Design of double intelligent parking garage based on HuiYu technology

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Abstract. In view of the ubiquitous parking problem in the city, a double-layer intelligent parking garage that saves space, is smart and labor-saving. On the basis of the existing parking garage, the first problem to be solved is how to effectively use the transitional parking space in the three-dimensional garage (mainly refers to the parking space that the vehicle cannot be occupied by the upper vehicle after parking). In order to solve the above problems, this paper designed a double-deck parking garage to solve this problem. Mainly by the left and right lateral movement and vertical movement of the lower parking space. All parking spaces are free to move up and down to ensure that the lower parking space can be fully loaded without affecting the upper parking vehicle. Based on Huiyu's innovative technology, a double-layer intelligent parking garage was designed. The Huiyu model is used to complete the mechanical system design and production of physical models. The man-machine operation panel is compiled with ROBO PRO software. With button-type access, it has the function of non-slip and stable operation. At the same time, the optimal path algorithm saves time. The double-decker smart parking garage is safe, small, efficient and intelligent. It can park and pick up the car with a key. The double-deck parking garage achieves maximum use of space and is both reliable and economical. The double-deck intelligent parking garage is designed to meet the desired sporting requirements, removing the upper vehicle while ensuring that the vehicle's bottom layer does not move. At the same time, the optimal path algorithm makes it a powerful guarantee for fast access to vehicles. The double-layer intelligent parking garage designed and built has met the design requirements. Further improvement is to transform from Huiyu model to actual product, and it is necessary to solve the problem of parking garage bearing.

1. The introduction

With the continuous deepening of reform and opening up, China has made new progress in promoting the building of a well-off society in an all-round way. People's lives have improved markedly, and the per capita disposable income of the nation's residents has continued to grow. Therefore, the masses of the people have a wider demand for their lives, and motor vehicles. The rapid growth of transactions is...
a good illustration. By the end of 2016, the number of motor vehicles owned by China was 194.4 million, the number of private cars was 165.59 million, and the number of civilian cars was 108.76 million. It is estimated that by 2020, the number of cars in China will exceed 200 million.

With the unprecedented economic growth in China, how to deal with the current environmental changes quickly has become the key to maintain stable economic growth. Among the numerous emerging urban environmental problems, how to solve the parking problem has become a problem that must be solved in the construction of a modern city.

At present, the current situation of parking in residential areas mainly includes:
1. The number of parking Spaces is far from meeting the demand;
2. The phenomenon of disorderly parking in the residential area occurs from time to time;
3. The parking in the community is dominated by single-story parking Spaces;
4. Inconvenient parking and high technical requirements for drivers.

These problems are increasingly prominent, and it is urgent to improve the number of parking Spaces in the unit area of the community. Based on the creative combination of huiyu as the platform, mechanical principles, mechanical design, and other pre-study courses, this paper designs a two-layer intelligent parking garage.

2. Design prototypes
On the basis of the existing parking garage, the first problem we solve is how to make an effective use of a transitional parking space in the three-dimensional garage (mainly refers to the parking space that cannot be taken by the upper layer vehicles after parking vehicles) (figure 1).

In order to solve the above problems, this paper designed a double-deck parking garage to solve this problem.

It is mainly through the realization of the left and right lateral movement of the lower parking Spaces and the vertical movement of the upper and lower parking Spaces that all the parking Spaces can move freely so as to ensure that the lower parking Spaces can be full of vehicles without affecting the upper parking vehicles. (In this paper, the motion mode combining vertical movement up and down and lateral movement is called circular motion).

![Figure 1. The garage to compare](image)

3. Structure and main parameters of the comet system
The double-layer intelligent parking garage based on Fischer is shown in figure 2. The main power unit of the garage is the motor, each motor drives the screw connected to it to move, and then realizes the corresponding movement of the parking space. The efficiency of the screw transmission. The garage can be recycled flexibly, with novel structure and high degree of automation.
Table 1. Comparison table of main parameters

| Item                  | Physical garage | Fischer model |
|-----------------------|-----------------|---------------|
| Size(mm)              | 5116×4455×3500  | 220×191×150   |
| The garage weight to bear | 4600kg         | 1000g         |
| The screw weight to bear | 2300kg         | 500g          |
| Control mode          | PLC             | TXT Controller |
| Driveway              | Motor drive     | Motor drive   |

Firstly, the general functional model of the two-level intelligent parking garage is established, and then the sub-functional structure is explained. The double-deck intelligent parking garage is mainly composed of five parts: intelligent control module, bottom horizontal moving module, bottom clamping transmission module, vertical lifting module and second clamping transmission module.

3.1. Intelligent control module and its functions

The figure 3 is a touch-button operation panel, which is programmed and controlled by the TXT Controller and the limit switch to stop and take the car. At the same time, a switch button is set to select the position of taking the car.

In order to achieve the expected mechanical movement, the double-deck intelligent parking garage needs to complete a series of complex actions through the intelligent control panel: find a parking space -- identify the position of the vehicle -- judge the path of the vehicle -- mechanism movement and so on. In the design of double-deck intelligent parking garage, the key to the competitiveness of the product is to judge the shortest running track of the car. Program flow is based on the user issued instructions or pre-implanted procedures to act, is the main function of the machine. The realization of the main function is about the path planning of the movement of the parking space in the garage and the coupling of the servo parts.

Figure 2. The fischer structure of double deck intelligent parking garage

Figure 3. Intelligent control module
Multiple limit switches (buttons) are connected to the input ports of I/O expansion plate 1 and 2, and motor signal motion state signal is connected to the output ports of I/O expansion plate 1 and 2. Coupled with the "ROBO controller", the USB serial port output signal is connected to the computer, and the corresponding ROBOPro graphical program is written to identify the execution state, optimize the vehicle access path, and precisely control the parking space to reach the specified position through the limit switch to meet the precision requirements.

The position of the four parking Spaces is mainly limited by the contact switch.

3.2. Two-layer clamping transfer module and the bottom layer clamping transfer module

![Second layers clamp horizontal transfer module](image1)

**Figure 4.** Second layers clamp horizontal transfer module

![Vertical lifting module](image2)

**Figure 5.** Vertical lifting module

The two-layer clamping transfer module realizes the lateral movement of the two-layer vehicles through two symmetrical lead screw mechanisms, sprocket chains, and rack and pinion.

The device starts to start, and after the clamping action is completed, the base plate moves in translation under the action of the rack and pinion, touches the limit switch at the end, and the movement stops to complete the transposition action.

When the motor (M2) receives the motion command, the clamping mechanism starts to move towards the garage. At the same time, the clamping mechanism on the other side of the garage starts to move towards the garage.

When the contact switch at the preset position is touched, the motor (M2) stops moving, and then the transmission gear is driven by the motor (M1) to start the drive installation.
3.3. The rack carriage plate moves towards one side

The bottom clamping transmission module is clamped and positioned by two symmetrical screw mechanisms, and the transposition operation of the bottom vehicle is realized through the combination of sprocket chain and rack and pinion. The mechanical principles of the two modules are the same.

3.4. Vertical module and the bottom transverse module

Vertical module through double screw mechanism to realize the vehicle vertical lift, (M3) receives the signal starts when the motor movement, the movement to double screw gearing system, thus sports support plate with screw up and down, in order to guarantee the running smoothness of the formation of the start and end position to prevent contact switch, when bottom touch contact switch (on behalf of the vehicle has reached the preset position), contact switch of the potential change and the change of signal back to the controller, and controller to send the motor to stop movement instruction.

The mechanical structure of the bottom horizontal moving module is the same as that of the vertical lifting module. It also realizes the horizontal movement of the bottom vehicle through the combination of screw and slider. The base plate of the slider is fixed with the screw pair, and the horizontal movement of the bottom vehicle is realized through the rotation of the screw pair, and the horizontal movement of the bottom vehicle is precisely controlled by the contact switch.

3.5. Straight lift module and the bottom transverse module

Vertical modules by double screw mechanism to realize the vehicle vertical lift, (M3) receives the signal starts when the motor movement, the movement to double screw gearing system, thus sports support plate with screw up and down, in order to guarantee the running smoothness of the formation of the start and end position to prevent contact switch, when bottom touch contact switch (on behalf of the vehicle has reached the preset position), contact switch of the potential change and the change of signal back to the controller, and controller to send the motor to stop movement instruction;

The mechanical structure of the bottom horizontal moving module is the same as that of the vertical lifting module. It also realizes the horizontal movement of the bottom vehicle through the combination of screw and slider.

The base plate of the slider is fixed with the screw pair, and the horizontal movement of the bottom vehicle is realized through the rotation of the screw pair, and the horizontal movement of the bottom vehicle is precisely controlled by the contact switch.

4. Workflow

In order to ensure that the user can park and take the car quickly and conveniently, the process of parking and taking the car is shown in figure 6.

![Figure 6. Parking state](image-url)
5. Working process and programming

5.1. Part of the parking

When the owner drives the car to waiting area, press the "stop" button, and the vehicle has priority to stay on the first floor. At the same time, the garage always keeps the parking position without vehicles.

According to figure 1 as an example, the state of the parking space is state 1 at this time, and the vehicle is parked at the no. 4 parking space: the owner puts the car on the no. 4 parking plate, and the left vertical screw pair drives the no. 1 parking space to the upper left, and stops when it touches the limit switch;

The upper clamping transmission device performs the tightening positioning movement. When the limit switch is touched, the movement stops.

The left lifting device drops, touches the limit switch of the lower left position, and the movement stops;

The lower screw drive 4 floors of tea are left to a lower left, vice driving on the left side of the vertical screw thread 3 floors to the middle position, the lower clamping transmission device drives the 4 floors of left to a lower left, the right side of the vertical screw drive to a lower right under the floors, touch the limit switch and stop motion, the lower screw drive bikes, 4 floors of lorries and 2 on the left, made the car movement to the lower left, clamping transmission device drives the no. 1 on the second floor plate right to the upper right, the right side of the lead screw drive 1 supporting plate down to the middle position, the lower screw right, end of the parking, parking state for 2 at this time.

Figure 7. Stopping part procedure
5.2. Pickup part
When the owner takes the car, he/she will check the position of his/her car on the display screen and press the corresponding parking number button on the control panel. The car will move to the position
of taking the car with the trailer board. For the vehicle with no. 3 parking space, the optimal path algorithm is adopted, and the parking space moves from the initial position to the exit position.

6. Conclusion
The double-deck intelligent parking garage is safe, small, efficient and intelligent. It can be used to park and pick up cars with one key. Double-deck parking is adopted to realize the maximum utilization of space, which is both reliable and economical.

(1) The two-level intelligent parking garage makes full use of the innovative intelligence. ROBOPro graphical programming is used to control the garage to complete the functions of finding parking space, identifying vehicle position, judging vehicle path and mechanism movement.

(2) Compared with the actual mechanical structure, some mechanisms constructed by the model of the comet can’t achieve the desired effect. For example, when the bottom screw is subjected to the weight of the vehicle, it moves slowly. Therefore, in the actual manufacturing process of the garage, should use the rack and pinion transmission, the parking force transferred to the shaft.

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