MRSD Project Course

Team I – AIce

Autonomous Zamboni Convoy

Individual Lab Report 2

Team

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1   Individual Progress

The follower Zamboni needs to be equipped with IMU and camera, so sensor XACRO files were included in the follower Zamboni URDF model. However, the definition to call sensor links are different in ROS Melodic and ROS Noetic. In our group, members using different versions of ROS. I modified the sensor XACRO files and solved the conflict when launching Zamboni URDF model with sensors equipped. The ice rink environment I developed before is not bright enough for detection. Also, the display of the ground image is not stable. I modified the sdf file of the environment and solved these problems. The ice rink and the zamboni models in simulation is shown in Figure 1. There is a point light on each corner of the rink. IMU and Camera can be seen on the top of the follower zamboni.
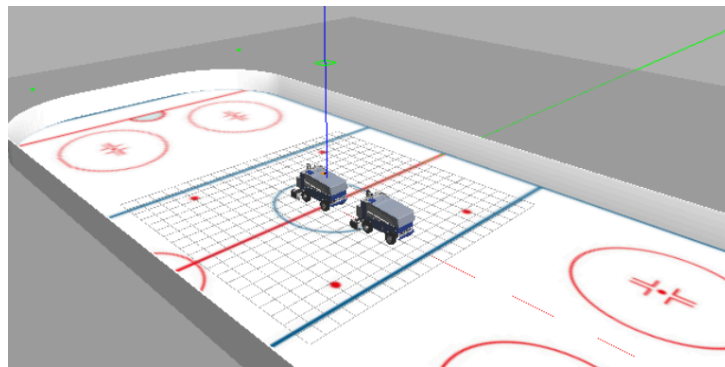

Figure 1: Gazebo Simulation Environment

In this project, the follower needs to follow the leader's path with an offset. I predefined a path and saved the waypoints in a file. Each waypoint is consisted of x, y and yaw values. I implemented a ROS node to read these waypoints and publish the rostopic of the path. The frame of the path is /map, which is the environment frame. I also used Rviz to visualize the path from topic /base_path. Figure 2 shows the zamboni model with the loaded path.
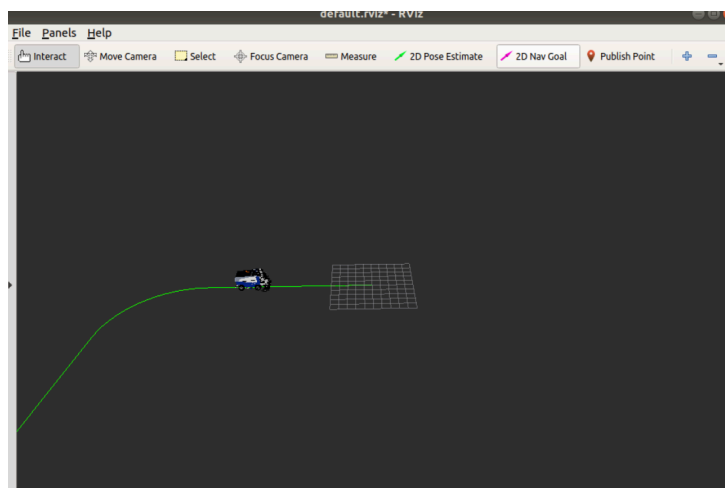

Figure 2: Path in Rviz

I also familiarized with ROS navigation stack, especially for teb_local_planner plugins and move_base package. The move_base node links together a global and local planner to accomplish the global navigation task. Most local planners of ROS navigation are designed for two-wheel differential drive model, but the Ackermann steering model has a minimum steering radius limitation due to the structure. The teb_local_planner plugin provides a dynamics model with

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a minimum steering radius limitation, so its planned paths are more suitable for the Ackermann vehicle.

2 Challenges

The challenges I faced were version conflicts and environmental issues with ROS when I tried to run the simulation after integrating with my teammate's work. I spent some time debugging our latest simulation version in order to get it running successfully.

The current challenge for the path following is that the odometry frame of the follower Zamboni vehicle has an initial drift from the world frame. As shown in Figure 2, the initial waypoint of the path is at the origin of the world frame. However, the initial position of the Zamboni is not at this origin. This problem would influence the further development of path following.

3 Teamwork

Each team member's distributions are shown below:

Rathin Shah: Progressed on the Localization of the robot and was able to validate its performance; integrated the Pure Pursuit Controller developed in Simulink with the simulation setup in gazebo; worked on making the schematic for Power Distribution Board-PCB.

Nick Carcione: Familiarized with current Zamboni architecture; identified hardware components necessary for drive-by-wire conversion and began looking into their availability; acquired the backup RC car platform; created the management style presentation

Yilin Cai: Spawned multi-robots in Gazebo and controlled two Zamboni moving individually by keyboard teleoperation; developed wheel odometry for follower Zamboni; integrate robot localization package fusing odometry and imu for follower's pose estimation

Jiayi Qiu: Solved ROS version conflicts when launching Zamboni URDF model; familiarized with ROS navigation including teb_local_planner plugins, move_base package; loaded predefined waypoints to Zamboni simulation and visualized the path in Rviz

Kelvin Shen: integrated RealSense D435i into Zamboni model in Gazebo; estimated pose of the leader Zamboni using ArUco board and the RGB image; extracted depth values in the Depth image after cropping out the ROI based on the marker detections

4 Plan

I plan to move the Zamboni vehicle along the path I loaded in a constant velocity. That is to achieve path tracking with a given path. For the final desired trajectory, the velocity at each waypoint is required. The follower velocity profile can be generated from the leader velocity profile. Therefore, my next task is to implement leader velocity estimation algorithm based on relative position and relative heading angles.