Automated Vehicle Simulation Scenarios

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Problem

As automated driving system(ADS)-equipped vehicles (AVs) are beginning to be deployed on public roads, public safety is a top concern. There is currently no process to ensure that an AV is safe to be deployed, meaning that the impact of AVs on public safety is unknown. The objective of this work is to develop scenarios that involve pedestrians and animals for testing the driving performance of AVs.

Background Info

What is NHTSA?

Figure 1: NHTSA Logo

NHTSA is the National Highway Traffic Safety Administration agency focused on traffic safety in the United States Department of Transportation.

What is CARLA?

Figure 2: CARLA Logo

CARLA is an open-source simulator with functionality to develop flexible automated vehicle simulations with integrated digital assets (maps, vehicles, pedestrian road actors).

What is Unreal Engine?

Figure 3: Unreal Engine Logo

The CARLA simulator utilizes Unreal Engine as the base of the simulator to run the 3D AV simulations and addons including ASAM OpenDRIVE to define the road networks.

What is Blender?

Figure 4: Blender Logo

Blender is a 3D graphics application used to create models and other computer aided designs.

Work

9	Animal Crash With Prior Vehicle Maneuver
10	Animal Crash Without Prior Vehicle Maneuver
11	Pedestrian Crash With Prior Vehicle Maneuver
12	Pedestrian Crash Without Prior Vehicle Maneuver

Figure 5: NHTSA Pre-Crash Scenarios

NHTSA provides a pre-crash scenario typology with 37 scenarios representing the most common police-reported crashes. By utilizing this typology, we can ensure that we are creating simulation scenarios and collecting data for the most common pre-crash scenarios. I am focusing on pre-crash scenarios nine to twelve in the typology which consist of vehicle to pedestrian and vehicle to animal crashes with and without prior vehicle maneuver.

Although the CARLA simulator is equipped with digital assets ranging from vehicles and maps to pedestrian, other road actors including animals are not included. To address this issue and continue with our driving safety approach for AVs, I had to integrate my own animal model (dog) into the CARLA simulator. This was done using Blender, as seen in Figure 6, to apply a functional physics model and CARLA simulator functionality onto the dog model. With this functionality added, I was able to take the 3D model and integrate it into the CARLA simulator to develop scenarios nine and ten in the NHTSA pre-crash typology.

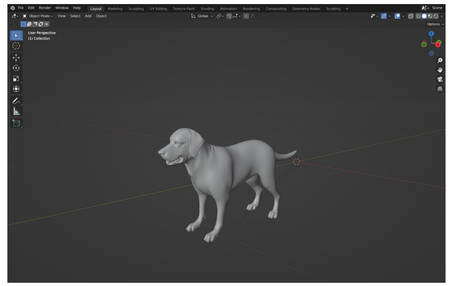

Figure 6: Dog 3D model in Blender

Figure 7: AV and Pedestrian CARLA Simulation Scenario

Since the CARLA simulator is preloaded with certain digital assets, the vehicles and pedestrians integrated into the simulator are prebuilt with physics models. Due to this, I was able to develop a simulation scenario for an AV and a pedestrian as seen in Figure 7. This simulation scenario can be matched to pre-crash scenario number eleven in Figure 5 since it includes a pedestrian collision with prior movement by the AV.

Obstacles

Since the CARLA simulator's digital assets do not include any animals, the only physics model provided by CARLA is a vehicle physics model which can be used to import new vehicle models into the simulator. With no other available physics model, I had to utilize the vehicle physics model on the 3D dog model due to time constraints and the complexity of creating an entirely new model. Throughout this research journey, I also faced many environment and version issues with the CARLA simulator and my Ubuntu operating system. Although these obstacles set me back multiple weeks throughout the semester, I was able to overcome the version issues and continue the development of the AV simulation scenarios.

Future Research

In the future, I plan on continuing this AV research and expanding this project. Since I did not complete the full development of the pedestrian and vehicle pre-crash scenarios in Figure 5 due to time constraints, I would like to continue my work on them. Additionally, I would like to collect data from the scenarios and utilize the DA methodology to calculate the performance of the AV as it navigates the scenario. Once this is complete, I think that it would be beneficial to expand the scope of the animal scenarios and include a variety of animals to assess how different animals can affect the DA score.

Conclusion

To ensure that AVs are fully functional and safe for commercial use, it is imperative that operational safety concerns are addressed. This research utilizes simulation scenario methods and performance calculations using the driving assessment methodology to ensure AV and public safety. As this work is continued, we can expect to see an increase in AV performance which in turn leads to an increase in operational safety.

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