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# Research on Intelligent Parking Simulation System for Intelligent Vehicle Simulation

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## Abstract

**With the rapid growth of cars and the scarcity of parking spaces, the contradiction between them has become increasingly acute. How to solve the "parking problem" has always been a problem of great concern to every country. Only expanding the number of parking spaces or building new parking lots by traditional means can not actually solve this problem. With the vigorous development of the Internet of things and navigation technology, which are widely used in all walks of life, the management of the parking lot is also transforming and upgrading to intelligent, so as to realize the interconnection of parking lot information. This paper presents an optimization design scheme of intelligent parking simulation system for automobile intelligent simulation. The intelligent parking simulation system is designed by database, and then the system is optimized by variable universe fuzzy arithmetic. The research of intelligent parking system based on intelligent simulation not only optimizes the allocation of social resources and promotes the image of the city, but also solves the problems of people's livelihood. It is an important part of promoting the construction of smart city.**

## Keywords

**Automobile; Intelligent Simulation; Intelligent Parking.**

## 1. Introduction

In people's daily life and work, cars have become the preferred means of transportation. With the rapid development of electronic control technology, vehicles are developing in the direction of energy saving, comfort, environmental protection and safety. Full intelligence will be the development trend in the future[1]. In recent years, with the popularity of vehicles, parking problems can be seen everywhere, especially in large cities, where parking spaces are relatively tight, it is difficult to find a parking space, and it takes a lot of time to reverse[2]. Therefore, the research on intelligent parking system is urgent. Intelligent parking technology is a new technology of unmanned driving developed in recent years. In cities or streets, the parking system can make the driver Park easily. The system not only has potential development prospects, but also has potential economic benefits[3].

During the process of parking, the intelligent parking assist system can first use various sensors to sense the surrounding environment of the vehicle, eliminate the blind area of the field of vision, and carry out real-time warning when encountering dangerous conditions to build a safe parking space. Secondly, the system can replace the driver to control the steering wheel for automatic steering operation. It can not only reduce the labor intensity of the driver, but also relieve the tension of the driver and improve the fault tolerance rate of the driver in the parking process. In addition, according to the specific conditions of different parking spaces, you can choose the appropriate parking path to park quickly and accurately[4]. This not only greatly saves the time cost and reduces the probability of traffic jam caused by parking, but also can effectively reduce the fuel consumption, save energy and reduce the emission of air pollutants, and meet the needs of consumers for automobile energy saving, safety, environmental protection and comfort[5]. Due to these advantages of intelligence, this

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paper uses the method of big data combined with variable universe fuzzy arithmetic to study the intelligent parking simulation system.

The research on intelligent parking system is of great significance. From the perspective of safety, intelligent parking can improve the safety of parking and avoid accidents[6]. From the perspective of comfort, during parking, it can reduce the burden of the driver and relieve the psychological pressure of the driver. It is not necessary for the driver to control the steering wheel, but only to operate the accelerator and brake pedal according to the instructions, park the vehicle in the parking position, reduce the difficulty of reversing and improve the portability of driving[7]. Intelligent parking is one of the important components of intelligent transportation. Considering that intelligent parking is a semi intelligent driving problem under low-speed working conditions, it can be used as a prelude to intelligent driving and provide reference for automatic driving[8]. In this paper, the feature reconstruction model of intelligent parking simulation system optimization design is established. The intelligent parking system is built by big data, and the system is optimized by variable universe fuzzy arithmetic, and the key factors affecting intelligent parking are extracted. Its innovation lies in:

This paper uses the method of big data combined with variable universe fuzzy arithmetic to reduce the execution cost of the arithmetic.

## 2. Methodology

### 2.1 Design of Intelligent Parking System Using Database

Through the research on intelligent parking lot management system and navigation products, it is found that the reasons for the current "parking difficulty" and "car search difficulty"[9]. On the one hand, the parking lot is low in intelligence, and the navigation and guidance function is not realized inside, so the car owner needs to spend a lot of time to find the parking space. On the other hand, the intelligent parking lot management system is relatively independent. The intelligent parking lot can only use supporting systems and software, lacking a system that manages all intelligent parking lot information in a unified way, and truly realizes the interconnection of parking lot information. The last aspect is that although the navigation product can provide the location information of the parking lot, it does not prompt the information such as the number of parking spaces in the parking lot, so the owner blindly selects the parking lot for parking[10]. To sum up, in order to solve the above problems, we need a system that can uniformly manage the information of urban intelligent parking lots, and organically combine the information of parking lots with navigation, which not only realizes the interconnection of parking lot information, but also provides a reliable basis for car owners with parking needs to select the parking lot for parking.

The general intelligent parking system is composed of the following parts: (1) Environment sensing system. Collect vehicle environment information, including effective parking space and body posture information, and transmit the detected information to the central controller ECU to determine the vehicle parking strategy. Intelligent parking system input: the environment sensing system (various sensors) takes the detected relative position between the vehicle and the parking space, the vehicle body direction angle and the obstacles around the vehicle as the input of the intelligent parking system. (2) Central controller ECU. The core of the intelligent parking system is to process and analyze the information transmitted from the sensing system, feed back the current position of the vehicle, the target parking space and the surrounding obstacle information in real time, determine the corresponding parking strategy, output the corresponding angle and speed information, and finally transmit it to the vehicle's execution system. (3) Actuator. Control the steering angle, accelerator or brake of the vehicle according to the control command sent by the ECU to complete the process of intelligent parking. Since the vehicle speed is low during parking, as long as the steering wheel and brake pedal of the vehicle are controlled, the vehicle can run according to the designed path, and the vehicle can park safely in the parking space.

Database design is the core of the intelligent parking service system. A reasonable database design can not only better meet the business needs of the system and accurately express the relationship between data, but also enhance the maintainability and scalability of the system[11]. According to the actual development needs, the database design is strictly based on the three paradigms of database. While meeting the business needs of the system, the appropriate data redundancy design is conducive to the rapid development of functions. The intelligent parking service system mainly involves user information, parking lot information, parking space information, parking record information, reservation information, etc; The parking lot information relates to the management of parking space information and parking lot internal plan information. The relationship between entities is shown in Figure 1.

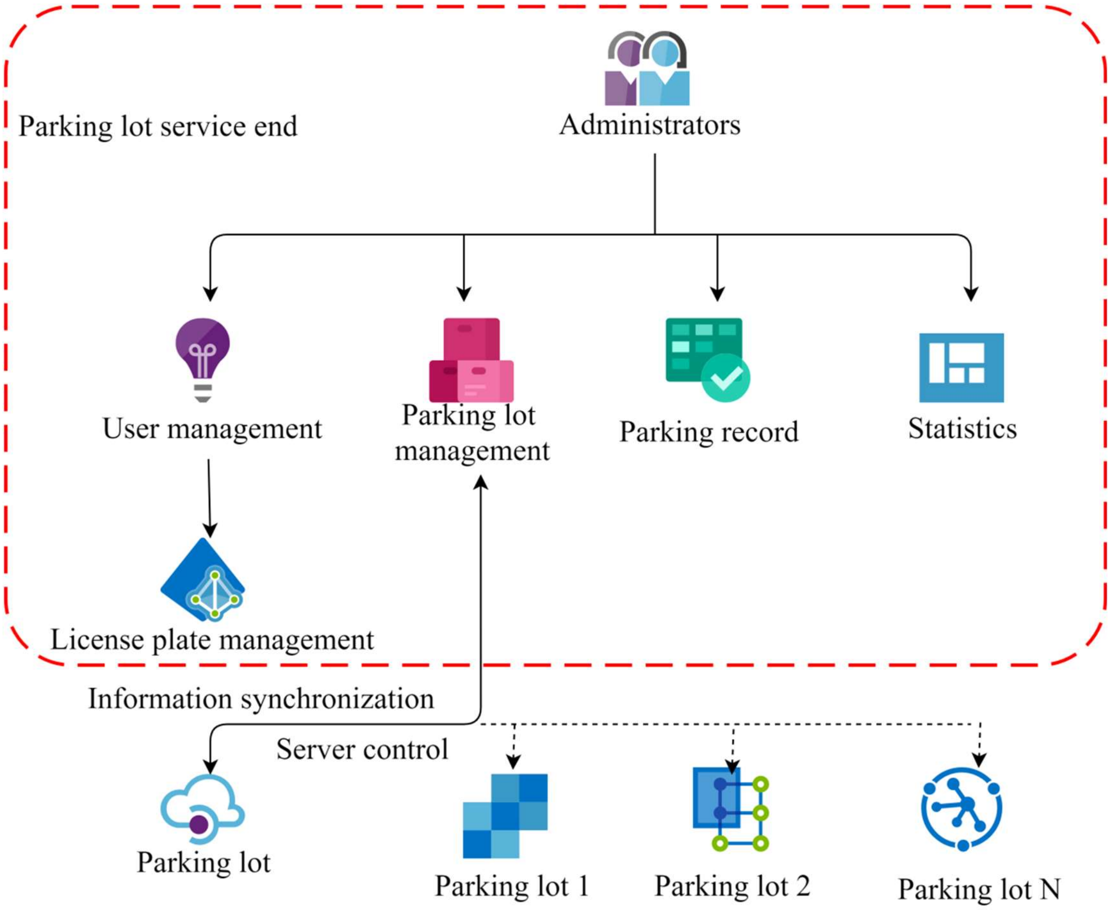


**Figure 1.** Relationship between management end of intelligent parking service system and parking lot

## 2.2 The Variable Universe Fuzzy Algorithm is Used to Optimize the Intelligent Parking System

With the rapid development of science and technology, the modern control theory and method are becoming more and more perfect, and people pay more attention to it, and it is gradually widely used in various commercial products and industrial processes. There are several typical control technologies applied in the intelligent vehicle system, and the commonly used ones are fuzzy logic and neural network. Considering from the practical application, the control effect of fuzzy arithmetic may be superior to other methods. Fuzzy control is a non-linear control technology without accurate model, easy to understand, simple to implement and low cost. Fuzzy system is a control system based on a kind of fuzzy logic, which is closer to human thinking and natural language. In essence, the fuzzy logic system is to provide a method, that is, to transform the language rules of skilled experience knowledge into active control behavior. It is an expert system based on control rules, especially when the traditional quantitative analysis method is more complex, or sometimes only qualitative When the description is uncertain or uncertain, it is useful to use fuzzy system to analyze. It can be said that fuzzy control system will be closer to the combination of traditional mathematical methods and human decision-making. The variable universe fuzzy logic system uses the expansion function to adjust the universe of the fuzzy controller in real time, so that the fuzzy controller can describe and discriminate the system deviation or the deviation change rate in any universe. In this way, the dependence on expert experience and knowledge is reduced to a certain extent, and the control accuracy and robustness of the fuzzy control system are improved. The fuzzy controller is essentially an interpolator. For the general fuzzy logic system, the design of the fuzzy controller should be simplified as much as possible. The fuzzy controller often uses multi-dimensional fuzzy logic, that is, a multi input and single output fuzzy controller.

Let the domain of the input quantity $r_i(i=1,2,3...,n)$ be $R_i=\left[-E,E\right]$ and the domain of the input quantity $y$ be $Y=\left[-U,U\right]$; The fuzzy partition on $r_i(i=1,2,3...,n)$ is $A_i=\{A_i\}$, and the fuzzy partition on $Y$ is $U=\{U_j\}(1\le j\le m)$. It is assumed that $A_i,U$ is a language variable.

If $r_i$ is the peak point of $A_i$ and $y_i$ is the peak point of $U_j$, according to the interpolation principle of fuzzy logic control, the output can be expressed as:

$$y=\sum_{j=1}^{m}\prod_{i=1}^{n}A_i(r_i)y_j \tag{1}$$

Assuming that the input parameter error is $e$, the maximum error range $e_{\max}$ is $\left[-E,E\right],E$, which is a positive real number. Generally, the area $\left[-E,E\right]$ is fuzzy divided by $\{NB,NM,NS,ZO,PS,PM,PS\}$. The idea of variable domain theory: under the condition that the conventional fuzzy control rules do not change, the scope of its domain will shrink with the reduction of error or expand with the increase of error. The key is to determine the appropriate expansion function. The variable universe means that the input universe $R_i$ changes with the change of the input variable $r_i$, and the output universe $Y$ changes with the change of the output variable $y$. For example, when the input variable is $r_i$ and the output variable is $y$, the universe adjusted by the expansion factor is:

$$R_i^{'}=[-\alpha_i(r_i)E_i,\alpha_i(r_i)E_i] \tag{2}$$

$$Y^{'}=[-\beta(y)U,\beta(y)U] \tag{3}$$

According to the change of the universe and the monotonicity of the exponential function, with the decrease of the error $e$, the expansion function is also decreasing, and the corresponding universe is also decreasing. It can be seen that a smaller universe means that the controller package has more control rules. In other words, the universe will shrink with the reduction of the error $e$. The number of rules can be increased accordingly, and the control accuracy is also improved. In short, the expansion and contraction of the expansion and contraction function will lead to the corresponding change of the scope of its universe, and solve the contradiction between the computational complexity and the control accuracy. Then the output of the variable universe fuzzy logic is:

$$y(t+1)=\sum_{j=1}^{m}\prod_{i=1}^{n}A_i\left(\frac{r_i}{\alpha_i(r_i)}\right)\beta\left[y_j(t)\right]y_j \tag{4}$$

 

The change of domain response is equivalent to the real-time adjustment of control rules, and the selection of expansion function is used to adjust the change of domain. It can be seen that the selection of the expansion function can achieve the purpose of adjusting the control rules to obtain a better control effect.

## 3. Result Analysis and Discussion

Accurate measurement of parking space length is the key to realize automatic parking. In this paper, two ultrasonic sensors are installed on the same side of the vehicle body obliquely to collect parking space information. After the lateral distance measurement is completed by the ultrasonic sensor in front of the side of the vehicle body, the first jump edge of the parking space is judged. Once the jump in distance information is detected, the wheel speed pulse acquisition module is started to start counting. After the ultrasonic wave sensor behind the vehicle body enters the parking space according to the traveling speed of the vehicle, it is used to detect the second jump edge of the parking space. When the jump is detected, the main controller reads the number of wheel speed pulses at this time, According to the relationship between the pulse and the distance, the distance of the vehicle is calculated. Finally, according to the known installation distance between the front and rear sensors, the specific length of the parking space can be obtained through calculation.

During the real vehicle test, two suitable obstacles in front and back shall be designed to simulate the actual parking space, and then the vehicle shall be driven slowly through the two obstacles. It is designed in the software program that when the vehicle passes through the first transition edge of the parking space, the buzzer emits a drip sound to represent the beginning of the parking space measurement, and when the vehicle passes through the second transition edge, the buzzer emits a drip sound to represent the end of the parking space measurement. At this time, the parking space length observed by the upper computer is recorded and compared with the actual parking space length. In the real vehicle measurement parking space test, the actual parking space length between two obstacles is 750cm, and the distance between two ultrasonic sensors installed on the side of the vehicle body is 350cm. The parking space length data measured by the ultrasonic sensor and the wheel speed pulse signal is shown in Table 1.

**Table 1.** Test value of parking space length

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Measured parking space | 1037 | 1056 | 1042 | 1031 | 1045 | 1026 | 1024 | 1064 | 1050 |
| Actual parking space | 1030 | 1050 | 1034 | 1033 | 1049 | 1015 | 1037 | 1057 | 1058 |
| Error value | 7 | 6 | 18 | -2 | -4 | 11 | -13 | 7 | -8 |

It can be seen from table 1 that the data transmission mode between the Arduino control board and the parking control board is bit by bit serial communication. When the two ultrasonic sensors work at the same time, the data transmitted each time plus the characters used for separation can reach up to 8 bits. At the same time, there is a delay time for the two sensors to work alternately to receive echoes, resulting in a large deviation between the measured parking space length and the actual parking space length in individual cases. However, after calculation, it can be found that the average value of the error value of the parking space length measurement is 2.2. In combination with the conversion formula between the measured distance and the actual distance obtained from the wheel speed pulse acquisition test above, the deviation between the final parking space length and the actual parking space length after compensation processing can be controlled within an acceptable range.

## 4. Conclusion

This paper presents an optimization design scheme of intelligent parking simulation system for automobile intelligent simulation. The intelligent parking simulation system is designed by database, and then the system is optimized by variable universe fuzzy arithmetic. Finally, the simulation analysis and real vehicle experiment are carried out. The final experiment shows that the precision of the intelligent parking simulation system after the intelligent arithmetic is improved by 8.26% compared with the traditional arithmetic. Intelligent parking technology is one of the hotspots of intelligent driving technology research in recent years. It is a new technology for easy driving in urban parking environment. Although the intelligent parking system has not been widely used in the automobile market, with the rapid development of the automobile industry and electronic industry, the parking system will be more widely used. This paper only studies from the perspective of dynamics and kinematics, and does not involve obstacle identification, collision and other issues. In the future, we can conduct in-depth research on these aspects.

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