PointCloud to LaserScan

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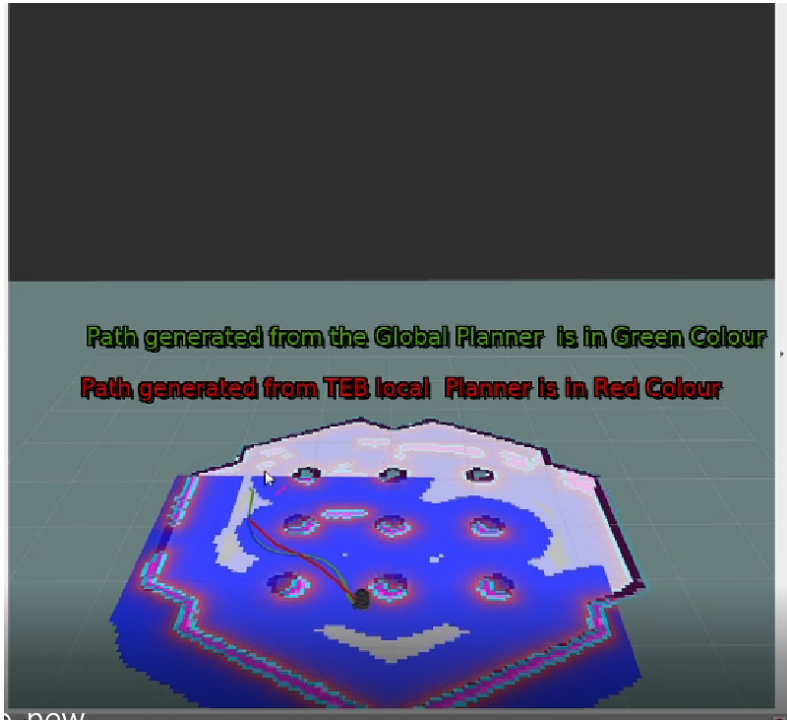
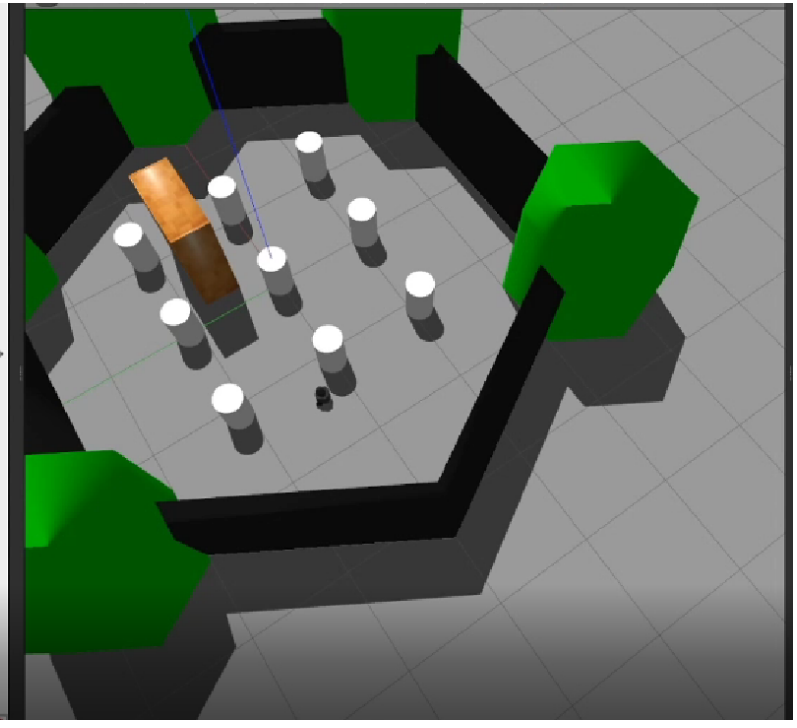
Navigation Stack

- Will talk about this in later lectures.
- A 2D navigation stack that takes in information from odometry, sensor streams, and a goal pose and outputs safe velocity commands that are sent to a mobile base .





Navigation Stack uses LaserScan Messages to detect Obstacle !

- Recall Lab 3 , (Obstacle Avoidance) !
- ranges gives the distance of occupied grids with respect to the robot .

sensor_msgs/LaserScan Message

File: sensor_msgs/LaserScan.msg

Raw Message Definition

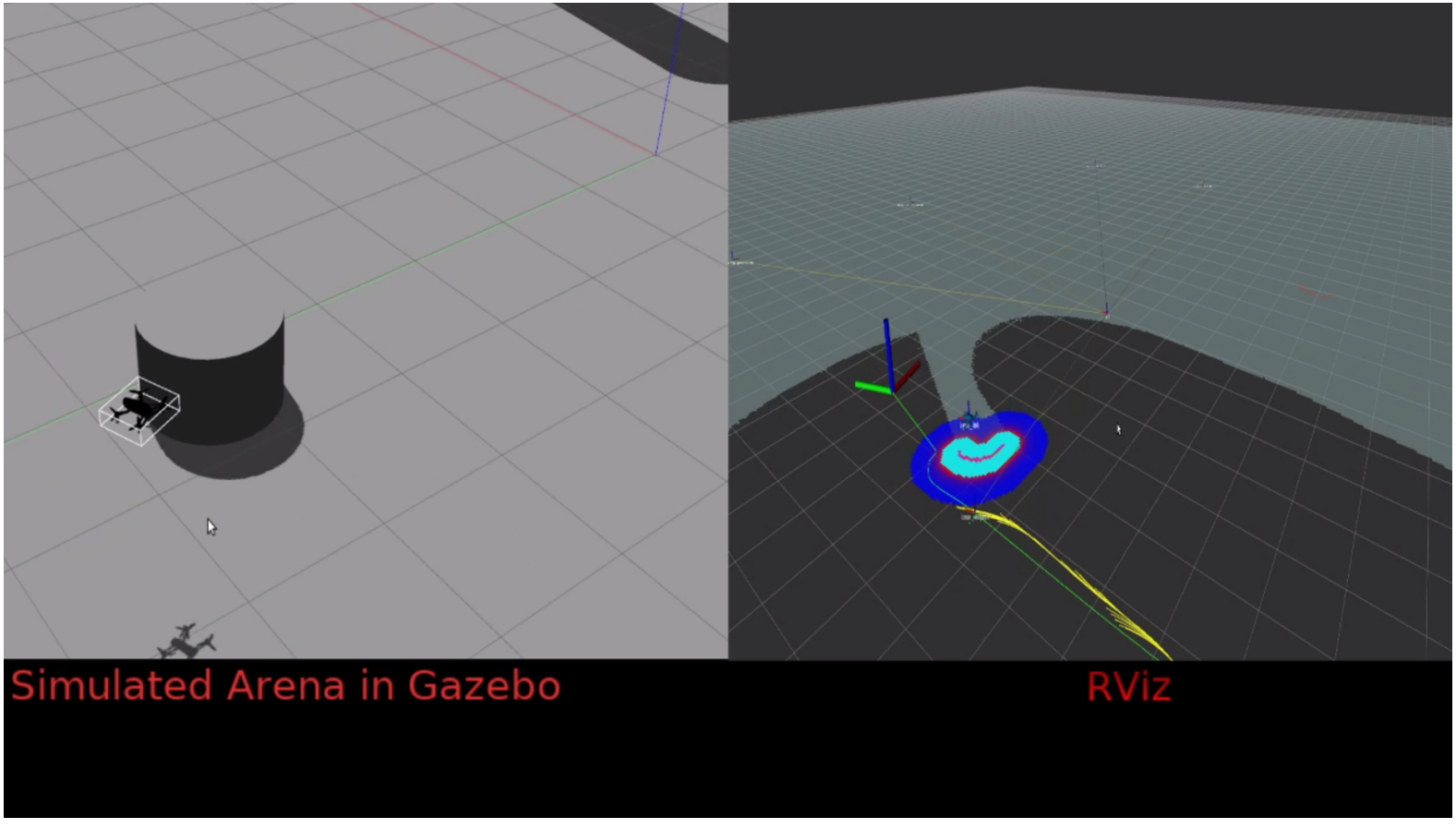
```
# Single scan from a planar laser range-finder
#
# If you have another ranging device with different behavior (e.g. a sonar
# array), please find or create a different message, since applications
# will make fairly laser-specific assumptions about this data

Header header            # timestamp in the header is the acquisition time of
                         # the first ray in the scan.
                         #
                         # in frame frame_id, angles are measured around
                         # the positive Z axis (counterclockwise, if Z is up)
                         # with zero angle being forward along the x axis

float32 angle_min        # start angle of the scan [rad]
float32 angle_max        # end angle of the scan [rad]
float32 angle_increment  # angular distance between measurements [rad]

float32 time_increment   # time between measurements [seconds] - if your scanner
                         # is moving, this will be used in interpolating position
                         # of 3d points
float32 scan_time        # time between scans [seconds]

float32 range_min        # minimum range value [m]
float32 range_max        # maximum range value [m]

float32[] ranges         # range data [m] (Note: values < range_min or > range_max should be discarded)
float32[] intensities    # intensity data [device-specific units].  If your
                         # device does not provide intensities, please leave
                         # the array empty.
```

But

- Unfortunately the drone doesn't have the LiDAR to create the laserScan Messages for us!
- **Fortunately** we have the obstacle (lab8 part1) and drone Position wrt. to the origin (world frame) .

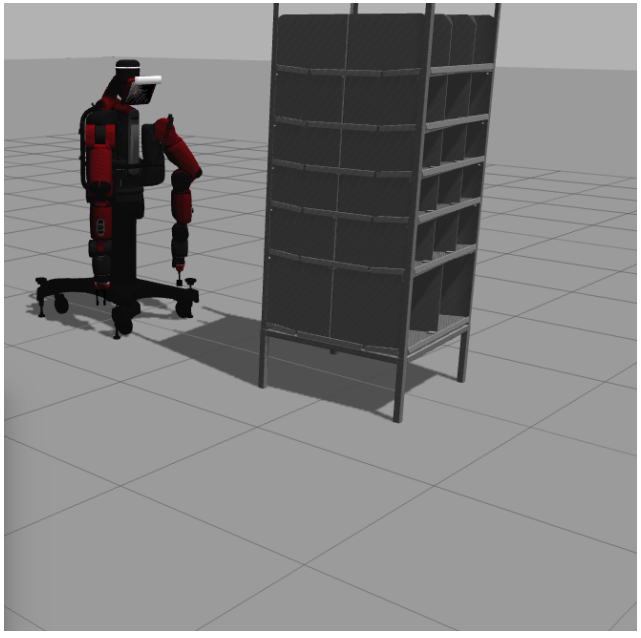
RViz

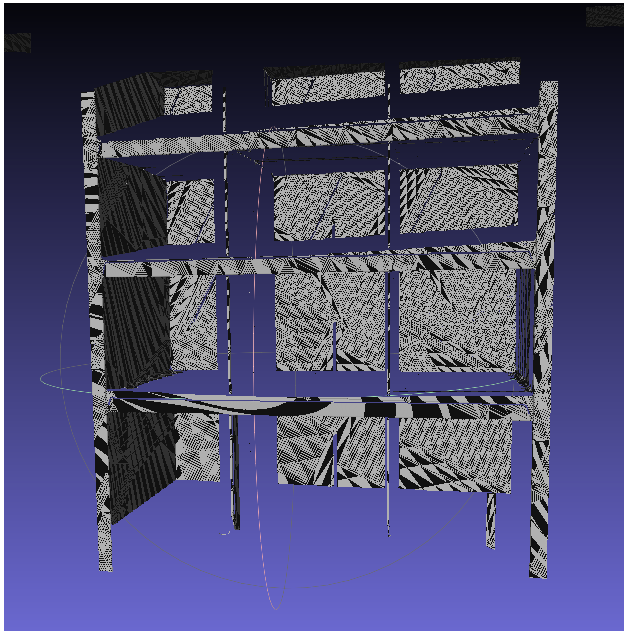
- RViz is a 3d visualization tool which helps us to see the robot's perception of its world (real or simulated).
- command to open RViz : rosrun rviz rviz



What is a Point Cloud ?

- A point cloud is a set of points in 3-D space. more info at link : Math works





- ref figure : stack exchange
- Application : Many , google it !:)

Difference Between LaserScan and PointCloud

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sensor_msgs/PointCloud2 Message

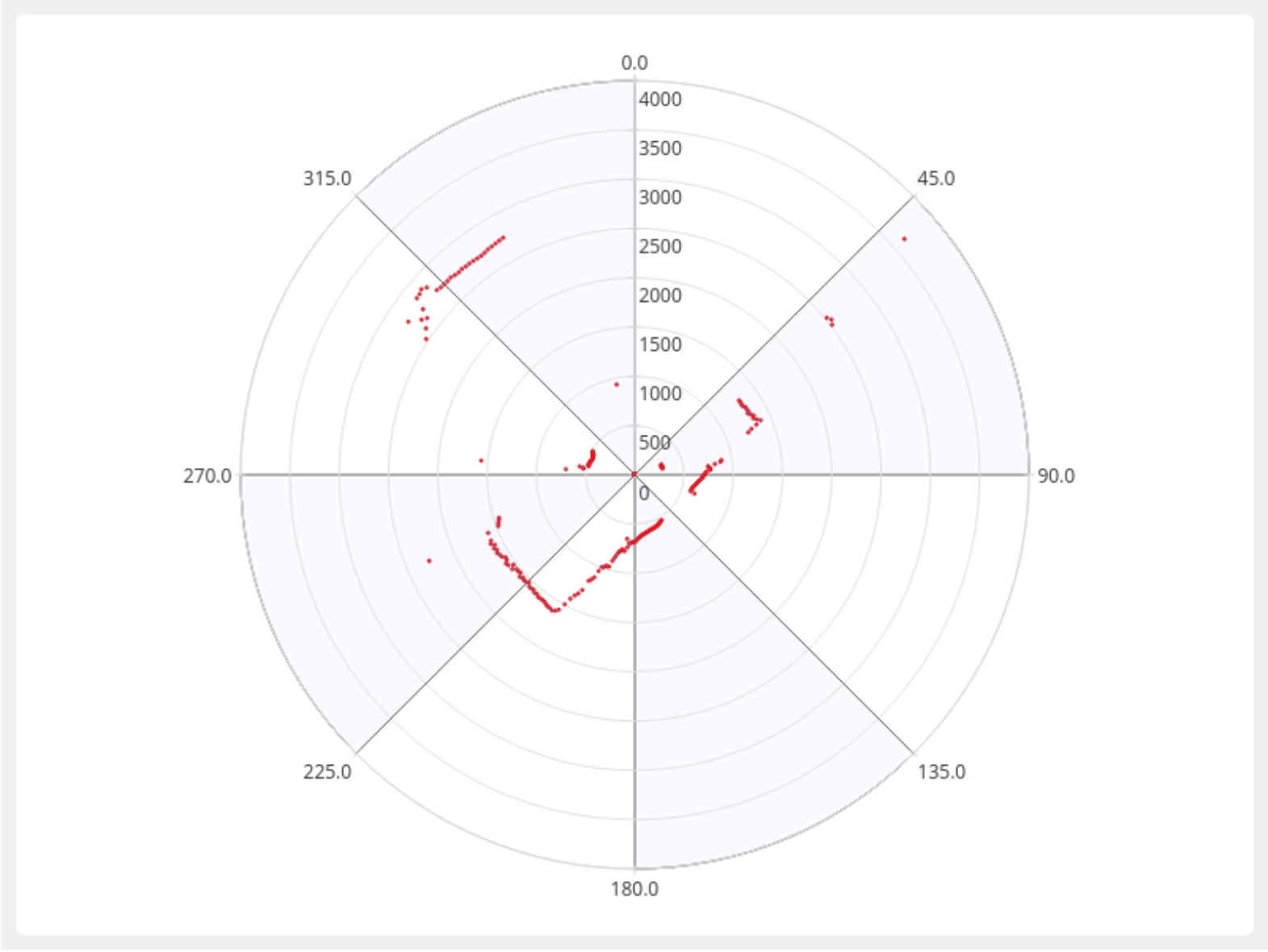
File: sensor_msgs/PointCloud2.msg

Raw Message Definition

```
# This message holds a collection of N-dimensional points, which may
# contain additional information such as normals, intensity, etc. The
# point data is stored as a binary blob, its layout described by the
# contents of the "fields" array.

# The point cloud data may be organized 2d (image-like) or 1d
# (unordered). Point clouds organized as 2d images may be produced by
# camera depth sensors such as stereo or time-of-flight.

# Time of sensor data acquisition, and the coordinate frame ID (for 3d
# points).
Header header

# 2D structure of the point cloud. If the cloud is unordered, height is
# 1 and width is the length of the point cloud.
uint32 height
uint32 width

# Describes the channels and their layout in the binary data blob.
PointField[] fields

bool    is_bigendian # Is this data bigendian?
uint32  point_step   # Length of a point in bytes
uint32  row_step     # Length of a row in bytes
uint8[] data         # Actual point data, size is (row_step*height)

bool is_dense        # True if there are no invalid points
```

Difference Between LaserScan and PointCloud

- LaserScan : list of points representing 1D lengths



ref :Turtle Bot3 webpage

Difference Between LaserScan and PointCloud

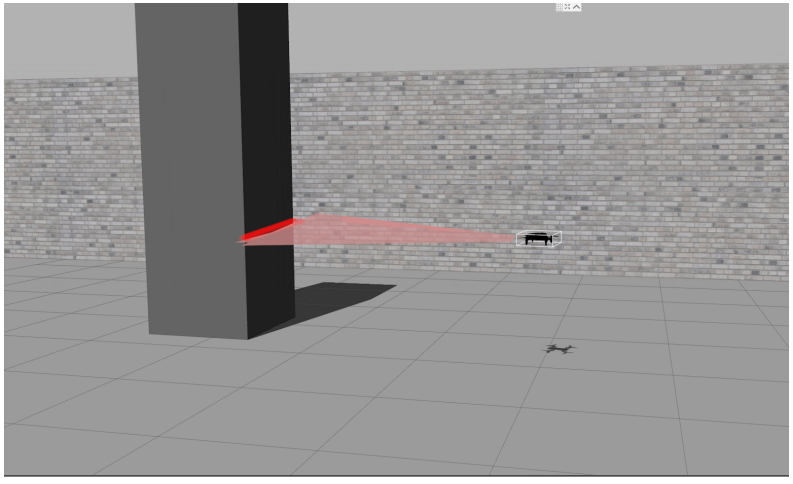
- PointCloud : actual 2(or3)D point cloud
- LaserScan : Polar Coordinates (angle and ranges)
- PointCloud : Cartesian Coordinates (actual x,y,z points)
- More differences at link : ros wiki

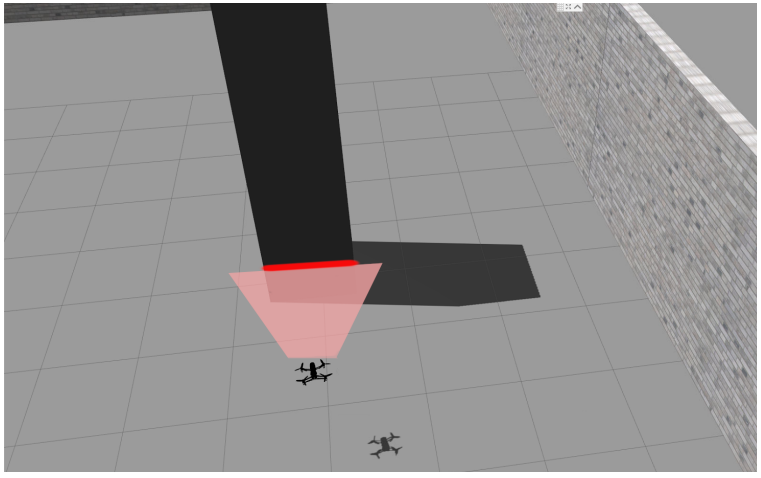
How to get LaserScan Messages

- Get Point Cloud of obstacles.
- Publish the informationi in a ros topic of message type PointCloud2
- Convert PointCloud2 Message to laserScan Messages , **the laser Scan ranges should be with respect to drone**. (There Could be other methods also , feel free to explore)

Get Point Cloud of obstacles ?

- Drone will only move in 2 Dimension (x-y plane)
- Flying At fixed height h





Get Point Cloud of obstacles ?

- We have the obstacle's center Positions (x_obs,y_obs) (lab8 part1) wrt. **origin**

```
obs_poses_list:
  -
    header:
      seq: 0
      stamp:
        secs: 2919
        nsecs: 139000000
      frame_id: "world"
    child_frame_id: "obstacle_3"
    transform:
      translation:
        x: -3.392229932848181
        y: -3.044680007518848
        z: 0.7935459706385772
      rotation:
        x: 4.964664796444344e-08
        y: 4.964664796444344e-08
        z: 1.461305056859797e-10
        w: 0.9999999999999989
  -
    header:
```

Get Point Cloud of obstacles ?

- Over Approximate the Obstacle's 2D Projection on x,y surface as a Circle with radius r ,and Center (x_obs,y_obs) at height h
- Create A Circle (Point Cloud)
- Publish the coordinates of all the **points** on a circle circumference to a topic (sensor_msgs/PointCloud2)

Get Point Cloud of obstacles ?

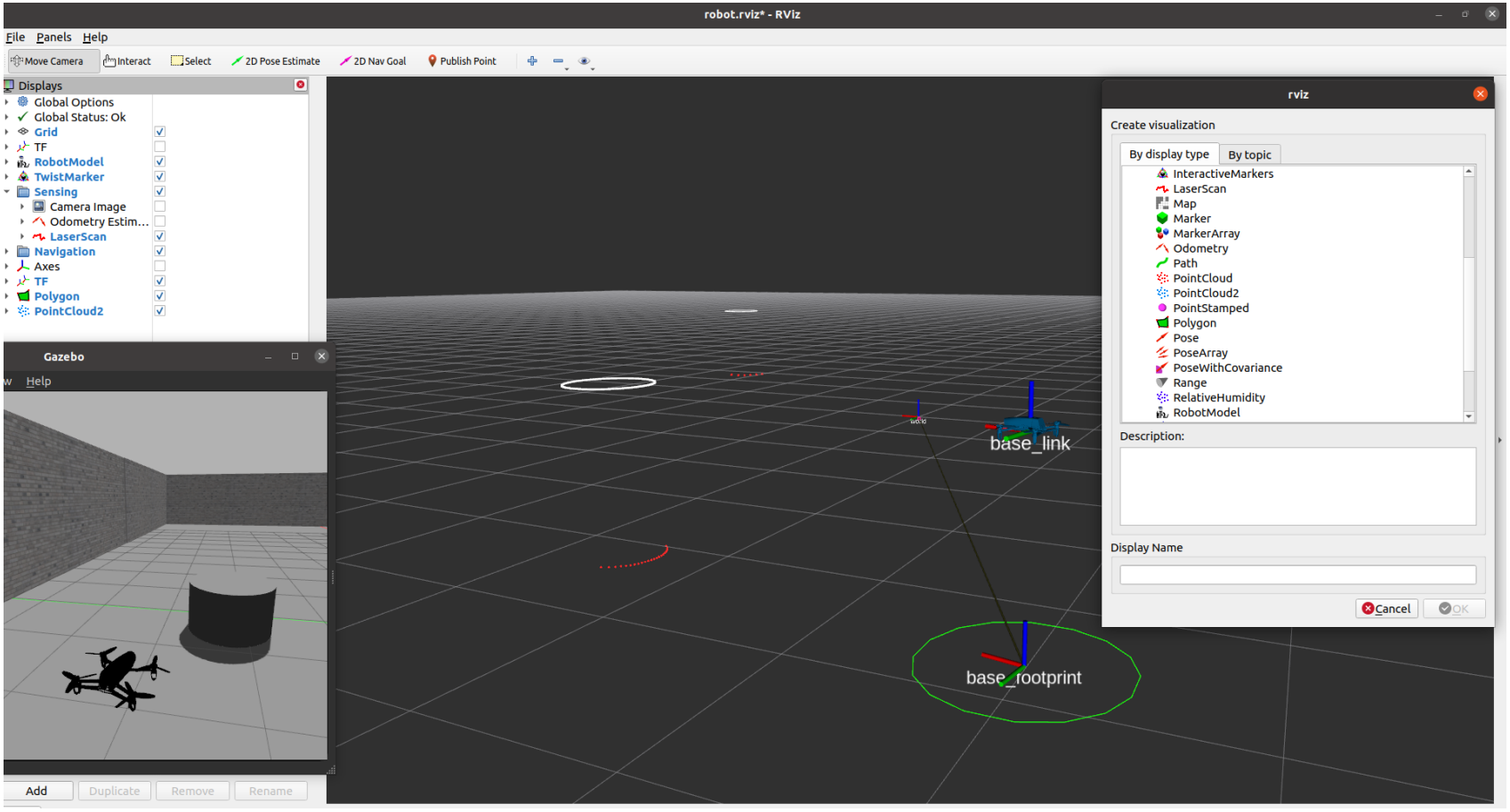


Figure 1: rviz_obs

convert PointCloud Message to LaserScan Messages?

- We will use a Standard ROS package to covert the PointCloud to LaserScan Messages
- name of package & link : pointcloud_to_laserscan
- Most Important Parameter :
- ~target_frame (str, default: none)
  - If provided, transform the pointcloud into this frame before converting to a laser scan. Otherwise, laser scan will be generated in the same frame as the input point cloud.
- After this ,We are ready to work with Navigation Stack (next week)

Assignment

- Create Point Cloud of the obstacles present in your Environment
- Convert the PointCloud Messgaes to LaserScan Messages using the Standard ROS package