Automated Driving Using External Perception

Individual Lab Report - ILR02

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Team E - Outersense

Author:

Dhanesh Pamnani

Team Members:

Atharv Pulapaka
Ronit Hire
Jash Shah
Shreyas Jha

Carnegie Mellon University

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1 Individual Progress

1.1 Design of Infrastructure

For this progress review I worked on the Design of the infrastructure units. The team needs 3 infrastructure units for covering the track spanning 5m in length and 2.4m width. I designed the structure on Solidworks based on the materials that were available and techniques which were discussed with Tim. The design is shown in Figure 1.

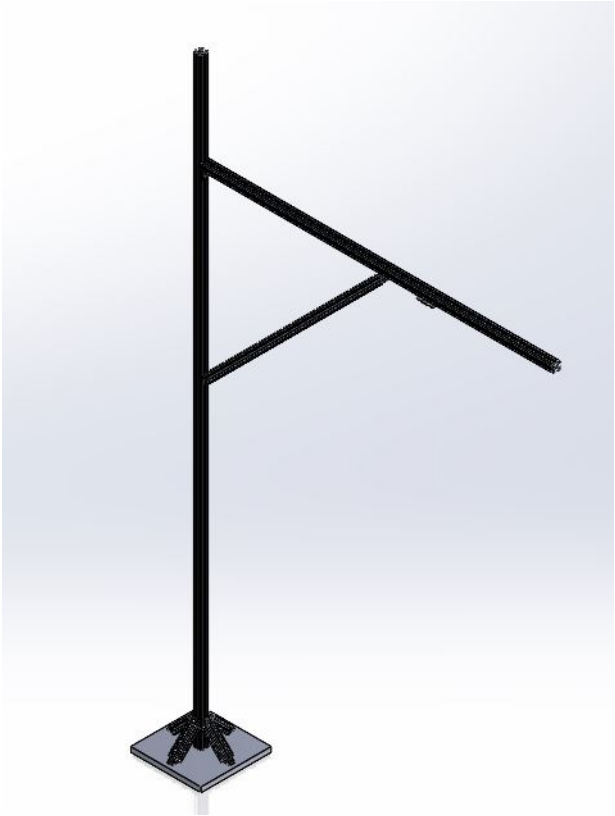

Figure 1: Infrastructure Design

1.2 Manufacturing

I began the manufacturing by cutting the 1.5" square pipe to the right length. The stand was conceptualized to be a 4 legged structure to ensure that the stand is stable in all directions. The legs were riveted onto the main frame using gussets. The gussets themselves were CNC routed. A strength structure equivalent to 16 rivets was calculated and a FOS of 2, took the total rivet count to 32. Next the cantilever had to assembled on the main frame in a way that it can be sliding to adjust for the different heights the team requires. This is a stake holder requirement as they want to see the imapact of the height of the camera in our performance. This sets a hard requirement to have the stand adjustable, however, to make it easy to do we decided to use auminium extrusions instead of having bolting holes on the main frame.
For this I used an aluminium extrusion on the main frame, dimensions of which are 25mm * 1500mm, the cantilever is designed such that it can slide along this extrusion. The cantilever naturally has a bending nature due to self weight which was balanced by using a truss. The base

and the legs were then welded to the main frame and a bottom plate. Dead weight on this bottom plate will allow for the stand to be stable for toppling conditions. Figure 2 shows the stand.

Figure 2: Manufactured Infrastructure

Further, I helped Atharv in the control simulation of the MPC blocks by inputting a latency block that would push the signals from the camera / perception block out of sync with the MPC block. Ronit worked on the delay of generating inputs while I worked on the latency. The key difference being the signal generated at first time step will be pushed and sent at nth time step in latency, while inputs will be generated at every mth timestep for delays.

2 Challenges

2.1 Infrastructure Manufacturing

Some challenges that we have faced so far include the challenges in procuring the right material in the budget and time. The initial plan was to build the main frame using the aluminium extrusion, however the shipping cost for that was 500 dollars which would overshoot our budget. Another challenge was that due to its height the main frame was unstable. This will cause problems in camera calibration and is a risk we have noted. Further the aluminium welding was a challenge but we were guided by Tim and Jim from the RI shop. Lastly the base plate contracts and folds up on cooling after welding, this completely makes the structure unstable.

3 Team Work

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

- **Jash Shah**: Jash worked on the making the perception and detection of angles of a colored cube more robust and time invariant. he also helped me in manufacturing to make sure we reach the deadlines we have kept for the particular task
- **Shreyas Jha**: Shreyas mainly worked on customization of the RC car and made it tele-operated using a mobile based application. He has been working on understanding how VESC can be integrated on the car
- **Ronit Hire**: Ronit worked on the perception with Jash. He also helped Atharv in the control architecture. Further, he helped me with the manufacturing of the infrastructure stands. Ronit has been involved in all domains of the team and not just assists in the individual work but also guides us wherever possible.
- **Atharv Pulapaka**: Atharv has been primarily involved in understanding MPC and the latency budgets that the other systems can have. He has been working on Simulink Simulations of the car and the track.

4 Plans

The path forward for the team can be divided in various fronts

- **My Plans**: I will be working on manufacturing 2 more stands and then move on to design and prototyping of the Realsense mount. This will be followed by the toppling test which will help determine the stability of the infrastructure unit. Post this I will join the perception team and work on camera calibrations and eventually the pose estimation of the RC car. For this we have to set up a test bench and go through a lot of literature to understand how the effect of vibration of the stand can be compensated. I will also be digressing in controls and planning to assist Atharv in those domains. Lastly any mechanical customization required on the car would be my responsibility.
- **Team Plans**: The team will be working on making the car controllable using ROS commands. The car customization is on priority for the team The camera calibration and test bench for that are the next few steps in this domain Controls will continue working on the latency and will also be finalizing the architecture that would be used going ahead.