**EXPERIMENT – 05: SIMULATING TELEOPERATION OF TURTLEBOT IN ROS**

**AIM**: To create a simulation for tele operating turtle bot using ROS in Gazebo.

**PROCEDURE/STEPS:**

**Step 1**: Open Terminal in Linux window

**Step2:** Create a Catkin workspace

**Step 3:** Download and install turtlebot teleoperation package from github "git clone -b noetic-devel https://github.com/ROBOTIS-GIT/turtlebot3_simulations.git"

**Step 4:** use catkin_make command to update the changes in the workspace

**Step 5:** Export the turtlebot model using the command

"export TURTLEBOT3_MODEL=burger"

**Step 6:** Use "roslaunch turtlebot3_gazebo turtlebot3_world.launch" command to invoke the simulation environment.

**Step 7:** Once the environment is ready, Launch the teleoperation process by running the command "roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch"

**Step 8**: The Turtle bot can be controlled by using the keyboard.

**RESULT:** Thus teleoperation of the turtle bot was simulated successfully using gazebo

**EXPERIMENT – 06: CREATING A VIRTUAL MAP USING GAZEBO**

**AIM:** To create a virtual map using gmapping in Gazebo

**PROCEDURE/STEPS:**

Step 1: Open a new terminal

Step 2: Run ros core

Step 3: Open a New terminal

Step 4: Export the turtlebot model using the command "export TURTLEBOT3_MODEL=burger"

Step 5: Launch the environment model using the command "roslaunch turtlebot3_gazebo turtlebot3_world.launch"

Step 6: Open a new terminal

Step 7: Export the turtlebot model using the command "export TURTLEBOT3_MODEL=burger"

Step 8: To launch the mapping process use the command "roslaunch turtlebot3_slam turtlebot3_slam.launch slam_methods:=gmapping"

Step 9: Open a new terminal

Step 10: Export the turtlebot model using the command "export TURTLEBOT3_MODEL=burger"

Step 11: Run the teleoperation node using the command “roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch”

Step 12 : Move the turtle bot by using the Key board control and map all areas in the environment.
Step 13: Once the robot covers all the part of the environment close the teleoperation process using the command “Ctrl+c”

Step 14: Open a new terminal

Step 15: Save the map generated using the command “rosrun map_server map_saver -f ~/map”

**EXPERIMENT – 07: SIMULATING NAVIGATION OF TURTLE BOT USING GAZEBO**

AIM: To simulate the navigation of Turtlebot in an environment using the map generated in gazebo.

**PROCEDURE/STEPS:**

Step 1: Open a new terminal

Step 2: Export the turtlebot model using the command “export TURTLEBOT3_MODEL=burger”

Step 3: Launch the Environment model for which the map is available using the command “roslaunch turtlebot3_gazebo turtlebot3_world.launch”

Step 4: Open a new terminal

Step 5: Export the turtle bot model using the command “export TURTLEBOT3_MODEL=burger”

Step 6: Open the map generated using the command “roslaunch turtlebot3_navigation turtlebot3_navigation.launch map_file:=$HOME/map.yaml”

Step 7: In the Rviz window click on “2D pose estimate” to overlay the map data available and the real time sensor data.

Step8: Using keyboard control move the robot and map the environment precisely.

Step 9: Once the map and the real time data is inline, close the teleoperation node.

Step 10: Click on the 2D Nav Goal option

Step 11: Click on the map to set the destination of the robot and drag the green arrow toward the direction where the robot will be facing.

Step 12: Repeat the step 11 to make the robot move to a desired location in the map.

**EXPERIMENT – 08: TELE OPERATION OF TURTLE BOT3.**

AIM: To execute a teleoperation process using the Turtlebot Burger

**PREREQUISITE:**

1. A turtlebot Burger loaded with Ros Noetic version up and running with IP configured to the Remote PC from which the Robot is controlled.
2. 2. All the required packages like tele operation, SLAM and Navigation and Simulation should have been loaded already.

**PROCEDURE/STEPS:**

Step 1: Open a terminal in the Remote PC

Step 2: Run Ros core.

Step 3: Open a new terminal and connect to the SBC of the Turtlebot burger through the IP address. Using the command “ssh pi@{IP_ADDRESS_OF_RASPBERRY_PI}”. Note: Use the password “turtlebot”. If prompted.

Step 4: Now export the model of the Turtle bot using the command “export TURTLEBOT3_MODEL=burger“

Step 5: Invoke the turtle bot using the bringup launch code- “roslaunch turtlebot3_bringup turtlebot3_robot.launch” Note: Ensure the steps 4,5 are executed in the terminal of the SBC

Step 6: Open a new terminal in remote pc

Step 7: Now export the model of the Turtle bot using the command “export TURTLEBOT3_MODEL=burger“

Step 8: Run the teleoperation node using the command “roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch”

Step 9: When the terminal shows the keyboard control for teleoperation press the appropriate keys to control the movement of the bot.

Step 10: Check whether the robot moves in the correct direction as programmed.

**EXPERIMENT – 09: GENERATION OF MAP USING LIDAR AND GMAPPING PACKAGE.**

AIM: To generate a map of an environment using the LIDAR data and Gmapping package in ROS

**PREREQUISITE:**

1. A turtlebot Burger loaded with Ros Noetic version up and running with IP configured to the Remote PC from which the Robot is controlled.

2. All the required packages like tele operation, SLAM, Navigation and Simulation should have been loaded already.

**PROCEDURE/STEPS:**

Step 1: Open a terminal in the Remote PC

Step 2: Run Ros core.

Step 3: Open a new terminal and connect to the SBC of the Turtlebot burger through the IP address. Using the command “ssh pi@{IP_ADDRESS_OF_RASPBERRY_PI}”. Note: Use the password “turtlebot”. If prompted.
Step 4: Now export the model of the Turtle bot using the command “export TURTLEBOT3_MODEL=burger“
Step 5: Invoke the turtle bot using the bringup launch code- “roslaunch turtlebot3_bringup turtlebot3_robot.launch” Note: Ensure the steps 4,5 are executed in the terminal of the SBC
Step 6: Open a new terminal in remote pc
Step 7: Now export the model of the Turtle bot using the command “export TURTLEBOT3_MODEL=burger“
Step 8: To generate the Map run the Slam node first using the command “roslaunch turtlebot3_slam turtlebot3_slam.launch”
Step 9: open a new terminal
Step 10: Now export the model of the Turtle bot using the command “export TURTLEBOT3_MODEL=burger“
Step 11: Launch the teleoperation using the command “roslaunch turtlebot3_teleop turtlebot3_teleop_key.launch”
Step 9: When the terminal shows the keyboard control for teleoperation press the appropriate keys to control the movement of the bot.
Step 10: Move the robot to each and every corners of the environment to be mapped.
Step 11: Once every points are mapped, close the teleoperation process using “Ctrl+C”
Step 12: Once the teleoperation is closed, Save the map generated using the map saver command –“rosrun map_server map_saver -f ~/map”.
Step 13: Check the map file with extension “.yaml” and “.pgm”