Running a Visual SLAM Algorithm and connecting it to a Quadrotor

Today we will be looking at testing an existing Visual SLAM architecture in Ubuntu using ROS1. The objectives are as follows:

- Testing a dense SLAM approach called LSD-SLAM (Large-Scale Direct Monocular SLAM). For more information on how LSD_SLAM including the papers associated with it, check https://cvg.cit.tum.de/research/vslam/lsdslam?redirect=1
- Controlling a Quadrotor equipped with a camera, IMU and LIDAR
- Connecting the Quadrotor to the LSD-SLAM
- Connecting the Quadrotor to a feature based SLAM which we will develop

We will doing the above in ROS Noetic (ROS1) because the libraries are still being ported to ROS2. We will also be using a Virtual Machine with ROS Noetic.

1. **Starting the Virtual Box and Virtual Machine:**

   Start VirtualBox from the Ubuntu applications menu
   File | Import Appliance
   browse and import /opt/york/its/net/vm-images/ROS-Noetic_2.2.ova
   You can leave the default settings except:
   * you may need to reduce the RAM to 8192 MB
   * you **must change the Machine Base Folder to /tmp/**. Note that this folder will be deleted on a reboot.
   Start the VM - it will automatically log in with the ROS 1 environment set, but if you do need the password it's "NoeticVM"

2. **Testing a dense SLAM approach called LSD-SLAM:**
   Check that you have the folder LSDSlam in the home/ros/workspace folder. If it is there, open up a terminal and type:

   echo "source ~/workspace/LSDSlam/devel/setup.sh" >> ~/.bashrc

   source ~/.bashrc

   This would direct the ROS ecosystem to find LSD executables etc from the various terminals you will be opening.

   Download the LSD_room and LSD_machine.bag datasets from https://cvg.cit.tum.de/research/vslam/lsdslam?redirect=1: by typing the following links in firefox browser.

   https://vision.in.tum.de/webshare/g/lsd/LSD_room.bag.zip
   https://vision.in.tum.de/webshare/g/lsd/LSD_machine.bag.zip

   This will download the files into your downloads directory. Extract them and move them into a folder called datasets in the **/home/ros/workspace/LSDSlam** folder.

   Open 5 terminals. In the first terminal type:
   roscore to start the ros master node.

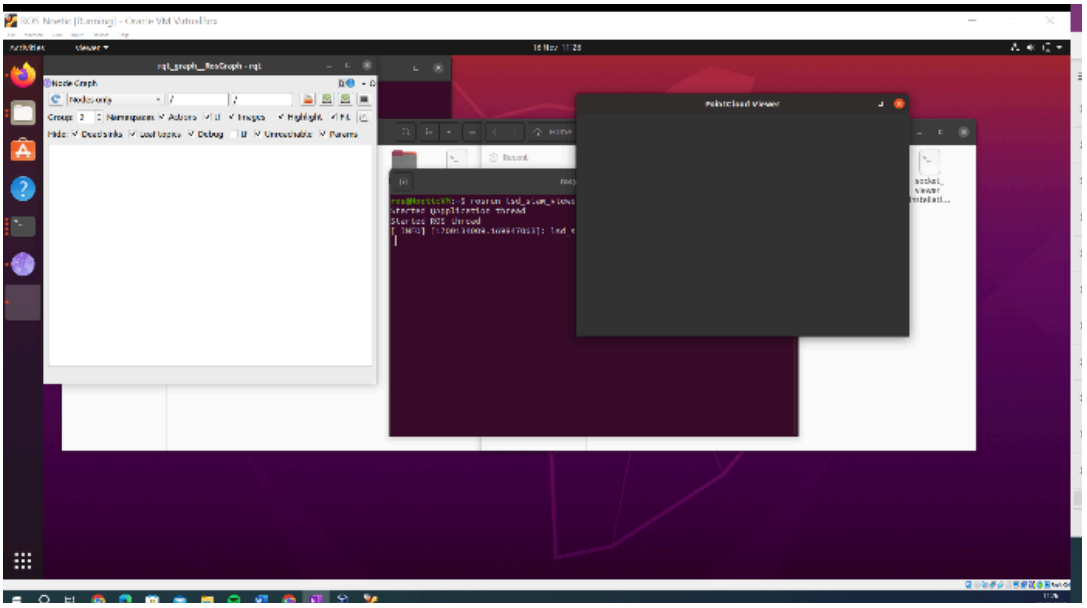
In the second terminal, type:
rosrun rqt_graph rqt_graph

This will bring up the RQT graph that shows what ROS nodes are running and how they are connected to each other.

In the third terminal type:
Source the setup.bash of the LSD_SLAM by typing:
source ~/workspace/LSDSlam/devel/setup.sh

This makes ROS remember the commands and execution scripts associated with using LSD_SLAM.

Then type **rosrun lsd_slam_viewer viewer** to launch the lsd_slam viewer (https://github.com/tum-vision/lsd_slam). This will launch the map that is generated as the camera moves around in the environment.



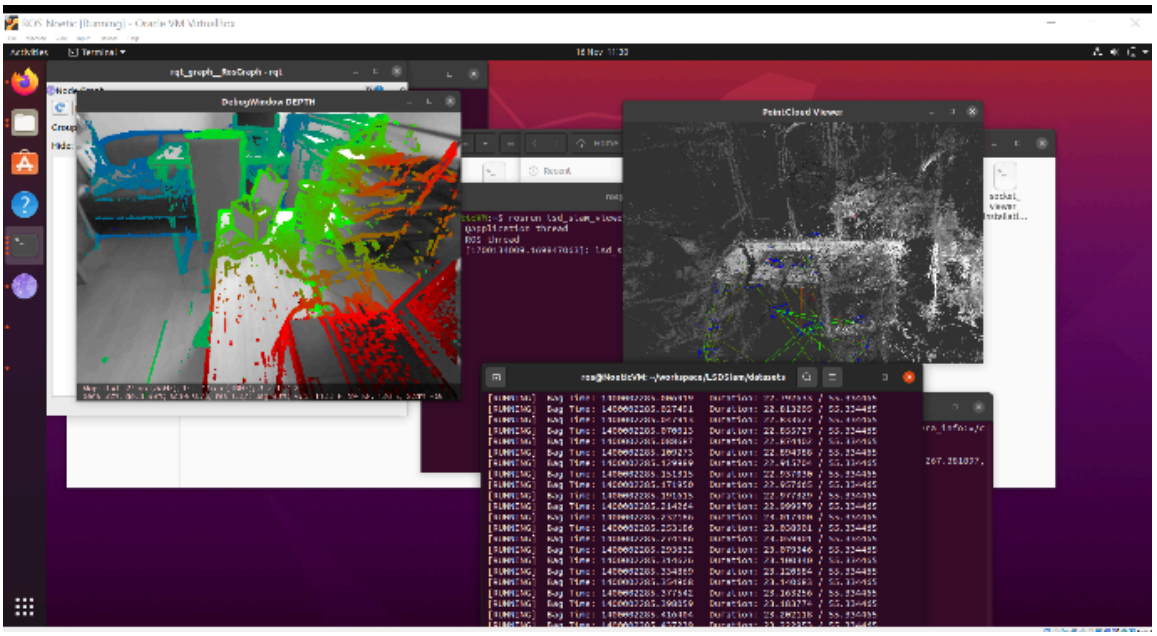
In the fourth terminal type: **rosrun lsd_slam_core live_slam image:=/image_raw camera_info:=/camera_info**

This runs the visual slam algorithms (lsd_slam_core live_slam) and sets the lsd_slam implementation to take raw camera images using image:=./image_raw. Camera_info:=/camera_info is used to capture extrinsic and intrinsic information about the camera you are using

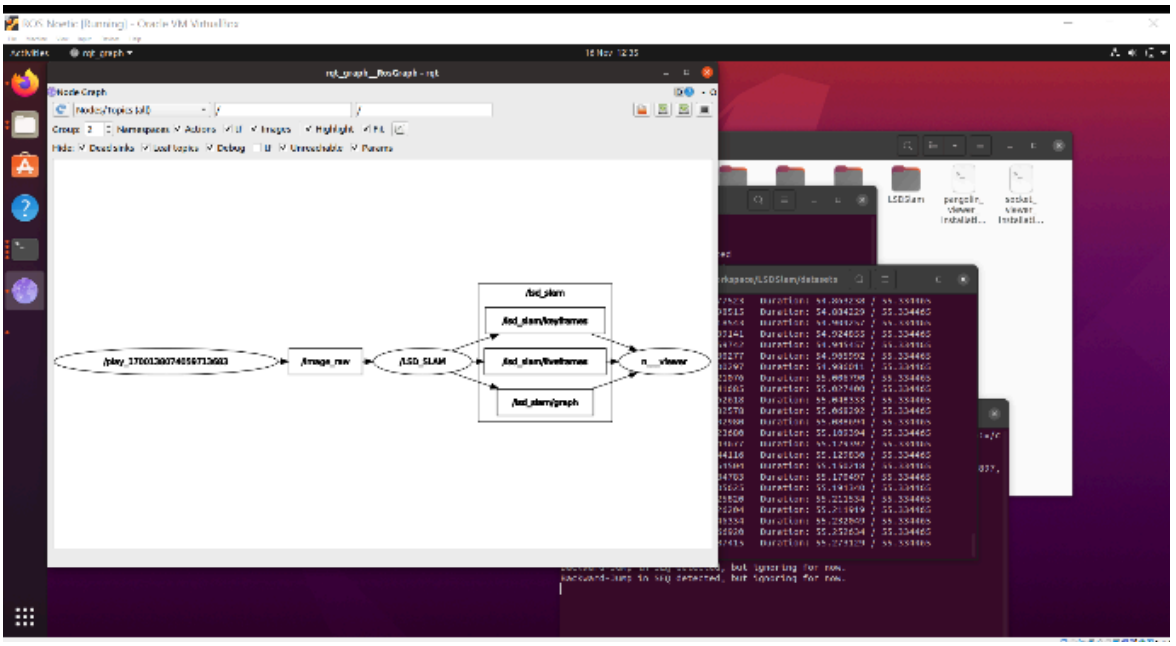
Go to the directory where the datasets are:
cd /home/ros/workspace/LSDSlam/datasets

And type: **rosbag play LSD_room.bag** this would playback a ros dataset

You should get



The debugWindow shows the movement of the camera in the room environment while the pointCloud viewer displays the created map and the camera trajectory as it moves through the environment



Check the Node Graph or rqt_graph and you should get something similar to the above.

Exercise 1:
Try if you can play back LSD_Machine.bag dataset.

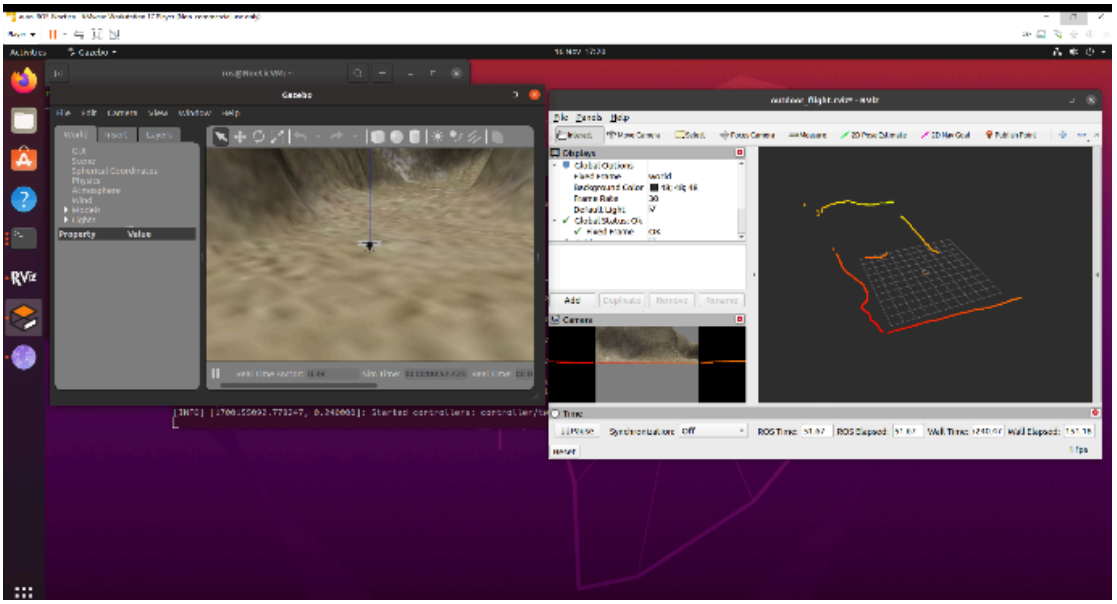
3. **Flying the Hector Quadrotor.**

We will use the camera on a hector Quadrotor to perform SLAM of the Quadrotor. But first, we need to get the Quadrotor workinig.
To do this, check that you have the directory:
/home/ros/workspace/HectorQuadrotator/

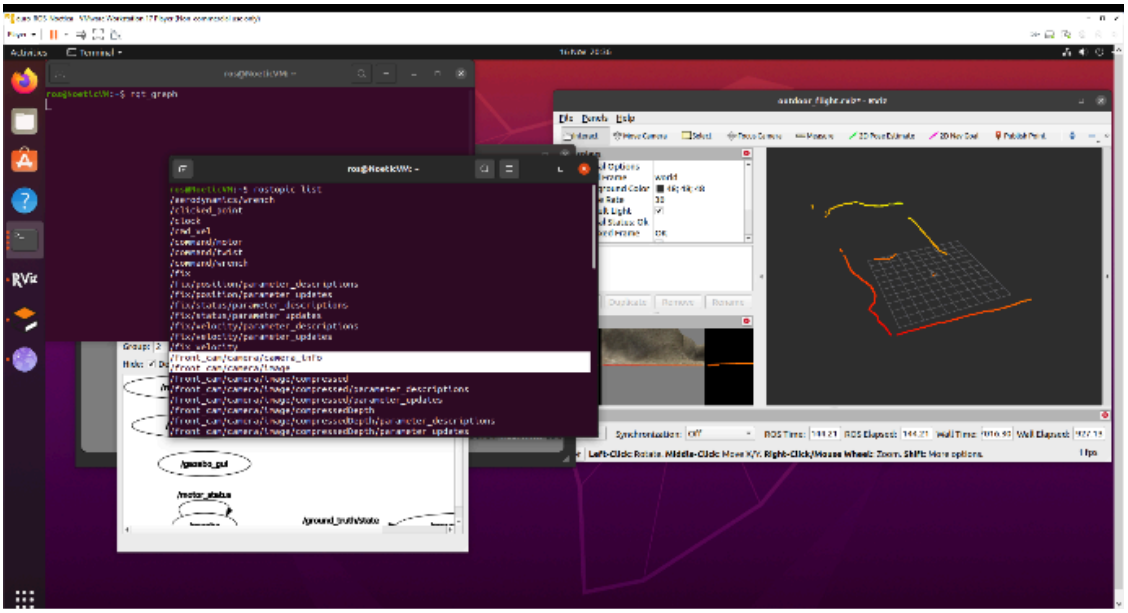
If so, open a terminal and type:
source ~/workspace/HectorQuadrotator/devel/setup.bash

Then type: **roslaunch hector_quadrotor_demo outdoor_flight_gazebo.launch**

To open up gazebo and Rviz with a Quadrotor. You should get the picture below:



Open another terminal window and type: **rostopic list**
This will display the list of topics being published and subscribed to in the ros system. You should see that two of the topics are **/front_cam/camera/camera_info** and **/front_cam/camera/image**



Open another terminal and type: **rosrun teleop_twist_keyboard teleop_twist_keyboard.py**

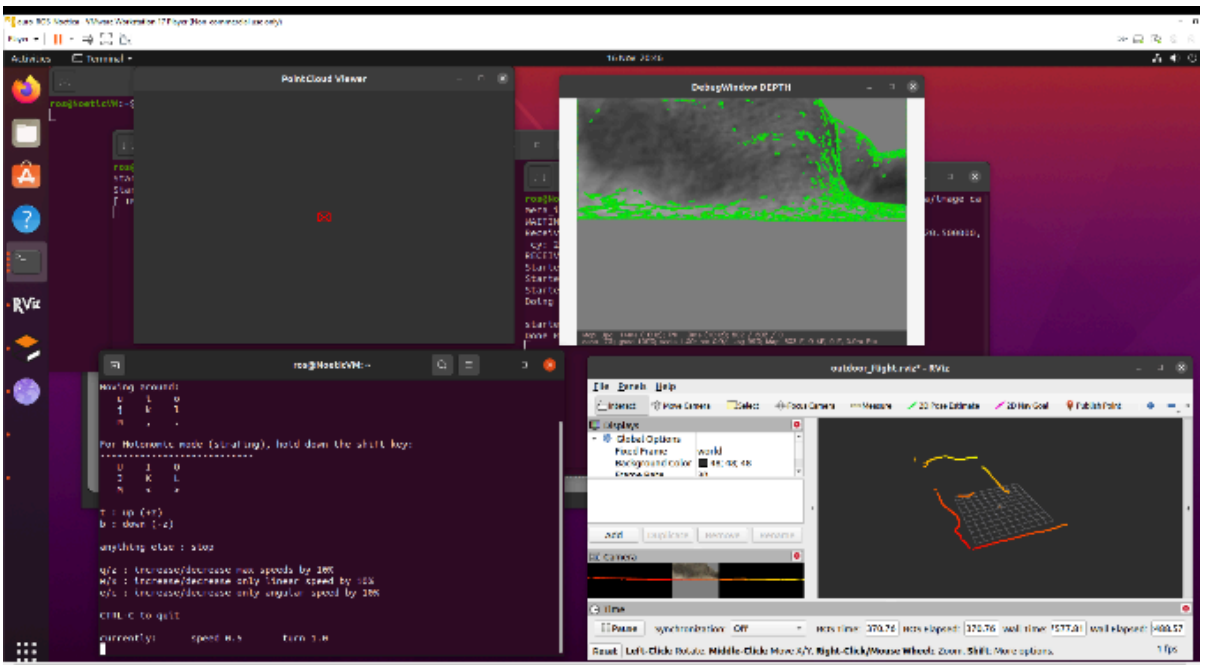
When you press the key **t**, you should see the Quadrotor raise from the floor. To make it land type **b.**

4. **Connecting LSD_SLAM to a camera on a Drone**
   Now we will attempt to connect the LSD_SLAM system to the camera on the Quadrotor.

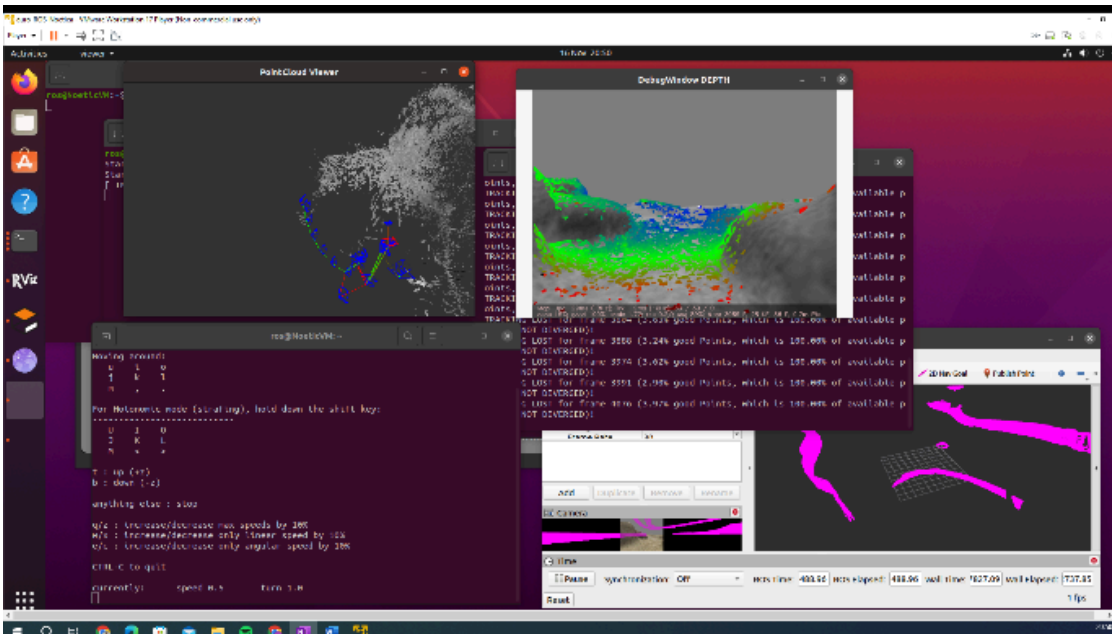
   Open a terminal window and type: **rosrun lsd_slam_viewer viewer**

   Open another one and type: **rosrun lsd_slam_core live_slam image:=/front_cam/camera/image camera_info:=/front_cam/camera/camera_info**

   You should have something like below:



Trying flying around and you should get the picture below when you click on the pointcloud viewer window.



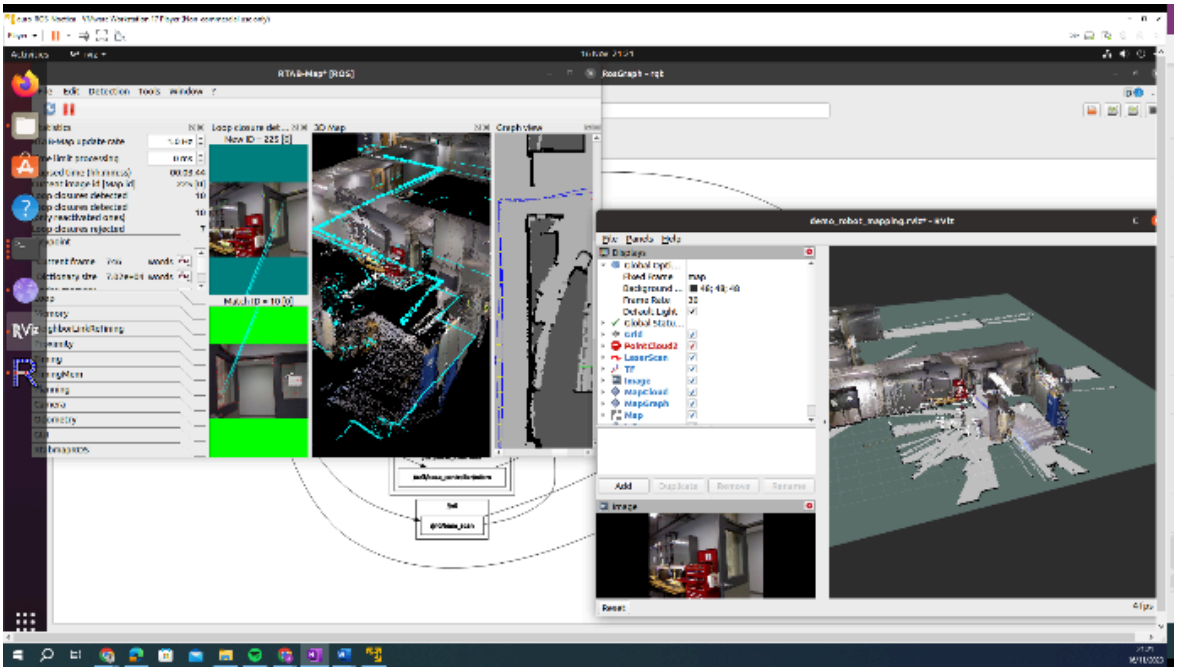
Exercise 2:

Try to run rtab_map slam by typing in a new terminal

roslaunch rtabmap_demos demo_robot_mapping.launch rviz:=true rtabmapviz:=false

Download demo_mapping.bag from this website (http://wiki.ros.org/rtabmap_ros) and run **rosbag play --clock demo_mapping.bag** in another terminal.

You should get the figure below:



See if you can configure the URDF for hector_quadrotor to take a RGB-D camera and then connect the published topics to the RTAB_map node. Remember to use the rqt graph as it is very helpful in helping to see what is being published and to where.

That is all for this week 😊