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Research on the improvement of test and evaluation scheme of APA Automatic Parking Assistance System for parallel parking

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Abstract

With the rapid development of the level of artificial intelligence, the automotive industry is also approaching the direction of intelligent cars, due to the increasing number of motor vehicles in the city, the problem of difficult roadside parking is increasing day by day, therefore, the automatic parking assist system (APA) is optimized on the basis of the original memory parking, based on the body radar sensor and camera for the detection of the environment, feedback to the system, based on the data collected Therefore, this paper analyzes the operation process of APA, focusing on the parallel parking space recognition, parking path and parking posture, analyzing the test results and proposing new test scenarios and methods for on-street parallel parking spaces in cities.

Keywords

Automatic parking, smart cars, parallel parking.

1. Introduction

At present, due to the development of artificial intelligence level, car high-level driving assistance has become an important direction for the development of contemporary cars, and the cost invested in the research of automatic car parking is also increasing. The traditional parking driver assistance system only installs cameras around the vehicle, and the vision coverage area is affected by the quality and quantity of the cameras, which can easily cause cutting accidents on narrow roads and parking spaces. In order to improve the driving experience and safety, it is necessary to enable the vehicle to collect the surrounding images in real time and use algorithms to process the data to form a panoramic surroundings image covering the vehicle, and control the vehicle through the on-board computer to achieve a high-level automatic parking assistance system that automatically finds a parking space and parks it safely.

Automatic parking assistance system is an important direction for the future development of intelligent vehicles, which can effectively reduce safety accidents in the parking process and reduce the difficulty of parking for drivers.

The automatic parking system through motion state planning and trajectory tracking technology is a method of parking control based on lane lines and the surrounding environment, but this research is currently aimed at the ideal environment in the parking lot, and less research has been done for on-street parking spaces in the city, so this paper is a research analysis of the existing parallel parking test methods.

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2. Research Methodology

2.1. Workflow of automatic parking assist system

The automatic parking assist system is a system that collects the image information around the vehicle through the body sensors to calculate the relative position of the vehicle without the driver's operation. The optimal parking path is calculated by the parking system processor, and then the vehicle is parked accurately along the calculated path.

Type of sensor	Laser laser rader	Millimeter wave rader	Ultrasonic wave rader	Camera
Parking line detection	√	√	×	√
Space parking detection	√	√	√	√
Long distance measurement	√	√	Weak	√
Cost	High	Moderate	Low	Moderate

Figure 1 Sensor type

2.2. Parking motion process

The motion process of car parking can be understood as follows: the system controls the car to drive slowly forward along the lane and adjusts its own heading angle so that it is parallel to the lane line, meanwhile, the radar and camera monitor whether there is a suitable parking space nearby in real time, and when the required parking space is detected, the system combines its own parameters and the surrounding environment information to control the car to drive to the starting parking area, meanwhile, the controller controls the car to drive along the At the same time, the controller controls the vehicle to drive along the planned path, so that the car moves to the end, and ends with the body parallel to the parking space line, and makes the steering wheel back to the right, because the driving speed is slow, so it does not consider the offset phenomenon in the process of car travel.

Parking space identification process

Take the initial position of the vehicle as the origin O, take the driving path as the y-axis,X-axis as the right side of the vehicle,. When the automatic parking system is started, the vehicle enters the parking space recognition state and drives slowly along the Y-axis, while the radar and the camera sense the surrounding environment .

The distance the vehicle travels is D,and the distance from the right obstacle is d. The radar detection distance from the obstacle can be expressed as $X(n) = d+L_2$, $Y(n) = D+L_1$.

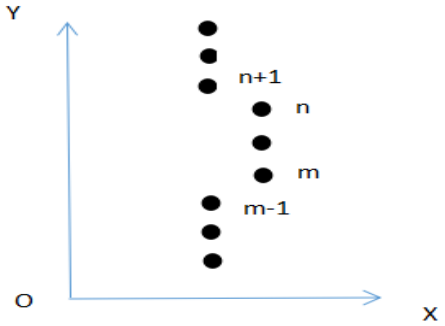

Figure II Detection position

Assuming that the speed of ultrasonic wave is V, t is the time of reception, V is the speed of vehicle travel, then the vehicle forward distance is D = V × N × T. The car driving process constantly detects the surrounding environment, detection point model , the feedback

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information collected can calculate the space available in the parking space, its lateral space △ $X = X_{(n+1)} - X_{(n)}$, when △ X meets the parking conditions automatically calculate △ Y whether to meet the requirements. Similarly $\triangle Y = Y_{(n)} - Y_{(m)}$, if both are satisfied at the same time, the system determines that the current parking space meets the parking conditions and enters the parking session for automatic parking, otherwise it speaks to continue to detect and find the next suitable parking space.

Parking Path

For parallel parking, its path calculation also has a variety of ways, common double arc parking way and arc - straight - arc parking way, double arc parking way due to the need to complete the steering wheel in a very short period of time a large rotation, for the car steering mechanical structure and tires caused irreversible damage, so in order to reduce the test difficulty, while reducing the damage to the test car, choose to use the arc - straight - arc -The arc parking method.

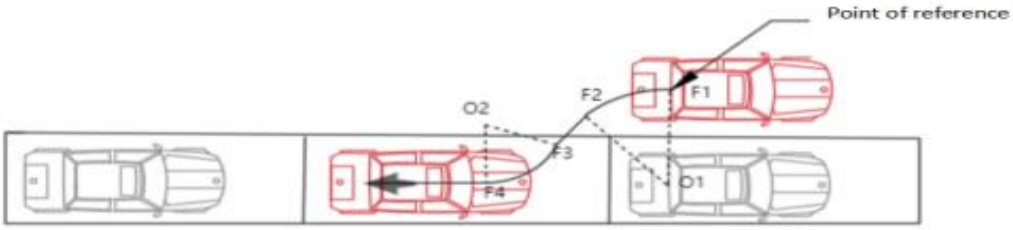

Figure Ⅲ Path planning

When the car enters the start parking area switch to R gear, reverse to point F1 quickly turn the steering wheel and drive to point F2 according to the maximum turning radius R, complete the first section of the arc path, at this time back to the right steering wheel to continue to reverse to point F3, complete the second section of the straight path, continue to turn the steering wheel to the maximum turning radius R parking to point F4, at this time the test car heading angle parallel to the parking space, back to the right steering wheel, parallel parking space Automatic parking is completed.

3. Parallel parking tesT

3.1. Vehicle parameters

Since the contour shape of the vehicle directly affects the parking system for calculation, but the contour of each car is more complex and difficult to calculate, so a rectangle is used instead of the modeling of the test vehicle, so a test vehicle is selected here.

The serial number	Test vehicle
Size of appearance Length × Width ×Heigth（mm）	4905×1940×1755
The wheelbase	2825
Wheel base	1635/1635
Before hanging	967
After the suspension	1073

Figure Ⅳ Automobile parameters

3.2. Test scene layout

Test site selection closed open-air parking lot, test to Luyi at least one straight road and the road is not broken or other obstacles affecting the function of the system (except test obstacles),

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roadside layout of three parallel parking spaces, the middle of which is the target parking space, test layout of three scenarios were three parking
spaces are vacant, a single side of the vehicle with obstacles on both sides of the obstacle and parking process there are pedestrians .

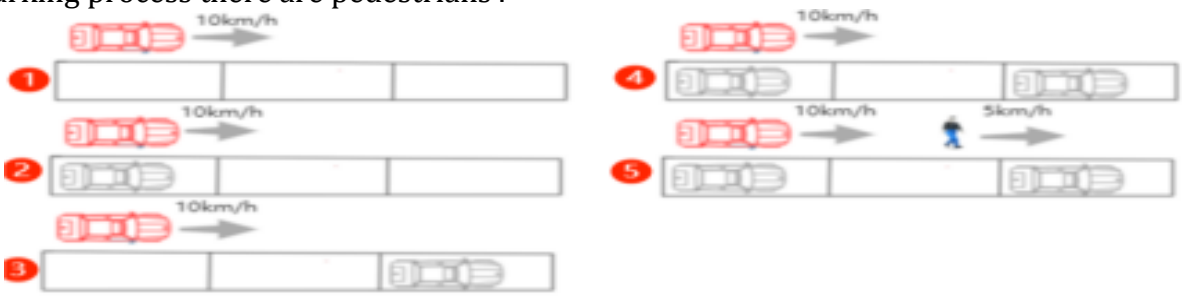

Figure V Test scenario

And the test vehicle is driven along the route at a speed of 10km/h to 20m from the parking space to turn on the automatic parking assistance system.

3.3. Testing process

When there is pedestrian interference in front, the system should identify the parking space available and avoid collision, if necessary, parking is required.Nowadays, there are many test devices designed for automatic parking assist systems, such as VBOX, RT inertial guidance devices, etc. These can meet the accuracy requirements for speed, path, deflection angle, etc. in the test, so the various devices are basically composed of gyroscopes, GPS and controllers, etc.

In this paper, VBOX was selected to test the test vehicle and the test scenario was laid out according to the national lane line standard.

The experimental procedure is as follows.

① The lane line survey trolley is used to collect the lane line, which is used to calculate the relative distance between the test vehicle and the lane.

② Set up the test scene, for the safety of the experiment, the obstacle vehicles are foam dummy cars, and to ensure that the parking space is basically parallel to the obstacle vehicles.

③After installing the VBOX test equipment and starting the automatic parking test, the driver drives the vehicle at a speed of 10±2km/h 20m from the parking space after starting the automatic parking system, the driver does not interfere with the operation of the vehicle to ensure the normal operation of the system. During the test, the VBOX collected real-time information of vehicle position, speed, deflection angle, etc.

④ The collected data file is imported into the VBOX system, which can get the vehicle's driving path, heading angle, speed and other information, and measure the parking posture of the test vehicle relative to the parking space after parking stops, and the measurement of the relative parking space when parking is shown in Figure 3.6 Transverse distance from the parking space line $\Delta D=\frac{(x1+x2)}{2}-\frac{(x3+x4)}{2}$ and similarly, the longitudinal distance from the parking space line $\Delta D=\frac{(d1+d2)}{2}-\frac{(d3+d4)}{2}$.

3.4. Experimental results and analysis

The data collected during the test are as follows.

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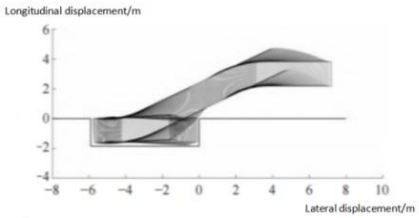

Figure Ⅵ experimental data

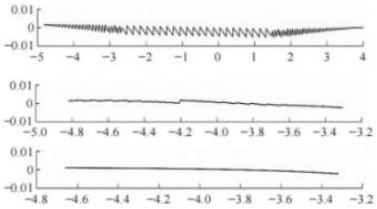

Figure Ⅶ Parking path

The maximum error is 0.006m in the first section, 0.003m in the second section and 0.0025m in the third section of the test. The testing requirements are satisfied.

Observing the test results,we can find that the current automatic parking assistance system has been relatively perfect, and the standard requirement for the number of parking position recognition is at least 3 times, and the number of rubbing the library is less than 10 times, so the number of parking position recognition and rubbing the library meet he test standard, and no collision occurs when there is pedestrian interference, which indicates that the system can meet the requirements in the conventional parking scenario based on the perception of the surrounding environment and the planning of the parking path.

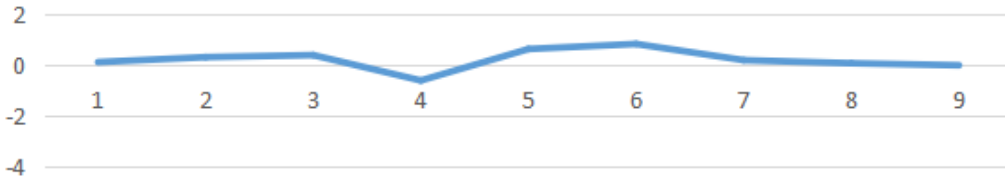

Figure Ⅷ Parking attitude

However, the results of parking posture fluctuate greatly and are affected by environmental factors, and the scenes in daily life cannot be constant, so the algorithm of the system and the performance of the body sensor need to be further optimized to ensure that the control of the vehicle can face more unexpected situations.

4. Test scenario optimizatioN

The test scheme of the above scenario is only applicable to the ideal environment with less environmental impact in the parking lot for the automatic parking system, and is not applicable to the on-street parking spaces in the city. Therefore, the test scheme for on-street parallel parking spaces should also be considered as a test standard, and the test scheme for on-street parallel parking spaces is established here.

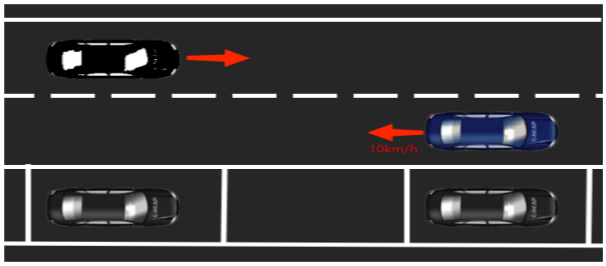

Figure Ⅸ Test scenario optimization

Which lane lines and parking spaces are required to meet the industry standard GB5768.3-2009 of the People's Republic of China to arrange, which test scenarios are divided into adjacent lanes there are obstacles to overtake the test vehicle, the test section to select the outdoor closed road with horizontal parking and can open the function of automatic parking assistance

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system, the test road includes at least two long straight road and the road does not affect the parking function of obstacles (test obstacles excluded), one side of the road has Three parallel parking spaces, the middle space on both sides of the parking obstacles vehicles, test vehicles along the lane line slowly forward, when the test car space identification is completed, start parking when the obstacles vehicles in the adjacent lane to 50km / h, 60km / h, 70km / h, 80km / h speed beyond the test car,the test is completed, record the number of kneading library, export the experimental data and path graph, and calculate the parking attitude.

5. Summary and OutlooK

In this paper, the automatic parking assistance system in parallel parking scenario is studied, the test vehicle is simplified, and the kinematic model of the vehicle is established to analyze the safe travel path during parking, but the existing test scenario is established in the ideal environment of the parking lot, because the environment around the on-street parking space within the city is variable, it needs to be studied in depth, in which the future automatic parking assistance system can focus on Research

Path planning, this paper's path research is limited to the parking process to adjust the posture, future research can be added to the library to adjust the posture or small parking space parking into the library.

Automatic parking into the garage, the use of network technology and high-precision sensors so that the vehicle in the parking lot to automatically find a parking space and parking into the garage.

Self-depot research, the use of high-precision maps and network technology, so that the driver through the cell phone terminal at the summer signal so that the vehicle automatically out of the garage and drive to the driver. The realization of automatic driving is the common goal of the entire automobile industry, and the direct communication between different vehicles minimizes the impact of people on traffic accidents, while the automatic parking assistance system is an important part of automatic driving and has a broad development space in the future.

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