به‌نام‌خدا

دانشگاه صنعتی امیرکبیر
دانشکده مهندسی کامپیوتر

اصول علم ربات
استاد جوانمردی

تمرین سری اول

(جواب سولات تئوری و گزارش قسمت های عملی)

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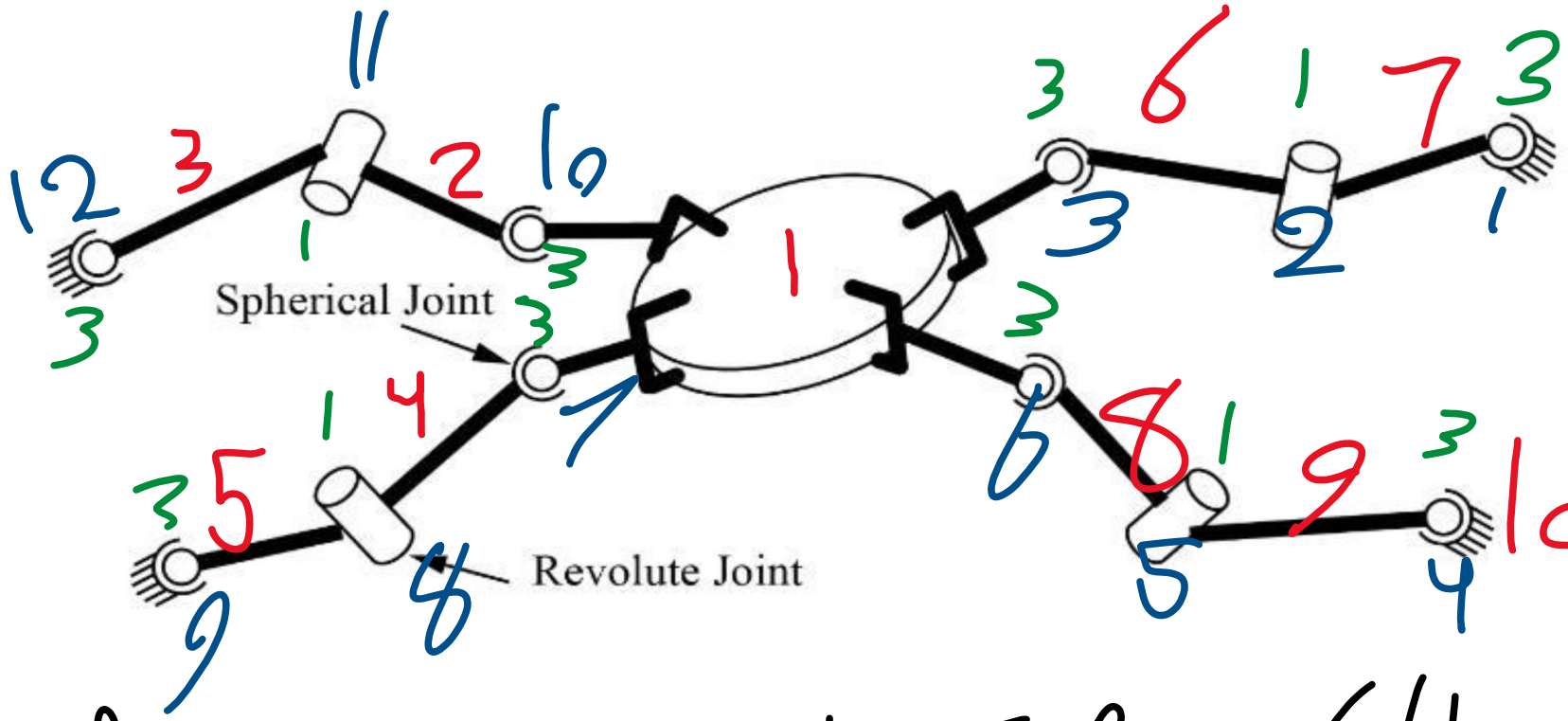
۹۸۳۱۰۲۵

فهرست

بخش تئوری) سوال اول

۱. ربات زیر از ۴ بازوی SRS تشکیل شده است که یک دیسک را نگه داشته‌اند. درجه آزادی آن را به دست آورید.

(راهنمایی: چهار مفصل واقع شده در چهار انتهای ربات به زمین متصل شده‌اند.) (بارم : ۵ امتیاز)



$m = 6$

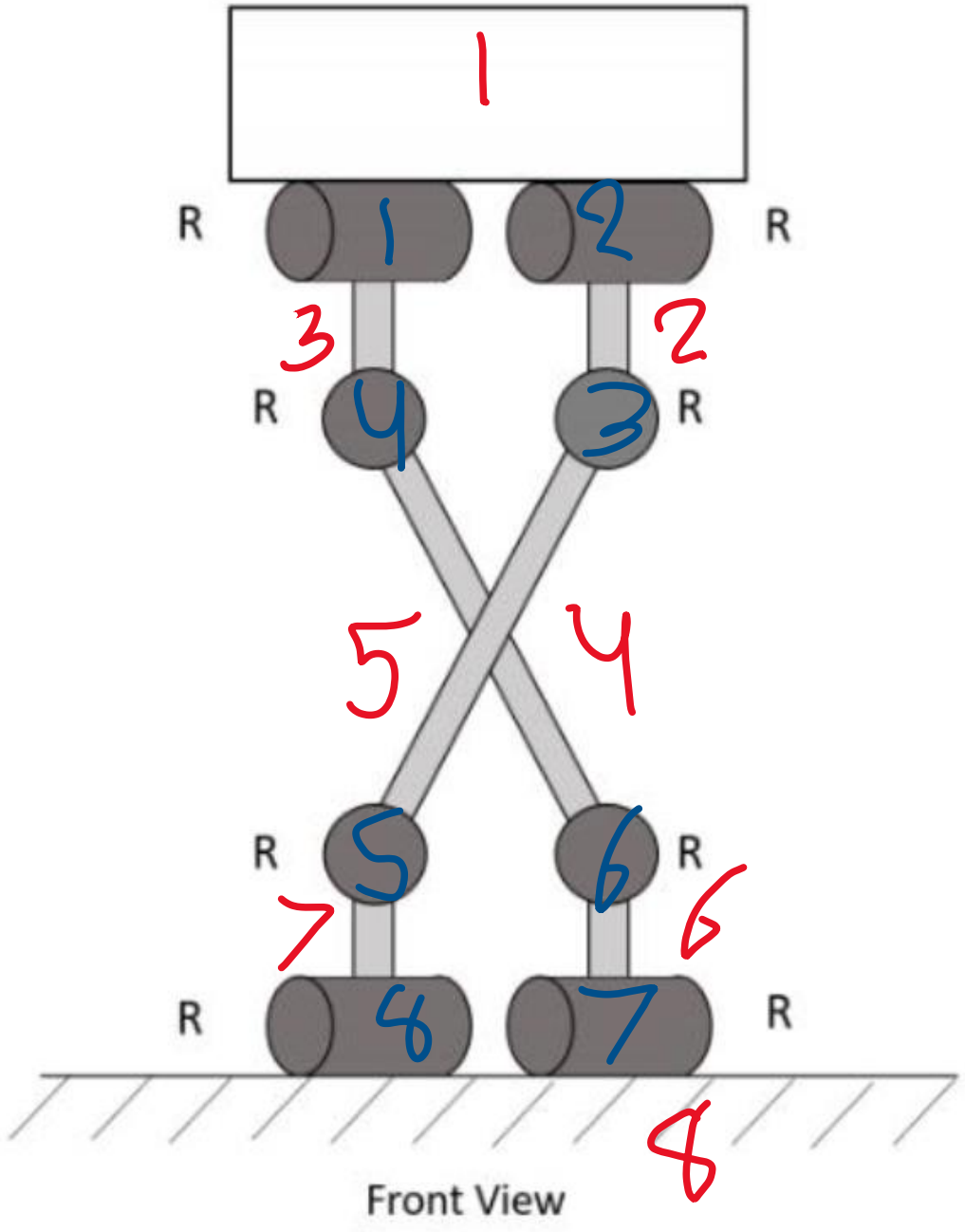
$N = 10$

$J = 12$

$\sum f_i = 28$

$dof = m(N-1-J) + \sum f_i = 6(10-1-12)+28$

$-18+28 = 10$



بخش تئوری) سوال دوم

برای ربات زیر درجه آزادی را به دست آورید.

$N = 8 \qquad J = 8$

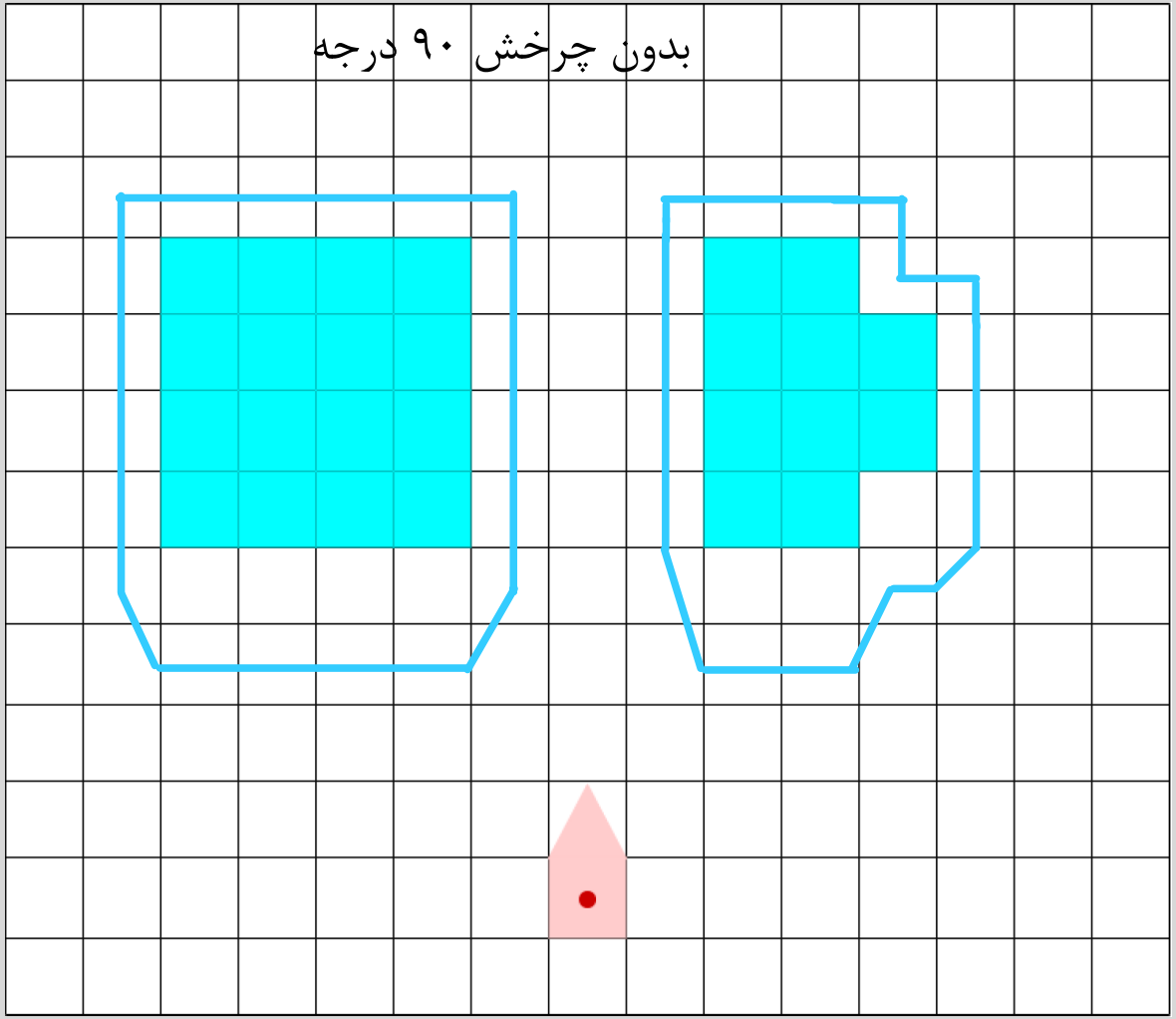
$f_1 = 1 \rightarrow \sum f_i = 8$

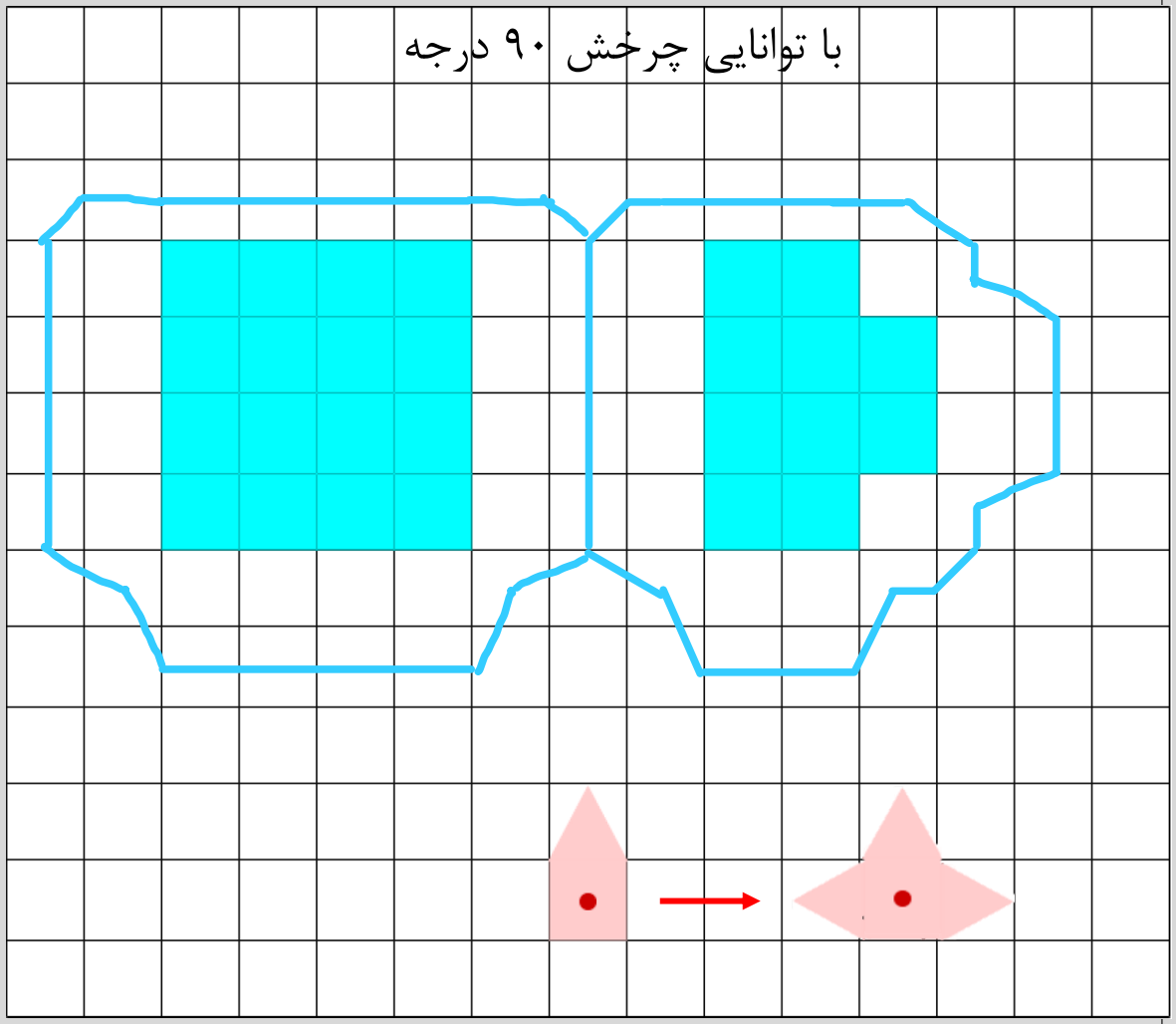
$m = 6$

$dof = 6(8-1-8) + 8$

$= -6 + 8 = \underline{2}$

بخش تئوری) سوال سوم برای ربات مشخص شده در تصویر زیر، C-space را مشخص کنید.





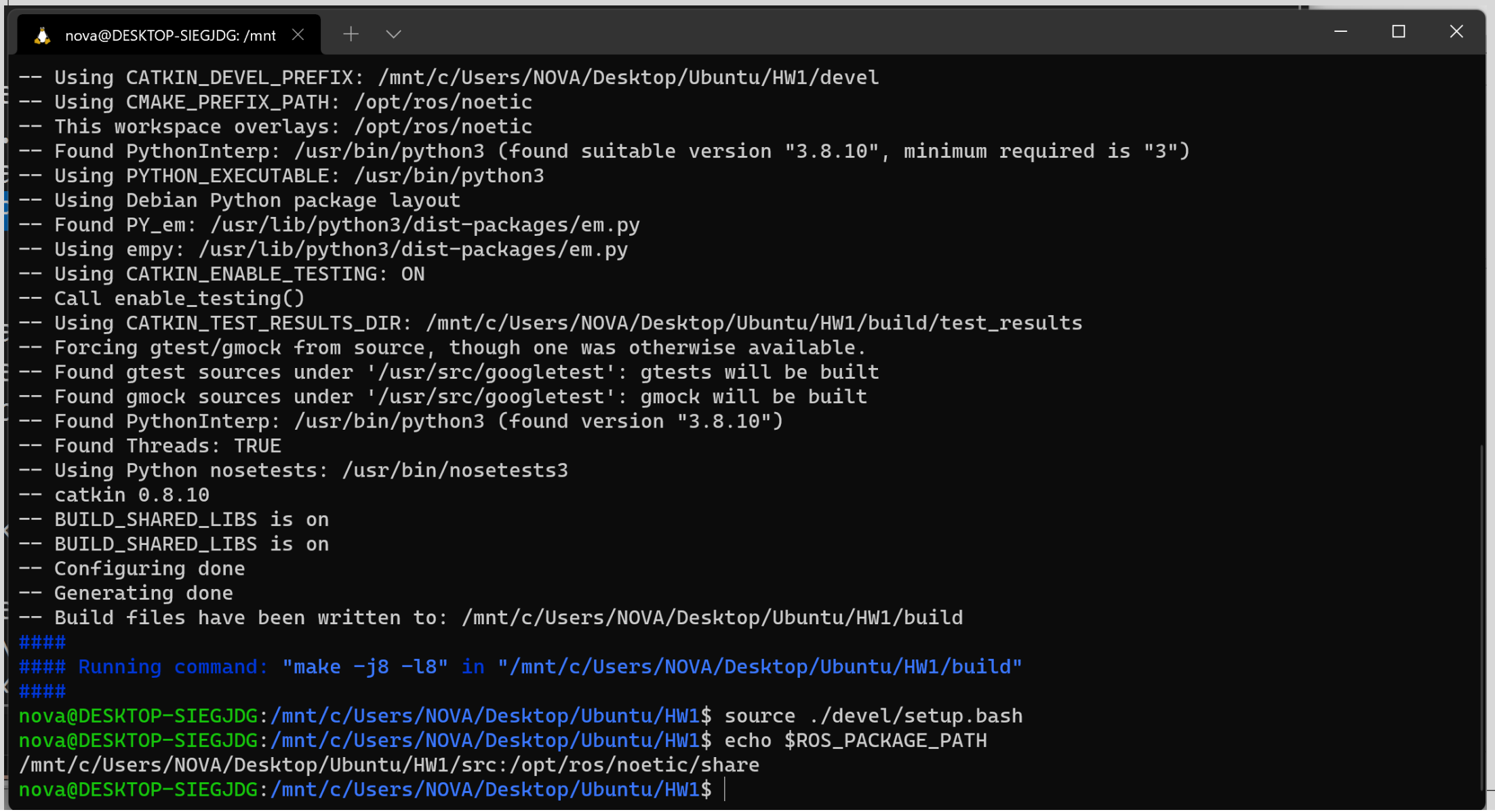
ربات روی مرز ها می تواند حرکت کند ولی درونشان نه

بخش شبیه‌سازی) گام اول

- نحوه شروع کار با ROS و ساخت یک work space

```
nova@DESKTOP-SIEGJDG: /mnt
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu$ mkdir HW1
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu$ cd HW1/
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ mkdir src
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ ls
src
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ catkin_make
Base path: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1
Source space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src
Build space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/build
Devel space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel
Install space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/install
Creating symlink "/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/CMakeLists.txt" pointing to "/opt/ros/noetic/share/catkin/cma
ke/toplevel.cmake"
####
#### Running command: "cmake /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src -DCATKIN_DEVEL_PREFIX=/mnt/c/Users/NOVA/Desktop/Ub
untu/HW1/devel -DCMAKE_INSTALL_PREFIX=/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/install -G Unix Makefiles" in "/mnt/c/Users/N
OVA/Desktop/Ubuntu/HW1/build"
####
-- The C compiler identification is GNU 9.4.0
-- The CXX compiler identification is GNU 9.4.0
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
-- Detecting C compile features
-- Detecting C compile features - done
-- Check for working CXX compiler: /usr/bin/c++
-- Check for working CXX compiler: /usr/bin/c++ -- works
-- Detecting CXX compiler ABI info
-- Detecting CXX compiler ABI info - done
```

بعد از ساخته شدن work space بوسیله دستور source مطمئن می شویم که از دستورات ROS در پروژه خودمان استفاده می کنیم

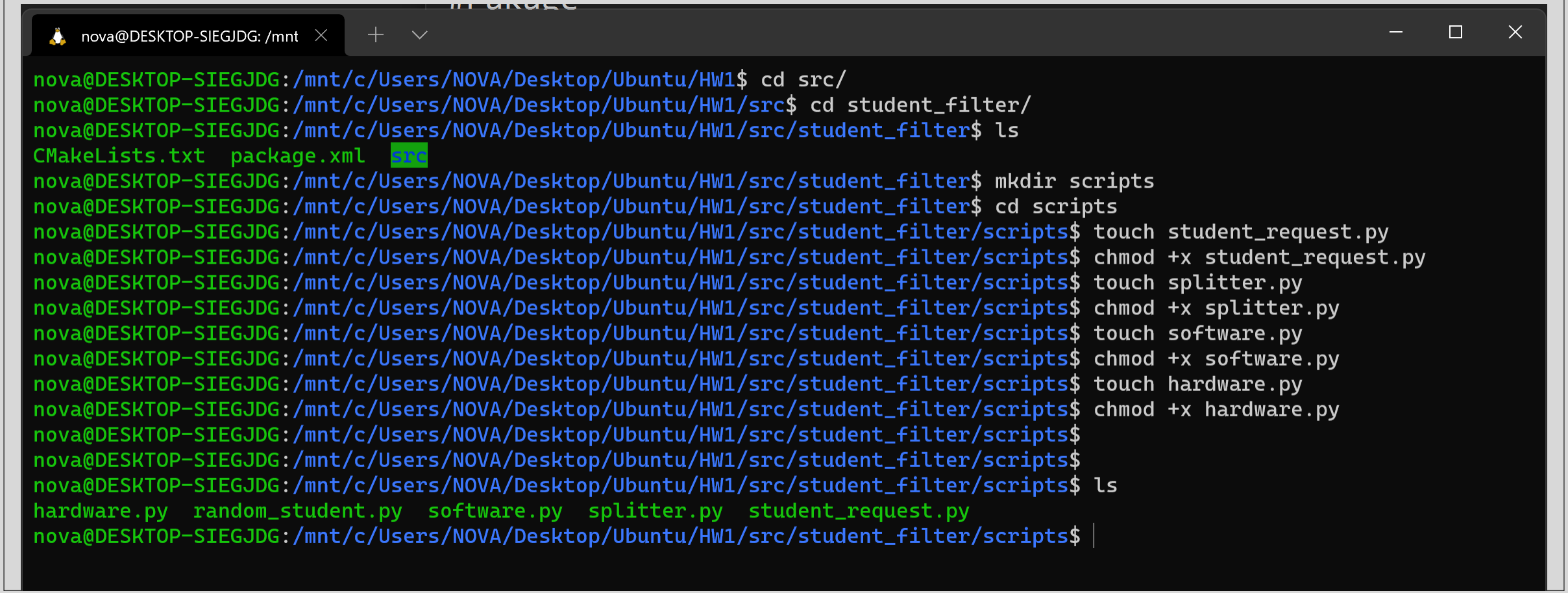


در مرحله بعد پکیج مورد نظرمون رو میسازیم

nova@DESKTOP-SIEGJDG: /mnt

```
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ cd src/
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ catkin_create_pkg student_filter rospy std_msgs
Created file student_filter/package.xml
Created file student_filter/CMakeLists.txt
Created folder student_filter/src
Successfully created files in /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter. Please adjust the values in packa
ge.xml.
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ cd ..
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ catkin_make
Base path: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1
Source space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src
Build space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/build
Devel space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel
Install space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/install
####
#### Running command: "cmake /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src -DCATKIN_DEVEL_PREFIX=/mnt/c/Users/NOVA/Desktop/Ub
untu/HW1/devel -DCMAKE_INSTALL_PREFIX=/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/install -G Unix Makefiles" in "/mnt/c/Users/N
OVA/Desktop/Ubuntu/HW1/build"
####
-- Using CATKIN_DEVEL_PREFIX: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel
-- Using CMAKE_PREFIX_PATH: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel;/opt/ros/noetic
-- This workspace overlays: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel;/opt/ros/noetic
-- Found PythonInterp: /usr/bin/python3 (found suitable version "3.8.10", minimum required is "3")
-- Using PYTHON_EXECUTABLE: /usr/bin/python3
-- Using Debian Python package layout
-- Using empy: /usr/lib/python3/dist-packages/em.py
-- Using CATKIN_ENABLE_TESTING: ON
-- Call enable_testing()
-- Using CATKIN_TEST_RESULTS_DIR: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/build/test_results
-- Forcing gtest/gmock from source, though one was otherwise available.
```

در مرحله بعد گره های مورد نظر را میسازیم و در آخر نیز فایل random_student.py را هم به آن ها اضافه میکنیم



در مرحله بعد فایلstudent.msg را میسازیم و پارامتر های آن را وارد میکنیم

random_student.py Student.msg

src > student_filter > msg > Student.msg

```
1   string name
2   string last_name
3   string departement
4   int32 age
```

nova@DESKTOP-SIEGJDG: /mnt

```
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$ cd src/
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ cd student_filter/
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter$ ls
CMakeLists.txt  package.xml  scripts  src
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter$ mkdir msg
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter$ cd msg/
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter/msg$ touch Student.msg
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src/student_filter/msg$ ls
Student.msg
```

بعد از ساخت فایل student.msg باید تغییراتی در فایل های package , Cmakelist ایجاد کرد و سپس catkin_make کرد

```
# Generate messages in the 'msg' folder
add_message_files(
  FILES
  Student.msg
)

## Generate services in the 'srv' folder
# add_service_files(
#   FILES
#   Service1.srv
#   Service2.srv
# )

## Generate actions in the 'action' folder
# add_action_files(
#   FILES
#   Action1.action
#   Action2.action
# )

# Generate added messages and services with any
generate_messages(
  DEPENDENCIES
  std_msgs
)
```

```
<!-- Use build_depend for packages you need at compi
  <build_depend>message_generation</build_depend>
<!-- Use build_export_depend for packages you need i
<!--   <build_export_depend>message_generation</buil
<!-- Use buildtool_depend for build tool packages: -
<!--   <buildtool_depend>catkin</buildtool_depend> -
<!-- Use exec_depend for packages you need at runtim
  <exec_depend>message_runtime</exec_depend>
<!-- Use test_depend for packages you need only for
<!--   <test_depend>gtest</test_depend> -->
<!-- Use doc_depend for packages you need only for b
<!--   <doc_depend>doxygen</doc_depend> -->
<buildtool_depend>catkin</buildtool_depend>
<build_depend>rospy</build_depend>
<build_depend>std_msgs</build_depend>
<build_export_depend>rospy</build_export_depend>
<build_export_depend>std_msgs</build_export_depend>
<exec_depend>rospy</exec_depend>
<exec_depend>std_msgs</exec_depend>
```

```
nova@DESKTOP-SIEGJDG: /mnt
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1$
 catkin_make
Base path: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1
Source space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src
Build space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/build
Devel space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/devel
Install space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/instal
l
####
#### Running command: "make cmake_check_build_system" in "
/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/build"
####
-- Using CATKIN_DEVEL_PREFIX: /mnt/c/Users/NOVA/Desktop/Ub
untu/HW1/devel
-- Using CMAKE_PREFIX_PATH: /mnt/c/Users/NOVA/Desktop/Ubun
tu/HW1/devel;/opt/ros/noetic
-- This workspace overlays: /mnt/c/Users/NOVA/Desktop/Ubun
tu/HW1/devel;/opt/ros/noetic
-- Found PythonInterp: /usr/bin/python3 (found suitable ve
rsion "3.8.10", minimum required is "3")
-- Using PYTHON_EXECUTABLE: /usr/bin/python3
-- Using Debian Python package layout
-- Using empy: /usr/lib/python3/dist-packages/em.py
-- Using CATKIN_ENABLE_TESTING: ON
-- Call enable_testing()
-- Using CATKIN_TEST_RESULTS_DIR: /mnt/c/Users/NOVA/Deskto
p/Ubuntu/HW1/build/test_results
-- Forcing gtest/gmock from source, though one was otherwi
se available.
-- Found gtest sources under '/usr/src/googletest': gtests
```

نوشتن و تست studend_request publisher

scripts > student_request.py > ...

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

import rospy
from student_filter.msg import Student
from random_student import randStudent


if __name__ == '__main__':
    rospy.init_node('student_request')
    rospy.loginfo('The node has been strated')
    pub = rospy.Publisher('std_request',Student,
    rate = rospy.Rate(1)

    while not rospy.is_shutdown():
        std = randStudent()
        pub.publish(std)
        rospy.loginfo(std.name)
        rate.sleep()

```

```
nova@DESKTOP-SIEGJDG: /mnt
core
... logging to /home/nova/.ros/log/be3ba71e
-aecb-11ec-b7f9-00155db24cc2/roslaunch-DESK
TOP-SIEGJDG-19593.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://DESKTOP-SIE
GJDG:44479/
ros_comm version 1.15.14


SUMMARY
========

PARAMETERS
 * /rosdistro: noetic
 * /rosversion: 1.15.14

NODES

auto-starting new master
```

```
nova@DESKTOP-SIEGJDG: /mnt
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA$ ros
run student_filter  student_request.py
[INFO] [1648495398.688353]: The node has be
en strated
[INFO] [1648495398.690089]: Sahar
[INFO] [1648495399.691477]: Akbar
[INFO] [1648495400.691600]: Karim
[INFO] [1648495401.691679]: Sahar
[INFO] [1648495402.691642]: Ahmad
[INFO] [1648495403.691589]: Karim
[INFO] [1648495404.691832]: Ali
[INFO] [1648495405.691597]: Ali
[INFO] [1648495406.691816]: Amir
[INFO] [1648495407.691760]: Maryam
[INFO] [1648495408.690997]: Aref
[INFO] [1648495409.691775]: Farhad
[INFO] [1648495410.690778]: Karim
[INFO] [1648495411.691687]: Mohsen
[INFO] [1648495412.691798]: Javad
[INFO] [1648495413.691717]: Mohsen
[INFO] [1648495414.691810]: Mohammad
[INFO] [1648495415.691363]: Maryam
[INFO] [1648495416.691780]: Akbar
[INFO] [1648495417.691795]: Ahmad
[INFO] [1648495418.691792]: Farhad
```

نوشتن و تست گره splitter که پیام دریافتی از تاپیک std_request را جداسازی و به تاپیک های hardware و software ارسال می کند

```python
import rospy
from student_filter.msg import Student

def splite(std):
    # rospy.loginfo(std.name + " "+ std.departement)
    pubs = rospy.Publisher('software',Student,queue_size=10)
    pubh = rospy.Publisher('hardware',Student,queue_size=10)


    if std.departement == "Hardware":
        pubh.publish(std)
    else:
        pubs.publish(std)

    rospy.loginfo(std.name + " "+ std.departement)


if __name__ == '__main__':
    rospy.init_node('splitter')
    rospy.loginfo('The node has been strated')
    rospy.Subscriber('std_request',Student,callback=splite)
    rospy.spin()
```

```
roscore htt | nova@DESI | nova@DESI | nova@DESI

nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA$ rosrun student_filter splitter.py
[INFO] [1648498911.828757]: The node has been strated
[INFO] [1648498912.566358]: Mohammad Software
[INFO] [1648498913.562227]: Amir Hosein Software
[INFO] [1648498914.562686]: Siamak Hardware
[INFO] [1648498915.563012]: Maryam Hardware
[INFO] [1648498916.562992]: Ahmad Hardware
[INFO] [1648498917.562654]: Aref Software
[INFO] [1648498918.562135]: Soroush Software
[INFO] [1648498919.562013]: Mohammad Hardware
[INFO] [1648498920.562348]: Karim Hardware
[INFO] [1648498921.562634]: Sahar Hardware
[INFO] [1648498922.562399]: Farhad Hardware
[INFO] [1648498923.561809]: Sahar Hardware
[INFO] [1648498924.562634]: Amir Software
[INFO] [1648498925.562656]: Akbar Hardware
[INFO] [1648498926.562829]: Aref Hardware
[INFO] [1648498927.562156]: Mehran Software
[INFO] [1648498928.562068]: Karim Hardware
[INFO] [1648498929.562616]: Javad Software
[INFO] [1648498930.562085]: Fatemeh Software
[INFO] [1648498931.562349]: Radin Hardware
[INFO] [1648498932.562236]: Sahar Hardware
[INFO] [1648498933.562428]: Reza Hardware
[INFO] [1648498934.561947]: Farhad Hardware
[INFO] [1648498935.562116]: Maryam Hardware
[INFO] [1648498936.562222]: Mehran Software
[INFO] [1648498937.562648]: Ali Hardware
[INFO] [1648498938.562323]: Ahmad Software
[INFO] [1648498939.562776]: Karim Software
```

در قسمت آخر نیز کد مربوط به گره های hardware و software را کامل می کنیم و سپس تست میگیریم و گراف گره و تاپیک آن را رسم میکنیم (اسلاید بعد)

scripts > hardware.py > ...

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


import rospy
from student_filter.msg import Student

def splite(std):
    rospy.loginfo("name:"+std.name + " "+std.last_name

if __name__ == '__main__':
    rospy.init_node('hardware')
    rospy.loginfo('The node has been strated')
    rospy.Subscriber('hardware',Student,callback=split
    rospy.spin()
```

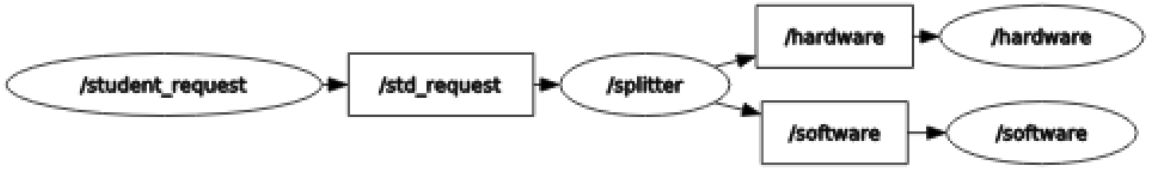
scripts > software.py > ...

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


import rospy
from student_filter.msg import Student

def splite(std):
    rospy.loginfo("name:"+std.name + " "+std.last_name

if __name__ == '__main__':
    rospy.init_node('software')
    rospy.loginfo('The node has been strated')
    rospy.Subscriber('software',Student,callback=split
    rospy.spin()
```



nova@DESKTOP-SIEGJDG: /mnt

```
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA$ rosrun student_filter hardware.py
[INFO] [1648499780.720490]: The node has been strated
[INFO] [1648499781.210917]: name:Aria Kashfi age:26 , Hardware
[INFO] [1648499785.211484]: name:Ali Hashemi age:23 , Hardware
[INFO] [1648499787.211912]: name:Sahar Hoseini age:68 , Hardware
[INFO] [1648499791.210868]: name:Siamak Hashemi age:57 , Hardware
[INFO] [1648499792.211044]: name:Saman Hoseini age:70 , Hardware
[INFO] [1648499796.211211]: name:Ramin Karimi age:32 , Hardware
[INFO] [1648499800.211030]: name:Mohsen Eslami age:49 , Hardware
[INFO] [1648499802.210584]: name:Reza Ghasemi age:69 , Hardware
[INFO] [1648499807.210239]: name:Radin Ansari age:40 , Hardware
[INFO] [1648499808.211693]: name:Akbar Modiri age:38 , Hardware
[INFO] [1648499813.210099]: name:Mehran Ansari age:61 , Hardware
[INFO] [1648499817.211497]: name:Karim Karimi age:34 , Hardware
[INFO] [1648499819.210124]: name:Aria Fallah age:21 , Hardware
[INFO] [1648499824.212011]: name:Sahar Pormokhber age:70 , Hardware
[INFO] [1648499831.210107]: name:Mohsen Sheikhi age:57 , Hardware
[INFO] [1648499832.210102]: name:Mohammad Reza Kashfi age:68 , Hardware
[INFO] [1648499835.210488]: name:Amir Ansari age:22 , Hardware
[INFO] [1648499836.211049]: name:Sahar Kabiri age:37 , Hardware
[INFO] [1648499842.210549]: name:Saman Ghafori age:62 , Hardware
[INFO] [1648499844.210527]: name:Radin Hoseini age:57 , Hardware
[INFO] [1648499845.209897]: name:Aria Fallah age:35 , Hardware
[INFO] [1648499846.210333]: name:Aref Pormokhber age:44 , Hardware
[INFO] [1648499852.210001]: name:Reza Pormokhber age:21 , Hardware
[INFO] [1648499860.210064]: name:Reza Kashfi age:32 , Hardware
[INFO] [1648499862.210057]: name:Mohammad Reza Ghasemi age:44 , Hardware
[INFO] [1648499865.210224]: name:Ali Kazemi age:51 , Hardware
[INFO] [1648499867.210150]: name:Siamak Akbari age:44 , Hardware
[INFO] [1648499868.210758]: name:Reza Majidi age:35 , Hardware
```

nova@DESKTOP-SIEGJDG: /mnt

```
^Cnova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA$ rosrun student_filter software.py
[INFO] [1648499768.083834]: The node has been strated
[INFO] [1648499768.211019]: name:Fatemeh Ansari age:31 , Software
[INFO] [1648499771.211807]: name:Aref Kabiri age:36 , Software
[INFO] [1648499773.211458]: name:Reza Majidi age:54 , Software
[INFO] [1648499775.211357]: name:Siamak Eslami age:69 , Software
[INFO] [1648499777.211751]: name:Aria Hoseini age:25 , Software
[INFO] [1648499778.211796]: name:Ahmad Eslami age:46 , Software
[INFO] [1648499780.209693]: name:Aria Kashfi age:70 , Software
[INFO] [1648499782.211389]: name:Akbar Ansari age:20 , Software
[INFO] [1648499783.211927]: name:Soroush Hoseini age:65 , Software
[INFO] [1648499784.211405]: name:Fatemeh Akbari age:56 , Software
[INFO] [1648499786.211646]: name:Ahmad Pormokhber age:53 , Software
[INFO] [1648499788.211627]: name:Siamak Hoseini age:70 , Software
[INFO] [1648499789.211602]: name:Ramin Hoseini age:63 , Software
[INFO] [1648499790.211490]: name:Soroush Ghafori age:61 , Software
[INFO] [1648499793.211723]: name:Maryam Fallah age:34 , Software
[INFO] [1648499794.213905]: name:Farhad Kazemi age:47 , Software
[INFO] [1648499795.210610]: name:Fatemeh Ghafori age:69 , Software
[INFO] [1648499797.210615]: name:Karim Ghasemi age:38 , Software
[INFO] [1648499798.210724]: name:Aref Hoseini age:46 , Software
[INFO] [1648499799.210733]: name:Mehran Akbari age:50 , Software
[INFO] [1648499801.210797]: name:Soroush Hoseini age:28 , Software
[INFO] [1648499803.212045]: name:Ali Fallah age:60 , Software
[INFO] [1648499804.211394]: name:Fatemeh Ghafori age:51 , Software
[INFO] [1648499805.212370]: name:Maryam Hoseini age:44 , Software
[INFO] [1648499806.211907]: name:Mehran Majidi age:20 , Software
[INFO] [1648499809.210848]: name:Mehran Hashemi age:47 , Software
[INFO] [1648499810.210455]: name:Siamak Akbari age:22 , Software
[INFO] [1648499811.212432]: name:Ali Ansari age:40 , Software
```

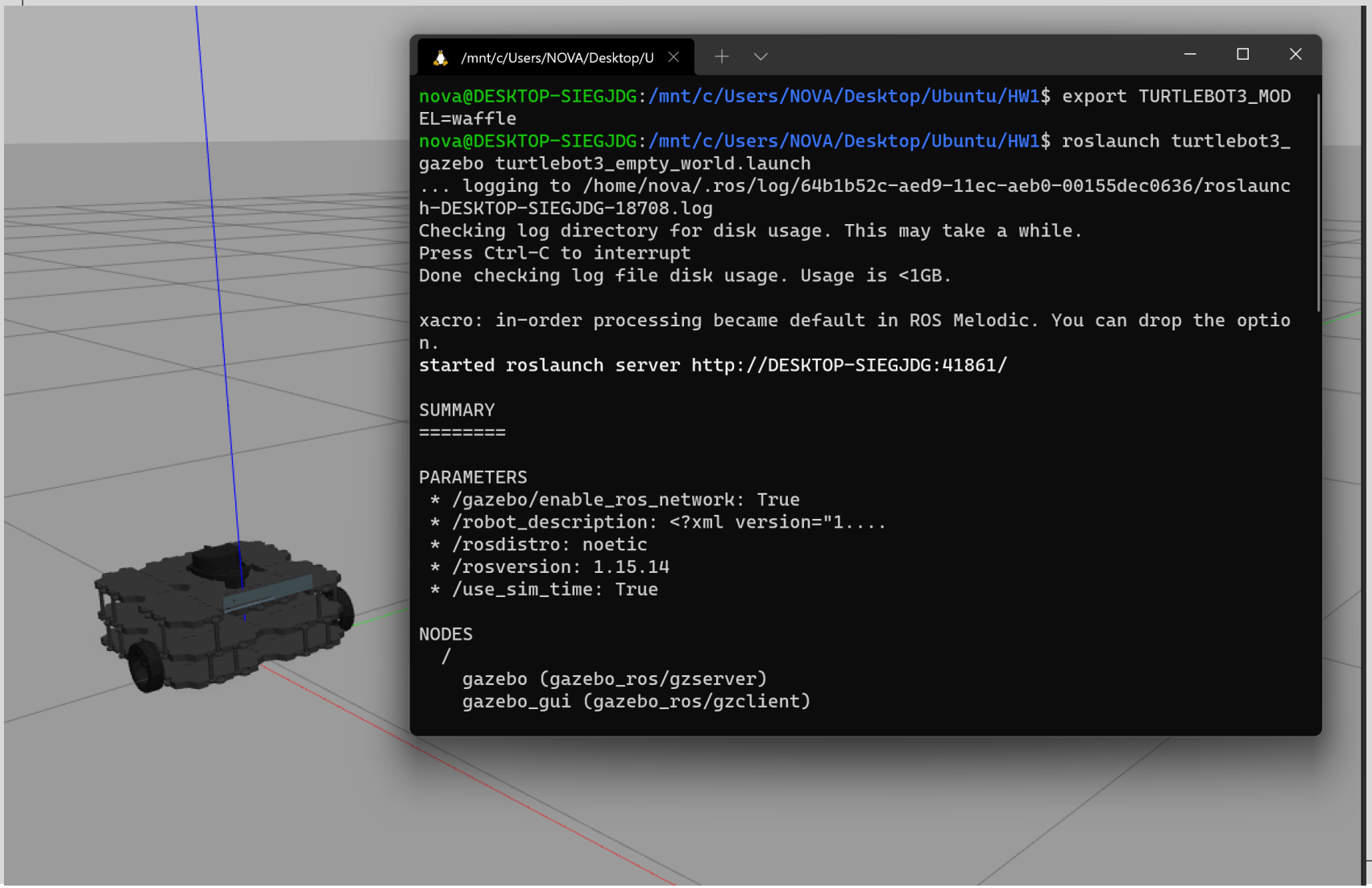
بخش شبیه‌سازی) گام دوم

دانلود پکیج های مربوطه و اضافه کردن پکیج های آن به پروژه

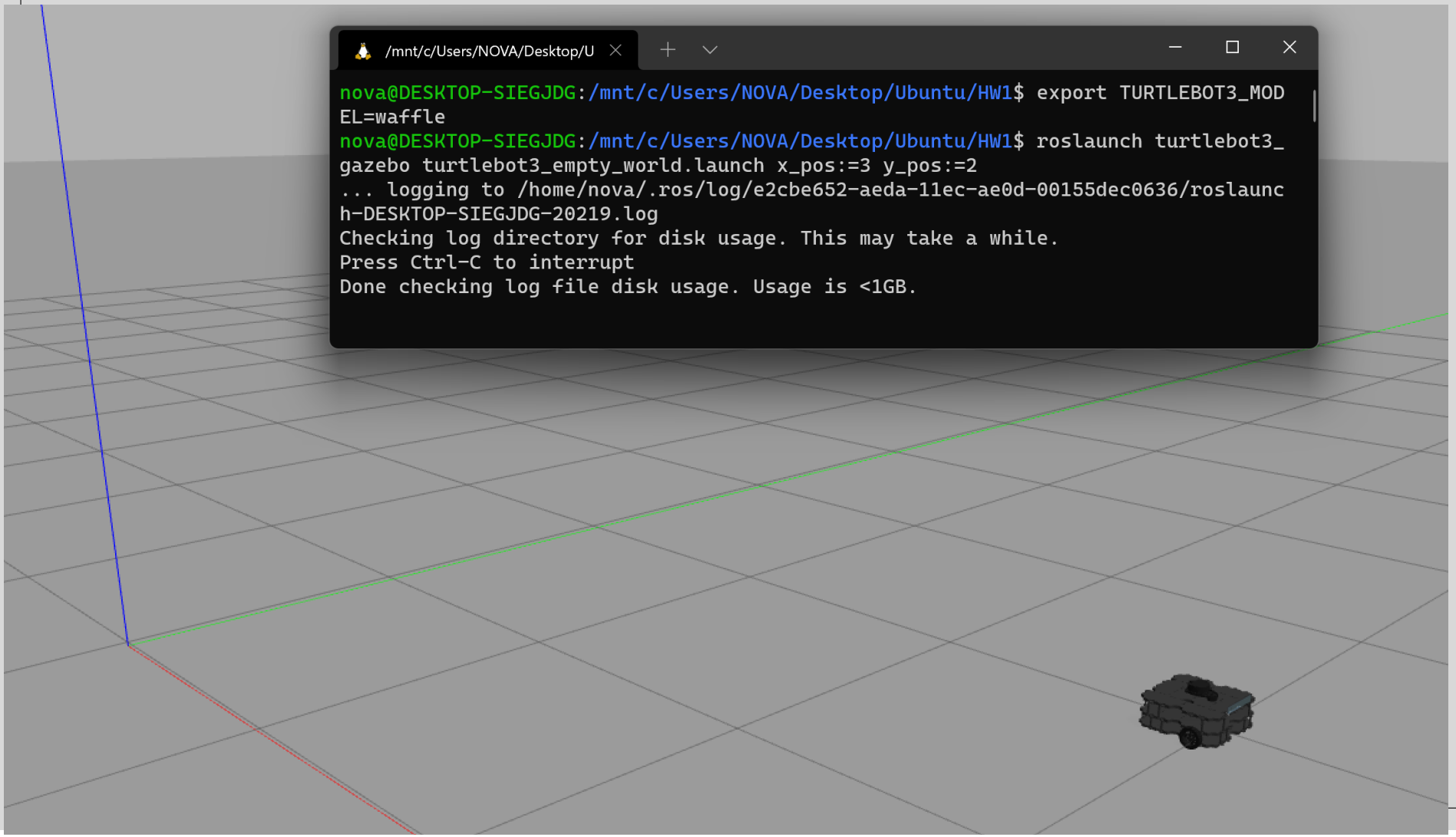
nova@DESKTOP-SIEGJDG: /mnt

```
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ git clone -b noetic-devel https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git
Cloning into 'turtlebot3_simulations'...
remote: Enumerating objects: 2959, done.
remote: Counting objects: 100% (572/572), done.
remote: Compressing objects: 100% (241/241), done.
remote: Total 2959 (delta 317), reused 511 (delta 286), pack-reused 2387
Receiving objects: 100% (2959/2959), 15.36 MiB | 654.00 KiB/s, done.
Resolving deltas: 100% (1685/1685), done.
Updating files: 100% (179/179), done.
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ git clone -b noetic-devel https://github.com/ROBOTIS-GIT/turtlebot3.git
Cloning into 'turtlebot3'...
remote: Enumerating objects: 6160, done.
remote: Counting objects: 100% (430/430), done.
remote: Compressing objects: 100% (302/302), done.
remote: Total 6160 (delta 244), reused 211 (delta 103), pack-reused 5730
Receiving objects: 100% (6160/6160), 119.88 MiB | 823.00 KiB/s, done.
Resolving deltas: 100% (3819/3819), done.
Updating files: 100% (127/127), done.
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ git clone -b noetic-devel https://github.com/ROBOTIS-GIT/turtlebot3_msgs.git
Cloning into 'turtlebot3_msgs'...
remote: Enumerating objects: 394, done.
remote: Counting objects: 100% (152/152), done.
remote: Compressing objects: 100% (65/65), done.
remote: Total 394 (delta 56), reused 125 (delta 37), pack-reused 242
Receiving objects: 100% (394/394), 88.16 KiB | 668.00 KiB/s, done.
Resolving deltas: 100% (157/157), done.
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src$ cd .. && catkin_make
Base path: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1
Source space: /mnt/c/Users/NOVA/Desktop/Ubuntu/HW1/src
```

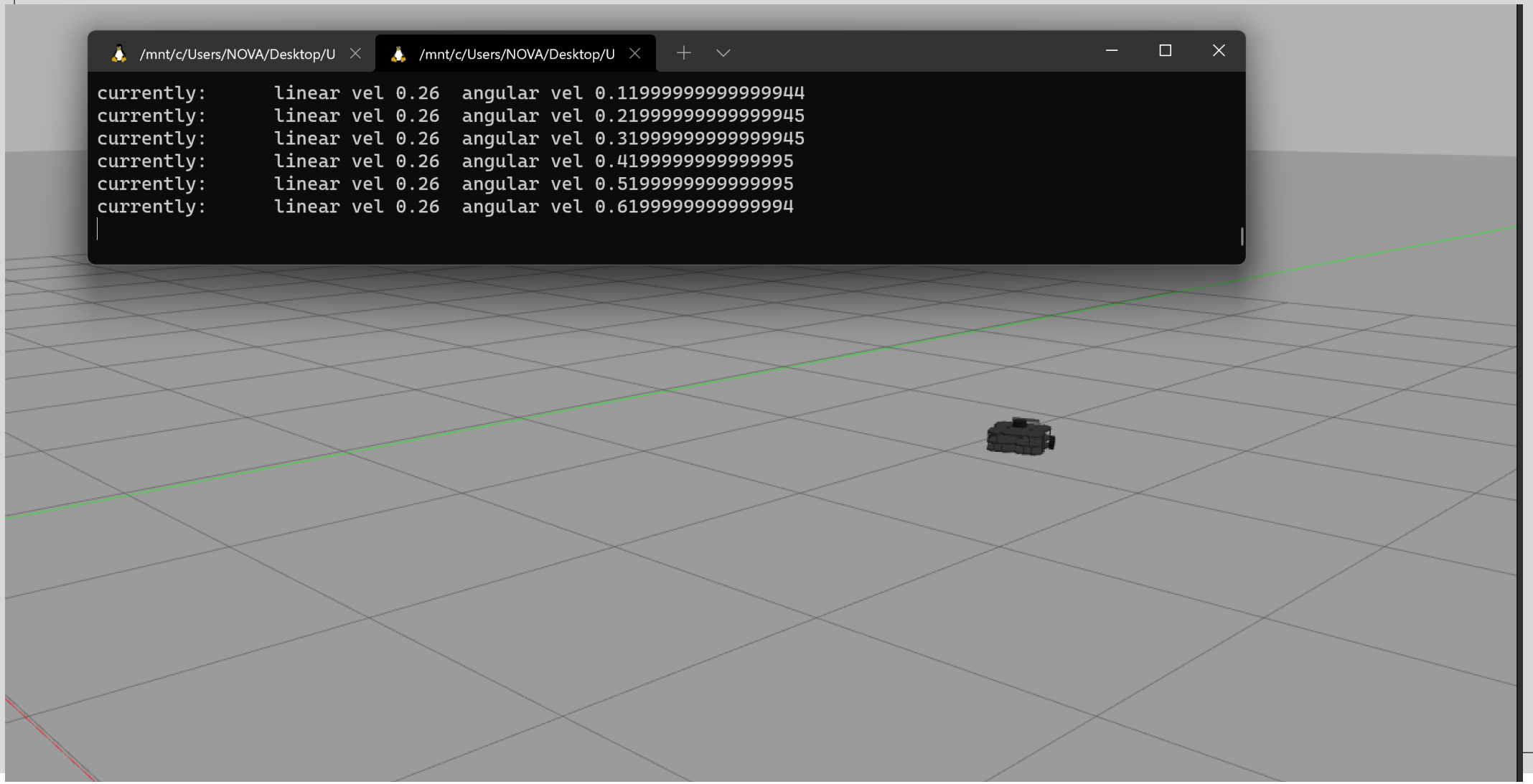
اجرای turtlebot3 در محیط gazebo



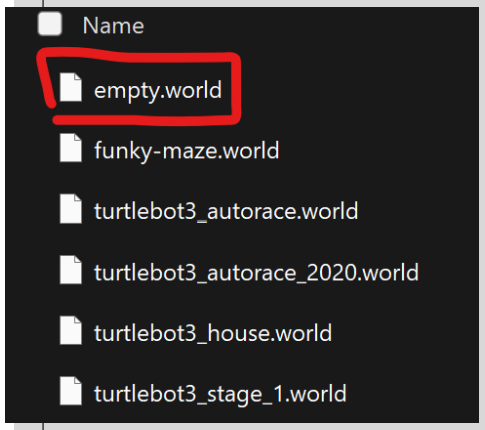
اجرا و قرار دادن مختصات اولیه ربات در نقطه (3,2)

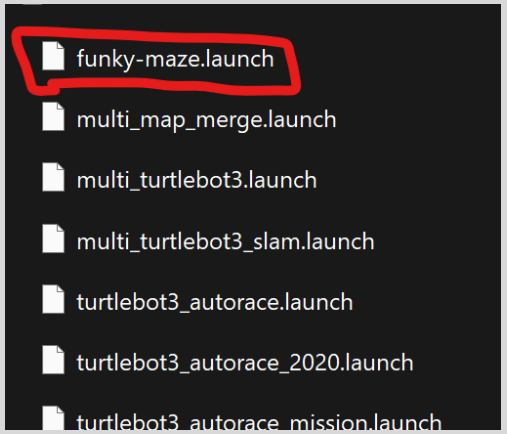


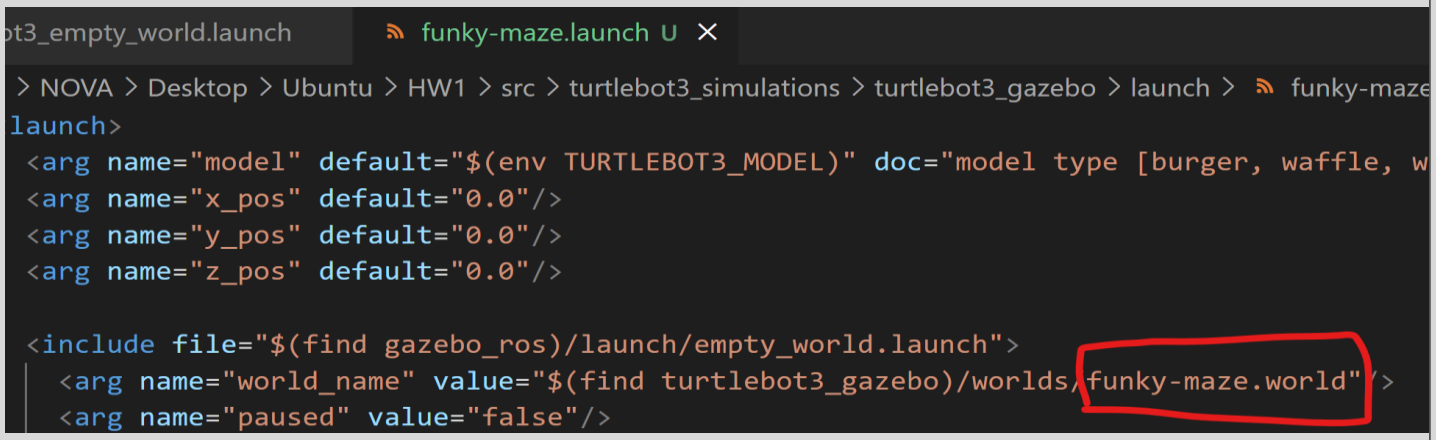
حرکت ربات بوسیله اجرای teleoperation

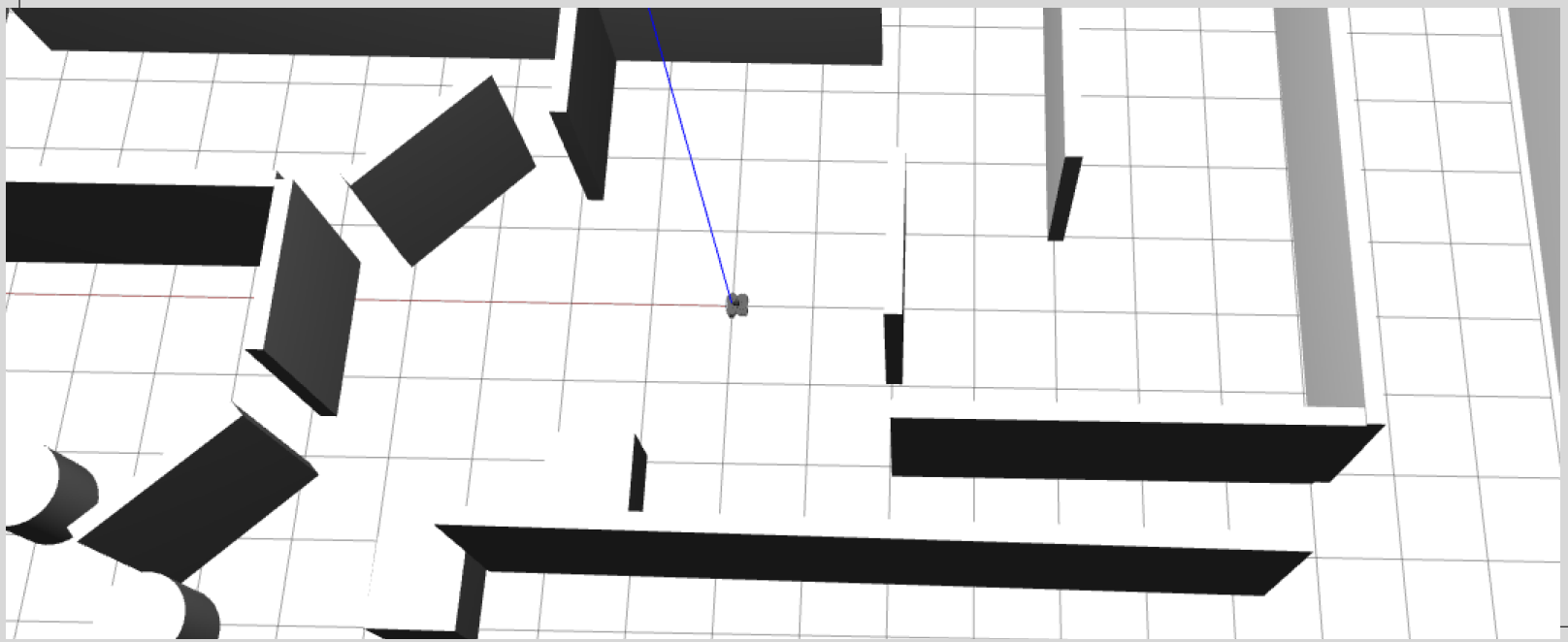


اجرای funky-maze.world



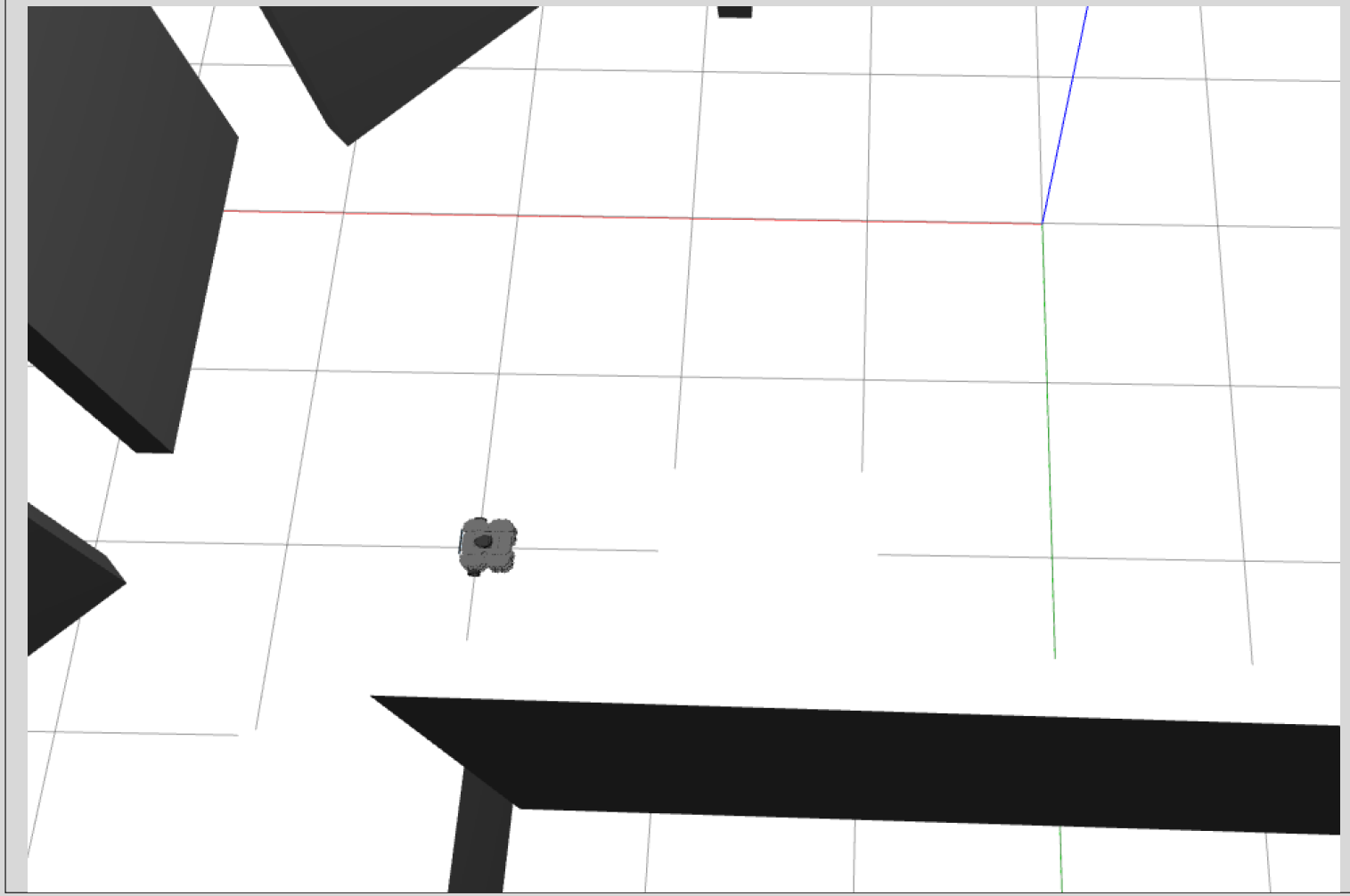






اجرا و قرار دادن مختصات اولیه ربات در نقطه (۳,۲)

```
nova@DESKTOP-SIEGJDG:/mnt/c/Users/NOVA$ roslaunch turtlebot3_gazebo funky-maze.launch x_pos:=3 y_pos:=2
```



حرکت ربات بوسیله اجرای teleoperation

Thank you 

Mohammad Javad Rajabi
9831025