TED UNIVERSITY

Faculty of Engineering
Department of Computer Engineering
Project Name: F&D Autonomous Driving

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[Autonomous Driving Algorithm - Final Project]

Introduction

We as F&D are developing an end-to-end autonomous driving algorithm. This project aims to develop an autonomous vehicle and simulation environment. The project requires an efficient fully autonomous driving algorithm that priorities efficiency and consistency.

Description

We will be responsible for the preparation of the environment in the Gazebo simulator. We will be designing the roads, placing the necessary sensors such as ultrasonic distance sensors and a camera, and integrating them into our vehicle model. This includes creating realistic traffic situations, setting environmental conditions such as lighting and weather conditions, and checking that all sensor inputs, such as cameras, are simulated as we intended to. Our main purpose to build an accurate virtual testing ground for us is to have a reliable environment for training and testing our autonomous driving algorithms.

Constraints

Economic

There are not many problems on the economic side of the project. One of the problems can be, if needed, CPU/GPU clusters to produce computing power for very efficient simulations. Sensors and the cost production of the vehicle is irrelevant.

Environmental

Virtual environments don’t use fossil fuel so they are environmentally friendly. Our project focuses on the virtual environment so environment impacts like Battery production is irrelevant. Our only environmental impact is the computers running simulations. Autonomous driving algorithms for energy efficiency can reduce overall energy consumption in transportation.

Social

Autonomous driving technology raises social questions about job displacement. Mostly for Taxi, Uber, Bus or other types of public transportation. At the same time, it creates accessibility for people who can’t drive. It is also a concern for people to trust AI for important tasks. Our project addresses responsibility to develop the system that focuses on energy efficiency alongside safety considering the social benefit of sustainable transportation

Political

Autonomous vehicle regulations change from country to country . Our project operates entirely in simulation,the project is not subject to road vehicle regulations.

Ethical

The project has several ethical considerations: -
Software Licensing: We must use only properly licensed or open source software.Gazebo, CARLA, ROS, Python libraries are open source and for academic use. -
Original Work: Trained AI and Simulation environment should be build by our team and should not copy any other model.

Health and Safety

The Project is in a virtual environment. Health and Safety risks are none.
However we need to consider;

- Long hours of coding and testing need proper and comfortable setup.
- Extended computer use can cause eye strain and fatigue
- Autonomous driving algorithms should not collide with any obstacles.

Manufacturability

Our project is based on a virtual environment so it does not involve manufacturing. We design environment setup and AI model.

Sustainability

Our project focuses on Energy Efficiency for sustainable transportation. By developing and testing in simulation, We train our model to be precise for corners, general consumption and obstacle avoidance to avoid resource consumption. Also by creating this project in a virtual environment we don't create any production waste. These technologies will help reduce the overall carbon footprint and help overall safety.

Professional and Ethical Responsibilities

Our team will not use any unlicensed software during development. The AI model of the car must be trained by the team and will not be taken ready from someone/somewhere.

Requirements

The autonomous vehicle developed in this project;

- The vehicle shall be able to determine the path it needs to take and drive the target location on that path.
- The vehicle must avoid going over the fixed road lanes.
- The vehicle must avoid crashing into cars.
- The Vehicle should be able to park by itself when it gets to its designated location.
- The vehicle must autonomously pass within 3 meters of the node that lies on the target path.
- Vehicle behavior must adhere to right-hand traffic conventions and lane discipline within the simulated road network.
- The System shall not do prohibited traffic autonomous behaviors; prolonged reverse driving, driving against lane traffic, collisions with obstacles, and driving on sidewalks or other non-drivable areas.
- The system shall process all sensor data in real time.
- The system shall detect lane markings on the road.
- The system shall detect static obstacles and estimate the distance of obstacles.
- The system shall drive in a safe path that avoids obstacles.
- The system shall update its driving decisions when new data enters.
- The system shall control the steering, acceleration, and braking.
- The system shall move stable while following the planned path.
- The system shall update the local trajectory at least every 500ms when obstacles or environmental changes are detected
- The system shall compute a complete global path from start to destination at most 25 seconds of route request
- The system shall process camera frames for object detection at minimum 10 FPS
- The system shall estimate object distances with $\leq 20\%$ error.
- The system shall maintain latency under 500ms for 90% of cases
- The system shall maintain simulation stability at 5x real-time speed for training purposes
- The system shall complete full processing pipeline without frame drops in 85% of normal scenarios
- The system shall use a communication bridge such as ROS/ROS2.

References

- X. Chen, H. Ma, J. Wan, B. Li, and T. Xia, “Multi-view 3D object detection network for autonomous driving,” in *Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR)*, 2017.
- N. Koenig and A. Howard, “Design and use paradigms for Gazebo, an open-source multi-robot simulator,” in *Proc. IEEE/RSJ Int. Conf. Intell. Robots Syst. (IROS)*, 2004.
- European Commission, “Ethics guidelines for trustworthy AI,” 2020.