Autonomous Car Simulation

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Section 1: Introduction and Description

1.1 Brief Description

Choosing this project was relatively easy for me, cars are a big passion of mine, and the area of self-driving and autonomous cars has exploded in popularity in the recent years, with the likes of Tesla and their own Autopilot system in their vehicles.

Creating this project will give me great knowledge of this new emergent field of A.I. and allow me the learn and practically try out some of the key techniques that are used to create autonomous driving systems. The project itself will be a simulation of an autonomous car using Unity to host the simulated environment, track and car itself, then, Python will be used to program the Artificial Intelligence used to control the cars actions thanks to its useful libraries and lots of support around the language for A.I..

Using this combination plays both to my strengths of my knowledge of Python already and allows me to explore a new area of Python, that being the A.I and Machine Learning side of the language, as well as explore a new language C# with Unity. Thus, developing my skills of developing A.I and learning new language quickly and efficiently such that I can implement the simulation needed.

I believe this project will also allow me to explore some Machine Learning and A.I. techniques that truly interest me, allowing me to develop a deep understanding of such techniques so that I will be able to apply them to many other fields. On top of exploring the new aspects of A.I. that I have not previously been exposed to, I will also be able to collect some knowledge from previous University modules into this one task proving that I can apply what was previously taught to a new situation.

For the track that the car will have to navigate, I will be taking a real racetrack found in northern England called Cadwell Park, this way, I can ensure a wide variety of corner types, angle as well as some lengthy straights for the car to adapt to. Not only does it ensure a wide range of corners for the car to learn, but it will allow for a direct comparison to real cars on the same track such that we can see how similarly this A.I. performed to real experienced drivers on the same track. The car will likely not behave in precisely the same way, however this comparison could give some extremely useful insight into the next steps of the car, and the current successes that the car made within this project.

1.2 Aims and Objectives

My main task for this project is to create a successful autonomous vehicle that can navigate a predefined track successfully avoiding any collisions with the track itself (i.e., without hitting any walls). Building on from this base task, I want to try and create a car that is able to navigate the course at speed, meaning that the vehicle is able to learn to accelerate and decelerate (or brake) for corners and straights, rather than the car just maintaining one constant slow speed to travel around the track.

There have been previous papers and projects exploring the simulation of an autonomous vehicle, however, most of these projects aim for the base case that I want to achieve, this being a car that can navigate around a predefined track safely without colliding with any of the environment. Alternatively, these projects used a slightly different case which is navigating around in a traffic light environment meaning following road laws, signs and potentially even avoiding collisions with other motorists.

My project differs in the aspect that I want to achieve a more advanced car that as mentioned, is able to understand a path and use this knowledge to accelerate and brake accordingly to provide a faster lap, whilst also remaining safe and avoiding the environment.

I also plan to have the car ‘see’ in a similar way to which real autonomous vehicles ‘see’ using Lidar by implementing a similar method into the simulation to gather data about the environment that the car will use to navigate.

In a simplified bullet point list, the progress and objectives will be as follows, from the most basic and beginning of the project, to implementing the A.I. into the car:

* Create 3D model of Cadwell Park
* Create Unity project, load in the track and create a car model
* Create the car controller
* Create all of the event handling within Unity (for collisions, resetting the car and maintain knowledge of the current world state)
* Start the Python side of the project
* Add in a WebSocket to both Unity and Python
* Set up the Neural Network generation and forward pass
* Implement the Genetic Algorithm (this choice will be explained further in this report)
* Train the cars using a multitude of different network topologies
* Analyse the performance of these different topologies

1.3 Short Summary of the Project

All in all, I will be developing an autonomous car simulation using the latest methods in Artificial Intelligence such as Deep Neural Networks (Deep Learning) and Genetic Algorithms to help evolve the car into a safe, effective and fast autonomous vehicle which then will be comparable to a nearly identical real-world scenario to find the strengths, weaknesses and improvements needed for this A.I. system.

Section 2: Literature Review

Also look up papers on deep learning

supervised learning and autonomous cars and why I cant do it for this

Section 3: Methodology used

The methods that I chose to use for this are a Neural Network that I can customize to change the depth (amount of hidden layers, a key aspect in Deep Learning) and the size of each layer (how many fully connected nodes are in a layer) as well as a Genetic Algorithm to evolve the cars by picking the best two cars from each generation and using them to create the next generation through crossover.

Section 4: Implementation

Section 5: Results

Section 6: Conclusion and Further Work

References

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