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Behavior Cloning for a Self-Parking Car

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Abstract - In the context of self-driving cars, Behavior Cloning can be used to train a model to perform complex driving tasks, such as parking, by observing human drivers perform these tasks. In a self-parking car, Behavior Cloning and genetic algorithms can be used together to train a model to perform the parking task. The model can be trained on a dataset of human driving behavior, where the expert driver is demonstrating the parking task. First, it allows the model to learn from human drivers, who have a wealth of experience and knowledge about driving and parking. Second, it enables the model to learn from a large dataset of driving behavior, which can improve its generalization performance. Finally, the use of genetic algorithms can help to optimize the model's performance and ensure that it is well-suited to the specific task of parking. Despite these challenges, Behavior Cloning and genetic algorithms have the potential to be powerful tools for training self-parking cars. By combining the strengths of imitation learning and optimization, these techniques can help to create models that are both accurate and efficient, and that can improve the safety and convenience of self-driving cars.

Key Words:
Car, self-Parking, Genetic algorithm, Accident safety, road, Virtual environment.

1.INTRODUCTION

Behavior Cloning for a Self-Parking Car involves training a model to imitate expert driving behavior, particularly in parking scenarios. This technique utilizes supervised learning to mimic the actions of skilled drivers. Genetic algorithms, inspired by natural selection, are employed to optimize the model's parameters, such as neural network weights, enhancing its performance in self-parking tasks. In the context of self-driving cars, Behavior Cloning with genetic algorithms offers a powerful approach to training models for parking maneuvers. By observing and replicating human driving behavior, the model can learn from a diverse dataset, improving its ability to generalize to various parking scenarios. The genetic algorithm fine-tunes the model's parameters, ensuring optimal performance tailored to the specific task of parking. While this approach has notable advantages, like leveraging human expertise and enhancing generalization, challenges exist. These include potential limitations in handling unforeseen situations and the computational complexity of the optimization process. Nonetheless, the combination of Behavior Cloning and genetic algorithms holds promise in creating accurate and efficient models for self-parking cars, contributing to the advancement of autonomous driving technology.

The implementation of self-parking cars involves programming the system correctly and linking the parts together to perform the tasks required of the self-parking car. This includes determining the distance using ultrasound, connecting the Arduino device and other parts, and programming the code. The system is designed to stop the car between two cars parked properly without colliding with them, using the appropriate parts for the self-parking car. The goal of this project is to build a Self Parking Car system that achieves the following objectives: exploiting narrow spaces, helping drivers with special needs, helping people who do not have high driving skills, and reducing traffic accidents. The system is designed to reduce many of the problems that people suffer from, such as parking the car in the appropriate places due to high traffic demand and the lack of car parking areas in cities. By using a simple, low-cost system, the self-parking car can stop properly, reduce the number of collisions between cars, and ensure that sensor data is highly accurate.

2. LITERATURE SURVEY

1. This paper provides an overview of the research advances made in autonomous driving, using six requirements as parameters for successful deployment. Autonomous vehicles (AVs) are a rapidly evolving field, with numerous studies and reviews published in recent years.

2. The researchers used a computational model to simulate traffic conditions and assess the impact of different types of vehicles on travel time . AVs are expected to have significant impacts on traffic management, safety, and sustainability.

3. This paper presents a review of recent research on theories and applications of deep learning for Self-Parking cars The literature highlights various challenges and opportunities in AV development, including sensor technology, machine learning algorithms, and regulatory frameworks.

4. This paper provides a comprehensive review of the previous studies in the transportation field that involve AVs with the aim of exploring the implications of autonomous vehicles. Researchers have proposed different approaches to address these challenges, such as integrating AVs with intelligent transportation systems, using simulation and testing to evaluate AV performance, and developing safety standards and guidelines.

5. This paper examines how many miles of driving would be required to demonstrate the reliability of autonomous vehicles. The literature also emphasizes the importance of addressing social and ethical issues related to AVs, such as privacy, fairness, and accountability.

6. This paper discusses the complexity of autonomous vehicle (AV) operation and the sustainability challenge. It highlights the need for further research on the environmental impact of AVs and the development of sustainable transportation systems The use of genetic algorithms in AV research is a promising approach for optimizing behavior cloning and improving the performance of self-parking cars.

7. This paper presents a review of recent research on autonomous vehicles enabled by the integration of IoT, edge intelligence, 5G, and blockchain. The literature suggests that collaboration between academia, industry, and government is crucial for advancing AV research and ensuring its safe and effective implementation.

3. PROPOSED WORK

1. **Define the Problem**: The first step is to define the problem and the objective function. In the case of a smart parking car, the objective is to find the optimal parking space based on certain criteria, such as proximity to the entrance, availability, and size.

2. **Initialize the Population**: The next step is to initialize the population of potential solutions. In the case of a smart parking car, the population could be a set of possible parking spaces that meet the defined criteria.

3. **Evaluate Fitness**: Once the population is initialized, the fitness of each solution must be evaluated. In the case of a smart parking car, the fitness could be based on the distance to the entrance, availability, and size of the parking space.

4. **Selection**: The next step is to select the fittest solutions from the population to reproduce. This is done using a selection process, such as tournament selection or roulette wheel selection.

5. **Crossover**: The selected solutions are then used to create new solutions through crossover. In the case of a smart parking car, this could involve combining the parking spaces of two solutions to create a new solution.

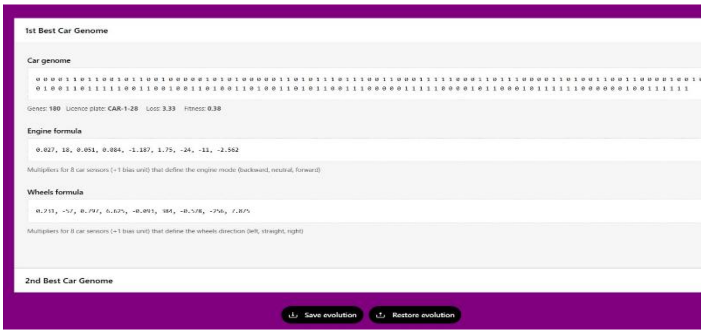
6. **Mutation**: After crossover, the new solutions are mutated to introduce diversity. This could involve randomly changing the parking space of a solution or swapping two parking spaces.

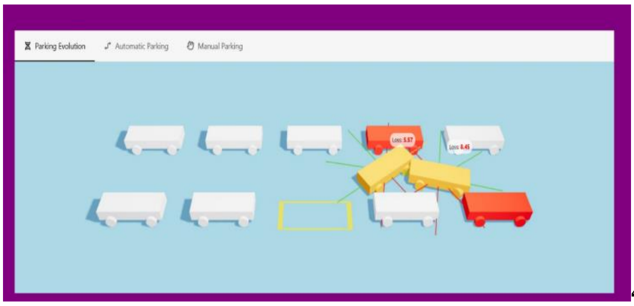
7. **Termination**: The process is repeated until a termination condition is met, such as a maximum

number of generations or a satisfactory fitness level.

8. **Implementation**: Once the optimal parking space is found, the smart parking car can be programmed to navigate to that space and park.

The genetic algorithm approach has been used in several studies to address the issue of scheduling the vehicle to the parking bay, as described in and The design of a genetic algorithm-based intelligent parking system is discussed in which uses a genetic algorithm to find a series of optimal angles of the moving vehicle at a parking space autonomously. The study in uses a navigation and reservation-based smart parking platform using genetic optimization for smart cities. The study in uses a genetic algorithm to determine the route from the current position to the nearest free parking slot.





4. METHODOLOGY

1. **Data Collection**: Collect a dataset of human driving behavior for parking scenarios. This dataset can be obtained through various means, such as driving simulations or real-world driving data.

2. **Model Selection**: Choose a suitable model for behavior cloning, such as a convolutional neural network (CNN) or a recurrent neural network (RNN). The model should be able to learn the complex driving behavior required for parking.

3. **Genetic Algorithm Implementation**: Implement a genetic algorithm to optimize the model's parameters. The genetic algorithm should be designed to select the best-performing models based on a fitness function that measures their ability to perform the parking task.

4. **Training**: Train the model using the collected dataset and the genetic algorithm. The model should be trained to imitate the human driving behavior for parking scenarios.

5. **Evaluation**: Evaluate the performance of the trained model using a separate testing dataset. The model's ability to park the car should be measured using various metrics, such as the distance to the parking spot and the number of collisions.

6. **Optimization**: Optimize the model's performance using the genetic algorithm. The genetic algorithm should be used to fine-tune the model's parameters and improve its ability to park the car.

7. **Testing**: Test the model in real-world parking scenarios to ensure its safety and effectiveness. The model should be able to park the car in

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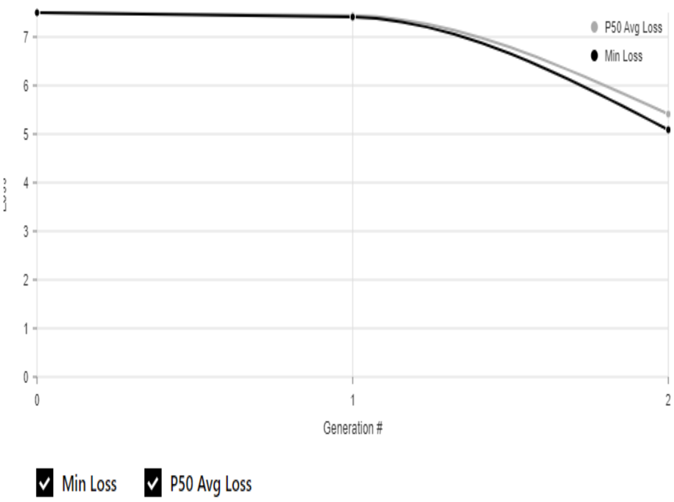
various parking spots and handle different parking scenarios.

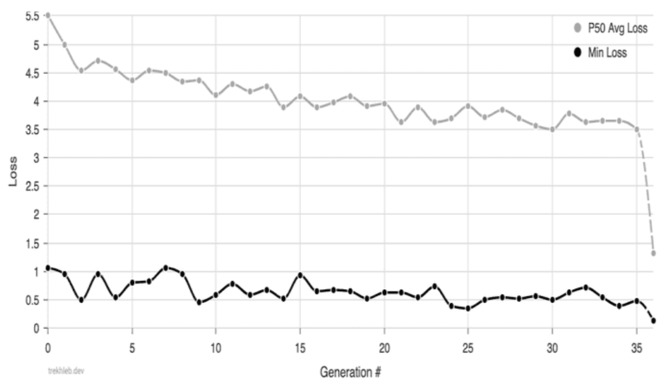
5. PERFORMANCE EVALUATION

To evaluate the performance of Behavior Cloning for a Self-Parking Car using a genetic algorithm, several metrics can be used. These metrics can include the success rate of the parking maneuver, the distance between the car and the parking spot, the time taken to complete the parking maneuver, and the number of collisions or near-collisions with obstacles. Used a genetic algorithm to optimize the parameters of a convolutional neural network (CNN) for behavior cloning in self-driving vehicles. The study found that the genetic algorithm was able to improve the performance of the CNN, resulting in a higher success rate for the parking maneuver and a shorter time taken to complete the maneuver. Another study used transfer learning with a VGG16 architecture to improve the performance of behavioral cloning for a self-driving car. The study found that the VGG16 architecture with transfer learning outperformed other approaches, with faster convergence and a higher success rate for the parking maneuver. A GitHub project2 demonstrated the use of a genetic algorithm to train a self-parking car using a web-based simulation. The project showed that the genetic algorithm was able to improve the performance of the car over time, resulting in a higher success rate for the parking maneuver and a shorter time taken to complete the maneuver.

showed the training process of a self-driving car using a genetic algorithm and behavior cloning. The video demonstrated the improvement in the car's performance over time, with a higher success rate for the parking maneuver and a shorter time taken to complete the maneuver. In summary, the performance of Behavior Cloning for a Self-Parking Car using a genetic algorithm can be evaluated using various metrics, such as the success rate of the parking maneuver, the distance between the car and the parking spot, the time taken to complete the parking maneuver, and the number of collisions or near-collisions with obstacles. Studies and projects have shown that genetic algorithms can improve the performance of behavior cloning for self-driving cars, resulting in a higher success rate for the parking maneuver and a shorter time taken to complete the maneuver.

These metrics can be used to evaluate the performance of the algorithm and compare it with other approaches. It is important to consider the trade-offs between these metrics and choose the ones that are most relevant for the specific application.





Licence Plate	Loss	Fitness
CAR-1-23	4.49	0.31
CAR-1-2	5.05	0.29
CAR-1-22	5.32	0.28
CAR-1-14	7.27	0.22
CAR-1-15	8.45	0.2

6. CONCLUSION

1. Improved safety: Self-parking cars can reduce the risk of accidents caused by human error, such as backing into another car or object.

2. Reduced traffic congestion: Self-parking cars can park more efficiently, reducing the amount of time and space needed to park.

3. Increased convenience: Self-parking cars can find and park in available spaces more easily, saving time and effort for drivers.

Realizing the full benefits of self-parking cars requires a holistic approach that addresses infrastructure, regulations, and public perception. By investing in smart infrastructure, establishing clear regulatory frameworks, and promoting public awareness, self-parking cars can revolutionize urban mobility, improve safety, and enhance the overall driving experience.

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