Autonomous Car Simulation using Machine Learning

Abstract

In this research endeavor, we present a comprehensive study on the development of an autonomous car system leveraging advanced machine learning techniques. The primary focus of our investigation encompasses three pivotal aspects: firstly, the prediction of bullock carts within the vehicular environment; secondly, the anticipation of abnormal speed vehicles for timely and appropriate responses; and finally, the prediction of unfamiliar vehicles to enhance the overall adaptability and safety of the autonomous system.

Our approach integrates cutting-edge machine learning algorithms, drawing upon computer vision and sensor data processing methodologies, to accurately predict and respond to the presence of bullock carts, vehicles displaying abnormal speeds, and those that are unfamiliar to the autonomous car system. Through rigorous experimentation and validation, we demonstrate the efficacy of our proposed model in real-world scenarios, highlighting its potential contributions to the advancement of autonomous driving technology. This research provides valuable insights into enhancing the predictive capabilities of autonomous vehicles, contributing to the broader field of intelligent transportation systems.

Keyword:- Computer vision, Deep learning, Bullock cart ,Reinforcement learning, Convolutional Neural Networks

A deep reinforcement learning-based approach for autonomous lane-changing velocity control in mixed flow of vehicle group level [October 2023]

This study proposes a deep reinforcement learning-based lane-changing model to train autonomous vehicles to complete lane-changing in interaction with different human driving behaviors. Lane-changing is a crucial driving behavior that impacts traffic flow safety and efficiency, especially in mixed traffic flows with autonomous and human-driven vehicles. The model constructs a mixed-flow lane-changing environment with surrounding vehicle trajectories extracted from natural driving trajectories. The reward function considers safety and efficiency, guiding vehicles not to collide. The model also integrates a collision avoidance strategy to ensure longitudinal motion safety. The trained model achieved a 90% success rate without collision in testing. The method's driving performance is analyzed for safety and efficiency evaluation indicators, proving its effectiveness in improving lane-changing efficiency and safety.

[https://www.sciencedirect.com/science/article/abs/pii/S095741742302660X]

Multiagent reinforcement learning for autonomous driving in traffic zones with unsignalized intersections [August 2022]

This study presents a multiagent deep reinforcement learning approach for autonomous driving vehicles operating in traffic networks with unsignalized intersections. The system consists of route-agents, a collision term, and an efficient reward function. This enhanced collaborative multiagent deep reinforcement learning scheme allows for safe and efficient navigation of multiple vehicles. It also provides flexibility for transfer learning and reusing knowledge from agents' policies in handling unknown traffic scenarios. Experimental results in simulated road traffic networks demonstrate the efficiency of the proposed multiagent framework, demonstrating its effectiveness in handling traffic networks with variable complexity and diverse characteristics.

[https://www.tandfonline.com/doi/abs/10.1080/15472450.2022.2109416]

Deep Learning-Based Vehicle Behavior Prediction for Autonomous Driving Applications[2020]

This deep learning approach predicts the future movements of vehicles in autonomous driving scenarios. Highlighting the limitations of conventional methods in complex environments, it advocates for deep learning's promise due to its ability to handle diverse data and non-linear relationships. The paper categorizes existing solutions based on input data (sensor types, historical trajectories), output types (future positions, maneuvers), and prediction methods (CNNs, RNNs). It evaluates performance of prominent works and identifies research gaps, pointing towards promising directions like incorporating social interactions and explainable AI for safer autonomous driving.

[https://ieeexplore.ieee.org/abstract/document/9158529]

Intelligent traffic control for autonomous vehicle systems based on machine learning[2020]

This study aimed to resolve a real-world traffic problem in a large-scale plant. Autonomous vehicle systems (AVSs), which are designed to use multiple vehicles to transfer materials, are widely used to transfer wafers in semiconductor manufacturing. Traffic control is a significant challenge with AVSs because all vehicles must be monitored and controlled in real time, to cope with uncertainties such as congestion. However, existing traffic control systems, which are primarily designed and controlled by human experts

[https://www.sciencedirect.com/science/article/abs/pii/S0957417419307912]

Safe, Efficient, and Comfortable Reinforcement-Learning-Based Car-Following for AVs with an Analytic Safety Guarantee and Dynamic Target Speed.[June 2023]

Autonomous driving systems and adaptive cruise control (ACC) have piqued considerable curiosity in recent years. Reinforcement learning (RL)-oriented control mechanisms hold potential for optimizing efficiency, stability, and comfort, yet frequently lack safety assurances. This document posits the Secure, Effective, and Pleasant RL-oriented car-following Blueprint for self-governing car-following, striking a balance between the maximization of traffic efficiency and the minimization of jerk, all while enforcing a rigid analytic safety constraint on acceleration. The efficiency, stability, and comfort hinges on the time-to-collision (TTC) threshold, a commonly employed metric for RL control systems. In simulation experiments, a representative former TTC-threshold-oriented RL self-driving vehicle controller might experience a collision in both training and testing. However, the efficiency, stability, and comfort controller proves to be secure in training scenarios featuring a diverse array of leader behaviors and in both routine-driving and crisis-braking examination scenarios.

[https://journals.sagepub.com/doi/full/10.1177/03611981231171899]

End-to-end, real time and robust behavioral prediction module with ROS for autonomous vehicles[August 2023]

As population density surges, unmanned vehicles are experiencing increased prevalence. The prevalence of these vehicles requires adept perception of their position and anticipation of environmental factors, akin to living organisms. Imperative for safety and strategic planning in dynamic settings, autonomous vehicles necessitate high-performance behavioral prediction modules. A swift and effective robotic behavioral prediction module has been devised in this investigation to empower autonomous vehicles in devising safer and more successful plans in dynamic environments. This progress in autonomous vehicles plays a vital role in fortifying safety and optimizing efficiency in the transportation sector.

[https://dergipark.org.tr/en/pub/aupse/issue/81260/1292652]