Bicycle Intelligent Stereo Parking Garage

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Abstract. With the saturation of Shared bicycle market, the parking problem of urgently needs to be solved. At present, the most common bicycle parking rack in China is the spiral circular cage, which is simple in shape but not perfect in function. In this paper, a stereometric parking system was designed. It was divided into the upper and lower layers where the parking devices (including parking panels and racks) were installed. There were a number of parking racks with safety clamps were installed on parking panels radially outward from the center. The parking system had an opening on each layer for bicycle picking up or returning. This parking system doubled the parking space and solved the parking problems of Shared bicycles which made a great contribution to the city appearance.

1. Introduction
With the vigorous development of automobile industry, automobile transportation has become the main mode of travel in many countries. However, with the increasing number of cars and the increasing travel pressure, problems such as traffic jams and parking difficulties continue to arise. And people's awareness of environmental protection is constantly decreasing. Reducing vehicle gas emissions has become one of the goals of environmental protection. Nowadays, more and more people choose a green and low-carbon way of travel-cycling. Bicycles are a large number of green modes of transportation with high frequency of use. Therefore, the state strongly advocates the use of bicycles as a means of transportation. According to the survey, the number of bicycles in our country has exceeded 100 million and has become the preferred means of transportation for urban residents to travel for short distances. In addition, with the development of sharing bicycles, the demand and frequency of people using bicycles are also increasing.

As a big country in bicycle production and use, China produces and discards a large number of bicycles every year, but the problem of bicycle parking and placement caused by this has not been properly solved. From the perspective of energy conservation, emission reduction and green travel, managers have clearly recognized the importance of bicycle traffic and are making efforts to improve the current situation of bicycle traffic. Our country started planning and construction of bicycle parking facilities long ago. However, with the saturation of the shared bicycle market, various colors of shared bicycles can be seen everywhere on the road, which not only occupies a large area, but also has difficulties in parking and picking up, disturbing the normal traffic order.

The rapid increase in the use of bicycles, although to some extent alleviated the traffic congestion pressure, has brought a series of problems in urban parking. The number of bicycles in China is very large, but the bicycle parking facilities and places are still relatively scarce. The layout is rather confusing. Some parking places are too simple and lack basic bicycle fixing facilities. It is easy to cause disorderly parking of vehicles, and it is easy to cause the following phenomena: If the parking space is narrow, it is easy to damage the appearance of the bicycle. Bicycles are parked in disorder, which makes it difficult to park and take them. Some bicycles even park in stairwells, safety exits and pedestrian passageways, affecting the appearance of the city. The parking place is not strictly
supervised and the theft frequency is high. On the sidewalk and bicycle lane design overlap, blocking traffic. Today, when natural resources are seriously insufficient and green travel is strongly advocated, energy conservation and emission reduction are promoted, and a new type of travel mode represented by sharing bicycles is adopted, it is particularly important to properly solve bicycle parking. The development of bicycle parking space and the design of parking devices are of great significance. Therefore, based on these problems, the project designed and researched an intelligent three-dimensional bicycle parking device based on the full investigation and analysis of the existing devices. The device will effectively solve the problems of time-consuming and labor-intensive parking vehicles and high cost of parking devices. To achieve convenient and fast bicycle access, and to ease the current situation of bicycle parking.

2. Current Status of Bicycle Parking

2.1. Lack of adequate parking space:
With the widespread use of bicycles, bicycles parked in disorder can be seen everywhere on the road. Many bicycles were piled up in places where there were no bicycle parking spaces. The parking of bicycles occupies the space of pedestrians, and affects the city appearance. A large number of bicycles piled up can easily cause bicycles to be stolen. In addition, many residential areas and units do not have bicycle parking spaces, and even prohibit the entry of bicycles. Users can only choose to park bicycles outside, thus safety and reliability cannot be guaranteed.

2.2. Lack of suitable parking facilities:
At present, bicycles are shared in many cities, and the convenience of sharing bicycles is favored by many people. However, the shortage of urban parking stations and the shortage of station capacity have brought a series of problems to the subsequent use. The bicycle has no suitable parking position, so it can only be placed in the open air, which accelerates the damage of the bicycle.

In some places where parking racks already exist, there are also various problems. For example, the most common type of spiral cage parking rack in the city, which has simple structure and convenient installation, has been widely used. However, the disadvantages of this kind of parking rack are also obvious. When the bicycle is parked, it is still open-air. When there is bad weather such as strong wind, the bicycle can not be effectively protected. And the bicycle parked in this way cannot control the distance between the two cars, and it is easy to cause unnecessary damage.

3. Current Status of Parking Devices [1-3]
By consulting relevant patents and papers, we can see that there are many new parking garage designs, which can be roughly divided into two categories according to the parking location: vertical placement (inclined to a certain angle) and horizontal placement. Some of them are open-air simple parking racks, and some are a complete parking garage.

3.1. Place the class vertically

3.1.1. Vertical bicycle parking stand
The advantage of this parking device is that it can greatly save ground space, but the disadvantage is that it is more laborious to store and may have potential safety hazards.
3.1.2. Suspension bicycle parking device

This kind of parking garage is no longer placed in the open air, has the function of anti-theft and anti-destruction, and has fast access speed and convenient use. However, such parking garages are relatively expensive and are not suitable for mass production.

3.2. Horizontal placement class

3.2.1. Double-deck bicycle parking device
This kind of parking device obviously improves the utilization of space, but the access is also laborious.

3.2.2. Fully automatic underground bicycle garage

![Fully automatic underground bicycle garage](image)

This kind of parking garage greatly improves the storage space, and the fully automated design makes access more convenient and fast. But similarly, such large parking garages are expensive and difficult to put into mass production.

Through the above analysis, it can be seen that the existing parking devices are limited by production costs, application scope and other conditions. These frames only appear in a small range in some specific occasions, and can not be applied to the shared bicycle flooding environment.

Therefore, the development of a bicycle garage with high space utilization, promotion, convenient access and protection for bicycles is a must.

4. Device Design

4.1. Design Principles

It is mainly placed in a narrow and narrow space with high space utilization rate, small occupied area and convenient access. When the bicycle is vertically placed and put down, it saves time and labor and has high efficiency. The garage has a certain amount of storage, which can protect and guard against theft for bicycles [4-7].

4.2. Brief description of device structure

The parking garage is mainly composed of shell, parking rack, parking device, hydraulic lifting device and control device. The parking garage has several parking devices on a parking rack. Each garage has two parking racks. The bottom parking rack is equipped with hydraulic lifting devices, so that the bicycles and vacancies on the two parking racks can be used. Six parking devices are distributed along the radial direction. PLC control device can control the motor to rotate the parking device 60 degrees at a time. The user can control the number of rotations and the direction of rotation at the control end, and can realize a rotation stroke of 60 degrees, 120 degrees and 180 degrees [8], so that only one car or empty seat is at the access position during the access process.

On the parking rack, we use vertical electric sliding rail parking device. The safety lock clip for locking the front wheel is mounted on the front wheel limiting frame, the slide block on the front wheel limiting frame can slide along the guide rail, and a small stepping motor is used for driving the slide block. The lifting device enables the parking garage to enter the underground when no one is using it. When receiving the use signal, it can lift one or two floors. The shell is equipped with safety guardrail, dust cover and other accessories, which has a certain role of dust prevention and safety protection.
4.3. Stored procedure

4.3.1. Parking process
When the user comes to the parking garage, the user can send out a signal through the mobile phone end to "wake up" the parking garage so that the parking garage lowered to the ground rises. When there is space on the parking rack on the top floor, the control device of the parking garage can make the parking garage only lift one floor; If there is no space in the parking rack on the top floor, the control device of the parking garage makes the entrance of the garage on the bottom floor rise to the ground. At this time, users issue parking instructions. The parking garage's PLC control device can rotate the nearest vacancy from the parking garage's access port to the access port. Then the user pushes the car in, and clips the bicycle into the front wheel limit frame of the vertical electric sliding track parking device. At the mobile terminal, the parking instructions are issued, and then the control of the parking garage is carried out. The device drives the stepper motor of the slideway, drives the slider and the front wheel limit frame on it to move, so that the bicycle can be tilted and parked. If there is no stop signal for a period of time, the hydraulic lifting device will reduce the garage to underground again.

4.3.2. Car pick-up process
When the user needs to use the car, the mobile phone can send a signal to "wake up" the parking garage and raise the parking garage down to the ground. When there is a bicycle on the top floor of the parking rack, the parking garage control device can raise the parking garage only one layer; if the top floor parking rack does not have a bicycle, the parking garage control device raises the entrance of the underground garage to the ground. At this time, the user sends out the car pick-up instructions, the parking garage PLC control device can make the nearest bicycle from the parking garage access port rotate to the access port, and put the bicycle down, the user manually unlocks the safety lock clamp, takes out the bicycle for use, takes out the car to complete. If there is no pick-up signal for a period of time, the hydraulic lifting device will reduce the garage to underground again.
4.4. Design of parking rack

4.4.1. Structural composition
The electric slide rail type parking device mainly consists of a stepping motor, a slide rail, a slide block, a front wheel limiting frame and a safety locking clip, as shown in fig. 6. The stepping motor is used to drive the slide block to slide on the slide rail. The guide rail used for guiding the parking rack is made of hardened steel and is placed on the installation plane after fine grinding. Grooves need to be machined on the guide rail for matching with the slide block. The front wheel limit frame is a hollow rectangular frame, which is connected and fastened with the slider through bolts. The safety lock clamp is bolted and fastened to the long frame of the front wheel limit frame. The safety lock clamp consists of a lock clamp shell, two fixed locking clasps, three outer splints and four clamping arms, as shown in Fig. 7. The clamping arm 4 is fixed to the outer clamping plate 3 by bolting, and a tension spring is connected to the tail end of the clamping arm so that the two clamping arms are closed under the action of the tension spring under static conditions. The outer splint 3 is fixedly coupled to the lock clip housing 1 by a fixing lock 2.

![Fig. 6. Parking device](image1)

1,2-guide 3-slider 4-front wheel limiting frame 5-safety lock clamp

![Fig. 7. Structure diagram of safety locking clip](image2)

1-lock clamp housing 2-fixed lock catch 3-lateral splint 4-clamping arm

4.4.2. Working process
When the bicycle is stored, the front wheel of the bicycle is pushed into the front wheel limiting frame, and the front wheel pushes open the two clamping arms of the safety locking clamp on the front wheel.
limiting frame. When the protruding ends of the two clamping arms enter the neutral positions of the spokes of the front wheel of the bicycle, the two clamping arms are closed under the action of the tension spring, thus achieving the purpose of locking the front wheel. When the stepping motor drives the slider upward, the bicycle can be erected. When picking up a bicycle, the front wheel can be removed from the front wheel limit frame by loosening the tension spring artificially and releasing the two clamping arms of the spring, so as to take out the bicycle [9-10].

4.5. The advanced nature of the parking garage
The parking garage is equipped with several parking devices on a parking rack. Each garage has two parking racks. The bottom parking rack is equipped with hydraulic lifting devices, so that the bicycles and vacancies on the two parking racks can be used. This kind of parking garage greatly improves the utilization rate of space, which makes it possible to park and share bicycles as much as possible in a very limited space, so that there is a certain amount of bicycle reserve during the peak period of in-use vehicles, so that there is no car available. In the peak period of returning the car, there is a certain amount of vacant reserves, so that a large number of bicycles will not be parked on the streets in a random manner, which can effectively control the current situation that the number of shared bicycles is saturated and the traffic jams are serious.

The parking devices are distributed along the radial direction, and the PLC control device can control the motor to rotate at a certain angle, so that only one vehicle or empty space is at the access position in the access process, thereby avoiding the problems that a large number of bicycles are arranged side by side, the gap between the two vehicles is narrow, and users are difficult to access and park in the traditional parking mode. It also effectively avoids the vehicle damage caused by the small gap between the two workshops and the sticking of the pedals and chains.

On the parking rack, we use vertical electric sliding track parking device. The safety lock for locking the front wheel is mounted on the slider, which can slide along the guide rail, and the small stepping motor is used to drive the slider. The parking device can park the bicycle upright, improve the utilization of the space, reduce the area of the parking rack and the parking space of the parking garage, and the stepping motor drives the slider to make the bicycle stand upright, saving manpower and improving access efficiency.

Compared with the traditional open-air parking device, the parking rack of the parking garage has a safety lock, a safety guardrail in the parking garage, a dustproof outer casing and the like, and the lifting device can make the parking garage enter the underground when no one is used, thereby The invention has relatively good dustproof and anti-theft capabilities. In bad weather, bicycles can also be protected. And the quality is relatively light, easy to move, transport and installation, easy to promote and use.

5. Conclusion
(1) Based on the analysis of the existing bicycle parking devices, an intelligent vertical parking device is designed, which consists of a clamping device and a vertical moving device. The clamping device can fix and release the front wheel of the bicycle, and the vertical moving device can move up and down the clamping device and the front wheel of the bicycle.

(2) The clamping device adopts a self-locking one-way sliding switch mechanism and a sliding clamping mechanism to realize the function of "opening upon pressing and closing upon pressing". The front wheel of the bicycle is fixed and released in the process of parking and picking up.

(3) Vertical moving device, which uses vertical moving guide rail to realize up and down movement of bicycle frame and clamping device. With the stepping motor, it is convenient and quick to stop the bicycle in a time-saving and labor-saving manner;

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