Automated Driving Using External Perception

Individual Lab Report - ILR07

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Team E - Outersense

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1 Individual Progress

Not a lot of substantial progress was made during the last two weeks for me individually. However the team still managed to reach all the PR goals that were set out. I had mainly decided to work on setting up the new track, the figure of 8 track, and the 3rd infrastructure sensing unit. The next goal was to do lane detection to obtain the region on which the car would traverse and set up a method to improve the handover between the infrastructure units. The sections below talk about these, the challenges faced and other things I worked on during the last PR.

1.1 Setting up the new track

The first task was to set up the new figure * track and expand the existing track. I obtained the dimensions of the new track on Solidworks based on the height of the infrastructure unit and the FOV. We tried 3 combinations. One in which both the cameras were oriented in a way that the larger FOV was along the length of the track, the other where the larger FOV was along the breath (as shown in Figure 1). The third combination was when the 2 cameras at the extreme were oriented in a way that the larger FOV is along the width and the middle camera was orientated that the larger FOV is along the length. We decided to go with the 2nd combination. However when we placed the order to get the carpets for the track, they were out of stock and we have not yet been able to get them. This is a huge blocker for us as we were not able to set up the new track.

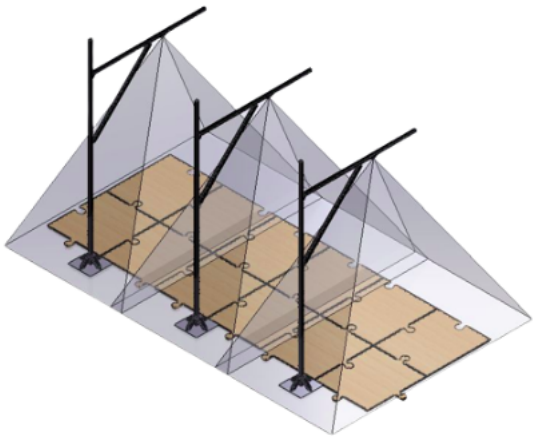

Figure 1: Camera calibration

1.2 Lane detection

Secondly, I had implemented a basic lane detection last semester which I wanted to scale up for this new track. However, because we were not able to set up the new track I was not able to test or develop this lane detection.

1.3 Third Infrastructure sensing unit

This task is broken into two components. One was setting up the infrastructure unit. The other was calibrating the third camera and doing the extrinsic calibration for the handover region. The

first task was straight forward and did not take a lot of time. I then calibrated the third camera and set it up on the infrastructure. Next step was to make the handover smooth but after testing the system with 3 cameras we observed that the current method holds good and need not be changed. We decided to not spend time in exploring other methods rather continue with the existing system.

1.4 Planning subsystem

Lastly, I also worked on the planning subsystem. As the biggest chunk of work for the team this semester is the planning of the cars, I decided to do some literature review about the best methods to keep the car on the center of the track. It is an interesting problem as we do not necessarily have a goal to reach, rather the goal is to stay as close to the center-line as possible. Additionally we need to plan for x, y, and velocity. I have been exploring various methods and have started with executing a basic Voronoi based planner. The advantages is that it can be used for discretized cells and gives the center-line. I have not planned in velocity yet and need to further work on this. The basic implementation is shown in Figure 2.

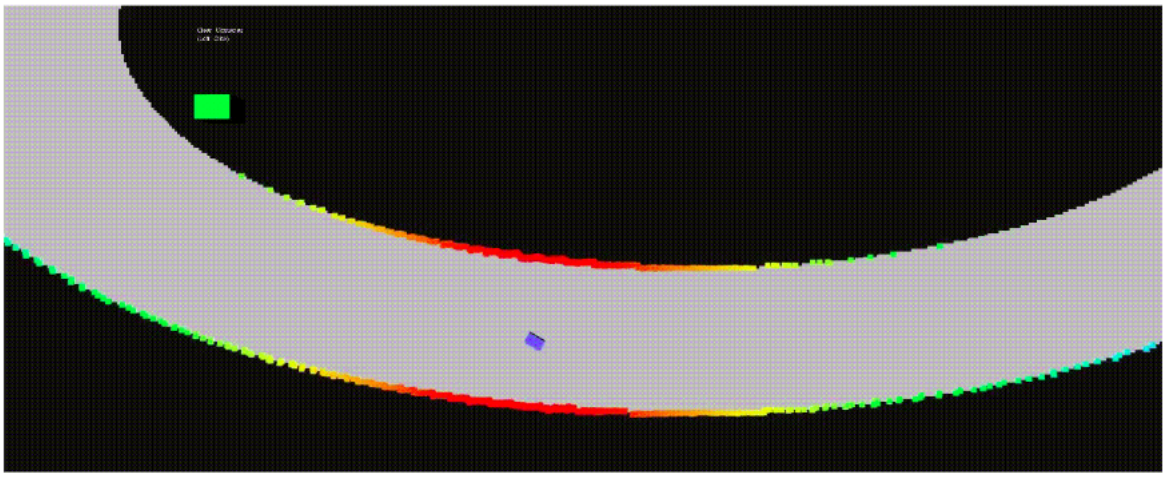

Figure 2: Ride height adjustment for RC car

2 Challenges

2.1 Unavailable track carpet

One of the tasks for this PR was to make the figure 8 track. However, the carpets that we use for the track were not available. This was a huge blocker for us as we could not complete the track set up for this PR and will be working on that in the next PR.

2.2 Computing system not responding as it should

During the testing of the system, we continued with the same process that we always did. Using two computers for two infrastructure sensors and one computer for the control system. However, it was surprising for the entire team to observe that the output from one of the system was at 6 hertz. This has never been observed before and we are unsure how to deal with this. We have been

actively trying to identify the problem and were even more surprised as the problem persisted even after changing the computing system. We will be looking into this in the next PR as well.

3 Team Work

This section talks about the work the team members have been doing in the project.

- **Jash Shah**: Jash worked on setting up Gezebo environment for the planning simulation. He is also working on getting everything ready for the planning subsystem. He was also involved in the research for the planning subsystem with me.
- **Shreyas Jha**: Shreyas integrated the VESC IMU package into the RC car's software. He calibrated the IMU to ensure it's accuracy and also worked on tuning the odometry published by the VESC driver from each RC car.
- **Ronit Hire**: Ronit worked on the perception system. He has been working on multi car detection and tracking. The tracking of the vehicle is a huge challenge as the tracker gives an ID to each object and if the tracker is reinitialised the ID changes. Data association is another challenge in this that Ronit is working on. He implemented a basic ID association using Aruco markers so that the controller system could be tested. He worked along with Atharv to do the testing for the multi car setup.
- **Atharv Pulapaka**: Atharv has been working on the control of multiple RC car. He has also been working on making the MPC more robust. He tested the 2 RC car setup with Ronit.

4 Plans

Now that we have 2 RC cars that can take independent input commands the next steps for the team involve first making the detection and tracking work without using Aruco markers. This will involve considerable amount of work given that the data association problem needs to be solved. Ronit will be working on this, and implementing various graph based methods to do this. Shreyas will be working on getting the odometry from the VESC to help in the data association. The other aim is to build a planning sub system that would help the cars stay at the center line of the track.

- **My Plans**: The next step for me is to develop the Voronoi based planner and test it out in the simulation environment in Gazebo as developed by Jash. I will also be working on setting up the figure 8 track and the 3rd RC car and 3rd infrastructure sensor. I will also be working with Atharv to implement the planner such that the MPC can take in the trajectory for 6 seconds from the entire plan.