

Hokuyo

UST-20LX



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Version : 1



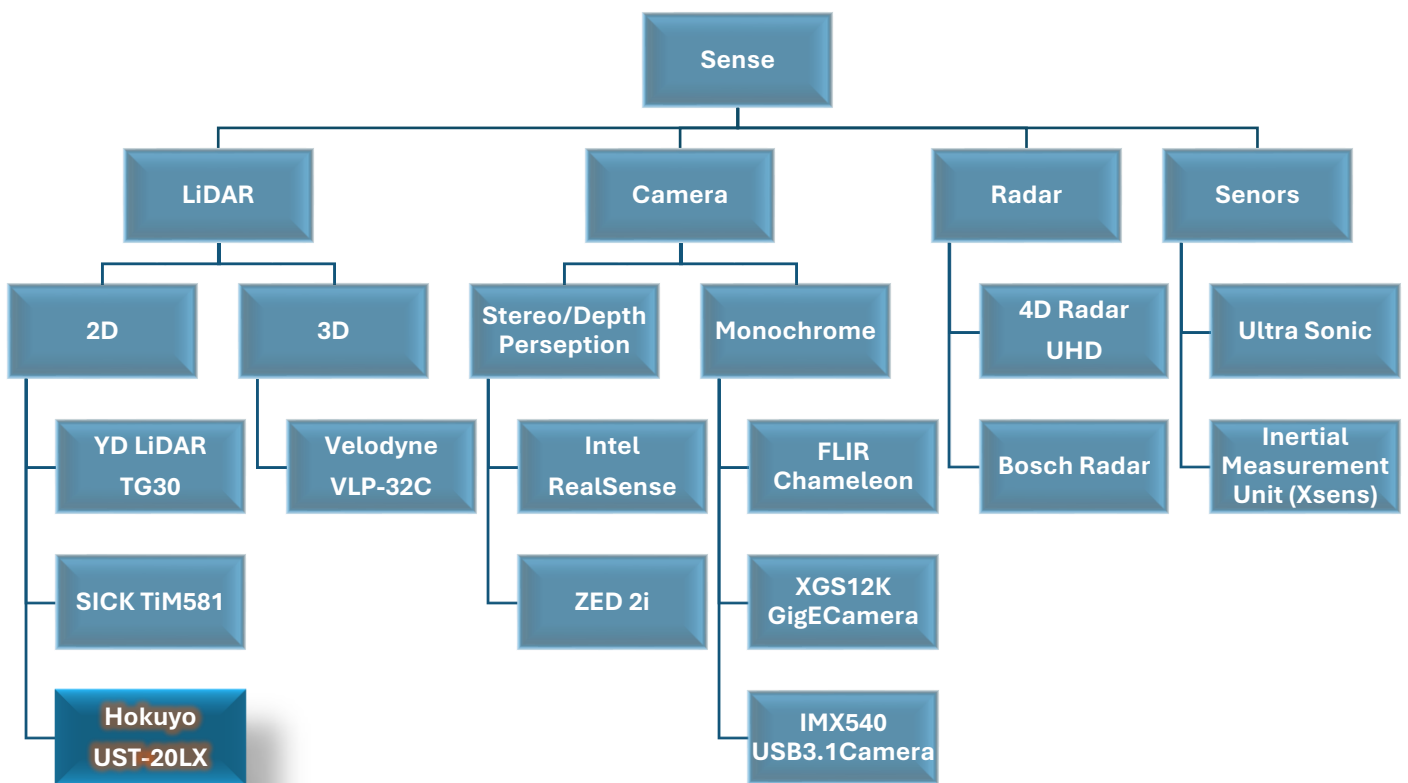
Version Control

| Version | Summary | Created by | Reviewed by | Date |
|---------|-----------------------------------|-----------------------|----------------------------|------|
| 1 | Starter Guide for Hokuyo UST-20LX | N Sai Pranay Kumar | G Nithish Chandra Reddy | |
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Sense Segment



I. Introduction to LiDAR

LiDAR (Light Detection and Ranging) is a remote sensing technology that uses laser light to measure distances. By emitting laser pulses and measuring the time it takes for the light to return after hitting an object, LiDAR can create precise, high-resolution 3D maps of the environment.

○ History of LiDAR

LiDAR technology has its roots in the 1960s, developed shortly after the invention of the laser. Initially, it was used for meteorological purposes, such as measuring atmospheric particles. Over the decades, advances in technology and computing power have significantly expanded LiDAR's applications, making it a crucial tool in geology, forestry, and, more recently, autonomous vehicles and robotics.

○ Types of LiDARs

2D LiDAR:

This type of LiDAR scans in a single plane, creating a two-dimensional map of the surroundings. It's commonly used in applications where a flat representation is sufficient, such as in industrial automation settings or simple obstacle detection systems.

3D LiDAR:

By rotating or using multiple beams, 3D LiDAR captures data in multiple planes, resulting in a three-dimensional map of the environment. This type of LiDAR is essential for more complex applications requiring a comprehensive spatial understanding, such as autonomous driving, advanced robotics, and detailed topographical mapping.

○ Applications of LiDAR

1. **Autonomous Vehicles:** LiDAR is critical in self-driving cars, providing detailed 3D maps that help the vehicle navigate and avoid obstacles.
2. **Geospatial Mapping:** Used for creating high-resolution topographic maps, LiDAR helps in urban planning, flood modeling, and forestry management.
3. **Archaeology:** LiDAR can penetrate forest canopies to reveal hidden structures and landscapes, aiding in archaeological discoveries.
4. **Environmental Monitoring:** It helps in tracking changes in vegetation, coastline erosion, and other environmental changes over time.
5. **Agriculture:** Precision farming uses LiDAR for crop assessment, field mapping, and soil analysis.
6. **Infrastructure Inspection:** LiDAR is used to inspect power lines, bridges, and other infrastructure for maintenance and safety assessments.

LiDAR's ability to produce accurate and high-resolution data quickly makes it invaluable across various industries, driving innovation and efficiency in multiple fields.

II. Hokuyo UST-20LX Introduction

○ Product Overview :

The Hokuyo UST-20LX scanning laser rangefinder is a small, accurate, high-speed device for obstacle detection and localization of autonomous robots and automated material handling systems. This model uses an Ethernet interface for communication and can obtain measurement data in a wide field of view up to a distance of 20 meters with a millimeter resolution. Due to its low power consumption, this scanner can be used on battery-operated platforms.

○ Specifications :

- Range : 0.06m to 20m
- Scan Angle : 270°
- Scan Speed : 25ms (motor speed, 2400 RPM)
- Accuracy : $\pm 40\text{mm}$
- Angular Resolution : 0.25°
- Operating Voltage : DC 12 V - 24 V

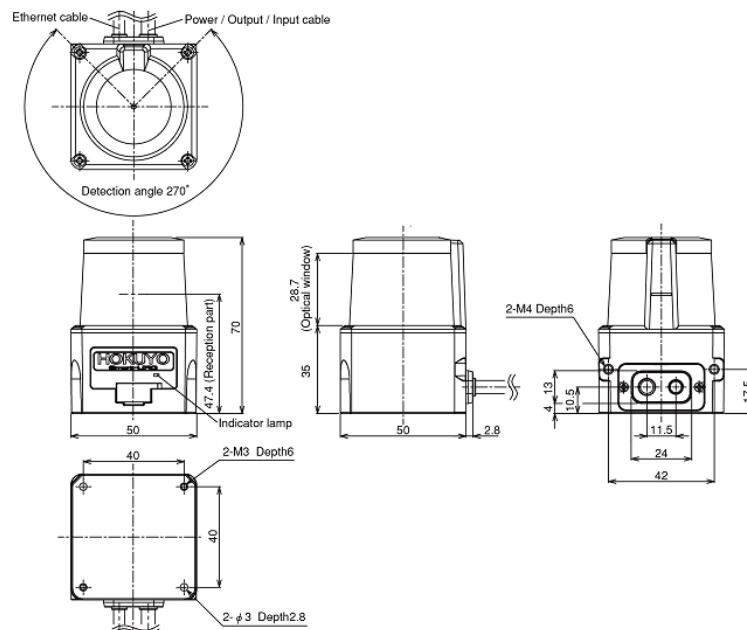


Figure 1 Hokuyo LiDAR External Dimensions

Official Website : <https://www.hokuyo-aut.jp/search/single.php?serial=167>

III. Prerequisites

Linux Version : Ubuntu 20.04 and before versions

Ubuntu Installation : <https://robocademy.com/2020/05/17/best-4-ways-to-install-ubuntu-for-ros/>

YouTube Link : <https://youtu.be/mXyN1aJYefc?si=XJbUZmC5jgrDRQQF> (Dual Boot)

ROS : Noetic and before versions

ROS Installation : <https://wiki.ros.org/noetic/Installation/Ubuntu> (noetic version)

Complete [ROS tutorials](#) to get familiar with ROS.

<https://robodev.blog/series/ros101> (ROS Basics)

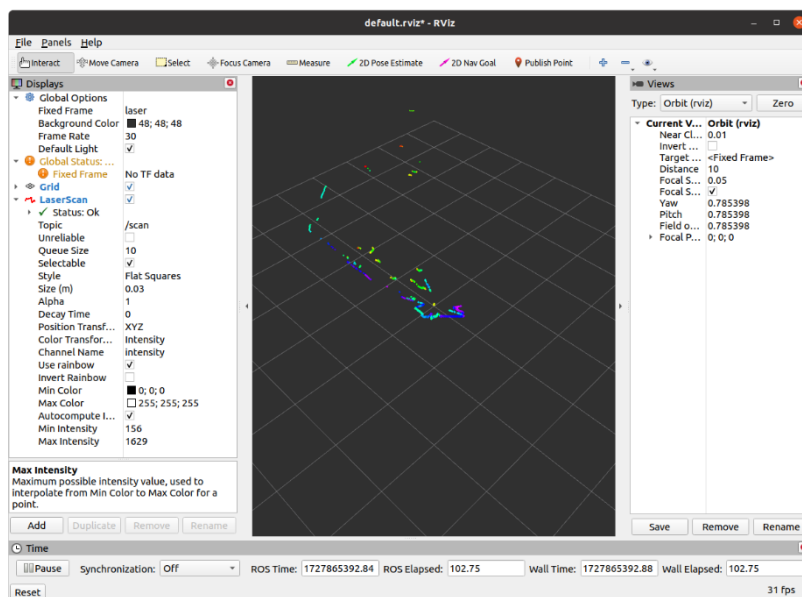
Before moving to the Hardware interface execute the .bag file and visualize the data... from the following link

Activity :

Dataset : <https://drive.google.com/drive/folders/1mP5sizC77ARcK9fO5BmCwU82d5yzVs6Y?usp=sharing>

- Instead of recording a .bag file. First, visualize the data with the bag file by following the steps.

Sample Output :



Note

- To uninstall Ubuntu (Dual Boot) - <https://youtu.be/mQyxtWrUNIE?si=3eXOnEqIGjViTH0D>
- If you face a Grub Screen Issue - <https://youtu.be/ih2NjlhLLic?si=TEpkIDzkKJVkWzZB>

IV. Hokuyo UST-20LX Interface

The device has two Cables: an I/O Cable for the Power source and an Ethernet Cable.

I/O Cable :

| Color | Signal |
|------------|--------------------|
| Red | COM I/P+ |
| Gray | COM O/P- |
| Light Blue | IP Reset Input |
| Orange | Synchronous Output |
| Brown | +Vin |
| Blue | -Vin |



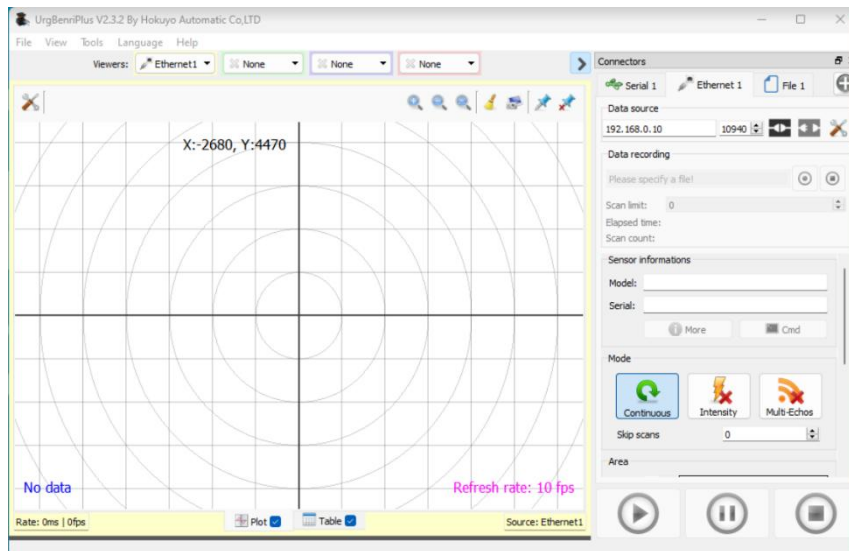
Figure 2 Hokuyo UST20LX SetUp

V. Visualization using SDK

Download the Tool Kit from <https://sourceforge.net/projects/urgbenri/>

Download and Install the application.

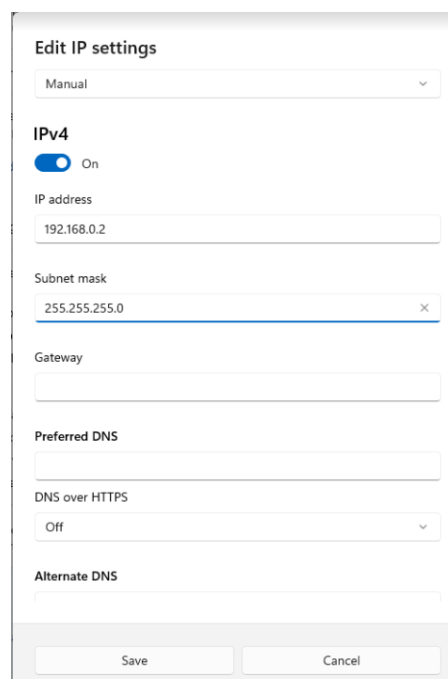
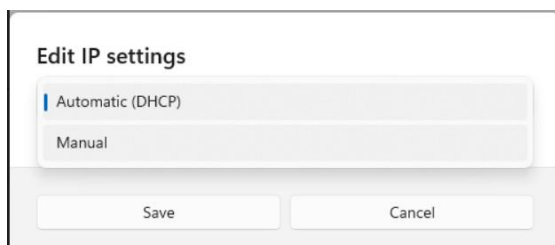
Open the Application you will get the screen as shown below...



Connect your Hokuyo UST20LX to the System.

Open Settings in your system to configure the LiDAR. Select the respective ethernet Connection and change it to Manual.

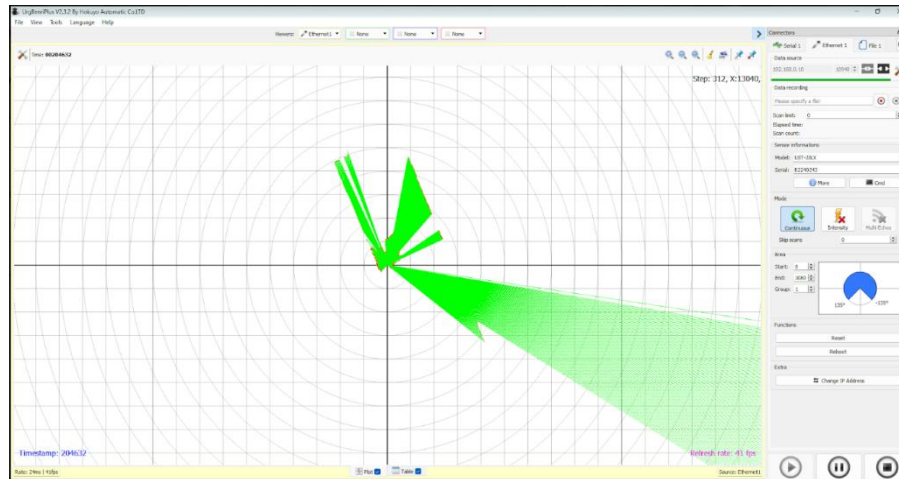
The IP Address of LiDAR is 192.168.0.10. So, change the System IP Address to the same 0 series (192.168.0.XX) as shown and save it...



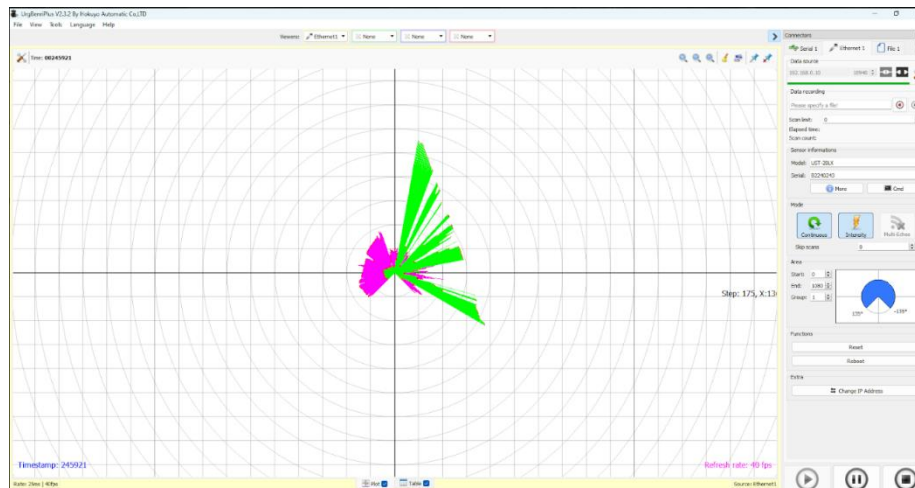
Now open the SDK set the IP Address and Port Number of the LiDAR as Shown and Click on Connect device...



As soon as the device is connected you can visualize the LiDAR data as shown...



We can also visualize Intensity Data for it



VI. Integrating with ROS

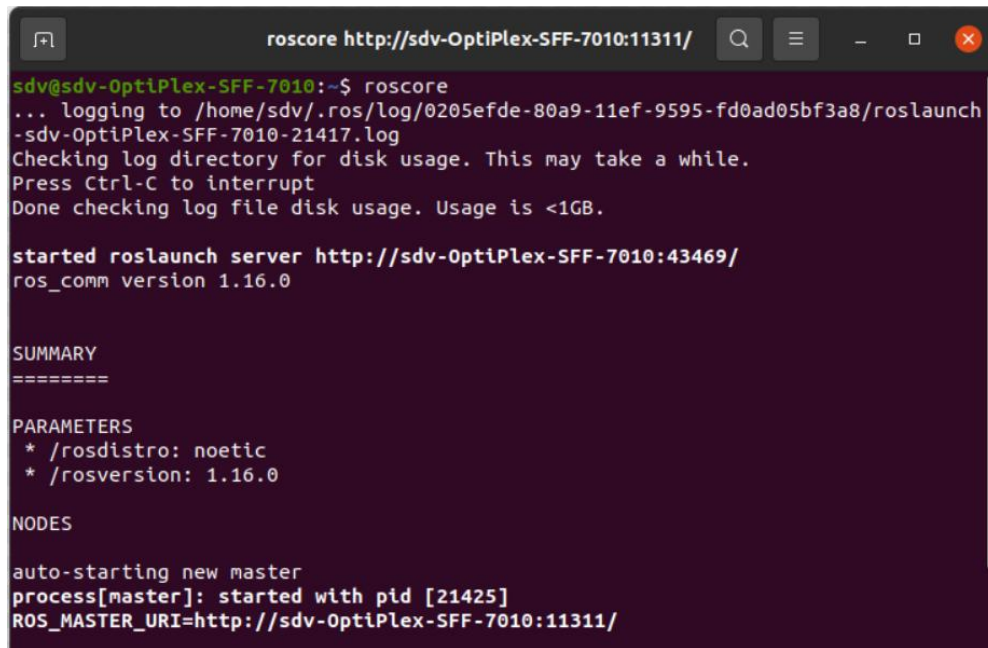
The Installation Procedure has been done in Ubuntu 20.04 and its respective ROS Version (Noetic).

Open the ROS Terminal and execute the following commands...

```
$ sudo apt-get install ros-noetic-urg-node
```

Connect your Hokuyo LiDAR to the System.

In One terminal run '*roscore*'



```

roscore http://sdv-OptiPlex-SFF-7010:11311/

sdv@sdv-OptiPlex-SFF-7010:~$ roscore
... logging to /home/sdv/.ros/log/0205efde-80a9-11ef-9595-fd0ad05bf3a8/roslaunch
-sdv-OptiPlex-SFF-7010-21417.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://sdv-OptiPlex-SFF-7010:43469/
ros_comm version 1.16.0

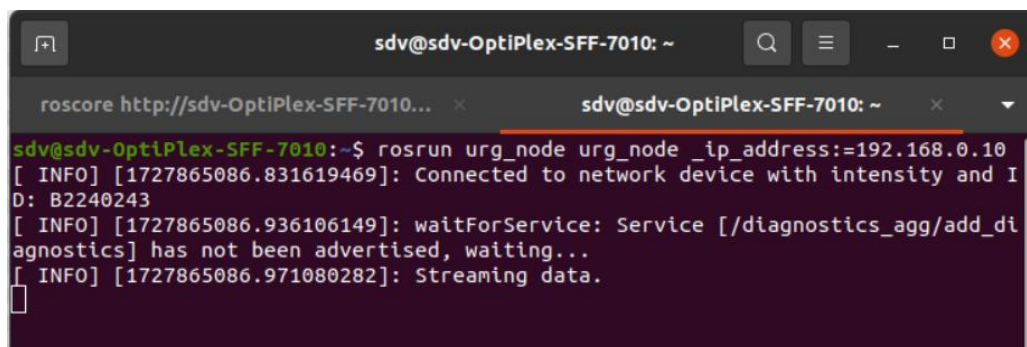
SUMMARY
=====

PARAMETERS
* /rostdistro: noetic
* /rosversion: 1.16.0

NODES

auto-starting new master
process[master]: started with pid [21425]
ROS_MASTER_URI=http://sdv-OptiPlex-SFF-7010:11311/
  
```

In another terminal execute the following command as shown...



```

sdv@sdv-OptiPlex-SFF-7010: ~

roscore http://sdv-OptiPlex-SFF-7010:11311/ x sdv@sdv-OptiPlex-SFF-7010: ~ x

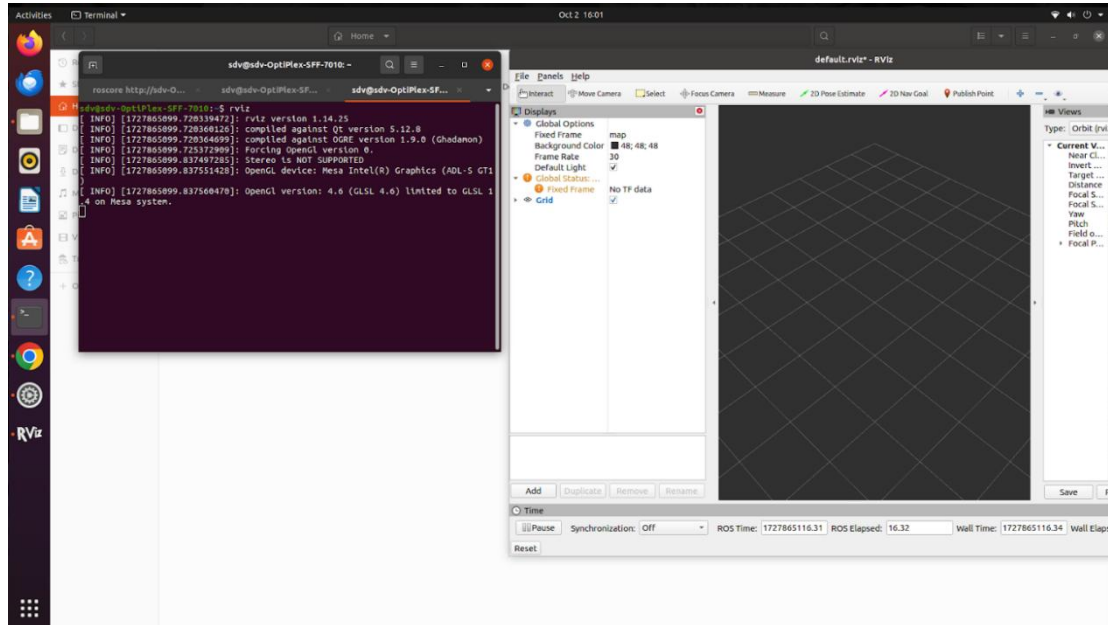
sdv@sdv-OptiPlex-SFF-7010:~$ roslaunch urg_node urg_node _ip_address:=192.168.0.10
[ INFO] [1727865086.831619469]: Connected to network device with intensity and I
D: B2240243
[ INFO] [1727865086.936106149]: waitForService: Service [/diagnostics_agg/add_di
agnostics] has not been advertised, waiting...
[ INFO] [1727865086.971080282]: Streaming data.

```

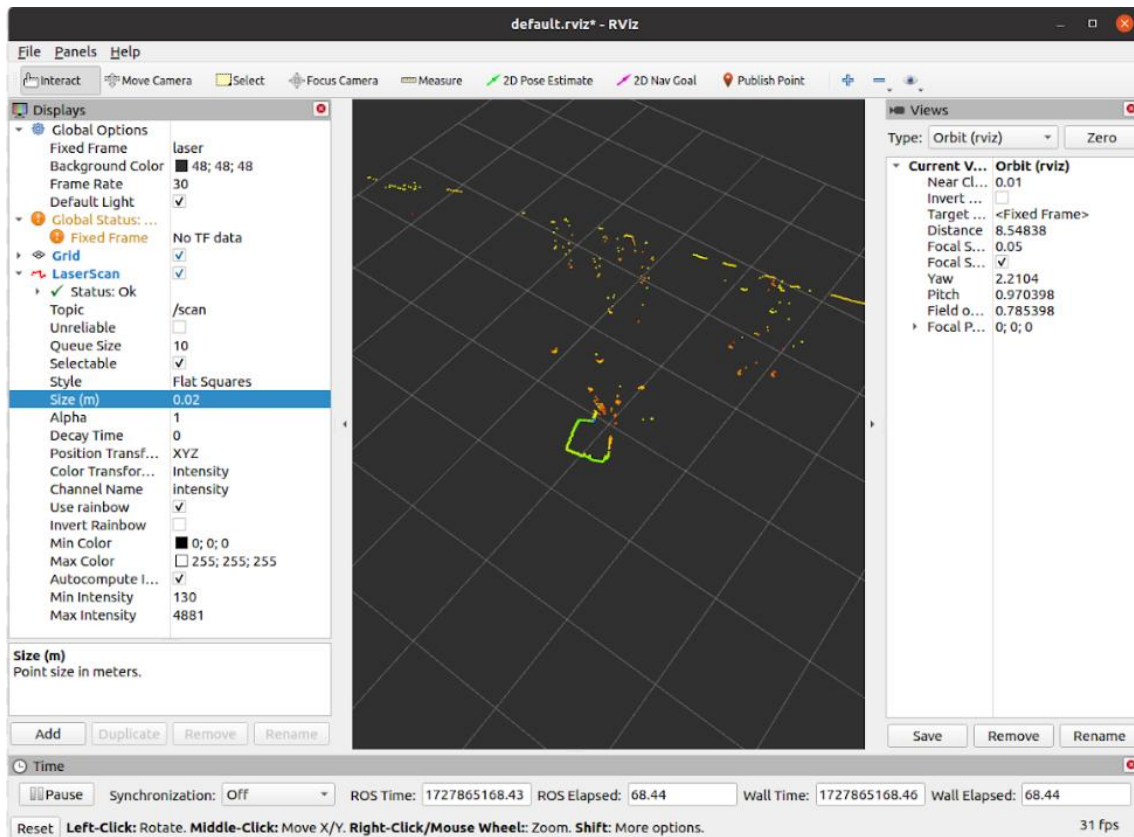
To check where data is coming or not use the following command

```
$ rostopic echo /scan
```

Now open rviz in another terminal.



Change fixed frame to '*laser*' now add the '*LaserScan*' topic from Add button in bottom. You can visualize the LiDAR data as shown

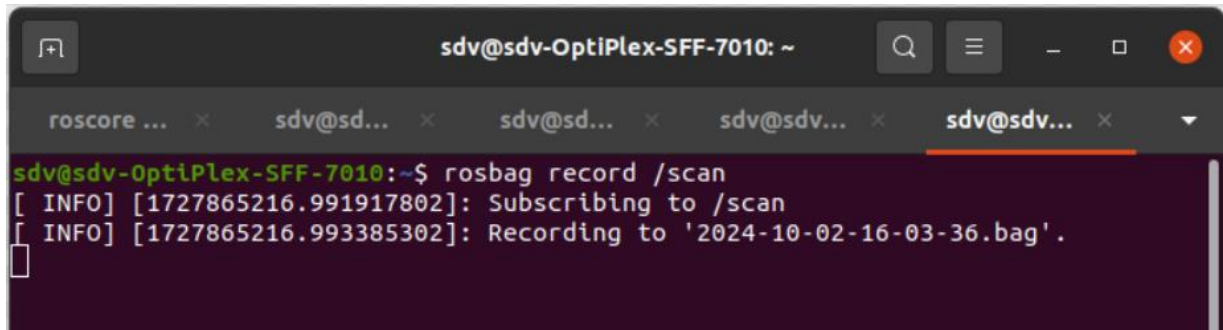


○ Recording the data into a .bag file :

To record the data firstly you have to connect the LiDAR to your system and launch it in the terminal...

```
$ rosrun urg_node urg_node _ip_address:=192.168.0.10
```

open another terminal and use the following command to record the data

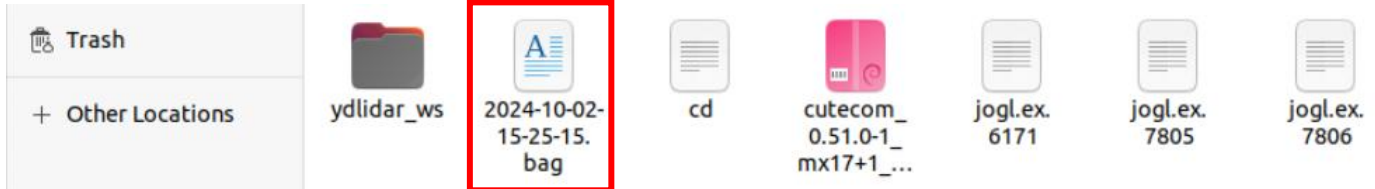


```
sdv@sdv-OptiPlex-SFF-7010: ~
roscore ... x sdv@sd... x sdv@sd... x sdv@sdv... x sdv@sdv... x
sdv@sdv-OptiPlex-SFF-7010:~$ rosbag record /scan
[ INFO] [1727865216.991917802]: Subscribing to /scan
[ INFO] [1727865216.993385302]: Recording to '2024-10-02-16-03-36.bag'.
```

/scan is used because it is the topic that Hokuyo publishes.

To stop the recording use Ctrl+C in the terminal.

This stores the .bag file in your workspace as shown



○ Visualizing .bag file :

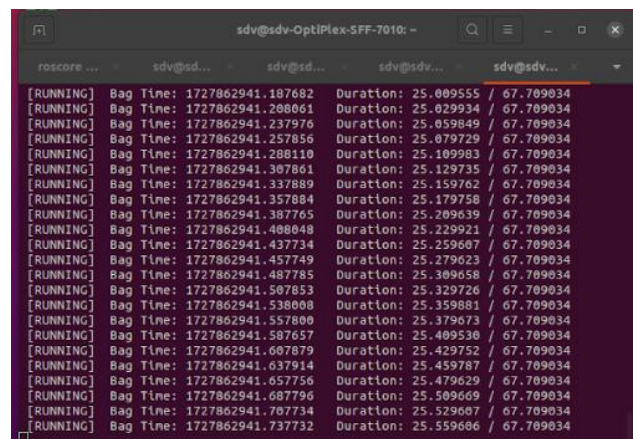
Disconnect the Hokuyo LiDAR if you are connected to the system.

To play the .bag file that you recorded. Open the terminal and run *roscore*.

Open one more terminal, use the following command

```
$ rosbag play 'Path_to_your_bag_file'
```

This will play the bag file as shown



```
sdv@sdv-OptiPlex-SFF-7010: ~
roscore ... x sdv@sd... x sdv@sd... x sdv@sdv... x
[RUNNING] Bag Time: 1727862941.187682 Duration: 25.009555 / 67.709034
[RUNNING] Bag Time: 1727862941.208061 Duration: 25.029934 / 67.709034
[RUNNING] Bag Time: 1727862941.237976 Duration: 25.059849 / 67.709034
[RUNNING] Bag Time: 1727862941.257856 Duration: 25.079729 / 67.709034
[RUNNING] Bag Time: 1727862941.288110 Duration: 25.109983 / 67.709034
[RUNNING] Bag Time: 1727862941.307861 Duration: 25.129735 / 67.709034
[RUNNING] Bag Time: 1727862941.337889 Duration: 25.159762 / 67.709034
[RUNNING] Bag Time: 1727862941.357884 Duration: 25.179758 / 67.709034
[RUNNING] Bag Time: 1727862941.387765 Duration: 25.209639 / 67.709034
[RUNNING] Bag Time: 1727862941.408048 Duration: 25.229921 / 67.709034
[RUNNING] Bag Time: 1727862941.437734 Duration: 25.259687 / 67.709034
[RUNNING] Bag Time: 1727862941.457749 Duration: 25.279623 / 67.709034
[RUNNING] Bag Time: 1727862941.487785 Duration: 25.309658 / 67.709034
[RUNNING] Bag Time: 1727862941.507853 Duration: 25.329726 / 67.709034
[RUNNING] Bag Time: 1727862941.538008 Duration: 25.359881 / 67.709034
[RUNNING] Bag Time: 1727862941.557800 Duration: 25.379673 / 67.709034
[RUNNING] Bag Time: 1727862941.587657 Duration: 25.409538 / 67.709034
[RUNNING] Bag Time: 1727862941.607879 Duration: 25.429752 / 67.709034
[RUNNING] Bag Time: 1727862941.637914 Duration: 25.459787 / 67.709034
[RUNNING] Bag Time: 1727862941.657756 Duration: 25.479629 / 67.709034
[RUNNING] Bag Time: 1727862941.687796 Duration: 25.509669 / 67.709034
[RUNNING] Bag Time: 1727862941.707734 Duration: 25.529607 / 67.709034
[RUNNING] Bag Time: 1727862941.737732 Duration: 25.559686 / 67.709034
```


To visualize it open RViz using another terminal.

Set the global frame as *laser* and add the topic */scan*.

Now you can visualize the recorded data as shown below...

