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Research Article

Route Control and Behavior Decision of Intelligent Driverless Truck Based on Artificial Intelligence Technology

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With the increase in global car ownership, the demand for traffic safety is very strong. Research shows that drivers account for more than 90% of global traffic accidents. Driverless cars can reduce traffic accidents caused for these reasons and greatly improve traffic safety. At the same time, driverless real-time path planning can select the best driving route for vehicles, reduce traffic congestion, and improve the efficiency of transportation. To sum up, driverless vehicles are considered an important solution to ensure traffic safety, improve traffic efficiency, reduce energy consumption and pollution, and change travel mode. An intelligent driverless vehicle is a key component of the intelligent transportation system, which organically combines various functions such as. Among them, path tracking and motion control play a very important role in intelligent driverless technology. At the same time, accurately tracking the desired feasible path and stable motion control are the basis of intelligent unmanned driving. Based on this, this paper uses artificial intelligence technology to study the path control and behavior decision-making of intelligent driverless trucks, and an improved tracking control method is proposed. Through this improved method, the intelligent unmanned vehicle can track the desired feasible path under different curvatures more accurately and stably. Finally, through the road test experiment of the intelligent unmanned vehicle experimental platform in the actual environment, the effectiveness of the scheme design and related algorithms of intelligent unmanned vehicle motion control in this paper is verified.

1. Introduction

Since the advent of the automobile, after more than 100 years of development, it has gradually become a part of people's daily life from the original means of transportation and transportation. The technical level and popularization of the automobile is an important symbol to measure the material living standard and modernization of a country or region [1]. With the rapid development of science and technology, people's daily life has been greatly improved. In the process of modernization, the automobile, as an intelligent complex, has made an indelible contribution to the progress of human civilization and social development with its unique superiority [2]. At the same time, the continuous development of the road transportation system has accelerated social innovation, promoted regional economic construction, and improved people's daily quality of life. In recent years, the production, sales, and ownership of cars worldwide have shown an increasing trend year by year. Since the twenty-first century, with the rapid progress of science and technology and the rapid development of the economy and society, China has become the largest automobile production and marketing market in the world [3]. However, with the increasing number of cars and drivers worldwide and the deteriorating driving and traffic environment, the road capacity decreases and gradually tends to saturation. These

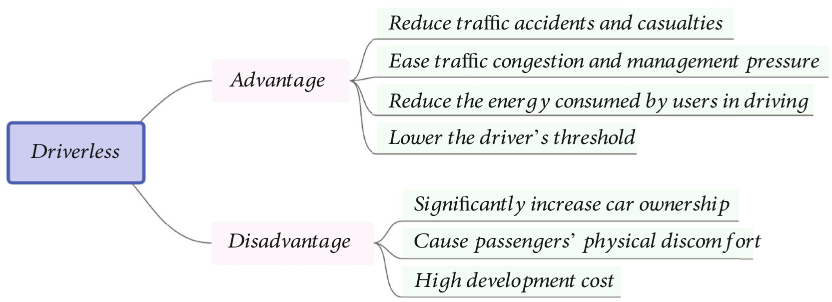

Figure 1: The advantages of unmanned driving.

reasons have led to the increase in traffic accident rate year by year, causing immeasurable losses to the country and the people. The advantages of unmanned driving are shown in Figure 1.

In 2013, the World Health Organization conducted an assessment of road traffic safety in 182 countries around the world. The assessment report said that about 1.24 million people in the world lose their lives in road traffic accidents every year and nearly 50 million people are injured in traffic accidents [4]. As per the latest data of World Health Organization (WHO), 1.3 million lives succumb to death due to road traffic accidents, and almost 20 to 30 million individuals suffer from nonfatal injuries leading to disabilities. These deaths and injuries have had an incalculable impact on the victims' families and caused irreparable tragedy to their lives and even their work. Statistics show that more than 90% of traffic accidents are caused by human factors. Driving fatigue is caused by drivers' failure to strictly abide by traffic rules and repeated driving operations for a long time. The main causes of road traffic accidents are the limitations of human drivers' perception ability and the illegal and wrong operation behavior caused by the congenital delay of driving emergency response [5]. However, nowadays, many traditional vehicle active and passive safety technologies have been applied, and they can improve the driving safety of the vehicle itself. However, this has not changed human beings as the main conductor of car driving, nor has it fundamentally solved the potential problem of causing traffic accidents. We need cars with advanced functions such as self-identification of roads, self-planning of driving paths, and automatic driving so that drivers can be liberated from complex environmental information and cumbersome driving behavior and get a safer driving experience [6]. How to improve the safety technology and safety performance of driving vehicles and reduce road traffic accidents has become a social problem of common concern to governments and research institutions all over the world, which is also one of the important topics facing the development of science and technology. Intelligent driverless vehicles monitor the road environment information, vehicle status information, and driver behavior information in real-time through an advanced sensor detection system, data information processing system, planning decision system, and control execution system [7]. It can partially or completely replace the driver to drive the vehicle and can use the sensor system to sense the information of the vehicle itself and its surrounding environment. Through the obtained information on the road, the vehicle itself, and obstacles, plan a safe and feasible path and control the speed and direction of the vehicle so that the vehicle can drive independently on the road safely and reliably [8].

To sum up, intelligent vehicles have broad application prospects and development space in many fields. Intelligent driverless vehicle involves many advanced technology fields, which can promote the cross integration of multidisciplinary knowledge and effectively guide the research of relevant key technologies [9]. Therefore, the research of intelligent driverless vehicles will lay a theoretical and technical foundation for the development of mobile robots in many fields and has important theoretical significance and practical application value. Based on this, this paper uses artificial intelligence technology to study the path control and behavior decision-making of intelligent driverless trucks and an improved tracking control method is proposed.

The unique contributions of the paper include the following:

(i) Summarization of the research status of driverless vehicle path planning and motion control emphasizing on path planning and motion control algorithm for driverless vehicle in structured roads

(ii) Proposal of a local path planning algorithm based on discrete optimization

(iii) Use of cost functions to evaluate security and smoothness of the candidate paths and selection of optimal path based on weighted summation and minimum value calculation

(iv) Development of a novel coordinate conversion calculation method to calculate coordinate conversions to enhance performance of the algorithm

The organization of the paper is as follows: Section 2 discusses the related studies; Section 3 presents the design of the application model followed by the results in Section 4, and the conclusion is written in Section 5.

2. Related Work

2.1. Research Status of Automatic Driving Abroad. As a high-tech comprehensive application carrier with the intersection

Figure 2: Various driverless cars.

of robotics, pattern recognition, artificial intelligence, computer vision, and automatic control, intelligent vehicles are widely used in the civil, military, and aerospace fields. Since the 1970s, some developed countries in the world, led by the United States, have carried out research in the field of intelligent driverless vehicle technology and have achieved remarkable results so far [10]. Various driverless cars are shown in Figure 2.

There is no doubt that the research level of driverless technology in the United States is the earliest and the best in the world. The advanced research projects agency of the U.S. Department of Defense (DARPA) first proposed the research plan for an unmanned combat platform. Since then, countries all over the world have begun to study the related technologies of intelligent unmanned vehicles [11]. In the 1980s, famous universities in the United States, such as Carnegie Mellon University, Massachusetts Institute of Technology, and Stanford University, gradually began to study the related technologies of intelligent driverless vehicles [12]. In 1995, Carnegie Mellon University developed a driverless vehicle code-named "Navlab2V" that successfully traversed the east and west of the United States, marking a huge breakthrough in driverless technology [13]. The experimental environment is the intercontinental highway between the East and the west of the United States, with a total distance of about 5000 km, of which at least 96% of the journey is completed by autonomous driving of intelligent vehicles [14]. After 2000, intelligent unmanned vehicles to the U.S. military unmanned warfare urgent needs and the global scope of the huge market potential in automotive electronics as the development driver and guide in both the military and civilian areas are in a rapid and rapid development stage. In this competition, the participating vehicles must complete autonomous driving-related action tasks in a complex urban traffic environment with no human assistance at all [15]. This signifies that intelligent driverless vehicles have been able to handle complex traffic situations and adapt to urban environment roads.

The Spanish Institute of Industrial Automation has been working on intelligent driverless vehicle control technology since the late 1990s. Its team research used longitudinal control as a starting point for its research, and it gradually implemented an adaptive cruise control system in urban working conditions. In terms of lateral control, they have realized overtaking, intersection management systems, and pedestrian collision avoidance systems at the same time [16]. In 2010, the VISLAB laboratory at the University of Parma, Italy, developed the "VIAC" intelligent driverless vehicle system with funding from the European Union. The intelligent vehicle system in July from Italy, across Eurasia, all travel about 13,000 kilometers, nearly three months, from Milan to Shanghai and participate in the Shanghai World Expo, its entire journey is mostly highway, and in the process of driving to take some protective measures. Japan's New Energy and Industrial Technology Development Organization (NETDI) demonstrated its fleet of integrated driverless travel systems in February 2013 [17]. This driverless driving system can control multiple trucks for autonomous driving at the same time. The German company Audi is also a leader in the field of civilian intelligent driverless technology. It plans to use its intelligent driverless technology in the 2016 A8 series sedan. Audi's driverless system has a high degree of autonomy and is capable of achieving many operations such as starting, stopping, and shifting gears on its own [18]. In May 2013, a Cisco survey on smart driverless cars showed that fifty-seven percent of consumers believe in driverless cars, which means that smart driverless cars will occupy a significant share of the future automotive market [19].

2.2. Domestic Research Status of Automatic Driving. In the late 1980s and early 1990s, China began to study the related technologies of intelligent vehicles. In the late 1980s, the National University of Defense Science and Technology, Harbin Institute of Technology, Shenyang Institute of automation, Chinese Academy of Sciences, and other units jointly studied the national "863" plan, that is, the theme of intelligent robot in the field of automation, and developed an intelligent autonomous mobile platform that can drive remotely [20]. The State Key Laboratory of Intelligent Technology of

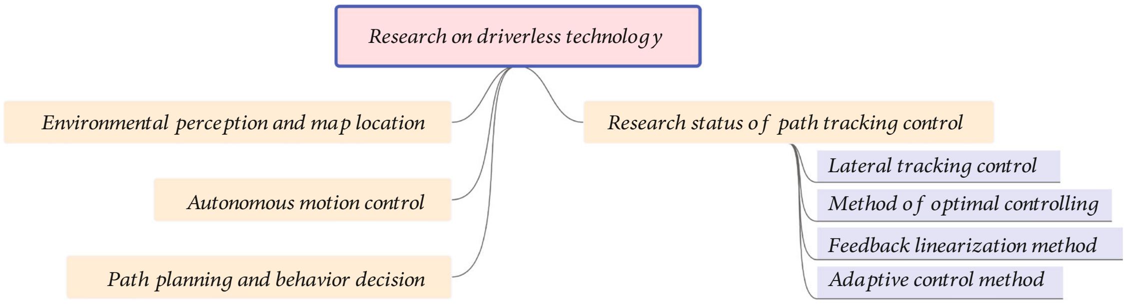

Figure 3: Classification of research directions of driverless technology.

Tsinghua University has carried out research on intelligent driverless vehicle technology through the funding of the national "863" program and "intelligent transportation" and other scientific and technological projects. It is experimentally verified that the vehicle has the function of being able to drive autonomously on highways and general city roads, and it is able to monitor its surroundings and avoid obstacles while driving [21]. In the early 1990s, the Intelligent Vehicle Group of the School of Transportation of Jilin University started developing the "JLUIV" series of intelligent vehicles and has so far developed the fifth generation of intelligent unmanned vehicles and has achieved many valuable research results. Beijing Institute of Technology is also one of the pioneers in the research of unmanned vehicles in China [22]. They have been conducting research on ground unmanned technology for military vehicles since the mid to late 1980s. So far, they have successfully developed military ground intelligent robots and end-guided special remote control target vehicles as well as unmanned vehicles that have participated in the China Smart Car Future Challenge, etc. [23]. In addition, many other domestic colleges and universities are also gradually joining the research field of intelligent vehicles and have successively developed the prototype of relevant intelligent driverless vehicles.

With the rapid development of domestic universities and research institutions for intelligent unmanned driving technology, major automobile manufacturers and Internet companies have also invested in the research and development of intelligent unmanned vehicles. With their technical advantages in the fields of the body and artificial intelligence, and big data analysis, respectively, they realize the technical improvement of intelligent unmanned vehicles directly from the hardware and software levels. Among them, the intelligent unmanned vehicle developed by Baidu is representative in China, and the intelligent unmanned vehicle developed by it realized autonomous driving in Beijing under a comprehensive road environment in December 2015 [24]. Looking at the development and research status of intelligent driverless vehicles at home and abroad, intelligent driverless vehicle technology has become a hot research field and gradually presents the trend of high integration, high intelligence, and practicality. Although China's intelligent unmanned driving technology has still made great progress, there is still a gap between the world's leading technology and the world's leading technology in environmental perception modeling, behavior decision-making, path planning, and motion control [25]. It is still a long way to go to realize intelligent unmanned driving technology in China, and we still need to continue our efforts. Western developed countries have invested a lot of research costs in the field of intelligent driverless vehicles, achieved fruitful research results, and developed a series of autonomous vehicles and safety-assisted driving-related products [26]. From the research status of domestic research institutions, there is still a considerable gap between China's intelligent unmanned vehicle technology and the advanced international level, and there is still a need to carry out in-depth relevant research. With the rapid development of artificial intelligence, robotics, automatic control technology, and computer technology, the research and application of intelligent unmanned vehicles will show a bright future.

2.3. Key Technologies of Intelligent Driverless Vehicle. A driverless vehicle belongs to a kind of mobile robot. Some key technologies and problems in its research field are connected with the research of mobile robots, which is both related and different. Intelligent Unmanned Driving Technology is a comprehensive technology that is a combination of many frontier disciplines. The research directions of unmanned driving technology can be divided according to the functional requirements of intelligent unmanned vehicles and the dynamic complexity and uncertainty in the real environment [27], as shown in Figure 3.

Environmental perception and map positionings are the basis and premise for intelligent driverless vehicles to be able to drive autonomously, and the accuracy of perception of the environment around the vehicle will directly affect the operation results of intelligent driverless vehicles. In the unmanned transportation system, the intelligent driverless vehicle needs to perceive the environment around the vehicle through sensors and then analyze and process the data so as to refine the information of the vehicle environment and the vehicle state information [28]. Path planning is the premise that intelligent driverless vehicles can avoid obstacles and drive stably. Its purpose is to provide the optimal driving path for intelligent driverless vehicles. Path planning can usually be divided into global path planning and local path planning. Global path planning is based on the established map data without considering the constraints of dynamic obstacles [29, 30]. Local path planning is usually used in

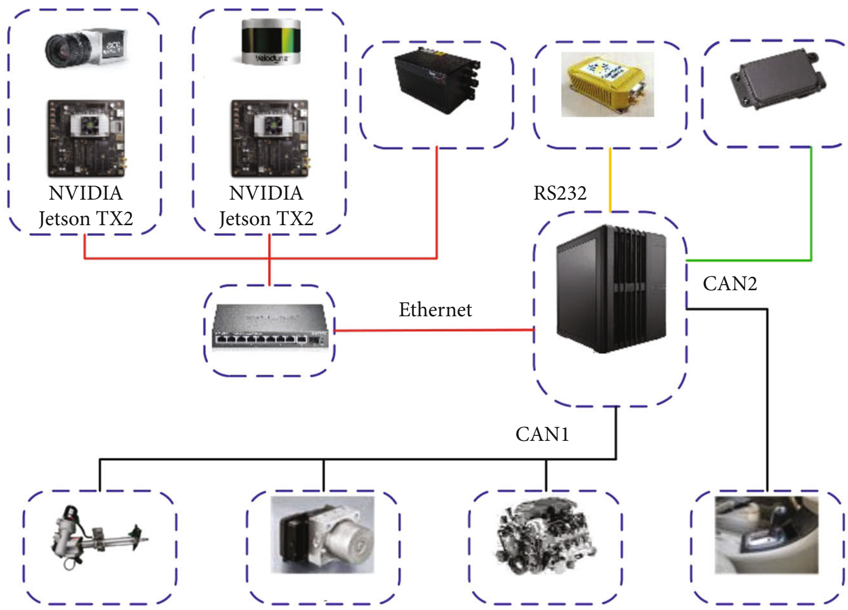

FIGURE 4: Hardware topology of unmanned vehicle.

obstacle avoidance in a dynamic local environment. It can sense the local environment information around the vehicle and the constraints brought by the dynamic environment through sensors.

The information is estimated by self-learning to predict future environmental changes to make an autonomous decision judgment that is most conducive to completing the initial task. Autonomous motion control, as a key problem in the research of intelligent unmanned vehicles, has also received the attention of many researchers [31, 32]. The task of autonomous motion control of intelligent unmanned vehicles is to generate control commands based on the current vehicle's own position and attitude information and the desired information derived from path planning and to control the intelligent unmanned vehicle to follow the desired path accurately and quickly by driving with autonomous motion according to the command information [33]. To sum up, in order to be practical, intelligent driverless vehicles must have accurate environmental perception and map positioning ability, reliable path planning, behavior decision-making system, and a good and safe autonomous motion control system.

The study in [34, 35] developed a UAV-supported vehicular network framework that considered both power and coverage aspects of UAVs in order to make it commensurate in a smart city environment. The study used optimization techniques to adjust the height of the drone considering traffic and energy consumption aspects. An adaptive model was developed that helped to maneuver the position of the drones on the basis of vehicular traffic predictions.

3. Design of Application Model

3.1. Hardware Structure. The experimental platform distributes the algorithms of the perception module, decision planning module, and underlying control module of the unmanned vehicle to different controllers. The decision planning is performed by the decision and planning algorithms, the corresponding control strategy is formulated, and finally, the underlying control executes the relevant actions. The hardware topology of the experimental platform is shown in Figure 4. The camera communicates with the decision planning controller through the GigE interface via a router as the transmission intermediary, and the 16-wire LIDAR and four-wire LIDAR communicate with the decision planning controller via a router as the transmission intermediary. The decision planning controller receives the CAN message transmitted by the millimeter-wave radar through the USB to CAN module, and the communication between the planning decision controller and the underlying control module is through the USB to CAN module.

The software system of the experimental platform of this topic mainly consists of three parts: environment perception layer, planning and decision layer, and bottom control layer. The software system of the driverless car is divided into three layers, the top layer is the environment perception layer, the middle layer is the planning and decision layer, and the bottom layer is the bottom control layer. The three layers work in their own way and interact with each other, so as to realize the autonomous driving of the driverless car. The task of the bottom control is to complete the decision-making, and the planning level formulates the corresponding control strategy, which is divided into vertical control and horizontal control. The behavior rule base is established by data-driven so that planning decisions can be made directly for different environmental information, represented by reinforcement learning, decision tree, and other related machine learning methods.

3.2. Local Path Planning Algorithm for Unmanned Vehicles. In this section, a local path planning algorithm based on

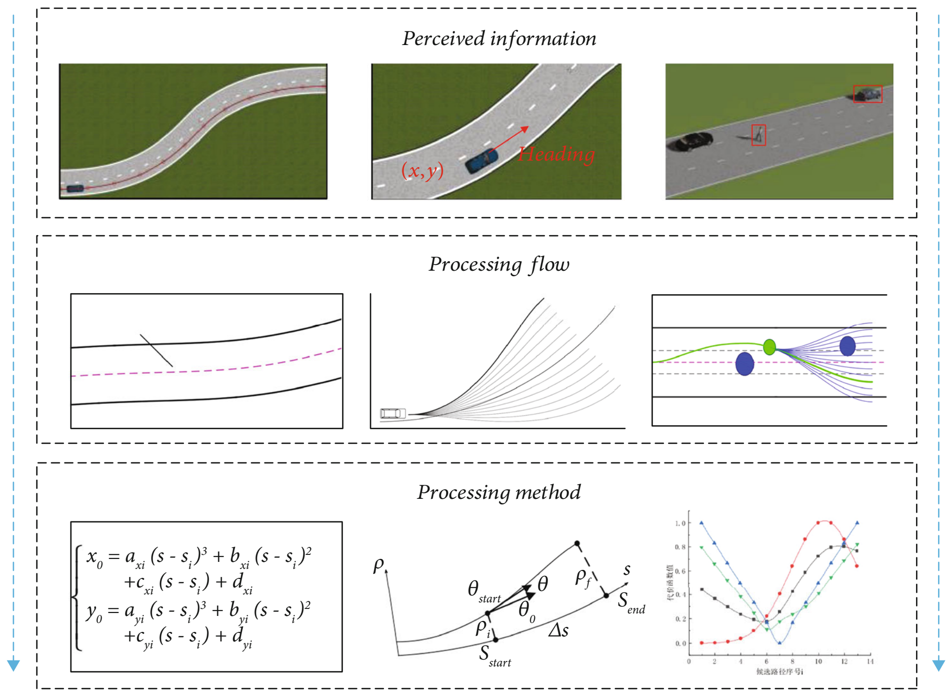

Figure 5: The flow chart of the path planning algorithm.

discrete optimization is proposed. Local path planning has an extremely important role in the development of autonomous vehicles because it helps the vehicle adapt their movements based on the dynamic environments especially when obstacles are detected. This method uses the cost function to evaluate the security and smoothness of the discretely generated candidate paths and then carries out weighted calculations according to each cost function to obtain the locally optimal path. The flow chart of the path planning algorithm is shown in Figure 5.

Global path planning is a prerequisite for local path planning, and local path planning needs to know the information about the global path in advance. Because the first and second-order derivatives of the cubic spline curve have continuity, this paper uses the cubic spline curve to fit the global path:

$$\begin{cases} x_0(s) = a_{xi}(s-s_i)^3 + b_{xi}(s-s_i)^2 \\ +c_{xi}(s-s_i) + d_{xi} \\ y_0(s) = a_{yi}(s-s_i)^3 + b_{yi}(s-s_i)^2 \\ +c_{yi}(s-s_i) + d_{yi} \end{cases}. \quad (1)$$

The baseline, that is, the global path, will be divided into many small segments during fitting. Candidate paths are a series of paths starting from the current position of the vehicle, and the end of the path is the same as the forward direction of the baseline. The lateral offset of the candidate paths in this paper satisfies the equation of the cubic spline curve, so the candidate paths can be expressed by

$$\rho_i(s) = \begin{cases} a_i \Delta s^3 + b_i \Delta s^2 + c_i \Delta s + \rho_{si} \\ s \in [s_i, s_f) \\ \rho_{fi}, \\ s \in [s_f, \infty) \end{cases}. \quad (2)$$

The calculation process needs to consider the current heading of the vehicle while ensuring that the end of the path is in the same direction as the forward direction of the baseline. The equations for the four boundary conditions are as follows:

$$\begin{cases} \rho_i(s_i) = \rho_{si} \\ \rho_i(s_f) = \rho_{fi} \\ \dfrac{d\rho}{ds}(s_i) = \tan\theta \\ \dfrac{d\rho}{ds}(s_f) = 0 \end{cases}. \quad (3)$$

Different candidate paths are determined by different end lateral offsets, setting the appropriate amount of variation of the lateral offset. The boundary conditions and candidate paths are shown in Figure 6.

In order to further improve the efficiency of the algorithm, a new coordinate transformation calculation method is used in this paper. The candidate path can be represented by a series of discrete points, and the discrete points of the candidate path can be found by the following equation:

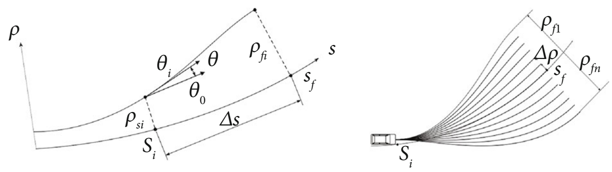

Figure 6: The boundary conditions and candidate paths.

$$\begin{cases} x_i = x_0 - \rho_i(s) \cos \theta_n \\ y_i = y_0 - \rho_i(s) \sin \theta_n \end{cases}. \tag{4}$$

The optimal path is the path that is smooth and can guide the unmanned vehicle to follow the baseline well while satisfying the safety. In this paper, a weighted multiobjective cost function is designed to evaluate the candidate paths, and the optimal path is selected by choosing the path with the smallest cost function after normalizing the cost functions and performing a weighted summation calculation. The relevant mathematical expressions are as follows:

$$\begin{gathered} f(i) = w_s f_s(i) + w_o f_o(i) + w_{sm} f_{sm}(i) \\ \text{select} = \min (f) \end{gathered}. \tag{5}$$

The choice of the optimal path in this paper gives priority to security, so the function of the weight value of each cost function is designed according to the threshold value of the security cost function. When the value of the security cost function is above the threshold value, it indicates that the security is low, so the security cost function takes a larger weight to reduce the probability of choosing such a path.

3.3. Design of Path Security Cost Function. In order to solve the problem of unmanned vehicles avoiding stationary and moving obstacles, a weighted path safety cost function considering stationary and moving obstacles is designed in this paper. When driverless vehicles are driving on the road, static obstacles on the road, such as vehicles parked on the roadside, are potential hazard sources. The path planning algorithm must ensure that a safe and feasible path can be obtained. Although the distance between obstacles and candidate paths can well reflect the security of candidate paths, too many candidate paths or obstacles will bring a lot of calculation, resulting in poor real-time performance. Discrete Gaussian convolution calculation only needs the result of collision detection of candidate paths and can complete the security evaluation of all candidate paths with a small amount of calculation, which has good real-time performance The Gaussian filter helps in reducing noise and blurs regions in the image. In this paper, discrete Gaussian convolution combined with collision risk is used to evaluate the security of each candidate path. The formula is as follows:

$$\begin{aligned} f_{\text{sta}}(i) &= \sum_{k=1}^{N} C_k g_{sta}(i-k), \\ g_{sta}(j) &= \frac{1}{\sqrt{2\pi}\sigma_s} \exp\left(\frac{-(\Delta\rho * j)^2}{2\sigma_s^2}\right). \end{aligned} \tag{6}$$

This shows that the security cost function can explicitly explain the security of candidate paths and can be used as an index to measure the security of candidate paths in this paper. When the driverless vehicle is driving on the road, there are still moving obstacles such as pedestrians and moving vehicles, so the influence of moving obstacles on path selection must be taken into account. The motion cost is estimated based on the Gaussian convolution barrier:

$$X = [x_k, y_k, v_k \sin \beta_k, v_k \cos \beta_k]^T. \tag{7}$$

By substituting the state quantity into the standard Kalman filter based on the uniform velocity model, the position coordinates of moving obstacles at the next time can be predicted. Then, the safety cost function of moving obstacles can be obtained by using Gaussian convolution combined with collision risk. The path safety cost function is defined as the weighted sum of the static obstacle safety cost function and the moving obstacle safety cost function. The formula is as follows:

$$f_s(i) = w_{sta} f_{sta}(i) + w_d f_d(i). \tag{8}$$

When only static obstacles are detected, only the static obstacle safety cost function works. The purpose of the path offset cost function is to make the driving vehicle as close to the global path as possible. When other cost functions are zero, the path offset cost function is the only factor that determines the path selection. In this paper, the sum of absolute curvature values of discrete sampling points of candidate paths is used as the cost function of curvature change, and the formula is as follows:

$$f_c(i) = \sum_{k=1}^{N} |C_k|. \tag{9}$$

In order to solve this problem, the path continuity cost function considers the influence of the path planned in the previous cycle on this planning when selecting the optimal path. On the premise of meeting the security, select the path with the smallest change from the previously planned path. The formula is as follows:

$$f_{co}(i) = \frac{1}{s_{fi} - s_{si}} \sum_{k=1}^{N} \left| \rho_{k,i} - \rho_{k,pre} \right|. \tag{10}$$

4. Experiments and Results

This section mainly carries out the simulation experiment of intelligent driverless vehicle path tracking control, that is, by

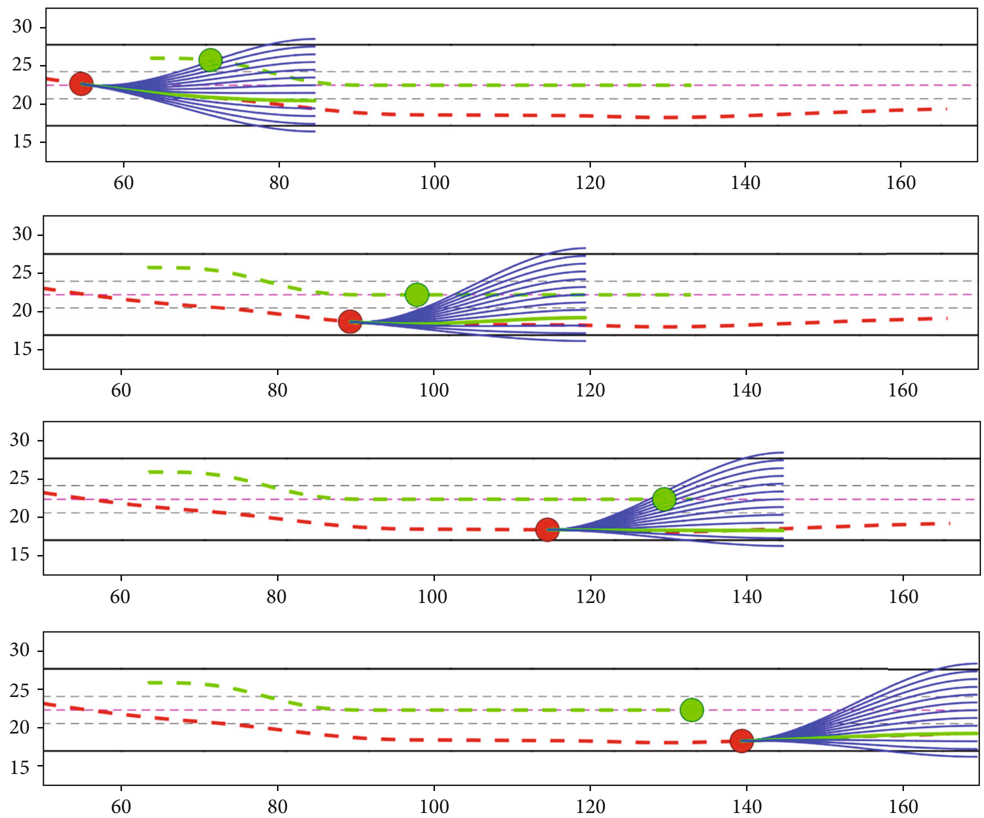

Figure 7: The schematic diagram of obstacle avoidance of unmanned vehicle.

designing the software process of improved path tracking algorithm, selecting, and setting different expected path environments; the path tracking simulation experiment is carried out; and the experimental results and data of the improved tracking method and the traditional tracking method are compared to verify the effectiveness and robustness of the proposed improved tracking method. The unmanned vehicle runs on a 200-m-long one-way three-lane straight road. A stationary obstacle vehicle is parked 50 m in front of the unmanned vehicle. The mobile obstacle vehicle in the left adjacent lane 100 m in front will change lanes to the middle lane when the unmanned vehicle approaches. The schematic diagram of obstacle avoidance of unmanned vehicles is shown in Figure 7.

Under the same expected feasible path, the preview distance corresponding to the tracking position error of different expected positions is different. The simulation results show that it is reasonable and effective to find the appropriate preview distance by comparing the tracking position error. When the preview distance is set to a series of different values, the average value of tracking position error will be different. By comparing the average value, it is easy to find that the tracking position error corresponding to the improved dynamic adaptive preview distance value is the smallest. At the same time, when comparing the variance of all tracking position errors, there is no more prominent error value. The comparison of average value and variance of tracking position error is shown in Table 1.

Table 1: The comparison of average value and variance of tracking position error.

Preview distance	Average value of position error	Variance
0.3	0.10164	0.00132
0.4	0.09257	0.00106
0.5	0.10996	0.00152
0.6	0.13042	0.00213
0.7	0.15332	0.00311
Adaptive value	0.08535	0.00092

Table 2: Comparison of real-time performance.

	Premodel improvement		After improving the model	
	t_{ave}	t_{max}	t_{ave}	t_{max}
30 km/h	5.968	19.502	14.454	33.372
70 km/h	6.198	18.031	15.735	29.093

Based on the improved dynamic prediction model, the tracking performance is compared before and after target optimization. The dynamic prediction model largely determines the solution time of the controller at each step. The dynamic prediction model uses repeated of the predictors in order to estimate the coefficients that connect the longitudinal predictors to a static model. The real-time performance of the controller before and after the improved model is shown in Table 2.

Table 2 shows that before and after the improved model, the real-time performance of the controller does not change in magnitude and the maximum calculation time does not exceed 35 ms. The controller based on the improved model has good real-time performance. It can be seen that compared with before optimization, the yaw rate is within the stability range due to constraints, and the phase plane of centroid sideslip angle-centroid sideslip angle velocity has a smaller variation range, indicating that the comprehensive constraints of yaw rate and centroid sideslip angle make the vehicle have good stability. The controller can track the vehicle track accurately and improve the stability under the condition of low road adhesion.

5. Conclusion

The driverless vehicle has become the latest development direction of the whole automobile industry. Driverless technology can comprehensively improve the safety of automobile driving. On the basis of consulting a large number of literature and data on driverless vehicle path planning and motion control, this paper summarizes the research status of driverless vehicle path planning and motion control and focuses on the path planning and motion control algorithm of the driverless vehicle under the structured road. In this paper, a local path planning algorithm based on discrete optimization is proposed. Various cost functions are used to evaluate the security and smoothness of candidate paths, and the optimal path is selected by weighted summation calculation and minimum value. In view of the complex calculation of the original coordinate conversion method, a new coordinate conversion calculation method is used to calculate the coordinate conversion, which improves the real-time performance of the algorithm.

The path planning and motion control algorithm proposed in this paper still has some shortcomings, which need to be further improved in future work. In this paper, a local path planning algorithm based on discrete optimization is proposed. The optimal path is selected by weighted summation of cost function and then minimum value. However, the weight coefficients of each cost function are selected through experimental analysis, and the impact of each weighting coefficient on path planning is not deeply explored. In the future, the impact of the value of the weight coefficient of each cost function on the effect of path planning will be studied. In addition, we need to further study the relationship between the risk of obstacles and the standard deviation of collision risk, so as to make the path planning algorithm more humanized and apply the algorithm to more complex scenes.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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