

Research on Parking Guidance System Based on Ultrasonic-Ranging

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Abstract. This paper uses ultrasonic detection system to identify the parking space of intelligent vehicles. After completion of parking space detection, the main control unit plans the parking path according to the detected environmental information, and generates the steering control strategy. The car will stop the parking lot quickly and stably under the proper motor steering control strategy. The theoretical significance of this paper is to improve the parking stability, reduce parking space and parking time on the basis of previous research and modern control theory.

Introduction

With the increase of city population, the rapid expansion of the streets, parking more and more tense, and the size of each parking space will be reduced, the parking environment is becoming increasingly complex compact, which puts forward higher requirements for the driver of the precision driving technology, and this is even a common driver driving the driver can not have. If one cannot accurately and rapidly into a parking place, namely the need to try again, which not only increases the tension of the driver and impatience, will lead to traffic jams, CO₂ emission increases, increased air pollution and waste of energy, and the energy saving and emission reduction development policy of our country advocates is not consistent. Therefore, automatic parking is studied the technology can effectively reduce the parking collision accident rate; in addition to the two lane next to the parking lot, when the road is quite narrow, new parking speed is relatively slow, can not be timely stop into the car parking spaces, will seriously disrupt traffic order; even without disturbing traffic conditions, automatic parking system can save a lot of time, improve efficiency, reduce the probability of collision, to ensure the safety of storage, but also can reduce the pollution of the environment[1].

Parking Guide System Design

The ultrasonic ranging is analyzed, to understand its characteristics, the ultrasonic attenuation effect exists in the process of communication, the farther away from the source, ultrasonic attenuation is more severe, so the ultrasonic range is limited, should be designed according to needs. Transit time by using the method of this project, the main principle is to use the return pulse ranging, ultrasonic range finder of the different area of different sizes, can be determined according to the instructions, but sometimes the blind size will vary according to the change of environment, so in practical application, the best is measured, and then the blind shielding ultrasonic range finder off by software. At the same time, the temperature measurement module is added to the system. The chip uses DS18B20, this chip can make ultrasonic no longer be disturbed by temperature. In order to make the automatic parking control system accurate, the model STM32 is adopted as the control chip of the ultrasonic module. Installation distance measurement is carried out on the basis of the above. On the basis of ultrasonic distance measurement, the vehicle kinematics or dynamics model is used, and then the relevant simulation is carried out according to human driving behavior. A large number of practical experiments are carried out with the intelligent vehicle as the experimental subject, the data in the experiment process is analyzed and summarized[2], and an optimal parking guidance path is determined. The optimal parking guidance path is based on the time axis as the foundation, through the precise control of each section of the parking process of vehicle speed and driving time to ensure the accuracy of the parking path. Figure 1 shows the general technical line of the project[3].

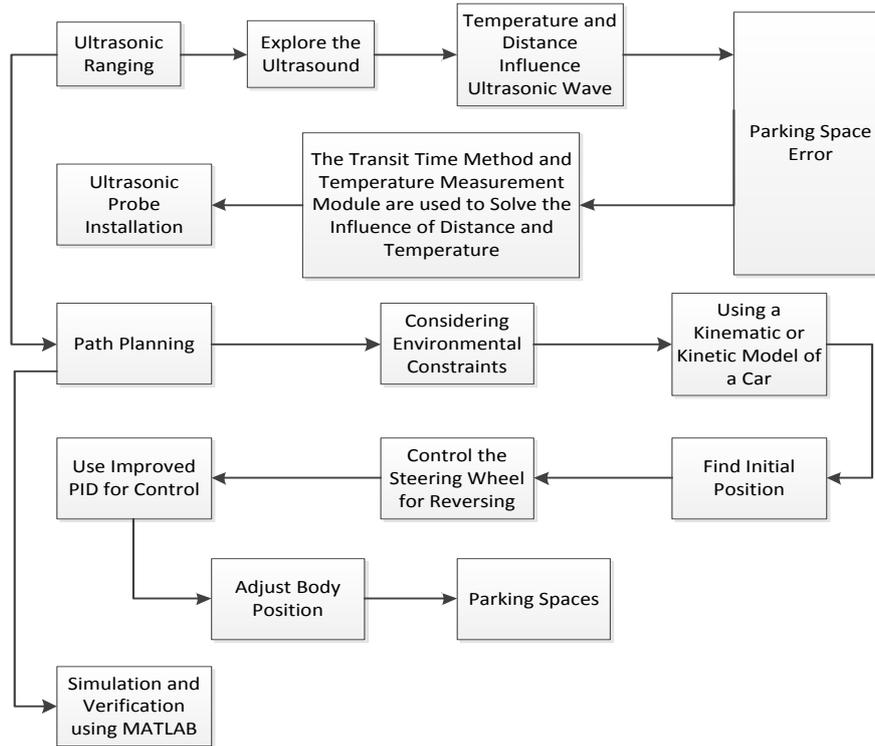


Figure. 1 General Line of Project Technology

Using ultrasonic system ranging. Ultrasonic ranging is very important for the parking system, but due to ultrasonic attenuation effect exists in the process of communication, the farther away from the source, ultrasonic attenuation is more severe, so the ultrasonic range is limited, should be designed according to needs. Ultrasonic ranging method includes transit time detection method, acoustic amplitude detection method and phase detection method. Transit time detection method is the most simple, low cost and measurable distance, but it will produce blind spots when measuring in short distance. However, the acoustic amplitude detection method is vulnerable to echo interference[4], so the detection accuracy is limited. Although the accuracy of phase detection method is high, the detection range is limited, and the detection distance is usually less than 8.5mm.

By comparison, transit time method is adopted in this system. Transit time method is the use of a measurement method of the highest frequency, its main principle is to use the return pulse ranging, ultrasonic range finder of the different area of different sizes[5], can be determined according to the instructions, but sometimes the size of the blind zone will change according to the change of environment, so in the practical application of the best method is measured[6], and then the blind shielding ultrasonic range finder off by software. In the absence of blind spots, the principle of range finding is shown in Formula 1.

$$\begin{cases} s = \frac{1}{2} ct \\ h = vt \\ d = \sqrt{s^2 - \left(\frac{h}{2}\right)^2} \end{cases} \quad (1)$$

Where t is the ultrasonic wave in the air from the transmitter to the receiver transit time, V is the average speed of the car in the sampling time, C for ultrasonic velocity, because the car is far less than the speed of ultrasonic wave, so the h can be ignored. Hence,

$$d \approx \frac{1}{2}ct \quad (2)$$

At room temperature, the speed of ultrasonic propagation is the same as that of sound transmission, which is about 340m/s. In air, there is a relation between the speed of propagation and the temperature.

$$c = 331.4\sqrt{1 + \frac{T}{273.15}} \approx 331.4 + 0.607T \quad (\text{m/s}) \quad (3)$$

(C is the propagation velocity of ultrasonic, and T is the temperature of propagating medium.)

It can be seen from formula 2 that the ultrasonic velocity is closely related to the temperature, so the temperature measurement module is added into the system. The chip is made of DS18B20. It is a single wire digital sensor. It has the advantages of high precision, small size, low cost and strong anti-interference. The operating temperature range is between -10 and 85°C, and the error is no more than + 0.5°C. Besides, it can also change the temperature conversion resolution by programming. So that the ultrasonic wave is no longer disturbed by temperature.

For automatic parking, the control system is accurate. The single chip microcomputer STM32 is used as the control chip of the ultrasonic module. In the ranging system, the main role of STM32 microcontroller is as follows:

- (1) STM32 microcontroller timing function, you can control the distance measurement system signal emission time.
- (2) the control system detects and processes ultrasonic signals, and uses the timing function to record the propagation time of ultrasonic waves in the medium.
- (3) measure the temperature of the environment through the temperature measuring chip.
- (4) according to ultrasonic distance measurement formula, comprehensive propagation time and ambient temperature, accurately calculate the size of the detection distance.
- (5) display the detected distance values on the LCD screen.
- (6) through serial communication, IIC communication protocol is used to communicate with the host computer.

STM32 has the advantages of high performance, low price, low power consumption and so on. It is helpful to improve the accuracy of ultrasonic ranging system[7]. The ultrasonic transmitting and receiving circuit is controlled by the STM32 timer, and the reception and transmission are carried out simultaneously, which eliminates the starting time of transmitting and receiving, and improves the ranging precision. Next, install 6 ultrasonic testers around the body for parking detection. As shown in Figure 2.

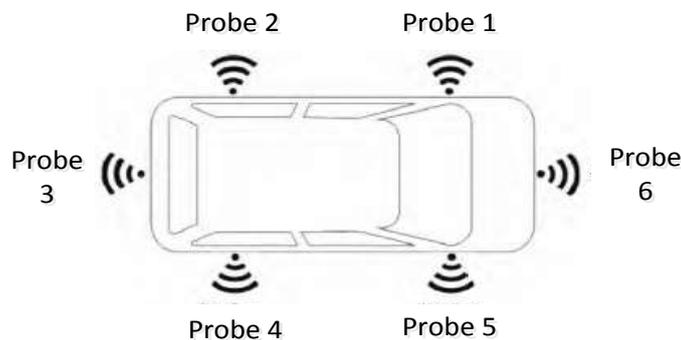


Figure. 2 Location of Ultrasonic Probe

On the basis of the detection of parking spaces, the specific parking spaces will be calculated, and then the path planning for parking will be done.

Path planning. There are two main approaches to the generation of parking paths:

- 1) path planning. Prior to plan a feasible geometric path, environmental constraints, vehicle kinematics and dynamics model considering[8].

2) experience based control algorithm. According to the experience of parking skilled drivers, simulating the driver's driving behavior, real-time control commands are generated. This method is related to the direction and location of the vehicle relative to the parking space, and there is no reference path to follow.

In this project, a new autonomous parking path generation method is adopted. As shown in Figure 3, the whole parking process is divided into 3 sections, namely, two sections of arc and a straight line. The first section is the arc to the right, the second line is straight, and the third section is the left arc. This parking path generation method can effectively avoid the possible collision point, closer to the driver's parking habits, but more successful than the average driver parking.

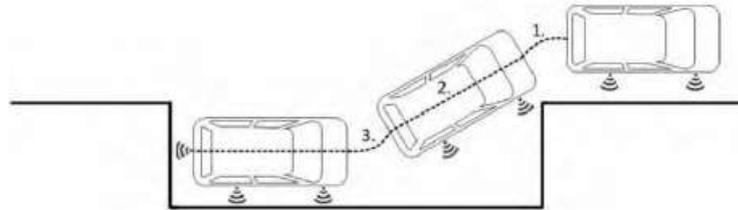


Figure.3 Parking Procedures

Careful observation and study of the actual process of the intelligent car parking; for a large number of actual experimental subjects; the paper analyzes and summarizes the experimental data in the process to determine an optimal parking guide path. The optimal parking guidance path is based on the time axis as the foundation[9], through the precise control of each section of the parking process of vehicle speed and driving time to ensure the accuracy of the parking path. In order to achieve this requirement, we adjusted the speed of the unmanned vehicle by PID, so that it can maintain a steady speed throughout the parking process, reversing the car at full speed. At the same time, when the car starts reversing, the initial position is also very important. The selection of the initial position has a great impact on the success rate of parking. Thus, a suitable initial position is identified by extensive experiments, i.e., parallel with the vehicle ahead, with the rear end aligned with the vehicle ahead, and the horizontal distance between 40~45 cm, as shown in Figure 4. Reversing the speed and timing of the car from the specified initial position, the car can automatically park on the preset path[10].

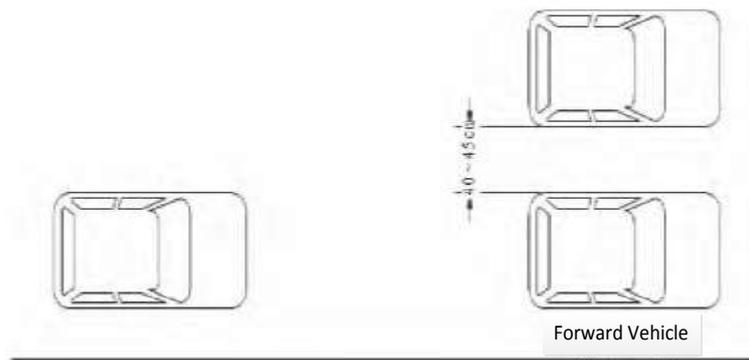


Figure.4 Initial Parking Spaces

Summary

This project uses ultrasonic detection system to identify the parking spaces of intelligent vehicles. After completion of parking space detection, the main control unit plans the parking path according to the detected environmental information, and generates the steering control strategy. The vehicle will be

adopted and modeled by the parameters of ultrasonic ranging system installed several independent in the side of the car, to detect parking spaces, parking information to the microcontroller will detect and calculate the size of parking space, and then determine whether to stop the car. When the right parking space is found, the optimal parking path is planned, and the motor steering control strategy is generated by using this path information. The car will stop the parking space quickly and stably under the appropriate motor steering control strategy. The project reference of modern control theory to improve the stability of parking on the basis of previous studies, reduce parking space and parking time, brings convenience for people parking; more important is the research will promote the development of intelligent parking system in our country, so the active parking system not only in some high-end car, but can common to every car.

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