**Frontiers in Computing and Intelligent Systems**
ISSN: 2832-6024 | Vol. 5, No. 2, 2023

# Research on the Application of Machine Learning in the Real Time Decision System of Autonomous Vehicles

**Shilong Li**

Jilin University-Lambton College, Changchun, China

**Abstract:** As human society enters the era of interconnection and intelligence; the rapid development of the automotive industry has made intelligent driving technology a new industry focus. This article conducts research on the application of machine learning in real-time decision-making systems for autonomous vehicles. The use of radial basis function artificial neural networks to solve the classification problem of overtaking intentions has been proven to be a universal approximator. Based on theoretical analysis and practical driving experience, it can be seen that driving behavior is often stimulated and influenced by multiple factors such as people, cars, roads, and the environment during the driving decision-making process. These factors are collectively referred to as driving decision influencing factors. Assist vehicle sensors in making decisions based on the identified signage information, accurately control the vehicle's driving route based on the identified lane markings, and improve the sensitivity of the sensors and the resilience of the entire system. Considering that the motor speed changes rapidly and in order to ensure stable transmission throughout the entire driving process, the system needs to be adjusted slowly, even if there is no small deviation adjustment, the adjustment speed is fast, and the large deviation generated during cornering or overtaking can be adjusted to prevent slow tracking response speed.

**Keywords:** Machine Learning; Autonomous Vehicles; Real-time Decision-making Systems.

## 1. Introduction

The decision-making mechanism of different driving behavior patterns and the execution mechanism of vehicle operation patterns are two important links to simulate the driver's task aggregation and comprehensive cognitive activities under the stimulation of multi-source information. Among them, the accuracy of driving decision is directly related to road traffic safety. In the decision-making process, driving behavior is often stimulated and influenced by multi-source information such as people, cars, roads and environment. With the rapid development of scientific and technological innovation in recent years, the rapid development of artificial intelligence has also prompted a new round of automobile revolution. At the same time, the rapid development of automobile industry has prompted intelligent driving technology to become a new focus of the industry, and the deeper automatic driving technology is bound to effectively reduce the probability of traffic accidents and ensure driving safety [1]. Autopilot technology is a cutting-edge technology developed rapidly on the basis of artificial intelligence, visual computing, pattern recognition and other technologies, and has been widely concerned by the society [2]. At present, the mainstream technical route of autonomous driving is to install sensors such as lidar, camera and inertial navigation in the car, and make decisions and control and execute the automatic operation of the vehicle by sensing the external environment in real time [3]. Its real connotation is that cars are connected with each other, and cars are connected with the cloud center to realize intelligent traffic guidance and control. Intelligent networked automobile is the final development stage of autonomous driving, and it is an important means to realize the four modernizations of automobile at present. In the future, the demands for infrastructure such as 5G communication and high-precision positioning, cloud platforms and roadside terminals are also increasing, so many new services, such as smart transportation, shared travel, big data mining and applications, emerge in large numbers, and the dynamic reconstruction of the industrial chain has come [4]. In this paper, the application of machine learning in real-time decision-making system of autonomous vehicles is studied. Learn the driving characteristics of a specific driver, so that the intention of self-driving vehicles is the same or similar to that of human drivers, which brings a good driving experience. Use spatial query to query the map elements within the vehicle range in real time according to a certain frequency [5]. According to the inquired sign information, the vehicle sensor decision-making is assisted, and the vehicle driving route is accurately controlled according to the inquired lane markings, which improves the sensitivity of the sensor and the toughness of the whole system, greatly reduces the false alarm rate and false alarm rate of traffic accidents, and improves the credibility and reliability of the automobile collision warning system [6].

## 2. Establishment of a Driving Decision Recognition Model


**Figure 1.** Autonomous Vehicle

The concept of autonomous driving was first proposed by John McCarthy, one of the founders of artificial intelligence, in 1969. He proposed in an article titled "Computer

Controlled Vehicles" that an "autonomous driver" can use a camera head to input visual information like a human eye to assist in vehicle control, as shown in Figure 1 of an autonomous vehicle.

In order to obtain accurate road information, autonomous vehicles need to select appropriate thresholds. When the light is strong, choose a large threshold. When the light is weak, choose a small threshold. In binary image, the first 10 lines adopt edge extraction method, and the next line adopts tracking edge extraction method. Use the position of the first 10 lines. Locate at the 11th line, then search for the black line in this area, and so on. Determine the next line according to the previous line. When the position of the black line is not found, keep the position of the previous line as the current black line, and expand the search area of the next line [7]. If you don't search for three consecutive black lines, you think this line is lost and quit the search. Vehicles sometimes need to accelerate to ensure that vehicles do not exceed the specified speed and quickly enter the set route. Therefore, it is necessary to adjust the vehicle speed in real time according to the deviation. Considering the rapid change of motor speed, large current and frequent acceleration and braking, it not only makes the drive chip start thermal protection, but even burns out the motor. At the same time, in order to make the vehicle change speed stably during the whole driving process, it is necessary to ensure that the motor speed is a gradual process and the system needs to be adjusted slowly. This can remove the interference and greatly improve the efficiency of the algorithm. Microscopic traffic scene information model and real-time decision-making model of self-driving vehicles.

As the input of the real-time decision-making model of autonomous vehicles, the microscopic traffic scene information model contains multi-level scene information, which provides an effective basis for behavior decision-making. Based on hierarchical state machine, the decision-making model divides human driving behavior into different levels of sub-behaviors, and establishes the corresponding top-level state machine and supercar state machine [8]. Hierarchical state machine models the behavior decision-making problem as the transition relationship between States, which reduces the complexity of decision-making and makes the decision-making system easy to maintain. According to theoretical analysis and practical driving experience, in the process of driving decision-making, driving behavior is often stimulated and influenced by multiple factors such as people, cars, roads and environment. These factors are collectively called driving decision-making influencing factors, which together determine the driver's action strategy at the next moment. According to this strategy and the current driving environment, the driver can make driving decisions timely and accurately [9-10].

# 3. Research on the Application of Machine Learning in the Real Time Decision System of Autonomous Vehicles

## 3.1. Establishment of a Real-time Decision-Making System for Autonomous Vehicles

The sensors equipped with autonomous vehicles mainly include maps, monocular cameras, LiDAR, millimeter wave radar, and GPS/INS. Among them, the map provides road information such as road width, number of lanes, and speed limits, which are matched with perceptual information obtained from cameras and LiDAR through virtual lane technology. The camera is used for lane detection. LiDAR provides three-dimensional distance measurement, achieving dynamic vehicle detection, roadside detection, etc. based on the distance point cloud of obstacles. This article uses machine learning algorithms to solve the classification problem generated during the driving process of autonomous vehicles, in order to approximate the subjective decisions of specific drivers and bring a good driving experience. The generation of overtaking intention in autonomous vehicle decision-making is essentially a classification problem, and commonly used machine learning classification algorithms include artificial neural networks, support vector machines, deep learning, etc. The use of radial basis function artificial neural networks to solve the classification problem of overtaking intentions has been proven to be a universal approximator. Environmental modeling includes global traffic models and local traffic models. Among them, the global traffic model mainly includes road network information, real-time road condition information, etc., used for global path planning. The micro traffic scene model belongs to the research focus of this project, mainly including road information, vehicle information, driver intention information, etc. in local environments. This paper analyzes the particularity of RBF neural network to the road environment, fully considers the behavior intention and behavior interaction of vehicles, and puts forward the overall framework of the road auto drive system, as shown in Figure 2.

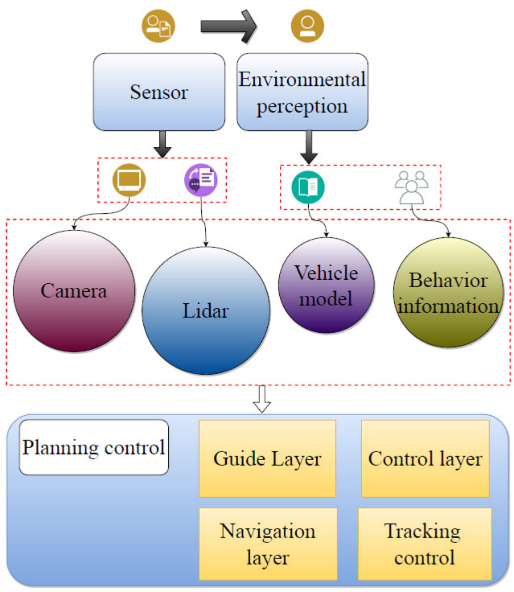


**Figure 2.** Overall Framework of auto drive system

Due to the complexity of real traffic scenes and unpredictable emergencies, it is a great challenge to establish a behavior decision-making system. The multi-level microscopic traffic scene information model is established by RBF neural network, which provides reasonable and effective decision-making basis for behavior decision-making module, can reduce the adverse effects caused by the uncertainty of perception system to a certain extent, and enhance the driving safety and decision-making rationality. RBF neural network is a kind of feedforward neural network, which contains a hidden layer with radial basis function and an output layer with linear neurons. The hidden layer unit realizes a radial basis function, and the output of each hidden layer unit is:

$$y_{j\cdot p} = z_p - \mu_j \quad (1)$$

Where $\mu_j$ represents the center of the basis function.

The output unit of the radial basis network realizes the linear excitation function, that is, the linear combination of basic functions, which is calculated as:

$$o_{k\cdot p} = \sum_{k=1}^{j+1} \omega_{kj} \quad (2)$$

Considering the lack of perception performance of self-driving vehicles, it is impossible to fully and accurately perceive the surrounding traffic environment, which makes the decision-making problem more difficult. In order to establish a complex behavior decision-making system, this paper fully draws lessons from the decision-making process of human drivers. On the one hand, human driving decision provides a model for self-driving vehicles, which is a good idea. On the other hand, the decision-making system of autonomous vehicles needs to be human-like, and its behavior can be understood by human drivers, so that it can truly integrate into the traffic flow and drive safely.

### 3.2. Realization of Real-time Decision System for Self-driving Vehicles

In the application of real-time decision-making system for autonomous vehicles, according to the actual situation, vehicles do not need to strictly follow the set route due to the need for self-judgment ability. Therefore, the steering control adopts a control algorithm to eliminate integral saturation elements. In order to make the vehicle run more smoothly, the system needs to be adjusted slowly, or even not adjusted on small deviations, while quickly adjusting to avoid large deviations in the motor. On the basis of considering the multi-objective decision-making system of vehicle driving safety, comfort, and stability, in order to make the system as close as possible to the handling characteristics of real drivers, this article selects a driving simulator as a data collection platform and designs various daily driving conditions to collect real driving data of drivers. The actual acceleration of the entire process has a good tracking effect on the expected acceleration. During the deceleration process, due to speed fluctuations in the front car, the expected acceleration of this car changes first by braking heavily and then accelerating. Then, as it approaches the front car, it gradually decelerates and brakes with pressure at the end, which is basically consistent with the driver's behavior pattern. When the distance between vehicles is too small, it is necessary to slow down to increase the distance. When the target speed is calculated by the vehicle distance model and is less than the current speed, it is controlled by the operating conditions to achieve speed following. Unlike the engine characteristics, the response of a car's deceleration braking is extremely fast, and the wheel cylinder braking resistance accounts for the majority of the total resistance during the braking process. Therefore, the vehicle's braking has good linearity. Simply set the program logic and acceleration control threshold to achieve the output of the target control curve. Considering that the motor speed changes rapidly and in order to ensure stable transmission throughout the entire driving process, the system can ensure that the motor speed is a gradual process. The system needs to adjust slowly, even if there is no small deviation adjustment, the adjustment speed is fast, and at the same time, it can adjust the large deviation generated during cornering or overtaking to prevent slow tracking response speed.

## 4. Conclusion

In the road traffic environment, the self-driving vehicle can reasonably change the speed and the following distance through control, so as to ensure the safe driving of the vehicle. Drawing lessons from the decision-making process of overtaking behavior of human drivers, taking the microscopic scene information model as the decision-making basis and the hierarchical state machine as the decision-making basis, the decision-making of overtaking behavior of self-driving vehicles is realized by hierarchical decision-making method. Among them, the microscopic traffic scene information model includes scene basic information, vehicle behavior information and driving or driving intention information, and multi-level information input makes the decision-making result more reasonable and feasible. In this paper, the application of machine learning in real-time decision-making system of autonomous vehicles is studied. By collecting the behavior decision data of a specific driver, RBF neural network is trained, and the driving characteristics are learned and fitted, so that the decision results are the same or similar to those of the driver, which brings a good and comfortable driving experience. In this paper, a driving decision recognition model is established. Based on the hierarchical state machine, the driving behavior of human beings is divided into different levels of sub-behaviors, and the corresponding top-level state machine and supercar state machine are established. Hierarchical state machine models the behavior decision-making problem as the transition relationship between States, which reduces the complexity of decision-making and makes the decision-making system easy to maintain. Of course, this system has the advantages of stable and reliable operation, low price, simple structure and good dynamic performance, which is the future direction of intelligent vehicles and automatic driving.

## References


[1] Tao X, Yuan Z. Real-time decision-making for autonomous vehicles under faults[J].arXiv e-prints, 2022, 44(5):32-36.

[2] Shu H, Liu T, Mu X,et al. Driving Tasks Transfer in Deep Reinforcement Learning for Decision-making of Autonomous Vehicles[J]. Autonomous Intelligent Systems, 2020, 25(4):30-35.

[3] Wang X, Qi X, Wang P,et al. Decision making framework for autonomous vehicles driving behavior in complex scenarios via hierarchical state machine[J].Autonomous Intelligent Systems, 2021, 1(1):1-12.

[4] Liu L, Lu S, Zhong R, et al. Computing Systems for Autonomous Driving: State of the Art and Challenges[J].IEEE internet of things journal, 2021, 28(8):8-14.

[5] Li S, Shu K, Chen C, et al. Planning and Decision-making for Connected Autonomous Vehicles at Road Intersections: A Review[J].Chinese Journal of Mechanical Engineering, 2021, 34(1):1-18.

[6] Garlick S, Bradley A. Real-Time Optimal Trajectory Planning for Autonomous Vehicles and Lap Time Simulation Using Machine Learning[J]. 2021, 30(5):19-24.

[7] Zhou X. Machine Learning for Triaging Failures in Autonomous Vehicles[J]. 2022, 36(8):11-14.

[8] Miglani A, Kumar N. Deep learning models for traffic flow prediction in autonomous vehicles: A review, solutions, and

challenges[J].Vehicular Communications, 2019, 20(7): 100184. 1-100184.36.

[9] Sankaranarayanan R, Umadevi K S, Bhavani N, et al. Cluster-based attacks prevention algorithm for autonomous vehicles using machine learning algorithms[J].Computers and Electrical Engineering, 2022, 23(9):101-112.

[10] An D, Liu J, Zhang M, et al. Uncertainty modeling and runtime verification for autonomous vehicles driving control: A machine learning-based approach[J].Journal of Systems and Software, 2020, 167(22):26-31.