The Design of Climb Stairs to Barrelled Water Trolley

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***Abstract*—This design is aimed at the difficulty of carrying barreled drinking water. The climbing car takes deformation wheel as the main form and planet wheel as the auxiliary form to climb up. When the deformation wheel turns forward, the inner wheel hub retracted under the control of the motor to realize stair climbing. In reverse rotation, the inner hub stretches, and the two hubs merge into the whole wheel to achieve flat driving. Its grasping mechanism is divided into three parts, which can control the lifting, movement and opening and closing of claws to meet the automatic loading and unloading of bottled drinking water.**

Keywords-Climbing Car; Wireless Control; Hydraulic Pressure; Automatic Loading And Unloading

I. INTRODUCTION

Research on stair climbing mechanisms and devices has a long history, with such patents appearing as early as the 1890s.Such research has been carried out overseas for a long time, and corresponding products have been developed. In China, the investment in this kind of research is late. Although there are some achievements in recent years, there are still many problems.[7]

From the previous researches on building climbing devices, there are various kinds of building climbing devices. However, none of the existing devices can achieve perfection due to various defects. These devices have their own advantages, but at the same time have their own shortcomings and shortcomings.

For example, crawler climbing mechanism has simple control, small fluctuation of center of gravity, stable climbing ability, but large mass and large size, and crawler will cause damage to the edge of the building. Planetary wheel climbing mechanism, small friction, small center of gravity fluctuation, excellent climbing ability, but the control complex can only be used to assist climbing mechanism. Leg - foot structure, climbing ability is good, but the center of gravity fluctuations, stability is not good, and large, complex structure.[8]

Compared with the advantages of traditional climbing devices, the combined climbing mechanism has been developed with various structures and combination methods. Jilin university of technology in China developed a "semi-walking wheel" with simple structure around 1970 by using the anti-biological theory, as shown in figure 1. Among various combinations, a new deformation wheel appears, as shown in figure 2.[4]

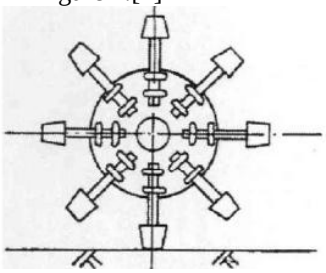

Figure 1. Half walking wheel

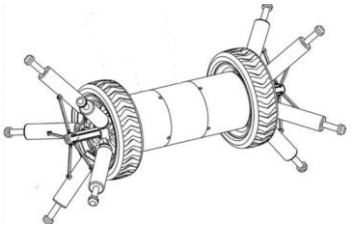

Figure 2. Deformation wheel structure

II. PRINCIPLE DESIGN

A. Overall Scheme Design

The climbing device of the car mainly adopts the deformation wheel of double-layer hub, the inner hub USES simple machinery to make it stretch, stretch control is controlled by the rotation direction of the wheel, so as to achieve the deformation effect and meet the requirements of stair climbing; The Samsung planetary wheel is adopted as an auxiliary device to reduce the volume and weight of the planetary wheel on the premise of maintaining the auxiliary climbing function. The car body is equipped with lifting plate, screw nut, guide rail, mechanical claw, etc. The screw

nut is driven by the motor, and the opening and closing of the mechanical claw is driven by the hydraulic device.

1) The deformation wheel realizes the climbing function and ground driving function of the car;

2) The screw and guide rail can realize the movement and lifting of the mechanical claw;

3) The opening and closing of the mechanical claw driven by the hydraulic device can fulfill the functional requirements of independent unloading of the car.

The car is generally composed of claws, claws slider, claws guide rail, motor, lifting plate, lifting plate push rod, hydraulic buckle, body, planet wheel, deformation wheel, drive motor and battery, which can meet the grasping and loading and unloading functions of the car, while the deformation wheel provides the car with ground running function and climbing function. See figure 3.

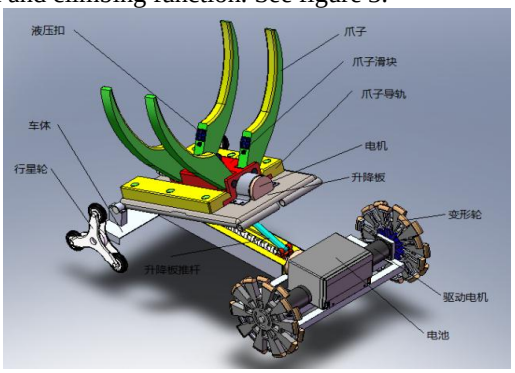

Figure 3. Overall model diagram of the car

B. Grab Mechanism

The bucket is made of PET material with high transparency. In order to ensure that the claw can fit the bucket body, the inner wall of the claw is designed as an arc shape, and the inner wall is coated with rubber, so as to ensure that the scratch on the barrel wall can be avoided when grasping the bucket.

In order to realize the function of automatic grasping, the car adopts the lifting structure. After the loading plate is raised, the claw can move up and down under the control of the motor. The four claws can grasp the bucket smoothly to ensure the smooth grasping process. Figure 4.

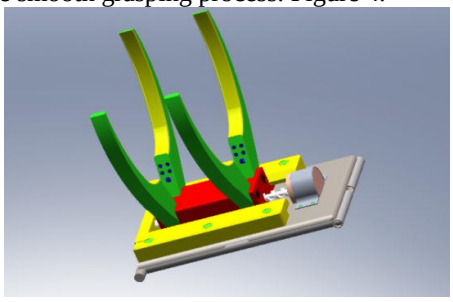

Figure 4. Lifting plate model

C. Design of Deformation Wheel

Compared with the traditional climbing device, this design optimizes the traditional climbing device in order to meet the smooth driving of the flat land and the stairs, and designs a deformation wheel controlled by a simple mechanical structure to meet the requirements of climbing stairs and driving on the ground. See figure 5.

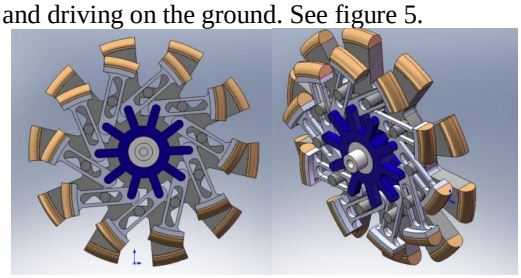

Figure 5. Deformation wheel

Retraction wheel leg, the wheel into a wheel leg structure, to achieve the climbing action; Stretch the wheel leg, transform the wheel into a complete wheel surface, to achieve the function of ground driving. See figures 6.

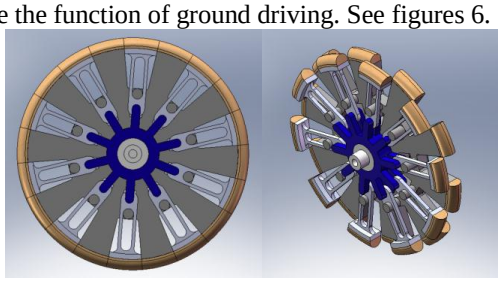

Figure 6. Extension of deformation wheel

III. SIMULATION ANALYSIS

D. Simulation of Wheel Leg Deformation and Bending Moment

The deformed wheel leg is where the stress is concentrated in the climbing process of the car. During the climbing process of the wheel leg, the overall load of the car is applied on the wheel leg. In order to explore the size of the shape variable of the wheel leg during climbing, Solid Works is used for simulation analysis.

The dimension of wheel leg is simplified as cantilever beam structure. The dimension is subject to the dimension of the root of wheel leg. The length is 70mm, the height is 17mm and the width is 28mm.The car is lightweight, so the hub is aluminum.

The above data were used to establish the model and obtain the deformation of the deformation wheel leg when climbing. See figure 7.The configuration variable of wheel leg is large, so the size of wheel leg is further optimized.

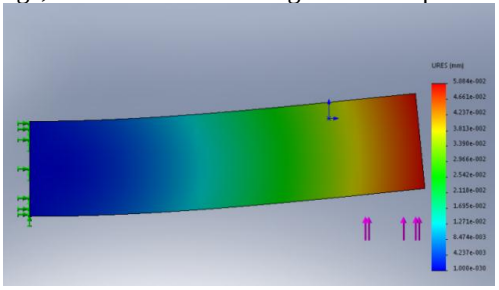

Figure 7. Wheel leg shape variables

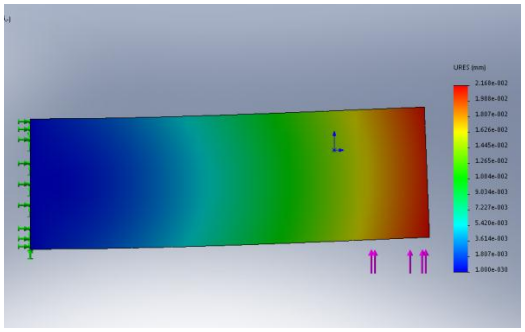

Figure 8. Shape variables after optimization of size

Optimized wheel leg size is 70 mm long, high 23 mm, width of 28 mm, this data modeling analysis, as shown in figure 8 can see, wheel leg form variables significantly reduced, so the size of the optimized data as the final size, and the wheel leg of their reduced, can meet the demand of practical work, so the structure size is available.

E. Stress concentration simulation of integral wheel leg

Solid Works was used to simulate the whole wheel leg, and it was shown in figure 9 that the stress concentration was obvious. Therefore, on the basis of all conditions remaining unchanged, the wheel leg was re-simulated after the root of the wheel leg was optimized by adding the transition corner again, and the stress concentration was obviously weakened, as shown in figure 10.

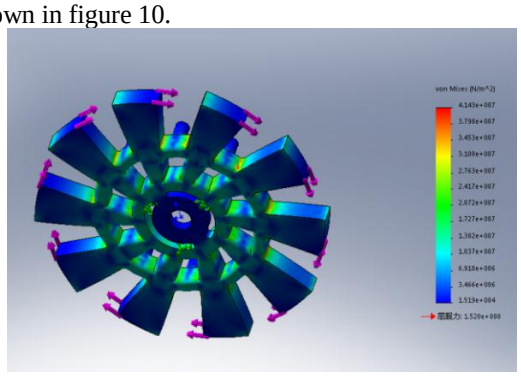

Figure 9. Stress distribution diagram

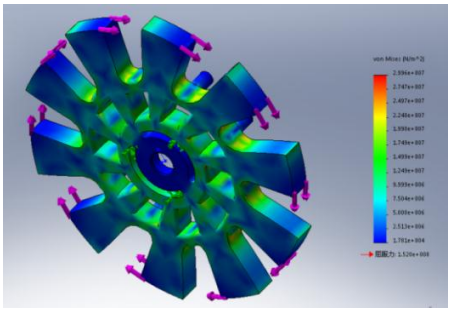

Figure 10. After adding the transition rounded corner

IV. CONCLUSION

Compared with the traditional climbing device, this paper makes a new structural design, which is a kind of deformation wheel climbing mechanism. This kind of deformation wheel can realize the two main functions of flat driving and stair climbing, and reduce the manual labor of workers during handling. The deformation mode is controlled by simple mechanical structure, and the two states can be easily switched.

The follow-up function design of the car still needs to be improved, such as increasing the loading capacity of the car and accelerating the turning speed of the car, both of which are the breakthrough points of the design research. In the future, the car will be further optimized for the above two points.

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