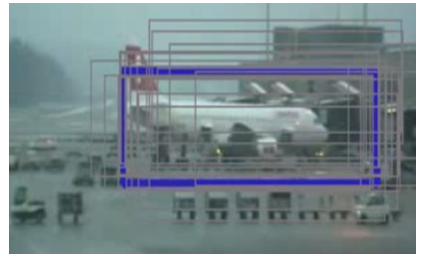
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

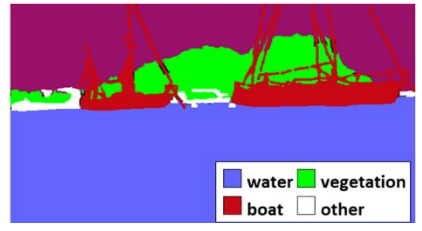


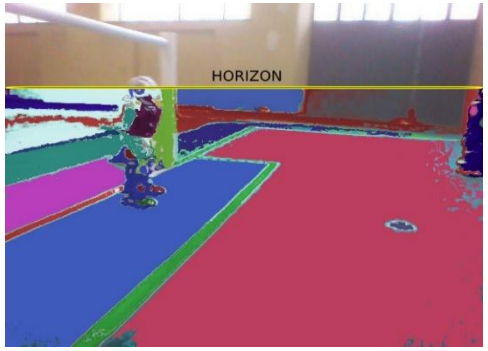
Corso di Sistemi Informativi
A.A. 2018/19

Docente
Domenico Daniele Bloisi

Simulatori








Maggio 2019

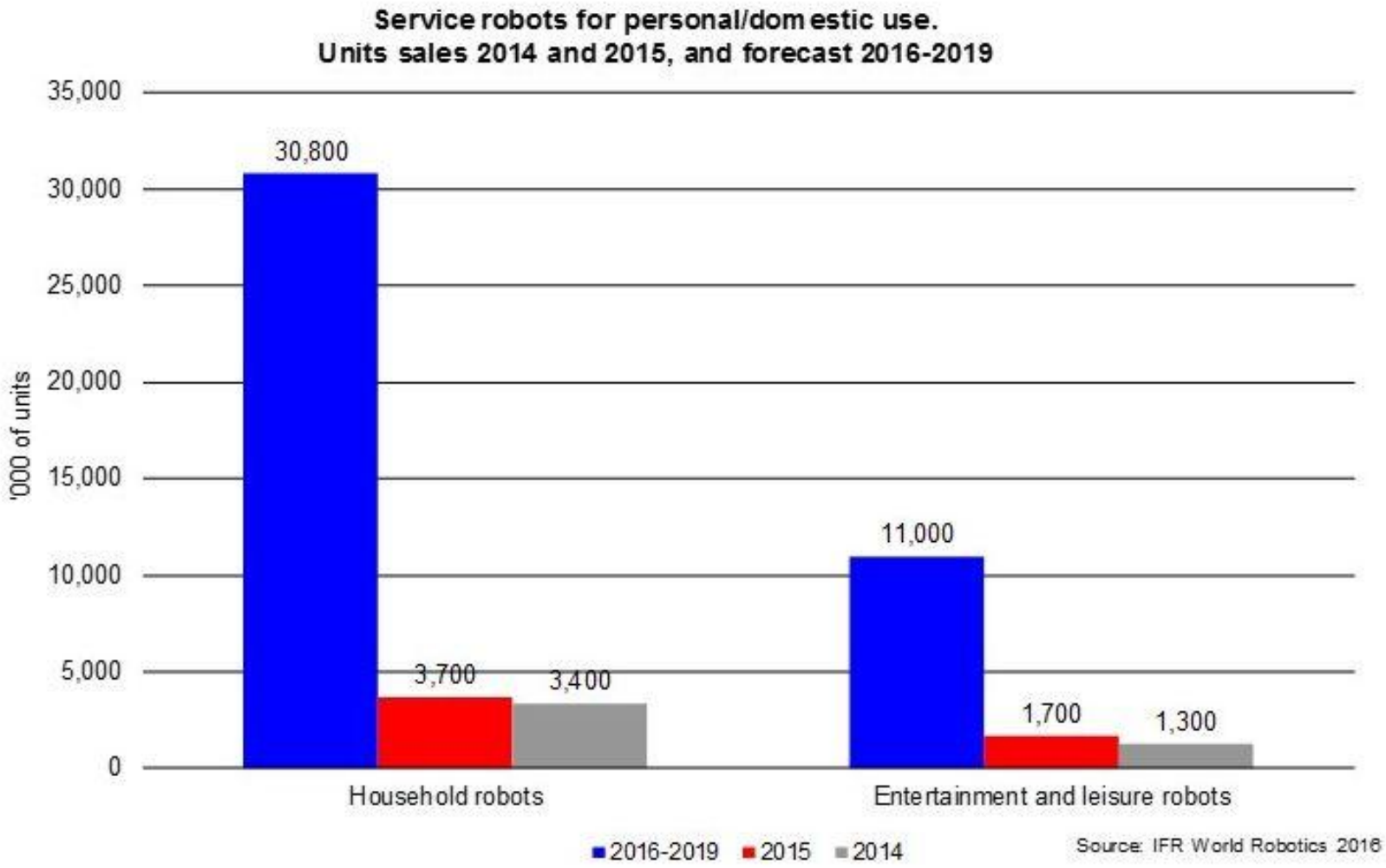
Service robots in the World

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



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

Turtlebot 3 – simulation

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

Con il tutlebot3 utilizzeremo il simulatore Gazebo

http://gazebosim.org/

Una guida all'uso di Gazebo con il Turtlebot3 è disponibile qui

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

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 – run a simulation

Per poter simulare il Turtlebot 3 sul proprio PC è necessario utilizzare lo specifico ROS package TurtleBot3 Simulations

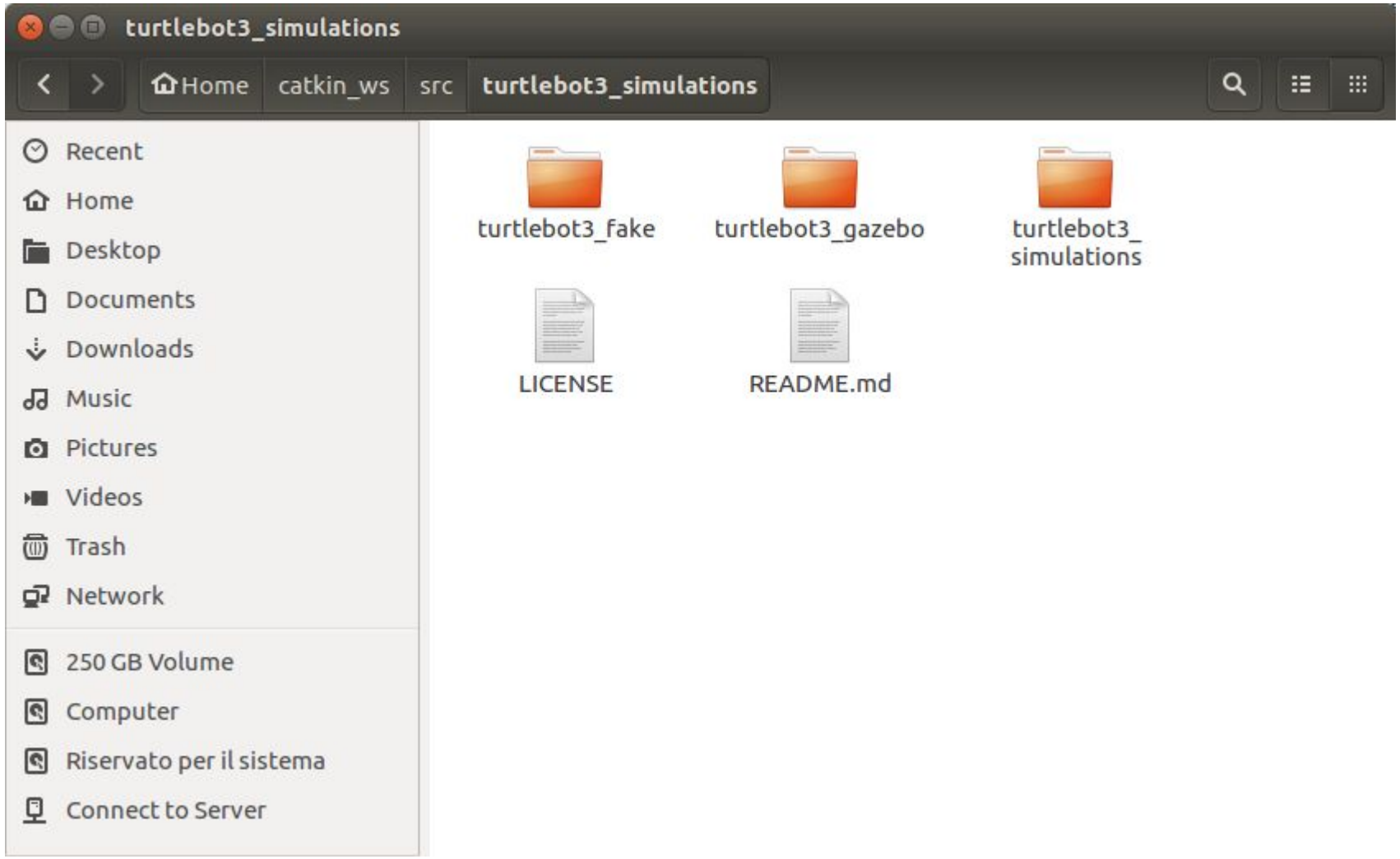
```
$ cd ~/catkin_ws/src

$ 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: ~/catkin_ws
bloisi@bloisi-U36SG:~/catkin_ws/src$ git clone https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git
Cloning into 'turtlebot3_simulations'...
remote: Enumerating objects: 9, done.
remote: Counting objects: 100% (9/9), done.
remote: Compressing objects: 100% (9/9), done.
remote: Total 1535 (delta 1), reused 1 (delta 0), pack-reused 1526
Receiving objects: 100% (1535/1535), 13.91 MiB | 2.39 MiB/s, done.
Resolving deltas: 100% (881/881), done.
Checking connectivity... done.
bloisi@bloisi-U36SG:~/catkin_ws/src$ cd ~/catkin_ws/
bloisi@bloisi-U36SG:~/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: "make cmake_check_build_system" in "/home/bloisi/catkin_ws/build"
####
-- Using CATKIN_DEVEL_PREFIX: /home/bloisi/catkin_ws/devel
-- Using CMAKE_PREFIX_PATH: /home/bloisi/catkin_ws/devel;/opt/ros/kinetic
-- This workspace overlays: /home/bloisi/catkin_ws/devel;/opt/ros/kinetic
-- Using PYTHON_EXECUTABLE: /usr/bin/python
-- Using Debian Python package layout
```

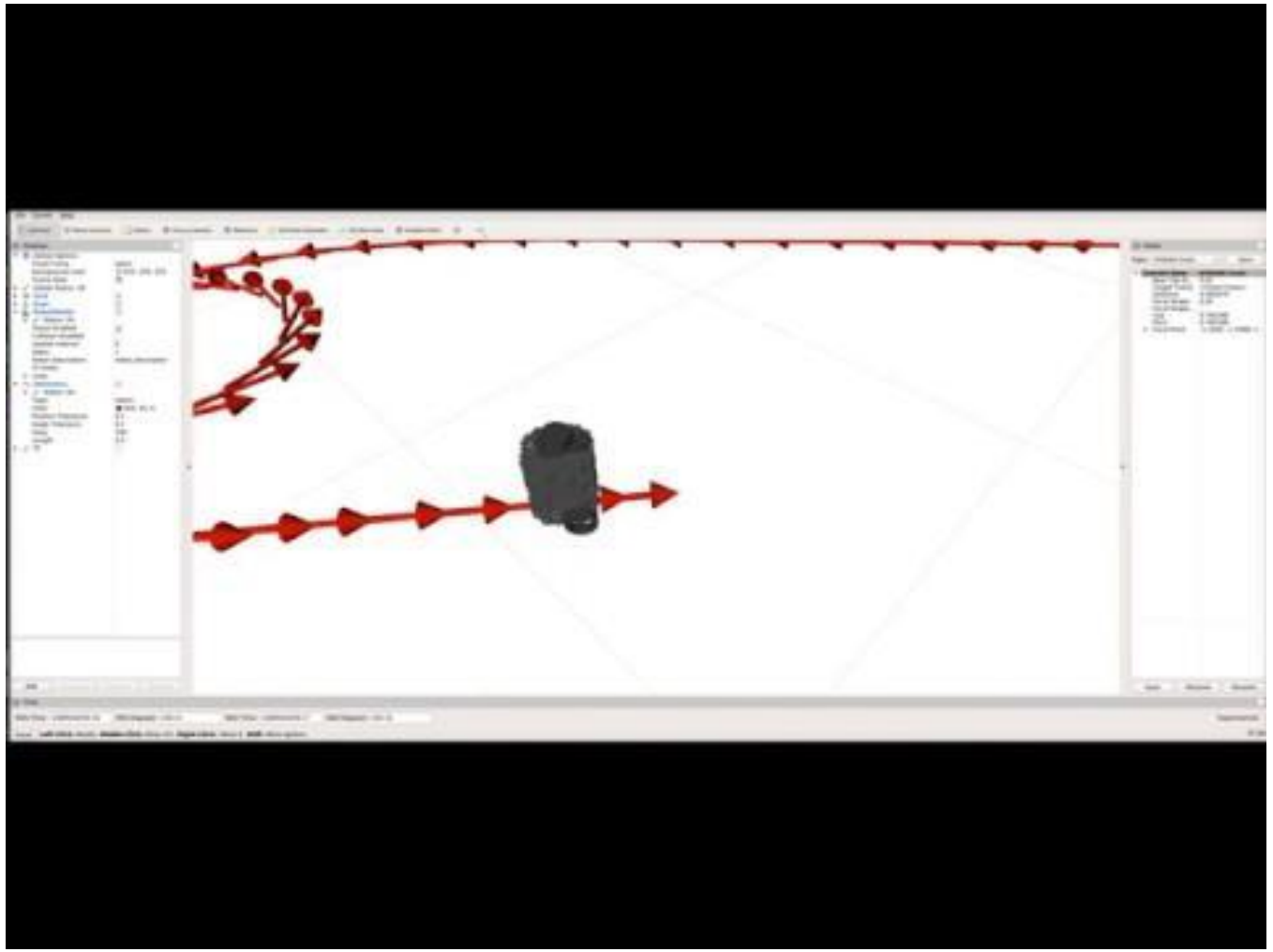
turtlebot3_simulations



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

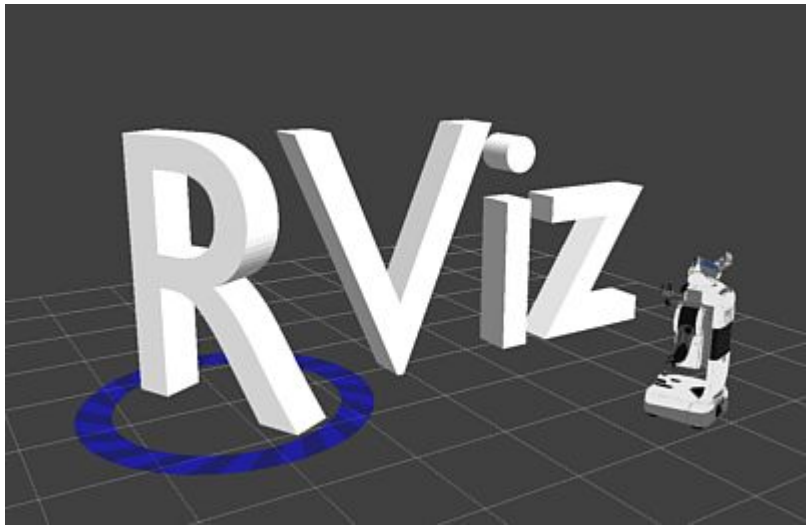
RViz

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

wiki.ros.org/rviz

ROSCon 2019 Diversity Scholarships: Applications Open!
Whoever you are, whatever you do, and wherever you do it, if you're interested in ROS, then we want you to join us at ROSCon in Macau!

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rviz

indigo | kinetic | lunar | melodic | *Show EOL distros:*

Documentation Status

viz: ros_base | rqt_common_plugins | rqt_robot_plugins | rviz

Package Summary

✔ Released ✔ Continuous Integration ✔ Documented

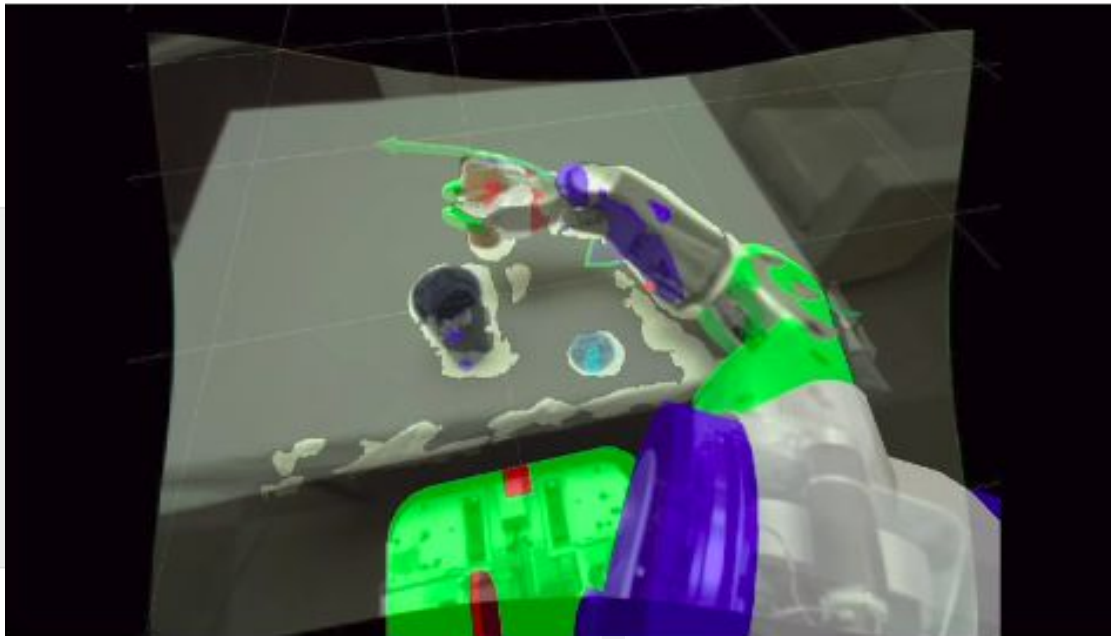
3D visualization tool for ROS.

- Maintainer status: maintained
- Maintainer: D. Hood <dhood AT osrfoundation DOT org>, William Woodall <william AT osrfoundation DOT org>
- Author: Dave Hershberger, David Gossow, Josh Faust
- License: BSD, Creative Commons
- Bug / feature tracker: https://github.com/ros-visualization/rviz/issues
- Source: git https://github.com/ros-visualization/rviz.git (branch: kinetic-devel)

Package Links
- Code API
- Tutorials
- Troubleshooting
- FAQ
- Changelog
- Change List
- Reviews

Dependencies (24)
Used by (180)
Jenkins jobs (7)

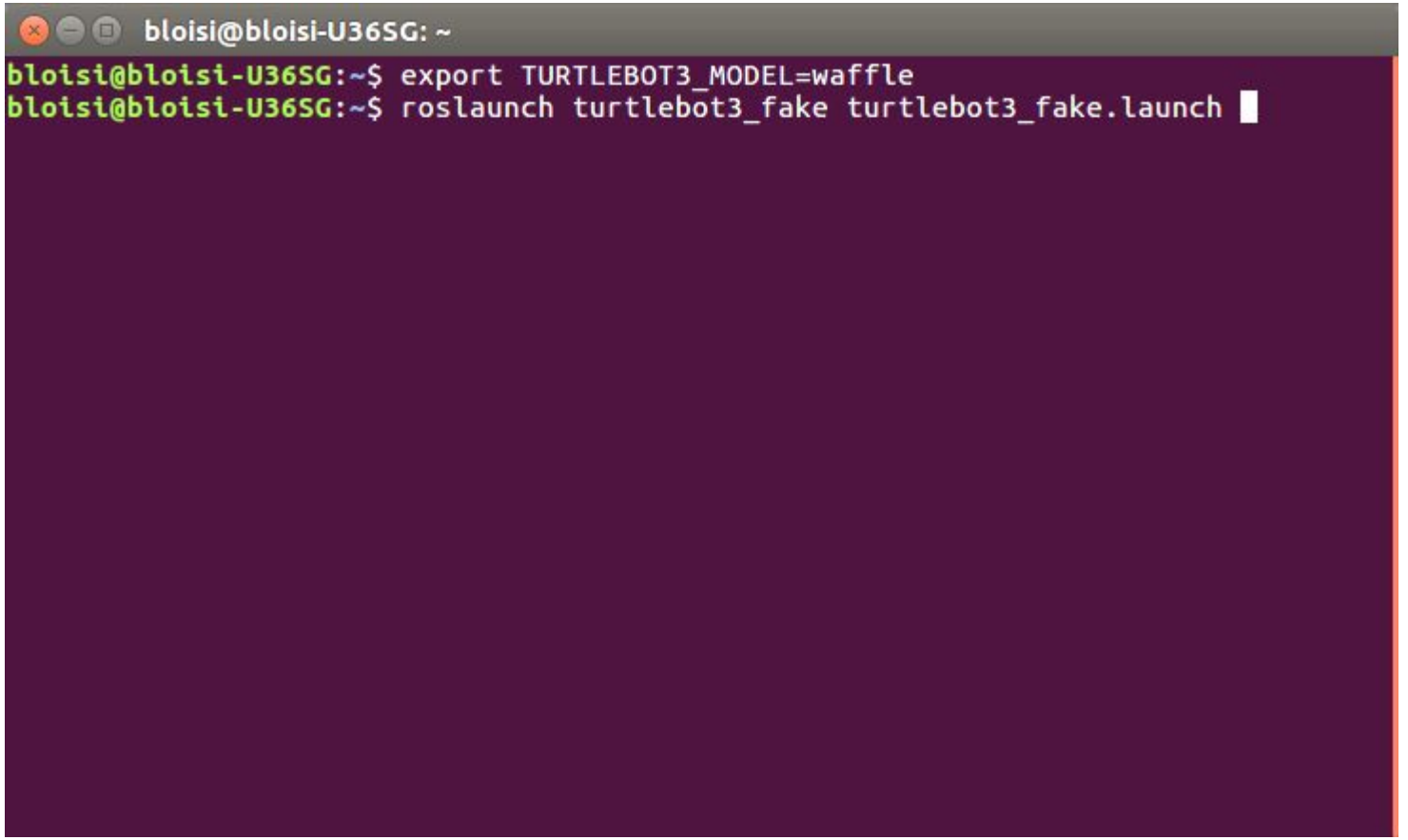
Contents
1. Overview



https://youtu.be/i-Sd4xH9ZE

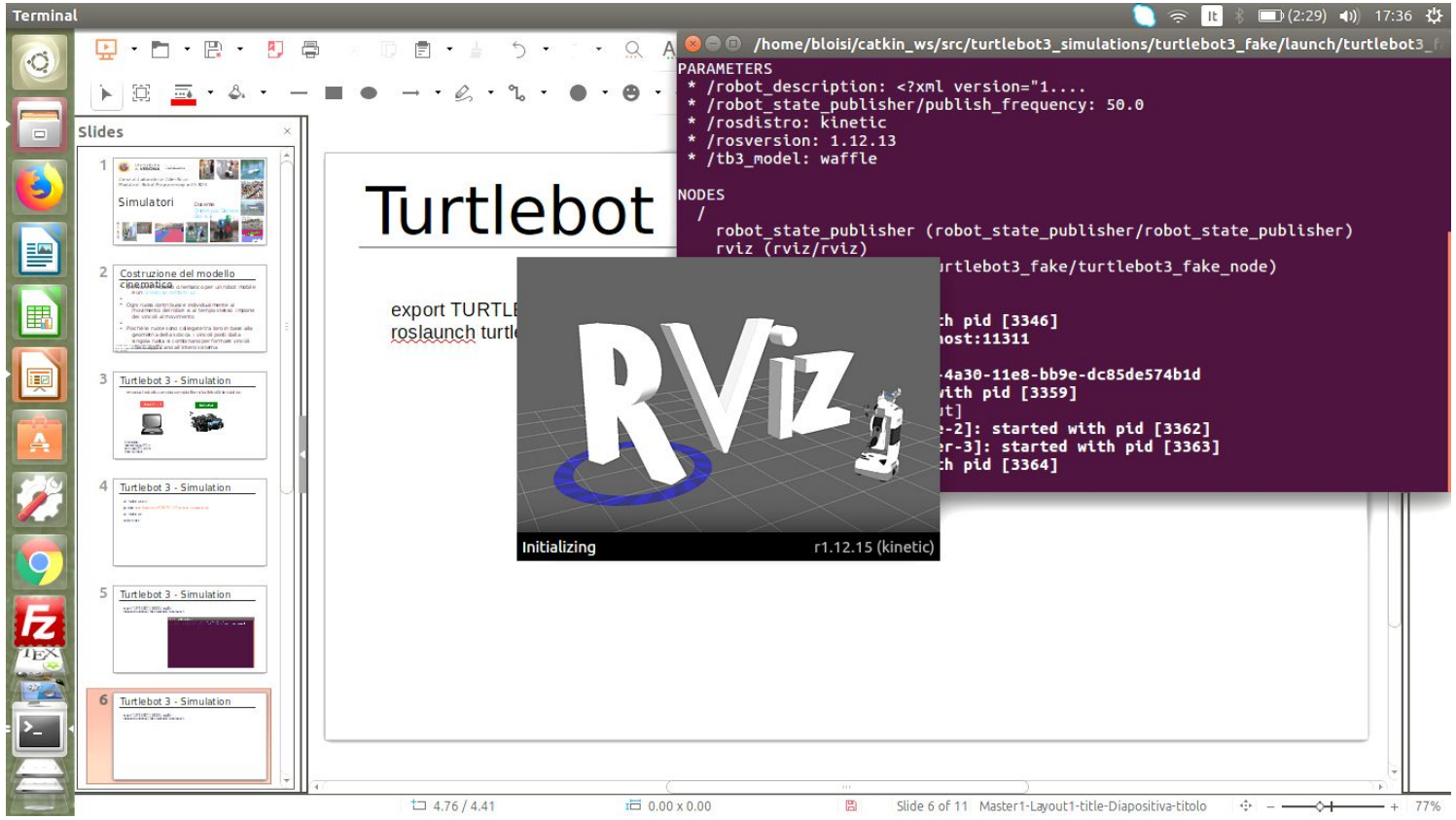
Turtlebot3 – run turtlebot3_fake

```
$ export TURTLEBOT3_MODEL=waffle

$ roslaunch turtlebot3_fake turtlebot3_fake.launch
```

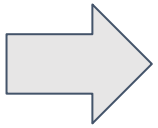


Turtlebot3 – run turtlebot3_fake

```
$ export TURTLEBOT3_MODEL=waffle

$ roslaunch turtlebot3_fake turtlebot3_fake.launch
```

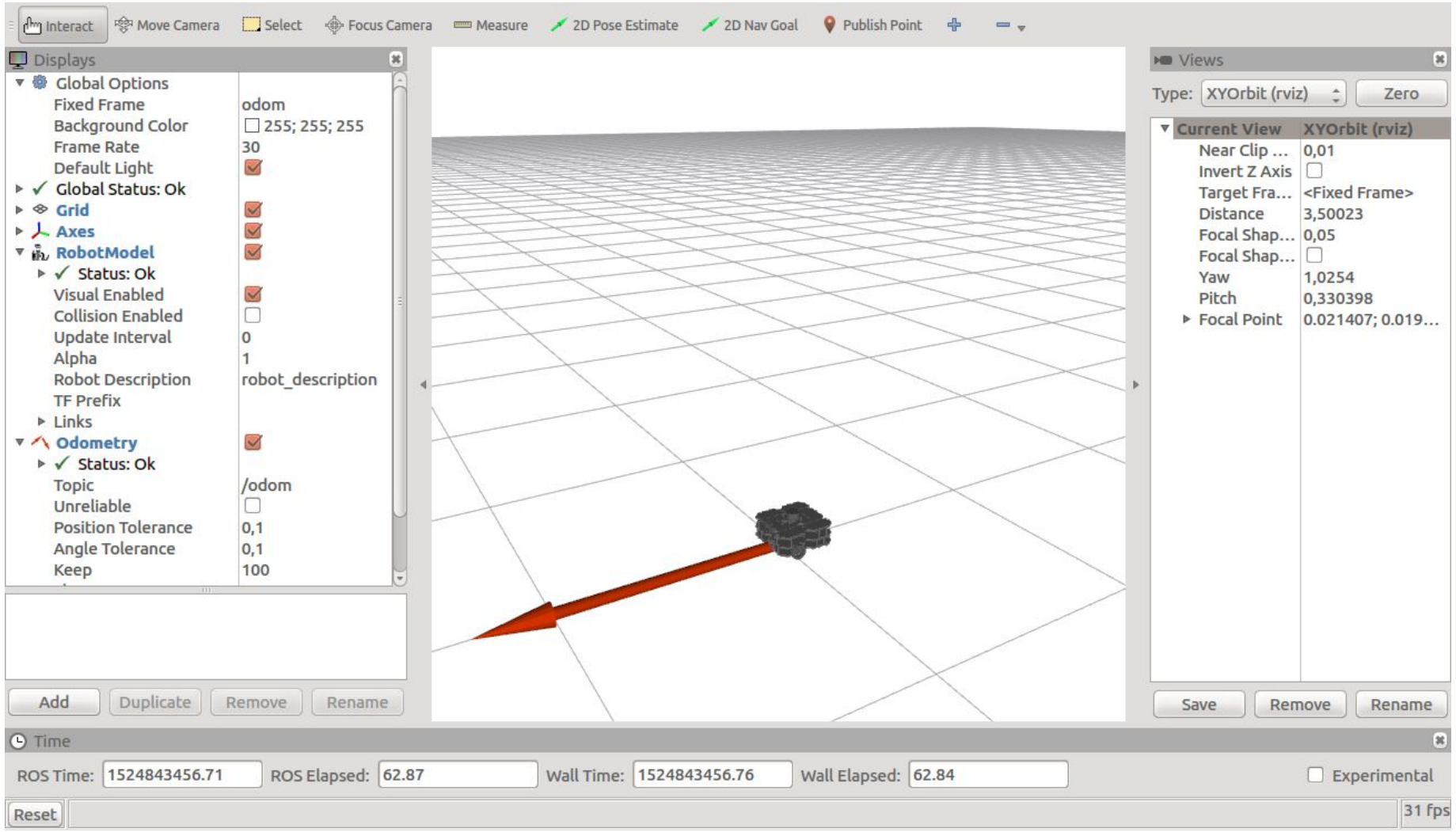


Turtlebot3 – run turtlebot3_fake



```
/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)
```

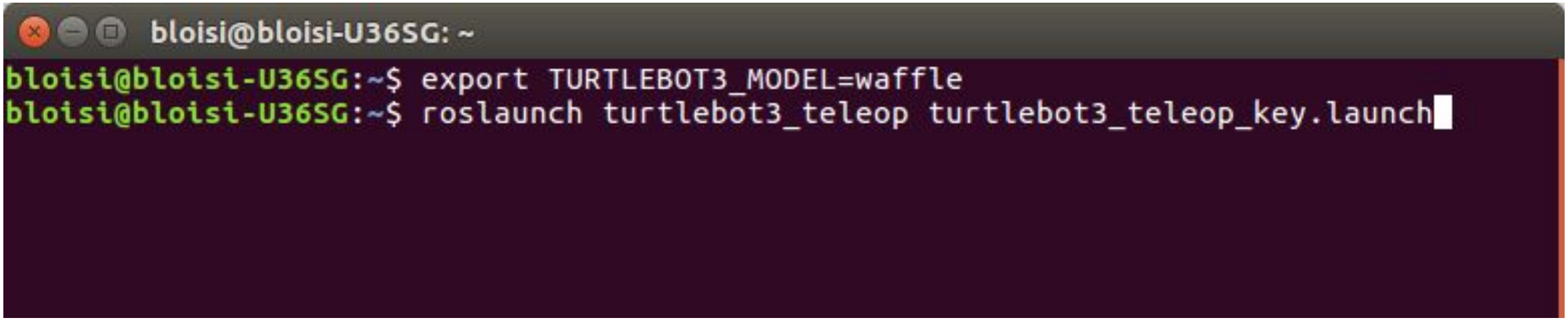
Turtlebot3 – visualizzazione



Turtlebot3 – teleop in simulation

Apriamo un nuovo terminal e digitiamo

```
$ export TURTLEBOT3_MODEL=waffle

$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
```

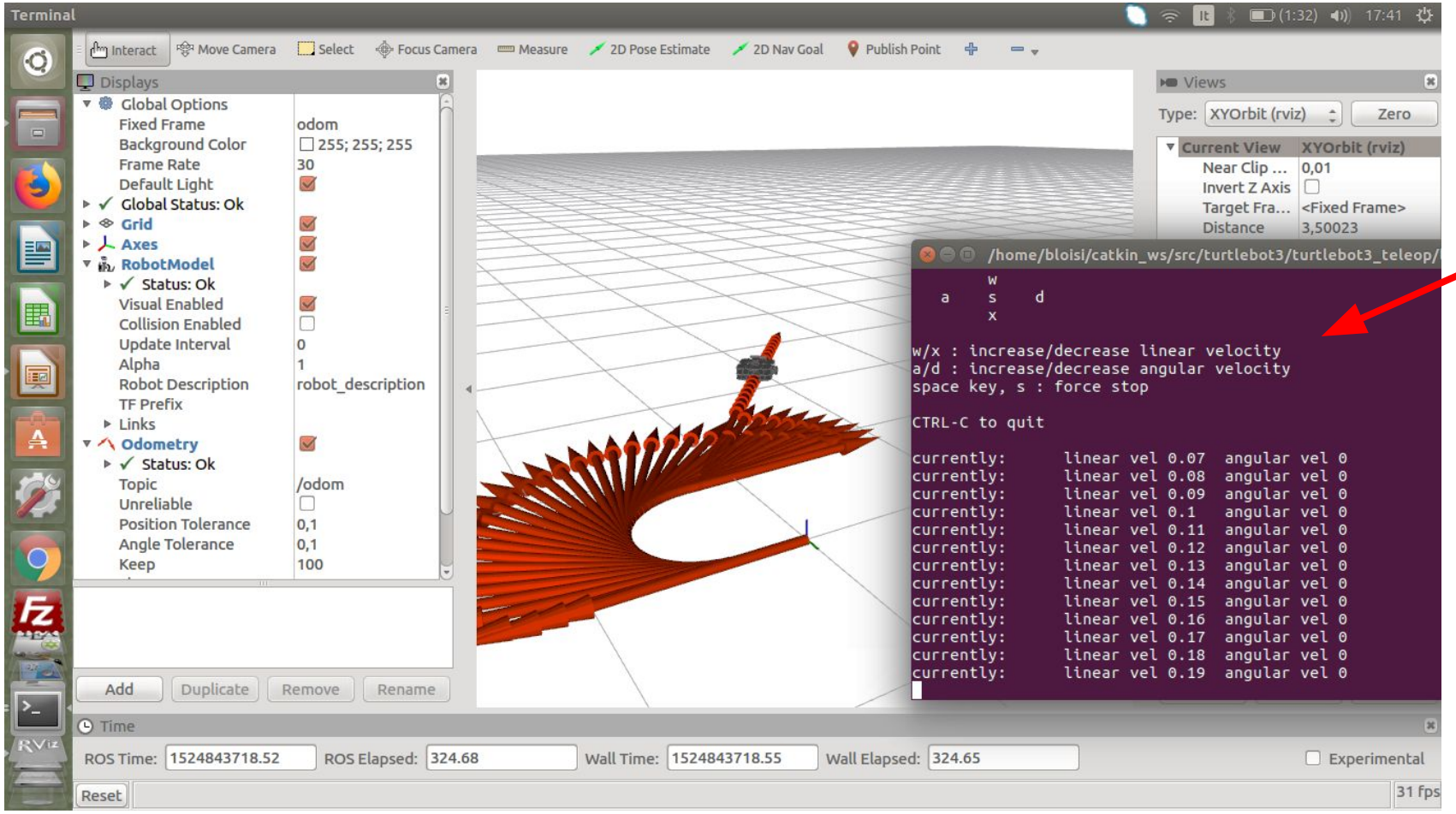


Turtlebot3 – i due terminal

```
/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]
```

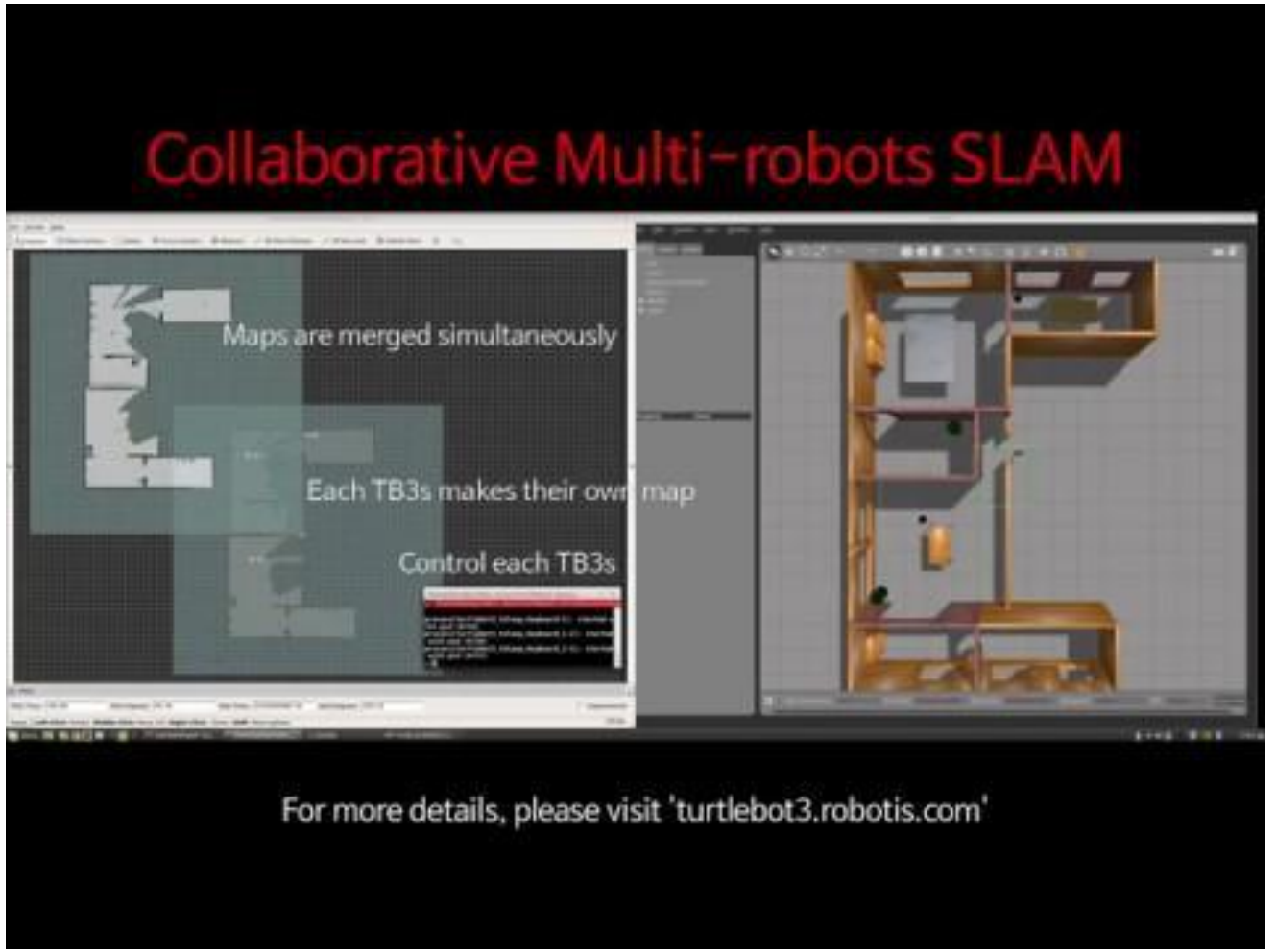
```
/home/bloisi/catkin_ws/src/turtlebot3/turtlebot3_teleop/launch/turtlebot3_teleop_key.launch
bloisi@bloisi-U36SG:~$ roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch
... logging to /home/bloisi/.ros/log/dd735886-789e-11e9-8efc-dc85de574b1d/roslaunch-b
loisi-U36SG-13923.log
Checking log directory 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



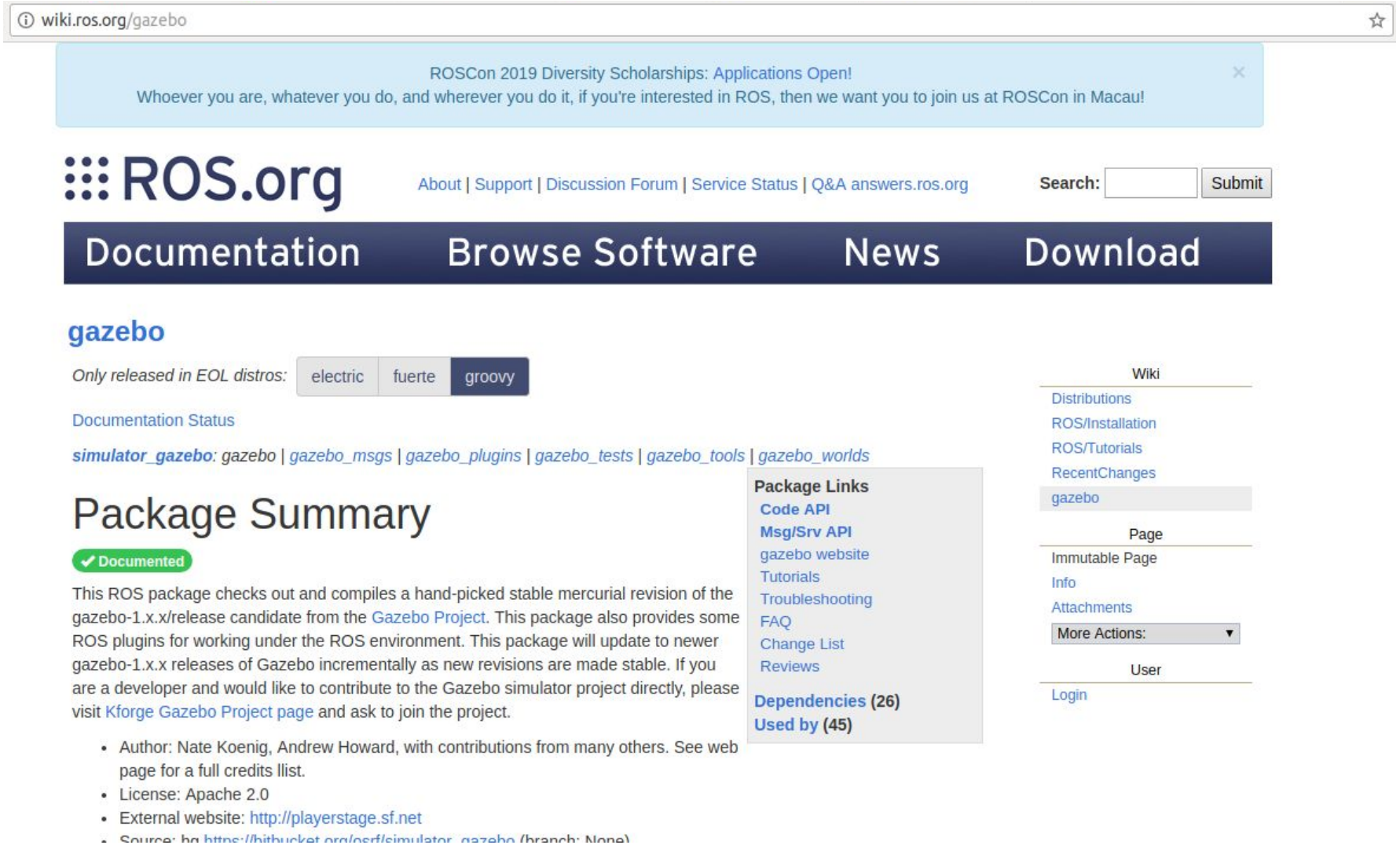
Per poter controllare il robot da tastiera, il terminal con il nodo teleop deve essere selezionato

Turtlebot3 – Gazebo



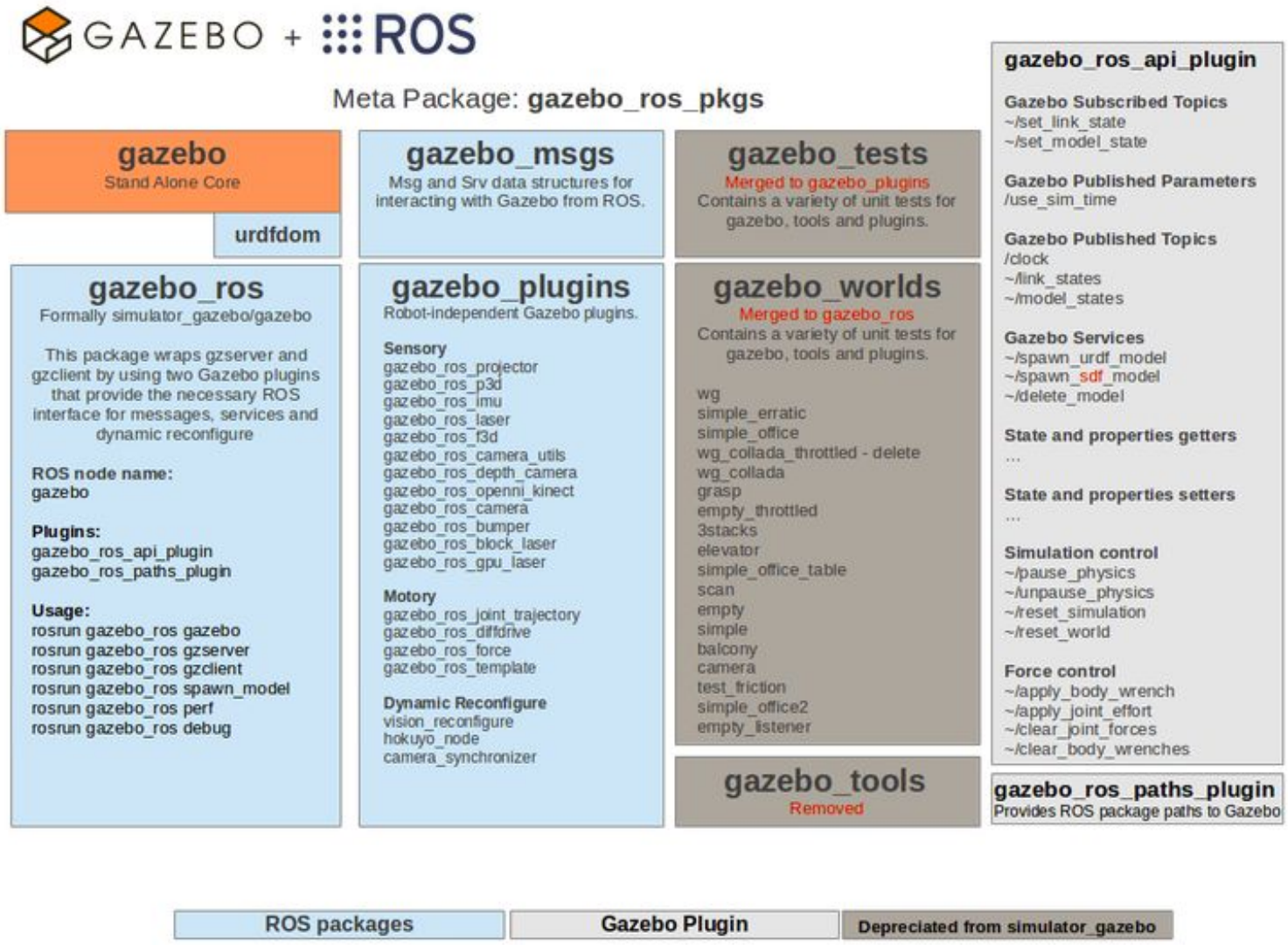
https://youtu.be/UzOoJ6a_mOg

Gazebo in ROS



http://wiki.ros.org/gazebo

Gazebo + ROS

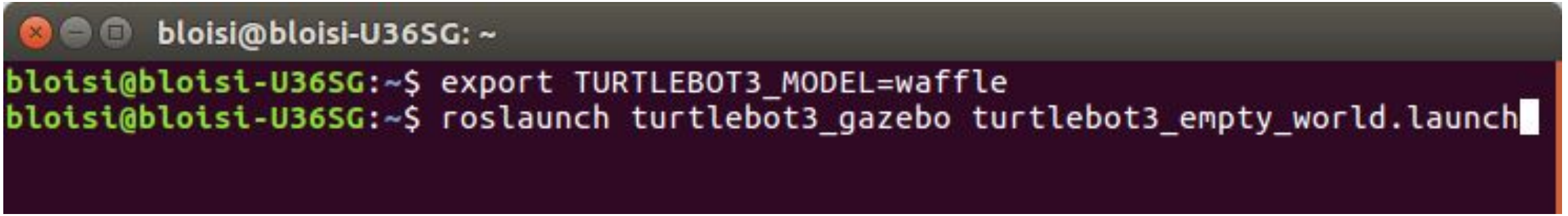


http://gazebosim.org/tutorials?tut=ros_overview

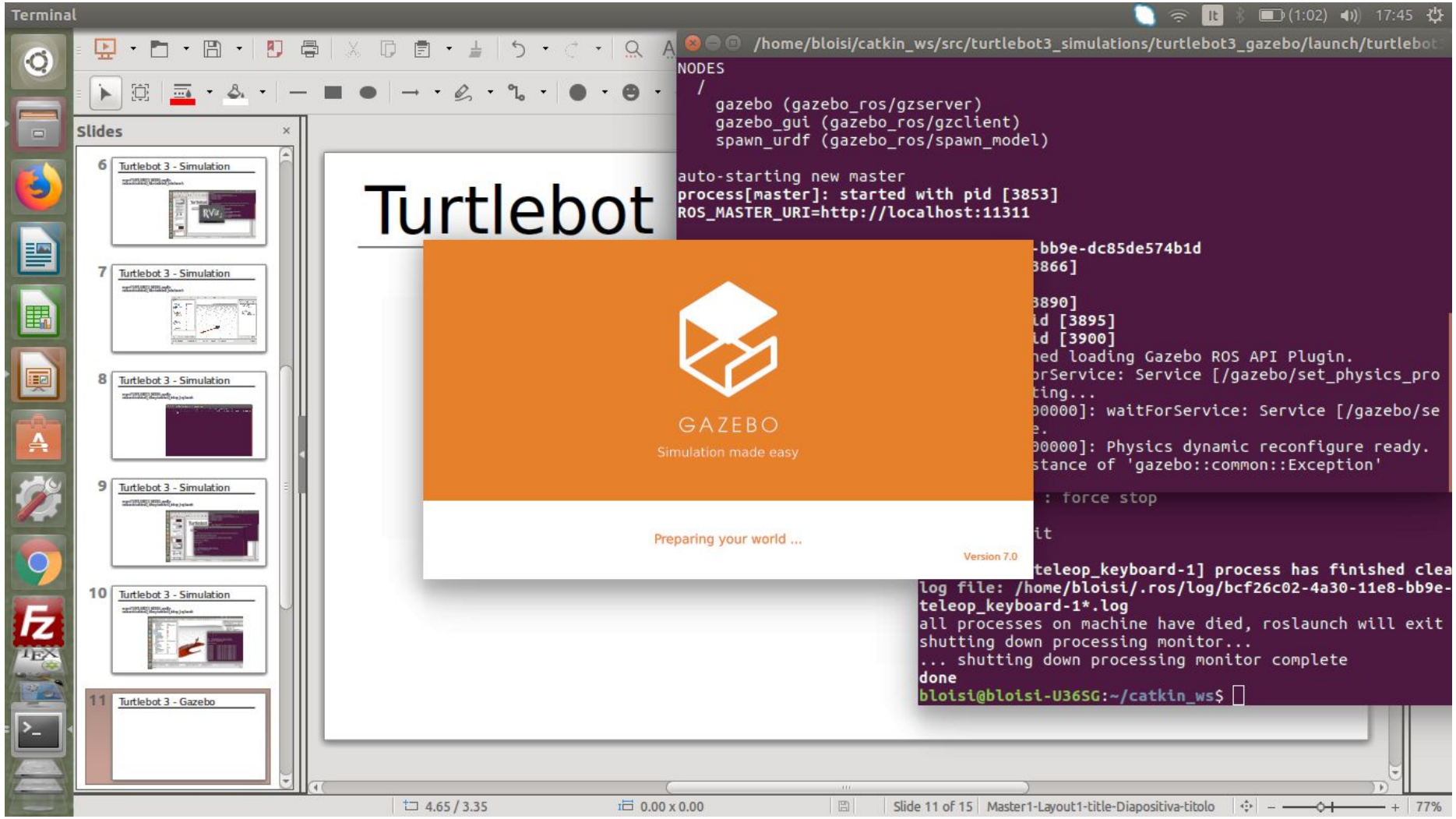
Turtlebot3 – empty world

Apriamo un nuovo terminal e digitiamo

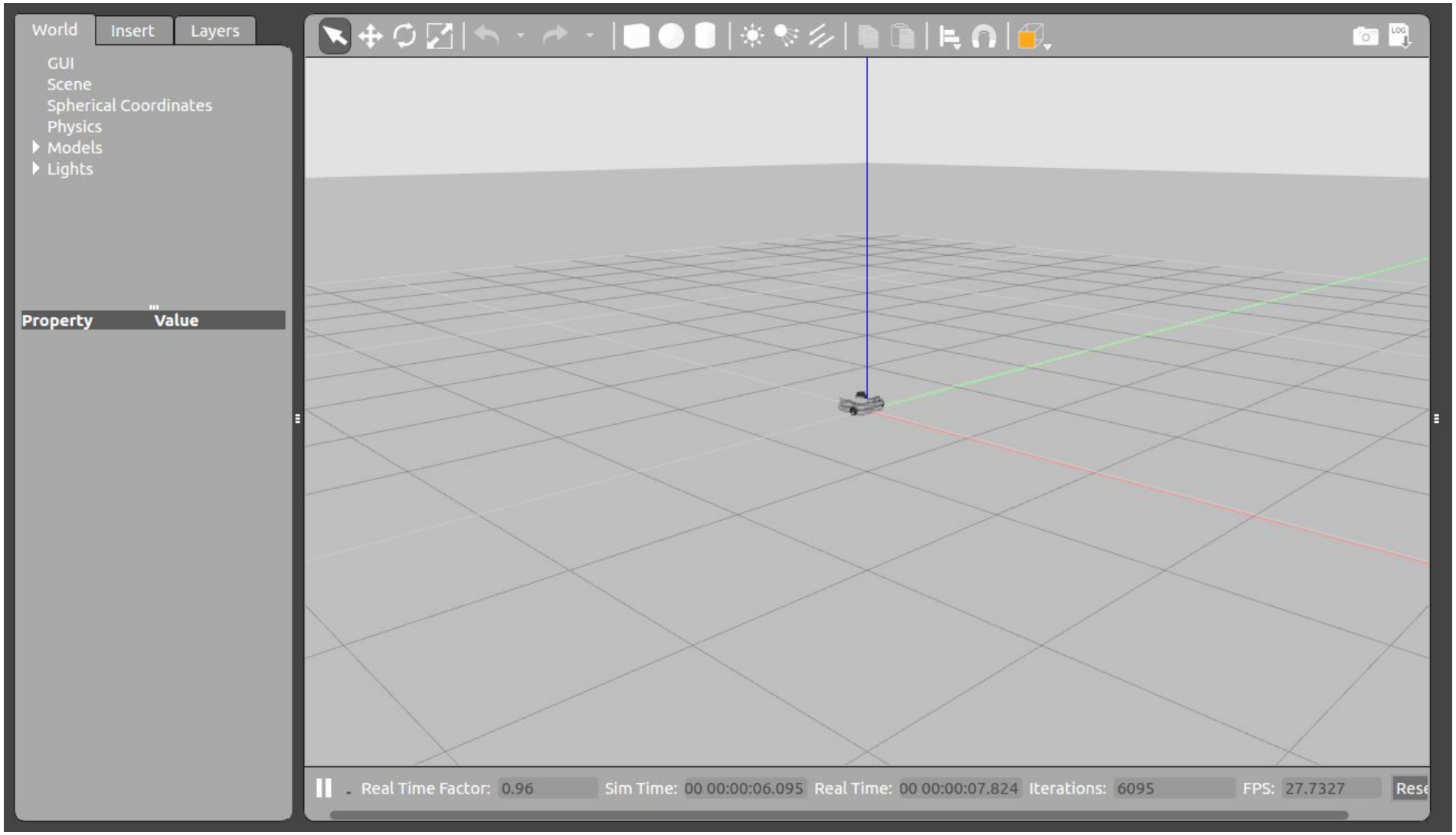
```
$ export TURTLEBOT3_MODEL=waffle

$ roslaunch turtlebot3_gazebo turtlebot3_empty_world.launch
```



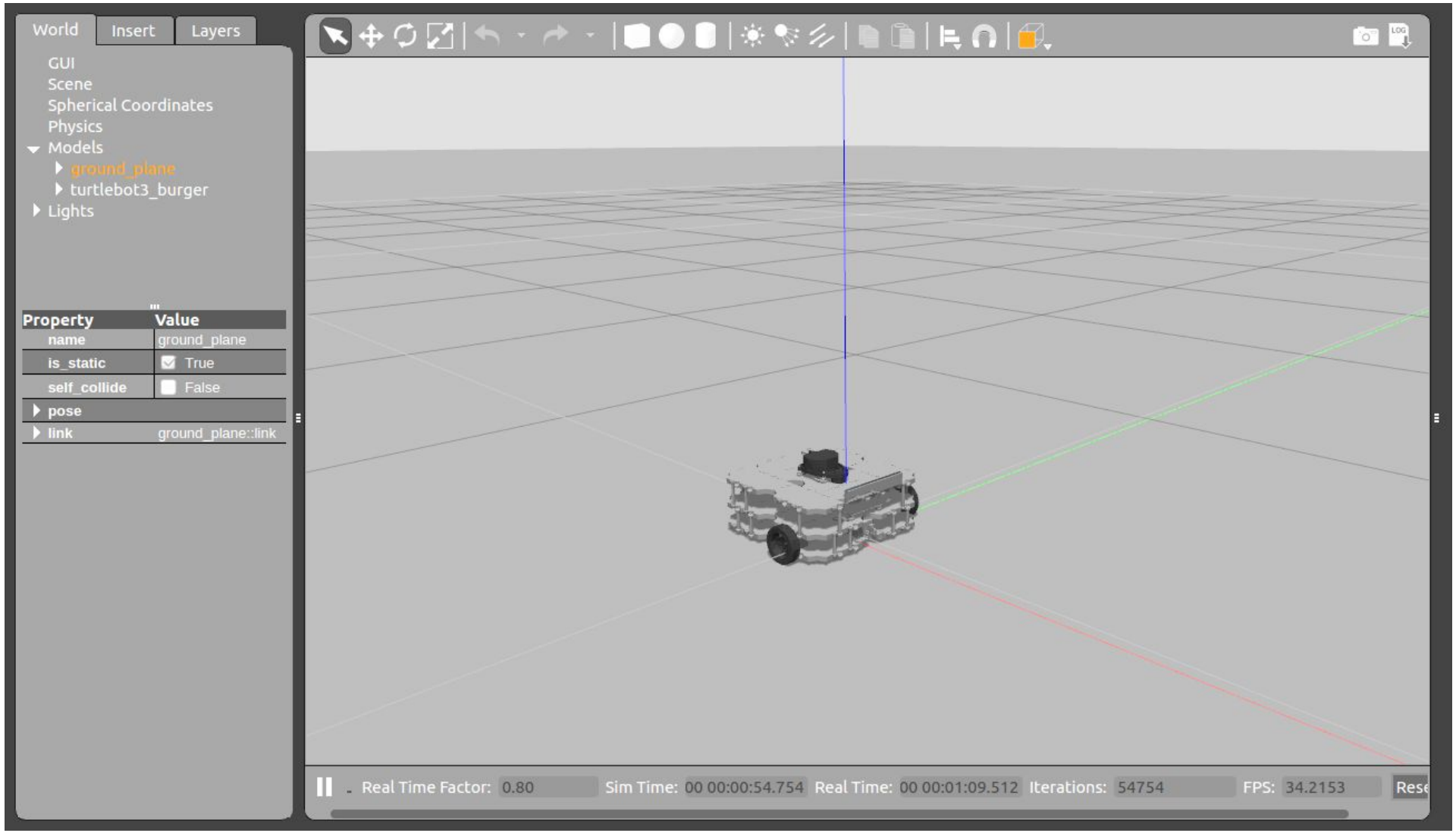
Turtlebot3 – empty world



Turtlebot3 – empty world

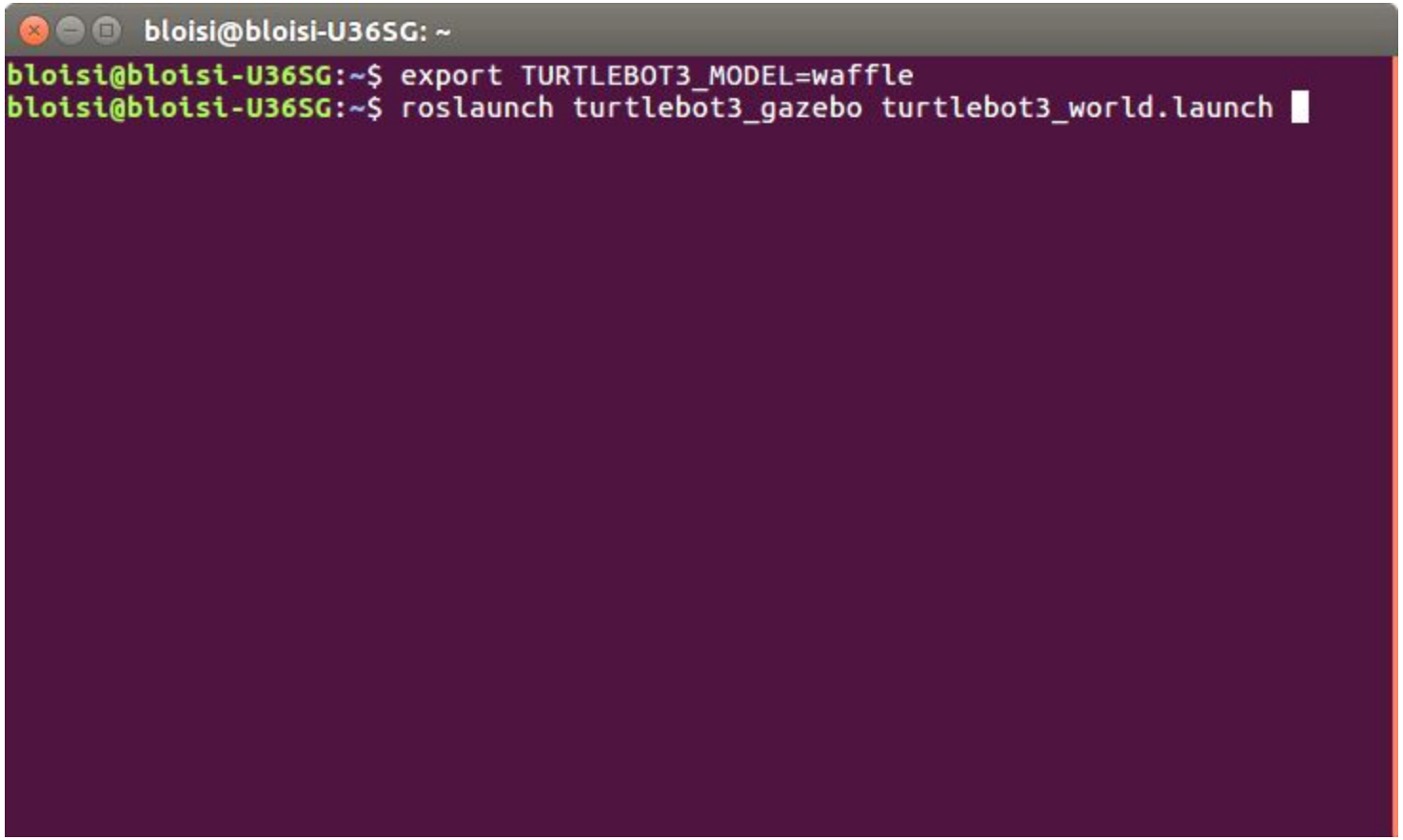


Turtlebot3 – empty world

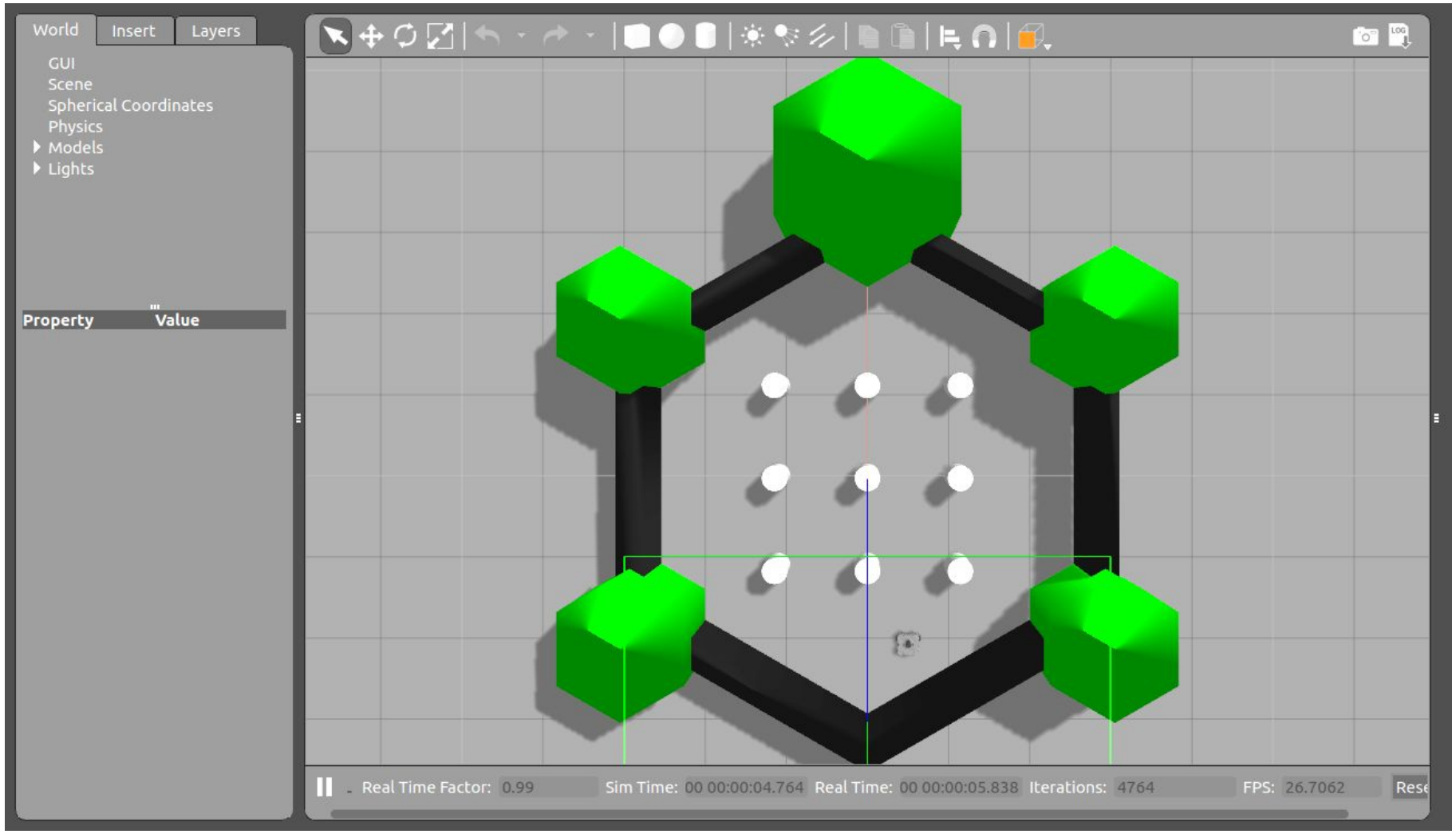


Turtlebot3 – Turtlebot3 World

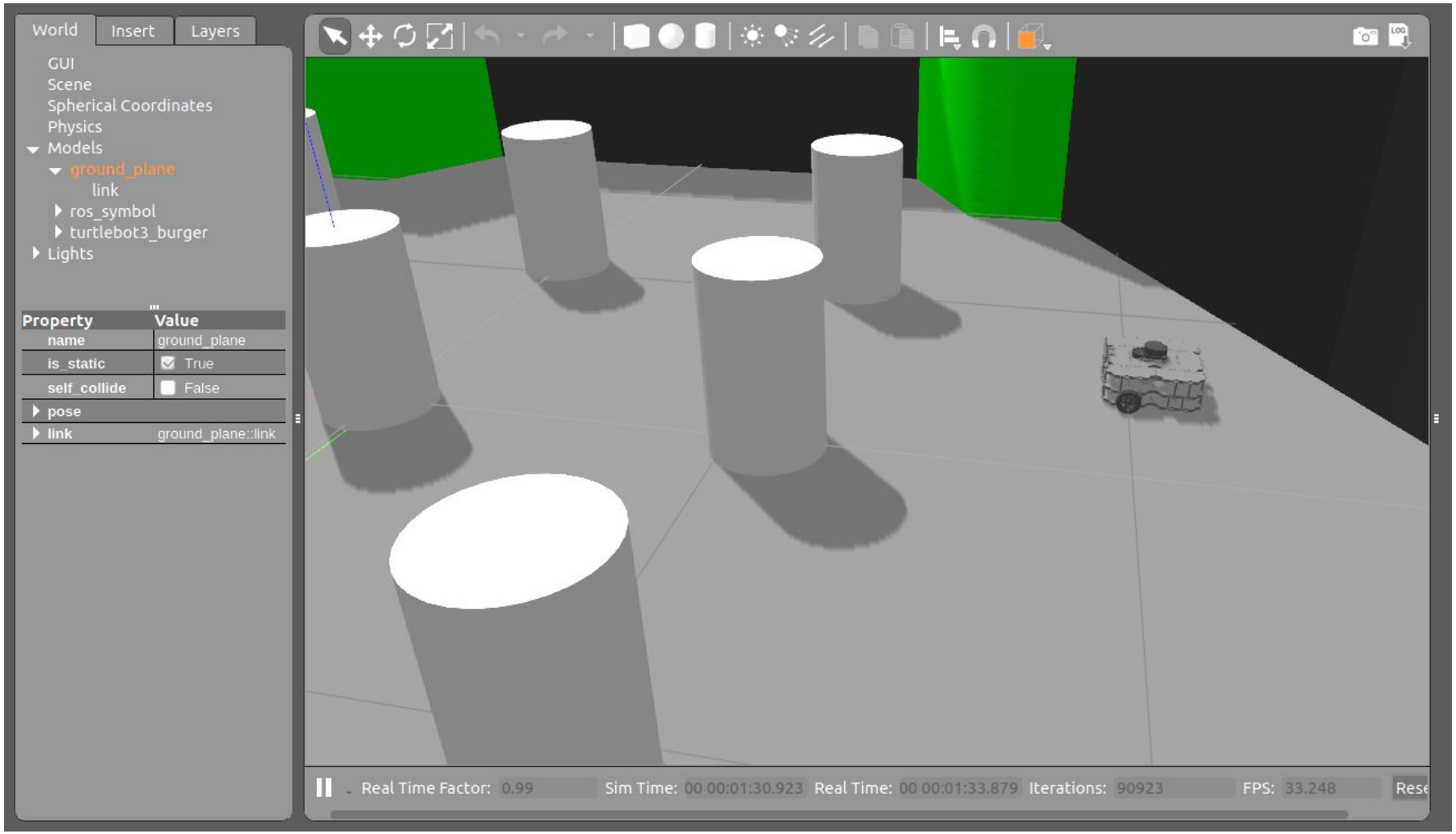
```
$ export TURTLEBOT3_MODEL=waffle

$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```



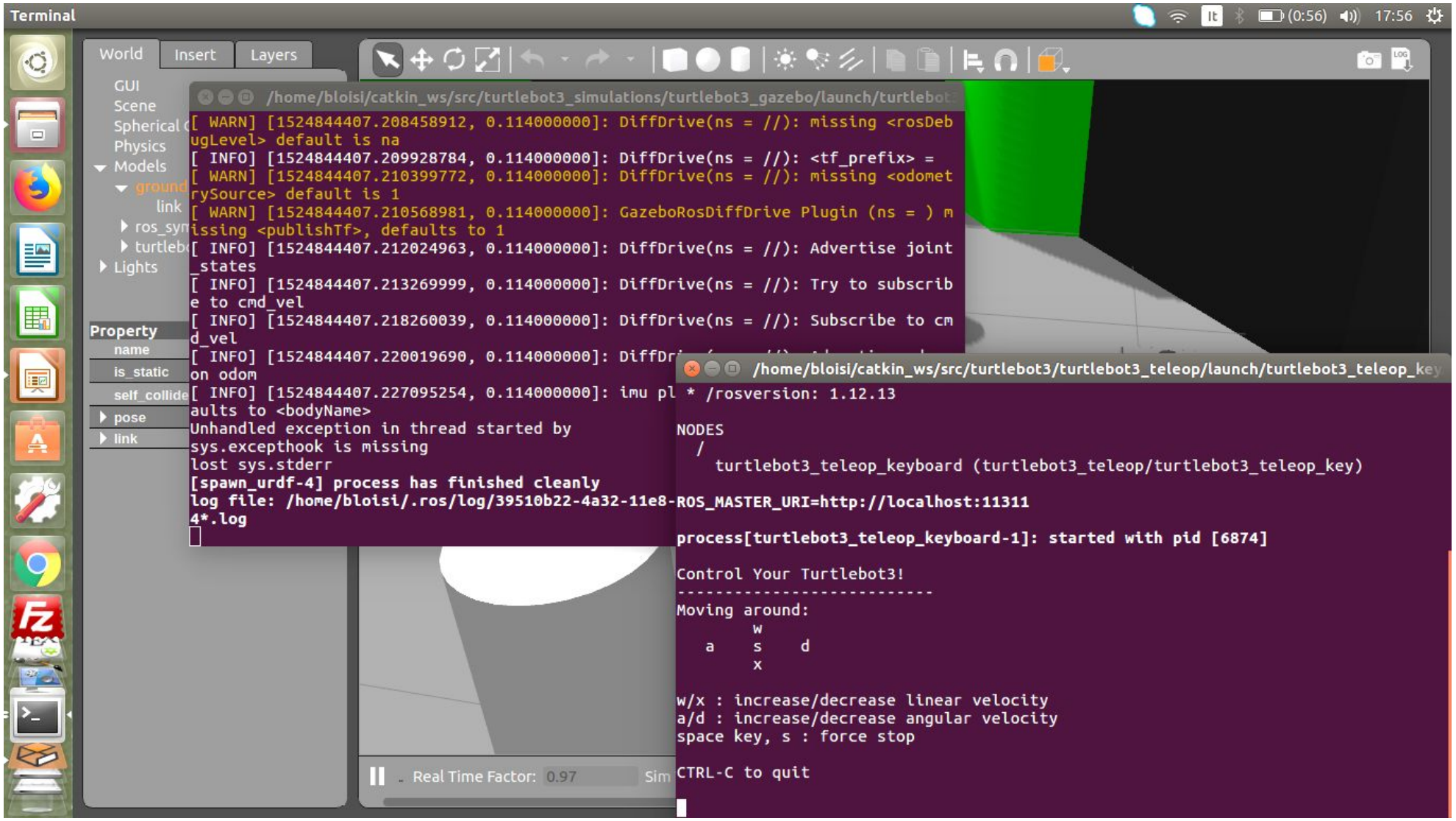
Turtlebot3 – Turtlebot3 World



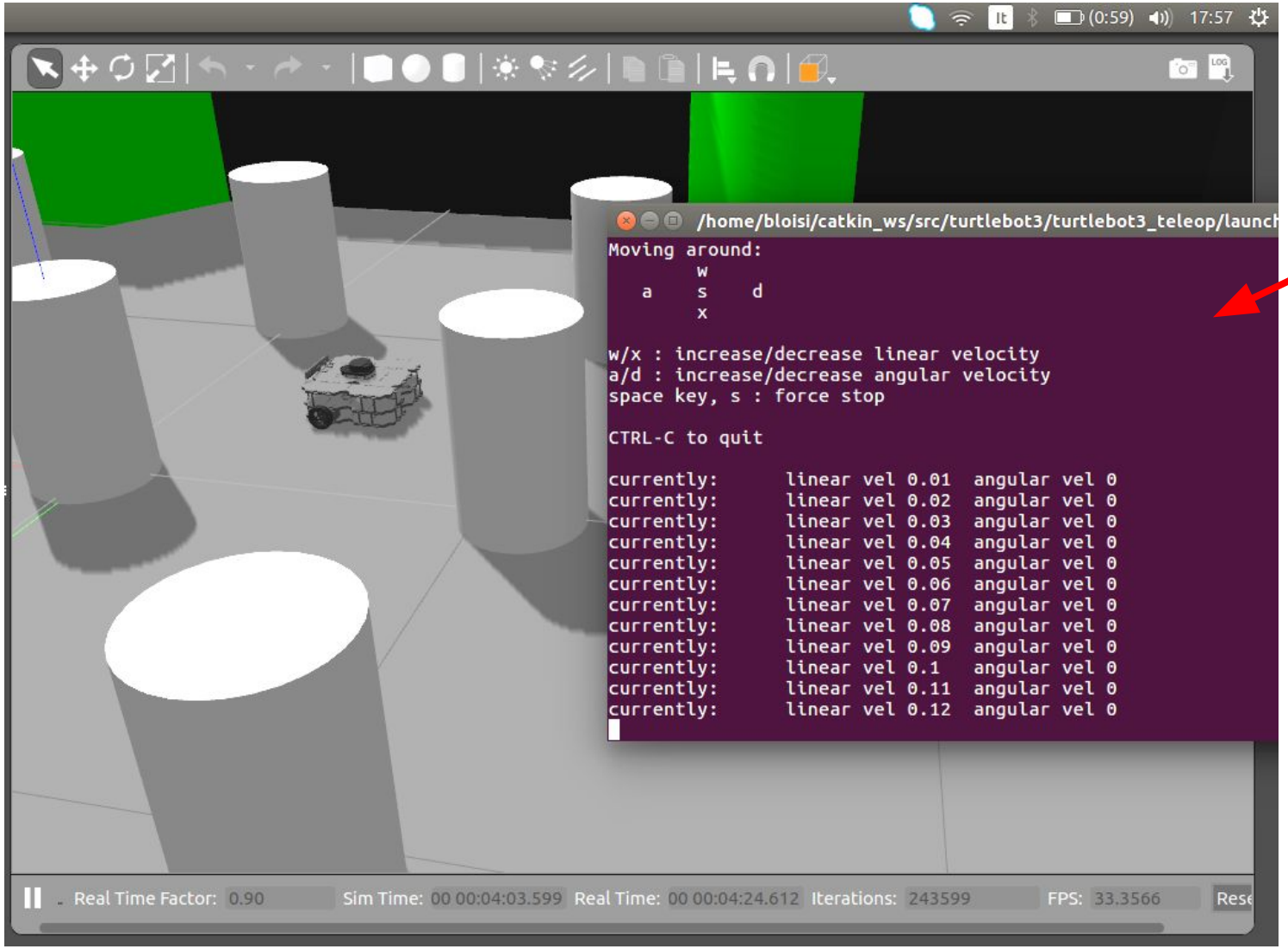
Turtlebot3 – Turtlebot3 World



Teleoperation in Turtlebot3 World



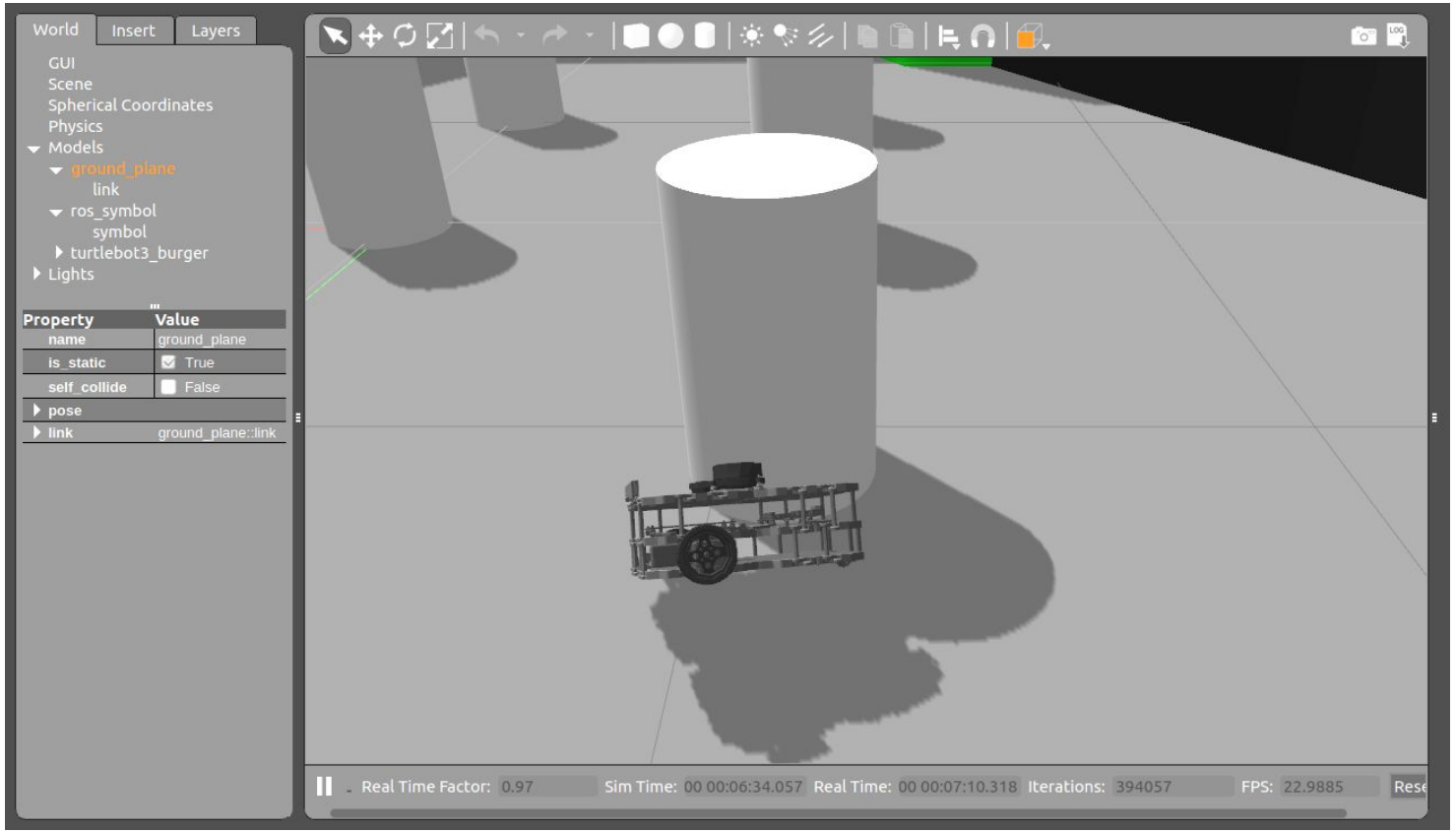
Teleoperation in Turtlebot3 World



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

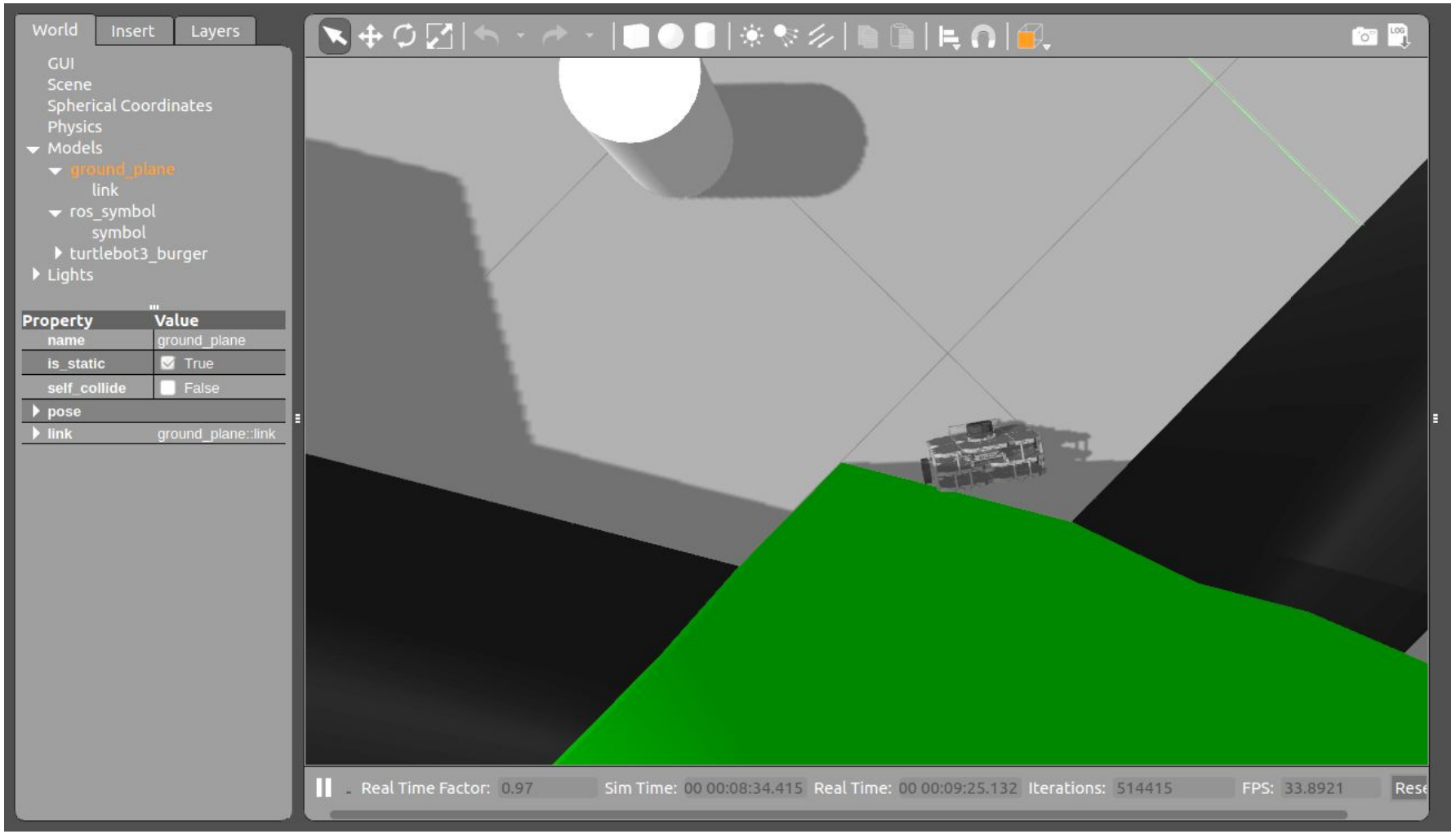
Esercizio Turtlebot3 World

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



Esercizio Turtlebot3 World

Esempio



Turtlebot3 – collision avoidance

Terminale 1

Lanciare il nodo per la simulazione del Turtlebot3 World

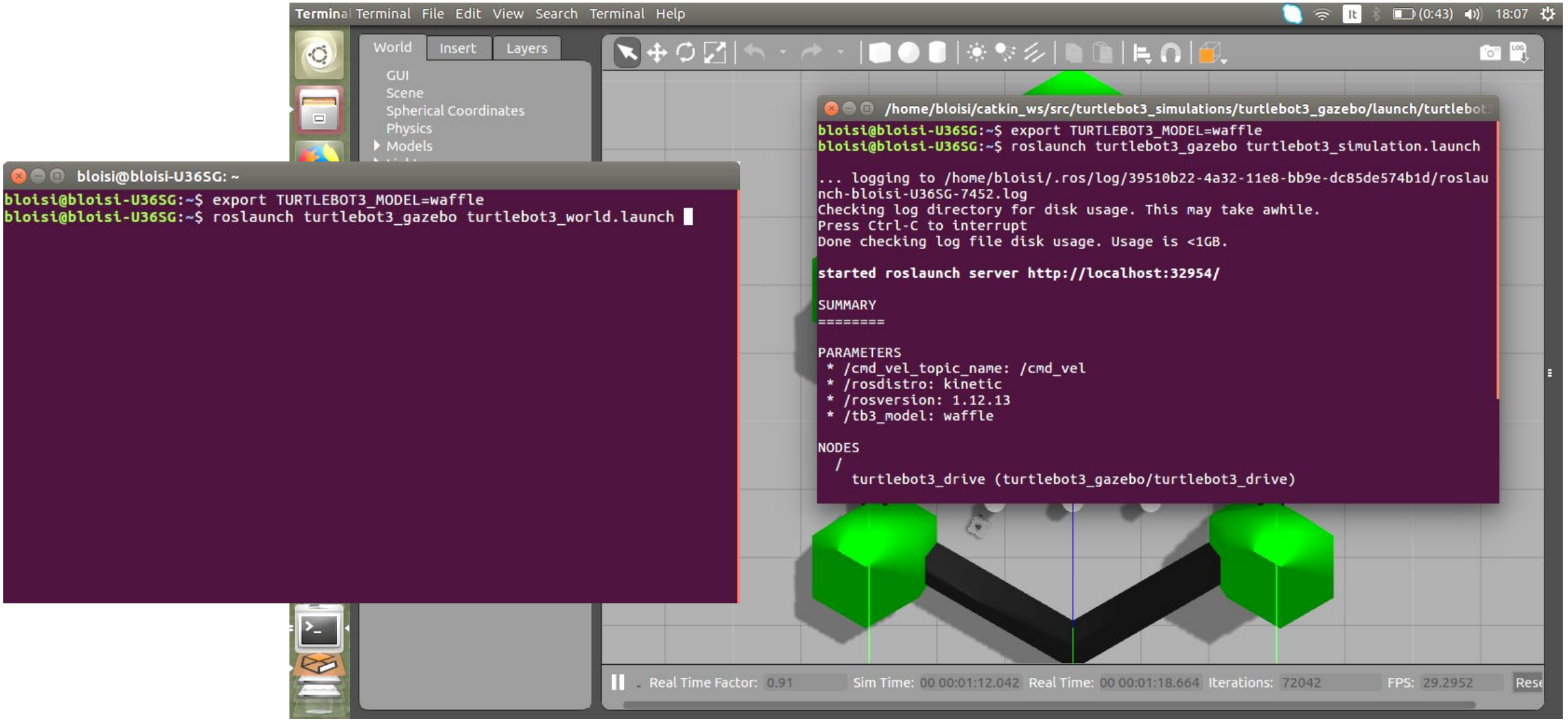
```
$ export TURTLEBOT3_MODEL=waffle
$ roslaunch turtlebot3_gazebo turtlebot3_world.launch
```

Terminale 2

Lanciare il nodo per l'autonomous drive

```
$ export TURTLEBOT3_MODEL=waffle
$ roslaunch turtlebot3_gazebo turtlebot3_simulation.launch
```

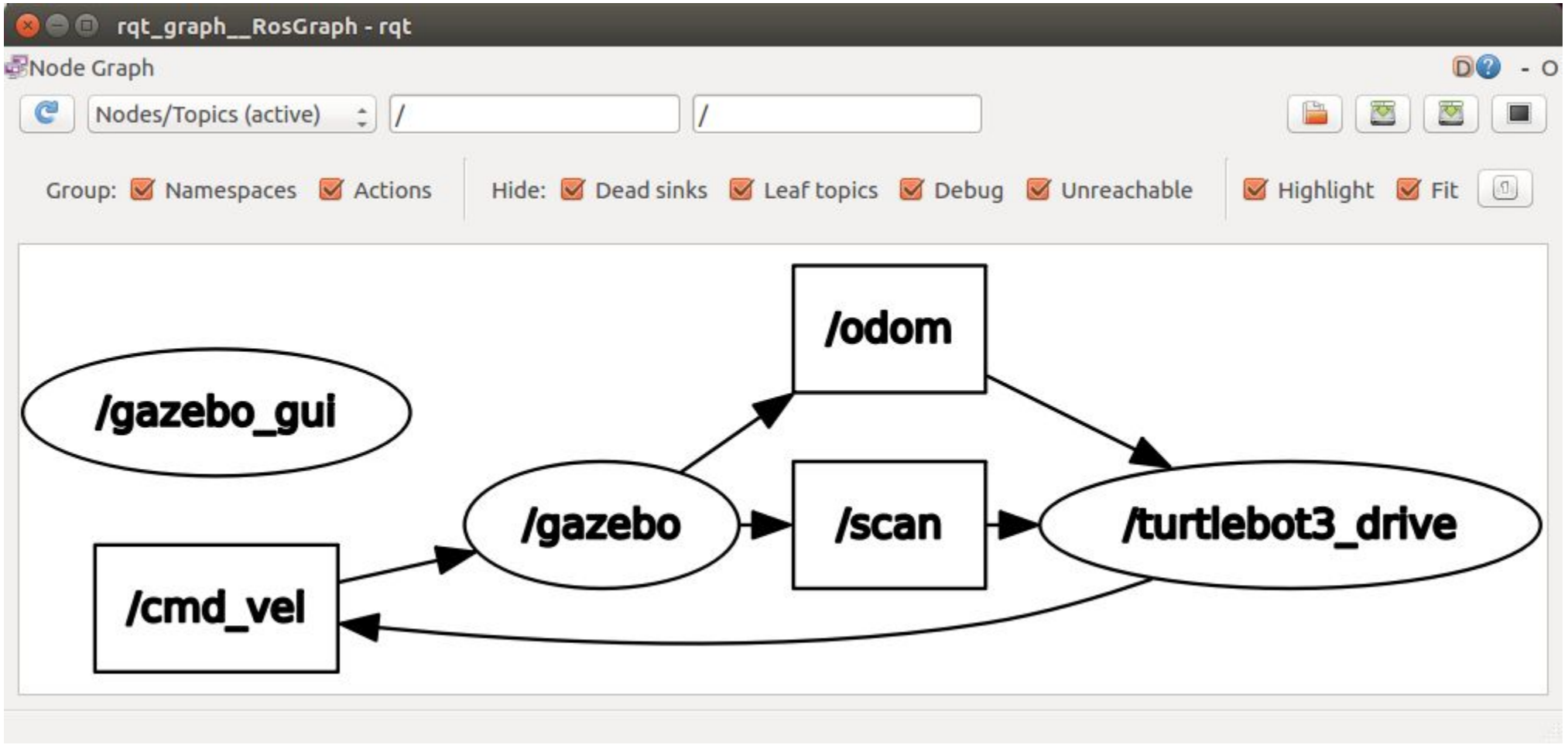
Turtlebot3 – collision avoidance



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



Turtlebot3 – RViz

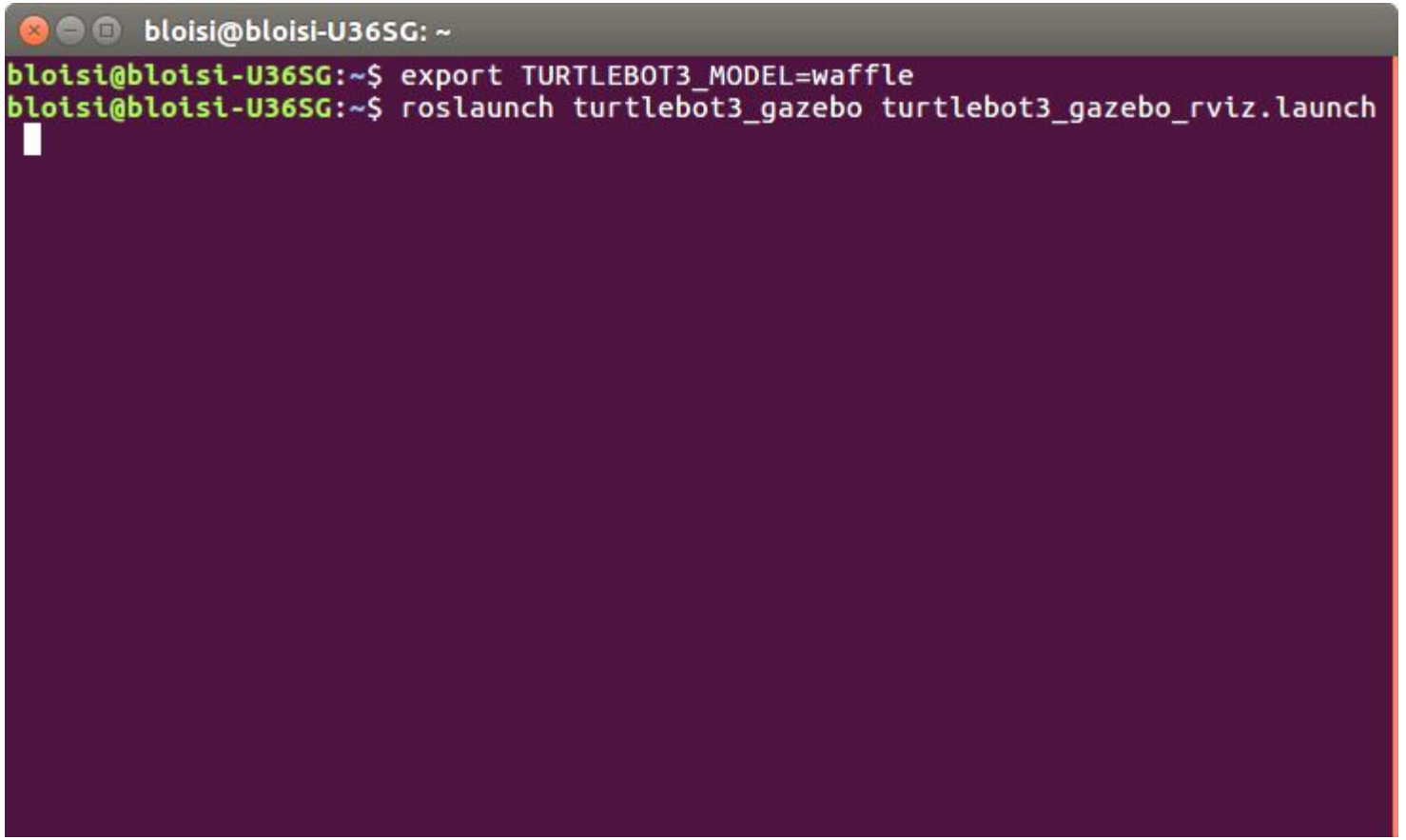
RViz può essere usato per visualizzare I topic che vengono pubblicati mentre la simulazione è in esecuzione.

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

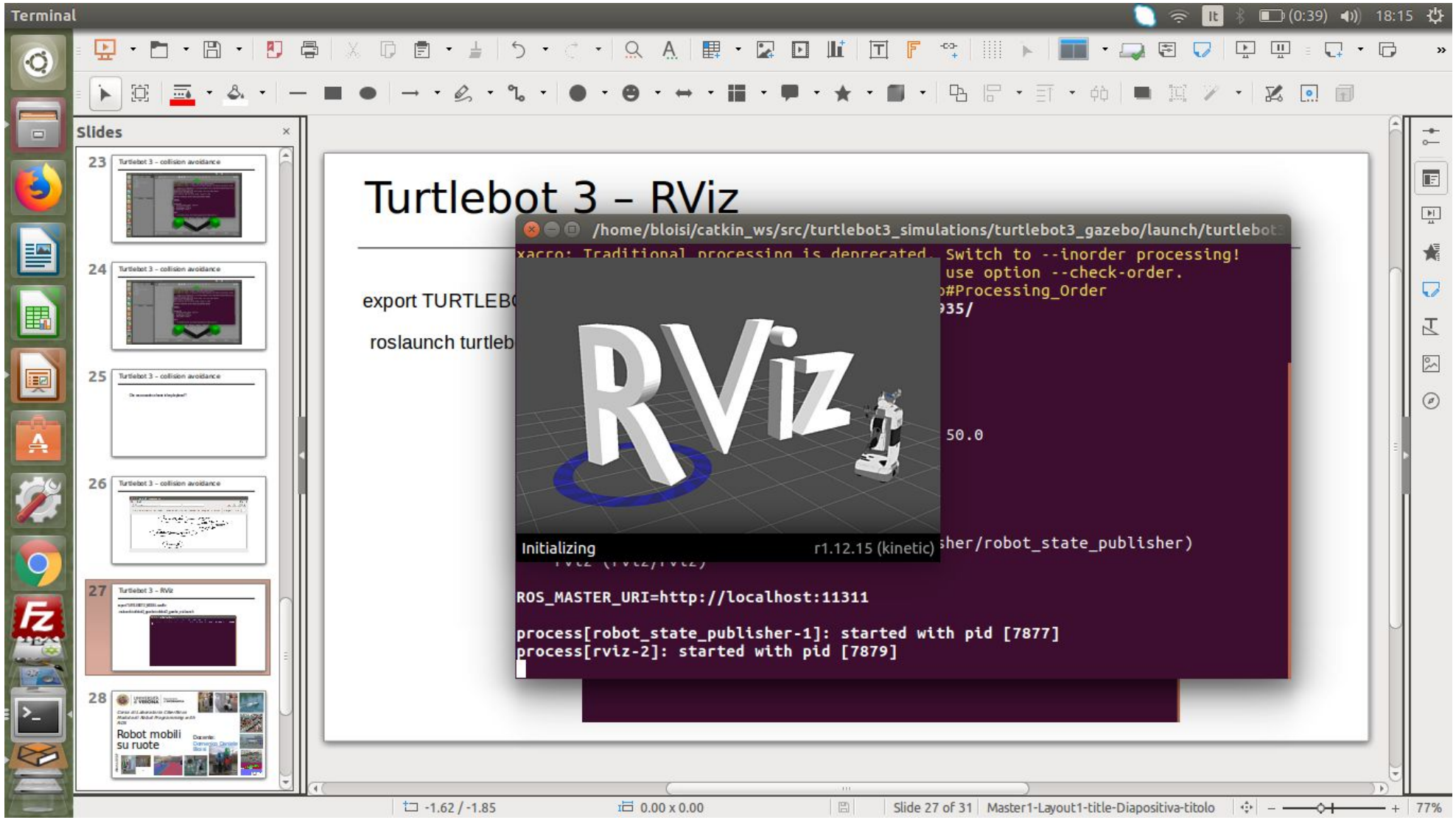
```
$ export TURTLEBOT3_MODEL=waffle
$ roslaunch turtlebot3_gazebo turtlebot3_gazebo_rviz.launch
```

Turtlebot3 – RViz

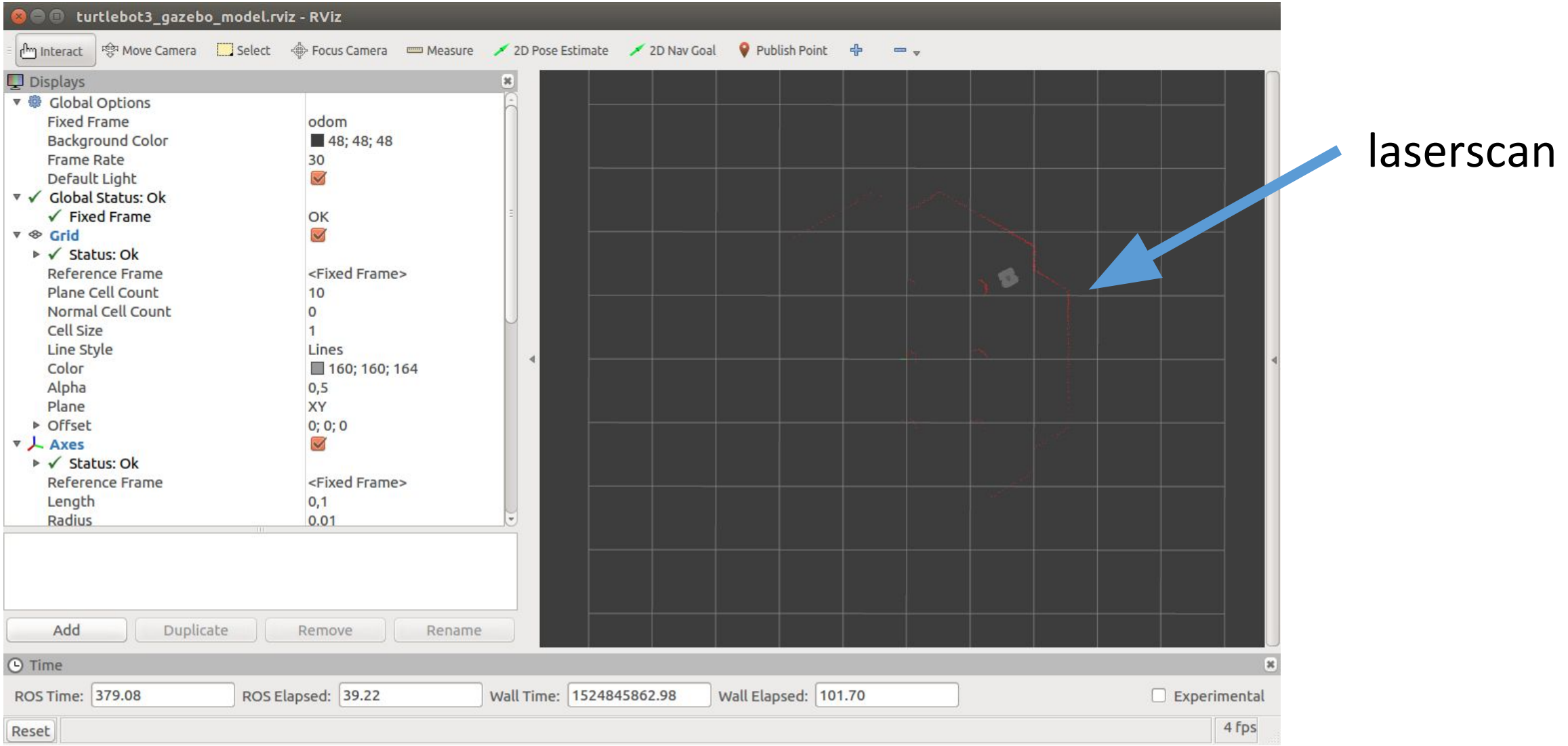
```
$ export TURTLEBOT3_MODEL=waffle
$ roslaunch turtlebot3_gazebo turtlebot3_gazebo_rviz.launch
```



Turtlebot3 – RViz

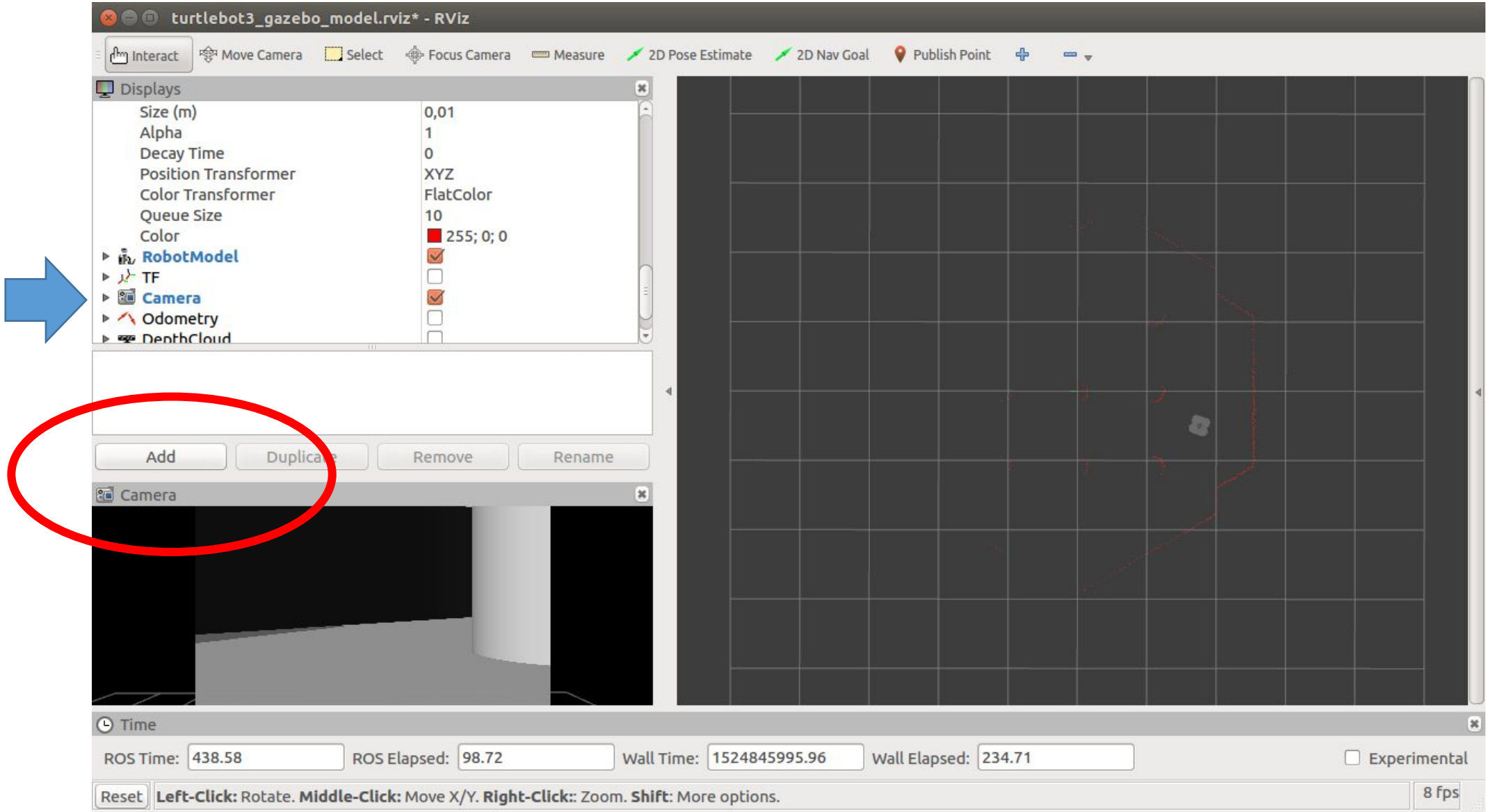


Turtlebot3 – RViz

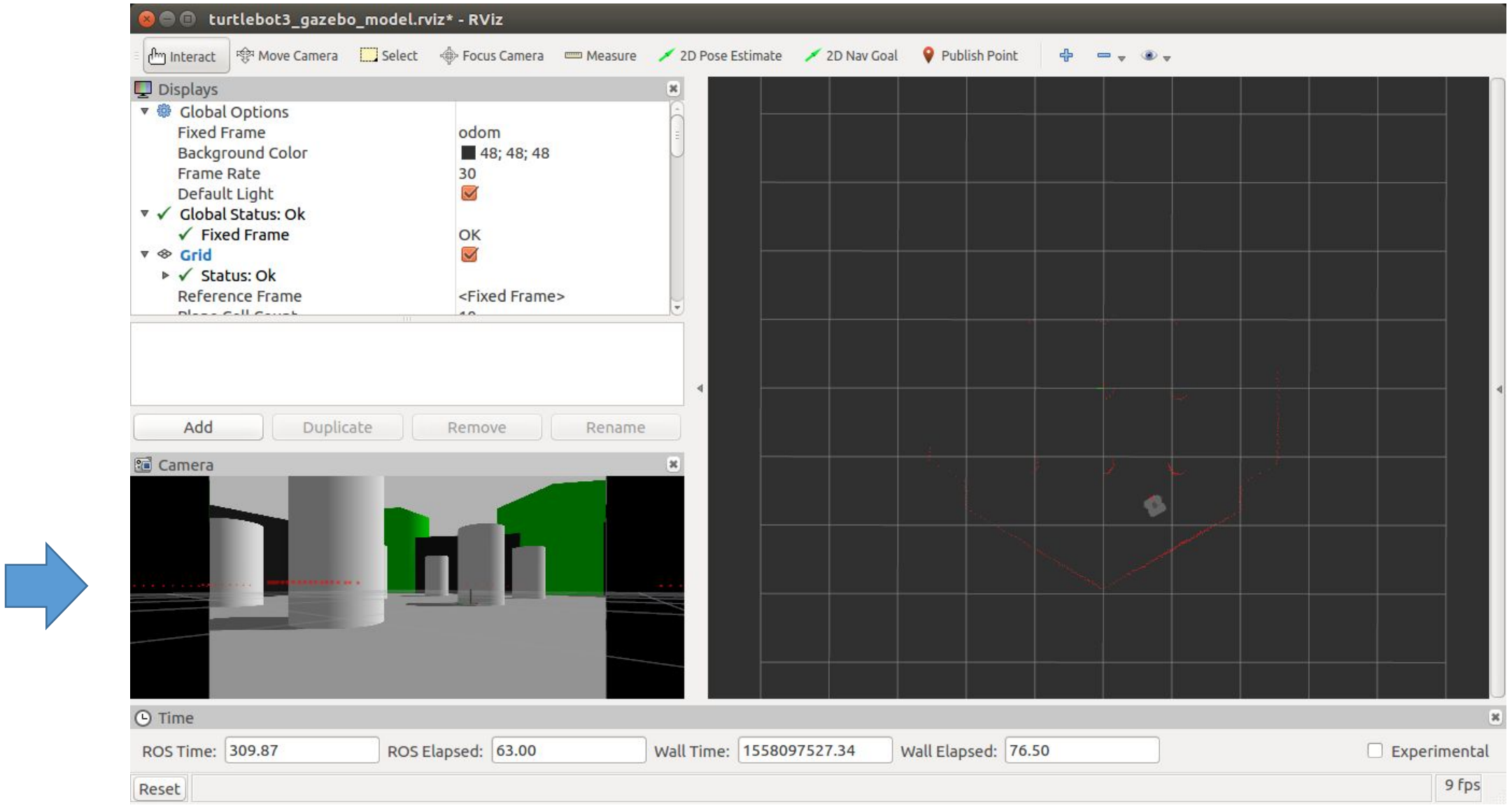


laserscan

Turtlebot3 – adding camera sensor



Turtlebot3 – adding camera sensor



Esercizio – TurtleBot3 House

1. Lanciare il nodo per la simulazione della Turtlebot3 House

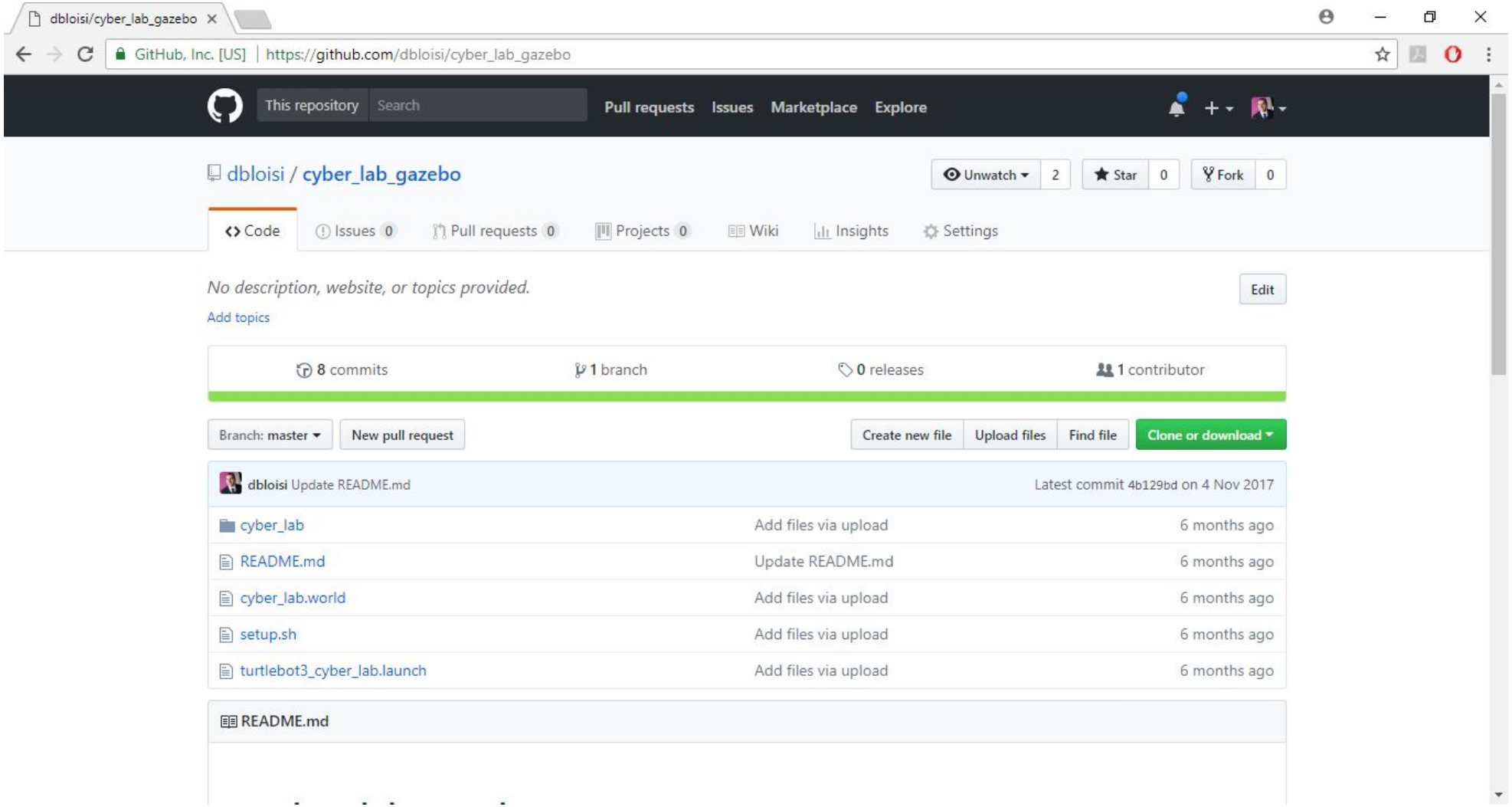
2. Lanciare la navigazione autonoma del turtlebot waffle nella Turtlebot3 House

3. Lanciare la teleoperazione da tastiera del robot

4. Visualizzare in RViz i dati provenienti dal laser e dalla telecamera

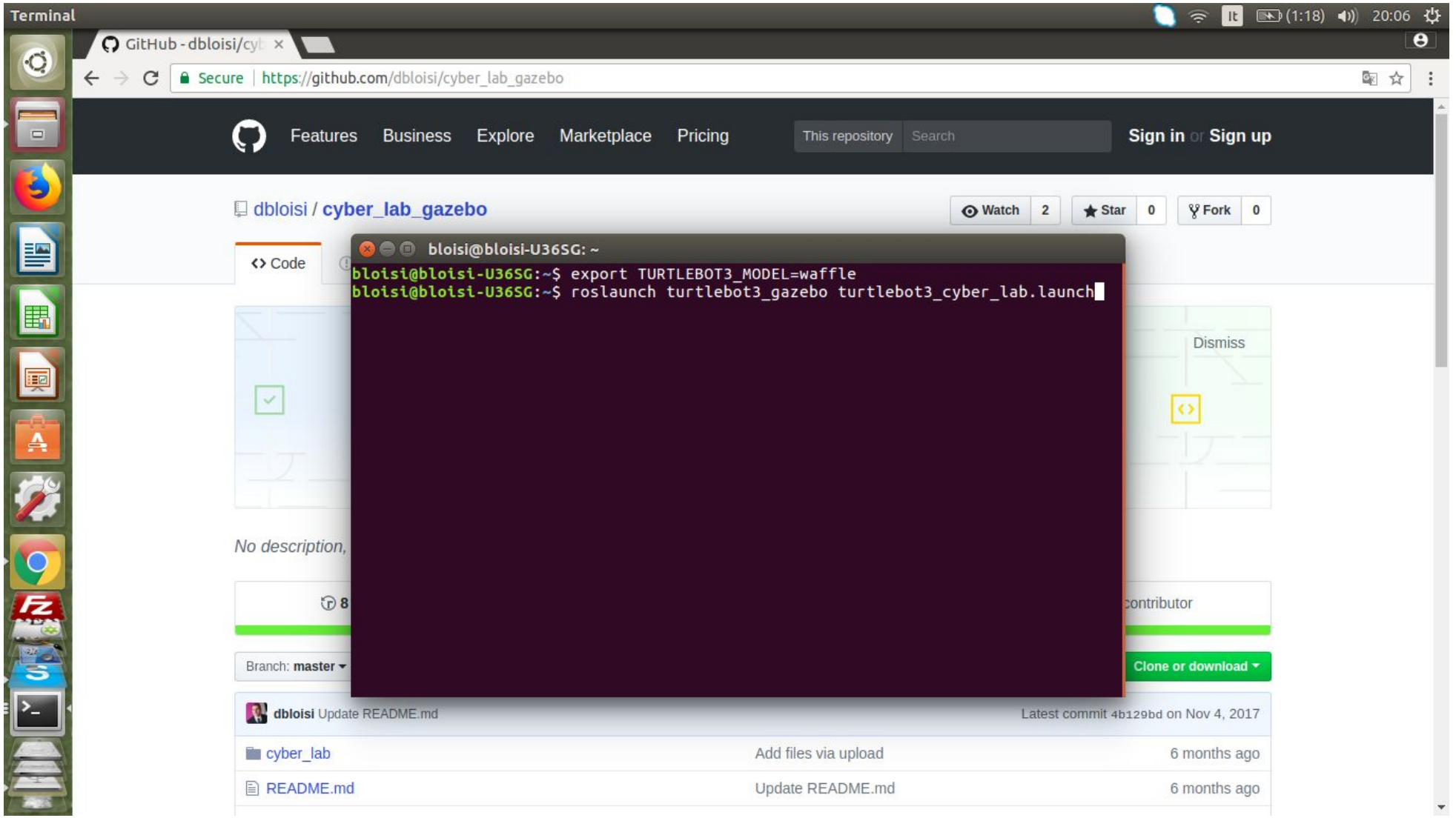
http://emanual.robotis.com/docs/en/platform/turtlebot3/simulation/#3-turtlebot3-house

Esercizio – cyberlab

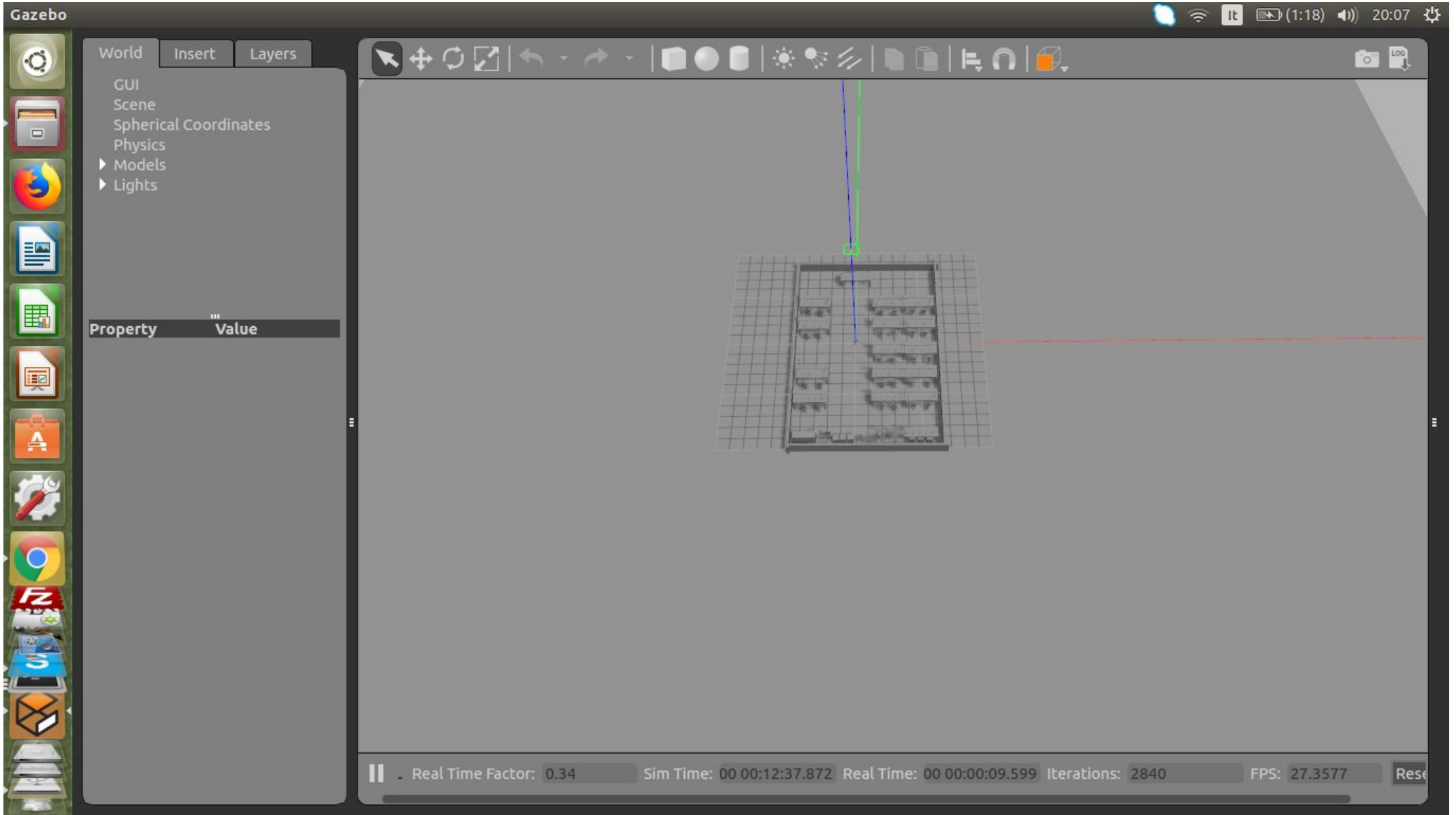


https://github.com/dbloisi/cyber_lab_gazebo

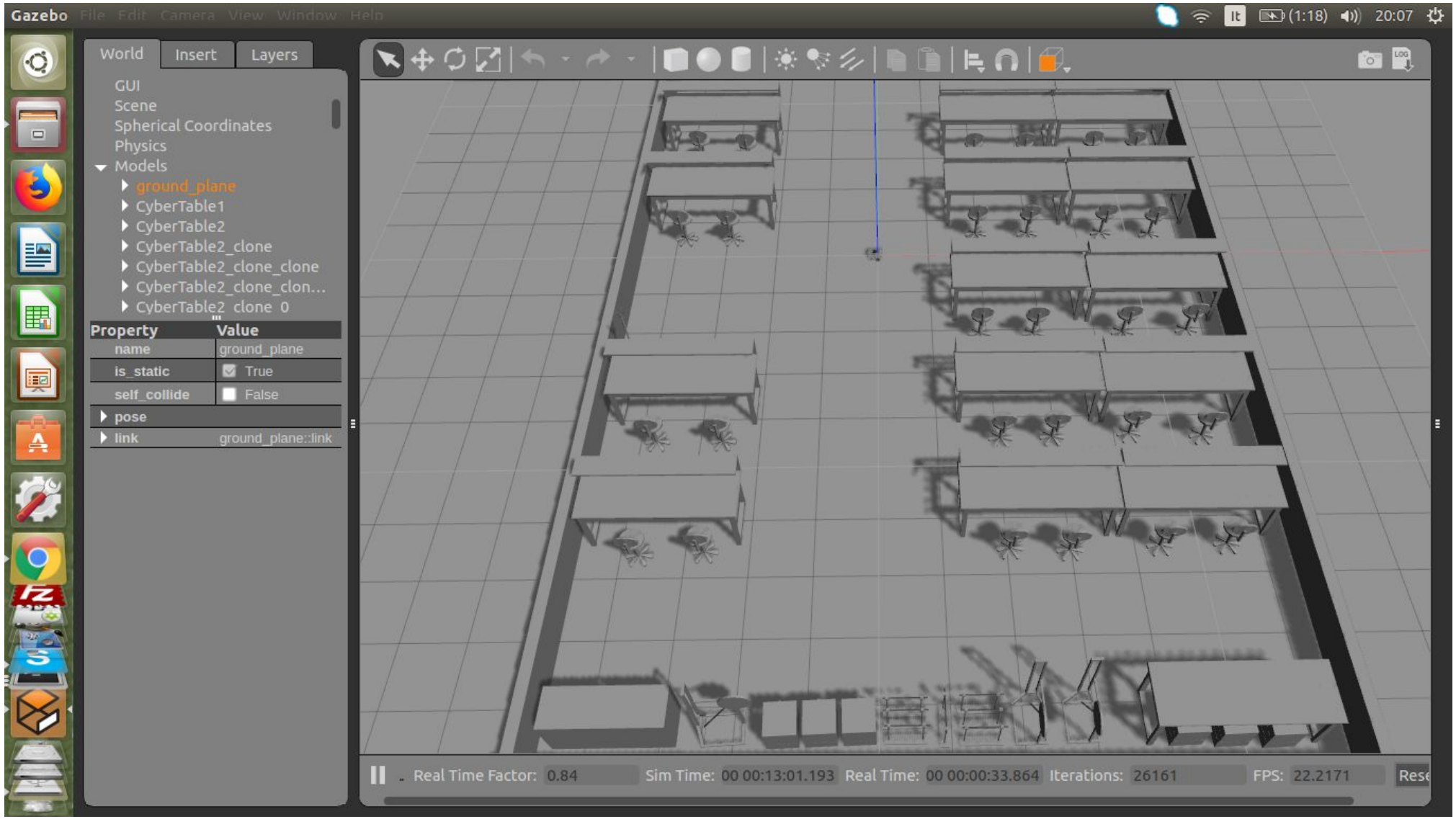
Esercizio – cyberlab



Esercizio – cyberlab



Esercizio – cyberlab



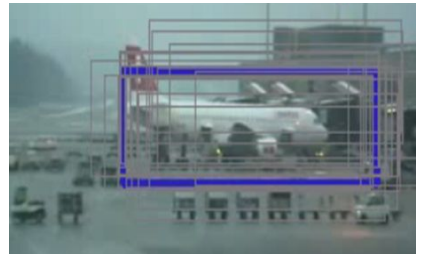
UNIVERSITÀ DEGLI STUDI DELLA BASILICATA

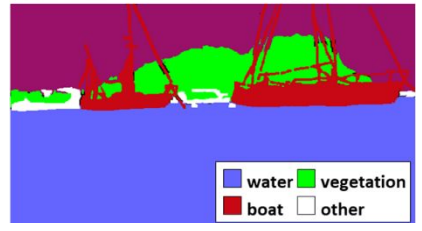


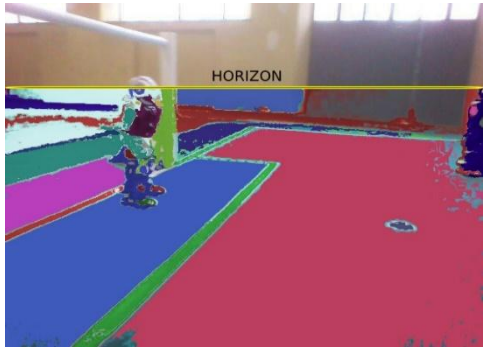
Corso di Sistemi Informativi
A.A. 2018/19

Docente
Domenico Daniele Bloisi

Simulatori








Maggio 2019