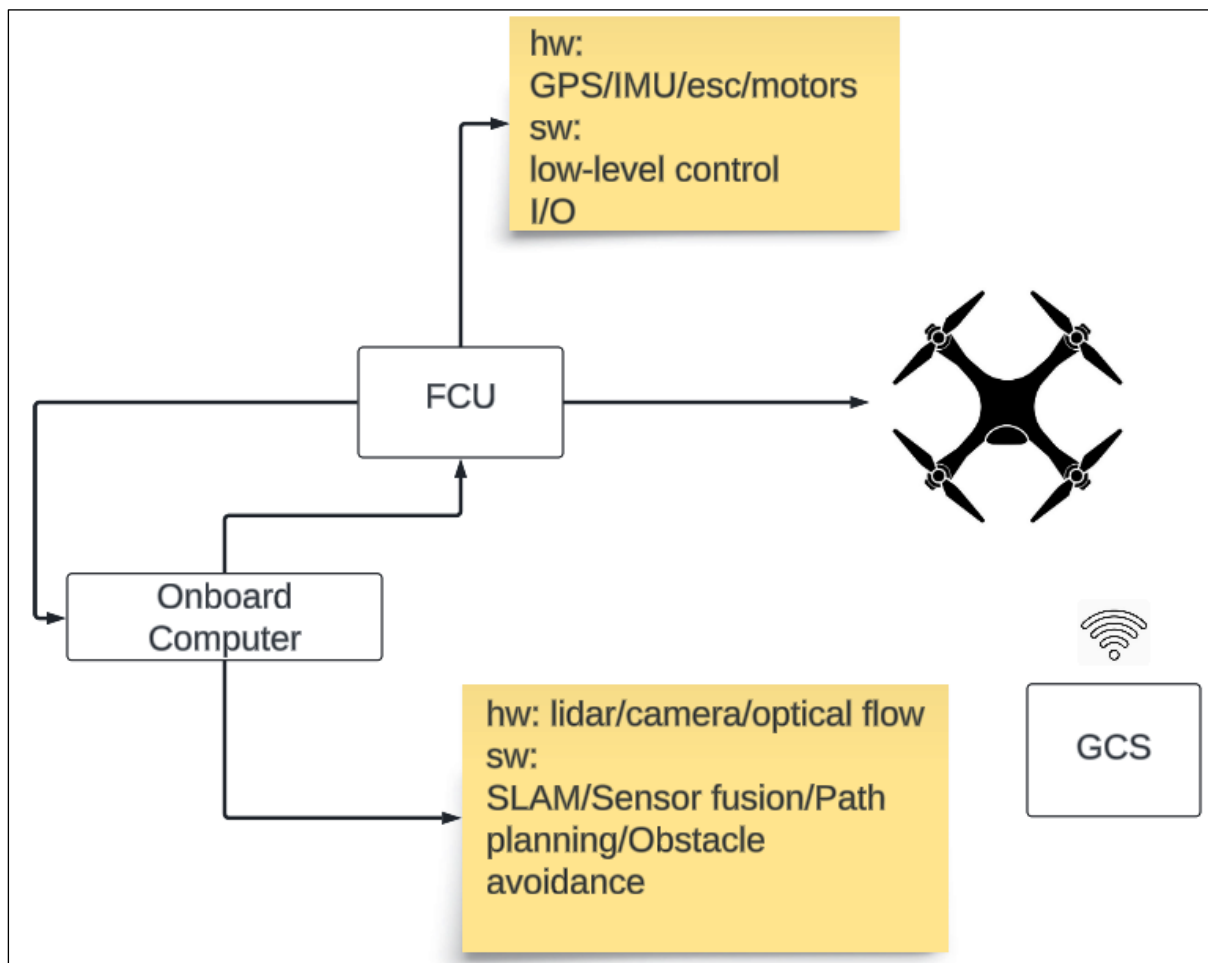


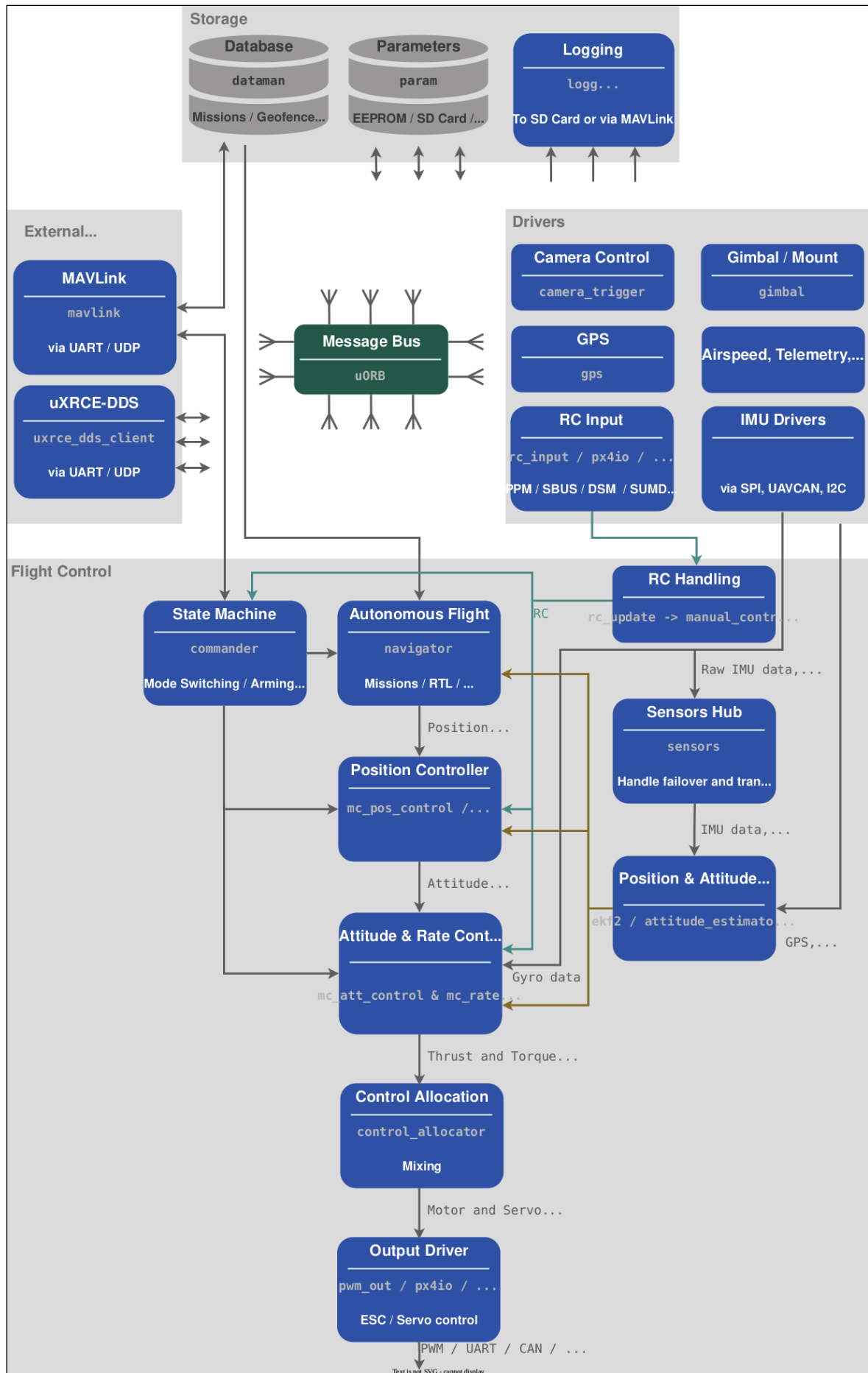
tag3ev11.0 tag3ev11.2

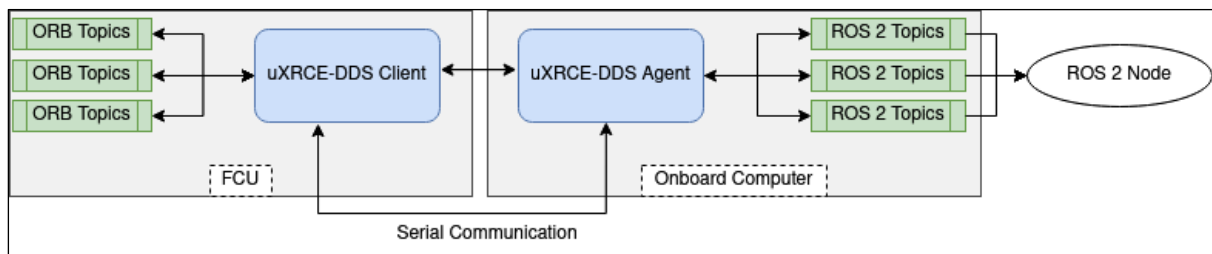
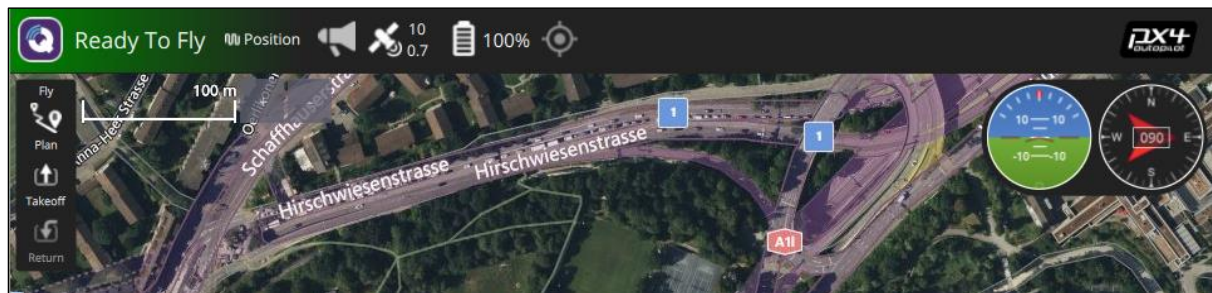
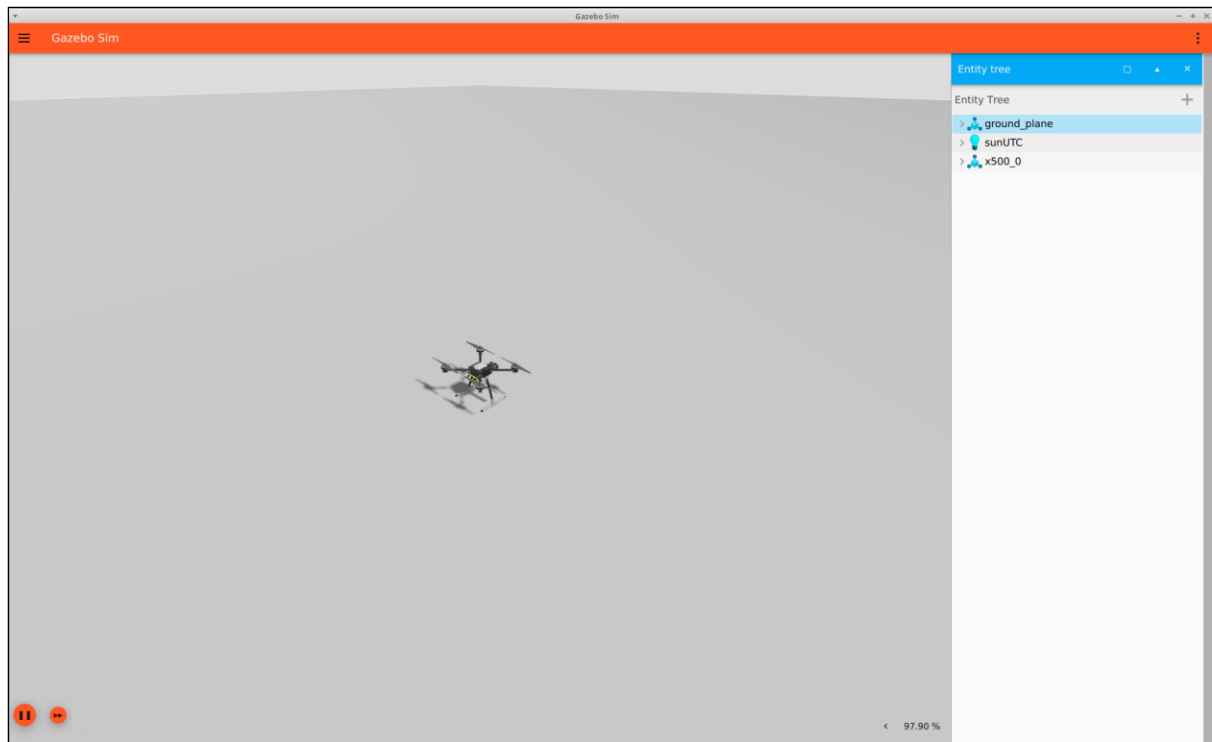
carter_camera_stereo

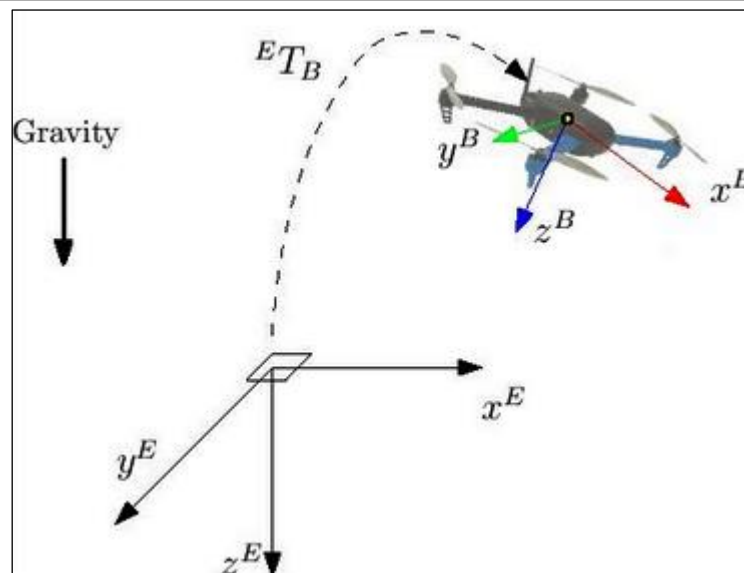
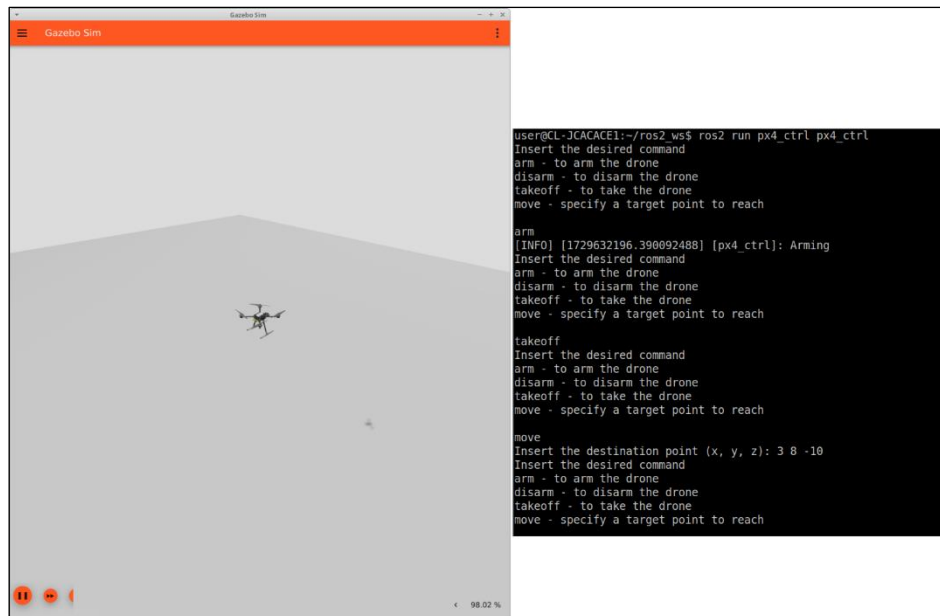


Chapter 11: Aerial Robotics and ROS 2

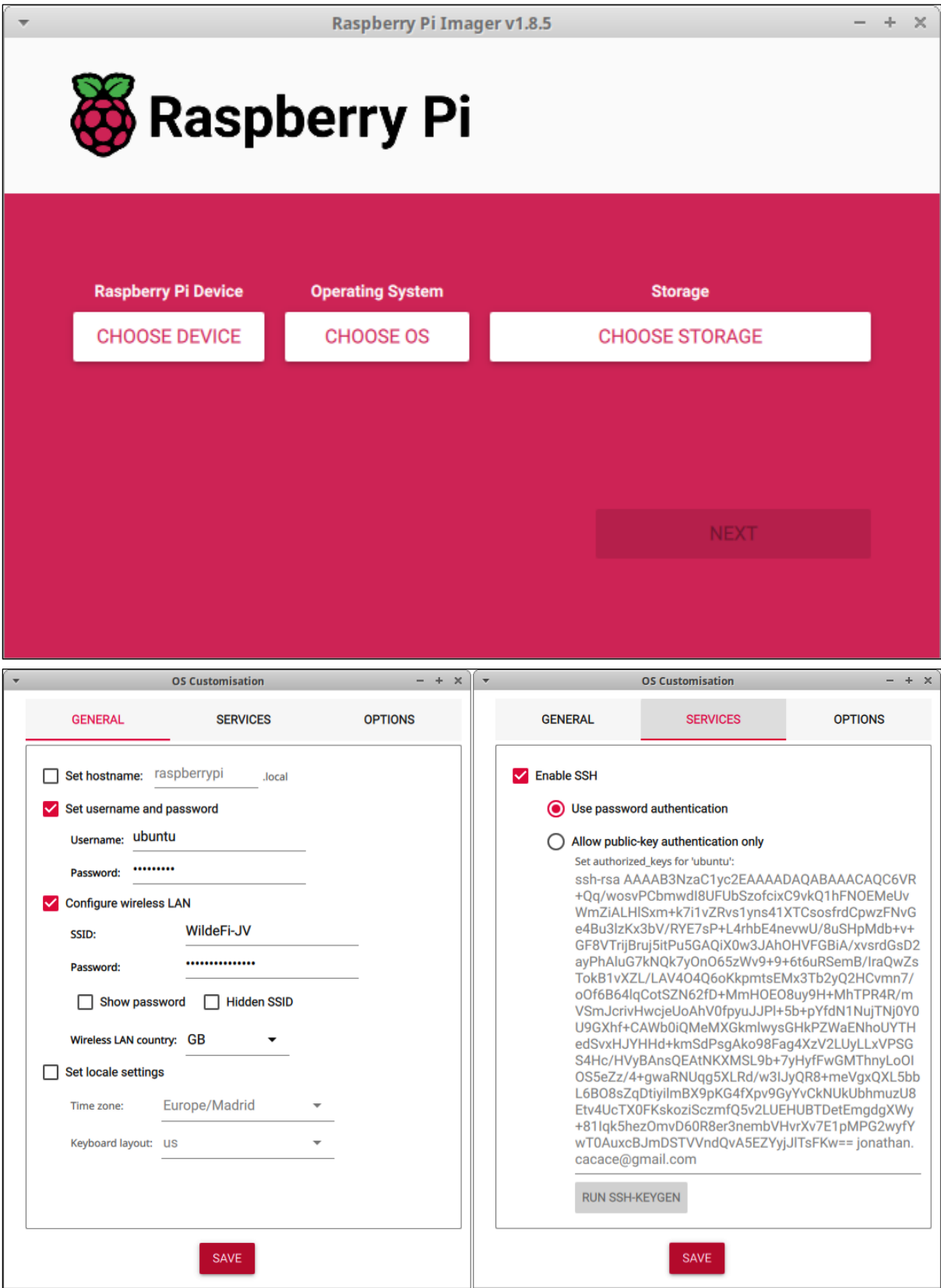


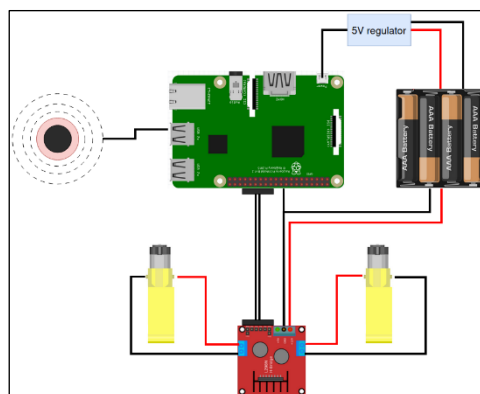
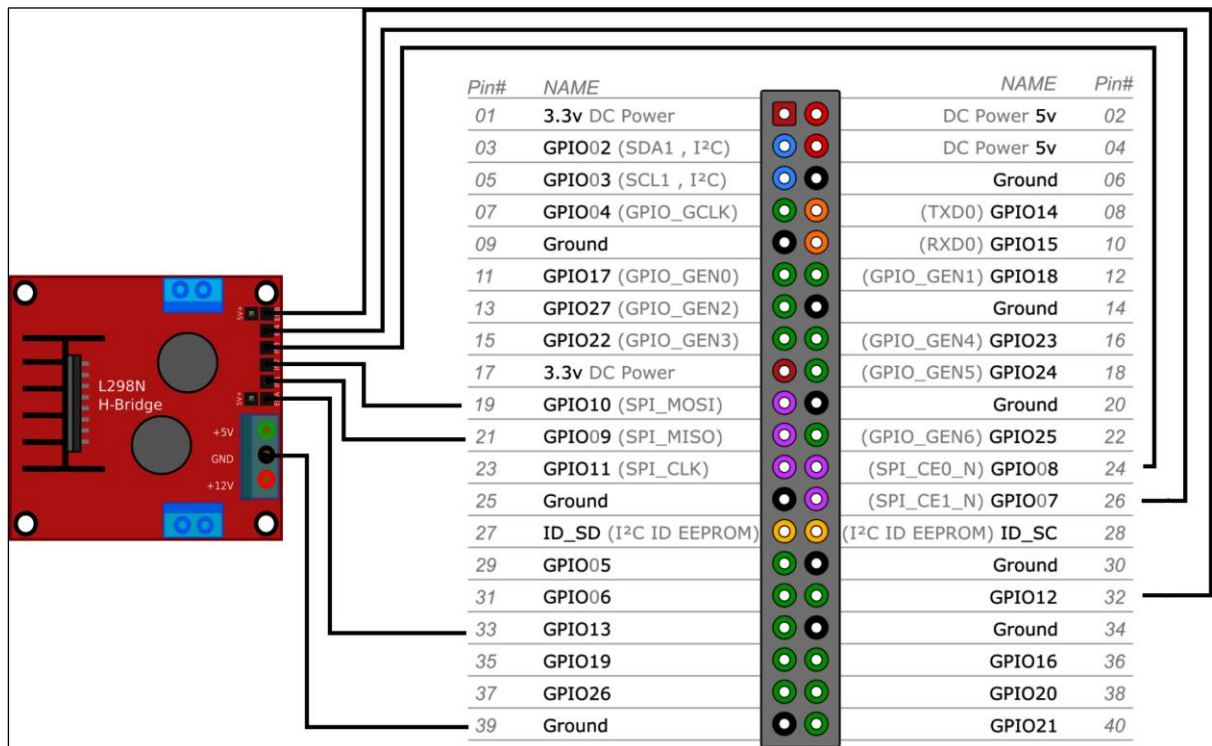
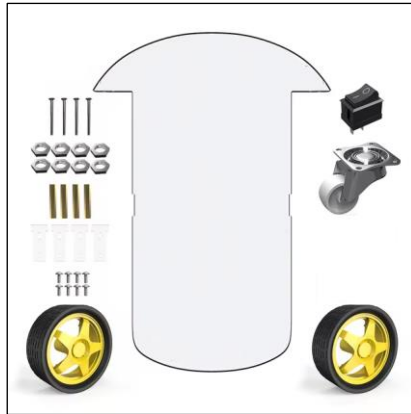


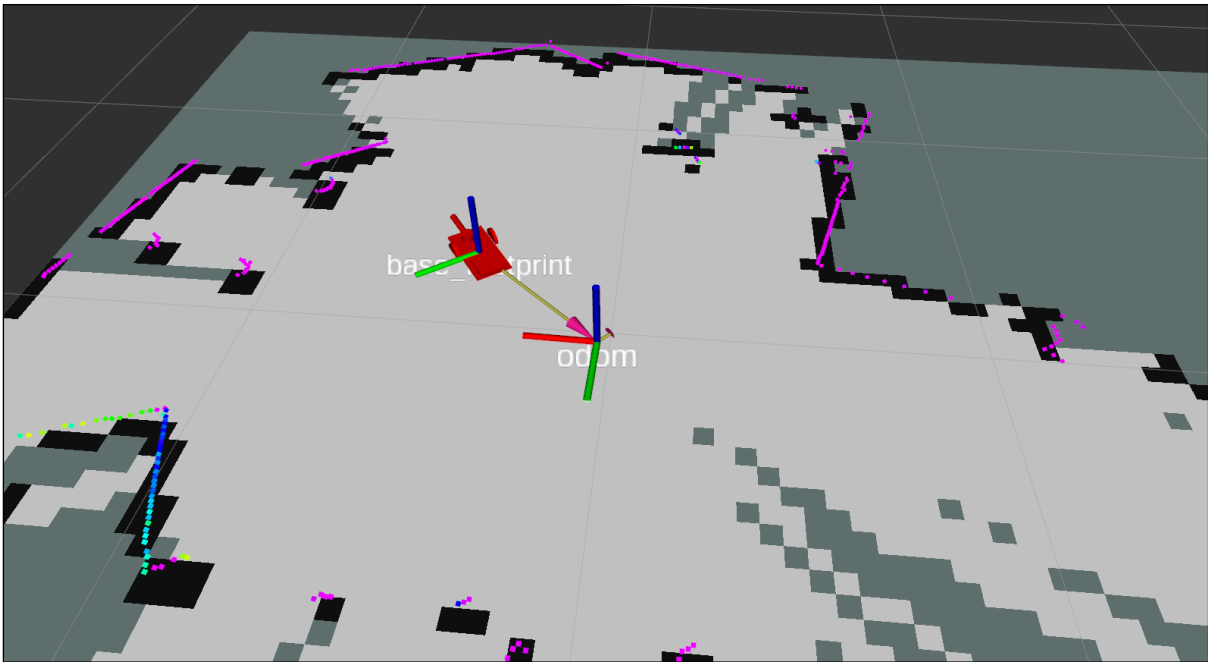
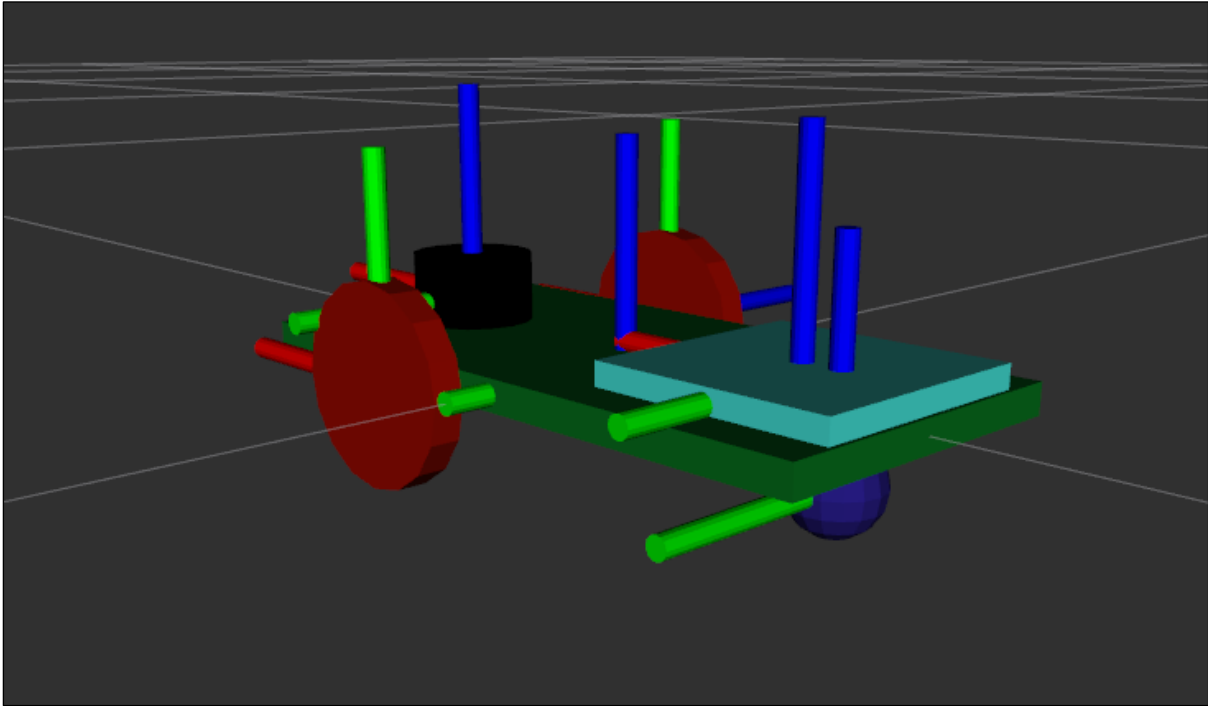
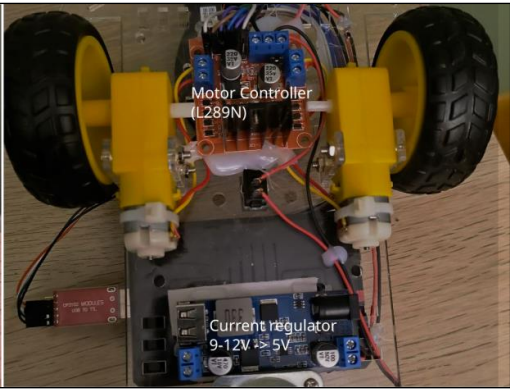
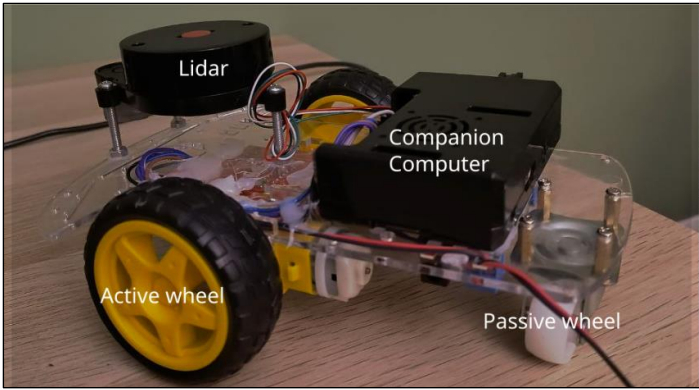




Chapter 12: Designing and Programming a DIY Mobile Robot from Scratch







Chapter 13: Testing, Continuous Integration, and Continuous Deployment with ROS 2

Create a new repository

A repository contains all project files, including the revision history. Already have a project repository elsewhere? [Import a repository.](#)

Required fields are marked with an asterisk (*).

Owner *

 jocacace ▾

Repository name *

/

Great repository names are short and memorable. Need inspiration? How about **didactic-spork** ?

Description (optional)



Public

Anyone on the internet can see this repository. You choose who can commit.



Private

You choose who can see and commit to this repository.



jocacace / ros2_ci_cd

<> Code

Issues

Pull requests

Actions

Projects

Wiki

Security

Insights

Settings



ros2_ci_cd

Public

Cancel changes

Commit changes...

2 workflow runs

Event ▾Status ▾Branch ▾Actor ▾

Update str_pub.cpp

master

now

In progress

...

ros2-pipeline-test #2: Commit 1491bdb pushed by jocacace

Triggered via push now

jocacace pushed

1491bdb

master

Status

Total duration

Artifacts

In progress

—

—

main.yml

on: push

build

9s

build

Started 2m 32s ago

Search logs

⚙

> ✓ Set up job

1s

> ✓ Run # Set up sources

2m 16s

> ✓ Run echo "source /opt/ros/jazzy/setup.bash" >> ~/.bashrc

1s

> ✓ Run actions/checkout@v3

0s

> ⚙ Run source /opt/ros/jazzy/setup.bash

15s

○ Post Run actions/checkout@v3

Triggered via push 13 hours ago

Status

Total duration

Artifacts

jocacace pushed

1491bdb

master

Success

2m 49s

—

Re-run all jobs

...

Create status badge

Delete all logs

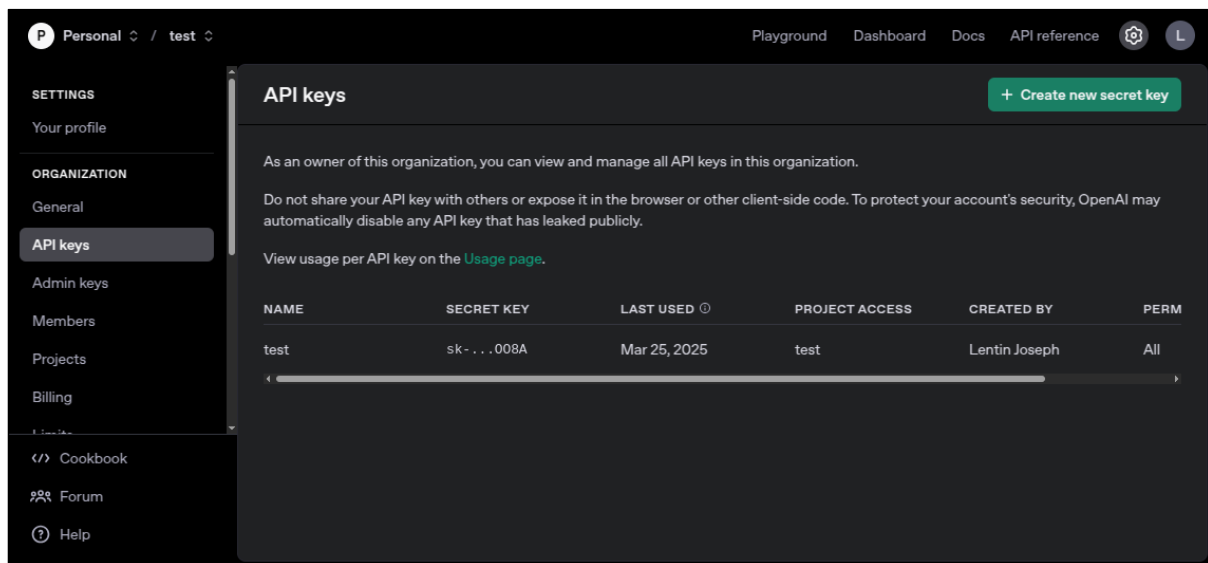
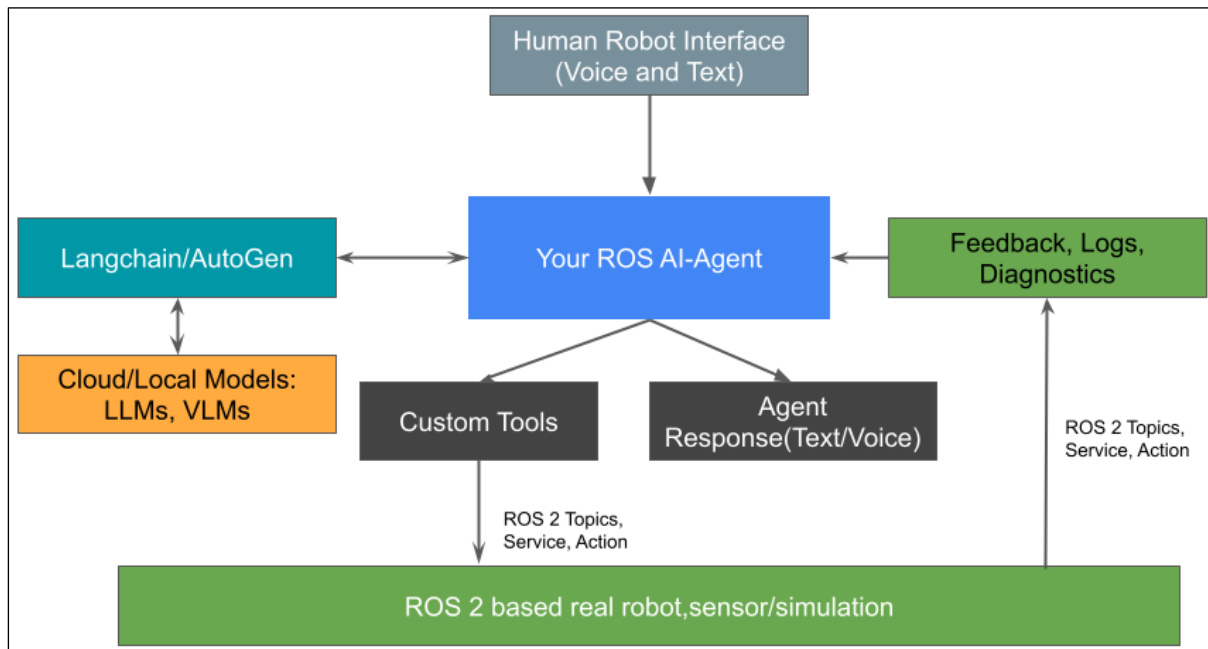
README

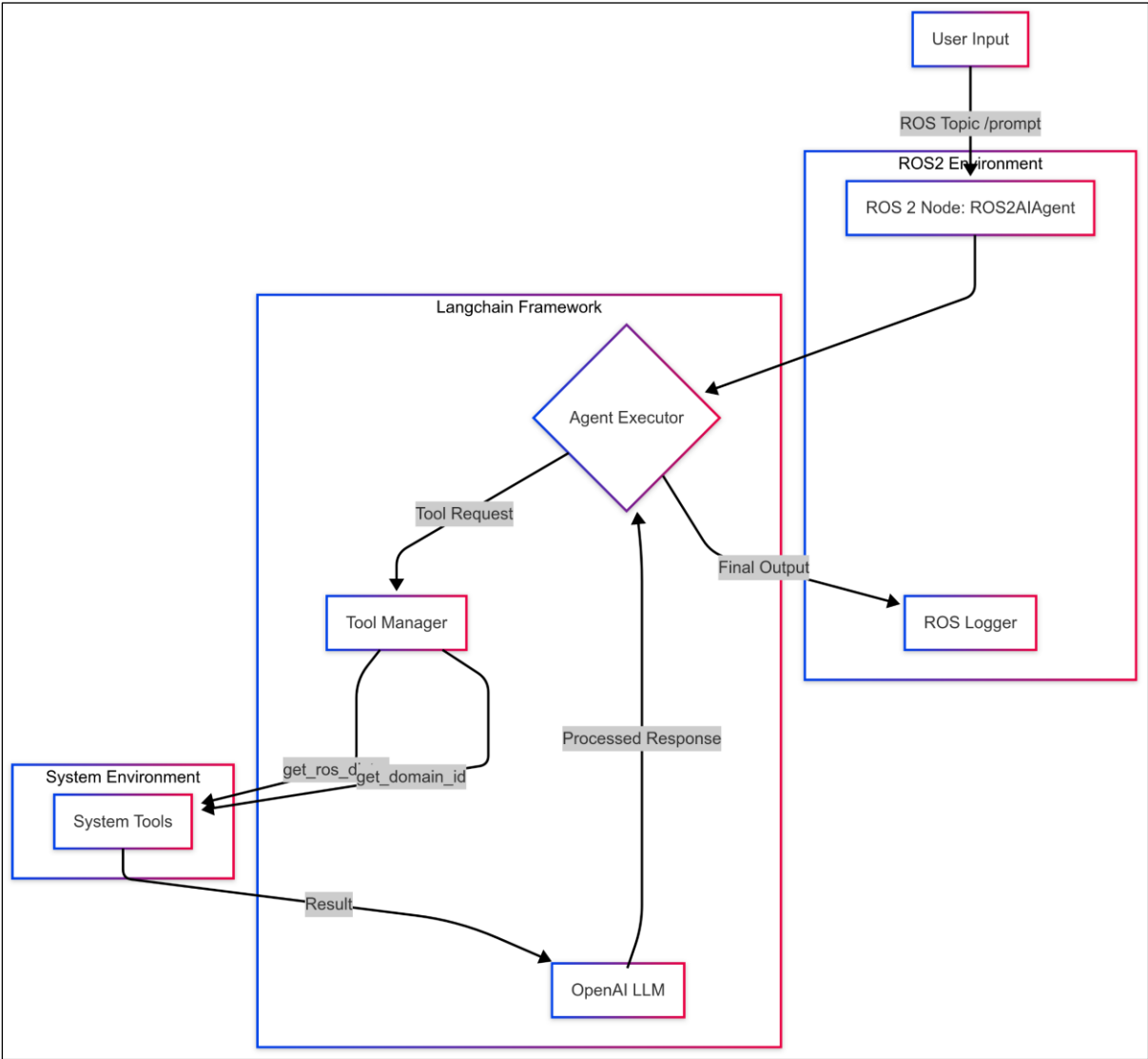
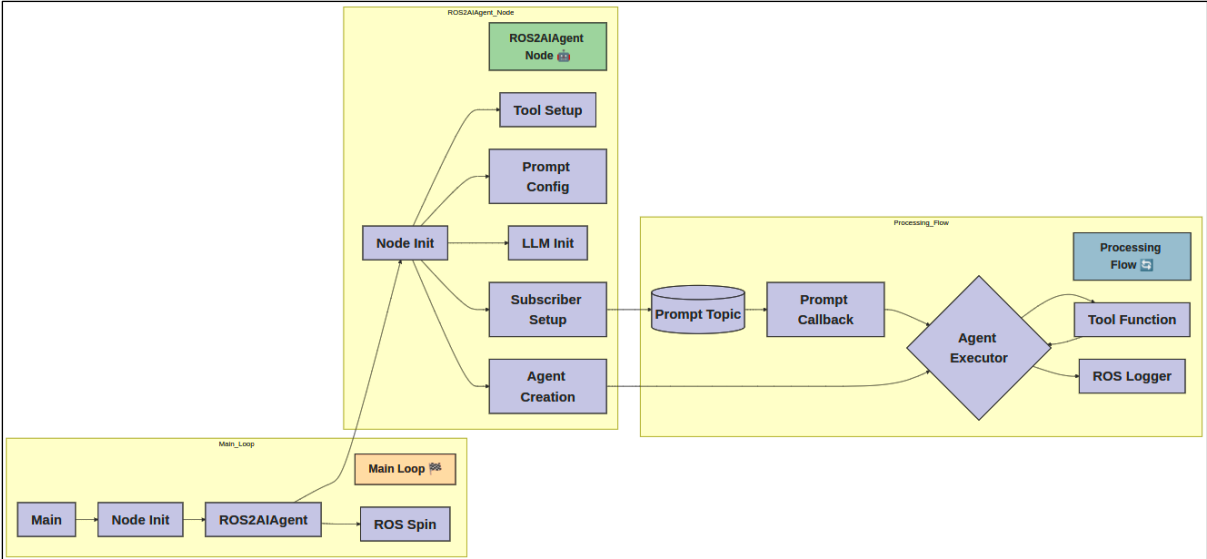
ros2-pipeline-test passing

README

ros2-pipeline-test failing

Chapter 14: Interfacing Large Language Models with ROS 2

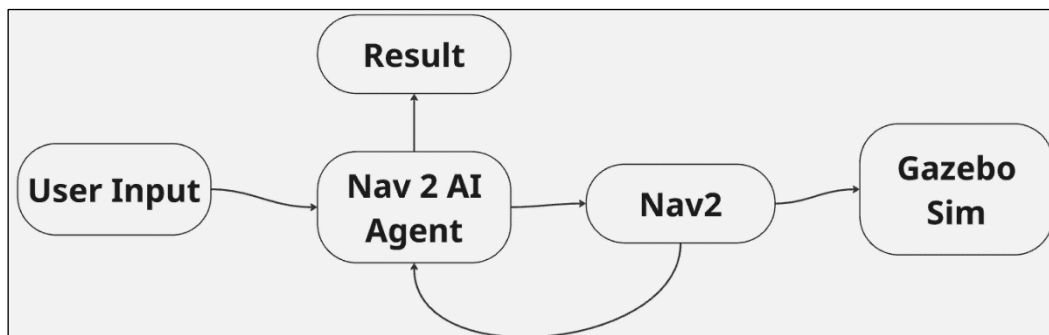
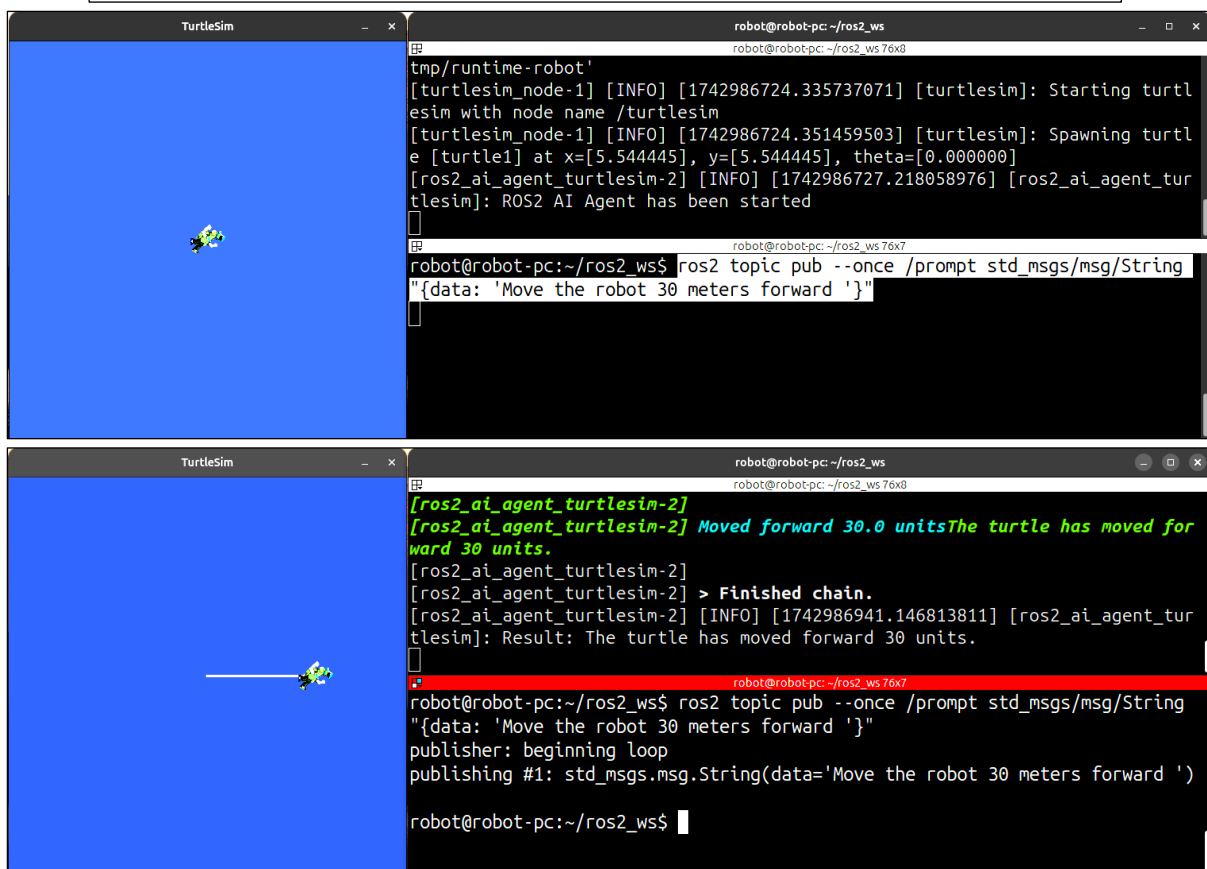
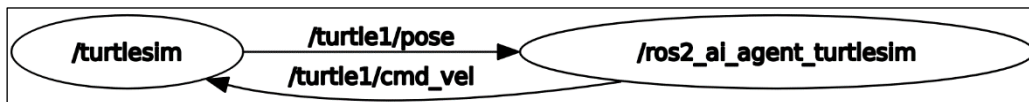


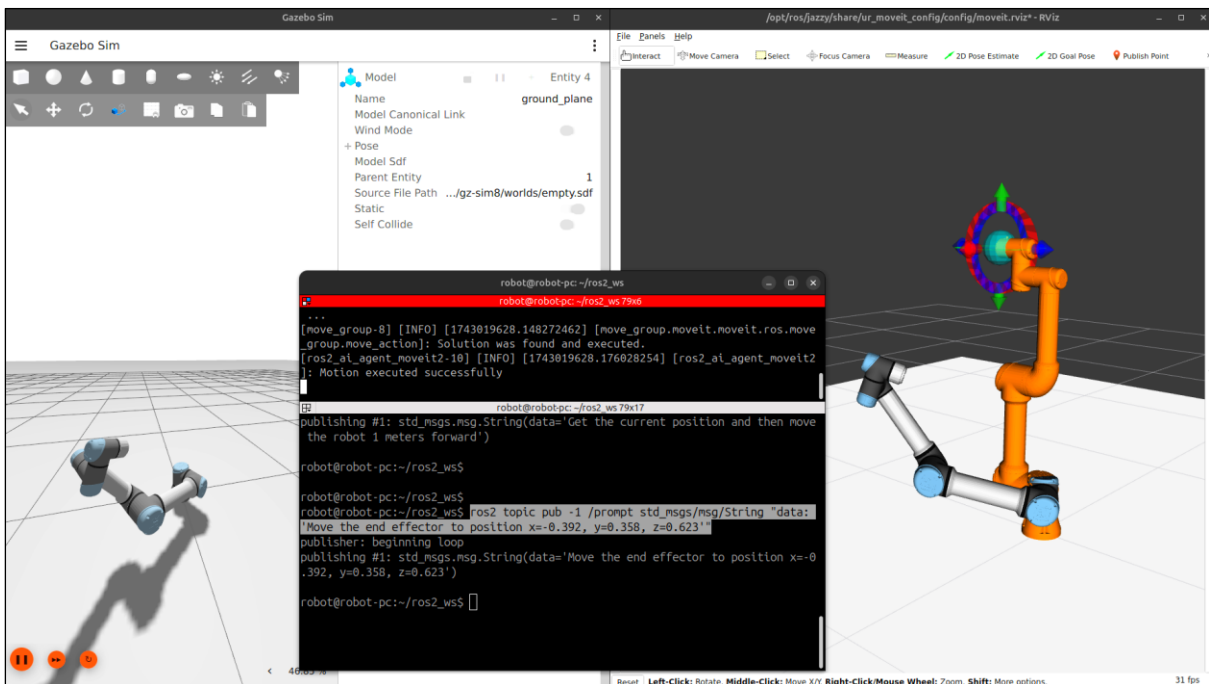
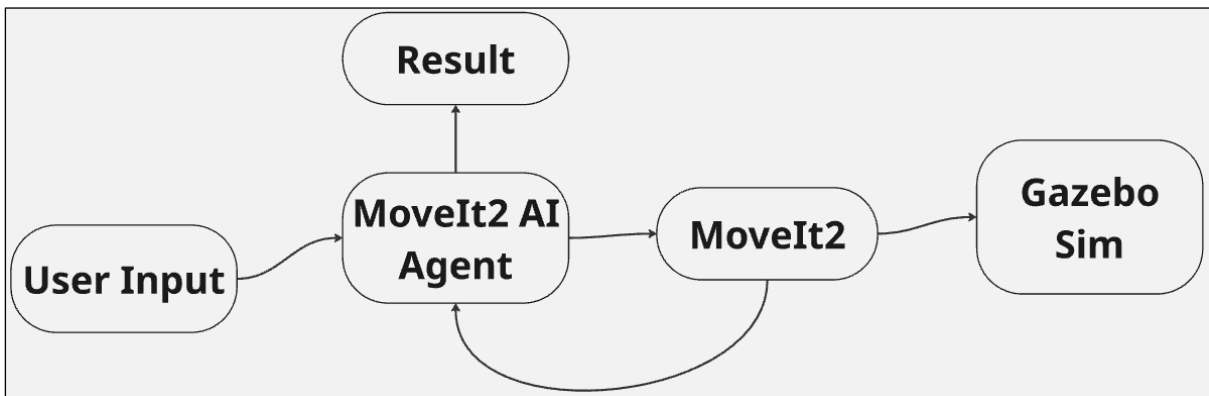
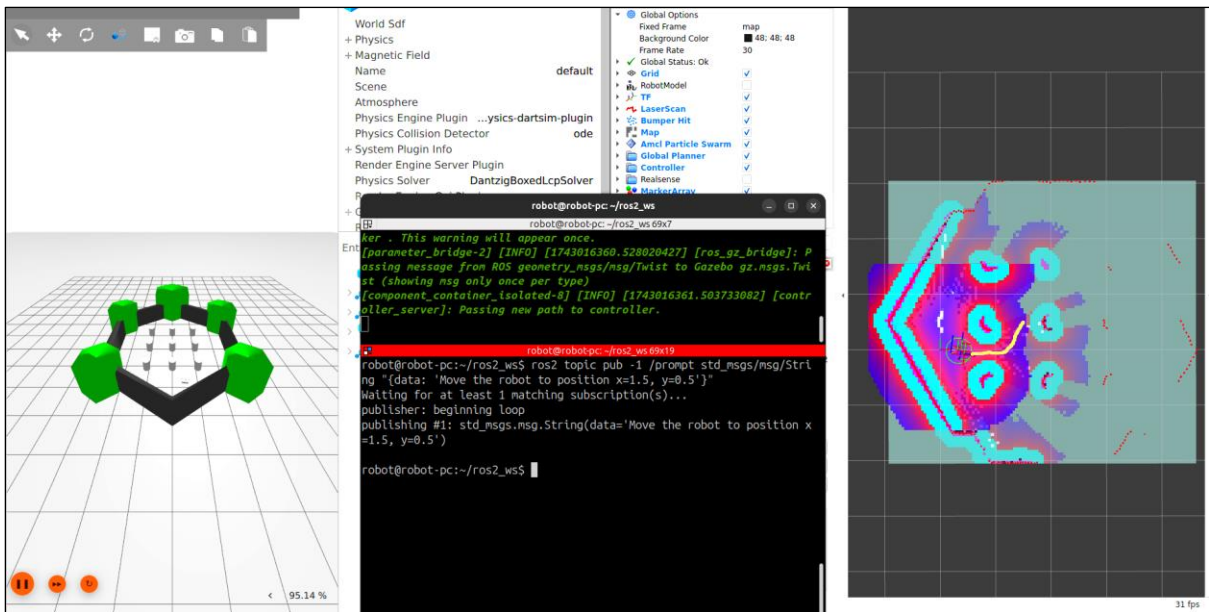


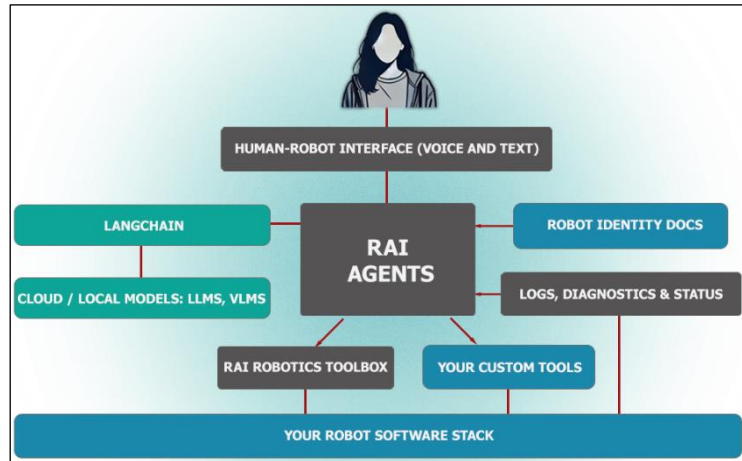
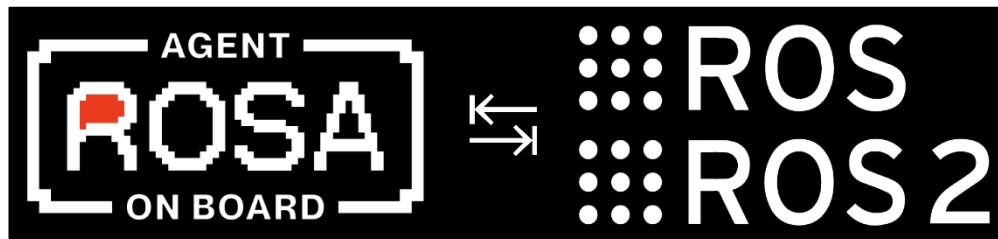
```

[ros2_ai_agent_basic_tools-1] > Entering new AgentExecutor chain...
[ros2_ai_agent_basic_tools-1]
[ros2_ai_agent_basic_tools-1] Invoking: 'list_topics' with '{}':
[ros2_ai_agent_basic_tools-1]
[ros2_ai_agent_basic_tools-1] Available ROS 2 topics:
[ros2_ai_agent_basic_tools-1] /parameter_events
[ros2_ai_agent_basic_tools-1] /prompt
[ros2_ai_agent_basic_tools-1] /rosout
[ros2_ai_agent_basic_tools-1] Here are the available ROS 2 topics:
[ros2_ai_agent_basic_tools-1] - /parameter_events
[ros2_ai_agent_basic_tools-1] - /prompt
[ros2_ai_agent_basic_tools-1] - /rosout
[ros2_ai_agent_basic_tools-1]
[ros2_ai_agent_basic_tools-1] > Finished chain.
[ros2_ai_agent_basic_tools-1] [INFO] [1742974621.873433350] [ros2_ai_agent_basic_tools]: Result: Here are the avail
able ROS 2 topics:
[ros2_ai_agent_basic_tools-1] - /parameter_events
[ros2_ai_agent_basic_tools-1] - /prompt
[ros2_ai_agent_basic_tools-1] - /rosout

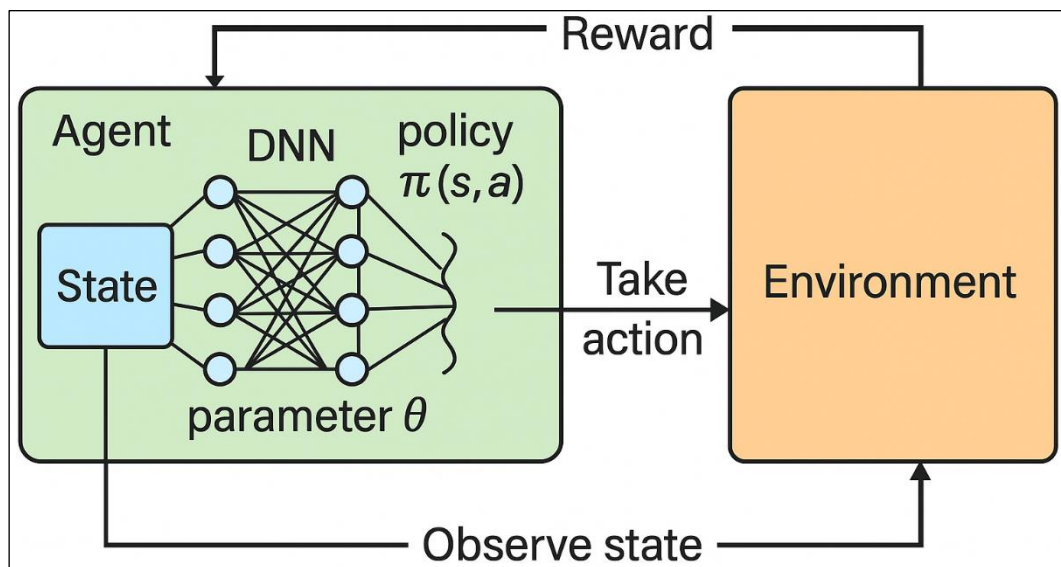
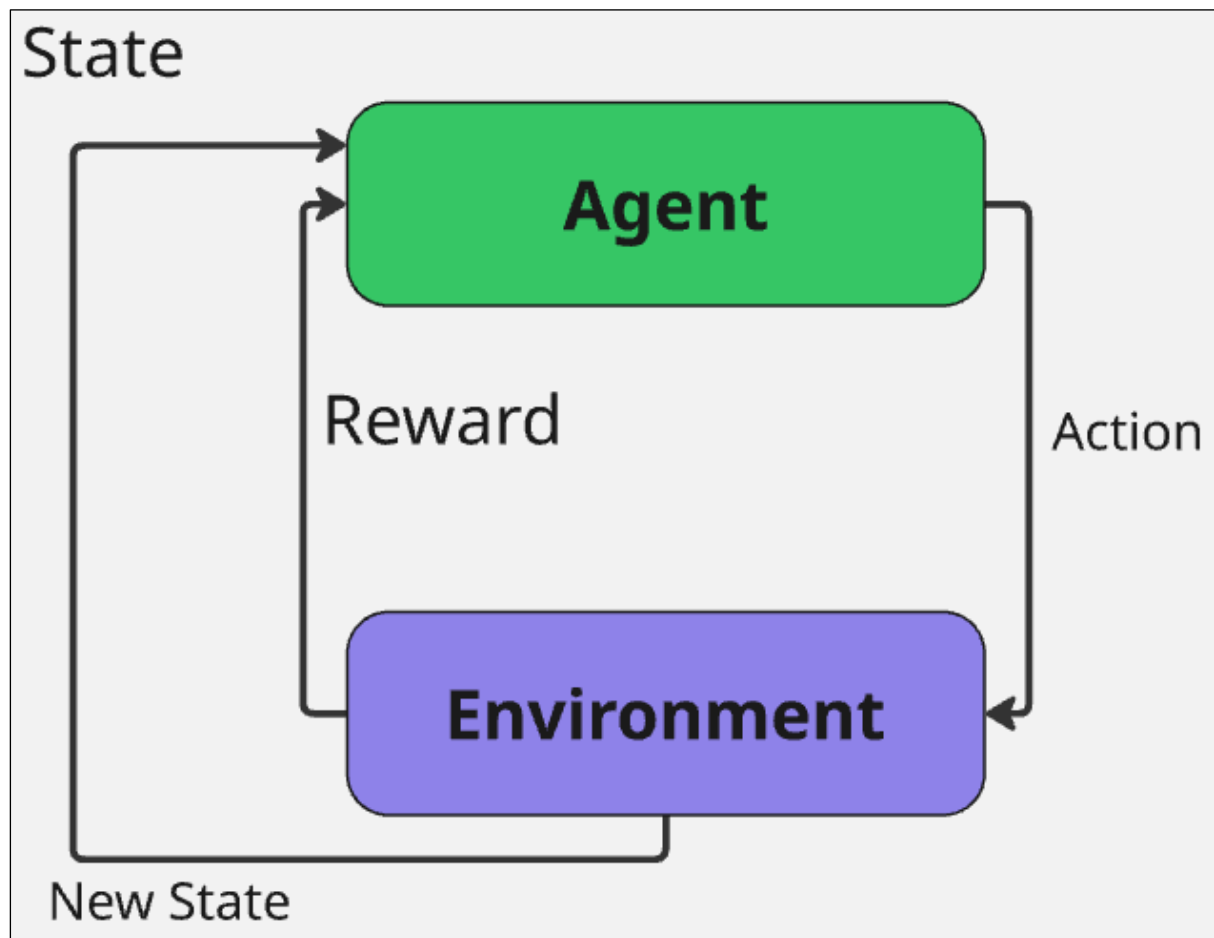
```

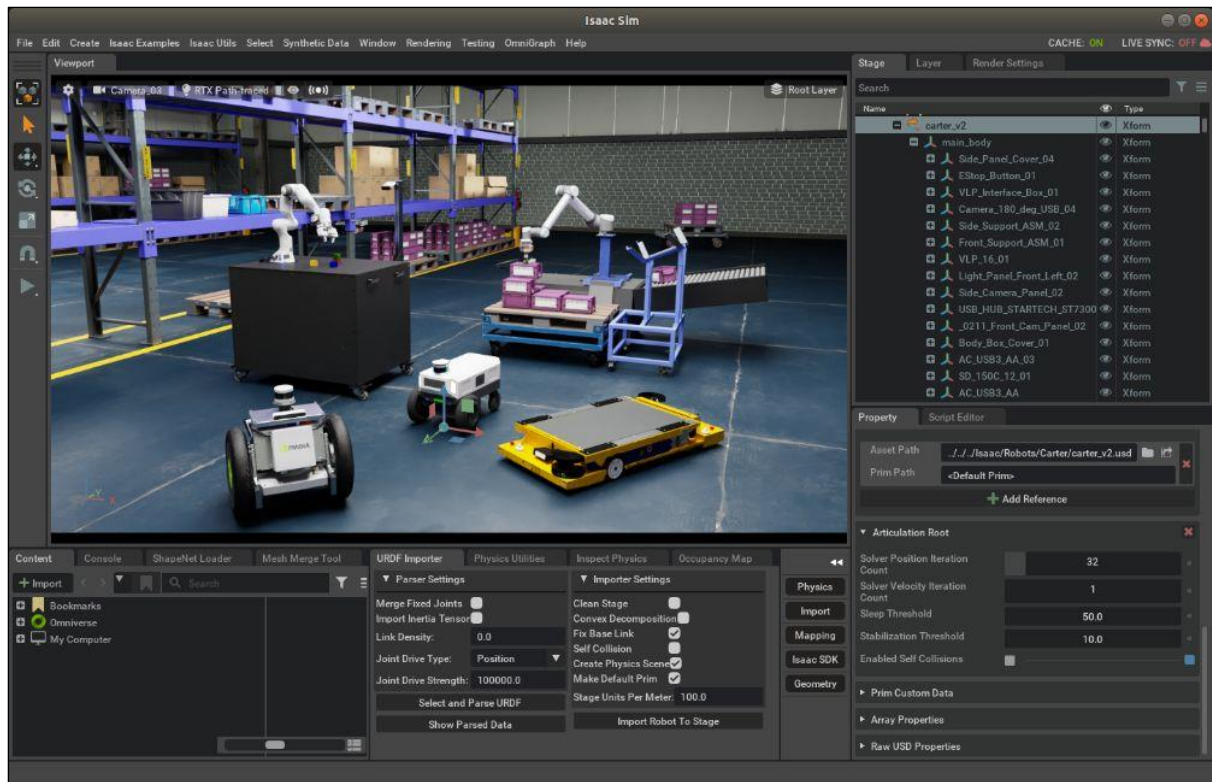


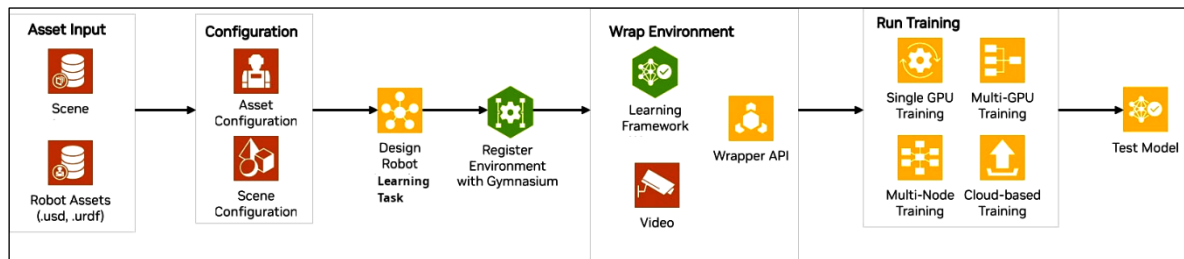
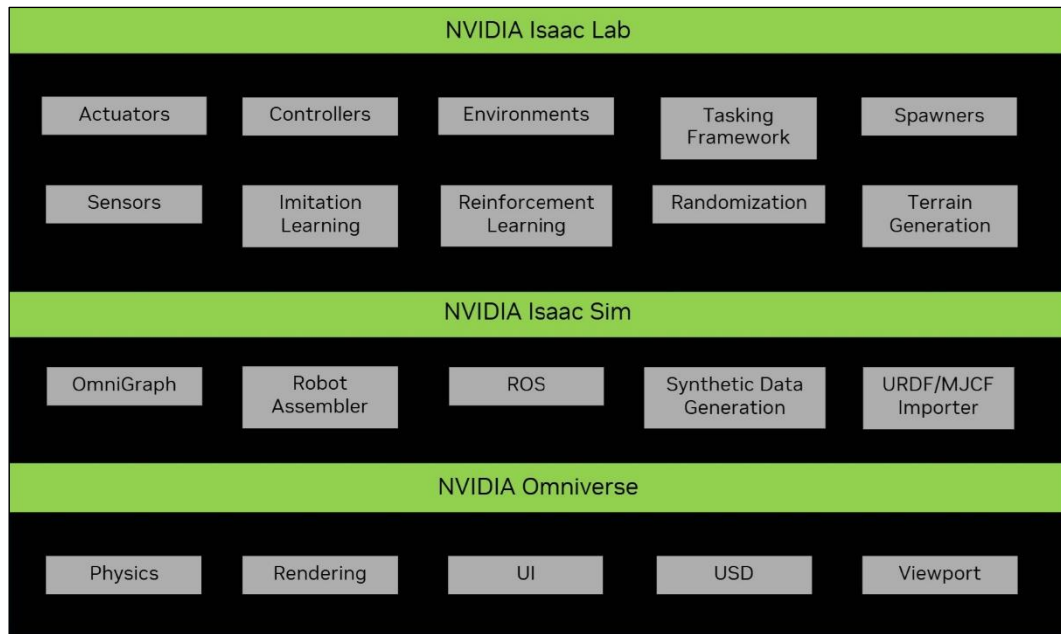




Chapter 15: ROS 2 and Deep Reinforcement Learning

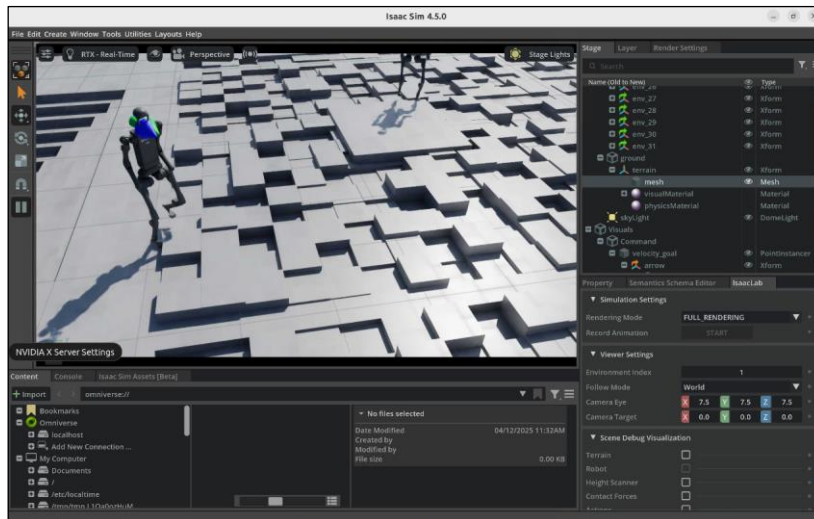
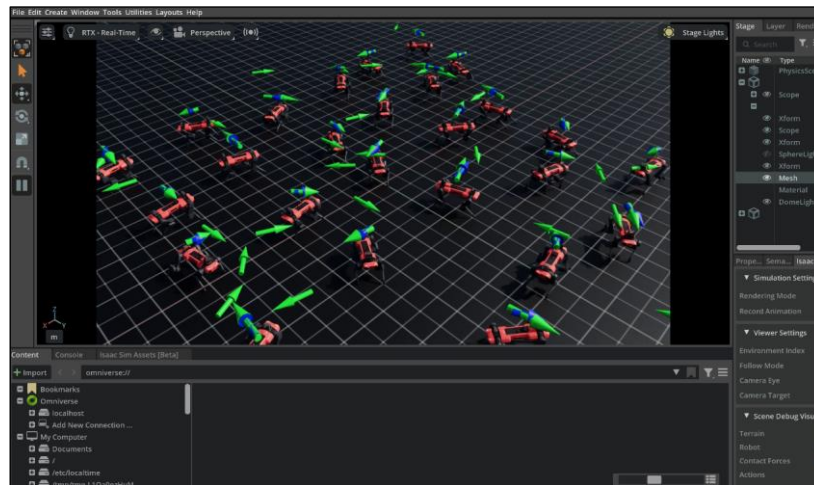
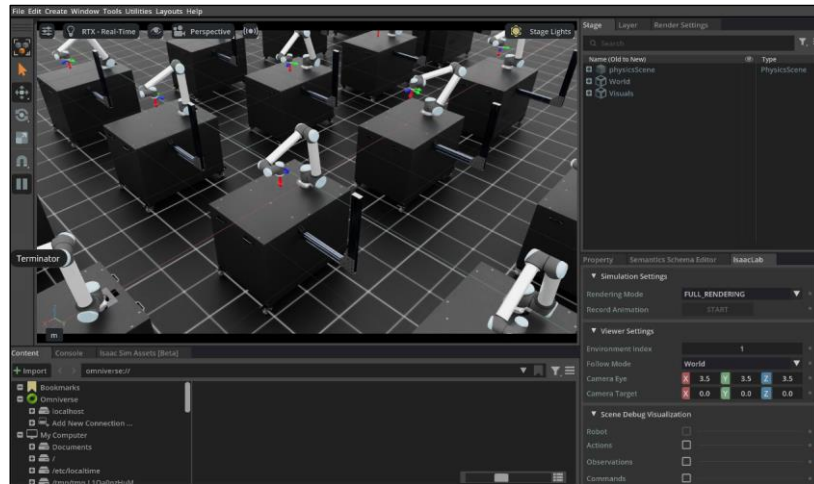


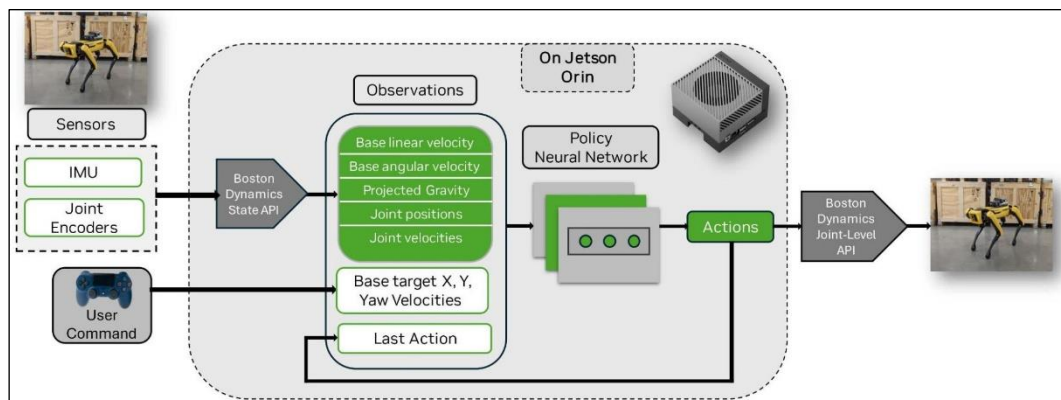
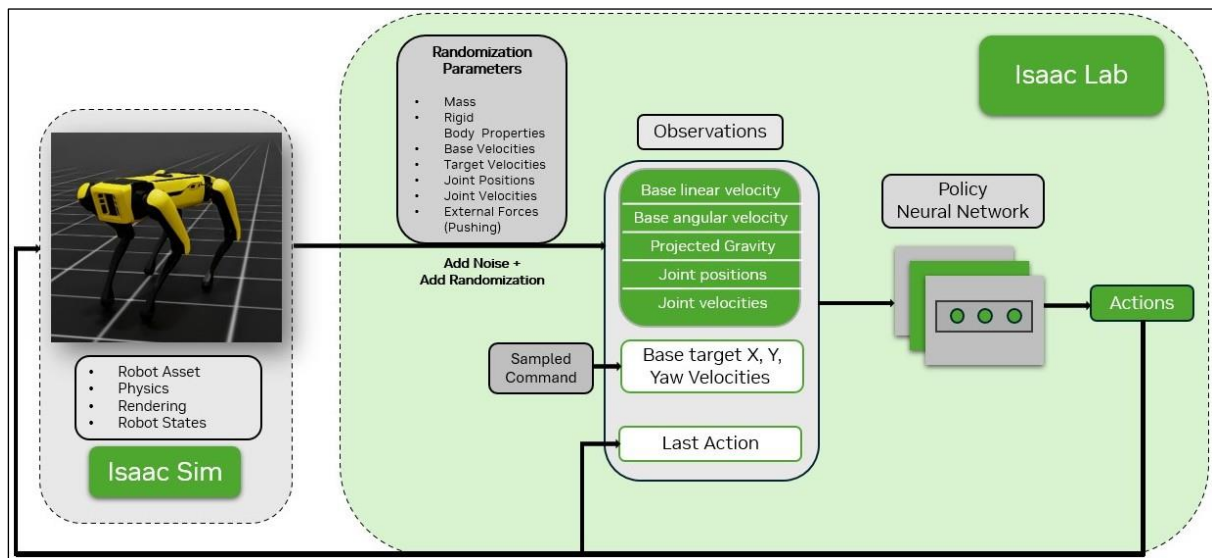
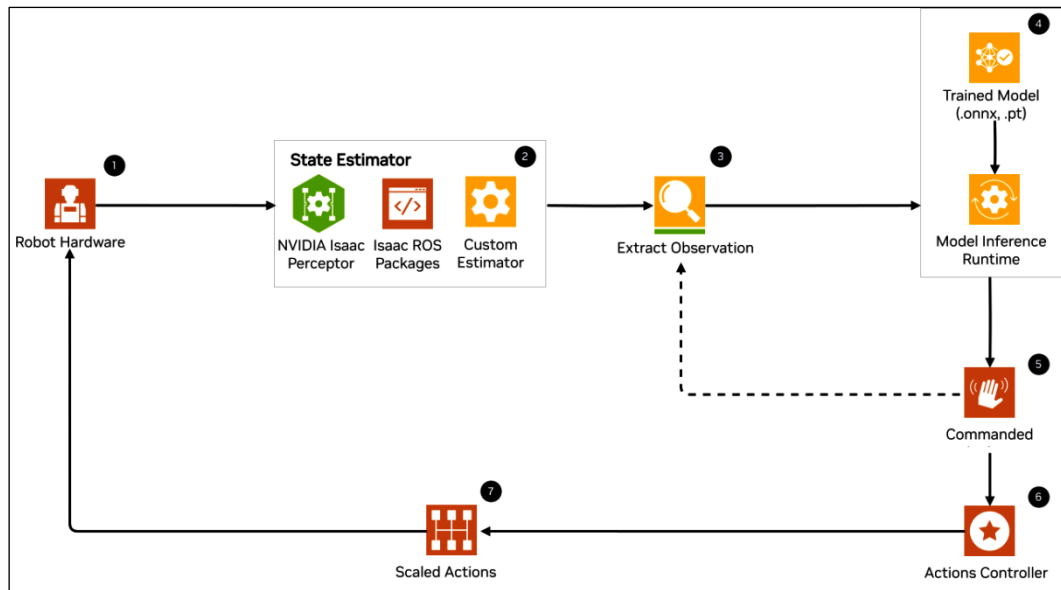




```

Learning iteration 80/1000
      Computation: 199459 steps/s (collection: 0.409s, learning 0.084s)
    Mean action noise std: 0.95
  Mean value_function loss: 0.0003
    Mean surrogate loss: -0.0019
      Mean entropy loss: 8.2010
        Mean reward: -0.34
          Mean episode length: 360.00
Episode_Reward/end_effector_position_tracking: -0.0166
Episode_Reward/end_effector_position_tracking_fine_grained: 0.0385
Episode_Reward/end_effector_orientation_tracking: -0.0457
  Episode_Reward/action_rate: -0.0016
    Episode_Reward/joint_vel: -0.0028
    Metrics/ee_pose/position_error: 0.0650
    Metrics/ee_pose/orientation_error: 0.2739
    Episode_Termination/time_out: 12.3333
-----
    Total timesteps: 7962624
      Iteration time: 0.49s
        Time elapsed: 00:00:42
          ETA: 00:08:04
  
```





Chapter 16: Implementing ROS 2 Visualization and Simulation Plugins

