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Design of Three-Dimensional Parking System Based on Crank Slider Mechanism

Yang Hang*, Zhu Jianhua, Zhan Yong, Li Shengtang, Wang Jiangchuan, Ye Zhenhuan, Wang Yulan, Zhang Qiang, Zhu Zhenglong, Yan Changguo, Fu Juan, Zhang Xu, Wang Chunpeng, Mao Yongnian

Zunyi Normal University College of Engineering, Zunyi, Guizhou, 563006

**Corresponding Author: Yang Hang*

Abstract: ***The rapid increase in the number of cars has caused parking to become a major problem at present. The various parking facilities that have emerged are relatively large, occupy a large area, and are difficult to maintain. In order to solve this problem, a parking mechanism was designed to meet the parking needs of people in the community, that is, private parking space expansion and upgrading parking device, small private parking space expansion parking device is based on offset crank slider mechanism to realize the lifting of small passenger cars, just use the slider as the driving part and the crank as the driven part. The design mainly analyzes the stroke, pressure angle, force and other factors of the offset crank slider mechanism, and analyzes and determines the size of the rods of each mechanism through MATLAB data, SOLIDWORKS modeling and assembly. The mechanical device has a simple design and structure, and is easy to process, install and maintain. The power part is driven by a chain drive to drive the slider to move up and down to achieve the crank up and down, thereby raising or lowering the car disc, achieving the effect of safe and fast parking.***

Keywords: three-dimensional parking system; private parking space; crank slider; pressure angle; geared motor

1 Introduction

Dirty, chaotic, poor, irregular parking has led to the paralysis of travel in the community, and the bumping of vehicles is inevitable. In view of the problems faced by the residential parking lot, the residential parking lot has the following research directions: (1) Continuous optimization of vehicle access design. Using advanced technology and theory, the control system of the parking lot is simulated and designed to achieve the optimal access scheme, facilitate the access of the vehicle, and reduce the access time [1-3] (2) intelligent: What is now hoped is a simple, convenient and fast way of life, so the intelligence of the residential parking lot is the key to solving this problem [4,5], as shown in Fig.1.

Fig.1 Status quo of parking lots in the community

At present, the car is already an indispensable means of travel, and with the support of the existing economy, each household has its own car for travel [6-9]。 Everything in the world has its own two sides, while there is a private car to facilitate travel, traffic congestion, traffic jams follow. Not only that, with the sharp increase in vehicles, parking spaces have been in a state of tension, in this form there will be a phenomenon of random parking of vehicles, which seriously affects traffic rules and people's living environment. Solving the parking of vehicles has become a major problem. Therefore, the parking problem has become more and more difficult, and it has become a major problem for the people in the community [10, 13]. The main manifestations are. At present, there are mainly the following types of parking lots.

(1) Open-air parking, as shown in Fig.2. Parking on the side of the road in the community or the parking lot planned by the community is called an open parking lot. The advantage of open-air parking is that it can park quickly, and the previous community only had this open-air parking lot. There are serious problems in parking in these old residential areas, with few parking spaces and difficult parking. Coupled with the lack of management, it brings inconvenience to the travel of these communities. Some old residential areas do not even plan parking lots, so they cause random parking of vehicles, and finally traffic paralysis. Parking spaces are few, parking spaces are very troublesome, parking disputes often occur [14, 15]. Because everyone can only park their cars on both sides of the road at will, the road in the community that is not spacious will become very narrow, the bumps and bumps of vehicles are inevitable, and the fire hazard is quite large. Another bad place in the open-air parking lot is that it occupies a large area, so that many facilities in the community will be reduced accordingly, such as: community greening.

Fig.2 Open-air parking lot

(2) Underground parking, as shown in Fig.3. It is currently the most used parking lot. Its advantage is to maximize the use of underground space and save space, so it plays an important role in the problem of road congestion in the community. Its advantages are more obvious than open-air parking. Its advantage is that it makes full use of the underground space of the residential and green areas of the community [16, 17], achieves the maximum utilization of space, and also provides a larger venue for other facilities in the community to improve the various internal facilities, and its living environment has also been correspondingly improved; The natural environment is small, almost negligible, and no longer worry about dust pollution, sun exposure, and thunderstorms; The facilities in the underground parking lot are also more comprehensive and the management is more standardized, effectively avoiding unnecessary conflicts in accessing vehicles; Finally, there are plenty of parking spaces, and there is rarely a scramble for parking spaces. On the contrary, the bad part of the underground parking lot is that the construction price is expensive, the time is long, the maintenance price is also very high, and the underground space is prone to water accumulation.

Fig.3 Underground parking lot

(3) Mechanical three-dimensional parking lot, as shown in Fig.4. Mainly appears in high-end residential areas, is the representative of parking technology, the work of stars. Mechanical three-dimensional parking lot is a more popular parking lot construction method in recent years, combined with the defects and problems of the previous old-fashioned parking lot [18], a more technical parking device is designed. Mechanical parking device is mainly a necessity of high-end residential areas, is an upgraded version of the general underground parking lot, its advantage is to make the greatest use of underground space, the use of artificial intelligence to achieve automatic access [19-20]. The bad part is that parking or picking up the car will waste a lot of time during peak hours, and if the device has problems and is damaged, repair is more troublesome, and the natural maintenance cost is large.

Fig.4 Mechanical parking lot

2 Overall Design and Analysis of Parking Devices

Combined with the advantages and disadvantages of the previous mechanical system design, select the best parts to apply and upgrade. Most of them use chains to drive rotation to achieve parking, and they are some medium and large parking garages that are not suitable for residential areas. In order to solve the parking problem of the current community, it is necessary to start from the perspective of the community, which is both economical and reliable, and does not affect the beauty of the community.

Through the comprehensive comparison of existing designs, in order to solve the difficulties of people in urban communities, the space utilization rate and utilization mode of parking in the community can be changed. After careful research, it was found that some space can also be used in the upper part of the parking space, whether it is an underground parking lot or an open parking lot, a part of the space can be used to park vehicles. The parking access of the designed parking device also needs to meet the single vehicle that is, the parking mechanism is designed to meet this requirement to meet the travel of the people in the community, that is, the private parking space expansion upgrade parking device, the small private parking space expansion parking device is based on the bias crank slider mechanism to achieve the lifting and lowering of the small passenger car, but the slider is used as the active part, and the crank is used as the follower.

During the design, the stroke, pressure angle, force and other factors of the bias crank slider mechanism are mainly analyzed, and the size of the members of each mechanism is determined by MATLAB data analysis, and SOLIDWORKS models and assembles them. The mechanical device is designed to have a simple structure, easy to process and its installation and maintenance, and the power part is to drive the slider back and forth through the chain drive to achieve the up and down swing of the crank. So as to lift or lower the car disc, the design of the parking lot needs to meet the advantages of simple structure, easy installation, small volume and so on.

It is understood that the engine rotation of the internal combustion engine is achieved by using the crank slider mechanism, using the slider as the active part, the linear motion into rotation, so the characteristics of this mechanism are applied, the crank is used as a follower, and then the crank slider mechanism is used to realize the lifting and lowering of

the tray, and a simple mechanical parking device is designed. The designed parking device is to achieve lifting and lowering in the form of rotation, and the applied mechanism is the bias crank slider mechanism, through the chain to drive the sprocket so that the slide moves on the guide rail, then the slider as the active part to make the crank swing, you can achieve the parking tray up and down movement. Use the geared motor movement, drive the chain rotation, the sprocket is connected with the chain through the member and the slider, the slider can move with the chain when the chain moves, the slider slides back and forth on the guide rail, the slider then drives the connecting rod movement, the linkage and the crank movement, the crank can swing back and forth the parking disc can rotate up or down, and it can park and pick up the car.

3 Design of The Crank Slider Mechanism

The design of the parking device to achieve energy transmission is the characteristic of the device, and it is also the novelty and highlight of the design of the device. The energy transfer of the device is achieved by using the crank slider mechanism, through continuous understanding of the characteristics and principles of the crank slider mechanism, the use of the characteristics and structure of the mechanism to analyze the installation position and direction. The device crank slider mechanism simplified diagram, the crank in the Fig.is as a follower, the slider as the active part, the slider in the chain drive down and back to the linear movement, driving the crank up and down to swing up and down can lift the goods up, as shown in Fig.5.

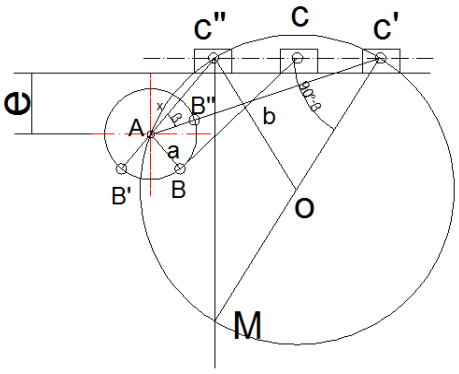

Fig. 5 Schematic diagram of the movement of the crank slider mechanism

The crank slider mechanism is shown in Fig.5, now suppose AB is a crank of length a, crank slider mechanism BC is set to length b, e is eccentric distance. According to the above assumptions and force analysis, it can be obtained that when the Y value is larger, the transmission of the mechanism is very beneficial, the more excellent the important indicators of the transmission performance of the mechanism, and the Y value is often used to measure the performance effect of the mechanism in engineering. Now with the slider as the active member, as its position changes, the Y value will also change, assuming that the minimum transmission angle is perpendicular to the position of the crank and the slider, so that its equation can be derived from Fig.5:

According to the known conditions, the relationship between X and the minimum transmission angle Y can be obtained:

From the above analysis, it can be known that the stroke H, the formation speed ratio coefficient of the slider K, the stroke is H, and the relevant parameters are a, b and e. According to what you have learned, you can design a crank slider mechanism.

The polar angle θ is calculated according to the relevant conditions, it can be concluded that the point of the crank is on the circumference, and the position of this point on the circumference can determine the magnitude of the force transmission performance of the stopping device, and if AC1(XX) is used as a design variable, then everything becomes simple. When the position of point A is determined, the parameters a, b, and we are determined. Next, you can find the connection between a, b, and e and the design variable X, build the equation and solve it.

The optimal force transfer performance of the crank slider mechanism is further analyzed. First of all, X must be used as a design variable, and then the value of X must be determined in a range, which is convenient for subsequent design and experimentation, and it is also very beneficial for the processing of related data later. The selection of the value range of X is the most important step. The starting point of the optimization interval is at C1: the structural characteristics of the crank slider mechanism can be known when the starting point of the optimal interval of the crank slider is at point C1. Find the starting point of the optimal interval, and then the end point. In the selection of the optimal end point, you can select according to the formula. After the calculation and analysis of the relevant data combined with the actual needs and characteristics of the device, it can be concluded that the end point of the optimal interval is at the M point. The positions of the starting point C1 and the end point M of the optimal interval are shown in Fig.9, and the starting and ending points of the optimal interval are obtained, and then in the range of values of X and finally can find a value corresponding to X. The most important step is to analyze the optimal solution of various sizes through MATLAB.

Three-dimensional parking system drive system selection and design

For the drive subsystem of the three-dimensional parking system, the selection of the motor is a particularly important step, and the motor generally used to transmit the torque is shown in Fig.6. Once the choice is unreasonable, the parking device will not be able to operate normally, and the impact on the entire device is relatively large. Since the torque required by the device during the transmission process is particularly large, the speed should be slowed down, thereby indirectly increasing its torque. Considering the safety and stability of the device, the geared motor with self-locking characteristics is finally selected to drive, and in order to reduce the speed of the motor, the geared motor is selected to be used in conjunction with the gear reducer. The installation of the gearbox is mainly to reduce the speed of the gear motor, thereby improving the torque, and also has a certain protective effect on the equipment.

Fig.6 Schematic diagram of an ordinary power transmission motor

If you choose other types of motors, although the efficiency will be improved, but cannot meet the requirements of the device with a large torque, its safety and stability will be greatly reduced. Combined with the requirements of the parking device, an asynchronous geared motor is selected as the motor of the device. This is shown in Fig.7.

Fig. 7 Geared motor for the drive subsystem of a three-dimensional parking system

The reason why the designed parking device will choose a geared motor depends entirely on a series of advantages of the geared motor and the characteristics of the operation of the device, which is mainly manifested in the following aspects: (1) Although the speed of the geared motor is relatively slow, its main feature is that it can be dragged, and the larger load power is also relatively large, on the other hand, its price is relatively cheap. (2) Geared motors are widely used in current industrial practice, and their main features are stability and economic applicability. (3) Because the geared motors are currently standardized production, it is easier to purchase alternative parts when repairing. (4) The geared motor is relatively quiet when running, which can provide a good environmental friendliness.

Three-dimensional parking system transmission subsystem chain and sprocket selection

Because the designed three-dimensional parking system requires high precision control of the position, and requires the transmission of large torque, the chain is selected for transmission, which has better torque and accuracy than the belt transmission. The calculation of chain transmission mainly involves the following aspects: indexing circular diameter: d = p/sin (180 °/z), z is the number of teeth, p is the pitch (check table); Tooth top circle (outer diameter) :D = p× (0.54 + cot180 °/z); Tooth top circle diameter: dam=d+1.25p-d1, din=d+(1-1.6/z) p-d1; Tooth root circle diameter: do=d-d1; Note: p Chain pitch, z sprocket teeth, d1 chain roller diameter

4 Design Results

The device designed herein is a private parking device based on the crank slider machine as the core design, the device uses a geared motor for energy supply, the geared motor output is stable and can be self-locking, slow speed is its biggest advantage. In the process of movement is more stable [], the geared motor is connected with the sprocket through the coupling, and the back-and-forth movement of the slider is driven by the transmission of the chain, at this time the slider is used as the active part, the crank is used as a follower, the crank is swayed up and down, and the extension end of the crank hangs the tray of the parking trolley, and the trolley tray can follow the crank rotation, which can realize the storage of the trolley. At both ends of the slider rail, a stroke switch is added to limit the stroke position of the slider, and the device is also added with an indicator limit switch, which is always on when the parking device is in motion, which is used to remind pedestrians and vehicles to pay attention to safety. The mechanism has the advantages of simple design, most of the required materials are standard parts, easy installation, easy maintenance and so on. The design results are obtained from the design of the drive and main transmission components as well as the key structural parts as shown in Fig.8.

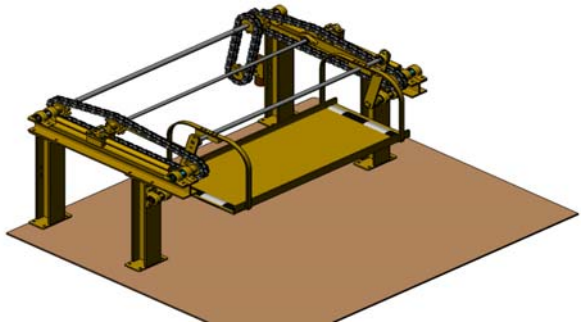

Fig. 8 Design result of a three-dimensional parking system based on a crank slider

The three views are shown in Fig.9.

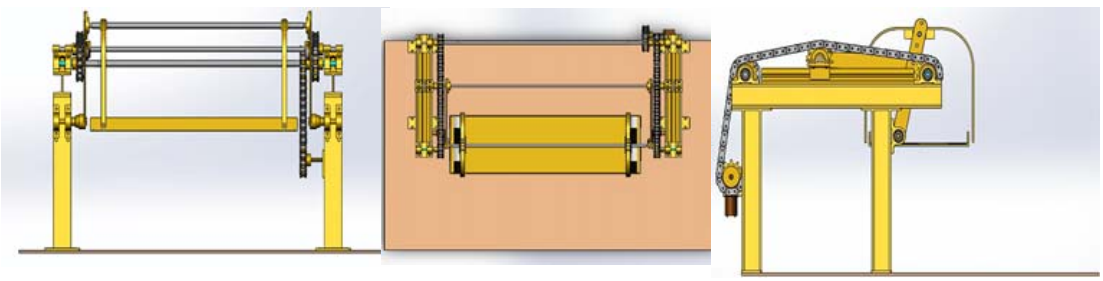

Fig.9 Three views of a three-dimensional parking system

The designed parking device is small in size, does not affect the beauty of the community environment, and does not make the people in the community feel depressed. The device uses the offset crank slider mechanism to realize the lifting and lowering of the parking tray, which does not affect the parking storage of the vehicle below, does not require the owner of the other party to move the vehicle, facilitates the travel of other vehicles, and is suitable for the roadside of the community, underground parking lot, etc. The mechanical structure of the device is simple, a large number of standard parts are used for assembly, so it is easy to install, small in size, and the material is easy to purchase, easy to replace parts and their maintenance, and low production costs. The design of the parking device is only a preliminary design, there are shortcomings, and it needs to be continuously optimized in the later stage. The design of material selection or details can only be put into use in the market after repeated comparison and optimization.

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