Rotary double-layer small high efficiency parking device

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Abstract. In order to solve the problem of urban parking, a rotary double-layer small parking device is designed. By using the rotating double-layer structure, the structure of rotation, frame, lifting and so on is mainly designed, and the device model works are designed and made, and the program design and system debugging of the device model are carried out by using Huiyu ROBO PRO programming software, which verifies the feasibility of the design scheme technology of the device. The rotary double-layer small parking device has a small area and high parking efficiency, which properly solves the problem of parking difficulties in residential areas.

Keywords: Rotary double-layer structure; physical model; fish control.

1. Introduction

With the rapid growth of China's economy and the development of urban economy, people's living standard has been greatly improved, and the number of private cars is constantly increasing. The parking space in the community is far from meeting the parking needs of residential buildings, resulting in the problems of chaotic parking order and crowded parking [1].

In order to solve the problem of difficult parking, many cities have taken various measures, among which the mechanical three-dimensional parking garage is a good method. The mechanical three-dimensional parking device has the advantages of large capacity, small occupation area per unit vehicle and high land utilization rate [2]. The first mechanical parking device at home and abroad was established in the United States in the 1920s, followed by the development of various kinds of garages in the United States, Japan, South Korea and other countries [3]. At present, there are mainly the following forms of three-dimensional parking garage at home and abroad [4-6]: vertical lifting three-dimensional garage, horizontal lifting three-dimensional garage, roadway stacking three-dimensional garage and vertical circulation garage. For example, Liu Xiaojuan et al. [7] took the vertical elevator type stereo garage as the main research object, and carried out the design and research on the control system of the lifting mechanism by studying the control mode of vertical lifting and rotating positioning of the stereo garage. Lu Bo et al. [8] used UG software to design a 4-layer, 9-parking lifting and moving stereo garage, and developed an automatic control system based on PLC and frequency converter. Wang Lijie et al. [9] studied the vehicle transport strategy and intelligent measurement and control method of stacking
stereoscopic garage in roadway, aiming at the problems of long access time and high failure rate of system operation. Ding Caihong et al. [10] introduced the design of vertical circulating stereo garage control system based on PLC. However, the overall area of the three-dimensional parking garage is large, which requires high manufacturing cost and land cost. Secondly, this kind of parking device also has the disadvantages of long vehicle access time and high driving technology requirements of the driver, so it is not suitable for the built-up area with small land area [2].

According to the shortcomings of the mechanical parking device and combined with the current situation of residential parking, a rotating double-layer small parking device is designed, and a sample model is made. The parking device are smaller and make full use of the space above the ground, reasonable structure does not affect the ground greening and lighting, not only save parking space, also relieve the parking problem, to a certain extent, reduce the environmental pollution of vehicle exhaust and the traffic noise, properly solve the problem of the residential parking and greening.

2. The whole design of rotating double-deck small efficient parking device

2.1. The Overall Structure
The rotary double small parking device adopts rotary double-layer structure, mainly by the center pillar and base fixed structure, the upper frame structure, the lower frame structure, screw, parking floor, lifting plate, driving wheel, motor, worm gear, worm, elevator guide rail, sensor, transmission belt, base stations and other parts of the overall structure is shown in figure 1.

![Fig.1 Overall structure diagram of rotating double-layer small intelligent parking device](image)

2.2. The Working Principle
A small efficient intelligent parking device is driven by a central rotating pillar to rotate the double-deck parking platform. A pickup and release device is set below one of the parking Spaces of the device, and then the pickup and release device is realized through the lifting device. Using sensor device and parking coordinates, accurate positioning can be carried out when the platform moves in a circle, so as to minimize the mistakes of vehicle parking. Rotating structure and round shape can effectively use the space above the ground. The system is controlled by Hui Fish control, which is fully mechanized and highly intelligent [11].

When parking the car, the second floor designated empty parking space will be transferred to the top of the pickup device through the rotating pillar of the control center, and then the parking space will be reduced to the level of the parking platform through the lifting device to realize the parking of the second floor. The first layer of parking space is directly under the action of the sensor along the lifting guide rail to achieve the pickup and release of the vehicle. The device can realize the goal of parking multiple cars in a small area, which is expected to solve the problem of difficult parking in residential areas.
2.3. Design Requirements

- Design parameter requirements of the stopping device. After literature search and actual situation analysis, the design structure size of the upper layer of the parking device is controlled in the diameter of 12000mm and the maximum load of 9t, which is mainly used for parking family cars. The size of the lower structure is controlled in the diameter of 4000mm and the maximum load capacity is 0.5t. It is mainly used for parking household electric vehicles and bicycles. Its design parameters are shown in Table 1.

- Can meet the requirements of fast storage, convenient access, position can be adjusted;

- The operation process is relatively reliable, its mechanical structure is relatively simple, convenient assembly and disassembly, and is conducive to adjustment and maintenance [12].

- Reduce manufacturing costs as far as possible;

- Easy to control.

| The name                        | The parameter value | unit |
|---------------------------------|---------------------|------|
| Superstructure diameter         | <12000              | mm   |
| Upper bearing weight            | <9                  | t    |
| Diameter of substructure        | <4000               | mm   |
| Lower bearing weight            | <0.5                | t    |
| Upper stop time                 | <5                  | min  |
| Lower parking time              | <3                  | min  |

3. Design of the key components of the rotating double-deck small efficient parking device

3.1. A.Rotating Structure Design

The rotating part of the rotating double-layer small efficient parking device is mainly composed of a rotating center pillar, Worm gear and worm and motor and fixed frame. The motor drives the worm gear to rotate, which drives the rotating center pillar to rotate to realize the rotating motion of the double-layer rotating structure, and completes the movement of the double-layer parking space.

![Fig. 2 Structure diagram of rotating part](image-url)
3.2. Frame Structure Design

3.2.1. Superstructure Design. The size of the upperThe parking device mainly has two layer structure, the upper structure on disk as the main body shape, each wheel is divided into six fan-shaped plate and each fan base plate for parking floor, namely the upper wheel with larger area, parking space is bigger also, one of the top parking floor is independent activities, the central pillar of each floor can control the wheel rotation, Through the lifting device to realize the pickup and release of vehicles, can park six family cars at the same time. The size of the upper disc structure of the parking device is controlled in the diameter of 12000mm, height of 2000mm, and maximum bearing capacity of 9t. The area of each pallet is 118400mm².

3.2.2. Lower Structure Design. The lower structure of the frame structure is similar to the upper structure, which is mainly composed of 12 fan-shaped parking floor parking platform, each parking floor and above space constitutes a parking space. The inner side of each parking floor is equipped with a monk guide rail, and under the action of the sensor along the lifting guide rail for lifting movement, the overall size of the lower turntable is controlled in the diameter of 4000mm, the height of 1200mm, the maximum bearing weight of 0.5t. Mainly used for parking household electric bikes and bicycles.

3.3. Lifting Device Design

3.3.1. The Structural Composition of The Lifting Device. The upper parking space of the parking device is mainly realized by the lifting device to pick up and put the vehicle, and the lower parking space can be directly moved up and down along the lifting guide rail through the parking floor to complete the first layer of the vehicle. The lifting device is mainly composed of lifting bottom plate, lead screw, transmission belt, transmission wheel, motor and bottom plate, as shown in Fig. 6.

3.3.2. The Working Process of The Lifting Device. When a user in the family car parked, first press the corresponding parking switch button, and then the upper structure of rotary turntable rotate will specify parking to take put the location of the upper part, each parking floor are independent existence, the control system under the action of the motor drive belt, which drives the driving wheel and screw, the lifting plate along the screw rise directly to the designated parking lots, and the fixed structure of the bottom plate and the designated parking bottom plate and the lifting bottom plate are closely combined, and then the lifting device drives the lifting bottom plate and the parking bottom plate to move outward to separate the parking bottom plate and the center of the shaft, and the parking bottom plate is dropped to the parking position on the ground, the vehicle is driven to the bottom plate, and the vehicle is fixed through the fixing structure of the bottom plate. Once again, driven by the screw rod rice, the parking floor rises to the original position, and is combined with the upper rotation center to complete the parking of the upper vehicles.

Fig. 3 Schematic diagram of superstructure
4. System modeling and control
The system is simulated and built by the Hui Fish module, and controlled by the programming software Robopro. The physical model is shown in Figure 5. By using mathematical model, the establishment of space database, the system will automatically analyze where no vehicle parking, then feedback to the main control system, control of parking vehicle parking, use the coordinates of the sensor device and parking lots, and the rotary table do circular motion, accurately positioning, vehicle parking to minimize the error.

Body motion control system, mainly composed of motor, sensors and other devices, to stop taking vehicle motor drives the spindle rotation through the control system, and through the identification of fixed parking sensor system, realize the intelligent control, take put through a sensor system for the bottom of the vehicle and motor, control the rotation of the screw, the vehicle stop efficient intelligent parking.

The lifting device is mainly controlled by Huiyu. When the button of the second fixed parking space is pressed, the control device issues instructions, and the motor drives the transmission belt and the transmission wheel. The screw rod rotates clockwise to meet the needs of the vehicle. When the first layer is pressed to fix the parking space, the parking floor moves up and down along the lifting guide rail under the action of the sensor so as to realize the pickup and release of the vehicle. Take 1-3 parking Spaces on the first floor as an example, and the control program of the fish is shown in Figure 6. Take No. 6-8 of the second floor parking space as an example, and the control program of the fish fry is shown in Figure 7.
5. Conclusion
Aiming at the problem of difficult parking in the existing community, a small parking device with a rotating double-layer structure is designed and a model is made. The parking device effectively uses the space above the ground and can realize the goal of parking more than two cars in a small area. The model is controlled by Robopro programming software. The sensor device and the coordinate of the parking space are used to accurately position the rotating wheel when it moves in a circle, so as to minimize the mistakes of vehicle parking and realize efficient and intelligent parking. Through the design of the structure and control of the model of the rotary double-deck parking device, it provides a reference for further improvement and production in the later period.

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