

**Question 1:**

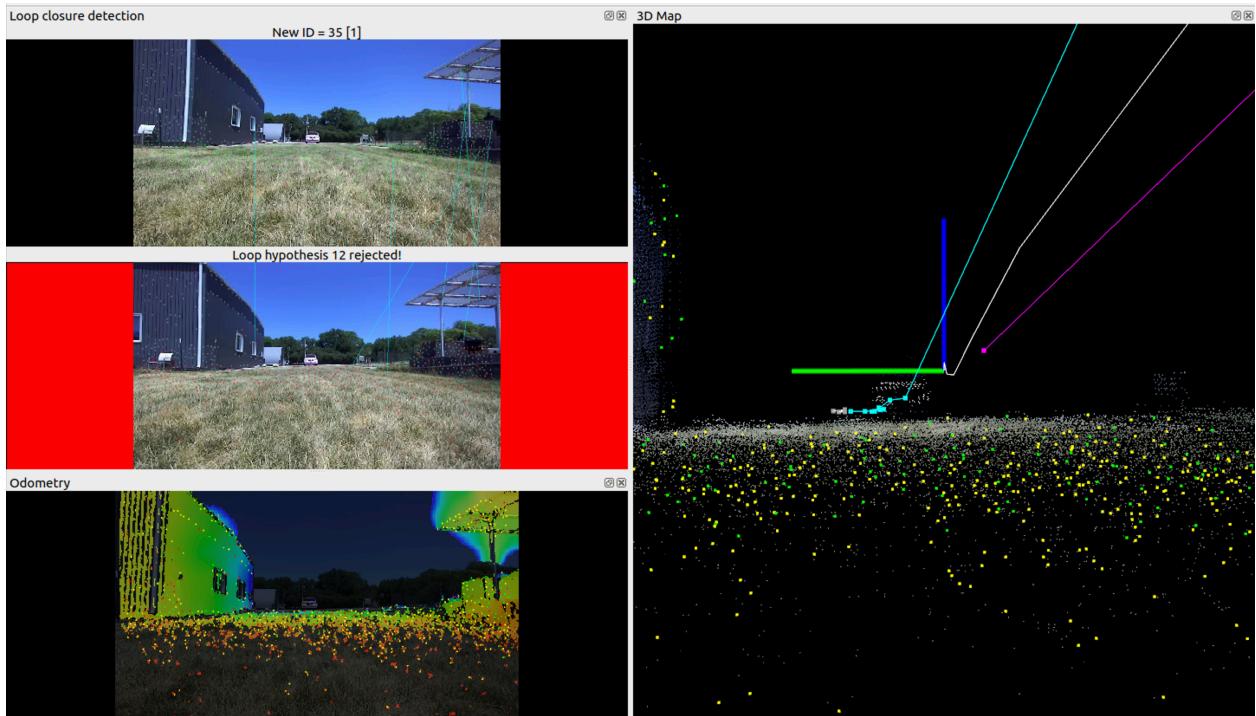


Figure 1: 3D map for rosbag1

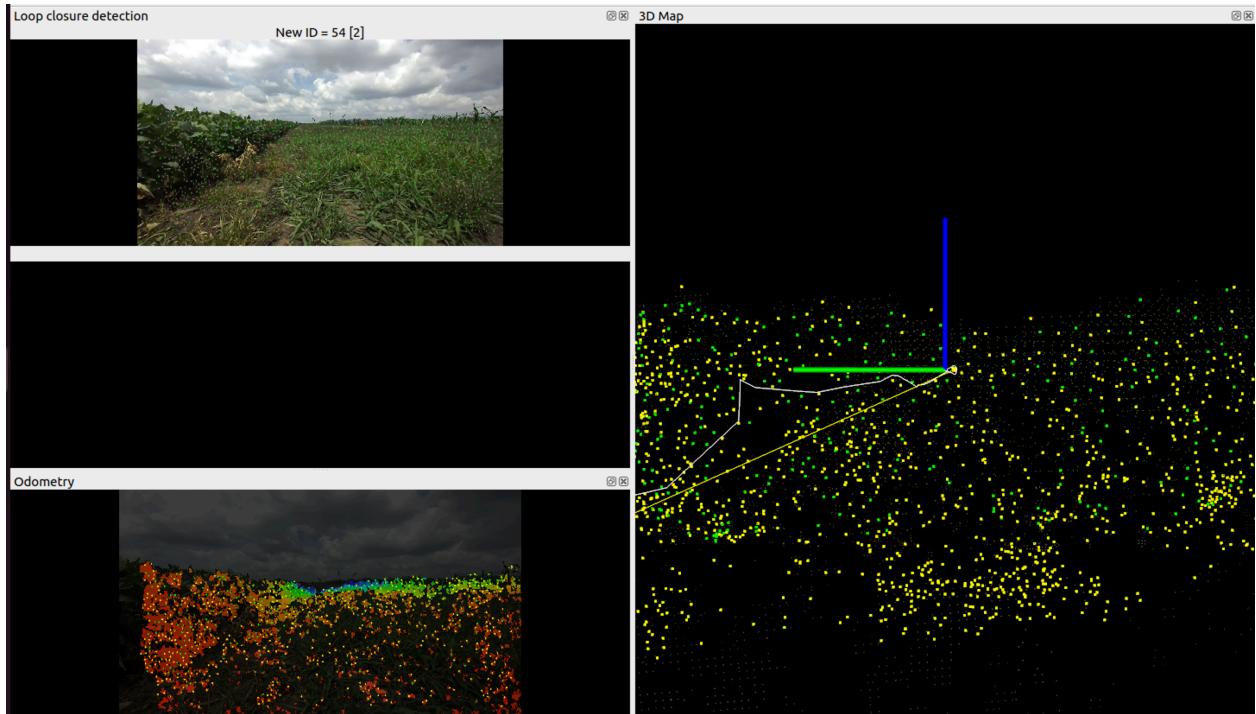


Figure 2: 3D map for rosbag2

**Question 2:**

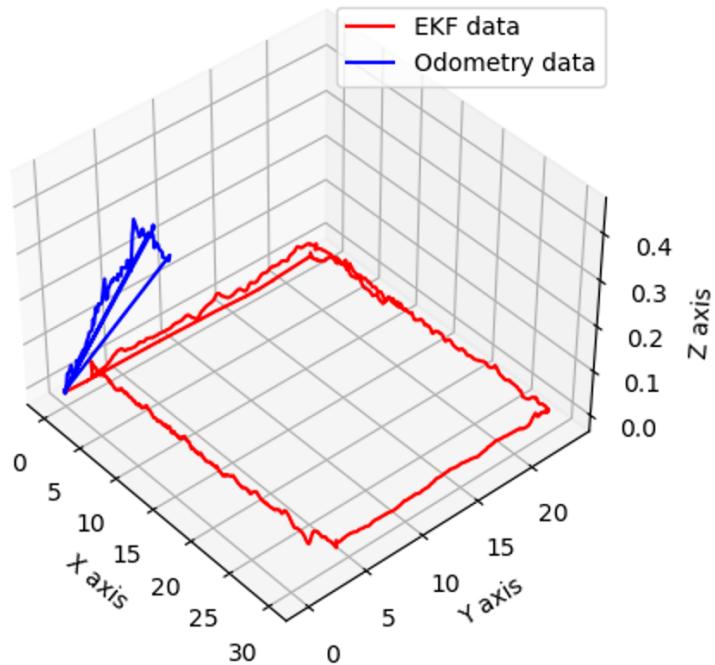


Figure 3: 3D plot for rosbag1

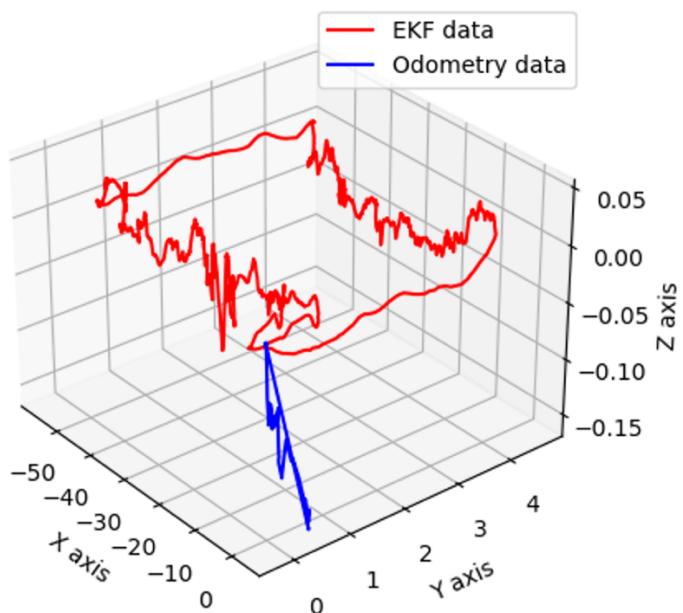


Figure 4: 3D plot for rosbag2

**Question 3:**

```
34 def compute_rmse(ekf_rmse, odom_rmse):  
35     ekf_rmse_path = 'ekf_rmse.txt'  
36     ekf_rmse = np.loadtxt(ekf_rmse_path, delimiter=',')  
37     odom_rmse_path = 'odom_rmse.txt'  
38     odom_rmse = np.loadtxt(odom_rmse_path, delimiter=',')  
39     N = 197  
40     rmse = np.sqrt(np.mean((ekf_rmse - odom_rmse) ** 2)/N))  
41     print(rmse)  
42     return rmse  
43  
44 compute_rmse()
```

Figure 5: RMSE function

Created a separate txt file that includes ekf data for every odom data within each time stamp so that the amount of data ( $N = 197$ ) is the same for each. This is because data gathered from ekf is significantly more than odom. The formula is applied in the ‘rmse’ variable.

*RMSE for rosbag1: 20*

*RMSE for rosbag2: 30*

**Question 4:**

Figures 3 and 4 show that the data has a lot of noise (can be visualized by the spikes in the data). This can be due to several reasons, for example RTAB uses LiDAR and its estimated data so that is one reason it contains noise. EKF data is fused with GPS data.