Chapter 1 Chapter 5

Conclusion And Recommendation

In this research, a prototype is developed for compliant usage in industrial setup. The robot is ~~as~~ 6R manipulator, with six-degree-of-freedom. Each joints is actuated with Dynamixel servo and are back-drivable. The end-effector is equipped with an RGB-D sensor. The robot is named as *r_mini*. Since the Dynamixel motors are not supplemented with a mathematical model, the joints are controlled based on time-parameterized controller where, the set up of each of the motor's velocity profile depends on the angular velocity limits and the angular acceleration limit which was successfully tuned. All of the *r_mini* controllers parameters and system configuration, including it's driver, are package as a stack of ROS packages.

A benchmark was done to ascertain the best sampling-based planner for the *r_mini*'s capability to avoid moving obstacles. The simulation for the benchmark considers a static object, placed in the manipulator's workspace. RRT was selected given it's rapid processing time at giving a planning solution. Another simulation was done where a moving object with the shape of a cylinder is placed in the robot's workspace. The robot avoids the moving obstacle successfully under 50 cycles from initial pose to a goal pose prescribed by the cycle space C_{cycle}.

The simulation based on the moving obstacle is reiterated with the robot hardware. The moving obstacle is augmented into the configuration space of the robot manipulator.

This thesis's SLAM implementation, by repurposing RTAB-Map as the SLAM framework and PHASER's implementation as the state estimation pipeline of the RTAB-Map, shows an intermittent and sparse estimation of the C_{ee} which fails to continuously estimate the joint-configuration of the manipulator.

1.1 Recommendation for Future Works

This thesis recommends a future work on improved state estimations of the RTAB-Map where the singularities reading during state estimation can be pass to a splining process. The splining would consider the last reading of the RTAB-Map estimation pipeline at, t_{last}, and the output from the *equation* ??,

$$\underset{t_{last} \leqslant t, C \in \{C_{cycle}, t\}}{\operatorname{argmax}} \|C - \hat{C}_{last}\|_2 \tag{1.1}$$

where $\hat{C}_{last}$ is the last state estimation of the RTAB-Map before data silence.