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Unmanned Vehicle Route Tracking Method Based on Video Image Processing

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Abstract

Most unmanned vehicle path tracking methods ignore video image processing, resulting in a lot of interference information and severe distortion in the original video image, unable to accurately obtain road information, and reducing the accuracy of path tracking. This paper proposes a vehicle path tracking method based on video image processing. The original road condition image is filtered by median filtering method to reduce the interference of noise on image quality; the filtered road condition image is binarized to distinguish the image from the target image and the background image; and the boundary contour of the binary image is extracted by four neighborhood method to obtain the required road condition feature information. At the same time, the computational complexity is reduced. Based on the road condition characteristic information, the preview deviation angle and path curvature are calculated by preview point sequence; the driving speed is determined according to the path curvature, and the longitudinal control is realized; the preview deviation angle is converted into the control quantity of front wheel rotation angle by Pure Pursuit algorithm, and the lateral control is realized. The experimental results show that the driverless vehicle can track the reference trajectory quickly with different reference speeds, and then its position deviation is controlled within 0.05 m. The average energy consumption of path tracking is 355.13 J, which shows that the driverless vehicle using this method can achieve precise path tracking with low energy consumption.

Keywords: Video Image; Driverless; Vehicle; Path Tracking; Preview Deviation Angle; Path Curvature;

1. Introduction

In 2017, the World Health Organization assessed road traffic safety in 182 countries around the world. The assessment reports 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. These deaths and injuries have an inestimable impact on the families of victims. It has caused irreparable tragedy to their lives and even their work. The World Health Organization says road traffic accidents are expected to be the seventh leading cause of death in the world by 2030 unless sustained action is taken. Statistical data show that more than 90% of traffic accidents are caused by human factors, such as violationtraffic rules,fatigue caused by long-term repetitive driving, limitations of human drivers' perception and congenital delays in driving emergency response [1]. The main causes of road traffic accidents are the wrong operation behavior and so on, and these conditions also lead to a series of traffic problems, such as traffic jams. In order to avoid these problems, it is necessary for vehicles to have advanced functions, such as self-identification of roads, self-planning of driving paths, and self-control of driving, so that drivers can be freed from complex environmental information and cumbersome driving behavior, and get a safer driving experience. Improving the safety technology and safety performance of driving vehicles and reducing road traffic accidents has become a social issue of common concern to governments and research institutions, which is also one of the important issues facing the development of science and technology [2].

Unmanned vehicles are mainly used to improve road traffic safety, reduce traffic congestion, and to reduce vehicle fuel consumption and environmental pollution. Many countries in the world are supporting the research in the field of driverless vehicles and intelligent transportation technology, mainly including the control research of driverless vehicle path tracking, lane maintenance, vehicle lane change and so on. The purpose of path tracking is to make the vehicle travel along the desired path while ensuring the lateral stability of the vehicle. Its control algorithm is the key of path tracking. The path tracking control algorithm is particularly important for the driverless vehicle. Therefore, path tracking is a key technology in the research direction of the driverless vehicle [3]. Early path tracking methods, such as geometric path planning and rolling path method, are more suitable for indoor robots [4]. However, because the driverless vehicle is a non-holonomic constrained vehicle body, which is constrained by turning radius, angular speed and so on, the path tracking method mentioned above is not applicable to the driverless vehicle. Therefore, unmanned vehicle path tracking method has become a hot research topic of relevant scholars. Jeon et al. took the change rate of lateral deviation and lateral deviation as input of the fuzzy controller, and the former wheel rotation angle as output of the controller to control the driverless vehicle running along the desired path [5]. For example, adopt adaptive sliding mode controller to realize path tracking of unmanned vehicle, and eliminate control

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system jitter and external interference according to Lyapunov stability theory [6]. Ojha et al. used model predictive control and forward feedback control to achieve four-wheel steering driverless vehicle path tracking [7] with the objective of minimizing lateral deviation. Depatla uses robust H output feedback control to track the driverless vehicle's path without considering the driverless vehicle's lateral speed. Simultaneously, simulation experiments are carried out. However, there is a big deviation between the theoretical results and the actual situation [8].

Unmanned vehicle path tracking is mainly composed of path recognition, steering control and speed control, and all of these are based on video image processing. Various methods of unmanned vehicle path tracking proposed in the above literature neglect video image processing, resulting in a large number of interference information and serious distortion in the original video image, so the processor cannot be directly used, and cannot accurately acquire road condition information and reduce the accuracy of path tracking. In this paper, a path tracking method for driverless vehicle based on video image processing is proposed. The driverless vehicle receives the preview information processed by video image processing technology, establishes a preview point sequence search model according to the current posture and the relative motion relationship between the preview point sequence and the path. It uses the strategy of multi-point preview to predict the curvature change of the path, and controls the vehicle according to certain rules. Through Pure Pursuit algorithm [9], the control quantity of front wheel rotation angle is calculated to control the steering of driverless vehicle. Finally, the effectiveness of the proposed tracking method is verified by experimental analysis.

2. Unmanned vehicle path tracking method

2.1. Video image processing technology

2.1.1. Wave filtering

Due to the influence of noise, the road condition images collected by the camera contain a lot of interference information. In order to reduce the interference of noise on image quality, software filtering method is used to smooth the image. Median filtering is a method of replacing the gray value at the noise point with the median value of gray value. This method can protect the edge of the image and filter out the noise at the same time. The filtering effect is better than that of mean filtering. Because the subsequent contour extraction requires high image quality [10], the median filtering method is selected in the video image processing technology of tracking unmanned vehicle path.

2.1.2. Binarization

In order to reduce computational complexity, save processing time and extract road information more intuitively, the filtered image should be binarized to get binary image. The gray value and threshold of the pixels in the image should be compared, and the image can be divided into two parts: the target image and the background image [11]. Threshold selection is critical. If the threshold is too high, too many target points are misclassified as background; if the threshold is too low, too many background points are misclassified as targets. Threshold is divided into static threshold and dynamic threshold. The specific process is shown in Fig. 1.

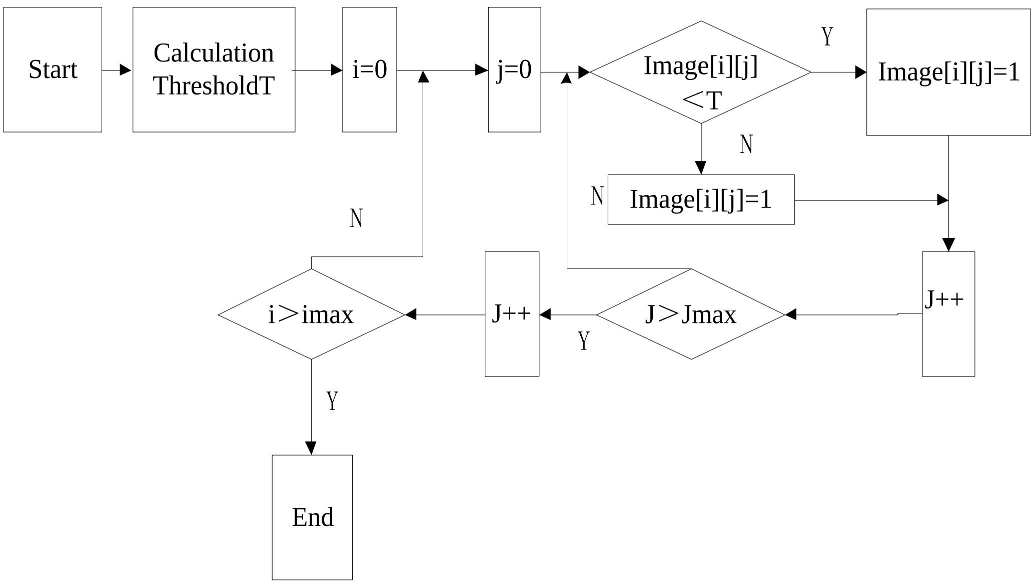


Figure 1. Flow chart of binarization

In Fig. 1, T denotes the threshold, i denotes the image row, j denotes the image column, and Image[i][j] denotes the gray value at (I,J). When the gray value at this point is less than the threshold, the value is zero, indicating that the image at that point is the background; on the contrary, the value is 1, denoting that the number of data for the target image is equal to i is reduced by 1, and jmax is equal to the amount of data for j by 1.

In the process of binarization, a dynamic threshold is selected, which is adapted to the driving environment of an unmanned vehicle in real time. The dynamic threshold is obtained by Otsu method, that is, the best threshold is selected from 0 to 255 in turn, and the image is divided into two parts, background and target, so that the variance between the two parts is maximized. The greater the variance between background and target, the greater the difference between the two parts of the image, that is, the best threshold [12]; on the contrary, the selection of threshold is unreasonable. Therefore, to maximize the variance between classes means that the probability of misclassification is the smallest, and Otsu method is simple to calculate, time-consuming and not easily affected by image brightness and contrast [13]. Calculate the normalized histogram p_i of the input image, that is:

$$p_i = \frac{n_i}{N} \tag{1}$$

Among them, n_i and N are target image and background image respectively.

For k=1, 2,... 255, the cumulative sum $p_i(k)$ and the cumulative mean m(k) are calculated.

$$p_i(k) = \sum_{i=0}^{k} p_i \tag{2}$$

$$m(k) = \sum_{i=0}^{k} i p_i \tag{3}$$

The global gray values are calculated by the above formulas.

$$m_G(k) = \sum_{i=0}^{255} i p_i \tag{4}$$

For k=1, 2,... 255, calculate the inter-class variance $\sigma_B^2(k)$:

$$\sigma_B^2(k) = \frac{[m_G P_1(k) - m(k)]^2}{P_1(k)[1 - P_1(k)]} \tag{5}$$

The optimal dynamic threshold is obtained to maximize the k of $\sigma_B^2(k)$.

$$\sigma_B^2(k) = \max_{0 \le k \le 255} \sigma_B^2(k) \tag{6}$$

If the gray level histogram is obviously bimodal, the gray value at the trough between the two peaks is selected as the threshold value. This method is suitable for processing images with obvious double peaks and deep valley bottom. For single peak histogram, the histogram with no obvious double peaks or wide flat valley bottom is not effective [14]. In practical applications, the image is often affected by noise, which results in two obvious peaks. Otsu method is chosen to calculate the threshold because of the complex and changeable road conditions in the driving process of driverless vehicles.

2.1.3 Contour extraction

If all binary images are analyzed and processed, the computational complexity is large and the processing speed is slow. In order to simplify the analysis and processing steps and accelerate the response speed of video image processing, the four-neighborhood method should be used to extract the boundary of binary image. If the current pixel value is 1, then the current binary image is the target image; if the four pixels of the binary image are 1, then the current pixel value is 0, and the binary image is the background image, otherwise the current pixel value is unchanged [15]. This method can effectively retain the road condition information required by driverless vehicles.

After the unmanned vehicle obtains the required road condition information through video image processing, it obtains the path preview information in the road condition information through multi-point sequence. The path preview information includes lateral position deviation, preview deviation angle, path curvature and so on, and finally realizes the path tracking of the unmanned vehicle.

2.2. Unmanned vehicle path tracking

2.2.1. Relative motion model of unmanned vehicle-path

After simplification and abstraction, the relative motion model of driverless vehicle-path is established as shown in Fig. 2.

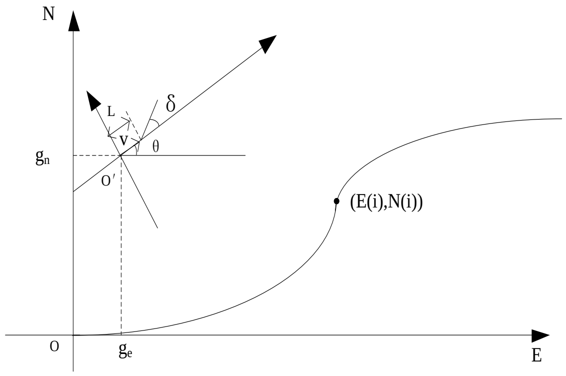


Figure 2. Relative motion model of driverless vehicle and path

Among them, E, N and O are global coordinates, E axis is in the positive East direction, N axis is in the positive North direction. The local coordinate system XO'Y is established with the midpoint of the rear axle as the origin of the coordinate, which specifies the forward direction of the X axle as the vehicle's direction; δ is the front wheel rotation angle; θ is the heading angle, that is, the angle between the vehicle's forward direction and the E axle; v is the forward speed; and L as the wheelbase. The road condition information obtained by video image processing technology is actually a series of ordered longitude and latitude coordinates, which are transformed from WGS-84 coordinate system to plane rectangular coordinate system. Then the starting point of the trajectory point sequence is used as the origin of coordinate to establish the global coordinate system. The coordinates of the trajectory point of the driverless vehicle in the global coordinate system are expressed as $(E(i), N(i))$ and i is the sequence number of trajectory points. The target path tracked by an unmanned vehicle is given in the form of the above point sequence. If the position coordinate of the midpoint of the rear axle of an unmanned vehicle is (g_e, g_n) in the global coordinate system, the kinematics model of the unmanned vehicle can be expressed as follows:

$$\begin{cases} g_e = k \cdot \cos\theta \\ g_n = k \cdot \sin\theta \\ \theta = \dfrac{k \cdot \tan\theta}{L} \end{cases} \tag{7}$$

2.2.2. Preview deviation angle and path curvature

In the process of manual driving, the driver's eyes constantly preview the forward path, and determine the direction, angle and speed of the vehicle according to the relevant information of the forward path, so that the vehicle can approach the forward path as far as possible [16]. For the problem of path tracking control of unmanned vehicle, the concept of path curvature and preview deviation angle is introduced by referring to manual driving behavior. Assuming that the angle between the moving direction of an unmanned vehicle and the line connecting the preview tracking point and the current position point is the angle, the angle is defined as the preview deviation angle by literature investigation. At the same time, through actual investigation and analysis, it is found that the lateral control problem of path tracking can be transformed into the tracking problem of preview deviation angle [17]. A multi-point preview strategy is proposed to describe the curvature change at the preview tracking point of the target path. In addition to selecting a preview point as the tracking point on the target image path after video image processing, the other preview points are only used to describe the curvature change of the path and obtain the curvature of the front path. Firstly, the preview point search algorithm model is established as shown in Fig. 3.

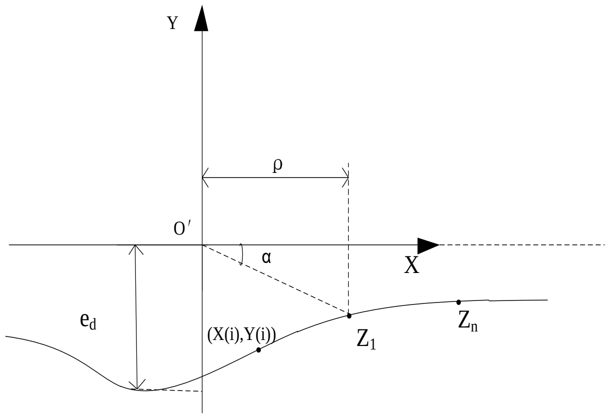


Figure 3. Model of preview point search algorithm

In Fig. 3, ρ is the preview distance, e_d is the lateral position deviation, that is, the distance deviation between the current position and the tracking path trajectory, and Z_j is the preview point sequence acquired on the target path, that is, the trajectory point sequence. Taking the unmanned vehicle as the reference object, the trajectory point sequence is transformed into the local coordinate system XO'Y, then the coordinates of the trajectory point sequence in the local coordinate system are expressed as $(X(i),Y(i))$, and the coordinates satisfy the following equation:

$$\begin{bmatrix} X(i) \\ Y(i) \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \cdot \begin{bmatrix} E(i) - g_e \\ N(i) - g_n \end{bmatrix} \tag{8}$$

The steps of searching preview tracking points Z_1 are as follows: first, the trajectory points are transformed into local coordinate system by formula (8), then the nearest points are found in the sequence of trajectory points describing the target path, which is the starting point of this search; secondly, starting from the starting point, along the direction of the vehicle body, one point is found in the sequence of trajectory points in turn to satisfy the following requirements:

$$\left[X(z_1) - \rho\right]\left[X(z_1+1) - \rho\right] \le 0 \tag{9}$$

In the formula, z_1 is the ordinal number of the points satisfying formula (9) in the sequence of trajectory points. This point is preview tracking point z_1, which can complete a preview tracking point search. When the vehicle moves to a new position, repeat the above steps and complete a new search. After confirmation, α was determined immediately. It is found that the driver mainly controls the speed according to the change of road curvature [18]. Therefore, in order to control the longitudinal speed of the driverless vehicle, it is necessary to find the remaining multiple preview points z_j, where j=1,2.... N, z_j determines the degree of curvature of the path through multiple preview points. In the local labeling system X O'Y, it is convenient to express the curvature change of the target path with a broken line, as shown in Fig. 4.

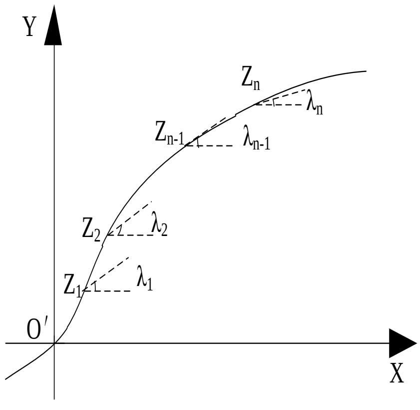


Figure 4. Schematic diagram of path bending degree calculation

The path curvature C is defined to describe the degree of path curvature at the preview point sequence.

$$C = \sum_{j=1}^{n-1} \left|\lambda_{j+1} - \lambda_j\right| \tag{10}$$

In the formula, λ_j denotes the angle between the tangent at the preview point z_j and the driving direction of the driverless vehicle, and $\left|\lambda_{j+1} - \lambda_j\right|$ denotes the relative variation of the tangent angle, which is used to describe the change of the curvature of the path and the degree of curvature of the road. The curvature of the path increases when the direction of the path changes unilaterally or swings left and right. Among them, z_j can be selected by equal interval number, that is, a preview point can be selected by a certain number of path sequence points at each interval. The number of preview points can be selected according to the degree of sparsity of the sequence points describing the target path. The sum of Euclidean distances between the interval points can be used as an index to select the number of intervals.

2.2.3. Implementation of path tracking

According to preview deviation angle and path curvature, the driverless vehicle path tracking is carried out. The main control variables in the process of path tracking are the front wheel rotation angle and longitudinal speed. The control system of unmanned vehicle is a typical time-delay, non-linear and unstable system, and the preview control action has obvious predictability, which is obviously superior to the traditional control algorithm based on information feedback [19]. The framework of the proposed path tracking algorithm is shown in Fig. 5.

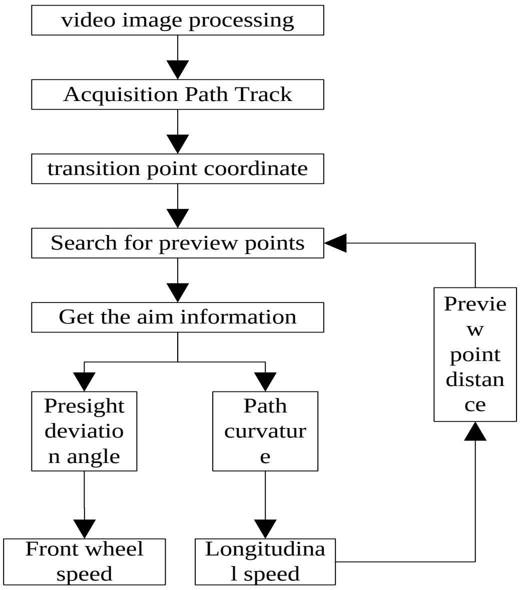


Figure 5. Path tracking algorithm

As can be seen from Fig. 5, after video image processing of the target path image of an unmanned vehicle, the path information is acquired according to the processed image acquisition path trajectory, and the path information is converted into the road point coordinates. The preview information of preview angle and path curvature is obtained by searching preview point in the road point coordinates. The speed and longitudinal direction of the front wheel of an unmanned vehicle are determined by preview point information. The speed is controlled, and the distance of the preview point is obtained according to the information of the preview point. It is more important to determine the preview distance and the lateral and longitudinal control speed. The following is a detailed analysis of the determination of the preview distance and the lateral and longitudinal control speed. (1) The determination of the preview distance.

Preview distance directly affects the accuracy of path tracking, and its selection is very important. The smaller preview distance can make the driverless vehicle track the path more accurately and can track the path with larger curvature. The larger preview distance can reduce the overshoot of the driverless vehicle in the tracking process and improve the tracking stability. The preview distance can be determined according to the longitudinal speed of the driverless vehicle. In addition, the preview distance is usually saturated at the minimum and maximum, so the relationship between the preview distance and the longitudinal speed of an unmanned vehicle can be expressed by empirical formulas:

$$\rho = \begin{cases} av + l_{\min}, & 0 \le v \le \dfrac{(l_{\max} - l_{\min})}{a} \\ l_{\max} & v > \dfrac{(l_{\max} - l_{\min})}{a} \end{cases} \tag{11}$$

In the formula, $l_{\min}$ and $l_{\max}$ represent the minimum and maximum preview distance respectively, and a is a constant. The preview distance can be obtained by the above formula.

(1) Longitudinal control based on path curvature

In the local coordinate system, λ_j can be expressed as:

$$\lambda_j = \arctan \frac{X_r(p_i+1) - Y_i(p_i)}{X_r(p_i+1) - X_r(p_i)} \tag{12}$$

In the formula, (X_r, Y_r) is the coordinate of the preview point in the local coordinate system. After calculating the curvature C from formula (10) and formula (12), only considering the effect of curvature change on vehicle speed, the larger the C, the smaller the vehicle speed; conversely, the greater the vehicle speed v. Vehicle speed may not exceed a certain value of $v_{\max}$ under certain conditions. Therefore, in order to ensure that the speed v decreases significantly with the increase of curvature C, the calculation of vehicle speed is as follows:

$$v = \left(1 - \frac{C}{k_c}\right)^2 v_{\max} \tag{13}$$

In the formula, k_c is constant. If the path is given, the curvature C at each point of the path and the maximum and minimum curvature $C_{\max}$ and $C_{\min}$ of the whole path can be calculated offline, then the selection range of k_c is $C_{\min} < k_c < C_{\max}$.

(2) Horizontal control based on Pure Pursuit algorithm

Taking the midpoint of the rear axle as the tangent point and the longitudinal symmetrical axis of the driverless vehicle as the tangent line, the deflection angle of the front wheel is calculated by the geometric relationship of the preview deviation angle, so that the driverless vehicle can travel along the arc passing through the preview point, and the preview deviation angle tends to zero [19]. By applying the sine theorem, we can get that:

$$\frac{l_d}{\sin(2\alpha)} = \frac{R}{\sin(\frac{\pi}{2} - \alpha)} \tag{14}$$

$$\frac{l_d}{\sin\alpha} = 2R \tag{15}$$

Where R is the radius.

Formula (14) can also be expressed as:

$$\kappa = \frac{2\sin\alpha}{l_d} \tag{16}$$

In the formula, l_d is the distance between the current position and the preview point Z_1, and κ is the arc curvature. According to the simplified Ackerman vehicle model, the front wheel angle δ can be expressed as:

$$\delta = \arctan(\kappa L) \tag{17}$$

According to formula (14) and formula (15), the control quantity of front wheel rotation angle based on Pure Pursuit algorithm can be obtained as follows:

$$\delta = \arctan \frac{2L\sin\alpha}{l_d} \tag{18}$$

In the formula $l_d = \rho \cdot \cos\alpha$, after the introduction of the formula (18), there is only one adjustable parameter, i.e. preview distance ρ, which makes the algorithm easy to implement and adjust.

3. Results

3.1. Analysis of the effect of road information processing

In order to study the validity of image processing technology in this paper, the road condition information before and after image processing should be compared, and the comparison results are shown in Fig. 6.

As can be seen from Fig. 6, there is obvious noise in the original road condition image, which is not conducive to the subsequent extraction of path information. After using the median filter in this method to filter out the noise points, the noise points in the image are obviously reduced, and the original contour boundary of the image is retained. The object and background can be effectively separated by binarization. At the same time, the contour extraction method not only retains the road feature information, but also greatly simplifies the amount of image information, which shows that the method in this paper has a good effect in processing the video image information.

3.2. Analysis of path tracking effect

Two methods are used to test the effect of this method on experimental driverless vehicle path tracking. Firstly, the effect of driverless vehicle path tracking under this method is judged by detecting the difference between the driverless vehicle corner command and the actual corner. The test results are shown in Fig. 7.

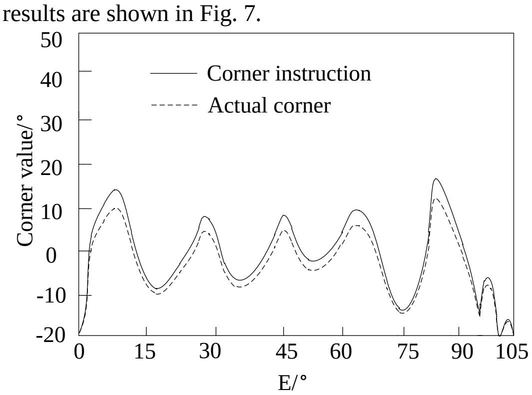
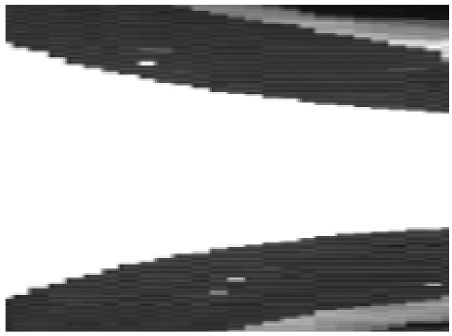


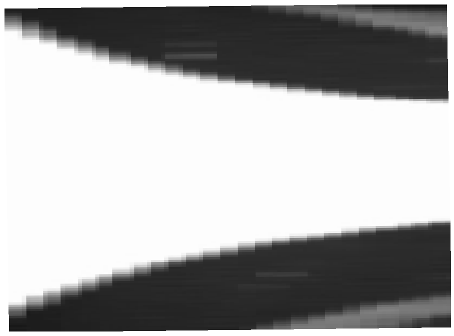
Figure 7. Corner instruction and actual Corner difference

It can be seen from Fig. 7 that in the whole experiment process, the difference between the measured angle instruction and the actual angle is very small, which shows that the control accuracy of this method is high, and it has a good effect on the path tracking of driverless vehicles.

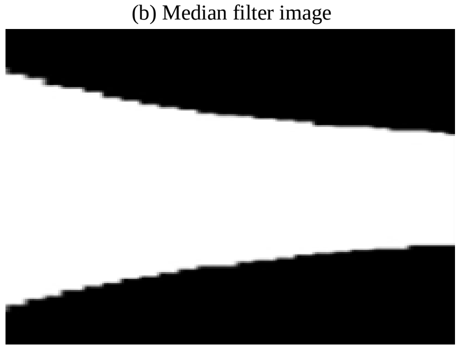
Secondly, starting from the speed of the driverless vehicle itself, the effect of this method on the path tracking of the driverless vehicle is verified. The results of unmanned vehicle path tracking at low speed of 18 km/h and high speed of 93 km/h are compared to detect the impact of this method on the unmanned vehicle path tracking at different speeds. The path tracking of an unmanned vehicle at two speeds is shown in Fig. 8.



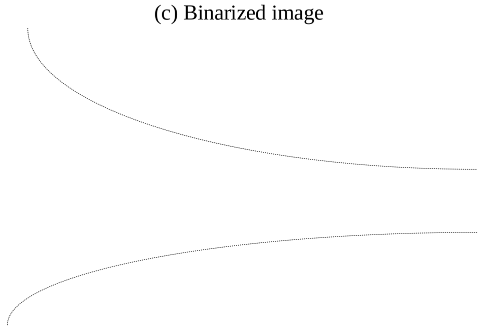
(a) Original road condition image



(b) Median filter image

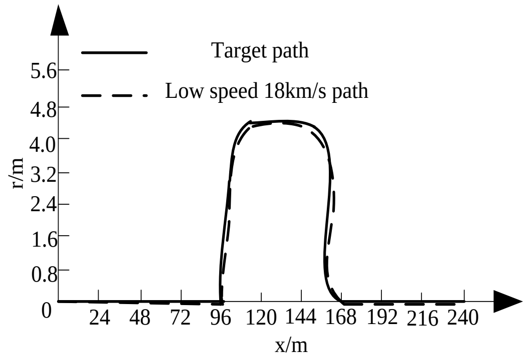


(c) Binarized image

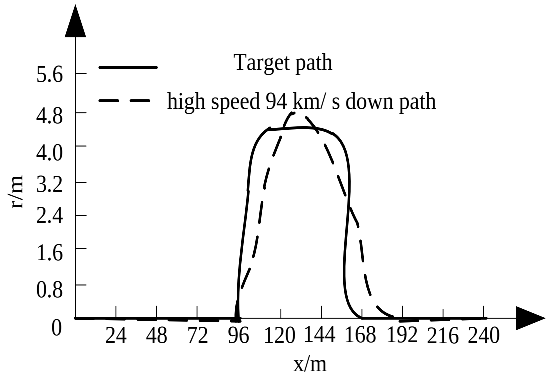


(d) Contour extraction effect drawing

Figure 6. Comparison Results



(a) Automatic tracing effect at low speed



(b) Automatic tracking effect at high speed

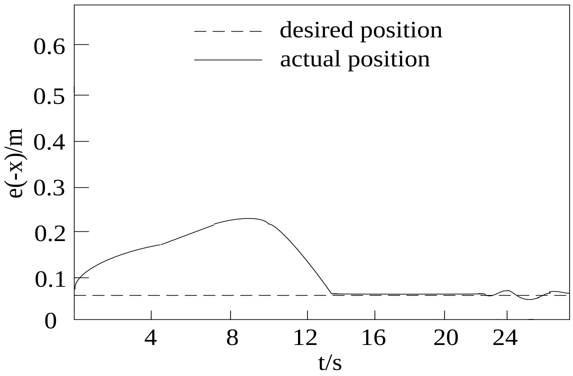
Figure 8. Automatic tracking effect at different speeds

From Fig. 8, it can be seen that although the path tracking effect of driverless vehicles at high speed is slightly lower than that of driverless vehicles at low speed, the path tracking errors at different speeds are relatively small, which shows that the path tracking effect of driverless vehicles using this method is better, and the effectiveness of this method is higher. After using this method, driverless vehicles can carry out the path tracking. Accurate and effective path tracking ensures safe and smooth driving of driverless vehicles.

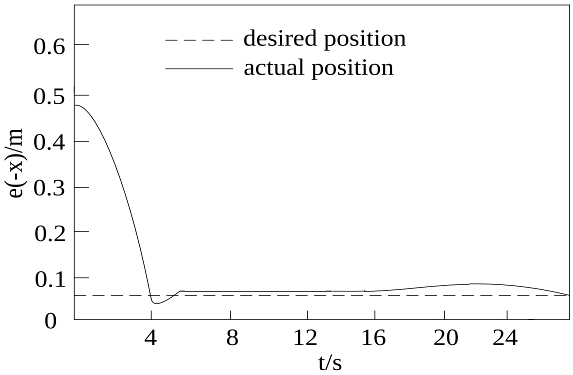
3.3. Analysis of posture deviation at different velocities

Through the above experiments, it is found that the path tracking effect of unmanned vehicle is better after using this method. In order to further verify the path tracking accuracy of this method, it is necessary to analyze the position and attitude deviation of unmanned vehicle at different speeds. In this experiment, the position and attitude deviation of unmanned vehicle at 18 km/h and 94 km/h are mainly studied. The test results are shown in Fig. 9.

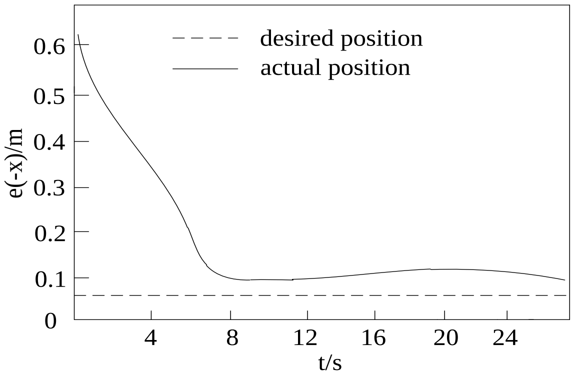
From Fig. 9, it can be seen that the driverless vehicle can quickly track the reference trajectory when the initial position of the vehicle is different from the reference trajectory and the reference speed is different. Under the condition of low reference speed, the actual trajectory of the vehicle is closer to the reference trajectory, and the position and attitude deviation after tracking the reference trajectory is smaller; under the condition of high reference speed, the vehicle still has good tracking effect, and the improvement of the reference speed does not lead to the decline of tracking performance. Therefore, this method can realize the rapid tracking of the reference trajectory of the unmanned vehicle, and has strong robustness to the change of the longitudinal speed of the unmanned vehicle.



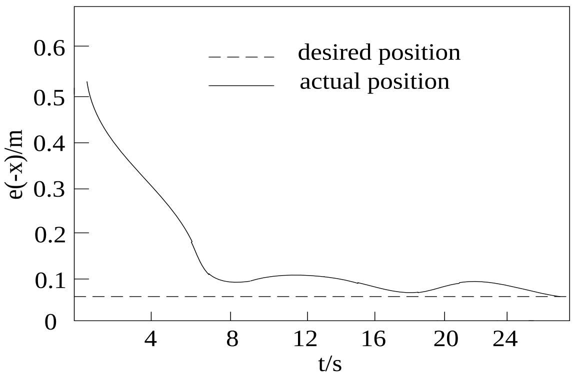
(a) 18 km/ h lateral position deviation



(b) 18 km/h longitudinal position deviation



(c) 94 km/h lateral position deviation



(d) 94 km/h longitudinal position deviation

Figure 9. Position and position deviation of different speed

3.4. Energy consumption analysis of vehicle route tracking based on this method

In order to verify the low energy consumption of driverless vehicle path tracking under this method, it is necessary to compare the energy consumption of the proposed method with the vehicle path tracking method based on Fuzzy annealing and the vehicle path tracking method based on neural network. In order to improve the accuracy of this experiment, many experiments are needed, and the results are shown in Table 1.

Table 1. Comparison of energy consumption/J

Number of experiments	The method	Vehicle path tracking method based on Fuzzy annealing	Vehicle path tracking method based on Neural Network
1	356	598	981
2	359	601	983
3	348	609	979
4	340	593	986
5	357	612	975
6	361	619	949
7	352	621	936
8	368	599	991
Mean value	355.13	606.50	972.50

According to the data in Table 1, the energy consumption of the method in this paper is 368J, the energy consumption of vehicle path tracking method based on fuzzy annealing is 621J, and the energy consumption of vehicle path tracking method based on neural network is 991J. The highest consumption value is significantly lower than the two traditional methods. And the average energy consumption of this method is 355.13J, which is much lower than the two traditional methods. Through the above data analysis, it can be concluded that the method in this paper can save energy consumption, because the method in this paper uses the four-neighborhood method to extract the boundary contour of the binary image, thereby obtaining the required road condition feature information. According to the obtained information, the preview deflection angle and the curvature of the path can be calculated, and the precise tracking control of the path of the unmanned vehicle can be realized, thereby reducing the probability of the occurrence of the path deviation and further reducing the energy consumption.

4. Discussions

According to the above analysis, the advantages of the drone path tracking method based on video image processing proposed in this paper are:

(1) Through this method, the collected road video image is filtered to reduce the influence of noise on image quality. Binary image processing can reduce the amount of calculation, save processing time, extract road information more intuitively, select dynamic threshold in the process of binarization, and can follow the driving environment of unmanned vehicles. Real-time adjusting the dynamic threshold has strong adaptability to the environment. The dynamic threshold is obtained by Otsu method, which is convenient to distinguish the background and the target of the image, so that the corrected image can accurately restore the road condition information. This image processing technology can adapt to various complex road conditions and provide material guarantee for subsequent acquisition of preview points.

(2) Most of the traditional path tracking methods pay little attention to the horizontal and vertical control of unmanned vehicles. However, the method in this paper performs path tracking of unmanned vehicles based on the preview deviation angle and path curvature. The main control variables in the path tracking process are the front wheel rotation angle and the vertical speed. By extracting multiple preview points on the target path to obtain the preview information of the path, the vertical and horizontal control of the driverless car is realized.

5. Conclusions

In order to solve the problems of image distortion and low path tracking accuracy when using traditional methods to track unmanned vehicles, a method for unmanned vehicle path tracking based on video image processing is proposed. The analysis of the experimental results shows that the method in this paper effectively improves the accuracy of path tracking, and the energy consumption is low, indicating that the method has high practical application value. However, the method in this paper does not take into account the issue of tracking efficiency, so the following will focus on tracking efficiency as the research focus for method optimization.

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