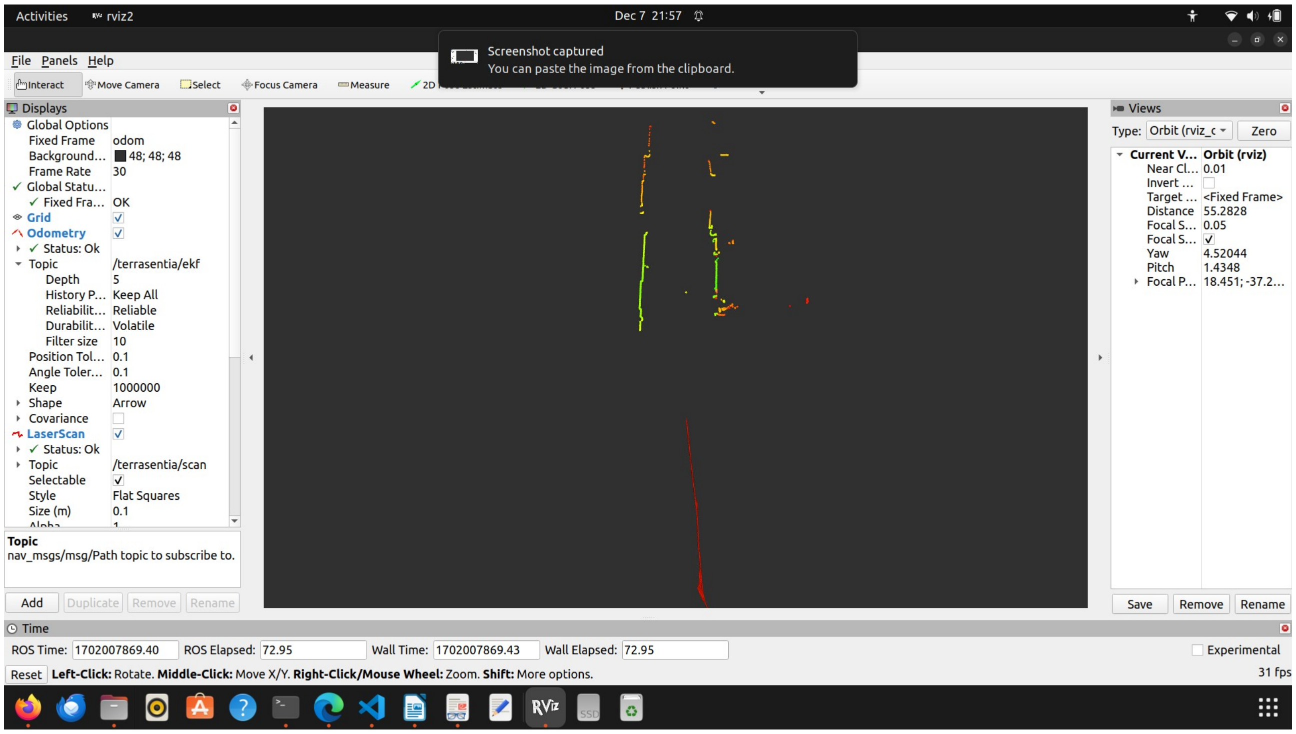
CODING EX – 3
KALAIPRIYAN R – KR53

1. Play the rosbag file ‘lidar’ and visualize the robot trajectory and the LiDAR measurements on rviz2. Add screenshots to your report.

SOLUTION:



Activities
rviz2
Dec 7 21:57
Screenshot captured
You can paste the image from the clipboard.
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Reset

Global Options	
Fixed Frame	odom
Background…	48; 48; 48
Frame Rate	30
✓ Global Statu…	
✓ Fixed Fra…	OK
Grid	✓
Odometry	✓
✓ Status: Ok	
Topic	/terrasentia/ekf
Depth	5
History P…	Keep All
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Position Tol…	0.1
Angle Toler…	0.1
Keep	1000000
Shape	Arrow
Covariance	
LaserScan	✓
✓ Status: Ok	
Topic	/terrasentia/scan
Selectable	✓
Style	Flat Squares
Size (m)	0.1
Alpha	1

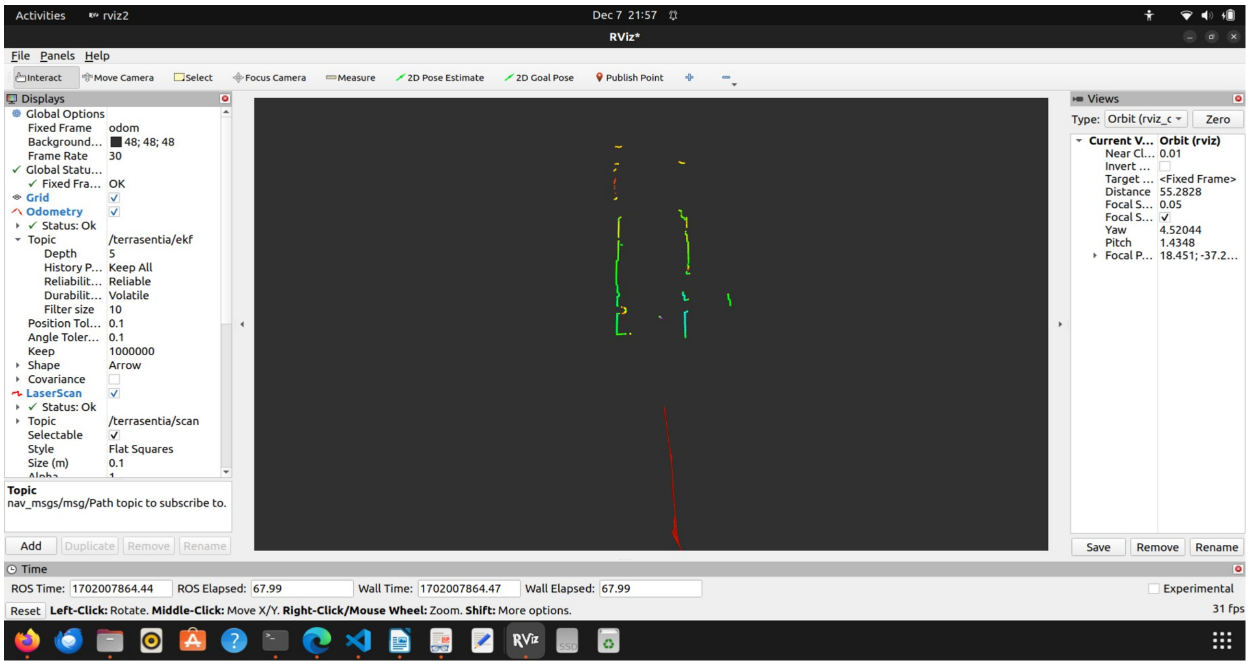
Topic
nav_msgs/msg/Path topic to subscribe to.

Type: Orbit (rviz_c Zero

Current V…	Orbit (rviz)
Near Cl…	0.01
Invert …	
Target …	<Fixed Frame>
Distance	55.2828
Focal S…	0.05
Focal S…	✓
Yaw	4.52044
Pitch	1.4348
Focal P…	18.451; -37.2…

ROS Time: 1702007869.40 ROS Elapsed: 72.95 Wall Time: 1702007869.43 Wall Elapsed: 72.95 Experimental

Left-Click: Rotate. **Middle-Click:** Move X/Y. **Right-Click/Mouse Wheel:** Zoom. **Shift:** More options. 31 fps



Activities
rviz2
Dec 7 21:57
RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Reset

Global Options	
Fixed Frame	odom
Background…	48; 48; 48
Frame Rate	30
✓ Global Statu…	
✓ Fixed Fra…	OK
Grid	✓
Odometry	✓
✓ Status: Ok	
Topic	/terrasentia/ekf
Depth	5
History P…	Keep All
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Position Tol…	0.1
Angle Toler…	0.1
Keep	1000000
Shape	Arrow
Covariance	
LaserScan	✓
✓ Status: Ok	
Topic	/terrasentia/scan
Selectable	✓
Style	Flat Squares
Size (m)	0.1
Alpha	1

Topic
nav_msgs/msg/Path topic to subscribe to.

Type: Orbit (rviz_c Zero

Current V…	Orbit (rviz)
Near Cl…	0.01
Invert …	
Target …	<Fixed Frame>
Distance	55.2828
Focal S…	0.05
Focal S…	✓
Yaw	4.52044
Pitch	1.4348
Focal P…	18.451; -37.2…

ROS Time: 1702007864.44 ROS Elapsed: 67.99 Wall Time: 1702007864.47 Wall Elapsed: 67.99 Experimental

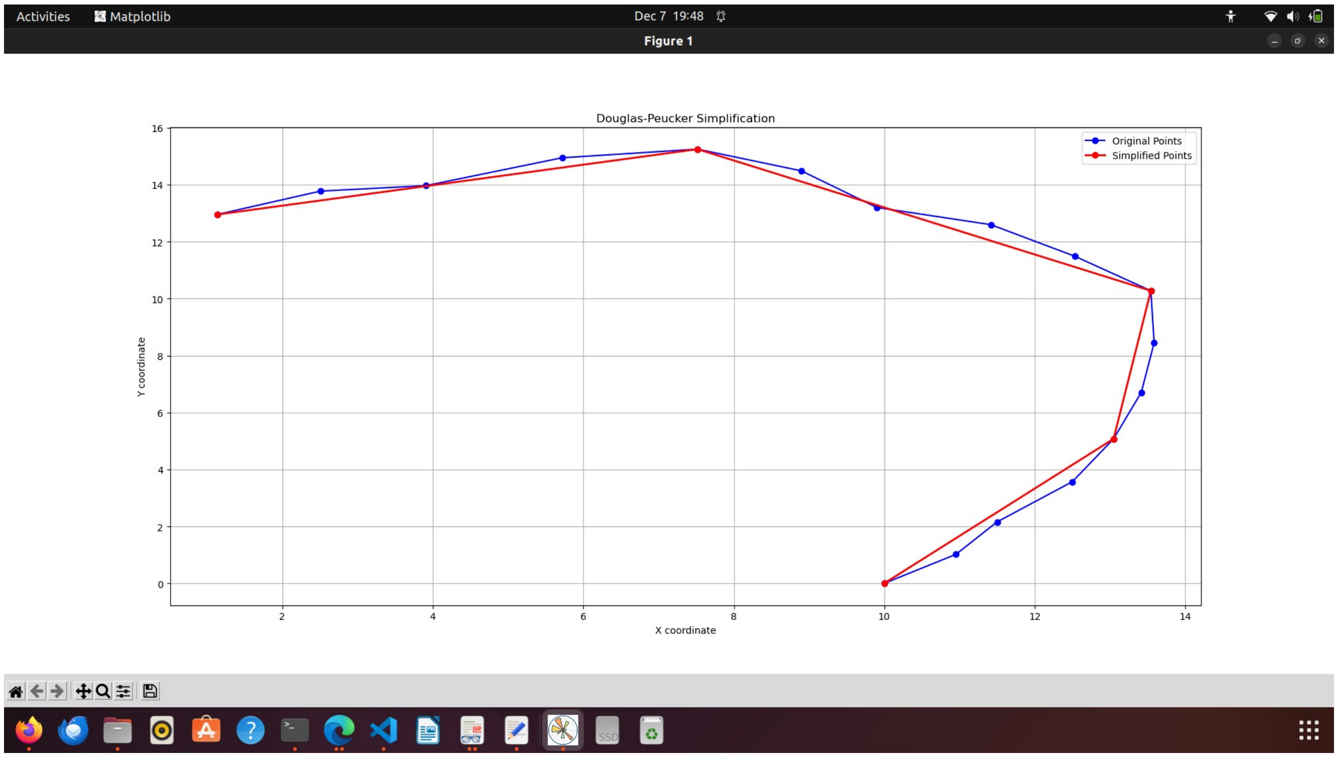
Left-Click: Rotate. **Middle-Click:** Move X/Y. **Right-Click/Mouse Wheel:** Zoom. **Shift:** More options. 31 fps

2. Write code in Python to find and fit lines and corners from LIDAR data, using one of the line fitting algorithms discussed in chapter 4.7.2 of Siegwart. Test your algorithm on the following data. Add the results to your report (you don't need the ros template for this question).

SOLUTION:

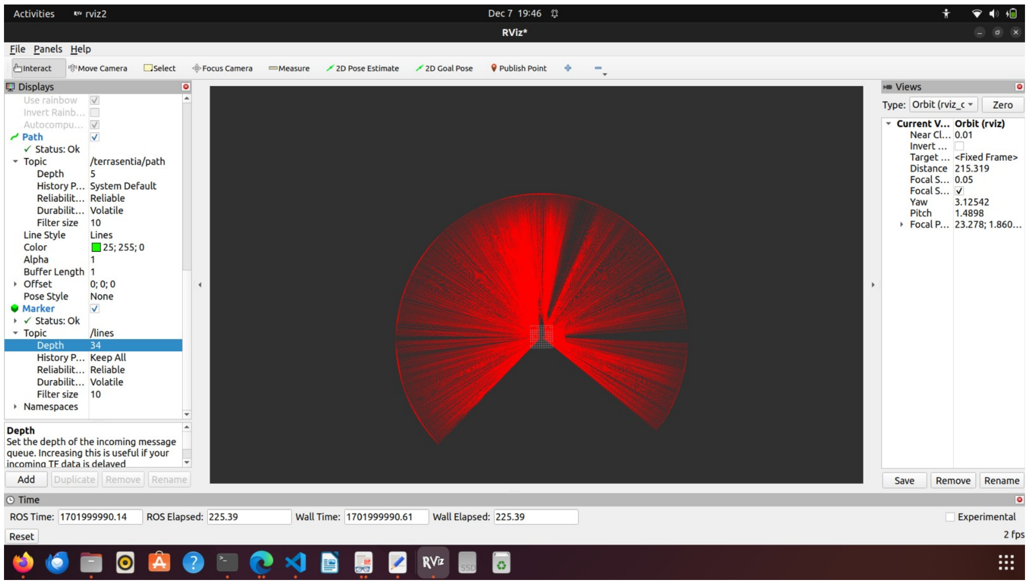
ALGORITHM USED : Douglas Peucker

Plot:



3. Use the function created in the previous question to find and fit lines and corners from the LiDAR data in the rosbag file. Visualize the lines on rviz2. Add screenshots to your report.
- The LiDar data is contained in the topic /terrasentia/scan.
- The function callback_scan() in the attached template is already reading the ranges. These ranges are stored in a vector whose first value corresponds to -45 degrees, and the last value corresponds to 225 degrees (the total field of fiew is 270 degrees).
- You may need to convert the LiDAR measurements from polar coordinates to rectangular coordinates, depending on the algorithm you want to implement.
- You can use line markers to draw lines on rviz. See example in the function draw_line_example_callback().

SOLUTION:


Activities
rviz2
Dec 7 19:46
RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Reset

Use rainbow	✓
Invert Rainb…	
Autocompu…	✓
Path	✓
Status: Ok	
Topic	/terrasentia/path
Depth	5
History P…	System Default
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Line Style	Lines
Color	🟩 25; 255; 0
Alpha	1
Buffer Length	1
Offset	0; 0; 0
Pose Style	None
Marker	✓
Status: Ok	
Topic	/lines
Depth	34
History P…	Keep All
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Namespaces	

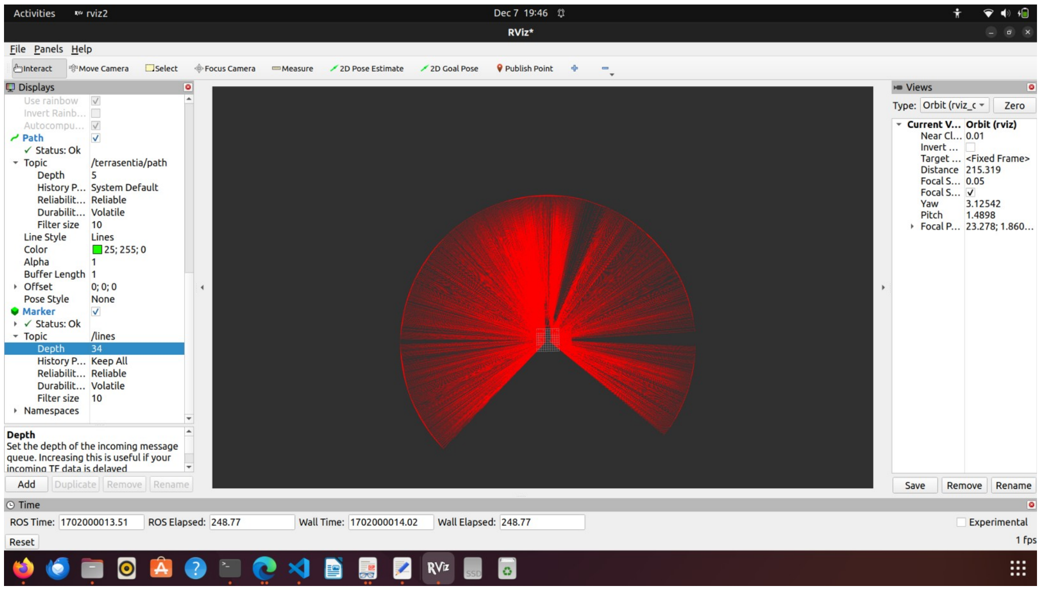
Depth
Set the depth of the incoming message queue. Increasing this is useful if your incoming TF data is delayed

Type: Orbit (rviz_c Zero

Current V…	Orbit (rviz)
Near Cl…	0.01
Invert …	
Target …	<Fixed Frame>
Distance	215.319
Focal S…	0.05
Focal S…	✓
Yaw	3.12542
Pitch	1.4898
Focal P…	23.278; 1.860…

ROS Time: 1701999990.14 ROS Elapsed: 225.39 Wall Time: 1701999990.61 Wall Elapsed: 225.39 Experimental

2 fps


Activities
rviz2
Dec 7 19:46
RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Reset

Use rainbow	✓
Invert Rainb…	
Autocompu…	✓
Path	✓
Status: Ok	
Topic	/terrasentia/path
Depth	5
History P…	System Default
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Line Style	Lines
Color	🟩 25; 255; 0
Alpha	1
Buffer Length	1
Offset	0; 0; 0
Pose Style	None
Marker	✓
Status: Ok	
Topic	/lines
Depth	34
History P…	Keep All
Reliabilit…	Reliable
Durabilit…	Volatile
Filter size	10
Namespaces	

Depth
Set the depth of the incoming message queue. Increasing this is useful if your incoming TF data is delayed

Type: Orbit (rviz_c Zero

Current V…	Orbit (rviz)
Near Cl…	0.01
Invert …	
Target …	<Fixed Frame>
Distance	215.319
Focal S…	0.05
Focal S…	✓
Yaw	3.12542
Pitch	1.4898
Focal P…	23.278; 1.860…

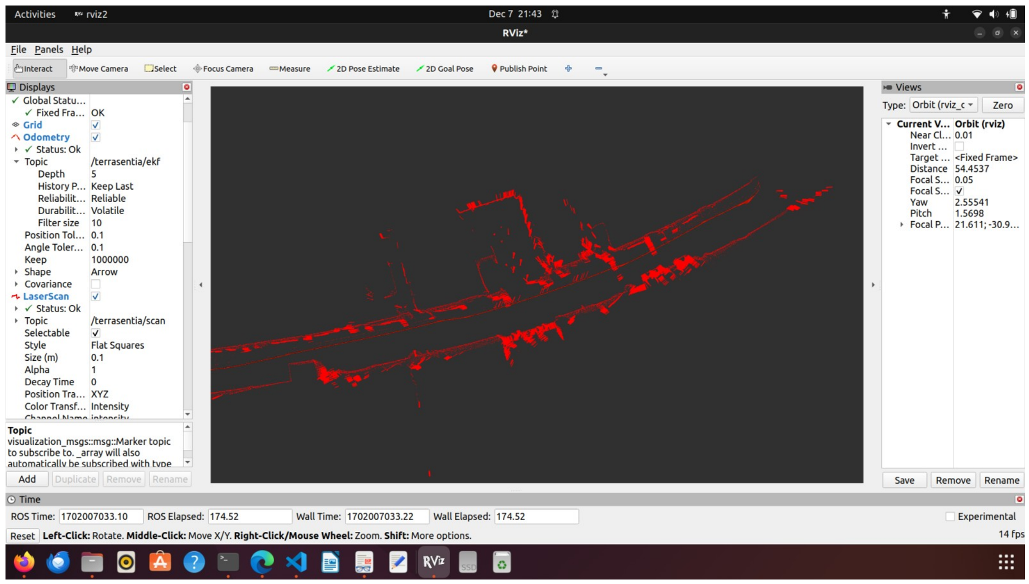
ROS Time: 1702000013.51 ROS Elapsed: 248.77 Wall Time: 1702000014.02 Wall Elapsed: 248.77 Experimental

1 fps

4. Mapping. Use the line fitting algorithm and the trajectory of the robot to create a complete geometric map of the corridor. Add screenshots to your report.
- The trajectory of the robot is given by the topic /terrasentia/ekf. You need to subscribe to this topic to get the position and orientation.
- Remember that the LiDAR measurements are given with respect to the robot coordinate frame. You will need to convert the estimated lines to a global reference frame (e.g. odom) for mapping.

SOLUTION:

CONCEPT USED:
SHORTENED THE SCANNING LINE FIT FROM THE PREVIOUS METHOD AND TRANSFORMED THE MATRIX.


Activities
rviz2
Dec 7 21:43
RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Experimental

Global Statu...	
Fixed Fra...	OK
Grid	✓
Odometry	✓
Status: Ok	
Topic	/terrasentia/ekf
Depth	5
History P...	Keep Last
Reliabilit...	Reliable
Durabilit...	Volatile
Filter size	10
Position Tol...	0.1
Angle Toler...	0.1
Keep	1000000
Shape	Arrow
Covariance	
LaserScan	✓
Status: Ok	
Topic	/terrasentia/scan
Selectable	✓
Style	Flat Squares
Size (m)	0.1
Alpha	1
Decay Time	0
Position Tra...	XYZ
Color Transf...	Intensity
Channel Name	intensity

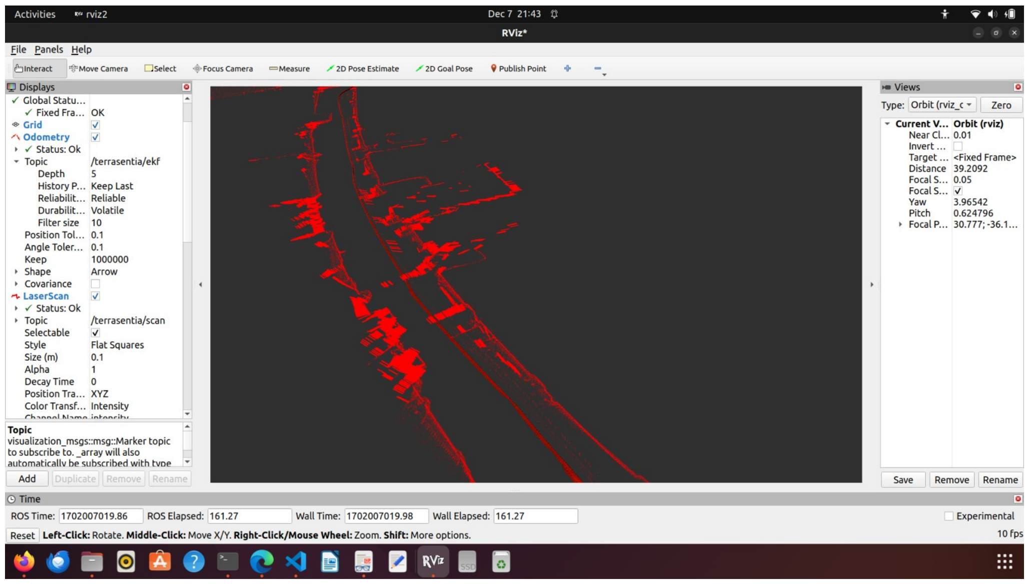
Topic
visualization_msgs::msg::Marker topic to subscribe to. _array will also automatically be subscribed with type

Type: Orbit (rviz_c Zero

Current V...	Orbit (rviz)
Near Cl...	0.01
Invert ...	
Target ...	<Fixed Frame>
Distance	54.4537
Focal S...	0.05
Focal S...	✓
Yaw	2.55541
Pitch	1.5698
Focal P...	21.611; -30.9...

ROS Time: 1702007033.10 ROS Elapsed: 174.52 Wall Time: 1702007033.22 Wall Elapsed: 174.52

Reset **Left-Click:** Rotate. **Middle-Click:** Move X/Y. **Right-Click/Mouse Wheel:** Zoom. **Shift:** More options. 14 fps


Activities
rviz2
Dec 7 21:43
RViz*
File Panels Help
Interact Move Camera Select Focus Camera Measure 2D Pose Estimate 2D Goal Pose Publish Point
Displays
Views
Add Duplicate Remove Rename
Save Remove Rename
Time
Experimental

Global Statu...	
Fixed Fra...	OK
Grid	✓
Odometry	✓
Status: Ok	
Topic	/terrasentia/ekf
Depth	5
History P...	Keep Last
Reliabilit...	Reliable
Durabilit...	Volatile
Filter size	10
Position Tol...	0.1
Angle Toler...	0.1
Keep	1000000
Shape	Arrow
Covariance	
LaserScan	✓
Status: Ok	
Topic	/terrasentia/scan
Selectable	✓
Style	Flat Squares
Size (m)	0.1
Alpha	1
Decay Time	0
Position Tra...	XYZ
Color Transf...	Intensity
Channel Name	intensity

Topic
visualization_msgs::msg::Marker topic to subscribe to. _array will also automatically be subscribed with type

Type: Orbit (rviz_c Zero

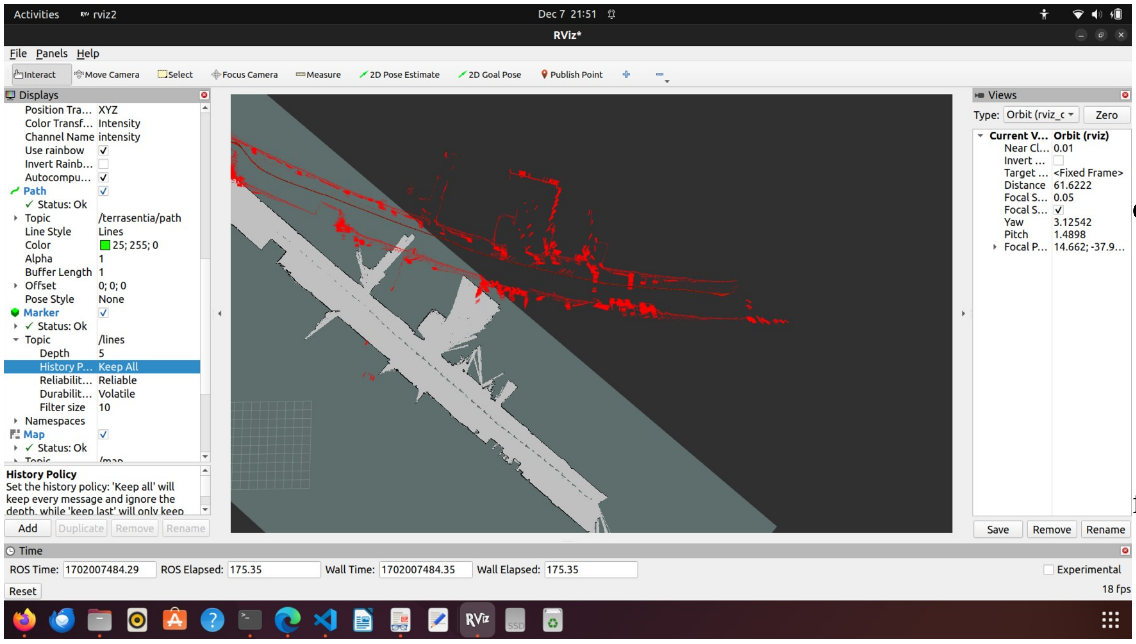
Current V...	Orbit (rviz)
Near Cl...	0.01
Invert ...	
Target ...	<Fixed Frame>
Distance	39.2092
Focal S...	0.05
Focal S...	✓
Yaw	3.96542
Pitch	0.624796
Focal P...	30.777; -36.1...

ROS Time: 1702007019.86 ROS Elapsed: 161.27 Wall Time: 1702007019.98 Wall Elapsed: 161.27

Reset **Left-Click:** Rotate. **Middle-Click:** Move X/Y. **Right-Click/Mouse Wheel:** Zoom. **Shift:** More options. 10 fps

5. SLAM. Use Gmapping to create a map based on SLAM (see tutorial below). Compare this map with the one you obtained with your implementation. Explain the differences you find.

SOLUTION:



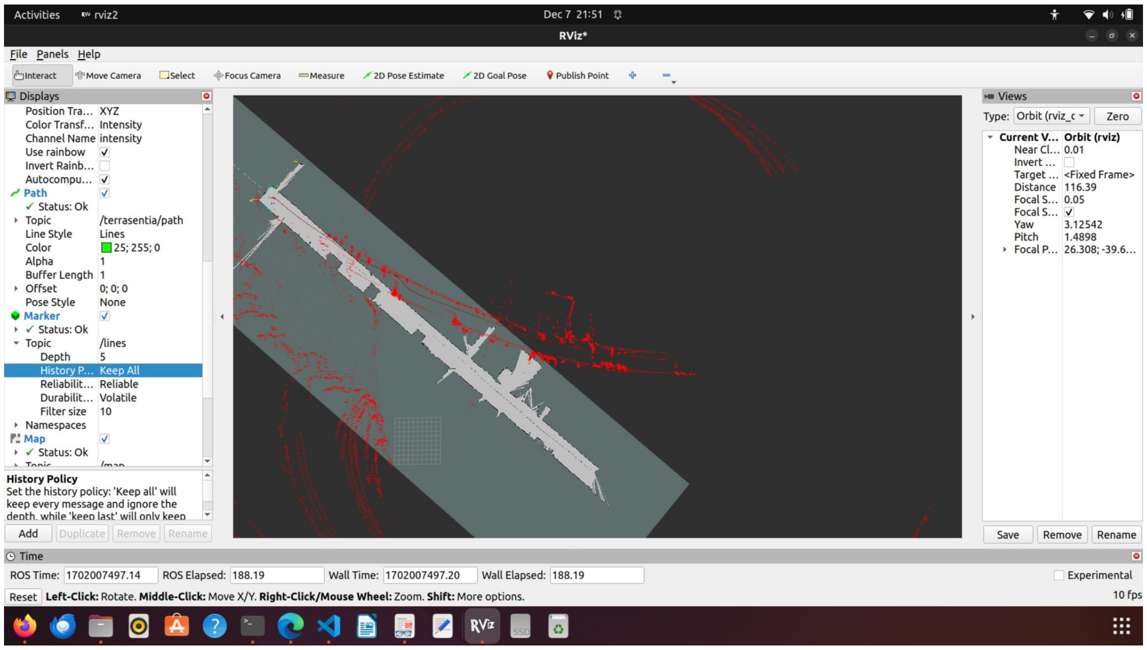
```
Position Tra...   XYZ
Color Transf...   Intensity
Channel Name      intensity
Use rainbow       ✓
Invert Rainb...
Autocompu...      ✓
Path              ✓
  ✓ Status: Ok
  Topic           /terrasentia/path
  Line Style      Lines
  Color           🟩 25; 255; 0
  Alpha           1
  Buffer Length   1
  Offset          0; 0; 0
  Pose Style      None
Marker            ✓
  ✓ Status: Ok
  Topic           /lines
    Depth         5
    History P...  Keep All
    Reliabilit... Reliable
    Durabilit...  Volatile
    Filter size   10
  Namespaces
Map               ✓
  ✓ Status: Ok

History Policy
Set the history policy: 'Keep all' will
keep every message and ignore the
depth, while 'keep last' will only keep
```

```
Type: Orbit (rviz_c    Zero
Current V...  Orbit (rviz)
  Near Cl...  0.01
  Invert ...
  Target ...  <Fixed Frame>
  Distance    61.6222
  Focal S...  0.05
  Focal S...  ✓
  Yaw         3.12542
  Pitch       1.4898
  Focal P...  14.662; -37.9...
```

```
ROS Time: 1702007484.29   ROS Elapsed: 175.35   Wall Time: 1702007484.35   Wall Elapsed: 175.35
18 fps
```

o

ff



```
Position Tra...   XYZ
Color Transf...   Intensity
Channel Name      intensity
Use rainbow       ✓
Invert Rainb...
Autocompu...      ✓
Path              ✓
  ✓ Status: Ok
  Topic           /terrasentia/path
  Line Style      Lines
  Color           🟩 25; 255; 0
  Alpha           1
  Buffer Length   1
  Offset          0; 0; 0
  Pose Style      None
Marker            ✓
  ✓ Status: Ok
  Topic           /lines
    Depth         5
    History P...  Keep All
    Reliabilit... Reliable
    Durabilit...  Volatile
    Filter size   10
  Namespaces
Map               ✓
  ✓ Status: Ok

History Policy
Set the history policy: 'Keep all' will
keep every message and ignore the
depth, while 'keep last' will only keep
```

```
Type: Orbit (rviz_c    Zero
Current V...  Orbit (rviz)
  Near Cl...  0.01
  Invert ...
  Target ...  <Fixed Frame>
  Distance    116.39
  Focal S...  0.05
  Focal S...  ✓
  Yaw         3.12542
  Pitch       1.4898
  Focal P...  26.308; -39.6...
```

```
ROS Time: 1702007497.14   ROS Elapsed: 188.19   Wall Time: 1702007497.20   Wall Elapsed: 188.19
Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel: Zoom. Shift: More options.
10 fps
```

The maps are not exactly matching as expected. This might be due to:

1. Sensor Noise:
LiDAR data might include noise, causing inaccuracies in the measurements that affect the map.
2. Map Resolution:
The gmapping resolution settings may not capture all the details that the LiDAR sensor detects.
3. Motion Distortion:
The robot's movement can distort LiDAR readings, leading to mismatches in the map.
4. Data Association:
Gmapping could struggle with matching LiDAR data to the map if the environment has repetitive or non-distinctive features.
5. Parameter Tuning:
Incorrectly tuned parameters of gapping can result in a map that doesn't align well with the sensor data.
6. Time Synchronization:
A lack of proper synchronization between sensor data and the robot's odometry can cause errors in the map