Automated Driving Using External Perception

Individual Lab Report - ILR06

September 14, 2023

Team E - Outersense

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1 Individual Progress

1.1 Camera calibration

The cameras needed to be calibrated as we had completely packed our system before we had left for the internships. The first step was setting up the calibration setup at B512. I then proceeded with the intrinsic calibration for all three Realsense cameras. Later I followed it up with accurate depth calibration and focal length calibration. The image below shows the results of calibration of one of the camera.

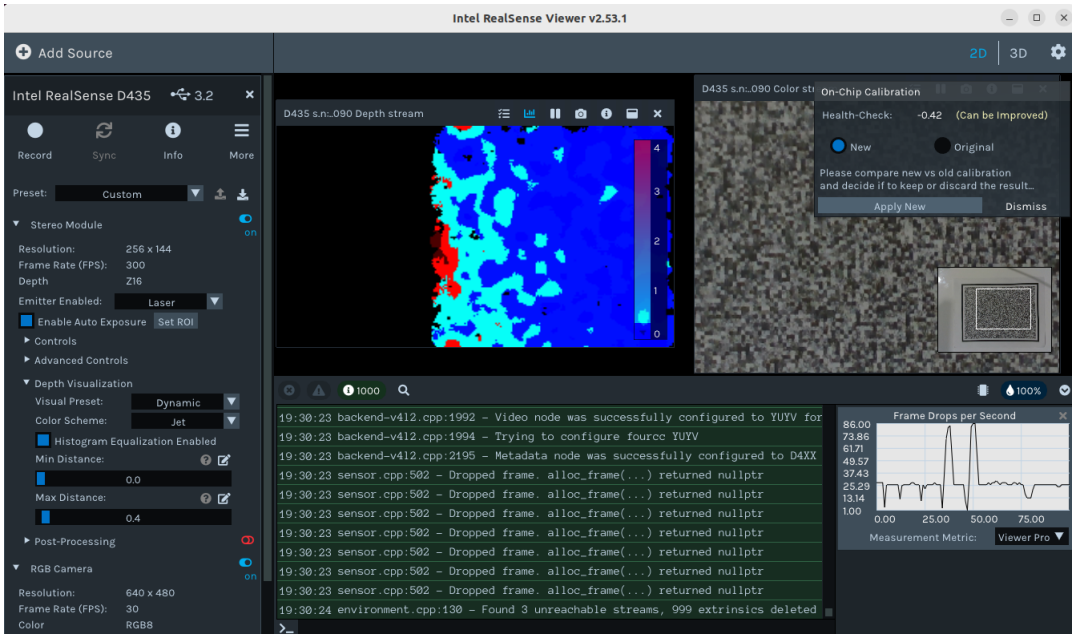

Figure 1: Camera calibration

1.2 Infrastructure setup

Secondly, I worked on setting up the infrastructure units for the demonstration. We will be demonstrating and running the entire system through the semester and hence it was imperative that the hardware is setup correctly. I started by adjusting the height of the adjustable infrastructure, this was followed by locating the camera at the right position. The cameras were first calibrated before this. We then placed the infrastructure at the right distance to ensure that the entire track was covered.

1.3 Track layout

This task is broken into two components. One was setting up the track that was used for the SVD for the team. The other was designing the new track for the FVD. The team after discussion with the sponsor decided that the track should have one intersection and a loop. We also wanted to scale it up to 3 infrastructure and more than 1 car. Keeping this in mind we decided to go with a track that looks like figure 8. Given the budget we decided to skip the Masonite sheets that help keep the track level. This brought forth some challenges that has been discussed later. The setting up the track that was used in the SVD also ahd some challenges of unevenness but we

managed to iron them out using heat and pressure. The details of the challenges are discussed below.

1.4 RC car Ride height

Lastly, I also worked on increasing the ride height of the vehicle. We had some challenges when we made the decision of removing the Masonite sheet from under the carpets. The unevenness of the carpet and the gaps in the intersection of the carpets was where our vehicle used to get caught and did not move ahead. I 3D printed a C clip for the suspension as there was no way of getting a new stiffer spring and increasing the ride height by adjusting the dampers. The C clip acted as a spacer for the springs limiting the motion and adjusting the suspension. The solution worked well as the car can now easily move over the carpet. The figure below shows the ride height adjusted system.

Figure 2: Ride height adjustment for RC car

2 Challenges

2.1 RC car ride height

The RC car that was manufactured had low ground clearance. This was causing the car to get stuck at the unevenness of the track. The power-bank, 3D printed structures, battery etc were additionally lowering the car. One way to improve this was to stiffen the suspensions of the RC cars and increase the front ride height.

2.2 Unevenness in the track

Since we were setting up the track after the internship break, the carpets had become uneven. The only way to iron these out was using a heat gun and applying a lot of pressure. Thankfully we had documented this solution previously when we had faced this problem and had an exact SOP that could be followed to resolve this.

2.3 Realsense camera stopped working

This week we also had to demonstrate our system to the juniors in the MRSD Open house. Everything was working well till the evening before the demonstration when we tested the entire system before leaving the campus. However during the demonstration one of the Realsense cameras stopped working which was working perfectly just a night before. We had accessed this as a potential risk before hand and kept a back up camera calibrated and ready to use. We were able to quickly in between the demonstrations change the camera and remount the new one and continue with the presentation. This however meant that we would not have a backup in-case things went wrong again. On this regards, we requested the other teams to lend us one camera in-case they are not using and were handed one by Jiyoon from the Pepper Gripper team. A special thanks to the entire Pepper Gripper team for their help.

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 and helped Ronit wherever required.

- **Shreyas Jha**: Shreyas worked on getting the RC car ready for the demonstration. He then integrated the RC car with control inputs and implemented npt on the RC car to sync all the systems involved. He also worked on getting the 3rd car ready. Lastly, he has been working on streaming image through Jetson so that a single laptop can be used instead of three.

- **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.

- **Atharv Pulapaka**: Atharv has been working on the control of multiple RC car. For this he has been working on porting his existing code to C++ and also performing simulations

that take in inputs for multiple vehicles. He has also been working on making the MPC more robust.

4 Plans

The path forward for the team focuses on having 2 or more RC cars that drive in the lane. So essentially it involves scaling up the entire system. The track, the infrastructure, the RC car, Perception stack and the control stack.

- **My Plans**: The next step for me is to scale up the track and build the new infrastructure for it. I will also be calibrating the third camera and scaling the infrastructure to cover the new expanded track. The track will be a figure 8 track which will have one intersection and provisions for dynamic obstacles. The loop will help see the effect of latency build up and can help us obtain certain heuristics about the system. I will also be working on the extrinsic calibration and transforms between the cameras that will help in the smooth handover from one camera region to another. Further, I will be working on the lane detection that would allow us to identify regions that are outside the track and hence plan to keep the car within the lane boundary limits. These goals are in accordance with what the team is targeting as we head towards scaling the system.