<u>CS210 : ARTIFICIAL INTELLIGENCE LAB</u>

LAB ASSIGNMENT 3: AI & Python

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Semester: 4th Sem

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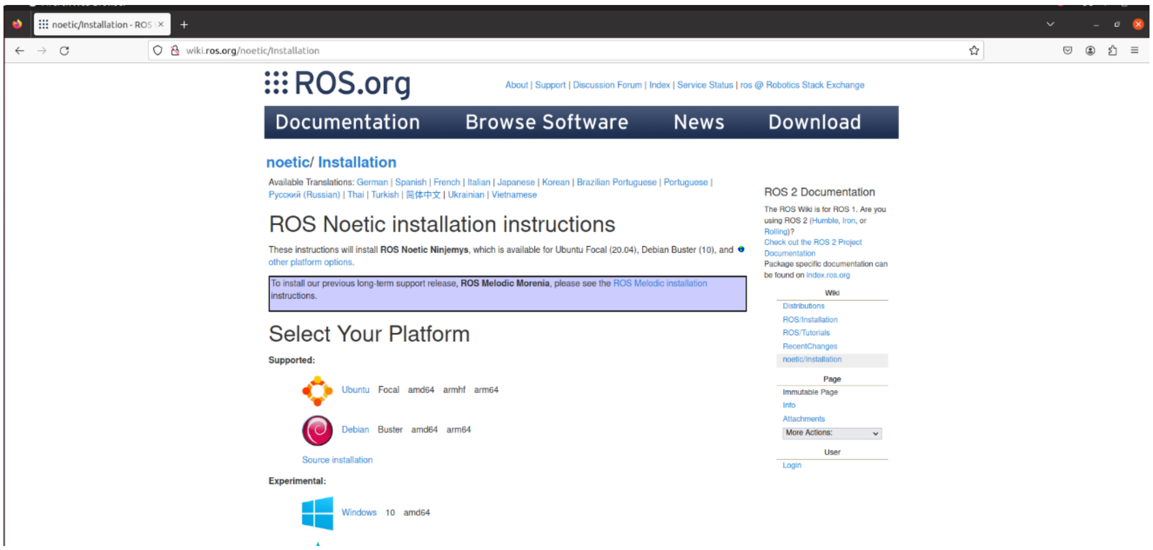
1. Robot Operating System (ROS) is an open source software development kit for robotics applications. ROS offers a standard software platform to developers across industries that will carry them from research and prototyping all the way through to deployment and production. Install the ROS 1 in your system as discussed in the LAB. (Help File). Mention the steps in Installation and Configuration.

   Step 1 : open browser and search ros noetic

Step 2 : ROS Noetic Ninjemys -> Installation -> Ubuntu

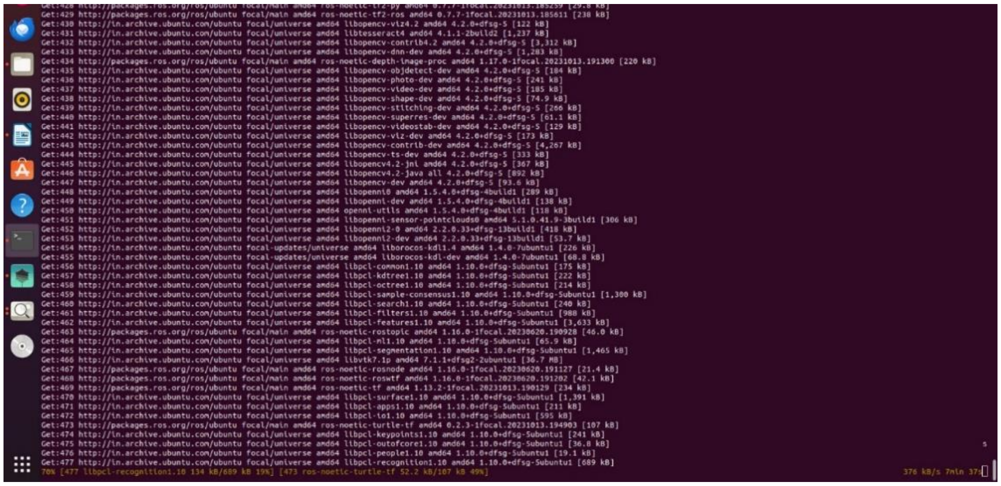


Step 3 : setup source.list

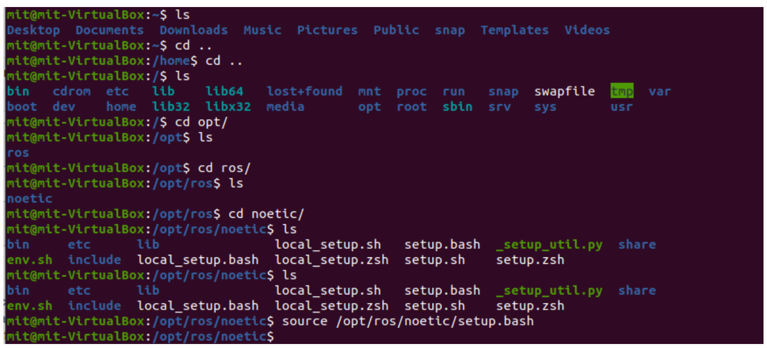
Step 4 : setup keys

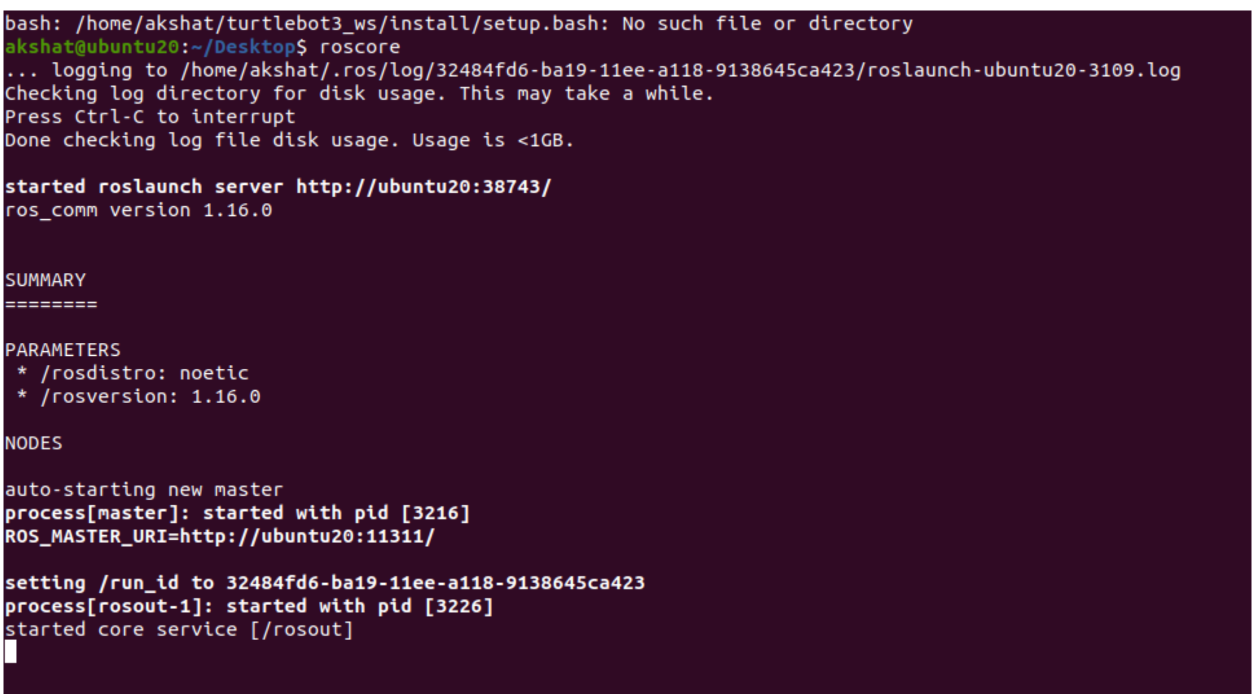
Step 5 : Installation

Step 6 Sudo apt install ros-noetic-desktop-full



Step 7 : set up environment



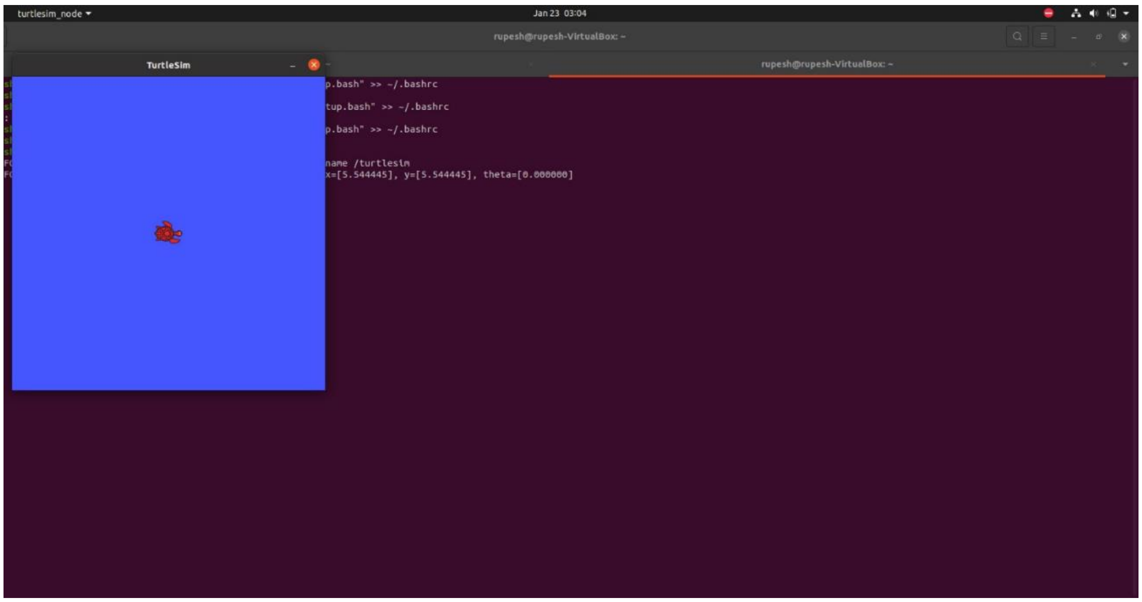


Step 8: echo "source /opt/ros/noetic/setup.bash" >> ~/.bashrc

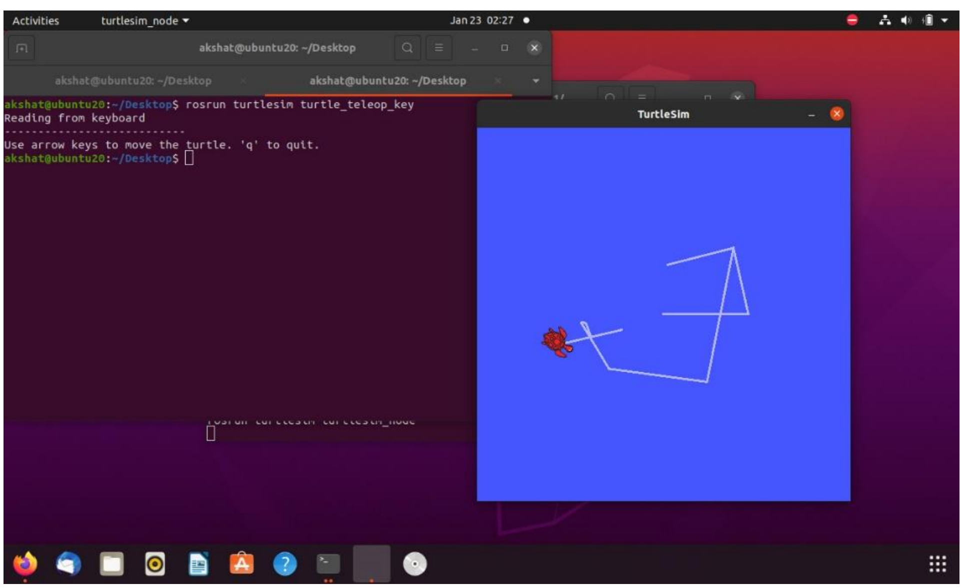
2.Execute the turtlesim node as discussed in LAB to control the Turtlesim by terminal and python script; and implement the basics of 2D navigation.

Explore the ROS Basic Commands : roscore, rosrun, rosnode and rostopic.

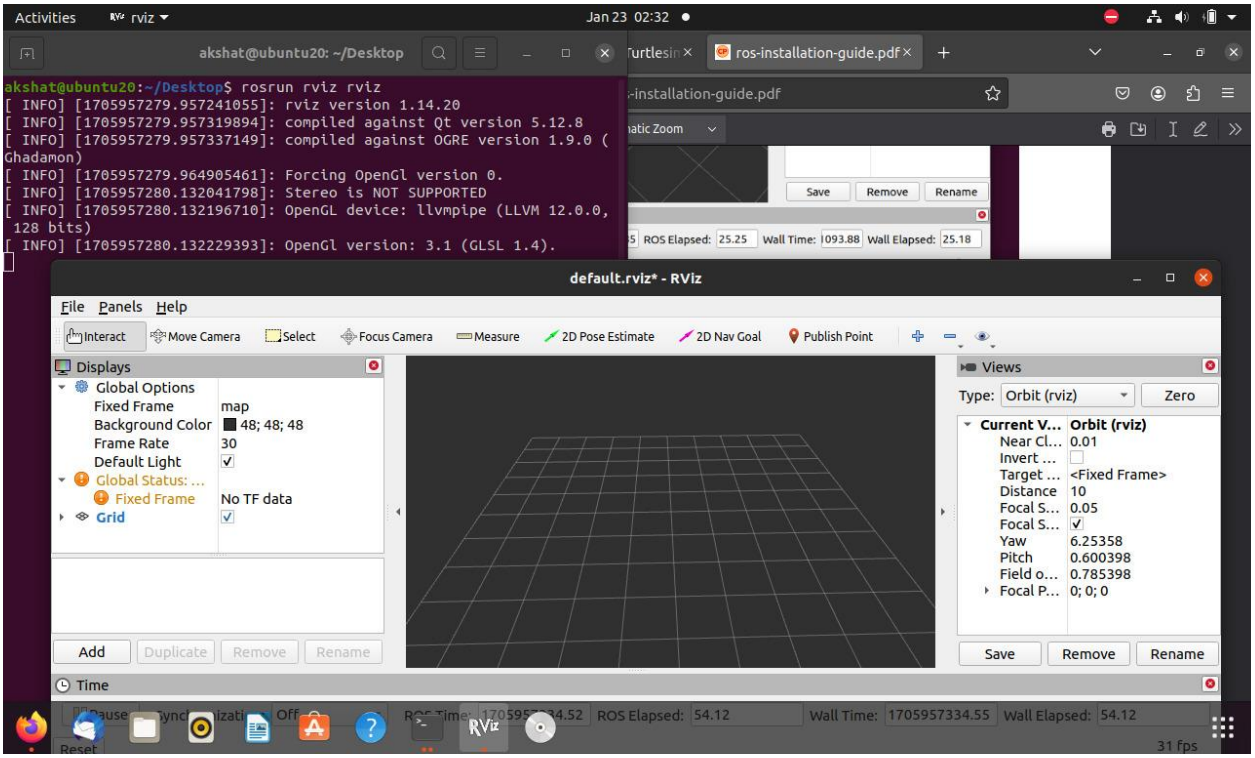
1. open terminal and run roscore stack : master roscore
2. open new terminal and run command **rosrun**
   rosrun turtlelism turtlelism_node



Moving the turtle



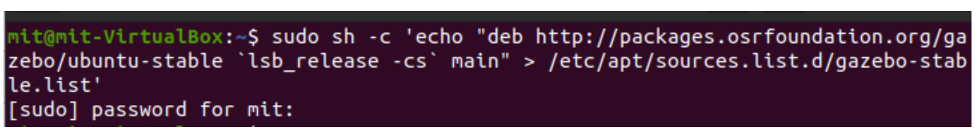
Rviz



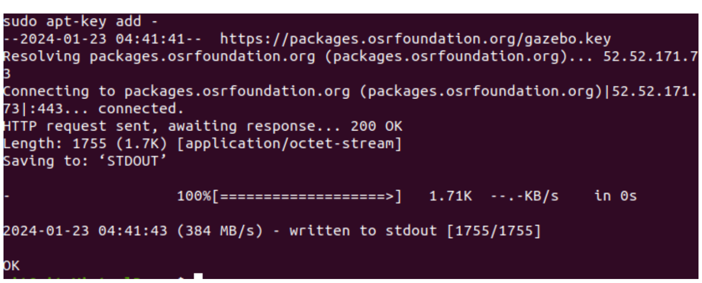
1. Install Gazebo in your system and mention the steps in installation and configuration.

Step 1 : Setup your computer to accept software from packages.osrfoundation.org.

```
sudo sh -c 'echo "deb http://packages.osrfoundation.org/gazebo/ubuntu-stable `lsb_rel
ease -cs` main" > /etc/apt/sources.list.d/gazebo-stable.list'
```




```
wget https://packages.osrfoundation.org/gazebo.key -O - | sudo apt-key add -
```



Step 3 : Install Gazebo.

```
Get:1 http://security.ubuntu.com/ubuntu focal-security InRelease [114 kB]
Hit:2 http://in.archive.ubuntu.com/ubuntu focal InRelease
Get:3 http://in.archive.ubuntu.com/ubuntu focal-updates InRelease [114 kB]
Get:4 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal InRelease [4,279 B]
Get:5 http://security.ubuntu.com/ubuntu focal-security/restricted amd64 Packages [2,462 kB]
Hit:6 http://packages.ros.org/ros/ubuntu focal InRelease
Hit:7 http://in.archive.ubuntu.com/ubuntu focal-backports InRelease
Get:8 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main i386 Packages [40.0 kB]
Get:9 http://in.archive.ubuntu.com/ubuntu focal-updates/main amd64 Packages [3,030 kB]
Get:10 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main amd64 Packages [134 kB]
Get:11 http://in.archive.ubuntu.com/ubuntu focal-updates/main i386 Packages [920 kB]
Get:12 http://in.archive.ubuntu.com/ubuntu focal-updates/universe amd64 Packages [1,155 kB]
Get:13 http://in.archive.ubuntu.com/ubuntu focal-updates/universe i386 Packages [768 kB]
Get:14 http://in.archive.ubuntu.com/ubuntu focal-updates/multiverse i386 Packages [8,456 B]
Get:15 http://in.archive.ubuntu.com/ubuntu focal-updates/multiverse amd64 Packages [26.1 kB]
Get:16 http://security.ubuntu.com/ubuntu focal-security/restricted i386 Packages [35.5 kB]
Get:17 http://security.ubuntu.com/ubuntu focal-security/restricted Translation-en [343 kB]
Get:18 http://security.ubuntu.com/ubuntu focal-security/multiverse amd64 Packages [23.9 kB]
Fetched 9,178 kB in 10s (911 kB/s)
Reading package lists... Done
```

Then gazebo 11

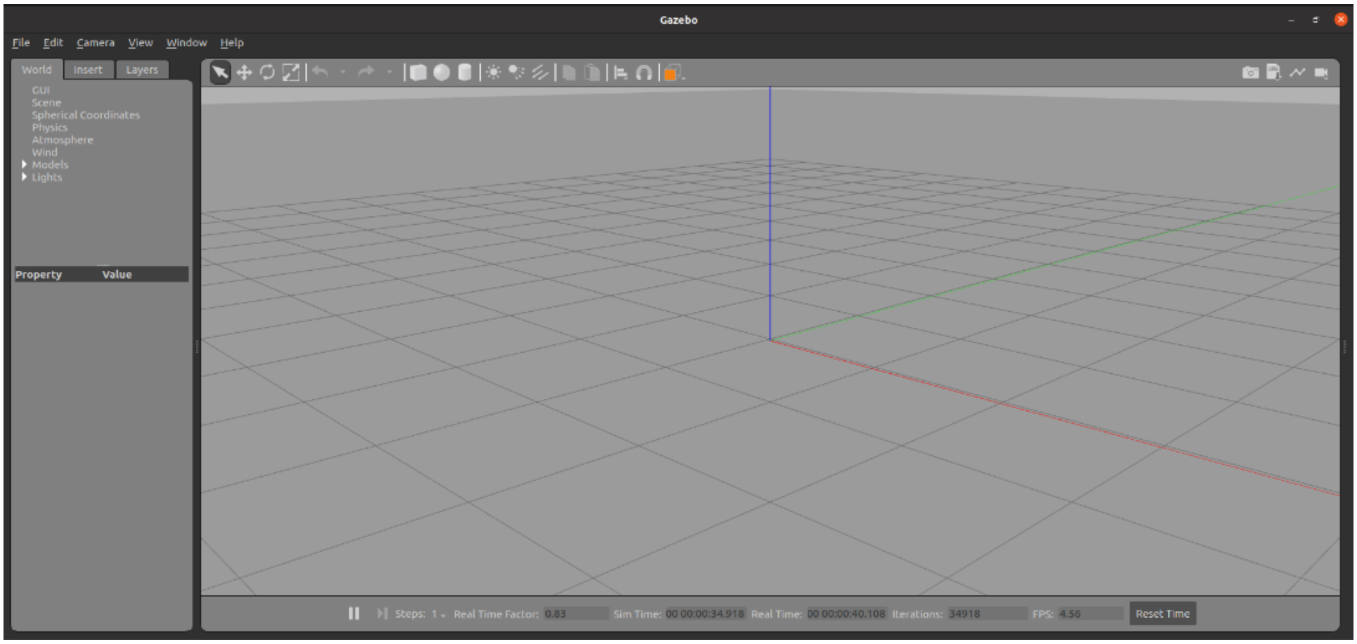
```
sudo apt-get install gazebo11

# For developers that work on top of Gazebo, one extra package

sudo apt-get install libgazebo11-dev
```

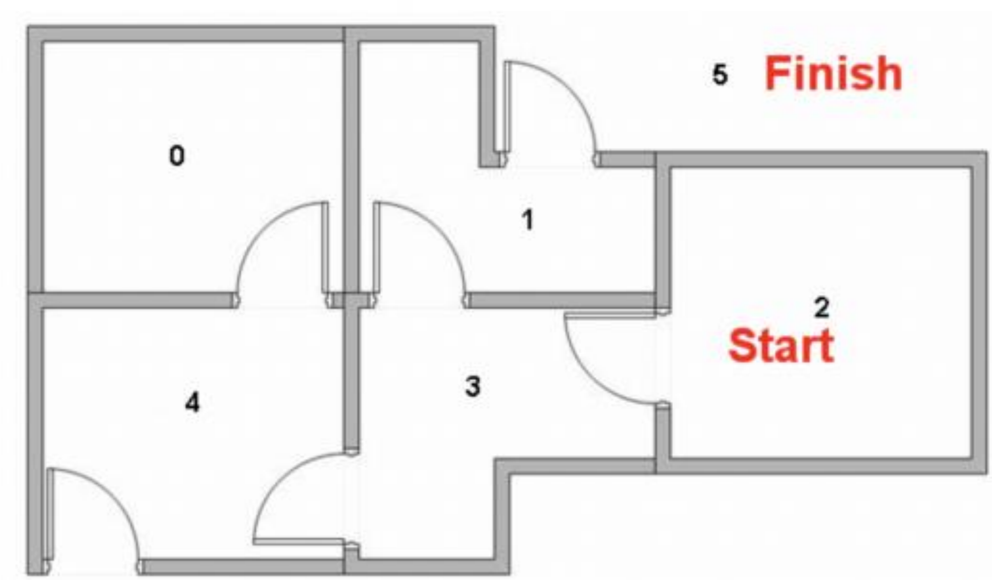
```
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  gazebo11-plugin-base libgazebo11 libgazebo11-dev libignition-common3 libignition-common3-av
  libignition-common3-av-dev libignition-common3-core-dev libignition-common3-dev
  libignition-common3-events libignition-common3-events-dev libignition-common3-graphics
  libignition-common3-graphics-dev libignition-common3-profiler
  libignition-common3-profiler-dev libignition-fuel-tools4 libignition-fuel-tools4-dev
  libignition-math6 libignition-math6-dev libignition-msgs5 libignition-msgs5-dev
  libignition-transport8 libignition-transport8-core-dev libignition-transport8-dev
  libignition-transport8-log libignition-transport8-log-dev libsdformat9 libsdformat9-dev
  sdformat9-sdf
Suggested packages:
  gazebo11-doc
The following packages will be upgraded:
  gazebo11 gazebo11-plugin-base libgazebo11 libgazebo11-dev libignition-common3
  libignition-common3-av libignition-common3-av-dev libignition-common3-core-dev
  libignition-common3-dev libignition-common3-events libignition-common3-events-dev
  libignition-common3-graphics libignition-common3-graphics-dev libignition-common3-profiler
  libignition-common3-profiler-dev libignition-fuel-tools4 libignition-fuel-tools4-dev
  libignition-math6 libignition-math6-dev libignition-msgs5 libignition-msgs5-dev
  libignition-transport8 libignition-transport8-core-dev libignition-transport8-dev
  libignition-transport8-log libignition-transport8-log-dev libsdformat9 libsdformat9-dev
  sdformat9-sdf
29 upgraded, 0 newly installed, 0 to remove and 234 not upgraded.
Need to get 19.2 MB of archives.
After this operation, 709 kB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main amd64 libignition-common3
-profiler-dev amd64 3.17.0-1~focal [40.4 kB]
Get:2 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main amd64 libignition-common3
-graphics-dev amd64 3.17.0-1~focal [8,540 B]
Get:3 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main amd64 libignition-common3
-events-dev amd64 3.17.0-1~focal [8,300 B]
Get:4 http://packages.osrfoundation.org/gazebo/ubuntu-stable focal/main amd64 libignition-common3
-core-dev amd64 3.17.0-1~focal [109 kB]
```

Gazebo



I was not able to construct my house but later on will try my best

4 Construct the following house configuration space/ environment using Gazebo.



NOT COMPLETED IN THE CLASS

5. Construct a wheeled differential robot in the environment of Gazebo. Move the robot in one direction . Show your creativity in the designing of the robot.

NOT COMPLETED IN THE CLASS

PART B : Exploratory Problem

6. Explore the

•History of ROS,

• ROS Versions and

• Examples of ROS-compatible robots and hardware.

History of ROS:

Origins:

ROS was first developed in 2007 by the Stanford Artificial Intelligence Laboratory (SAIL) as part of a research project aimed at creating a common platform for developing robotic software components.

- The initial version of ROS was based on a publish-subscribe architecture, where nodes can publish or subscribe to data on topics
- ROS has been widely adopted in various fields, including industrial automation, service robots, autonomous vehicles, and space robots.
- the history of ROS is one of rapid growth and success, driven by its strong technical foundations, broad adoption, and active user community.

ROS Versions:

ROS 1:

Provides a broad range of functionality, including hardware abstraction, low-level device control, message passing, visualization, and a comprehensive set of libraries and tools.

Proven success in research and development across the robotics community.

ROS 2:

A newer version focused on addressing limitations and expanding capabilities.

Offers a flexible framework for developing and running robotics applications.

Provides improved portability across different operating systems, including Linux, Windows, Mac, and real-time operating systems (RTOS).

Examples of ROS-Compatible Robots and Hardware:

ROSbots:

Small, four-wheeled robots equipped with a camera, LiDAR, and a point cloud device.

Ideal for learning ROS and research applications.

AiNex:

Humanoid robot with 24 degrees of freedom, powered by a Raspberry Pi.

Capable of walking, climbing, hurdling, grasping, and executing complex movements.

CRANE-X7:

Compact robot with a 7-axis structure.

Simulates flexible operations similar to a person's arm.

Turtlebot 2 and Turtlebot 3:

Turtlebot 2 is a versatile robot platform.

Turtlebot 3 is a smaller version with two different configurations and includes a 360º laser.

Q7 . Explore the different robot simulator used for research, design, and development of robots

Here are some robot simulators:

1. Virtual Robotics Toolkit

A simulator for LEGO Mindstorms or VEX robots. It is focused on STEM education and can be used by teams preparing for robotics competitions

2 Gazebo

Gazebo is a free, open-source 3D robotics simulator that simulates real-world physics. It can simulate populations of robots in complex indoor and outdoor environment

3 Webots

A free and open-source 3D robot simulator. It allows users to create 3D simulation models of robots interacting with their environment

4 . Nvidia Isaac Sim

A robotics simulation and synthetic data generation tool. It allows robot makers to train and test robots more efficiently