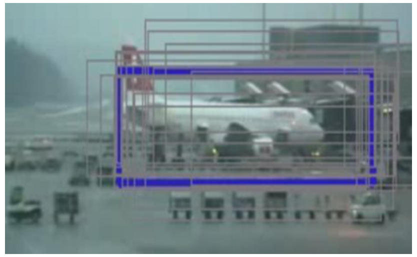
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

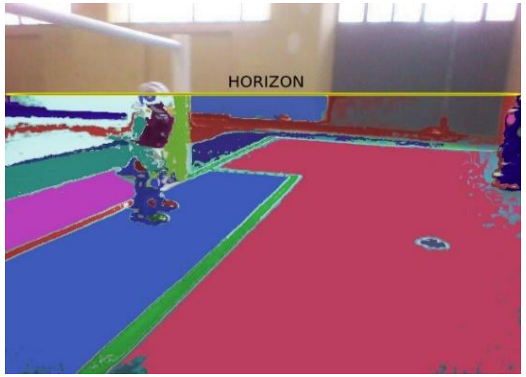
Corso di Visione e Percezione

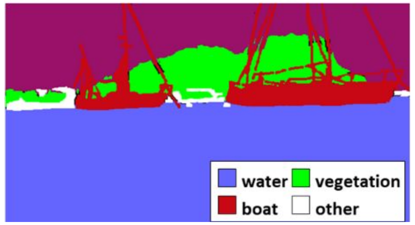
Docente

Domenico D. Bloisi

Simulatori in ROS



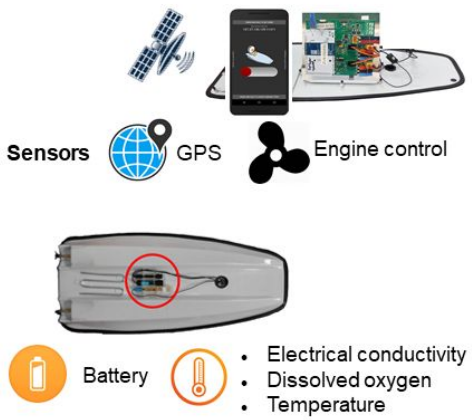


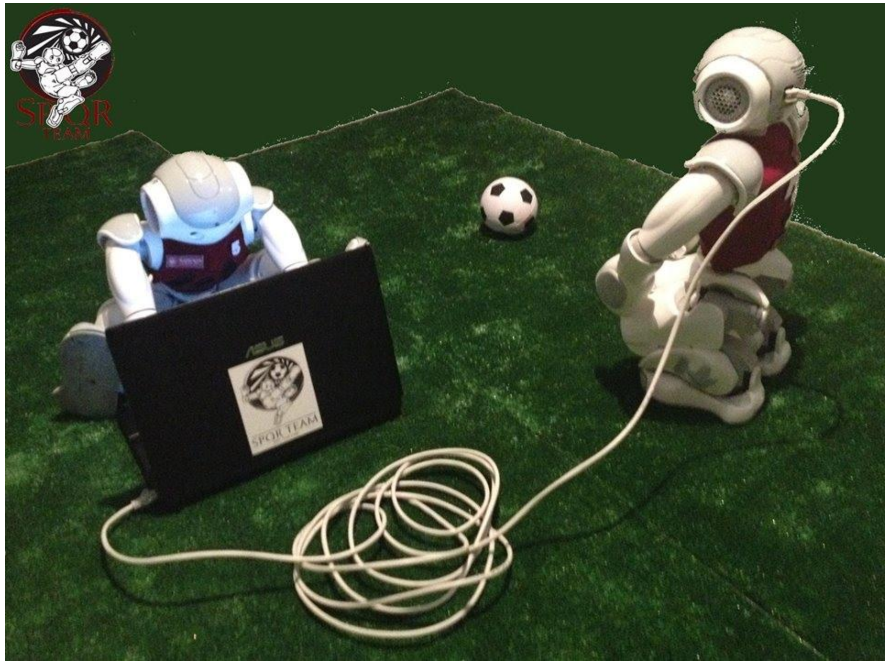


Domenico Daniele Bloisi

- Ricercatore RTD B
  Dipartimento di Matematica, Informatica ed Economia
  Università degli studi della Basilicata
  http://web.unibas.it/bloisi

- SPQR Robot Soccer Team
  Dipartimento di Informatica, Automatica e Gestionale Università degli studi di Roma “La Sapienza”
  http://spqr.diag.uniroma1.it





Informazioni sul corso

- Home page del corso
  http://web.unibas.it/bloisi/corsi/visione-e-percezione.html
- Docente: Domenico Daniele Bloisi
- Periodo: II semestre marzo 2021 – giugno 2021

  Martedì 17:00-19:00 (Aula COPERNICO)
  Mercoledì 8:30-10:30 (Aula COPERNICO)

Codice corso Google Classroom:
https://classroom.google.com/c/NjI2MjA4MzgzNDFa?cjc=xgolays

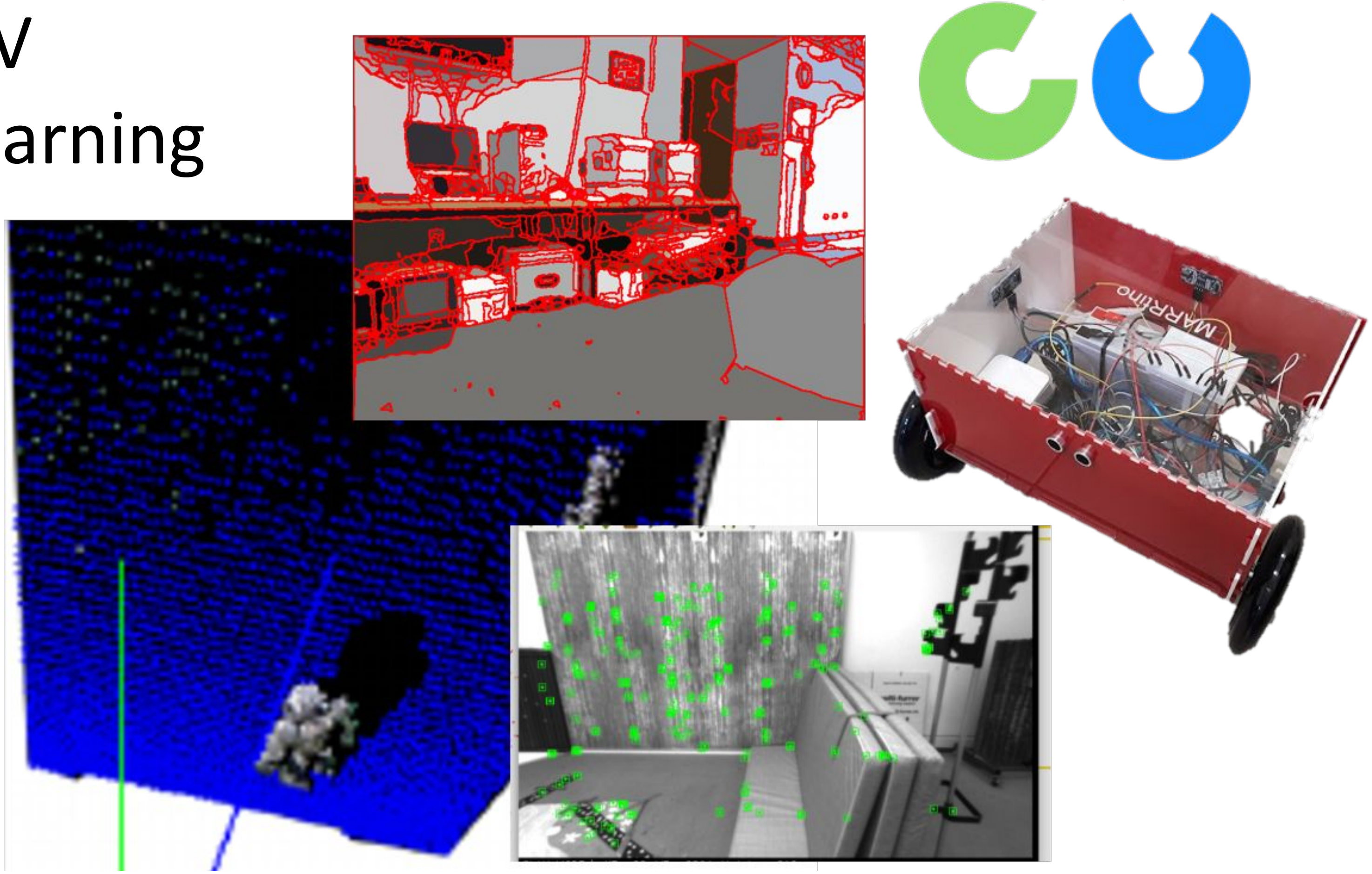
Ricevimento

- Su appuntamento tramite Google Meet

Per prenotare un appuntamento inviare una email a domenico.bloisi@unibas.it

Programma – Visione e Percezione

- Introduzione al linguaggio Python
- Elaborazione delle immagini con Python
- Percezione 2D – OpenCV
- Introduzione al Deep Learning
- ROS
- Il paradigma publisher and subscriber
- Simulatori
- Percezione 3D - PCL



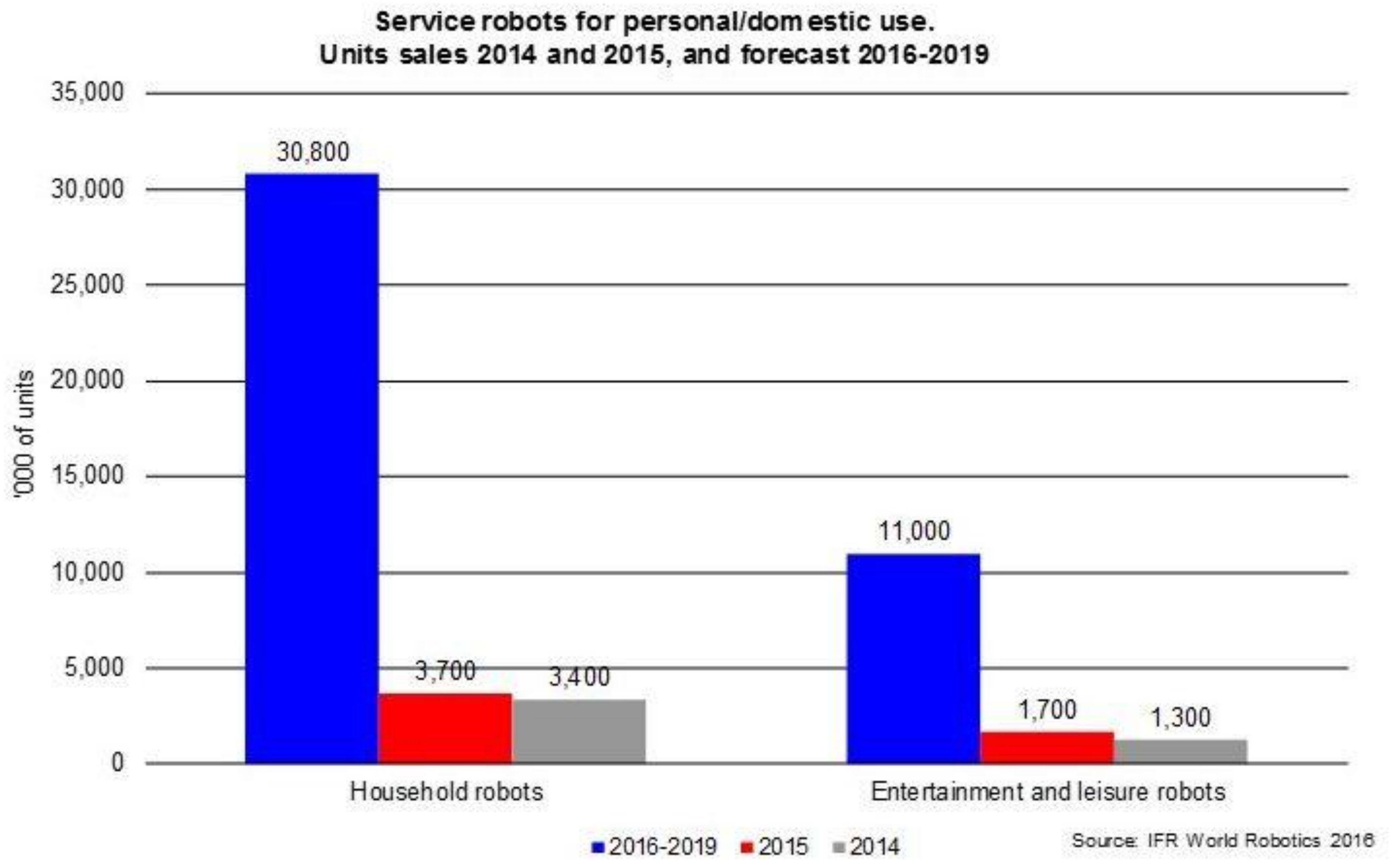
Service robots in the World

The worldwide number of domestic household robots will rise to 31 million between 2016 and 2019

The sales value of robots cleaning floors, mowing lawns, and cleaning swimming pools will grow to about 13 billion US dollars in this period

https://ifr.org/ifr-press-releases/news/31-million-robots-helping-in-households-worldwide-by-2019

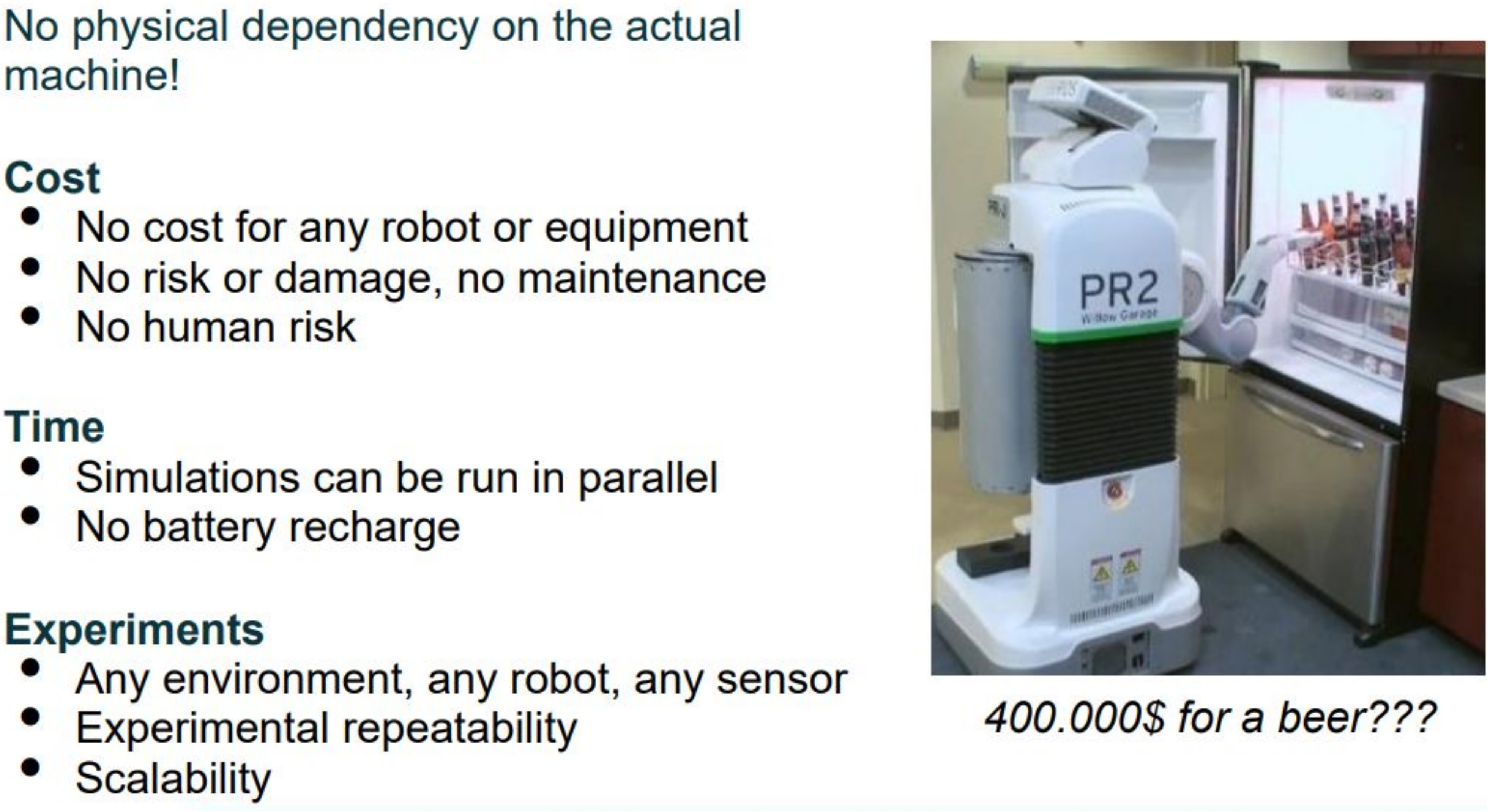
Sales and forecast numbers for service robots 2014-2019



Source: IFR World Robotics 2016

https://ifr.org/ifr-press-releases/news/31-million-robots-helping-in-households-worldwide-by-2019

Perché usare un simulatore?



No physical dependency on the actual machine!

Cost

- No cost for any robot or equipment
- No risk or damage, no maintenance
- No human risk

Time

- Simulations can be run in parallel
- No battery recharge

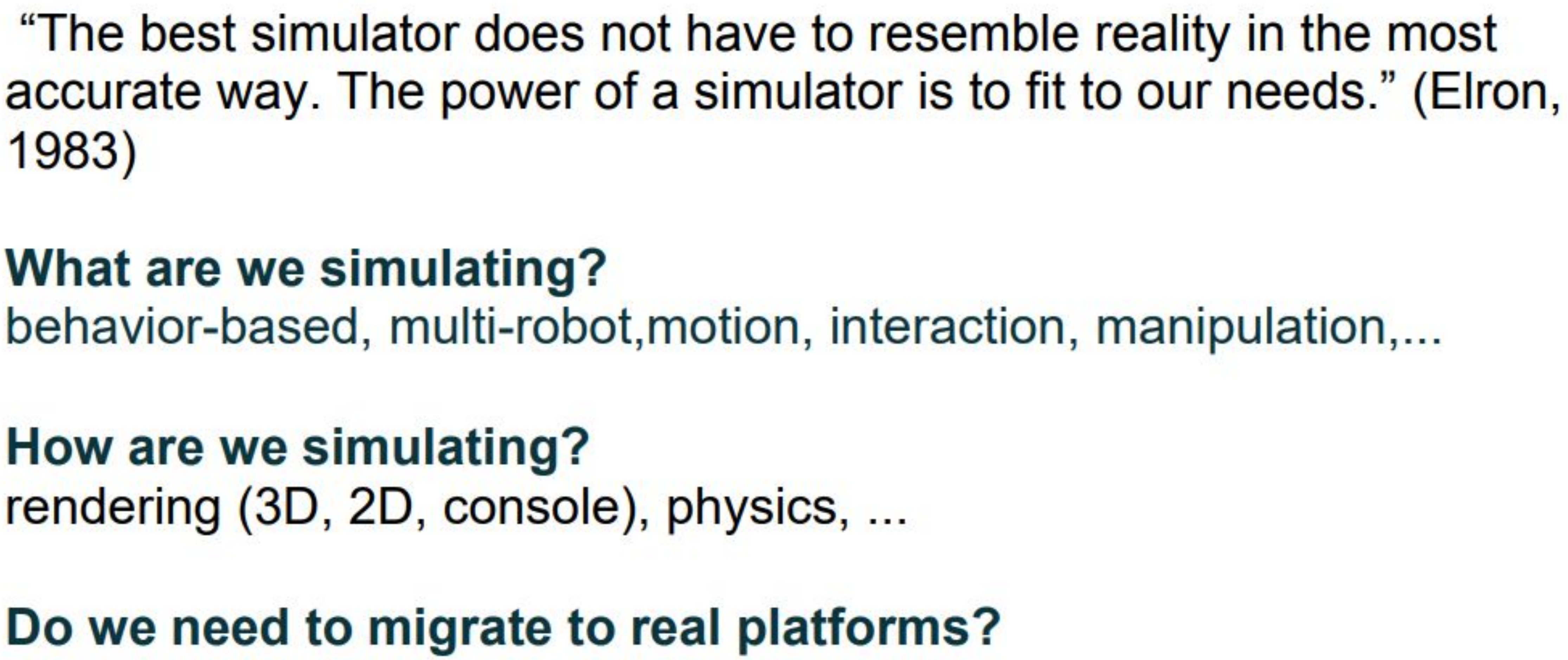
Experiments

- Any environment, any robot, any sensor
- Experimental repeatability
- Scalability

400.000$ for a beer???

https://www.dis.uniroma1.it/~nardi/Didattica/CAI/matdid/Randelli_Robotic_Simulators_20121009.pdf

Scegliere il giusto simulatore



“The best simulator does not have to resemble reality in the most accurate way. The power of a simulator is to fit to our needs.” (Elron, 1983)

What are we simulating?
behavior-based, multi-robot,motion, interaction, manipulation,...

How are we simulating?
rendering (3D, 2D, console), physics, ...

Do we need to migrate to real platforms?

https://www.dis.uniroma1.it/~nardi/Didattica/CAI/matdid/Randelli_Robotic_Simulators_20121009.pdf

Stato di un robot

Modello del Mondo

- Geometria
- Traversabilità
- Altri oggetti in movimento
- …

Configurazione

- Cinematica
- Dinamica
- Livello delle batterie
- …

image from
https://www.extremetech.com

Stato interno

- Ottenibile tramite lettura dei sensori propriocettivi

- Salvato in memoria

Stato esterno

Stato del mondo

- Ottenibile tramite lettura dei sensori esterocettivi

Robot’s state

The robot’s state is a combination of its external and internal state

Simulare lo stato del robot

- Se non si ha a disposizione il robot reale, è possibile lavorare allo sviluppo del software del robot utilizzando un simulatore

- Andrà simulato lo stato del robot

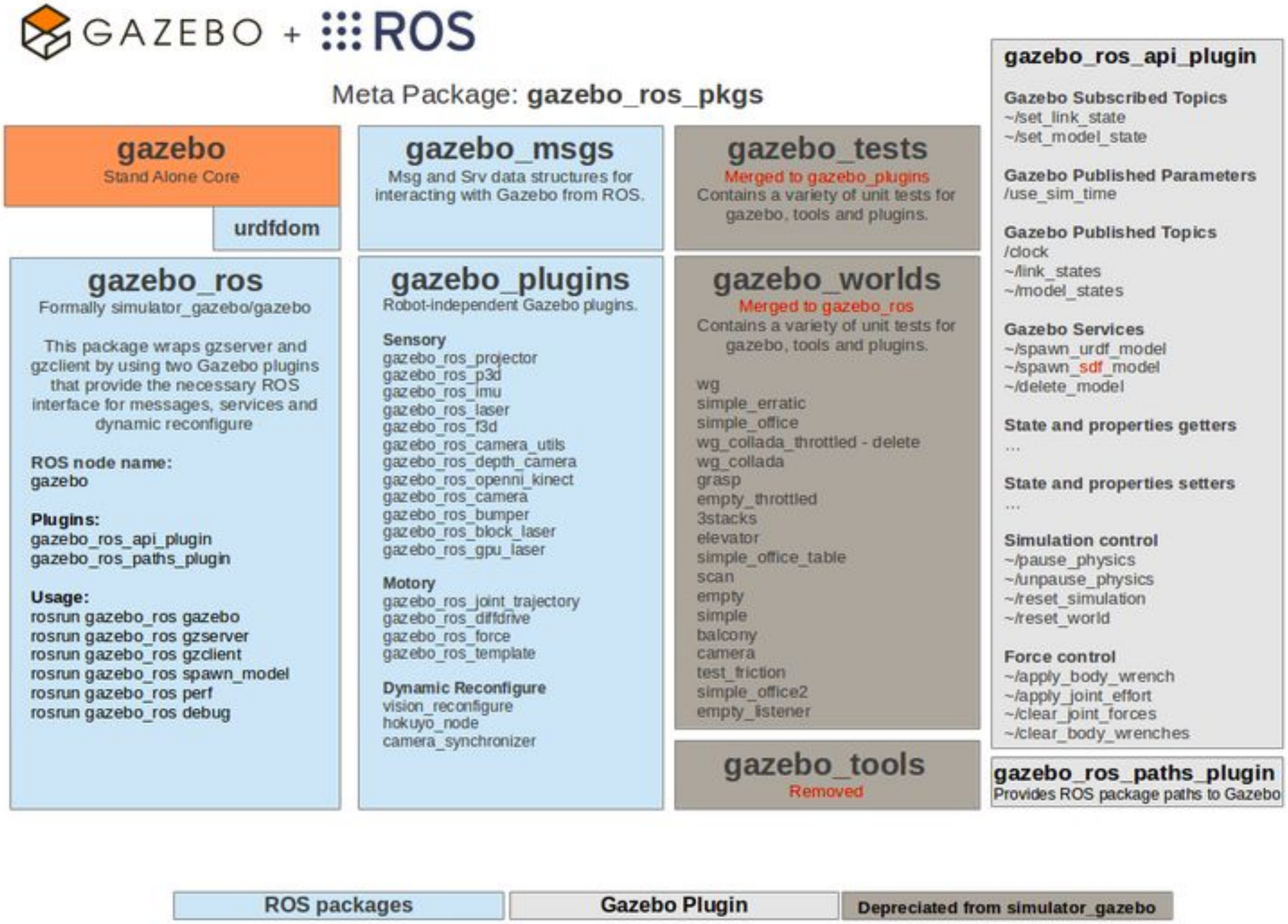
- Andrà simulato l’ambiente operativo in cui il robot si muove

Simulare l’ambiente

In ROS, per simulare l’ambiente operativo in 3D è possibile utilizzare Gazebo

http://gazebosim.org/

Gazebo + ROS



GAZEBO + ROS

Meta Package: **gazebo_ros_pkgs**

gazebo
Stand Alone Core

urdfdom

gazebo_msgs
Msg and Srv data structures for interacting with Gazebo from ROS.

gazebo_tests
Merged to gazebo_plugins
Contains a variety of unit tests for gazebo, tools and plugins.

gazebo_ros
Formally simulator_gazebo/gazebo

This package wraps gzserver and gzclient by using two Gazebo plugins that provide the necessary ROS interface for messages, services and dynamic reconfigure

ROS node name:
gazebo

Plugins:
gazebo_ros_api_plugin
gazebo_ros_paths_plugin

Usage:
rosrun gazebo_ros gazebo
rosrun gazebo_ros gzserver
rosrun gazebo_ros gzclient
rosrun gazebo_ros spawn_model
rosrun gazebo_ros perf
rosrun gazebo_ros debug

gazebo_plugins
Robot-independent Gazebo plugins.

Sensory
gazebo_ros_projector
gazebo_ros_p3d
gazebo_ros_imu
gazebo_ros_laser
gazebo_ros_f3d
gazebo_ros_camera_utils
gazebo_ros_depth_camera
gazebo_ros_openni_kinect
gazebo_ros_camera
gazebo_ros_bumper
gazebo_ros_block_laser
gazebo_ros_gpu_laser

Motory
gazebo_ros_joint_trajectory
gazebo_ros_diffdrive
gazebo_ros_force
gazebo_ros_template

Dynamic Reconfigure
vision_reconfigure
hokuyo_node
camera_synchronizer

gazebo_worlds
Merged to gazebo_ros
Contains a variety of unit tests for gazebo, tools and plugins.

wg
simple_erratic
simple_office
wg_collada_throttled - delete
wg_collada
grasp
empty_throttled
3stacks
elevator
simple_office_table
scan
empty
simple
balcony
camera
test_friction
simple_office2
empty_listener

gazebo_tools
Removed

gazebo_ros_api_plugin

Gazebo Subscribed Topics
~/set_link_state
~/set_model_state

Gazebo Published Parameters
/use_sim_time

Gazebo Published Topics
/clock
~/link_states
~/model_states

Gazebo Services
~/spawn_urdf_model
~/spawn_sdf_model
~/delete_model

State and properties getters
...

State and properties setters
...

Simulation control
~/pause_physics
~/unpause_physics
~/reset_simulation
~/reset_world

Force control
~/apply_body_wrench
~/apply_joint_effort
~/clear_joint_forces
~/clear_body_wrenches

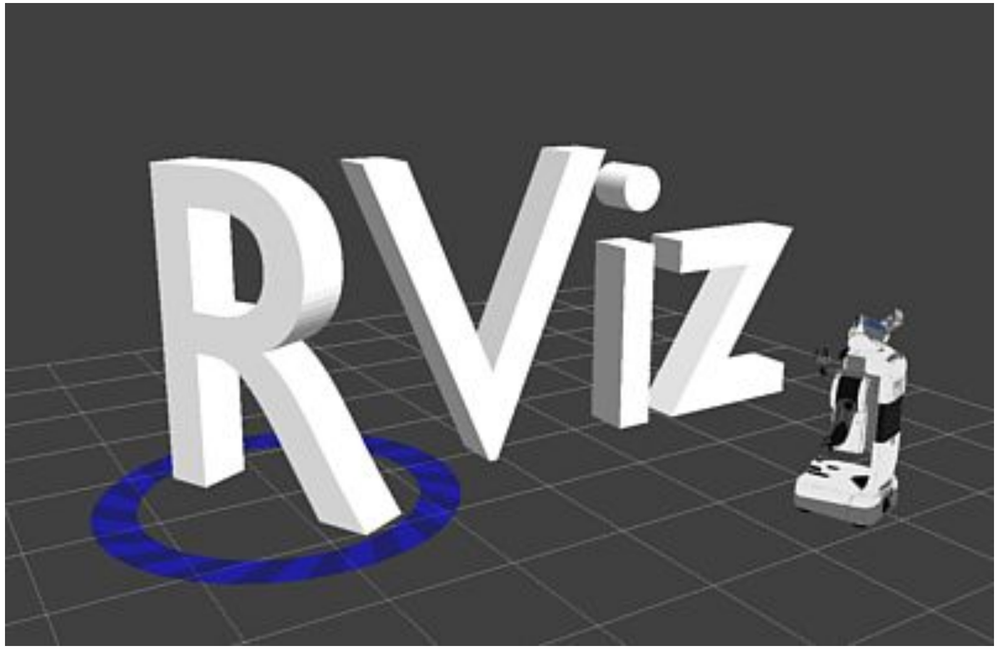
gazebo_ros_paths_plugin
Provides ROS package paths to Gazebo

ROS packages | Gazebo Plugin | Depreciated from simulator_gazebo

http://gazebosim.org/tutorials?tut=ros_overview

Visualizzare lo stato del robot

In ROS, per visualizzare lo stato del robot è possibile utilizzare RViz



http://wiki.ros.org/rviz

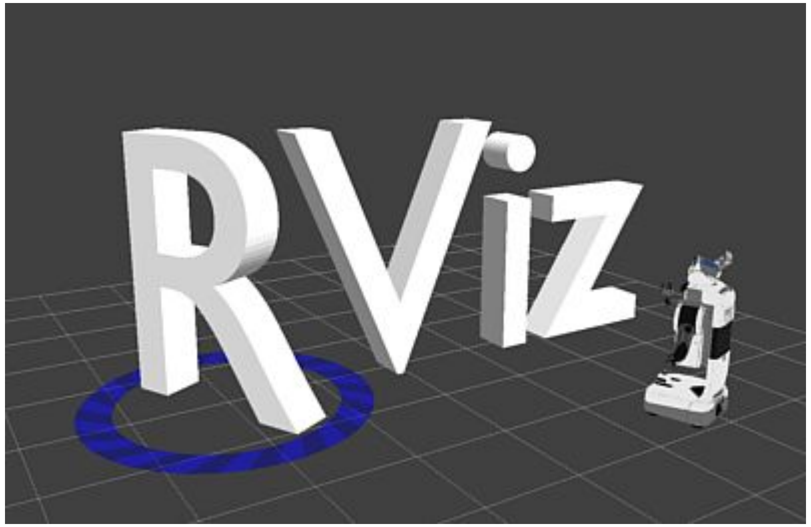
RViz

RViz è un tool di visualizzazione 3D di ROS che permette di percepire il mondo dalla prospettiva del robot

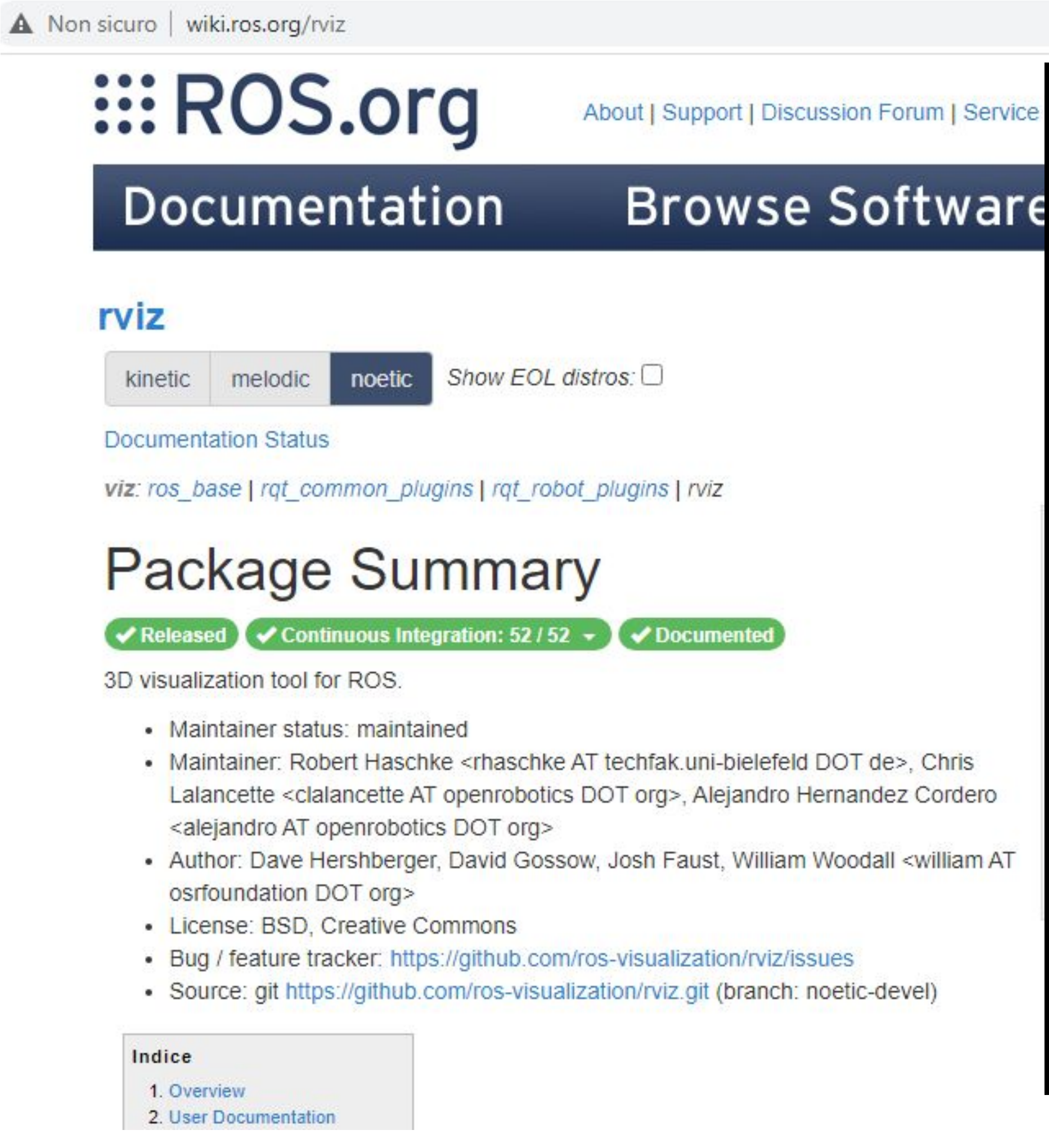
La documentazione relativa ad RViz è disponibile all’indirizzo
http://wiki.ros.org/rviz

Per lanciare RViz è necessario eseguire
il seguente comando

```
rosrun rviz rviz
```



RViz



Non sicuro | wiki.ros.org/rviz
ROS.org
About | Support | Discussion Forum | Service
Documentation
Browse Software

rviz

Show EOL distros: □

Documentation Status

viz: ros_base | rqt_common_plugins | rqt_robot_plugins | rviz

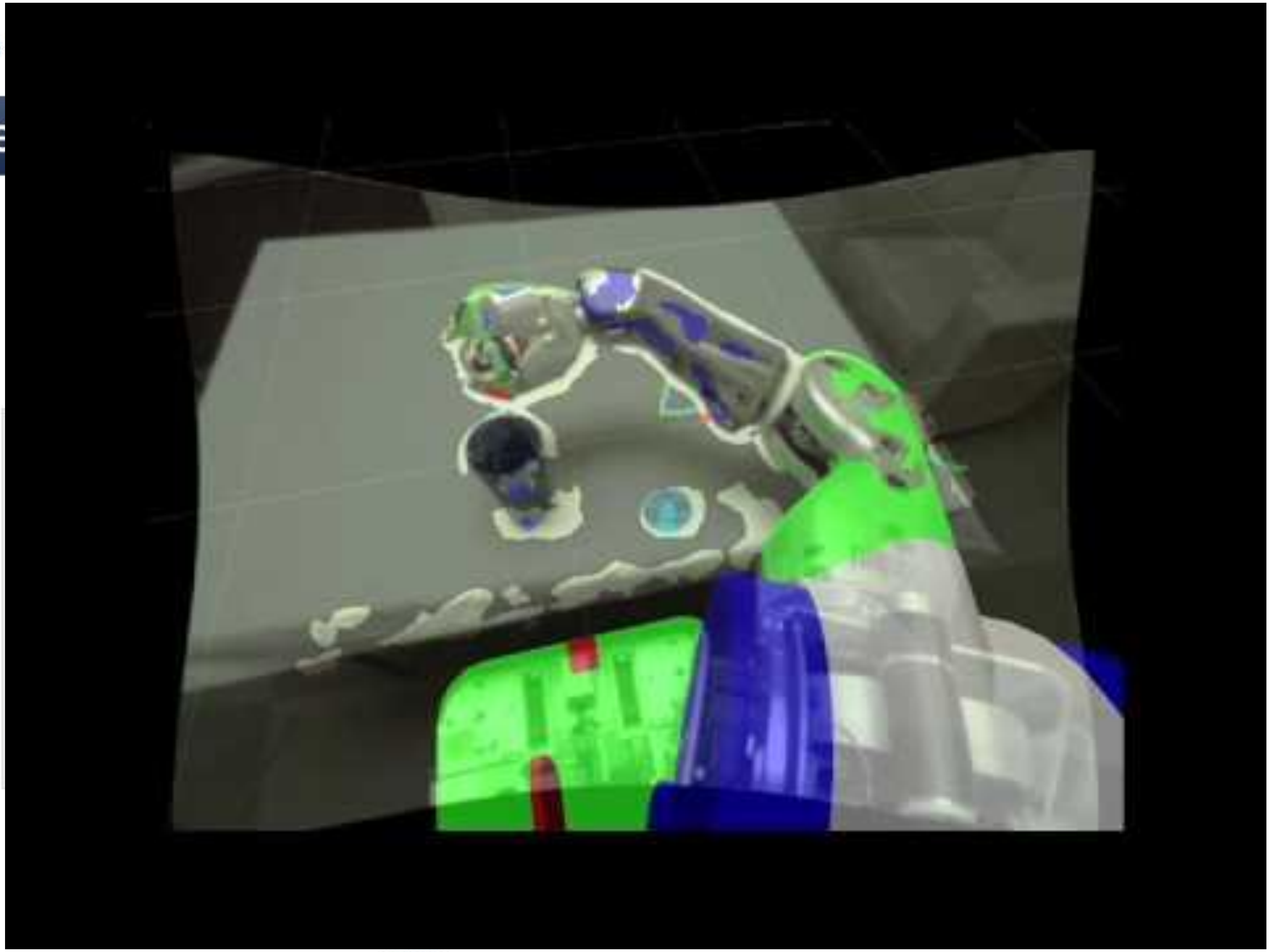
Package Summary

✓ Released ✓ Continuous Integration: 52 / 52 ✓ Documented

3D visualization tool for ROS.

- Maintainer status: maintained
- Maintainer: Robert Haschke <rhaschke AT techfak.uni-bielefeld DOT de>, Chris Lalancette <clalancette AT openrobotics DOT org>, Alejandro Hernandez Cordero <alejandro AT openrobotics DOT org>
- Author: Dave Hershberger, David Gossow, Josh Faust, William Woodall <william AT osrfoundation DOT org>
- License: BSD, Creative Commons
- Bug / feature tracker: https://github.com/ros-visualization/rviz/issues
- Source: git https://github.com/ros-visualization/rviz.git (branch: noetic-devel)

Indice



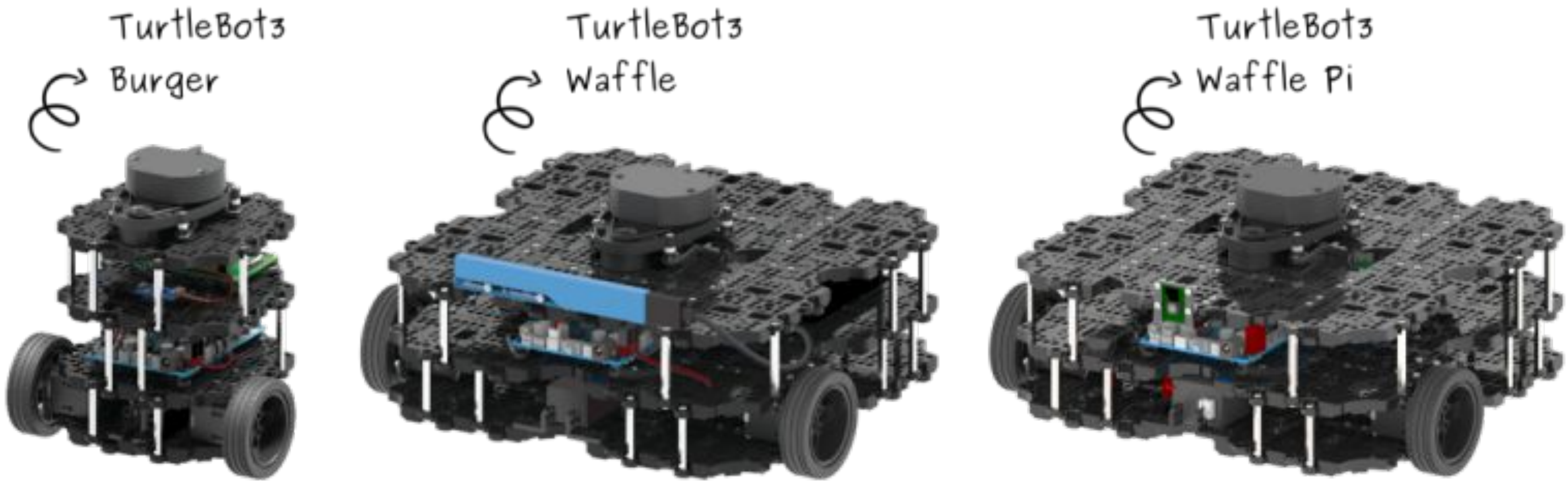
https://youtu.be/i--Sd4xH9ZE

RViz vs. Gazebo

“**Rviz** shows you what the robot *thinks* is happening, while **Gazebo** shows you what is *really* happening.”
[Morgan Quigley, *Programming Robots with ROS]*

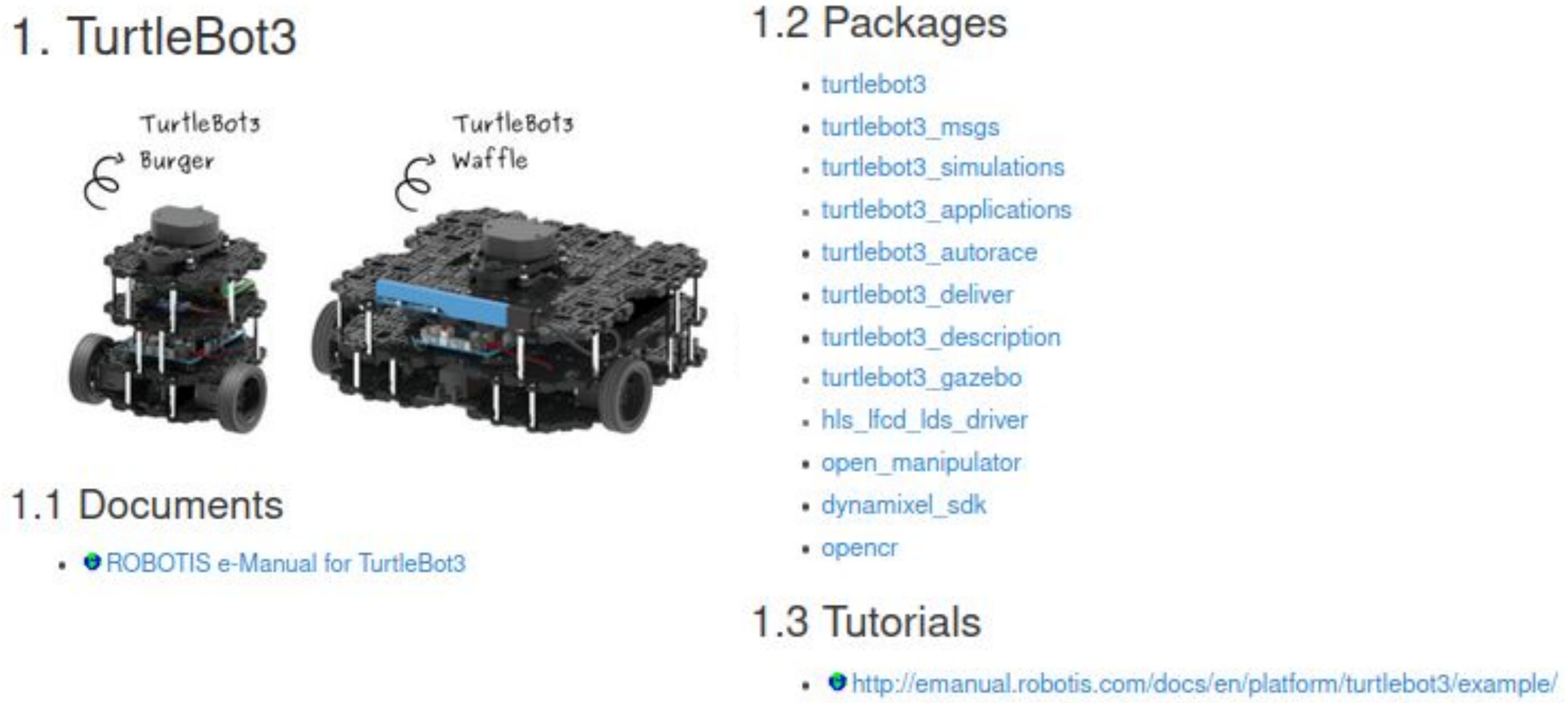
Robot da simulare

TURTLEBOT3



https://www.turtlebot.com/

TurtleBot3 in ROS



1. TurtleBot3

1.1 Documents

- ROBOTIS e-Manual for TurtleBot3

1.2 Packages

- turtlebot3
- turtlebot3_msgs
- turtlebot3_simulations
- turtlebot3_applications
- turtlebot3_autorace
- turtlebot3_deliver
- turtlebot3_description
- turtlebot3_gazebo
- hls_lfcd_lds_driver
- open_manipulator
- dynamixel_sdk
- opencr

1.3 Tutorials

- http://emanual.robotis.com/docs/en/platform/turtlebot3/example/

http://wiki.ros.org/Robots/TurtleBot

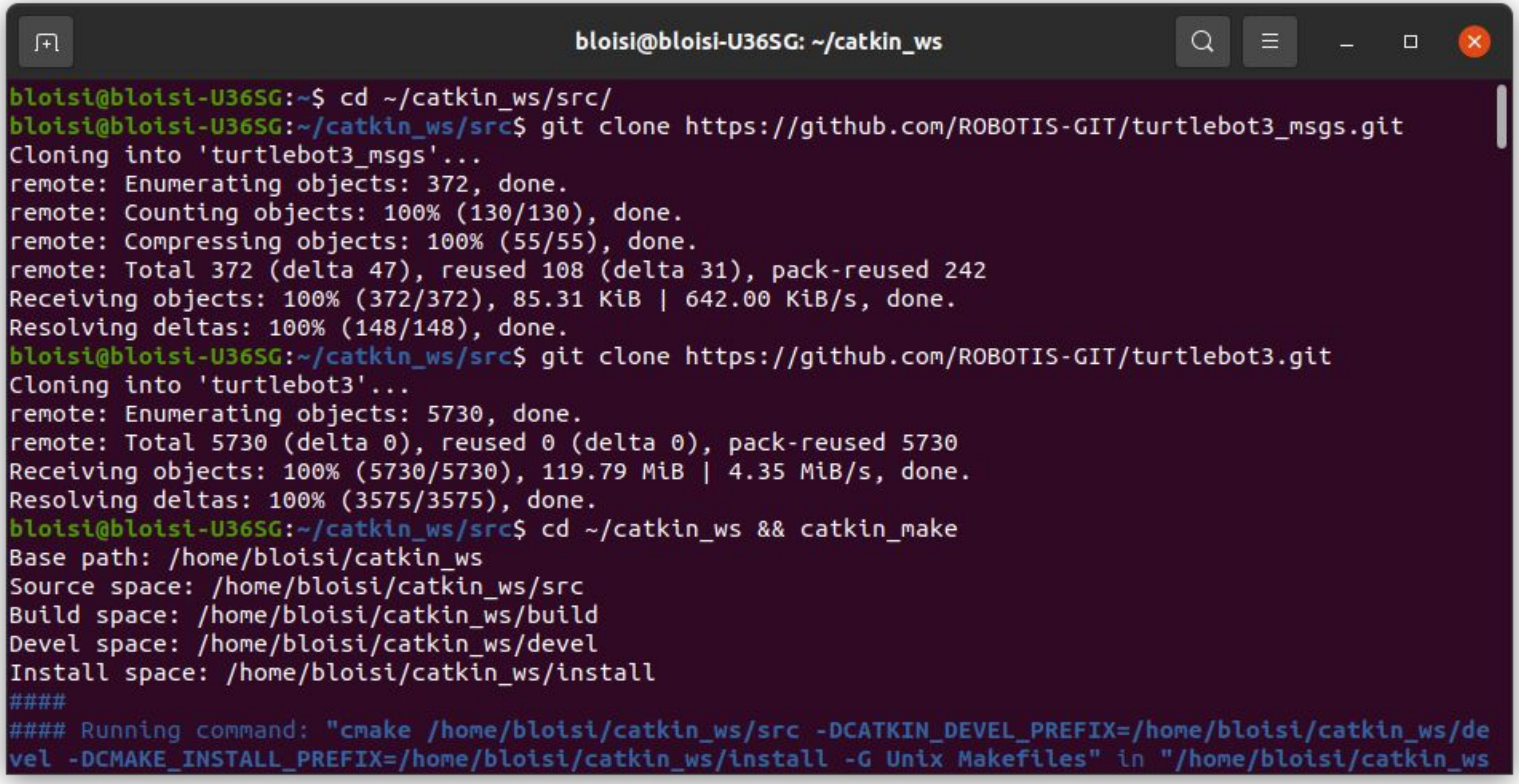
Installazione pacchetti per il TurtleBot3

Iniziamo ad installare i pacchetti ROS `turtlebot3_msgs` e `turtlebot3`

```
$ cd ~/catkin_ws/src/

$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git

$ git clone https://github.com/ROBOTIS-GIT/turtlebot3.git

$ cd ~/catkin_ws && catkin_make
```

http://emanual.robotis.com/docs/en/platform/turtlebot3/pc_setup/#install-dependent-ros-packages

turtlebot3_msgs e turtlebot3



```
bloisi@bloisi-U36SG:~$ cd ~/catkin_ws/src/
bloisi@bloisi-U36SG:~/catkin_ws/src$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git
Cloning into 'turtlebot3_msgs'...
remote: Enumerating objects: 372, done.
remote: Counting objects: 100% (130/130), done.
remote: Compressing objects: 100% (55/55), done.
remote: Total 372 (delta 47), reused 108 (delta 31), pack-reused 242
Receiving objects: 100% (372/372), 85.31 KiB | 642.00 KiB/s, done.
Resolving deltas: 100% (148/148), done.
bloisi@bloisi-U36SG:~/catkin_ws/src$ git clone https://github.com/ROBOTIS-GIT/turtlebot3.git
Cloning into 'turtlebot3'...
remote: Enumerating objects: 5730, done.
remote: Total 5730 (delta 0), reused 0 (delta 0), pack-reused 5730
Receiving objects: 100% (5730/5730), 119.79 MiB | 4.35 MiB/s, done.
Resolving deltas: 100% (3575/3575), done.
bloisi@bloisi-U36SG:~/catkin_ws/src$ cd ~/catkin_ws && catkin_make
Base path: /home/bloisi/catkin_ws
Source space: /home/bloisi/catkin_ws/src
Build space: /home/bloisi/catkin_ws/build
Devel space: /home/bloisi/catkin_ws/devel
Install space: /home/bloisi/catkin_ws/install
####
#### Running command: "cmake /home/bloisi/catkin_ws/src -DCATKIN_DEVEL_PREFIX=/home/bloisi/catkin_ws/de
vel -DCMAKE_INSTALL_PREFIX=/home/bloisi/catkin_ws/install -G Unix Makefiles" in "/home/bloisi/catkin_ws
```

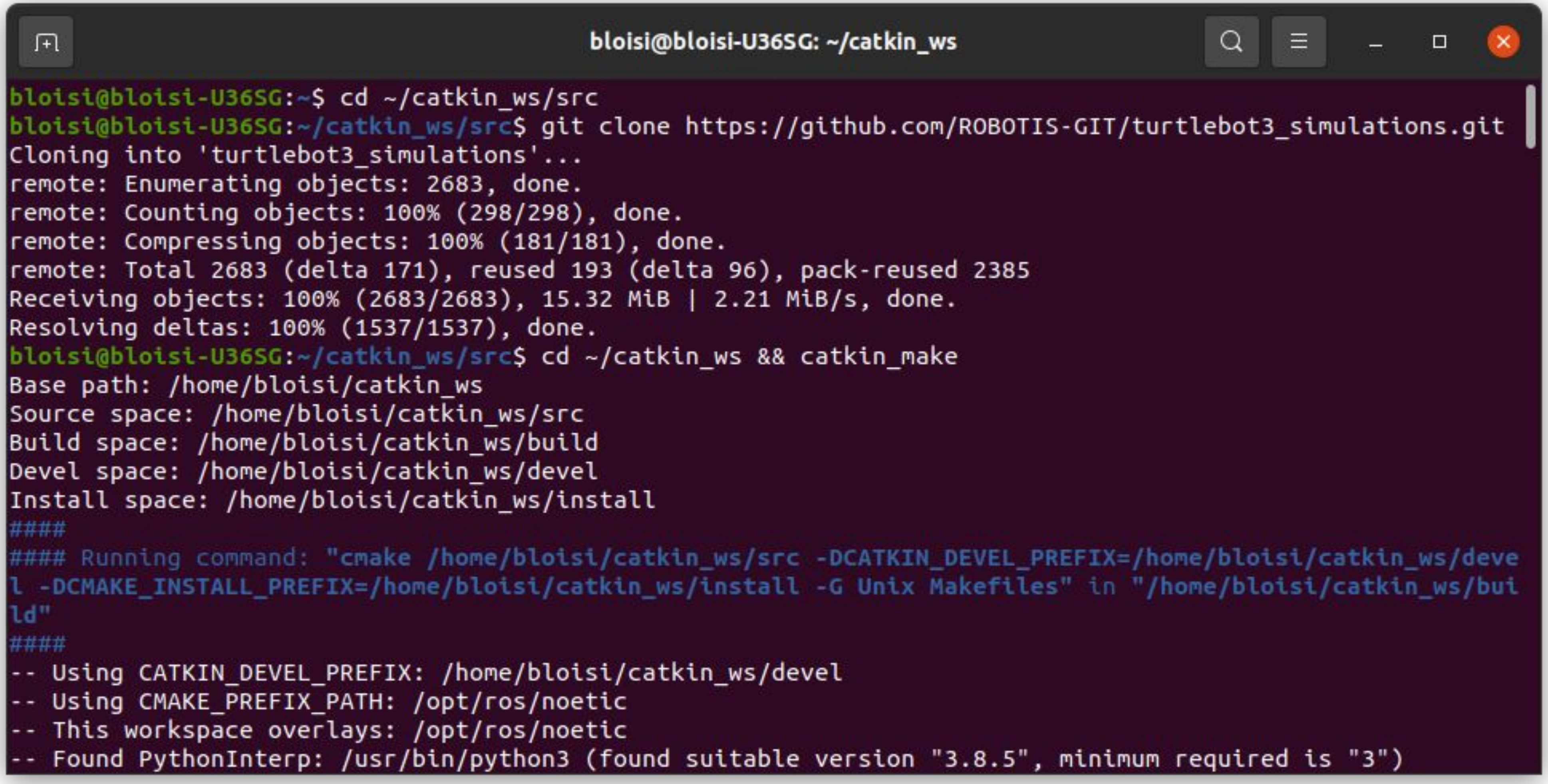
TurtleBot3 simulation

Per poter simulare il TurtleBot3 sul proprio PC è necessario utilizzare lo specifico ROS package
TurtleBot3 Simulations

```
$ cd ~/catkin_ws/src

$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git

$ cd ~/catkin_ws && catkin_make
```

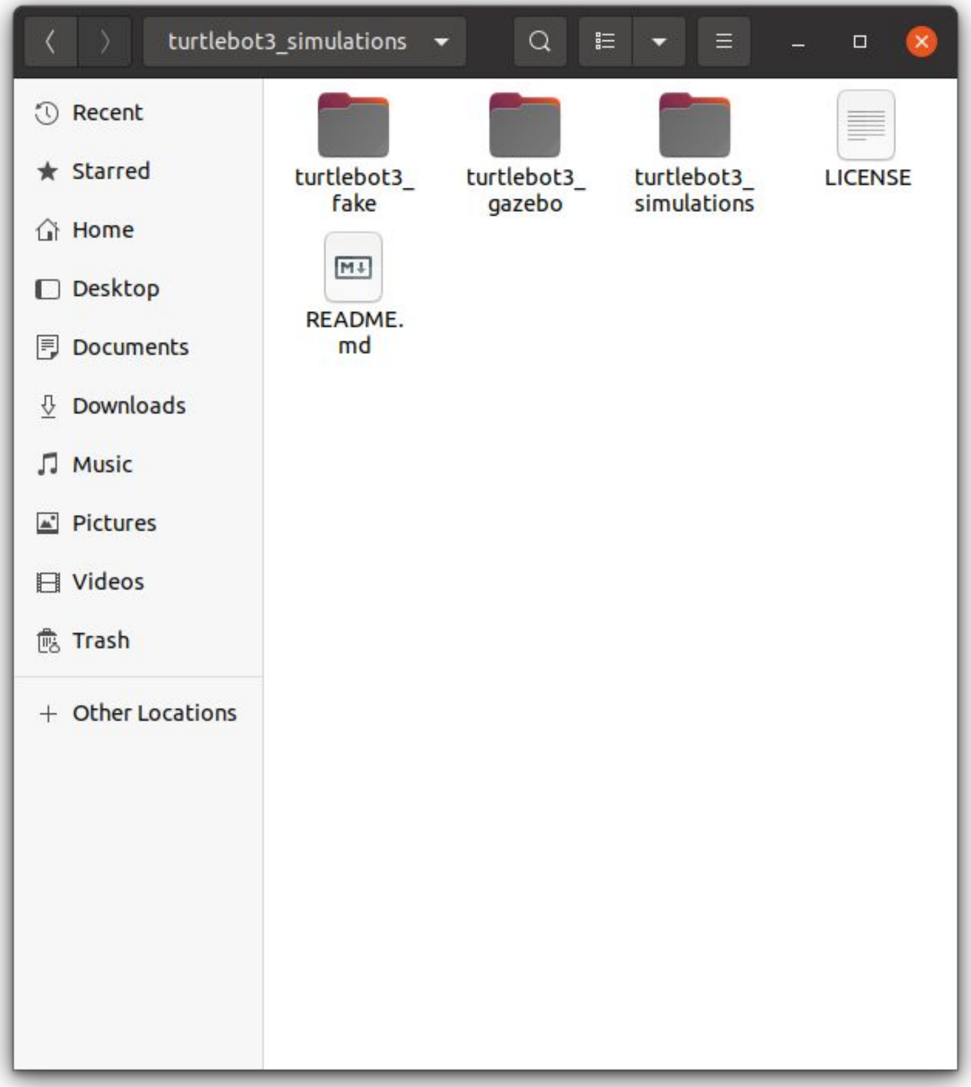
http://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/#simulation

turtlebot3_simulations



```
bloisi@bloisi-U36SG:~$ cd ~/catkin_ws/src
bloisi@bloisi-U36SG:~/catkin_ws/src$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git
Cloning into 'turtlebot3_simulations'...
remote: Enumerating objects: 2683, done.
remote: Counting objects: 100% (298/298), done.
remote: Compressing objects: 100% (181/181), done.
remote: Total 2683 (delta 171), reused 193 (delta 96), pack-reused 2385
Receiving objects: 100% (2683/2683), 15.32 MiB | 2.21 MiB/s, done.
Resolving deltas: 100% (1537/1537), done.
bloisi@bloisi-U36SG:~/catkin_ws/src$ cd ~/catkin_ws && catkin_make
Base path: /home/bloisi/catkin_ws
Source space: /home/bloisi/catkin_ws/src
Build space: /home/bloisi/catkin_ws/build
Devel space: /home/bloisi/catkin_ws/devel
Install space: /home/bloisi/catkin_ws/install
####
#### Running command: "cmake /home/bloisi/catkin_ws/src -DCATKIN_DEVEL_PREFIX=/home/bloisi/catkin_ws/deve
l -DCMAKE_INSTALL_PREFIX=/home/bloisi/catkin_ws/install -G Unix Makefiles" in "/home/bloisi/catkin_ws/bui
ld"
####
-- Using CATKIN_DEVEL_PREFIX: /home/bloisi/catkin_ws/devel
-- Using CMAKE_PREFIX_PATH: /opt/ros/noetic
-- This workspace overlays: /opt/ros/noetic
-- Found PythonInterp: /usr/bin/python3 (found suitable version "3.8.5", minimum required is "3")
```

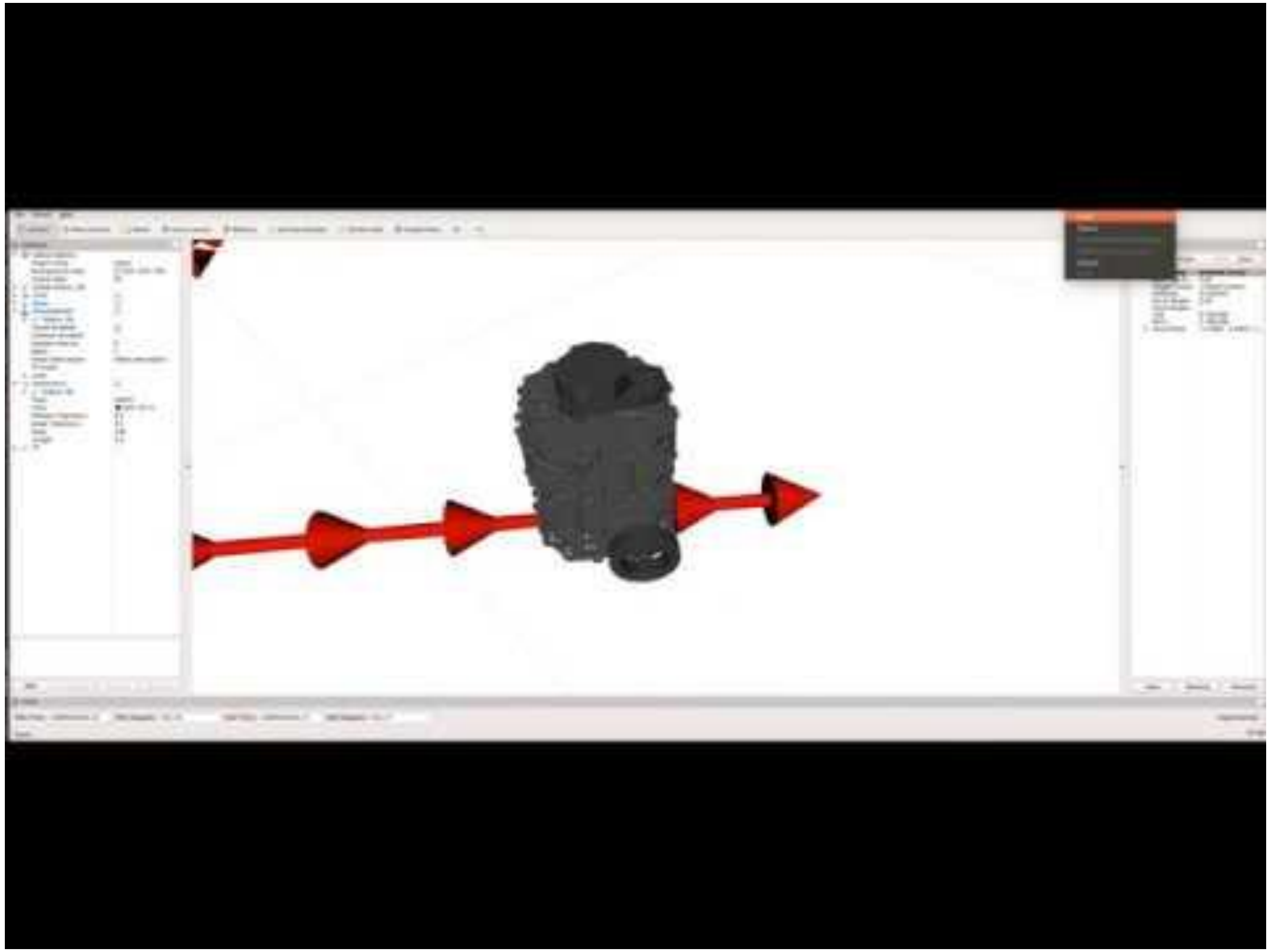
TurtleBot3_simulations folder



TurtleBot3 – fake node

- TurtleBot3 fake node è un nodo di simulazione che può essere eseguito senza necessità di avere un robot fisico

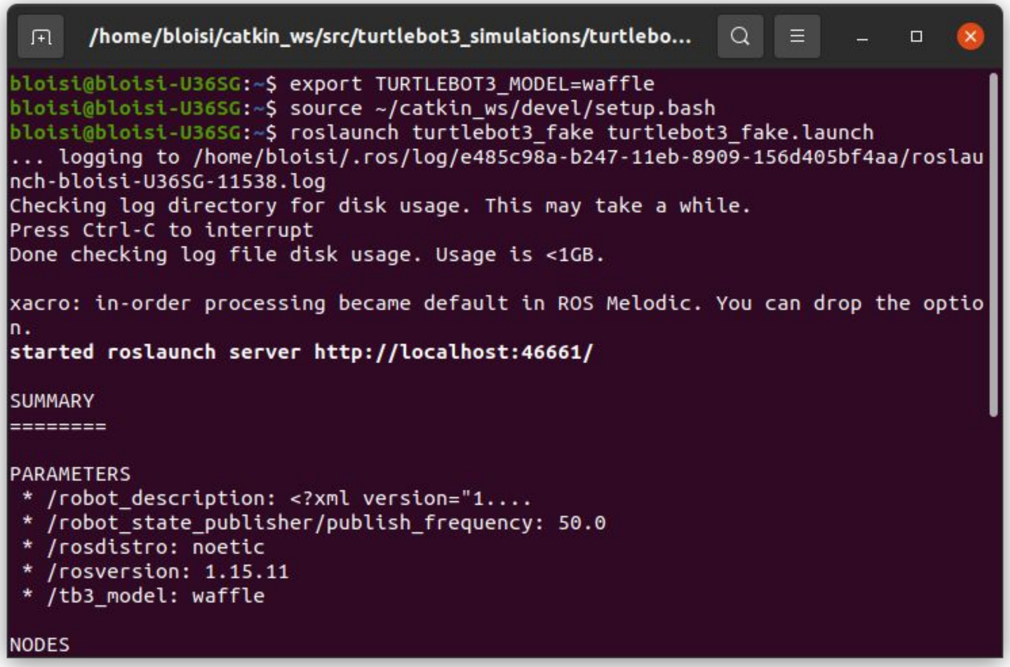
- Il TurtleBot3 virtuale può essere controllato in RViz con un teleop node



https://youtu.be/iHXZSLBJHMg

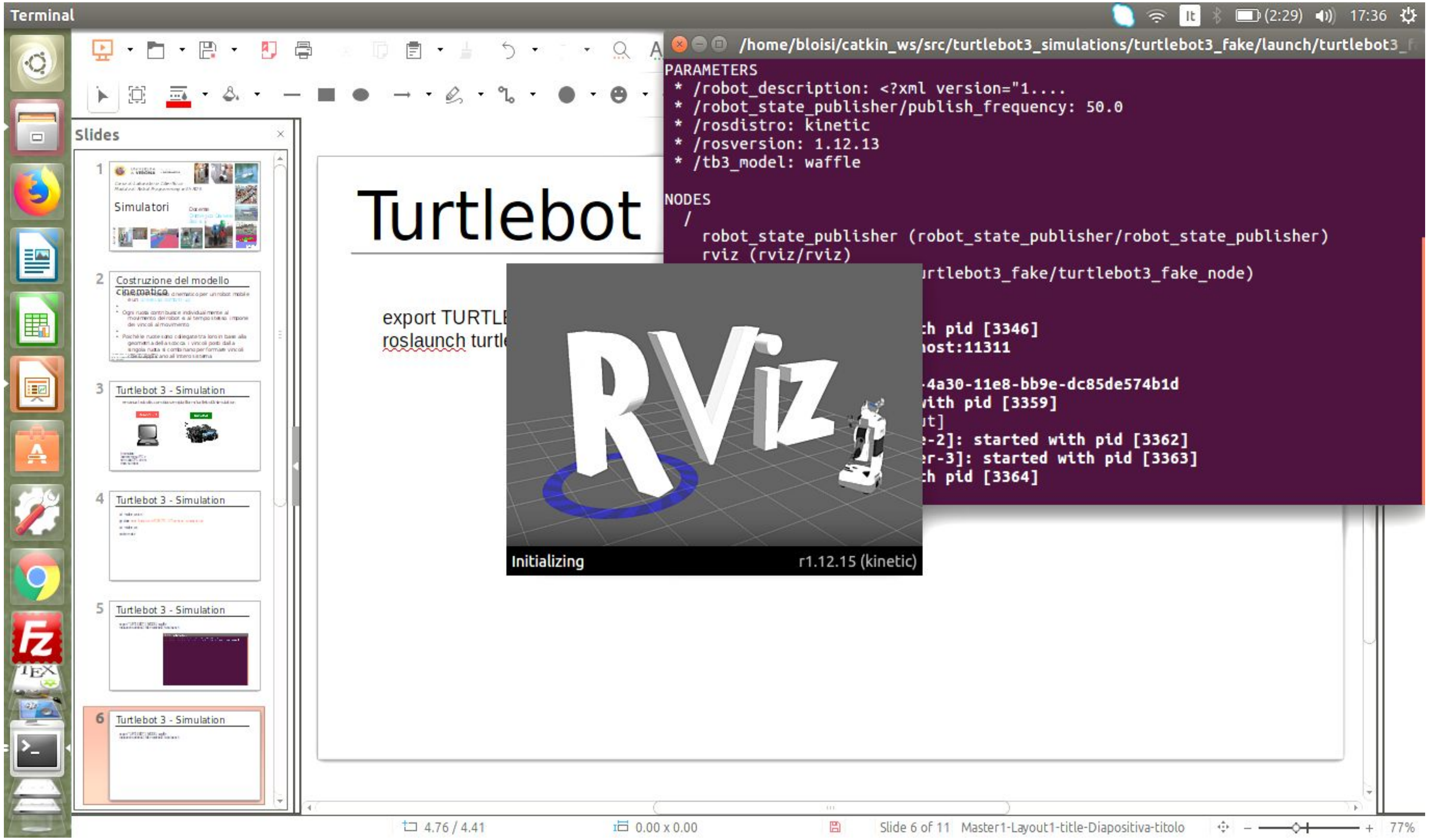
TurtleBot3 – run turtlebot3_fake

```
$ export TURTLEBOT3_MODEL=waffle

$ source ~/catkin_ws/devel/setup.bash

$ roslaunch turtlebot3_fake turtlebot3_fake.launch
```


/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebo...

```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ source ~/catkin_ws/devel/setup.bash
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_fake turtlebot3_fake.launch
... logging to /home/bloisi/.ros/log/e485c98a-b247-11eb-8909-156d405bf4aa/roslau
nch-bloisi-U36SG-11538.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.

xacro: in-order processing became default in ROS Melodic. You can drop the optio
n.
started roslaunch server http://localhost:46661/

SUMMARY
========

PARAMETERS
 * /robot_description: <?xml version="1....
 * /robot_state_publisher/publish_frequency: 50.0
 * /rosdistro: noetic
 * /rosversion: 1.15.11
 * /tb3_model: waffle

NODES
```

TurtleBot3 – run turtlebot3_fake



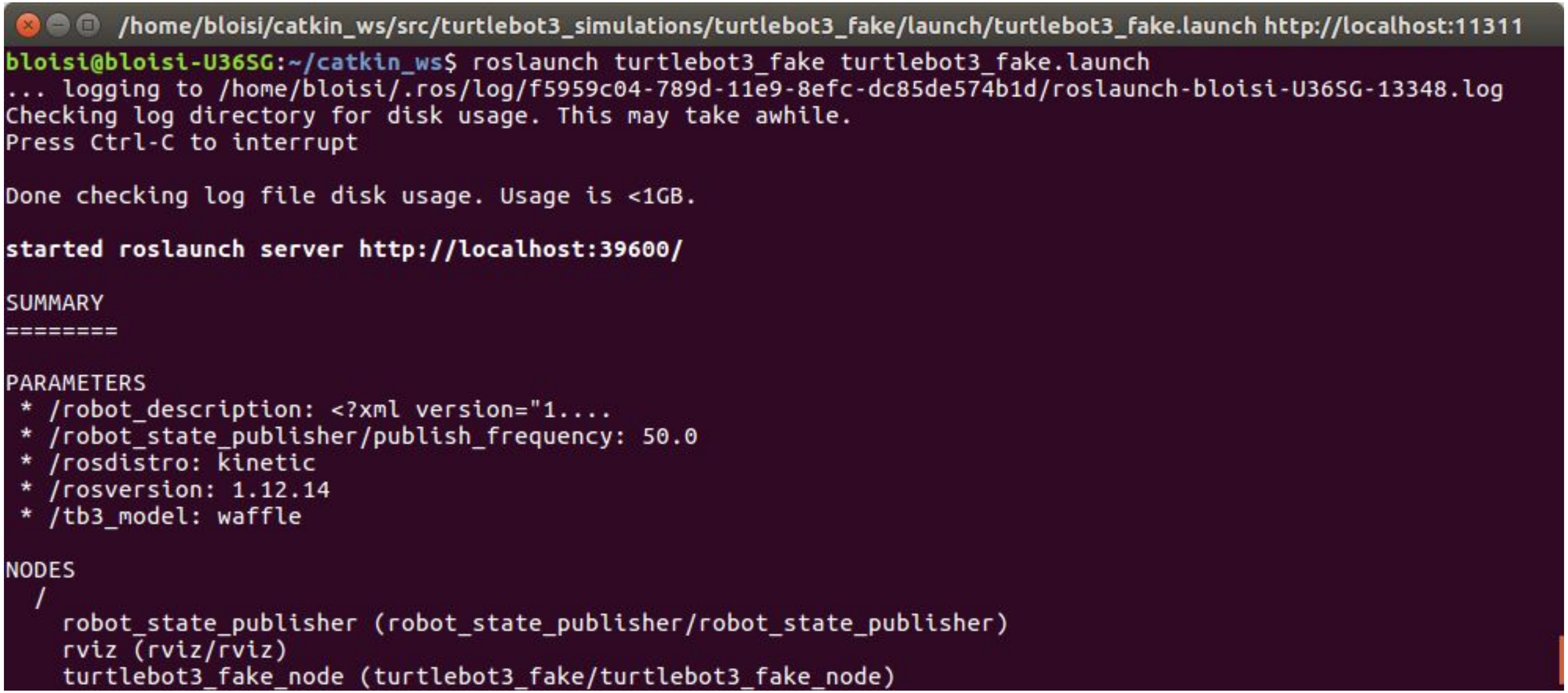
/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_fake/launch/turtlebot3_

```
PARAMETERS
 * /robot_description: <?xml version="1....
 * /robot_state_publisher/publish_frequency: 50.0
 * /rosdistro: kinetic
 * /rosversion: 1.12.13
 * /tb3_model: waffle

NODES
  /
    robot_state_publisher (robot_state_publisher/robot_state_publisher)
    rviz (rviz/rviz)
                         urtlebot3_fake/turtlebot3_fake_node)


                         :h pid [3346]
                         host:11311

                         -4a30-11e8-bb9e-dc85de574b1d
                         with pid [3359]
                         ut]
                         e-2]: started with pid [3362]
                         er-3]: started with pid [3363]
                         :h pid [3364]
```

Turtlebot

export TURTLE
roslaunch turtl

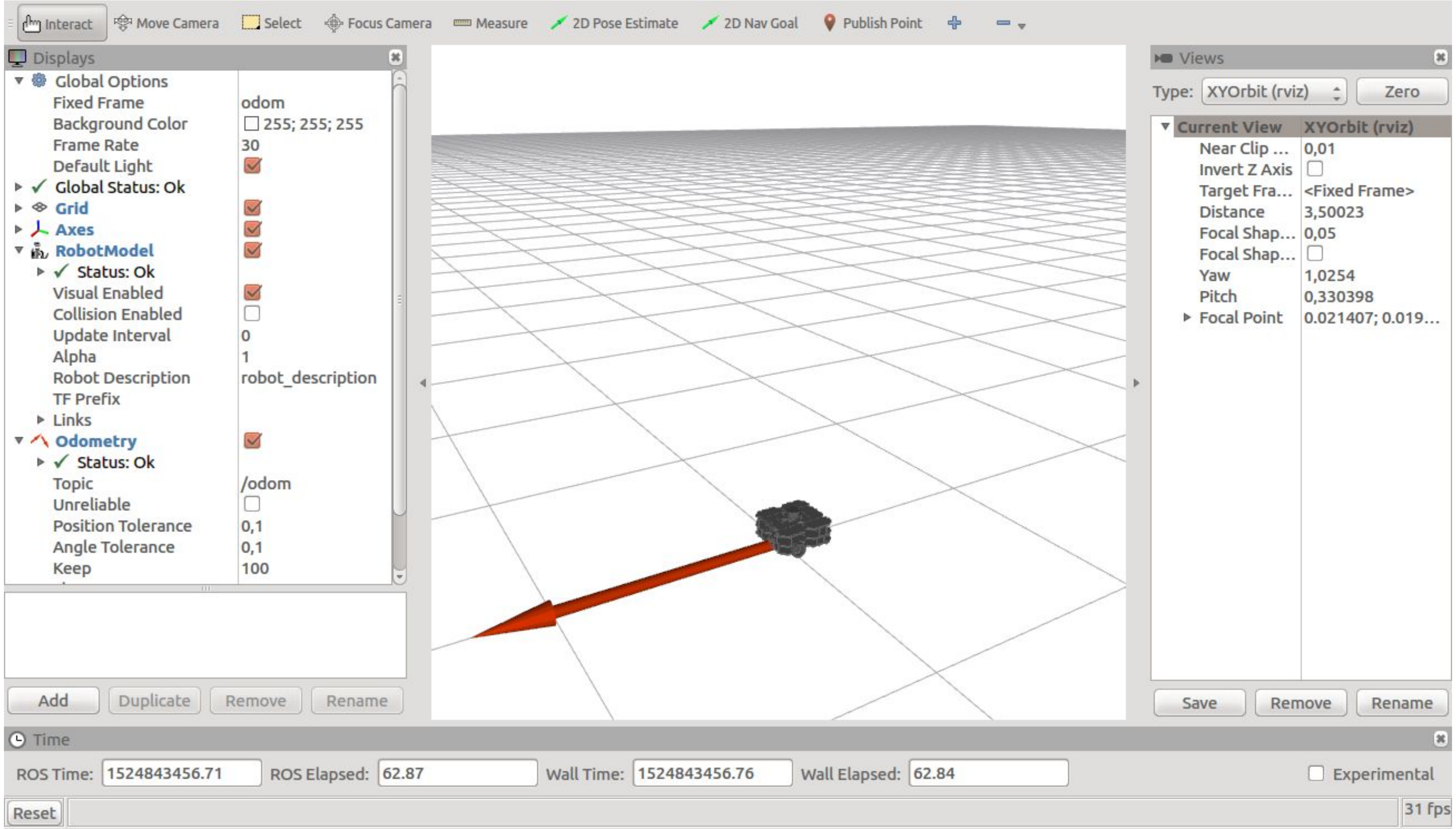
TurtleBot3 – run turtlebot3_fake



/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_fake/launch/turtlebot3_fake.launch http://localhost:11311

```
bloisi@bloisi-U36SG:~/catkin_ws$ roslaunch turtlebot3_fake turtlebot3_fake.launch
... logging to /home/bloisi/.ros/log/f5959c04-789d-11e9-8efc-dc85de574b1d/roslaunch-bloisi-U36SG-13348.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt

Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://localhost:39600/

SUMMARY
========

PARAMETERS
 * /robot_description: <?xml version="1....
 * /robot_state_publisher/publish_frequency: 50.0
 * /rosdistro: kinetic
 * /rosversion: 1.12.14
 * /tb3_model: waffle

NODES
  /
    robot_state_publisher (robot_state_publisher/robot_state_publisher)
    rviz (rviz/rviz)
    turtlebot3_fake_node (turtlebot3_fake/turtlebot3_fake_node)
```

TurtleBot3 – visualizzazione



Global Options	
Fixed Frame	odom
Background Color	□ 255; 255; 255
Frame Rate	30
Default Light	☑
✓ Global Status: Ok	
Grid	☑
Axes	☑
RobotModel	☑
✓ Status: Ok	
Visual Enabled	☑
Collision Enabled	□
Update Interval	0
Alpha	1
Robot Description	robot_description
TF Prefix	
Links	
Odometry	☑
✓ Status: Ok	
Topic	/odom
Unreliable	□
Position Tolerance	0,1
Angle Tolerance	0,1
Keep	100

Type: XYOrbit (rviz)

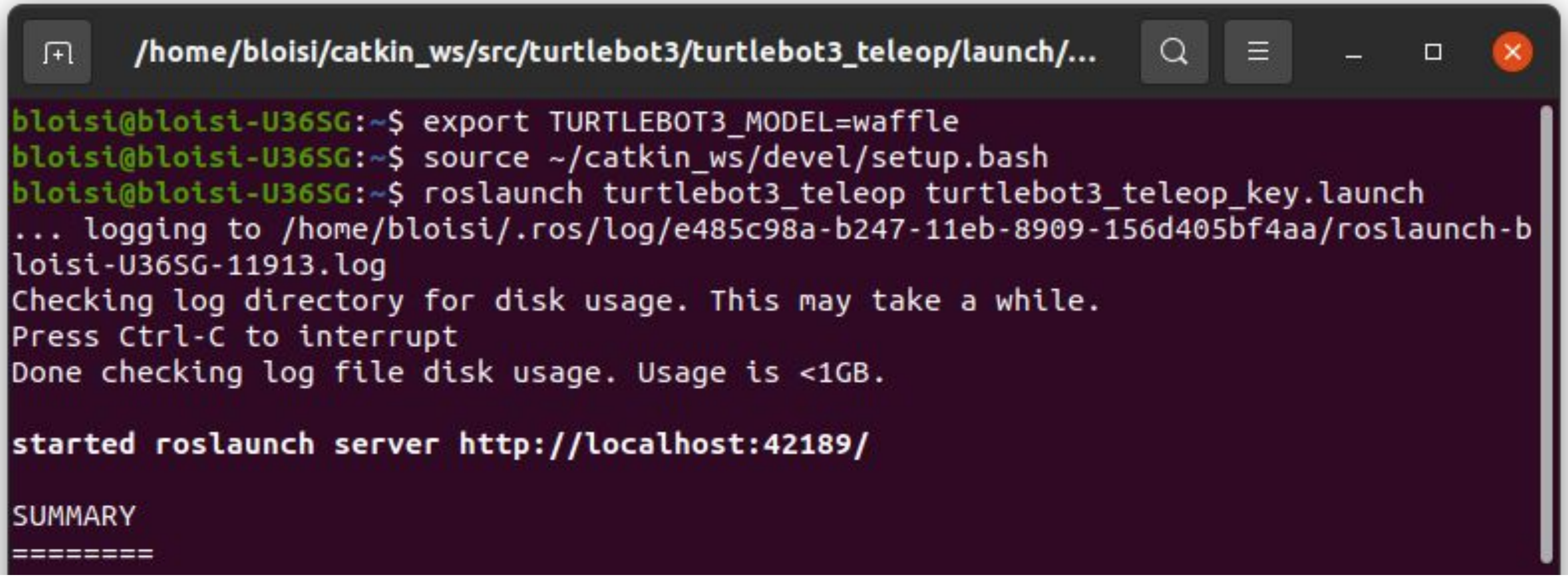
Current View	XYOrbit (rviz)
Near Clip ...	0,01
Invert Z Axis	□
Target Fra...	<Fixed Frame>
Distance	3,50023
Focal Shap...	0,05
Focal Shap...	□
Yaw	1,0254
Pitch	0,330398
Focal Point	0.021407; 0.019...

ROS Time: 1524843456.71 ROS Elapsed: 62.87 Wall Time: 1524843456.76 Wall Elapsed: 62.84 □ Experimental

TurtleBot3 – teleop in simulation

Apriamo un nuovo terminal e digitiamo

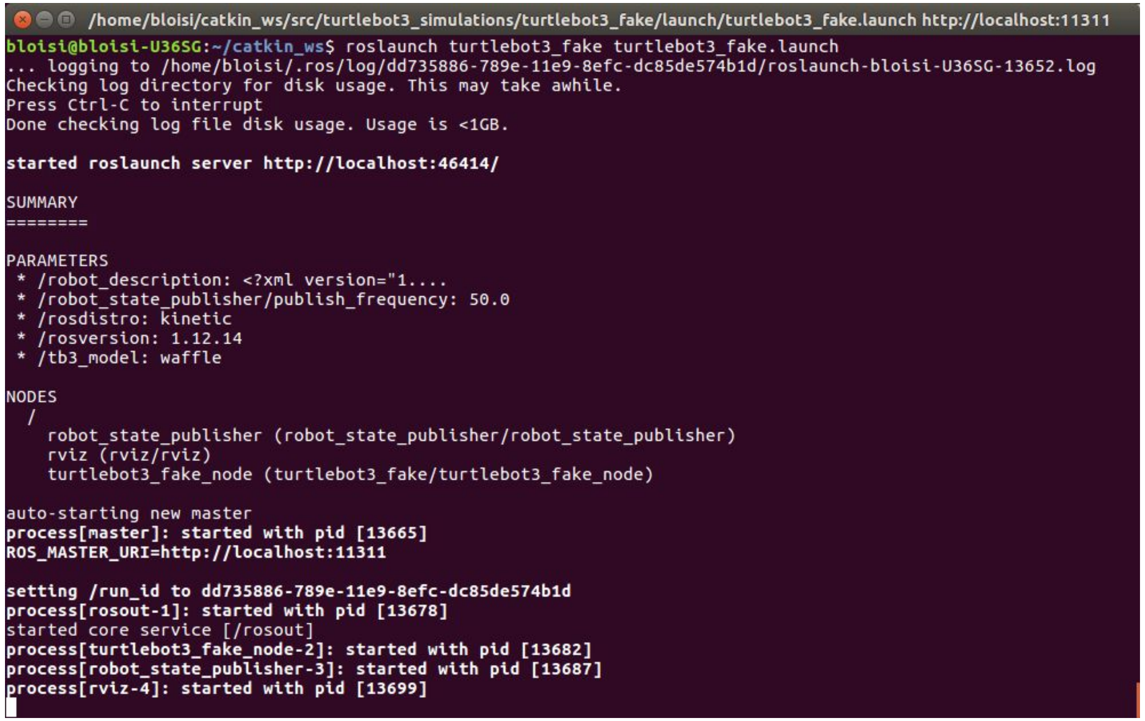
```
$ export TURTLEBOT3_MODEL=waffle

$ source ~/catkin_ws/devel/setup.bash

$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```



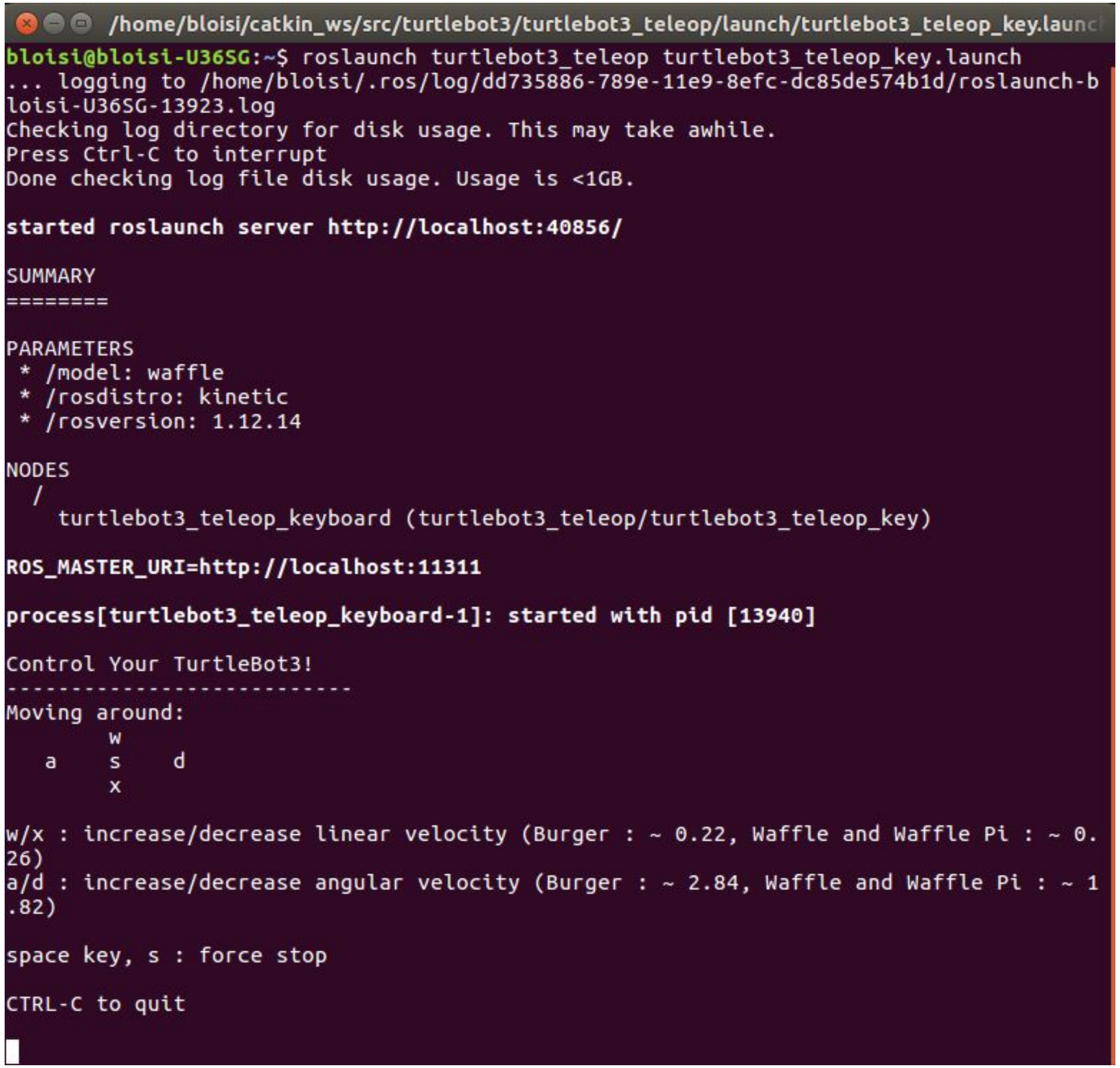
/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/launch/...

```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ source ~/catkin_ws/devel/setup.bash
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /home/bloisi/.ros/log/e485c98a-b247-11eb-8909-156d405bf4aa/roslaunch-b
loisi-U36SG-11913.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://localhost:42189/

SUMMARY
========
```

TurtleBot3 – i due terminal

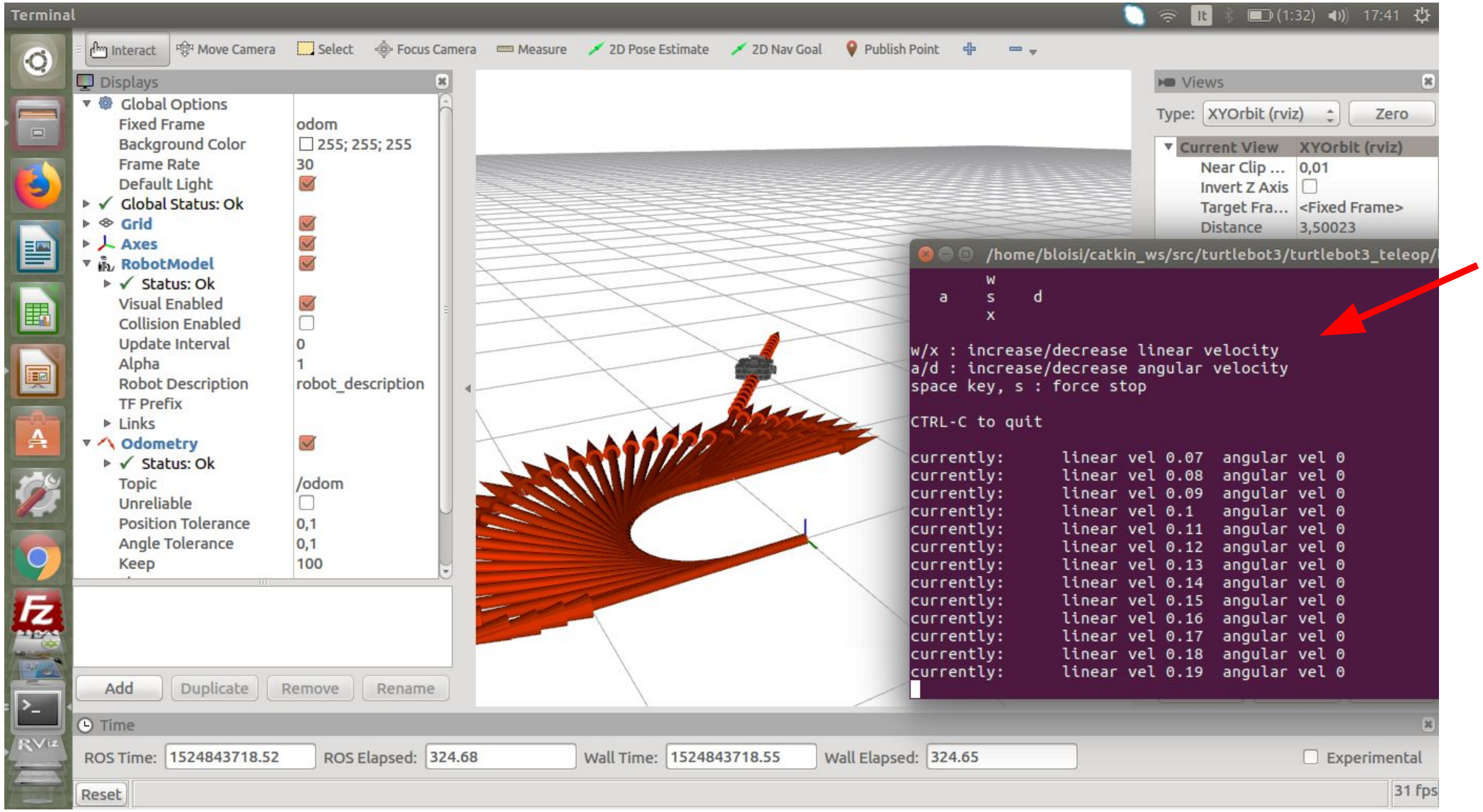


```
/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_fake/launch/turtlebot3_fake.launch http://localhost:11311
bloisi@bloisi-U36SG:~/catkin_ws$ roslaunch turtlebot3_fake turtlebot3_fake.launch
... logging to /home/bloisi/.ros/log/dd735886-789e-11e9-8efc-dc85de574b1d/roslaunch-bloisi-U36SG-13652.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://localhost:46414/

SUMMARY
========

PARAMETERS
 * /robot_description: <?xml version="1....
 * /robot_state_publisher/publish_frequency: 50.0
 * /rosdistro: kinetic
 * /rosversion: 1.12.14
 * /tb3_model: waffle

NODES
  /
    robot_state_publisher (robot_state_publisher/robot_state_publisher)
    rviz (rviz/rviz)
    turtlebot3_fake_node (turtlebot3_fake/turtlebot3_fake_node)

auto-starting new master
process[master]: started with pid [13665]
ROS_MASTER_URI=http://localhost:11311

setting /run_id to dd735886-789e-11e9-8efc-dc85de574b1d
process[rosout-1]: started with pid [13678]
started core service [/rosout]
process[turtlebot3_fake_node-2]: started with pid [13682]
process[robot_state_publisher-3]: started with pid [13687]
process[rviz-4]: started with pid [13699]
```



```
/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/launch/turtlebot3_teleop_key.launc
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /home/bloisi/.ros/log/dd735886-789e-11e9-8efc-dc85de574b1d/roslaunch-b
loisi-U36SG-13923.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://localhost:40856/

SUMMARY
========

PARAMETERS
 * /model: waffle
 * /rosdistro: kinetic
 * /rosversion: 1.12.14

NODES
  /
    turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://localhost:11311

process[turtlebot3_teleop_keyboard-1]: started with pid [13940]

Control Your TurtleBot3!
---------------------------
Moving around:
        w
   a    s    d
        x

w/x : increase/decrease linear velocity (Burger : ~ 0.22, Waffle and Waffle Pi : ~ 0.
26)
a/d : increase/decrease angular velocity (Burger : ~ 2.84, Waffle and Waffle Pi : ~ 1
.82)

space key, s : force stop

CTRL-C to quit
```

TurtleBot3 – teleop in simulation



Global Options
Fixed Frame: odom
Background Color: 255; 255; 255
Frame Rate: 30
Default Light: ☑
✓ Global Status: Ok
Grid: ☑
Axes: ☑
RobotModel: ☑
✓ Status: Ok
Visual Enabled: ☑
Collision Enabled: □
Update Interval: 0
Alpha: 1
Robot Description: robot_description
TF Prefix
Links
Odometry: ☑
✓ Status: Ok
Topic: /odom
Unreliable: □
Position Tolerance: 0,1
Angle Tolerance: 0,1
Keep: 100

Type: XYOrbit (rviz) Zero
Current View: XYOrbit (rviz)
Near Clip ...: 0,01
Invert Z Axis: □
Target Fra...: <Fixed Frame>
Distance: 3,50023

ROS Time: 1524843718.52 ROS Elapsed: 324.68 Wall Time: 1524843718.55 Wall Elapsed: 324.65 □ Experimental

/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/

```
        w
   a    s    d
        x

w/x : increase/decrease linear velocity
a/d : increase/decrease angular velocity
space key, s : force stop

CTRL-C to quit

currently:      linear vel 0.07  angular vel 0
currently:      linear vel 0.08  angular vel 0
currently:      linear vel 0.09  angular vel 0
currently:      linear vel 0.1   angular vel 0
currently:      linear vel 0.11  angular vel 0
currently:      linear vel 0.12  angular vel 0
currently:      linear vel 0.13  angular vel 0
currently:      linear vel 0.14  angular vel 0
currently:      linear vel 0.15  angular vel 0
currently:      linear vel 0.16  angular vel 0
currently:      linear vel 0.17  angular vel 0
currently:      linear vel 0.18  angular vel 0
currently:      linear vel 0.19  angular vel 0
```

Per poter controllare il robot da tastiera, il terminal con il nodo teleop deve essere selezionato

TurtleBot3 – Gazebo

https://youtu.be/UzOoJ6a_mOg

Guida TurtleBot3 con Gazebo

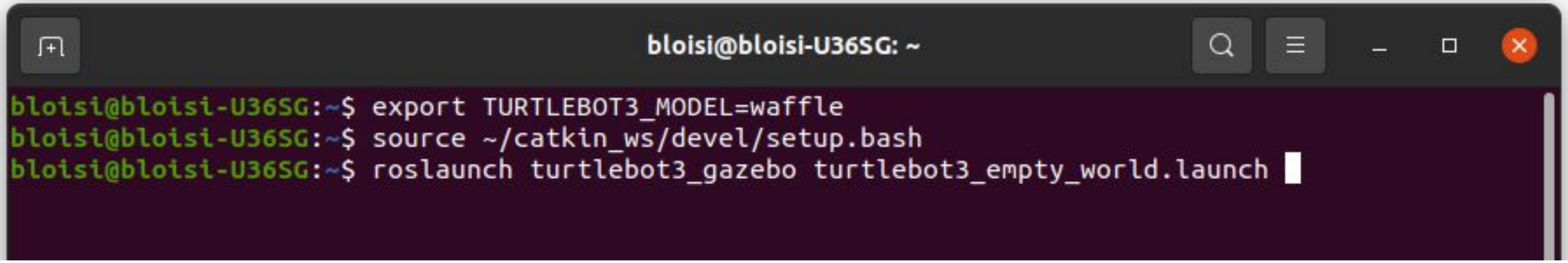
Una guida all’uso di Gazebo con il TurtleBot3 è disponibile al seguente URL

http://emanual.robotis.com/docs/en/platform/turtlebot3/simulation

TurtleBot3 – empty world

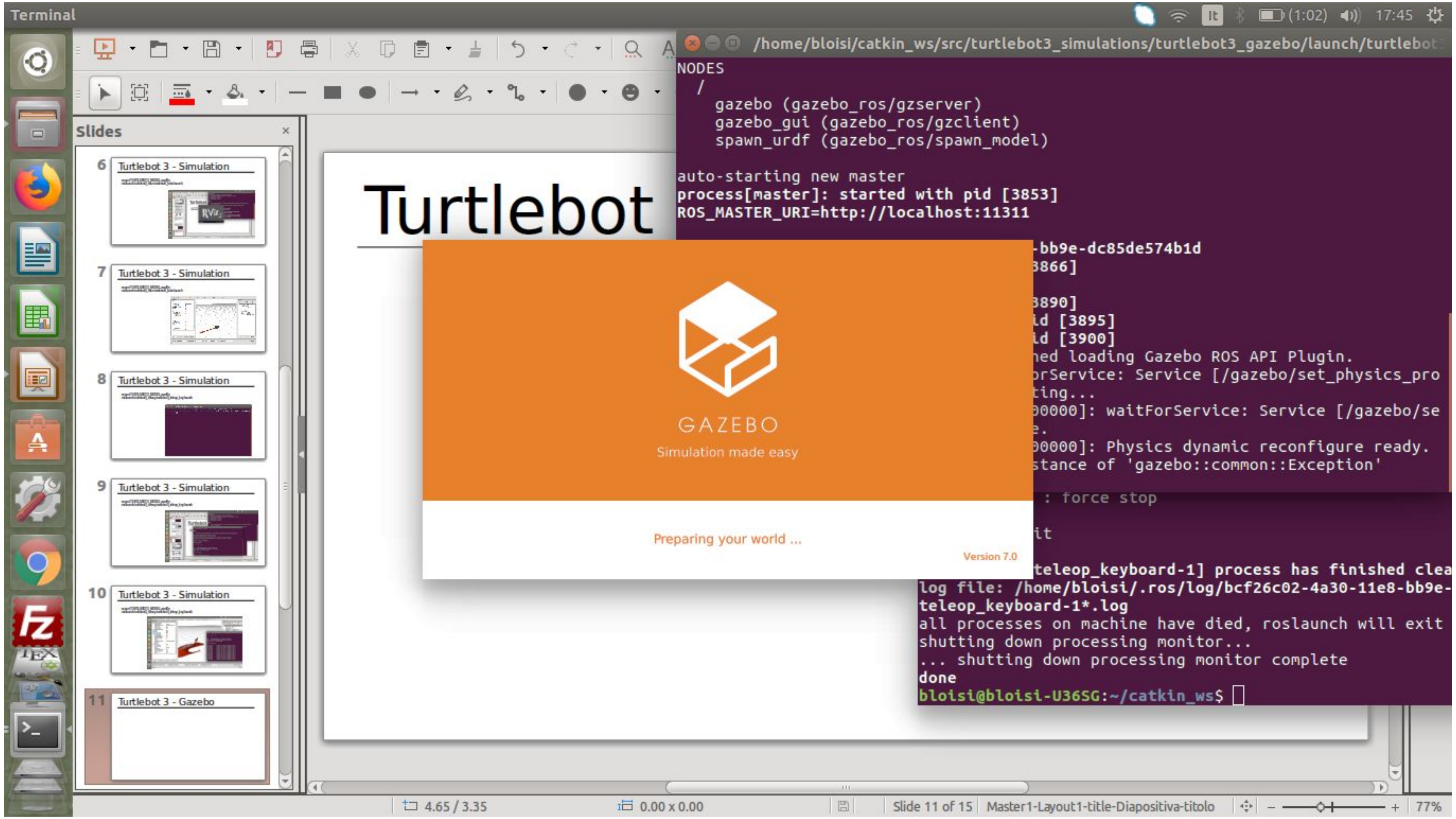
Apriamo un nuovo terminal e digitiamo

```
$ export TURTLEBOT3_MODEL=waffle

$ source ~/catkin_ws/devel/setup.bash

$ roslaunch turtlebot3_gazebo turtlebot3_empty_world.launch
```



```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ source ~/catkin_ws/devel/setup.bash
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_empty_world.launch
```

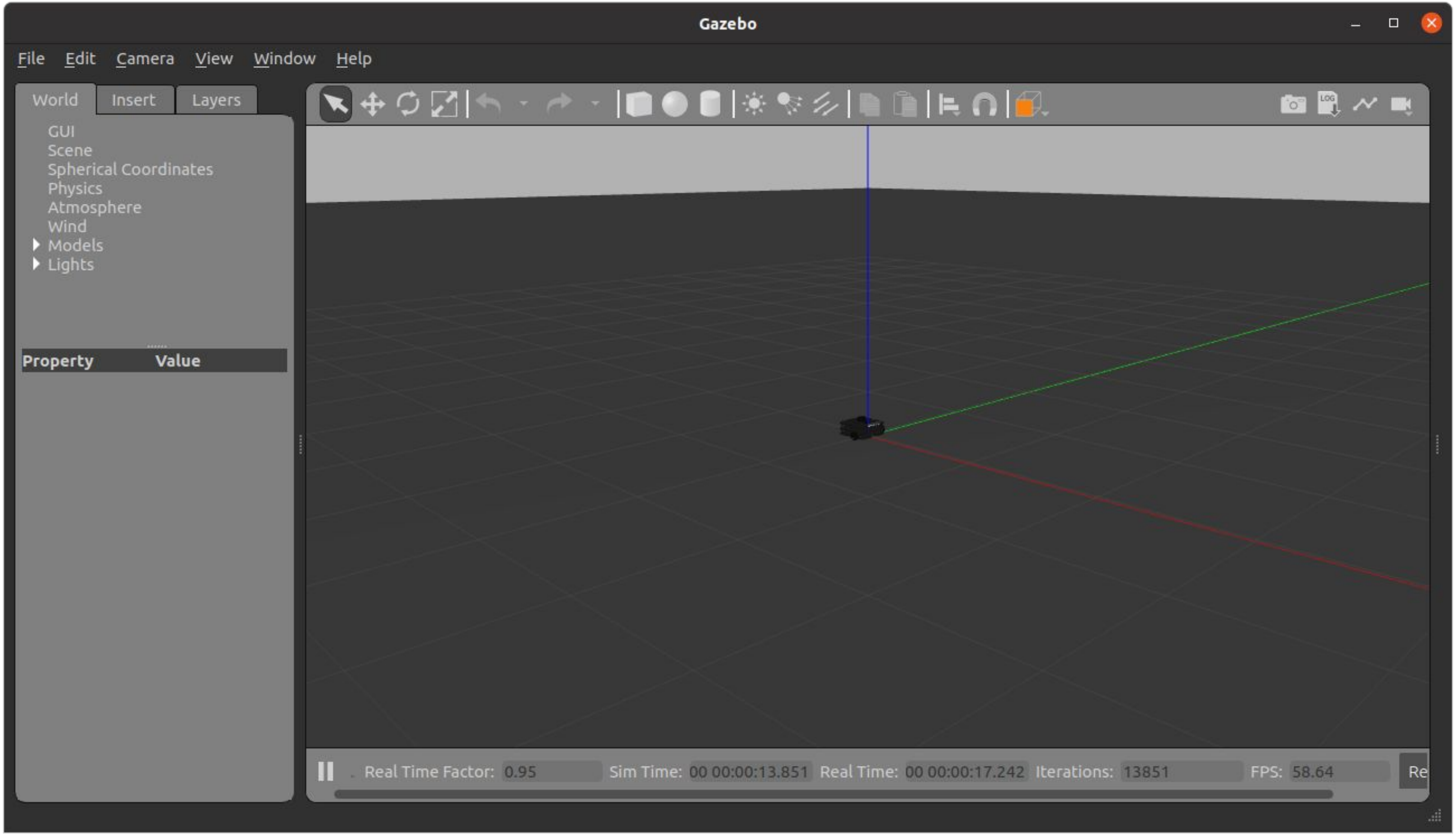
TurtleBot3 – empty world



/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_gazebo/launch/turtlebot

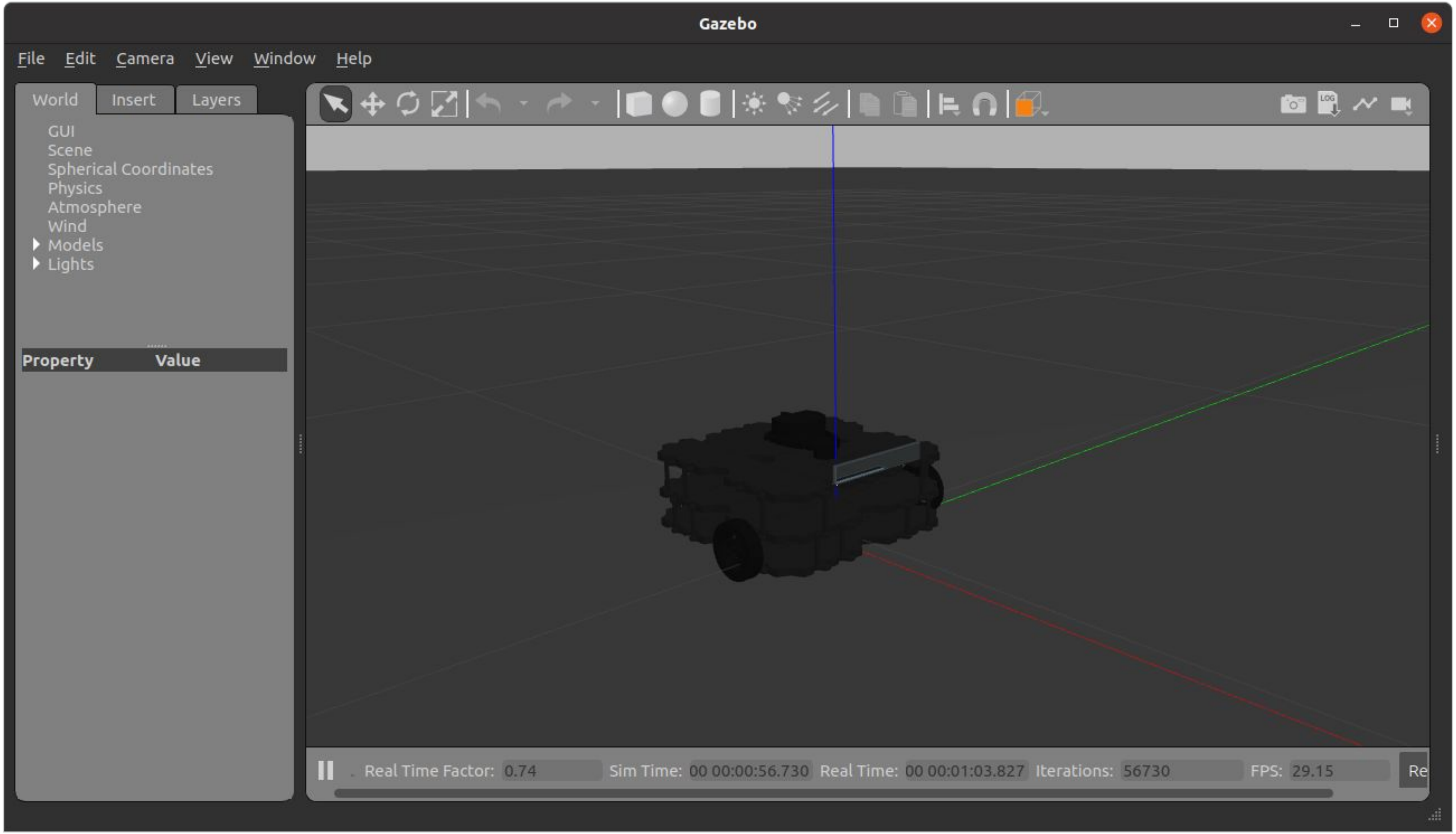
```
NODES
  /
    gazebo (gazebo_ros/gzserver)
    gazebo_gui (gazebo_ros/gzclient)
    spawn_urdf (gazebo_ros/spawn_model)

auto-starting new master
process[master]: started with pid [3853]
ROS_MASTER_URI=http://localhost:11311

                         -bb9e-dc85de574b1d
                         3866]

                         3890]
                         id [3895]
                         id [3900]
                         hed loading Gazebo ROS API Plugin.
                         orService: Service [/gazebo/set_physics_pro
                         ting...
                         00000]: waitForService: Service [/gazebo/se
                         e.
                         00000]: Physics dynamic reconfigure ready.
                         stance of 'gazebo::common::Exception'

                         : force stop

                         it

                         teleop_keyboard-1] process has finished clea
log file: /home/bloisi/.ros/log/bcf26c02-4a30-11e8-bb9e-
teleop_keyboard-1*.log
all processes on machine have died, roslaunch will exit
shutting down processing monitor...
... shutting down processing monitor complete
done
bloisi@bloisi-U36SG:~/catkin_ws$ 
```

TurtleBot3 – empty world



Real Time Factor: 0.95 Sim Time: 00 00:00:13.851 Real Time: 00 00:00:17.242 Iterations: 13851 FPS: 58.64

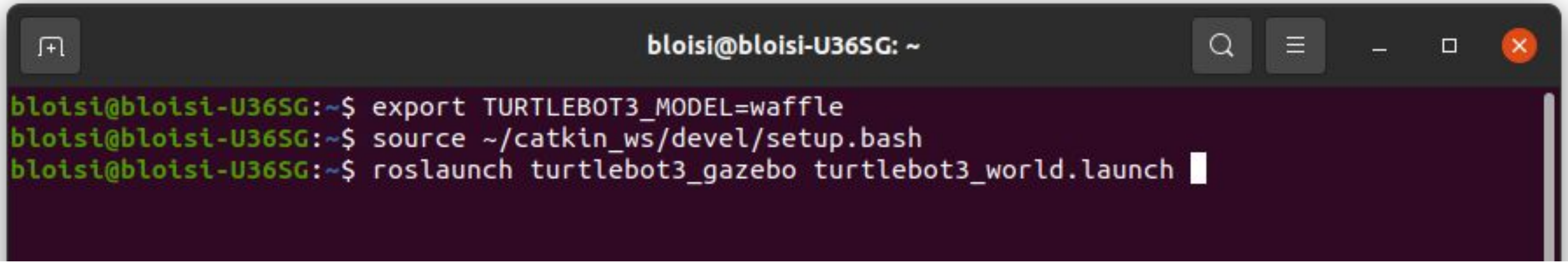
TurtleBot3 – empty world



Real Time Factor: 0.74 Sim Time: 00 00:00:56.730 Real Time: 00 00:01:03.827 Iterations: 56730 FPS: 29.15 Re

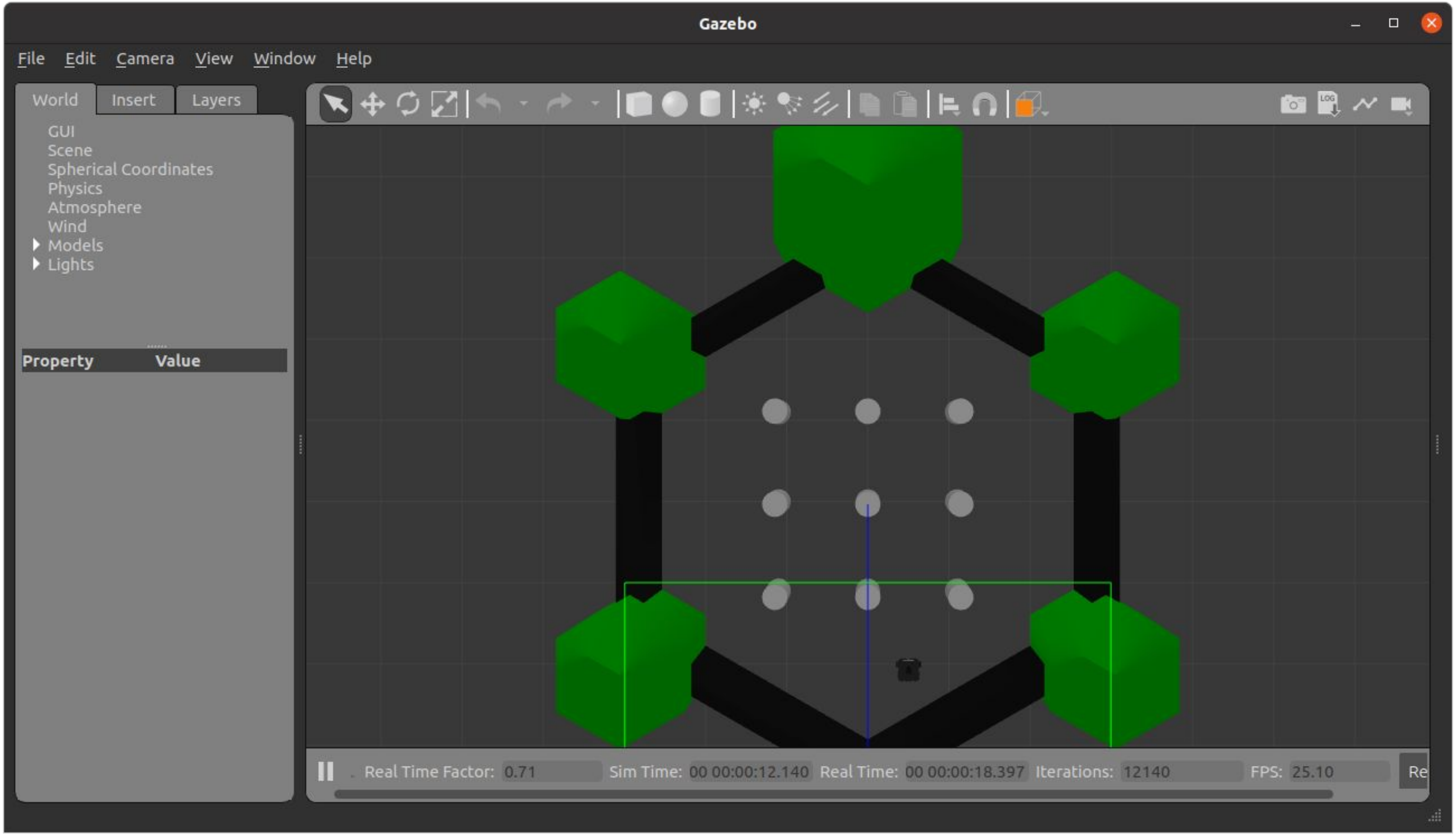
TurtleBot3 – TurtleBot3 World

```
$ export TURTLEBOT3_MODEL=waffle

$ source ~/catkin_ws/devel/setup.bash

$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



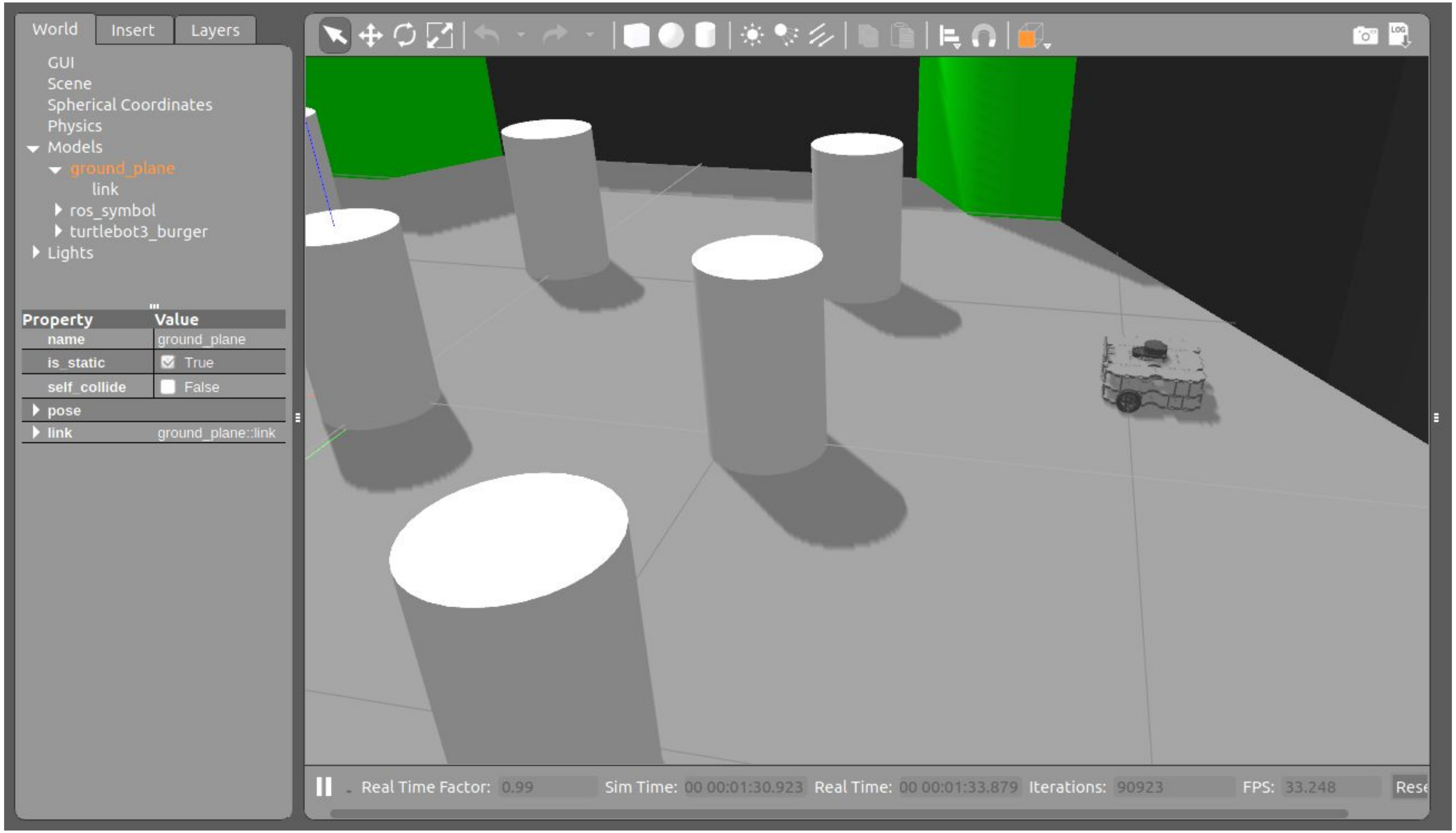
```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ source ~/catkin_ws/devel/setup.bash
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

TurtleBot3 – TurtleBot3 World



Real Time Factor: 0.71 Sim Time: 00 00:00:12.140 Real Time: 00 00:00:18.397 Iterations: 12140 FPS: 25.10

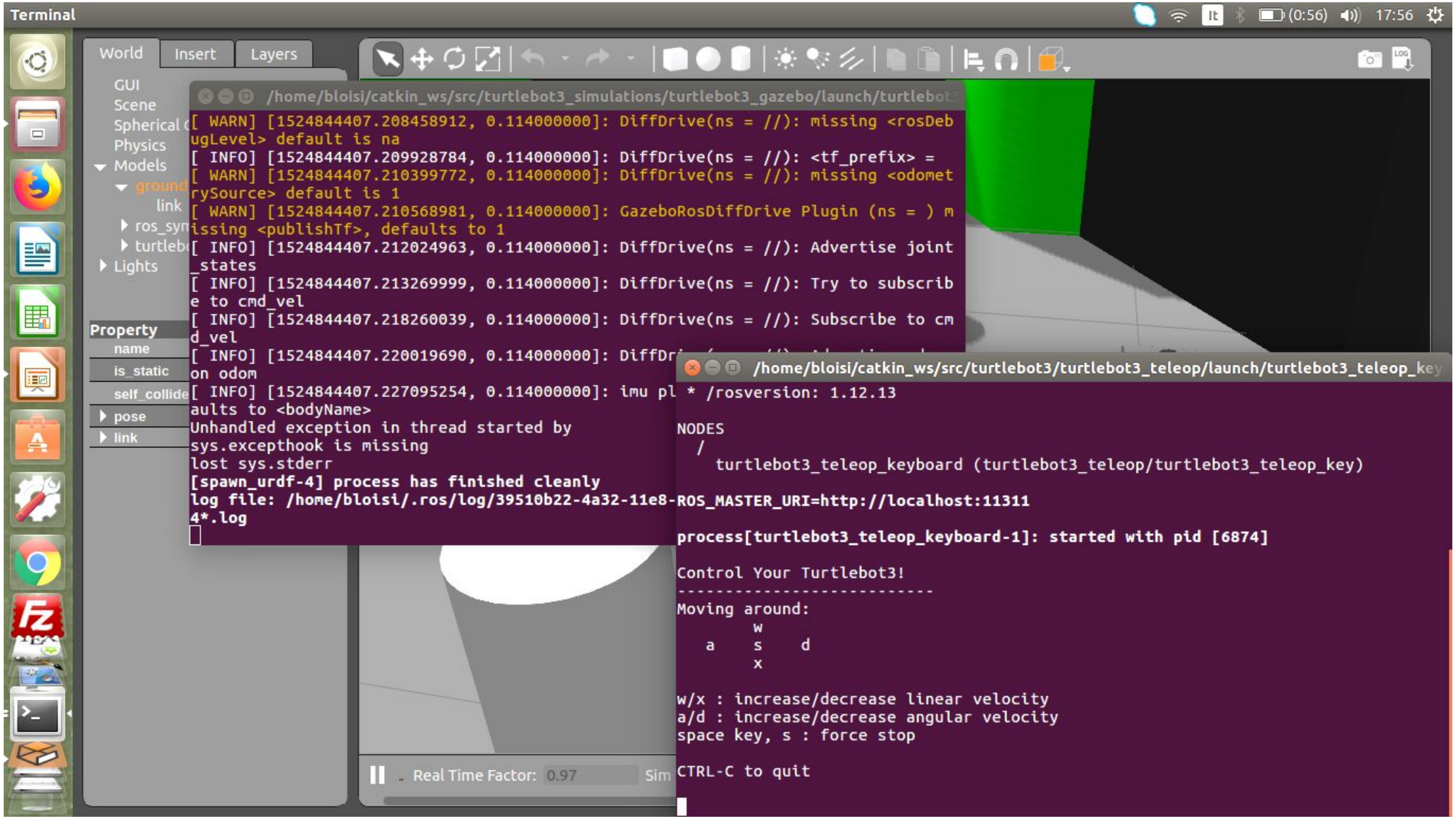
TurtleBot3 – TurtleBot3 World



Property	Value
name	ground_plane
is_static	☑ True
self_collide	□ False
pose	
link	ground_plane::link

Real Time Factor: 0.99 Sim Time: 00 00:01:30.923 Real Time: 00 00:01:33.879 Iterations: 90923 FPS: 33.248

Teleoperation in TurtleBot3 World



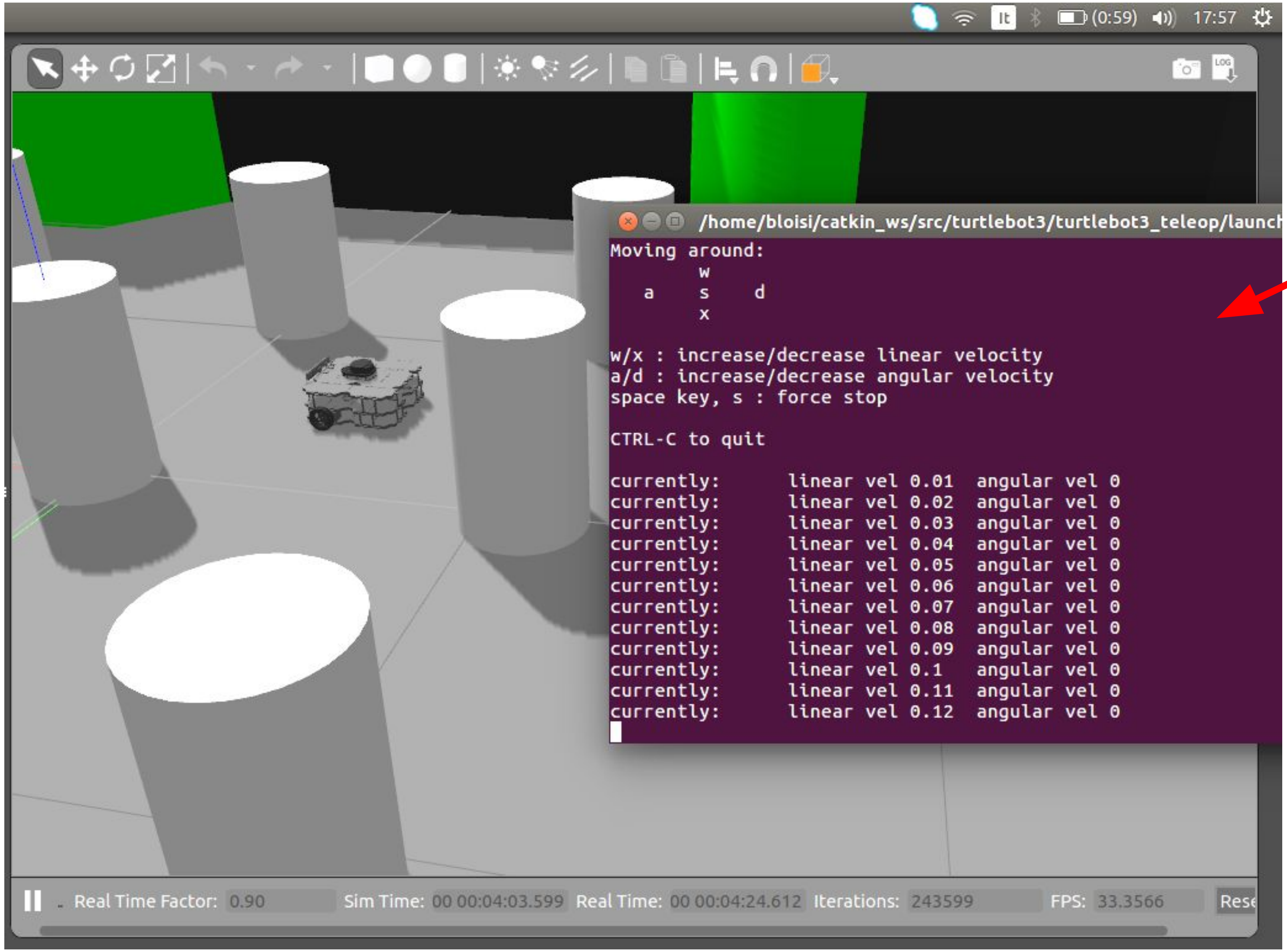
/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_gazebo/launch/turtlebot

```
[ WARN] [1524844407.208458912, 0.114000000]: DiffDrive(ns = //): missing <rosDeb
ugLevel> default is na
[ INFO] [1524844407.209928784, 0.114000000]: DiffDrive(ns = //): <tf_prefix> =
[ WARN] [1524844407.210399772, 0.114000000]: DiffDrive(ns = //): missing <odomet
rySource> default is 1
[ WARN] [1524844407.210568981, 0.114000000]: GazeboRosDiffDrive Plugin (ns = ) m
issing <publishTf>, defaults to 1
[ INFO] [1524844407.212024963, 0.114000000]: DiffDrive(ns = //): Advertise joint
_states
[ INFO] [1524844407.213269999, 0.114000000]: DiffDrive(ns = //): Try to subscrib
e to cmd_vel
[ INFO] [1524844407.218260039, 0.114000000]: DiffDrive(ns = //): Subscribe to cm
d_vel
[ INFO] [1524844407.220019690, 0.114000000]: DiffDr
on odom
[ INFO] [1524844407.227095254, 0.114000000]: imu pl
aults to <bodyName>
Unhandled exception in thread started by
sys.excepthook is missing
lost sys.stderr
[spawn_urdf-4] process has finished cleanly
log file: /home/bloisi/.ros/log/39510b22-4a32-11e8-
4*.log
```

/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/launch/turtlebot3_teleop_key

```
 * /rosversion: 1.12.13

NODES
  /
    turtlebot3_teleop_keyboard (turtlebot3_teleop/turtlebot3_teleop_key)

ROS_MASTER_URI=http://localhost:11311

process[turtlebot3_teleop_keyboard-1]: started with pid [6874]

Control Your Turtlebot3!
---------------------------
Moving around:
        w
   a    s    d
        x

w/x : increase/decrease linear velocity
a/d : increase/decrease angular velocity
space key, s : force stop

CTRL-C to quit
```

Teleoperation in TurtleBot3 World



/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/launch

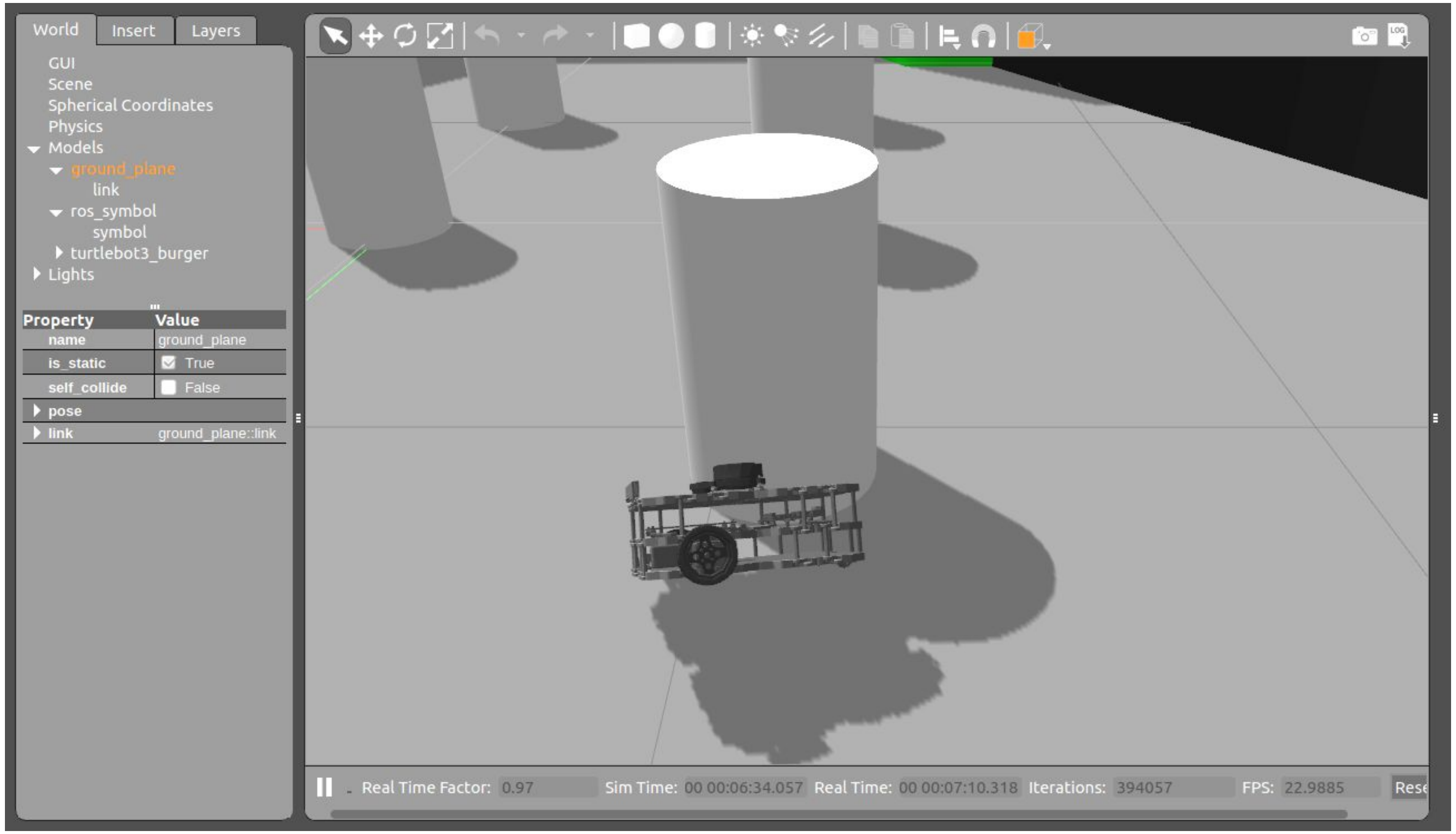
```
Moving around:
        w
   a    s    d
        x

w/x : increase/decrease linear velocity
a/d : increase/decrease angular velocity
space key, s : force stop

CTRL-C to quit

currently:      linear vel 0.01  angular vel 0
currently:      linear vel 0.02  angular vel 0
currently:      linear vel 0.03  angular vel 0
currently:      linear vel 0.04  angular vel 0
currently:      linear vel 0.05  angular vel 0
currently:      linear vel 0.06  angular vel 0
currently:      linear vel 0.07  angular vel 0
currently:      linear vel 0.08  angular vel 0
currently:      linear vel 0.09  angular vel 0
currently:      linear vel 0.1   angular vel 0
currently:      linear vel 0.11  angular vel 0
currently:      linear vel 0.12  angular vel 0
```

Real Time Factor: 0.90 Sim Time: 00 00:04:03.599 Real Time: 00 00:04:24.612 Iterations: 243599 FPS: 33.3566

Per poter controllare il robot da tastiera, il terminal con il nodo teleop deve essere selezionato

Esercizio TurtleBot3 World

Utilizzando il nodo di teleoperazione, provare a posizionare il robot su una sola ruota

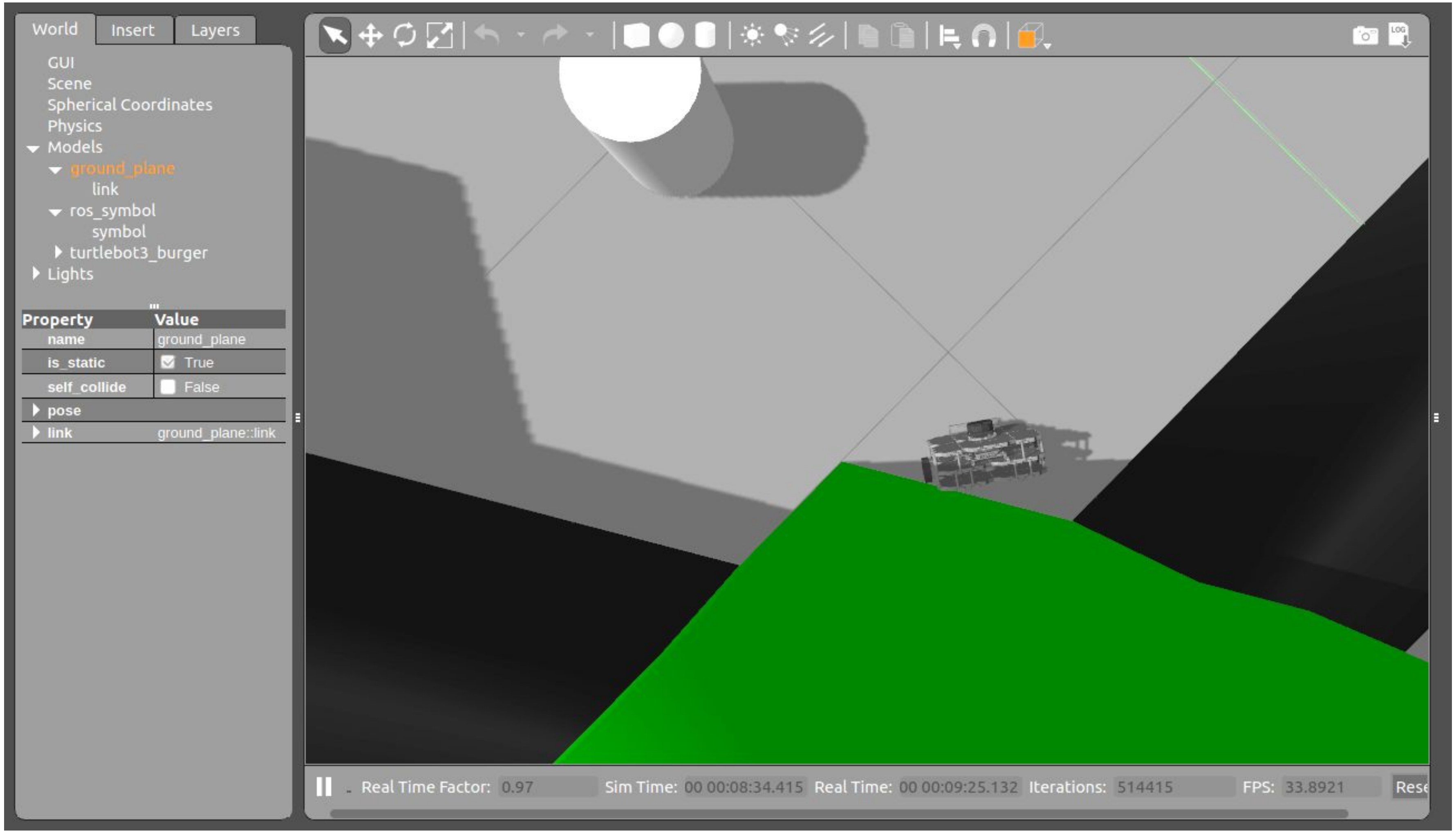


Property	Value
name	ground_plane
is_static	☑ True
self_collide	□ False
pose	
link	ground_plane::link

Real Time Factor: 0.97 Sim Time: 00 00:06:34.057 Real Time: 00 00:07:10.318 Iterations: 394057 FPS: 22.9885 Rese

Esercizio TurtleBot3 World

Esempio



GUI
Scene
Spherical Coordinates
Physics
Models
ground_plane
link
ros_symbol
symbol
turtlebot3_burger
Lights

Property	Value
name	ground_plane
is_static	☑ True
self_collide	□ False
pose	
link	ground_plane::link

Real Time Factor: 0.97 Sim Time: 00 00:08:34.415 Real Time: 00 00:09:25.132 Iterations: 514415 FPS: 33.8921 Rese

TurtleBot3 – collision avoidance

Terminale 1

Lanciare il nodo per la simulazione del Turtlebot3 World

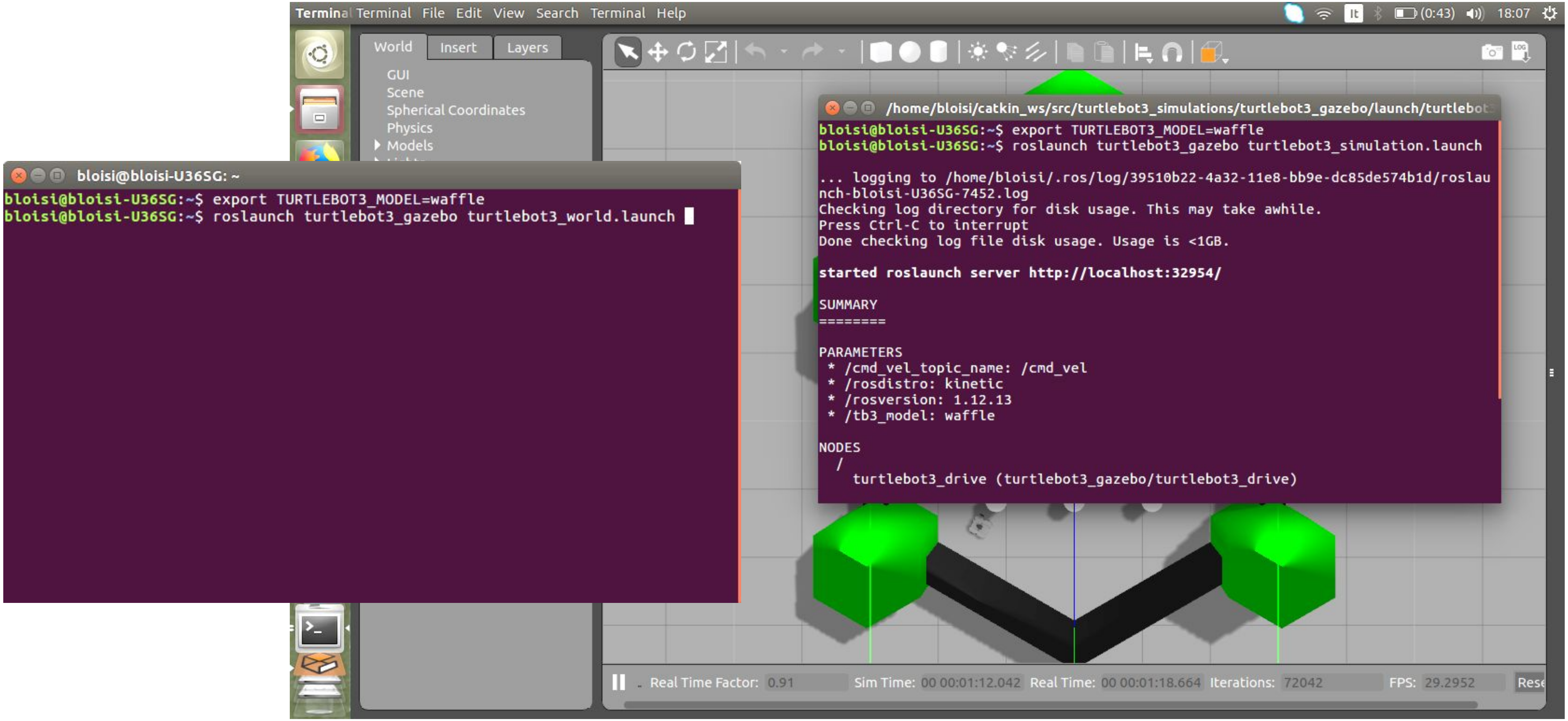
```
$ export TURTLEBOT3_MODEL=waffle
$ source ~/catkin_ws/devel/setup.bash
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

Terminale 2

Lanciare il nodo per l’autonomous drive

```
$ export TURTLEBOT3_MODEL=waffle
$ source ~/catkin_ws/devel/setup.bash
$ roslaunch turtlebot3_gazebo turtlebot3_simulation.launch
```

TurtleBot3 – collision avoidance



Terminal Terminal File Edit View Search Terminal Help
(0:43)
18:07
World
Insert
Layers
GUI
Scene
Spherical Coordinates
Physics
Models
bloisi@bloisi-U36SG: ~
/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_gazebo/launch/turtlebot
Rese

```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

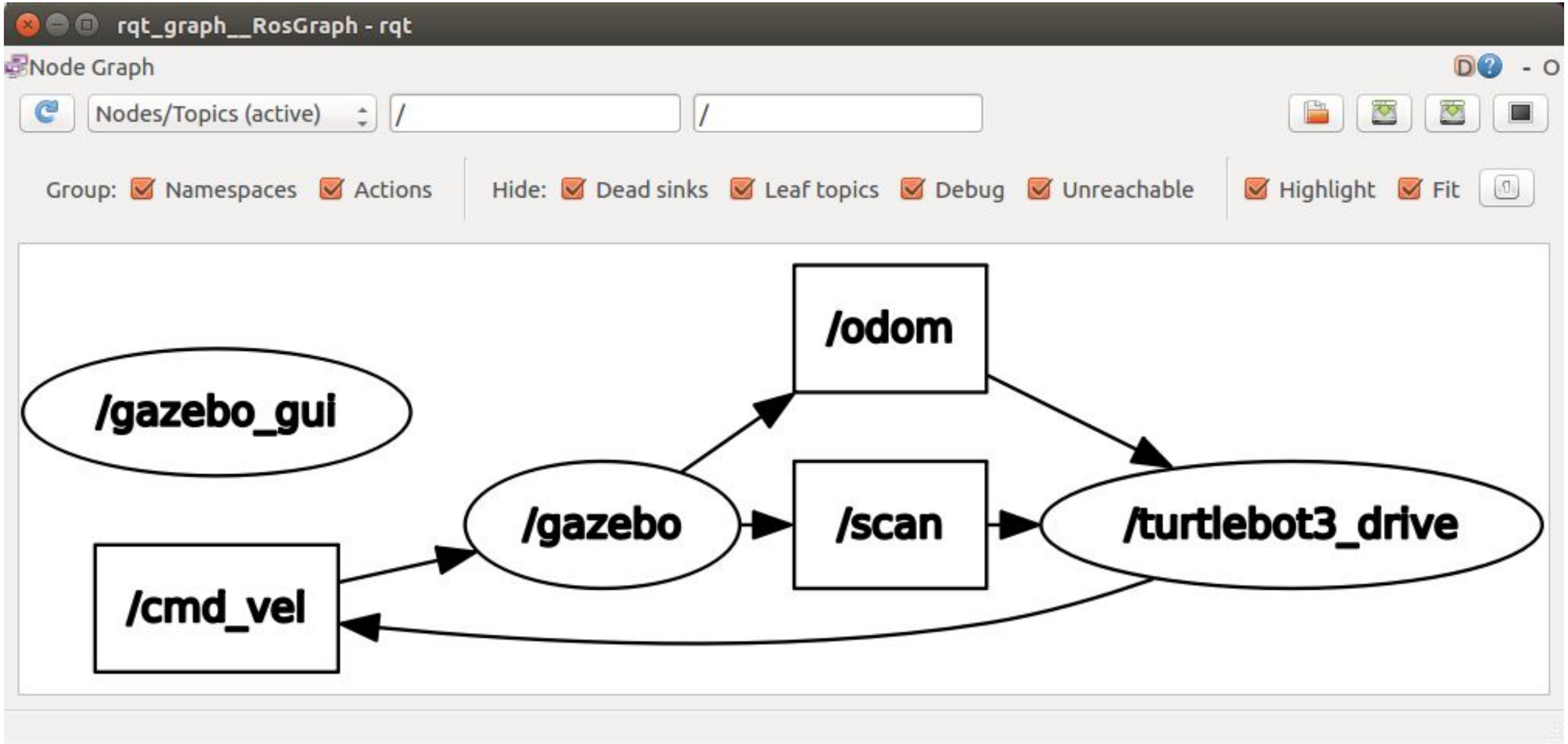
```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_simulation.launch

... logging to /home/bloisi/.ros/log/39510b22-4a32-11e8-bb9e-dc85de574b1d/roslau
nch-bloisi-U36SG-7452.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://localhost:32954/

SUMMARY
========

PARAMETERS
 * /cmd_vel_topic_name: /cmd_vel
 * /rosdistro: kinetic
 * /rosversion: 1.12.13
 * /tb3_model: waffle

NODES
  /
    turtlebot3_drive (turtlebot3_gazebo/turtlebot3_drive)
```

Real Time Factor: 0.91 Sim Time: 00 00:01:12.042 Real Time: 00 00:01:18.664 Iterations: 72042 FPS: 29.2952

TurtleBot3 – collision avoidance

E’ possibile lanciare un nodo per teleoperare il nodo mentre il robot si muove in modalità di navigazione autonoma?

TurtleBot3 – rqt_graph



rqt_graph__RosGraph - rqt

Node Graph

Nodes/Topics (active) | / | /

Group: ☑ Namespaces ☑ Actions

Hide: ☑ Dead sinks ☑ Leaf topics ☑ Debug ☑ Unreachable

☑ Highlight ☑ Fit

TurtleBot3 + Gazebo + RViz

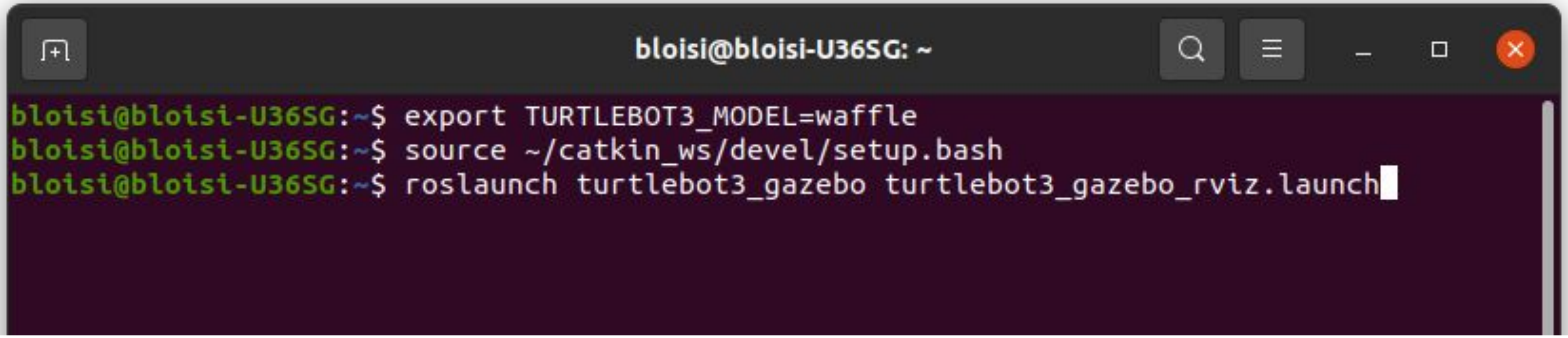
RViz può essere usato per visualizzare i topic che vengono pubblicati mentre la simulazione con Gazebo è in esecuzione.

Per lanciare RViz, apriamo un nuovo terminal e digitiamo i comandi seguenti:

```
$ export TURTLEBOT3_MODEL=waffle
$ source ~/catkin_ws/devel/setup.bash
$ roslaunch turtlebot3_gazebo turtlebot3_gazebo_rviz.launch
```

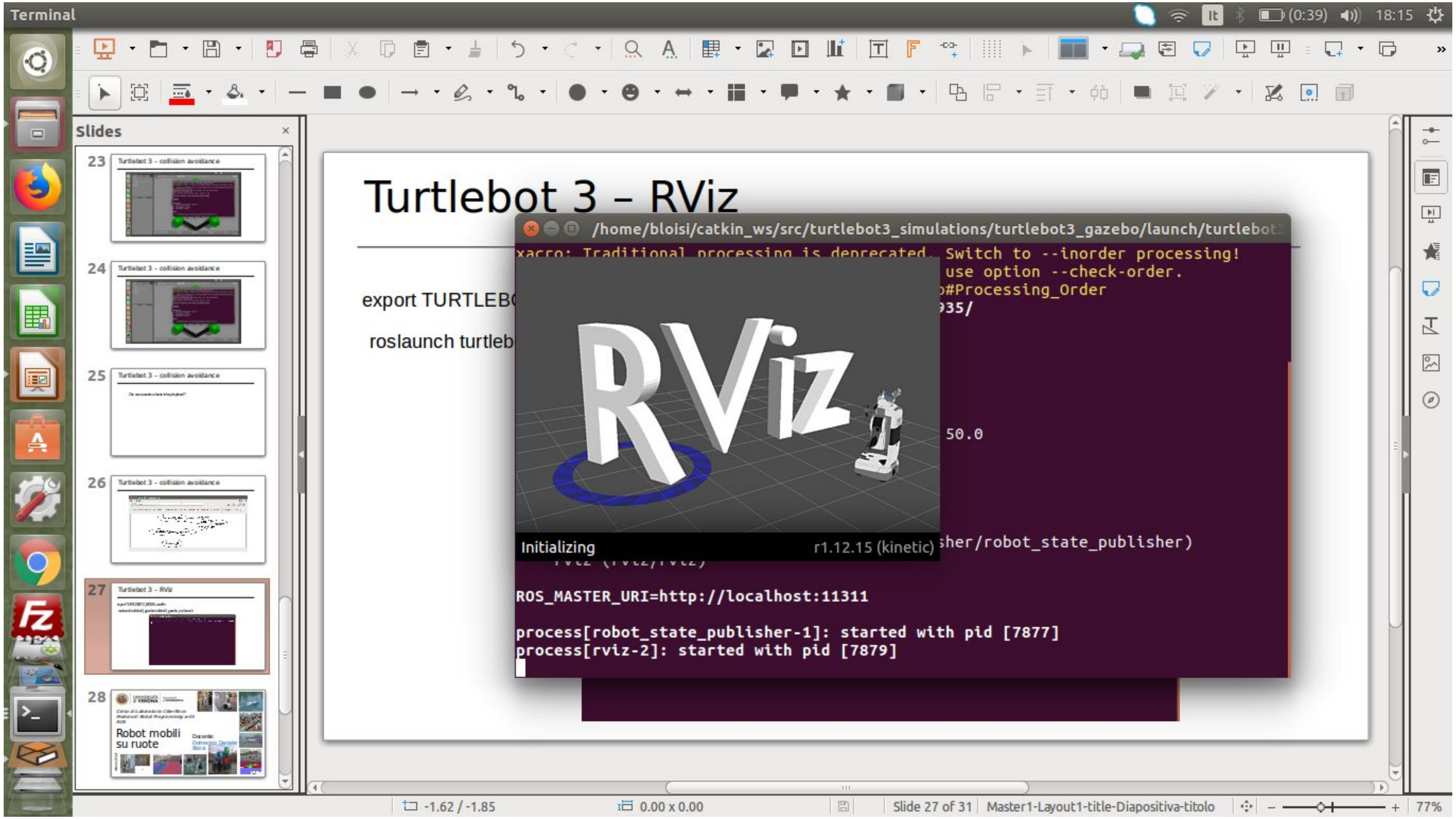
TurtleBot3 + Gazebo + RViz

```
$ export TURTLEBOT3_MODEL=waffle
$ source ~/catkin_ws/devel/setup.bash
$ roslaunch turtlebot3_gazebo turtlebot3_gazebo_rviz.launch
```



```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ source ~/catkin_ws/devel/setup.bash
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_gazebo_rviz.launch
```

TurtleBot3 + Gazebo + RViz



Terminal
(0:39)
18:15
Slides
23
Turtlebot 3 – collision avoidance
24
Turtlebot 3 – collision avoidance
25
Turtlebot 3 – collision avoidance
26
Turtlebot 3 – collision avoidance
27
Turtlebot 3 – RViz
28
Robot mobili su ruote
-1.62 / -1.85
0.00 x 0.00
Slide 27 of 31
Master1-Layout1-title-Diapositiva-titolo
77%
Initializing
r1.12.15 (kinetic)

Turtlebot 3 – RViz

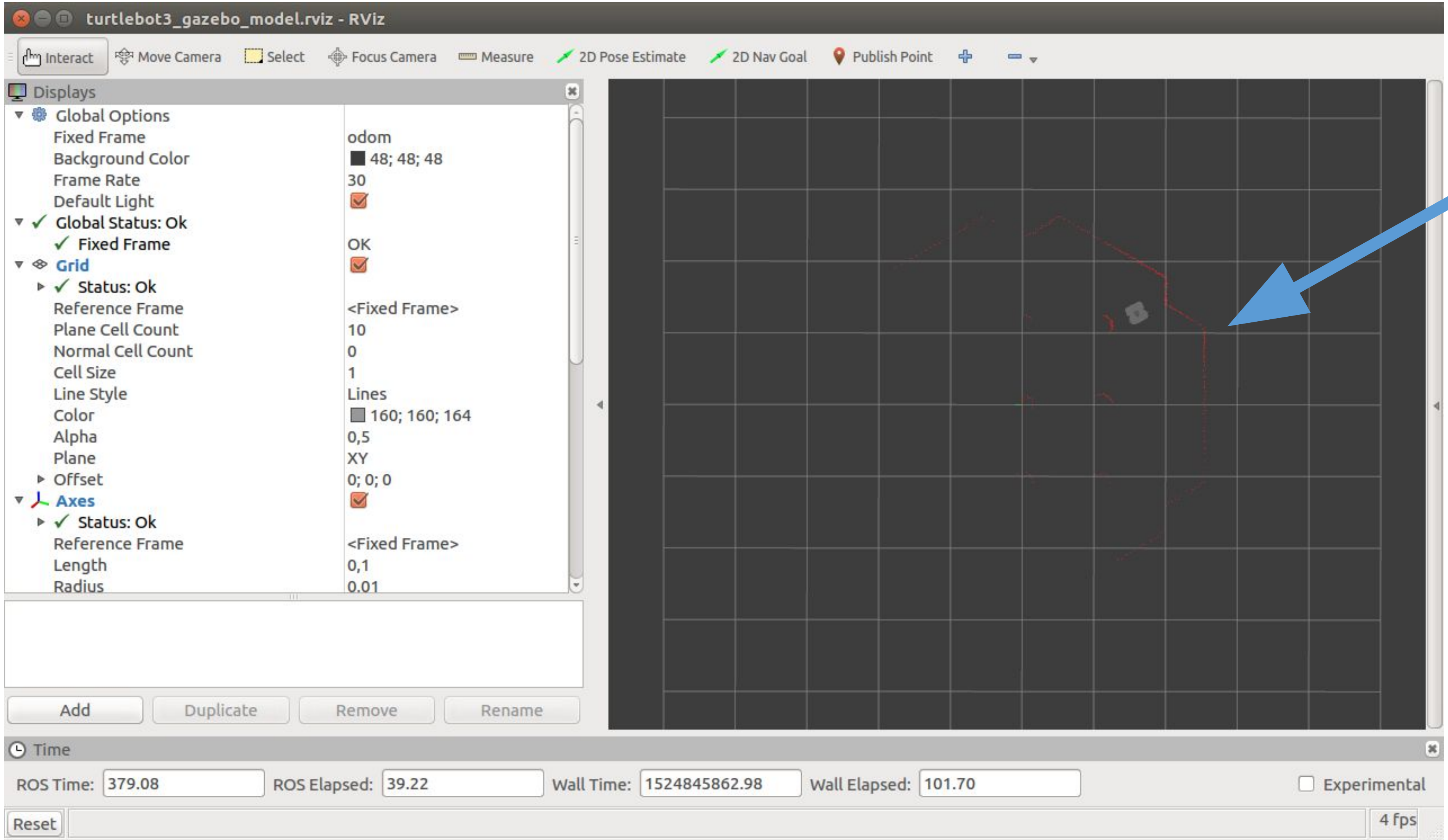
export TURTLEB

roslaunch turtleb

/home/bloisi/catkin_ws/src/turtlebot3_simulations/turtlebot3_gazebo/launch/turtlebot

```
xacro: Traditional processing is deprecated. Switch to --inorder processing!
                                             use option --check-order.
                                            o#Processing_Order
                                            935/

                                             50.0

                                            sher/robot_state_publisher)

ROS_MASTER_URI=http://localhost:11311

process[robot_state_publisher-1]: started with pid [7877]
process[rviz-2]: started with pid [7879]
```

Laserscan

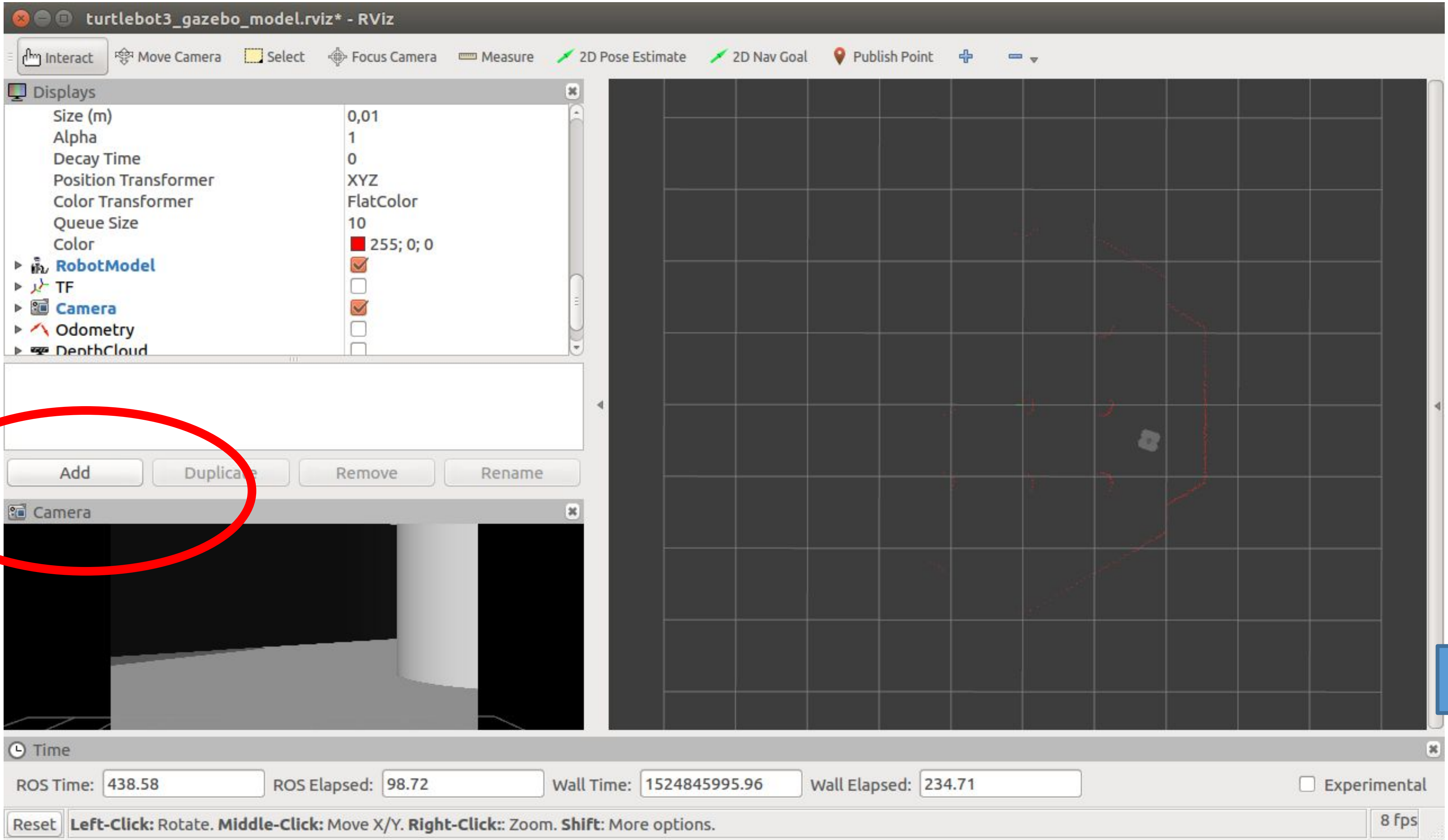


Global Options	
Fixed Frame	odom
Background Color	■ 48; 48; 48
Frame Rate	30
Default Light	☑
✓ Global Status: Ok	
✓ Fixed Frame	OK
Grid	☑
✓ Status: Ok	
Reference Frame	<Fixed Frame>
Plane Cell Count	10
Normal Cell Count	0
Cell Size	1
Line Style	Lines
Color	■ 160; 160; 164
Alpha	0,5
Plane	XY
Offset	0; 0; 0
Axes	☑
✓ Status: Ok	
Reference Frame	<Fixed Frame>
Length	0,1
Radius	0.01

ROS Time: 379.08 ROS Elapsed: 39.22 Wall Time: 1524845862.98 Wall Elapsed: 101.70 □ Experimental

laserscan

Adding camera sensor


turtlebot3_gazebo_model.rviz* - RViz

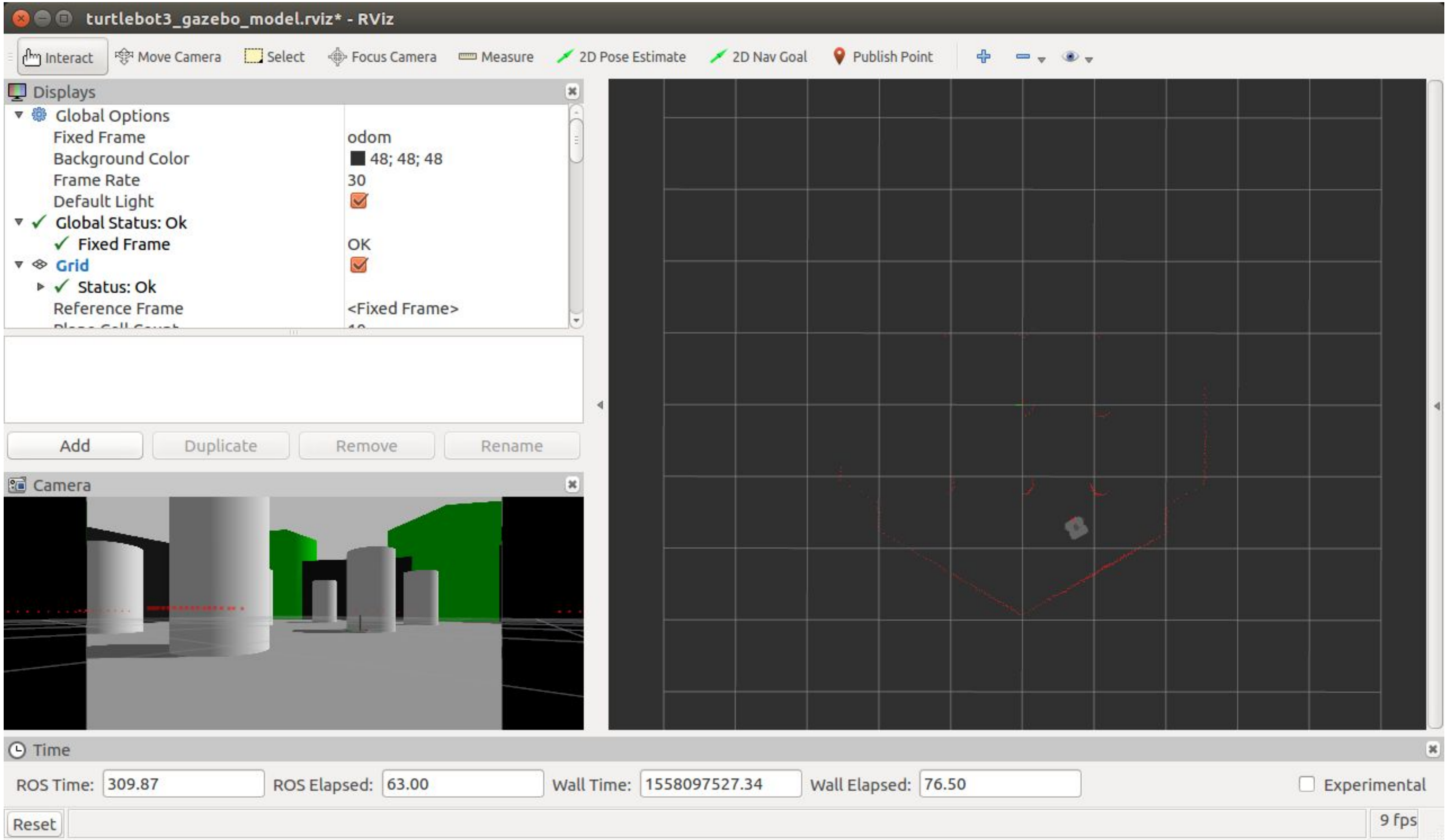
Size (m)	0,01
Alpha	1
Decay Time	0
Position Transformer	XYZ
Color Transformer	FlatColor
Queue Size	10
Color	🟥 255; 0; 0
▸ RobotModel	☑
▸ TF	□
▸ Camera	☑
▸ Odometry	□
▸ DepthCloud	□

ROS Time: 438.58 ROS Elapsed: 98.72 Wall Time: 1524845995.96 Wall Elapsed: 234.71 □ Experimental

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

8 fps

Adding camera sensor



- Global Options
  - Fixed Frame: odom
  - Background Color: 48; 48; 48
  - Frame Rate: 30
  - Default Light: ☑
- ✓ Global Status: Ok
  - ✓ Fixed Frame: OK
- Grid: ☑
  - ✓ Status: Ok
  - Reference Frame: <Fixed Frame>

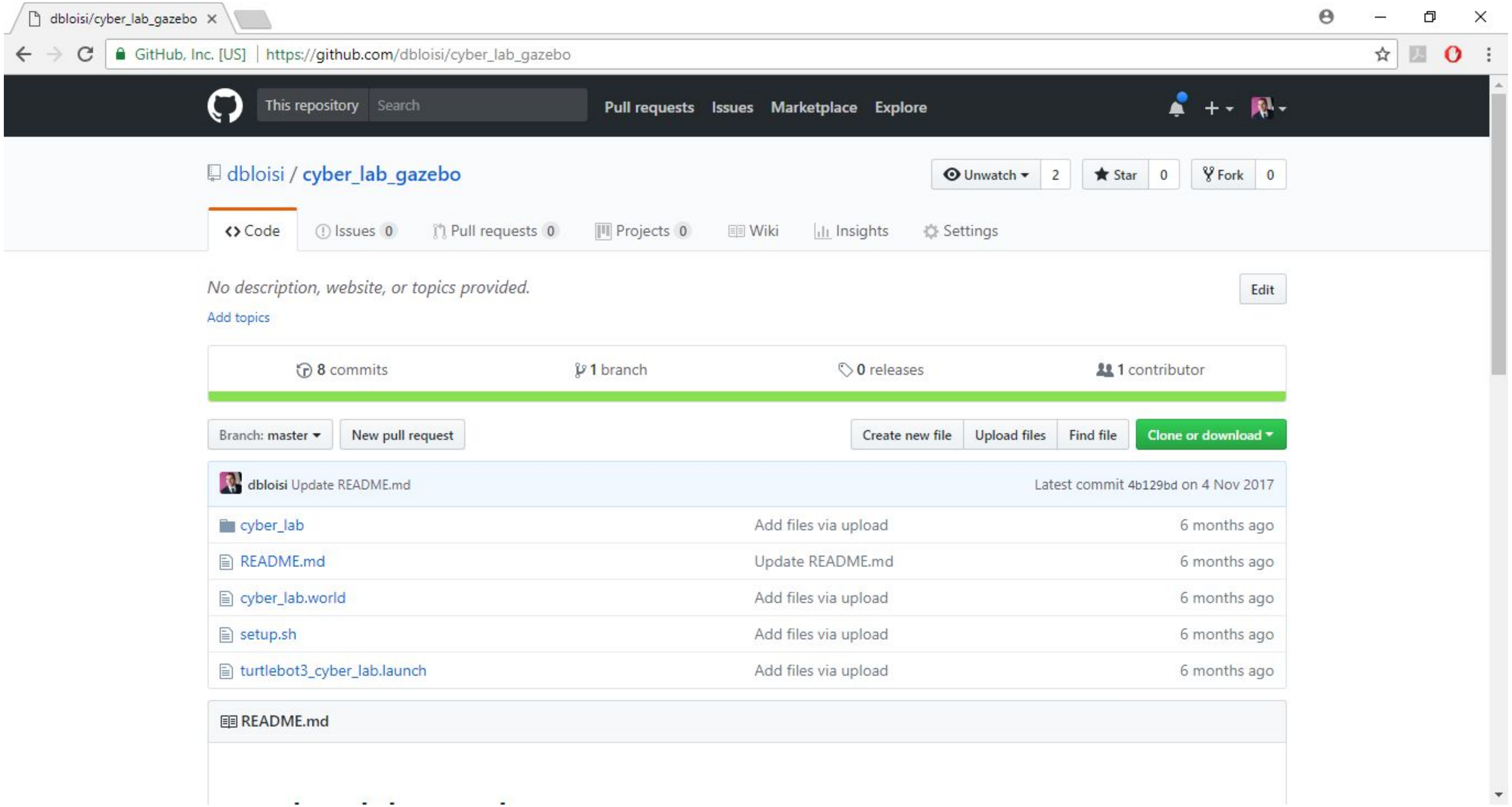
ROS Time: 309.87 ROS Elapsed: 63.00 Wall Time: 1558097527.34 Wall Elapsed: 76.50

Esercizio – TurtleBot3 House

1. Lanciare il nodo per la simulazione della TurtleBot3 House
2. Lanciare la navigazione autonoma del TurtleBot waffle nella TurtleBot3 House
3. Lanciare la teleoperazione da tastiera del robot
4. Visualizzare in RViz i dati provenienti dal laser e dalla telecamera

http://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/#3-turtlebot3-house

Esercizio – cyberlab



dbloisi / cyber_lab_gazebo

No description, website, or topics provided.

Add topics

8 commits | 1 branch | 0 releases | 1 contributor

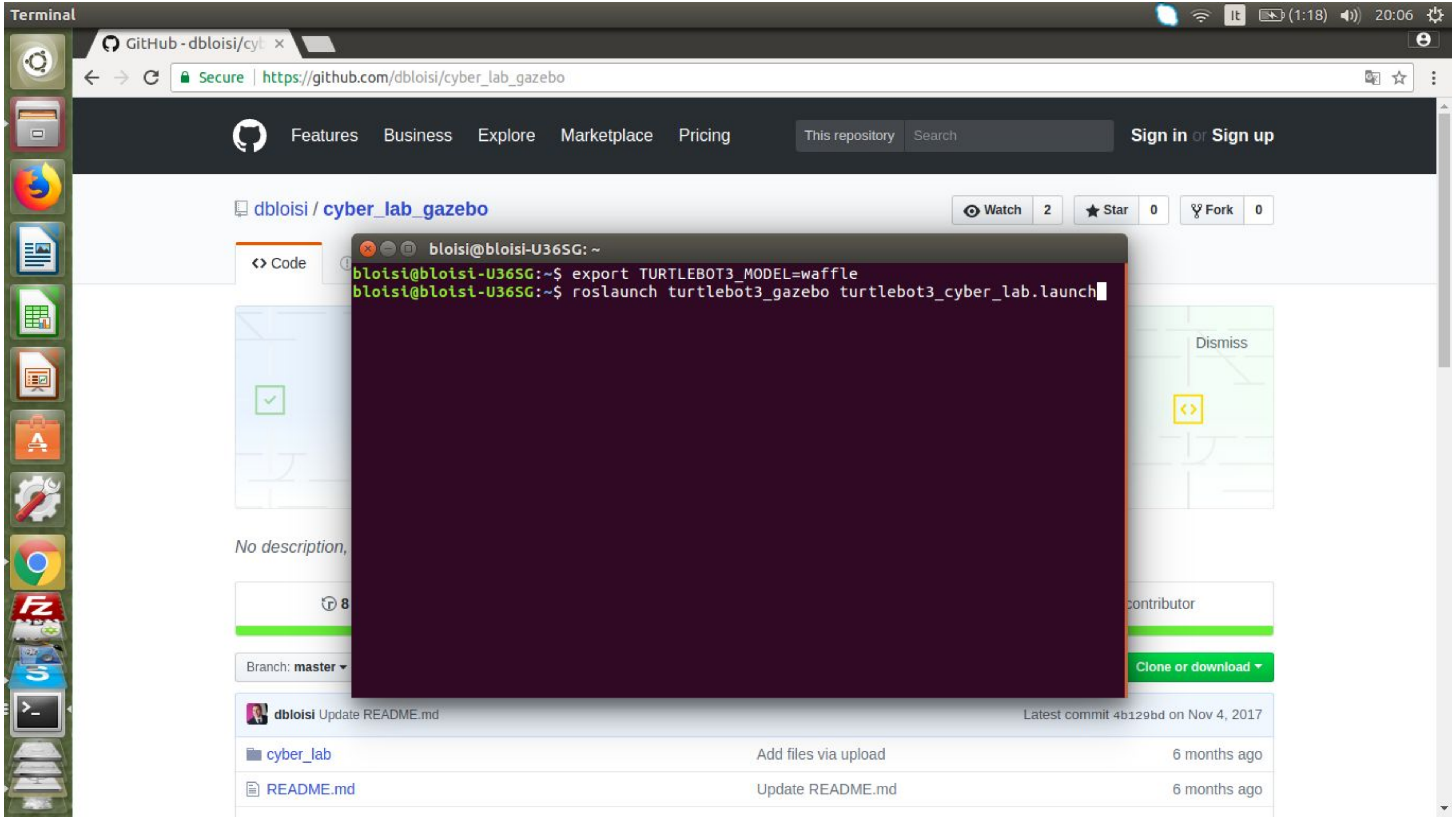
dbloisi Update README.md — Latest commit 4b129bd on 4 Nov 2017

cyber_lab	Add files via upload	6 months ago
README.md	Update README.md	6 months ago
cyber_lab.world	Add files via upload	6 months ago
setup.sh	Add files via upload	6 months ago
turtlebot3_cyber_lab.launch	Add files via upload	6 months ago

README.md

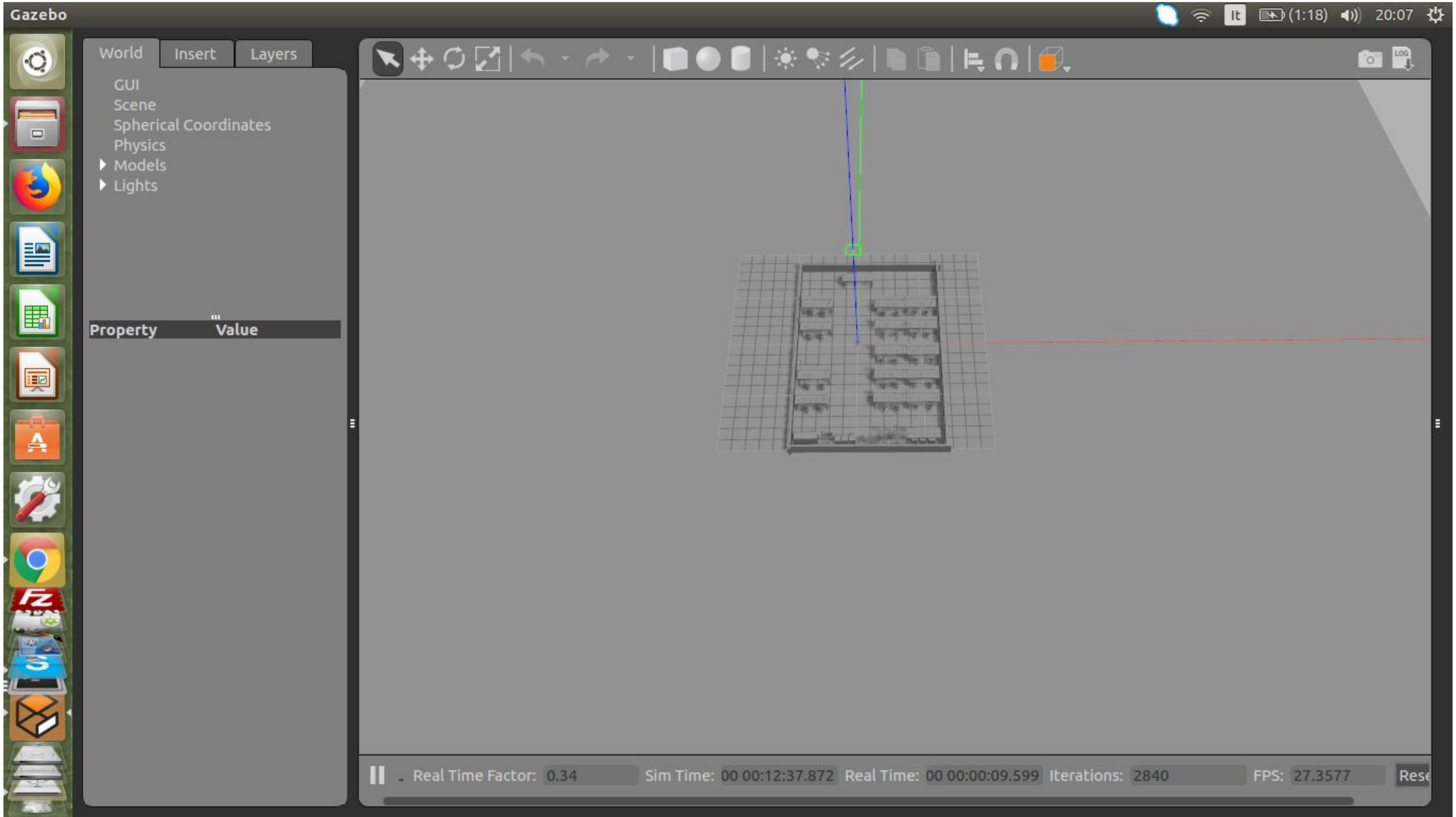
https://github.com/dbloisi/cyber_lab_gazebo

Esercizio – cyberlab



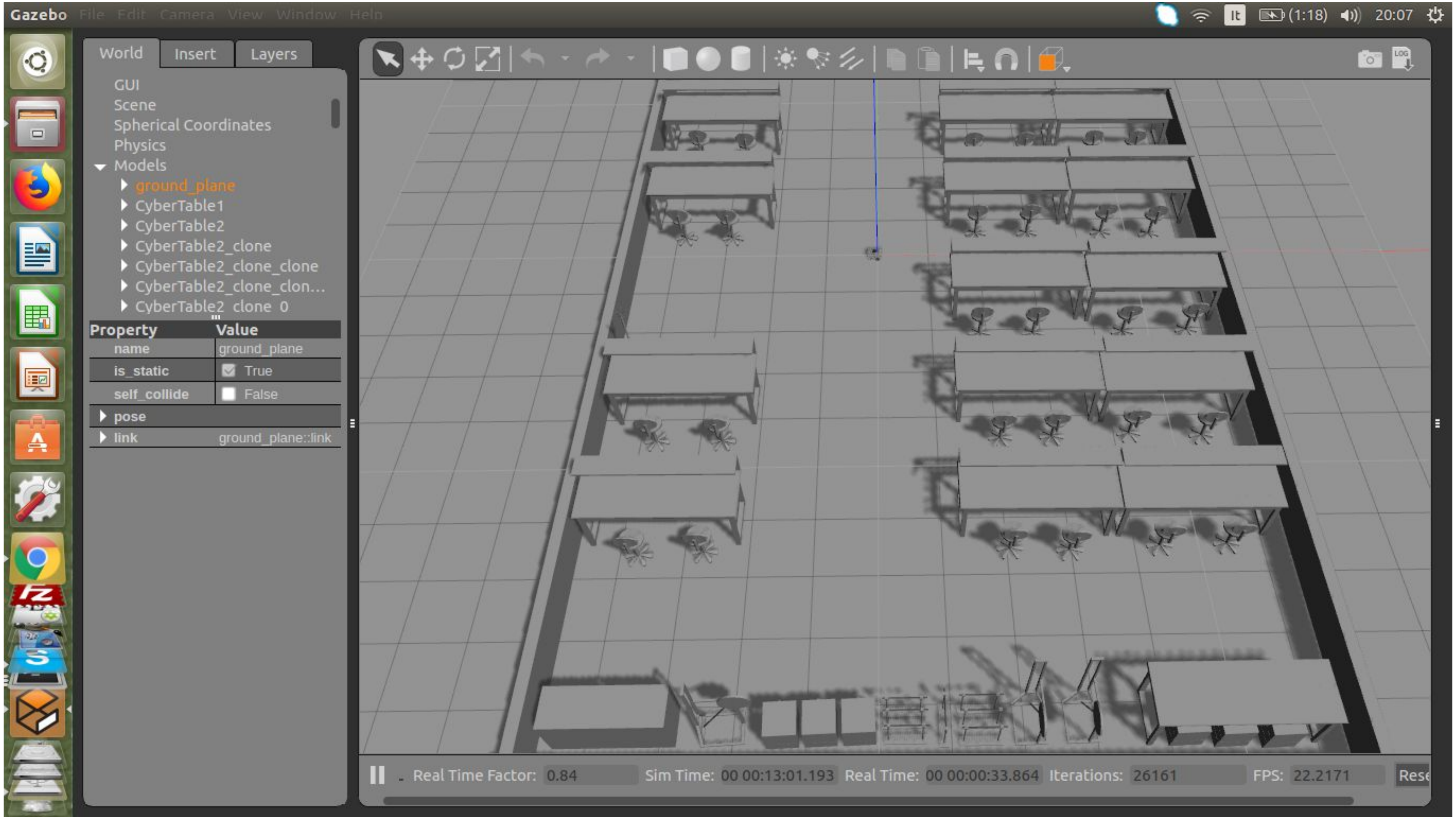
```
bloisi@bloisi-U36SG:~$ export TURTLEBOT3_MODEL=waffle
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_gazebo turtlebot3_cyber_lab.launch
```

Esercizio – cyberlab



Real Time Factor: 0.34 Sim Time: 00 00:12:37.872 Real Time: 00 00:00:09.599 Iterations: 2840 FPS: 27.3577

Esercizio – cyberlab



GUI
Scene
Spherical Coordinates
Physics
Models
ground_plane
CyberTable1
CyberTable2
CyberTable2_clone
CyberTable2_clone_clone
CyberTable2_clone_clon...
CyberTable2_clone_0

Property	Value
name	ground_plane
is_static	☑ True
self_collide	□ False
pose	
link	ground_plane::link

Real Time Factor: 0.84 Sim Time: 00 00:13:01.193 Real Time: 00 00:00:33.864 Iterations: 26161 FPS: 22.2171

UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

Corso di Visione e Percezione

Docente

Domenico D. Bloisi

Simulatori in ROS