# Individual Lab Report – 8

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Team D: CuBi

Team Members

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**Individual Progress**

By the end of last progress review, we were able to create a base map using Hokuyo LiDAR and Intel RealSense camera. Rtabmap ROS package was used to create the map using the camera. It was observed that LiDAR map gave clear cut edges than that of RealSense. Going on to the next steps the following questions were needed to be addressed:

- Should RealSense be used to map objects that are lower than the LiDAR height? Given that our LiDAR is 2D, it is limited in its position to detect smaller obstacles.
- Can RealSense give more reliable map than Hokuyo 2D LiDAR if a threshold is set given that RealSense provides better point cloud data at shorter ranges.
- Should sensor fusion of Hokuyo + LiDAR be performed for map creation? If the map produced by the camera is worse than that of LiDAR, then fusing the map should need a valid reason because the resulting map need not be better than a LiDAR map.

The figures 1 and 2 show the image of the world and a 2D occupancy map of that view respectively.

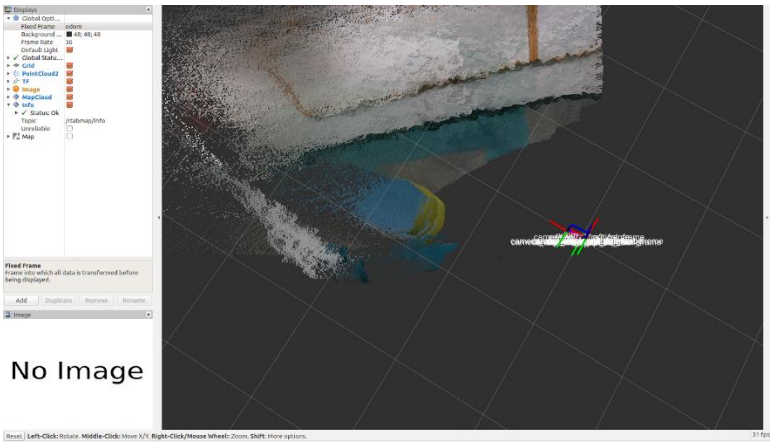


*Figure 1. Image of the world*

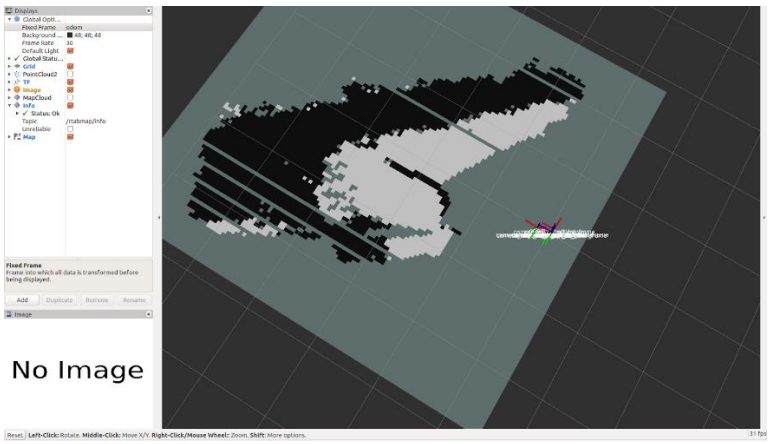


*Figure 2. 2D occupancy grid of the world using RtabMap*

There is no depth threshold set for the camera depth input for the above two figures. It is observed that the map obtained using the camera is not better than the previous map obtained from the LiDAR.

Next step was to set a maximum depth threshold for the camera to get the point clouds. After multiple iterations of the threshold, it was found that a value of 2.5m is the minimum allowed maximum depth for the RealSense and Rtabmap combination.

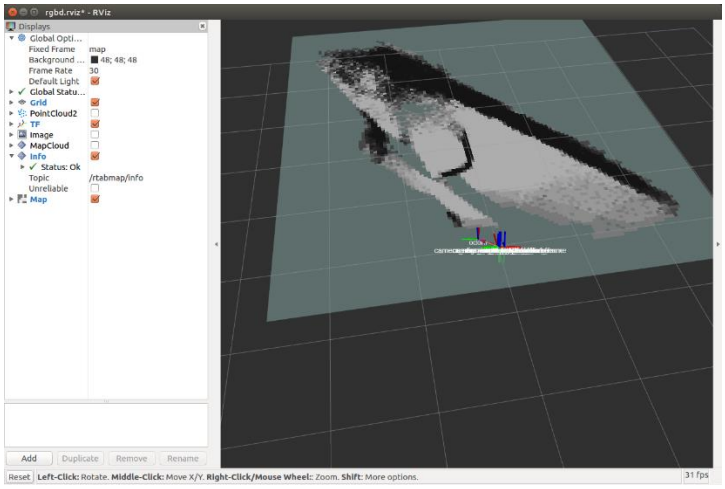


*Figure 3. 2D occupancy map with maximum range of 2.5m*

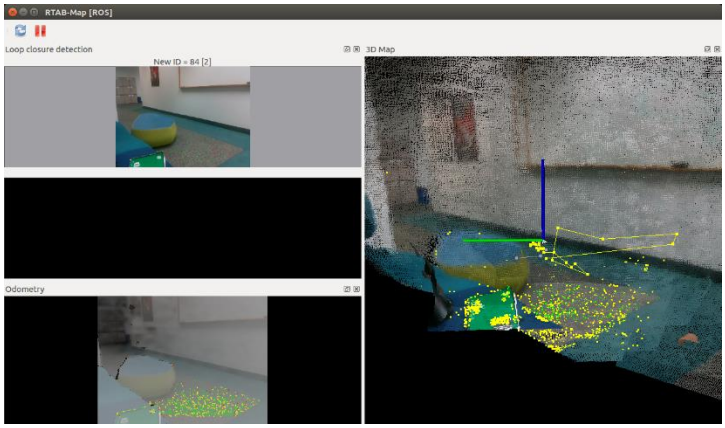


*Figure 4. A small obstacle(sofa) in the world*

It can be observed from figure 3 that the edges are more defined than that in figure 2. While setting a lower threshold does help in obtaining a better map with well-defined edges, it can be seen that the small sofa was not mapped properly.

After obtaining this result there were discussions if we need to map the small obstacles at all as we will have an obstacle detection subsystem separately and mapping small obstacles would then become redundant. However, for the planning subsystem it is required to know the all the obstacles position to prevent the robot from going to a void state.

The conclusion of the above discussion is as follows:

- Hokuyo LiDAR is a better standalone sensor for mapping.
- Mapping of small obstacles is useful for planning.
- For small object detection, obstacle detection subsystem with RealSense will be deployed.

I also helped Jorge with replicating the SVD for this progress review. After the code clean-up and integration, there were some issues. For example, CuBi was not able to close its fingers once it came close to an object to pick up. So, we came up with a debugging methodology to make CuBi work once again.

**Challenges**

There are a lot of dependencies between the subsystems and it is a challenge to anticipate how each output feeds into another. This is where Systems Engineering comes in handy, but the low-level details cannot be known unless implemented. For example, we don't know how exactly the planning subsystem can use the mapped obstacle position and it might be a waste of time to implement if its redundant. The only thing that is close to a solution is to communicate better about each subsystems inputs and outputs, and their requirements. Absence of a reliable test site has also been a roadblock and we are hoping to find a solution soon.

**Teamwork**

Laavanye helped me with the setting up of the packages for mapping. I took over the mapping subsystem from him this time and this required significant communication. Bobby and I work together on localization, so we designed as to how the base map fits into the entire system. Bobby also handles planning subsystem and we had to come up with strategies on mapping of the obstacles. Jorge and I worked on debugging CuBi and make it perform SVD again. He also discussed with me about the high-level issues that needs to be addressed in the mapping subsystem. Paulo had been working on the state machine in order to improve the robot's fail-safe mechanisms. My interactions with him were about explaining each other's work.

**Plans**

Next plan is to perform map fusion if deemed necessary and to create the base map in a way that is easily used by the localization subsystem. The other task is to start ideating and implementing the obstacle detection pipeline. As for the team, we plan to create more fail-safe states, plan exploration strategy, and begin the localization pipeline.