You’re a Terrible Driver

Fostering Confidence in Autonomous Vehicles

Steven Abouchedid, Vinny Caffaro, Noah Masur, Max Miller, Colton Wedell

Vehicle autonomy is a quickly developing technology that will only become more prevalent on the roads of tomorrow. However, many people do not trust this technology to drive for them. To solve this, we developed a driving simulation in which a user can compare their driving skills to those of an autonomous vehicle. In the simulation, the driver is given a course to complete on city streets, and must face traffic and other obstacles; they then can view their results compared to the autonomous vehicle. Throughout our project, we have discovered the challenges that developing autonomy presents, in addition to complications presented by the COVID-19 pandemic. However, we believe that we have created a detailed methodology to complete the development of our simulation, and that this simulation would be effective to improve trust in autonomous vehicles.

Introduction

Our grand challenge is to increase user trust in autonomous vehicles. Vehicle autonomy has developed significantly as a technology in recent years, and with this development has come public recognition. Autonomous vehicles rely on convolutional neural networks (CNNs) to scan the road and make accurate decisions. However, this technology is not yet perfect, and many people are concerned about it, or do not trust it (Schoettle and Sivak 2014). Yet a CNN makes a significantly better driver than a human. Autonomous vehicle adoption cannot be effective until a sufficient number of people are confident in it, so we intended to rectify this problem.

We had many knowledge gaps upon approaching this project, especially specific details on how to create a simulation that is best suited for testing driving ability. Over the course of the research stage, we discovered the following:

- Best methods to use when developing a driving simulation (Seyyed et al. 2017)
- Effects of obstacles on the reactions of the driver (Tarabay and Abou-Zeid 2018)
- Best practices to survey a driver about their perceived ability (Blane et al. 2018)
- Advanced methods for controlling an AI vehicle (He et al. 2014)

Methods

To create the scenario, we used multiple blocks of code like this one, written in the Lua language. This code creates a new object (vehicle, checkpoint, obstacle) and defines its type, position, color, and level of player control. The block shown here references the player’s vehicle, seen in its name “scenario_player0.” The vehicle type is called ETK 854tx, a fictional vehicle chosen because of its modern safety features and driving dynamics. It is not controlled by AI, hence the field “isAiControlled” set to 0.

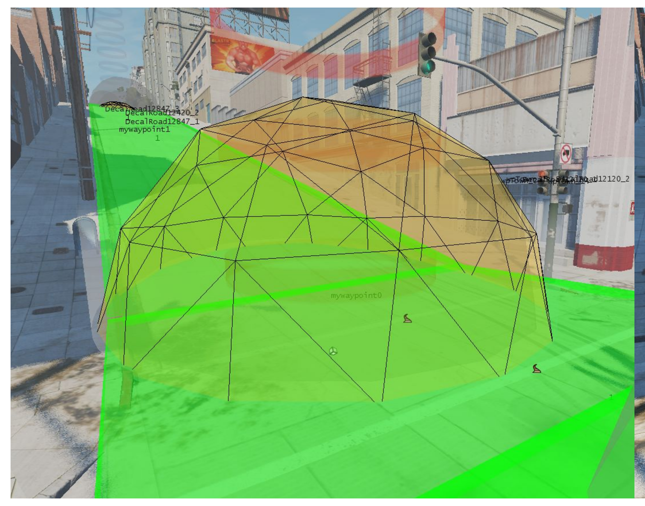
```
new BeamNGVehicle(scenario_player0) {
   JBeam = "etk800";
   color = "0.0509804003 0.0941177011 0.458824009 1.50399995";
   colorPalette0 = "0.0509804003 0.0941177011 0.458824009 1.50399995";
   colorPalette1 = "0.0509804003 0.0941177011 0.458824009 1.50399995";
   partConfig = "vehicles/etk800/etk854tx_A.pc";
   renderDistance = "500";
   renderFade = "0.100000001";
   dataBlock = "default_vehicle";
   position = "-717.121 100.907 118.553";
   scale = "1 1 1";
   rotation = "0.000901433 -0.00282594 0.999996 226.504";
   canSave = "1";
   canSaveDynamicFields = "1";
      isAiControlled = "0";
      licenseText = "GENIUS";
};
```

Set which vehicle model to use

Changes the position of the car on the map

Set if AI is controlling the car
Set license plate text

If the AI field was set to 1, this gave AI control of the vehicle, and allowed us to set the mode in the scenario’s compiler. These modes include traffic, random, and predefined path, and we used the traffic mode for most vehicles.



Checkpoint placement in editor.

Checkpoint in scenario.

Checkpoints were created in a very similar fashion, and added to the compiler to define the route and the order in which it should be driven. Obstacles were added in the same way, only using a “prop” type (such as a traffic cone) instead of a “vehicle” type.

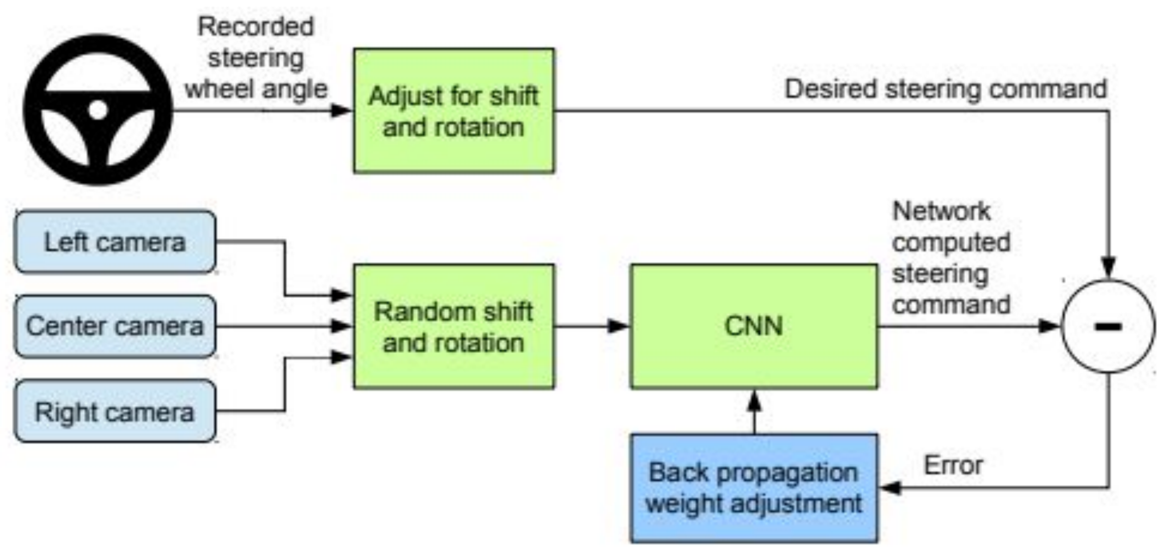


Diagram of a convolutional neural network (CNN).

Results

Our project consists of a simulation of a commute in a car. In it, users will drive a course and then will see their times compared with those of an artificially intelligent driver. While we don’t have traditional qualitative or quantitative results, the simulation we created has many important details that will help combat negative views on artificial intelligence.

The simulation itself is a scenario on BeamNG.drive, a vehicle simulator known for its realistic physics. Using this prebuilt framework to host the simulation allows for a simple, established method of deployment for user testing. Furthermore, through the realistic features available in BeamNG.drive such as cars and maps that mimic the real world, the scenario can appear like real life. This lifelike sentiment created within the simulator combined with vehicle components used for driving - a steering wheel and pedals - will recreate the feeling of a controlling a car. Other important details of the scenario include the obstacles, like traffic cones or slow cars, found throughout the map. Since the user does not know when these obstacles are going to appear, the scenario can replicate the unpredictability of driving. Eventually, the scenario will also include an artificially intelligent driver to compare with the user’s score. Currently, there is a pre-scripted path for the AI to follow, but we are still waiting for BeamNG.drive to increase the AI capabilities to fully roll out this feature. Once AI is fully implemented, the simulation will cause the user to relate the results of the artificially intelligent driver to their own life through the realism of the simulation. This will hopefully cause a reconsideration of their own personal viewpoints on autonomous driving.

While we did not have an AI that would simulate the decisions made by an autonomous vehicle, we were able to use an AI path scripting tool to simulate the route. (Follow the links below to access the videos.) The human driver tended to make quicker and smoother turns and decisions; however, they did not obey all traffic laws and good practices such as using turn signals and looking both ways at stop signs. The path driven by the AI took nearly twice as long, the timing difference being apparent when other vehicles interfered with the route. The human would accelerate and sometimes nearly miss the other vehicles, whereas the AI would decelerate and maintain several yards of cushion. In total, the route driven by the human was much more efficient while the route driven by the AI was safer and more perceptive to details.

Human Driver

AI-Like Driver

Use a Chapman University Google account to view.

Conclusions

Although our end goal was scaled back from our original intentions, we still created a useful platform on which to test a user’s driving ability. Our simulation provides a detailed layout and objective with extensive obstacles. To complete the work we had originally intended to do, we would only have to implement a scoring system (to directly compare driving maneuvers and reactions to obstacles) and improve the AI capability. In all, we feel that such a simulation would not only serve as an effective test of driving ability but also improve one’s trust in autonomous vehicle technology.

Vehicle used in the simulation, ETK 854tx.

Acknowledgements

Shana Welles for her extensive assistance and constructive criticism in the first two semesters of this project

Brian Hoover for his support, guidance, and feedback in the final semester, especially after transitioning to remote learning

Derek Prate for offering constructive feedback and extensive guidance on our project at the midway point

The team at BeamNG.GmbH for providing us with BeamNG.research (https://beamng.gmbh/research/) and getting us started with the simulator

Shaun Wiechmann and Josh Taylor, former group members and BeamNGeniuses

Literature cited

Schoettle B, Sivak M. A SURVEY OF PUBLIC OPINION ABOUT AUTONOMOUS AND SELF-DRIVING VEHICLES IN THE U.S., THE U.K., AND AUSTRALIA. :42.

Blane A, Lee H, Falkmer T, Dukic Willstrand T. 2018. Cognitive ability as a predictor of task demand and self-rated driving performance in post-stroke drivers – Implications for self-regulation. J Transp Health. 9:169–179. doi:10.1016/j.jth.2018.01.013.

He J, McCarley JS, Kramer AF. 2014. Lane Keeping Under Cognitive Load: Performance Changes and Mechanisms. Hum Factors. 56(2):414–426. doi:10.1177/0018720813485978.

Seyyed Meisam Taheri, Kojiro Matsushita, Minoru Sasaki. 2017. Virtual Reality Driving Simulation for Measuring Driver Behavior and Characteristics. J Transp Technol.(2):123.

Tarabay R, Abou-Zeid M. 2018. Assessing the effects of auditory-vocal distraction on driving performance and physiological measures using a driving simulator. Transp Res Part F Traffic Psychol Behav. 58:351–364. doi:10.1016/j.trf.2018.06.026.