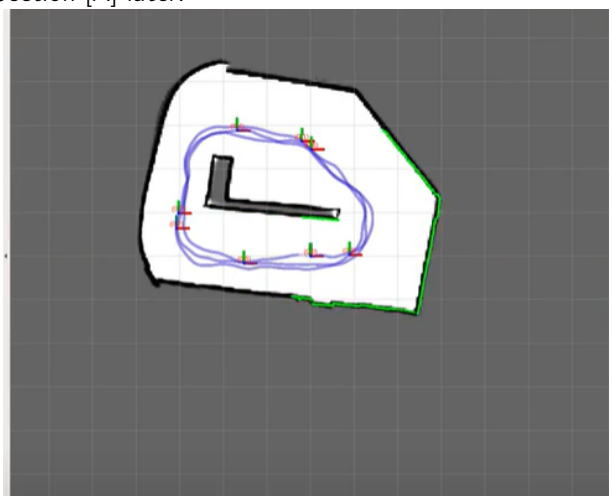
ROS Cartographer SLAM, AMCL Particle Filter, and Pure Pursuit Race Trajectory Following Report

Group Team 8 — Volta
Class F110

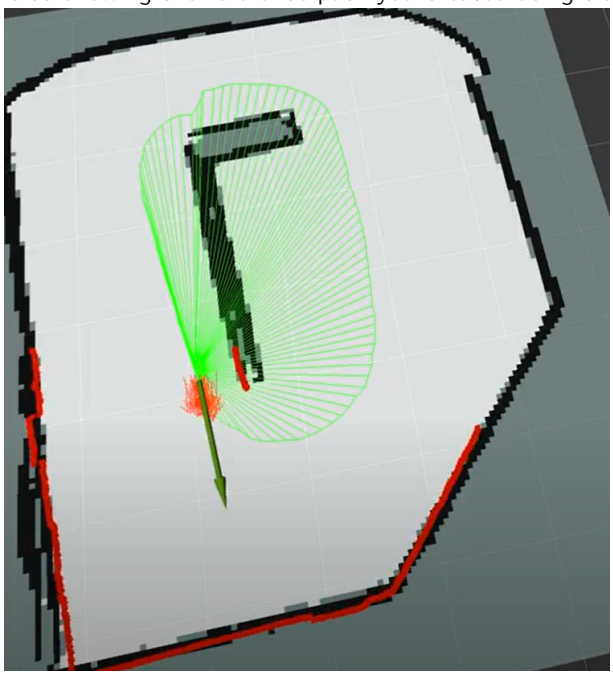
Mapping

Q1: An image of the map that you created using ROS cartographer. An Rviz screenshot is fine similar to the example we have provided at the end of Section A. Be sure to add the '$Trajectory >> Path$' topic as described in Section [A] later.



Localization and Raceline

Q2: An image (screenshot) of the car being localized by the particle filter on the same map as above ($SectionB$) but also showing the reference path you created using trajectory builder ($SectionC$).



Pure Pursuit

Q3: How did you arrive at the value of the lookahead distance for pure pursuit ?

We first started testing using the skeleton code's value of 1.0 but we soon realized setting the lookahead distance to anything lower than 1.0 caused the car to oscillate significantly, making it unstable on straights and sharp turns. After testing various values, we determined that a lookahead distance of 1.2 provided the best balance between responsiveness and stability. We tuned our lookahead distance based on the speed of our car. When the car moved at faster speeds, we observed that increasing the lookahead distance helped improve stability and maintain smooth path-following. Our dynamic velocity implementation, with a minimum speed of 20 and a maximum speed of 50, meant that the car was often traveling at higher speeds due to the majority of the track being straight. The 1.2 lookahead distance allowed the car to anticipate turns while maintaining stability on straight sections. However, increasing the lookahead distance beyond 1.2 caused the car to react to turns too early, often resulting in crashes into walls or corners. Thus, 1.2 was chosen as the optimal value for handling turns effectively while maintaining overall track performance.