Accelerating Autonomous Vehicles with Unity for Training and Test Optimization

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***Abstract*—High-quality simulations with realistic sensor data in Unity can be used to accelerate the training and testing of Autonomous Vehicles for edge-case scenarios.**

***Index Terms*—Artificial Intelligence, Autonomous Vehicles, Machine Learning.**

I. Introduction

In this project, we are exploring the capabilities of the video game engine Unity for training and testing machine learning (ML) models for autonomous vehicles, referred to as AVs. My contribution will be creating virtual environments and measuring their accuracy; accuracy refers to how close the virtual environment can reflect the real world in the eyes of the ML model. These virtual environments must closely reflect their real counterparts to train each ML model properly.

II. Literature Review

The environment has several kinds of hazards that must be accounted for in the ML model if the AV is to be fully autonomous. Conditions like bad weather (flooding, fog), other driver's mistakes (wrong-way driver, red light runners), and animal hazards (deer, turtles) are all realistic possibilities [1]. These features will be easy to recreate and place in a virtual simulation.

Real-world models of roadways are in high demand amongst top companies (Mercedes-Benz, GM)- 3d scans of the road and environment are taken for models to be trained on [2]. These real-world scans can have missing data or the real-world roads will have changed leaving the models with out-of-date data.

There are many other traffic simulators out there on the road, some important ones being: SITRAS, SUMO, and InTraDE [3]. Each simulator has its advantages and disadvantages- we will be using these simulators to drive in our Unity environments.

III. Project Proposal

Real-life road datasets are essential for developing autonomous vehicles, however getting said datasets proves more challenging than necessary. With game engines like Unity, we can create highly customizable simulations for supplemental training.

The virtual environments created in Unity can mirror complex urban and rural driving conditions, including scenarios that are more difficult to predict/recreate in the real world like weather and animals on the road. These edge cases are the true challenge in AV development. These events are unpredictable and in most cases rare, so consistently recreating them to train the AV ML model is cost-prohibitive- especially once you consider the true volume of training that must take place.

A. Relevant Technologies

Our project will be using Unity to simulate a virtual environment, this will be our test track for our virtual AV to use. We will have virtual sensors on the vehicle that will emulate their real-world AV counterparts. These virtual sensors will be accessed by our ML model to train with, while it has no awareness of the fact that it's in the virtual world. This is important as we're attempting to understand the feasibility of transferring the virtually trained model into real-world applications.

B. Possible Challenges

1) Environment: Do the roadway's dimensions match their real-world counterparts? Will the sensors on the vehicle provide similar data as the real world?
2) Vehicle: How accurate does the AV drive when compared to its real-world counterpart (scale, weight, 0-60 time, etc.)
3) Simulation: How accurate are Unity's physics? Can they be trusted to accurately recreate static and moving objects?

References

[1] P. Koopman and M. Wagner, "Challenges in autonomous vehicle testing and validation," SAE International Journal of Transportation Safety, Vol. 4, No. 1, pp. 15–24, April 2016. [Online]. Available: https://www.jstor.org/stable/26167741

[2] A. Kiran, S. S. Salunkhe, B. Srinivas, M. Vanitha, M. A.Ahmed, and J. V. N. Ramesh, "Accelerating autonomous vehicle safety through Real-Time Immersive virtual reality gaming simulations," Entertainment Computing, Volume 50, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S1875952124000429

[3] L. H. Meftah and R. Braham, "A virtual simulation environment using deep learning for autonomous vehicles obstacle avoidance," 2020 IEEE International Conference on Intelligence and Security Informatics (ISI), Arlington, VA, USA, 2020, pp. 1-7. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/9280513