Machine Optimization about Holding Portion of Automatic Teller Stereo Rotation Underground Bike Library

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Abstract. At the moment, the holding portions of automatic teller stereo rotation underground bike library are all driven by the motor moving forward or backward, the clamp-type hand is tightened or open by another motor under the guidance of some inductive sensors. Although this method is more accurate, but the requirement to the control system is relatively high, and there are some matters because of the motors and sensors, such as installation complexity, power consumption, incensement of the cost and difficulty of maintenance. Based on these, we have designed the clamp-hand controlled purely by machine. It stores and provides energy by releasing and compressing the spring. It uses the link mechanism to make the clamp-hand tighten up and open. This kind of clip-hand structure of purely mechanical control, it's simple, stable and reliable. It's economical and easy to maintain.

Keywords: bicycle storage; clamp-type hand; mechanical control.

1. Introduction

Currently, pollution caused by automobile exhausts growing. Therefore, every country calls on its people to take environment friendly ways of transportation, such as cycling. Underground bike library has thus emerged, but the present holding portions of underground bicycle library are all controlled by motor to grip and release, using sensors to control the hand gripping action when it happens. This way needs extra motor and various sensors, caused the installation complexity, increased power consumption, and increased the cost and difficulty of maintenance.

2. Structural Design and Calculation

2.1 Structural Design of the clamp-type hand

Hand of an industrial robot, also known as the end effector, it's a component of operations which enables the robot for grasping and gripping (adsorption) special tools (such as spray guns, wrenches, welding tools, nozzles, etc.) directly. It has features of imitating the movements of people hands and it is attached to the front end of robot arm .Since the shape, size, weight, material and surface state of the work pieces are so different, and therefore the end effector of industrial robot is varied. It can be divided into the following categories:

(1) clamp-type hand of reclaiming;

(2) adsorb-type hand of reclaiming;

(3) Private operator and converter;

(4) Bionic multi-fingered robot hand.

According to the characteristics of the bike, we use the clamp-type hand. We take the method of "Top-down" in the design process. According to the mechanical motion of the joints and the operational requirements of the analysis, we get the concept of target holding hands, design and draw the assembly sketches. Then we design each component in details and complete specific assembly

design. Finally, we do motion analysis test. The process from the rough to the recurrent refinement and enrichment doesn't conflict and there is no interference. It can achieve the desired motion, so the design can be proofed reasonable (Fig.1).

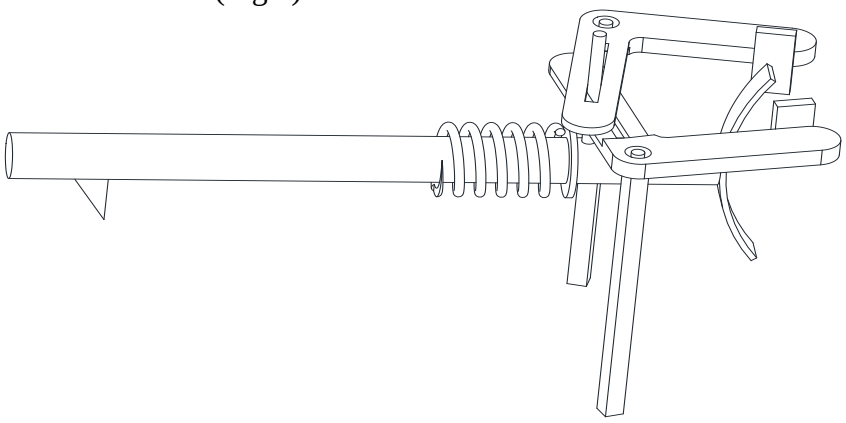

Fig.1 Schematic diagram of clamp-type hand

The clamp-type hand has a symmetrical structure, the selected drive mechanism causes simultaneous movement of two fingers. Because the hand has only one degree of freedom, we can ensure the determined motion. And the use of the link mechanism makes the structure compact, manufacture and installation simple, reduces costs, while ensures the reliability of institutions.

2.2 Calculate the clamping force of the hand

The force acting on the work piece by the actuator (suffers equal and opposite reaction of the actuator) called clamping force, represented by Nathen ratio of the original force with clamping force (P) called it reinforcement ratio. When the reinforcement ratio increases, to make an equal clamping force, the driving force would be smaller. That's to say we get a higher mechanical efficiency .Obviously the reinforcement ratio is an important indicator of the performance of the clamping mechanism.

Schematic diagram of the hand's force (Fig.2):

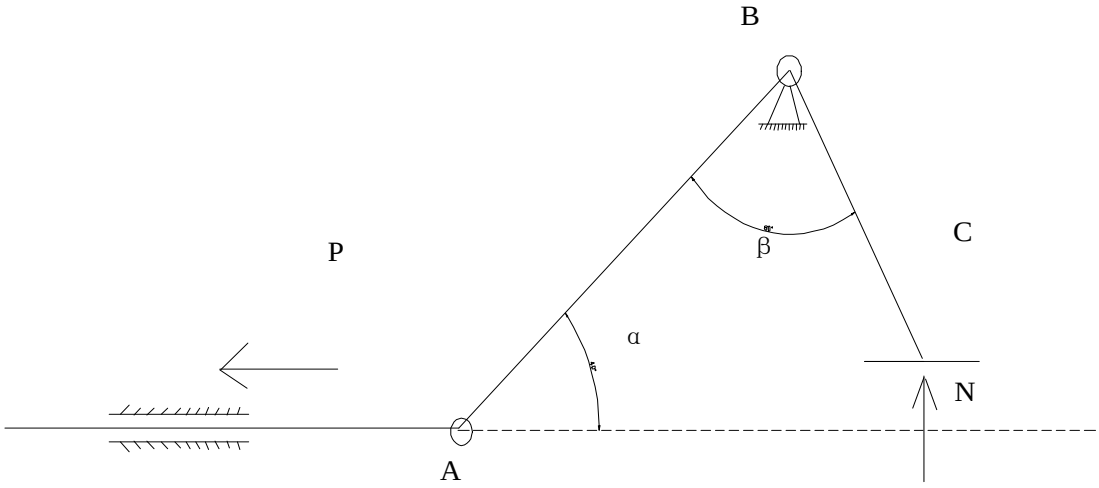

Fig.2 Analysis of the hand's force

Set AB rod length is L, BC rod length is K. According to the sum of the torque of the axis B is zero(that's ΣM = 0)and the geometric relationship ,we can get something as follows:

$$P\mathrm{L}\sin\alpha = N\mathrm{K}\sin(\beta+\alpha-\pi/2)$$

$$N/P = \frac{\mathrm{L}}{\mathrm{K}\sin\beta - \mathrm{K}\cos\beta\cos\alpha}$$

So, when the angle α is large ($\alpha < 90^0$), the hand is available to a large reinforcement ratio. Therefore, during the design and manufacture of hand gripping portion, we can make angle α bigger under the consideration of combination factors.

3. Operating Principle Analysis

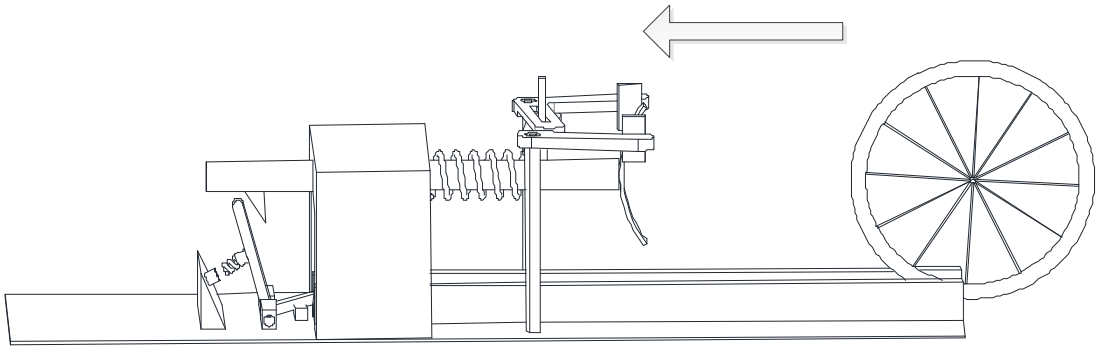

Fig.3 Push bike into delivery platform

As shown in Fig.3, the bike owners will push the bike along the wheel groove.

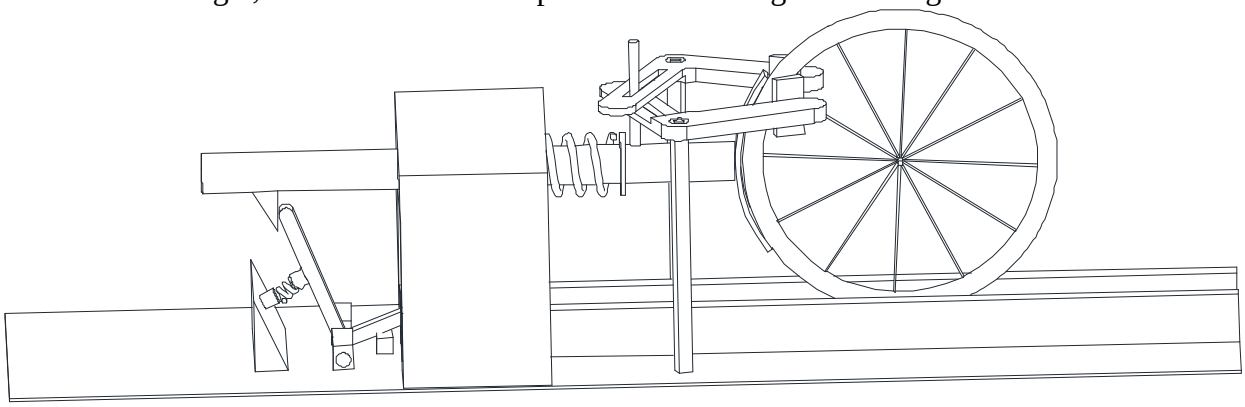

Fig.4 Bike is clamped by the hands

As shown in Fig.4, the front wheel touches the push rod and compresses the spring, the push Rod stops retreating back until the buckle withholds the L-rod. At this time, the push rod is locked and the front wheel is gripped by the hands. The whole bike fixes on the delivery platform stably. Then the platform will sent the bike to a free parking position under the control of the control system.

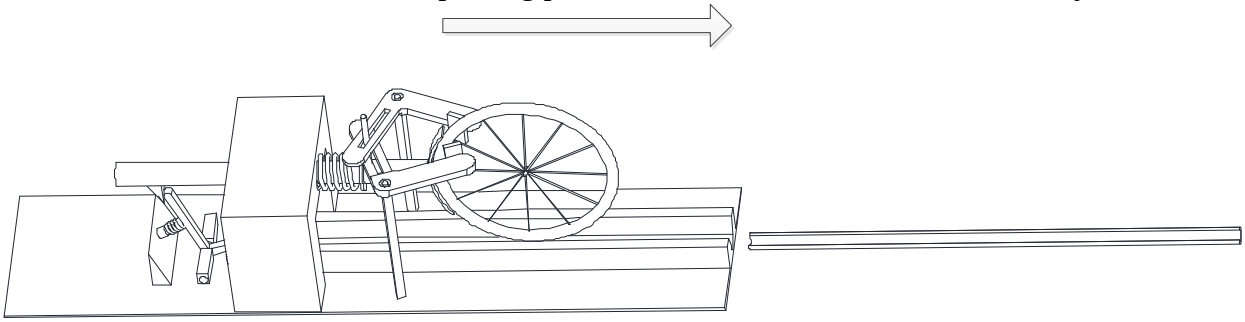

Fig.5 Delivery platform moves to the parking station

As shown in Fig.5, after finding and aligning to the vacant parking station, the delivery Platform will move to the parking station under the driver of the motor .The wheel groove of the Delivery platform is aligned to the parking stations, so parking station will be inserted into the wheel groove of the delivery platform.

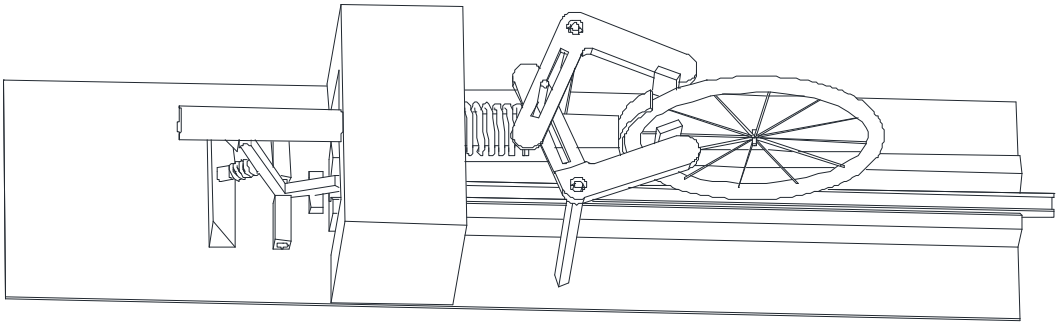

Fig.6 parking station inserts into the delivery platform

As shown in Fig.6, the bike moves into the groove of the parking station when parking station inserts into the delivery platform. As the front part of the parking station touches the L-rod (shown by arrow in Fig.7), the L-rod will counter-clockwise rotate under the effect of force .Soothe small spring under will be compressed and the buckle will disengage. And then the hand will be open. At last, the bike will be parked on the parking station.

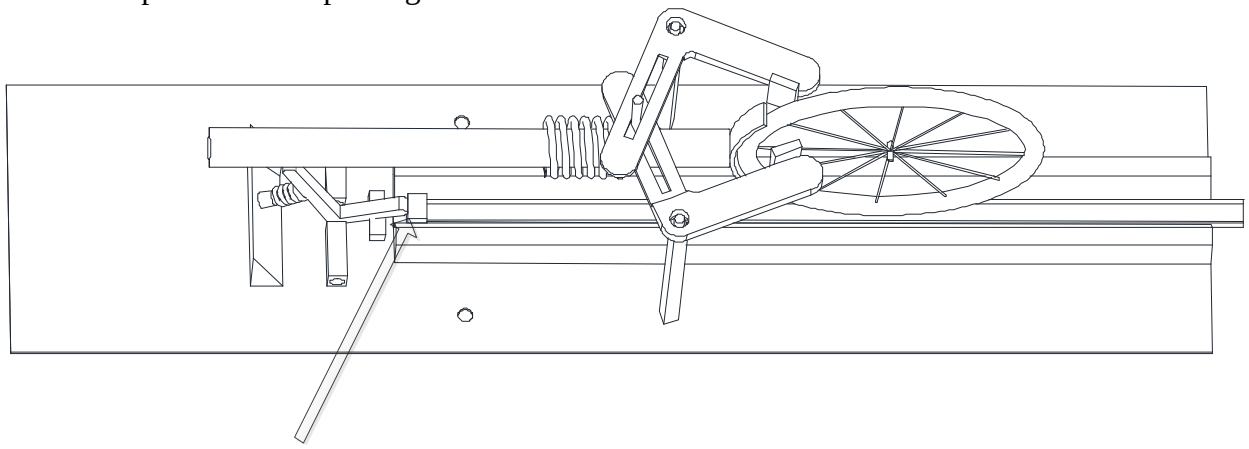

Fig.7 Schematic diagram of disengagement of the buckle

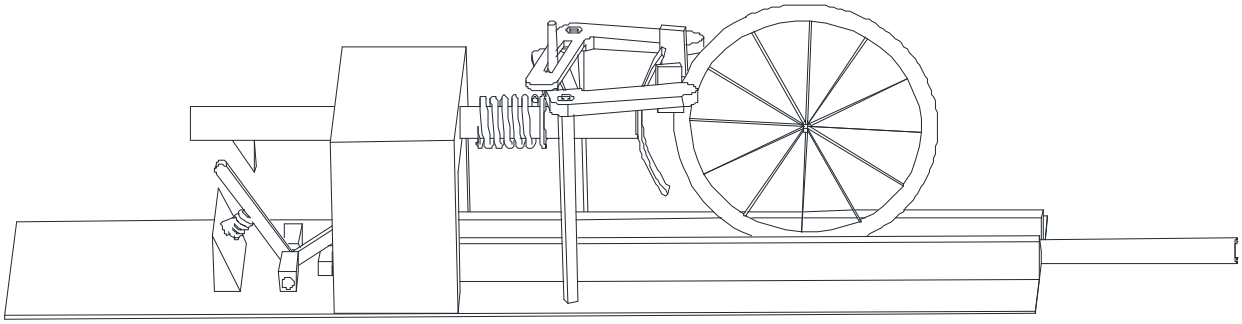

Fig.8 Hands open and delivery platform leaves parking station

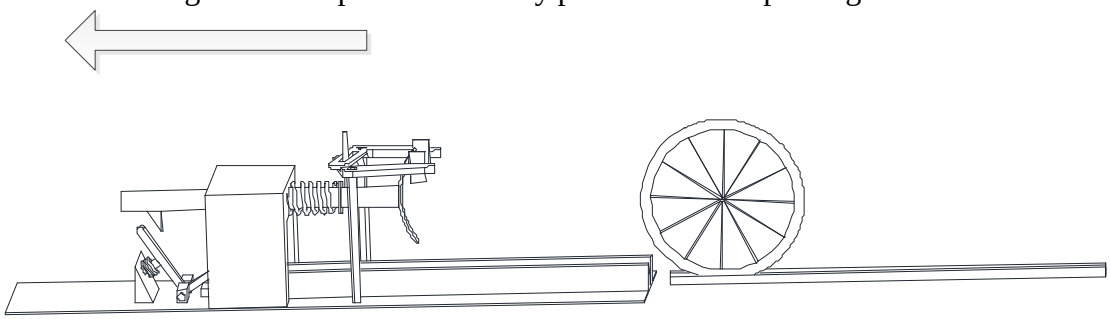

Fig.9 Bike parks on parking station

As shown in Fig. 8 and 9, the hands open and delivery platform move out of the parking station by motor and gets back to the top of the bike library. So far, the whole procession of saving bike has completed.

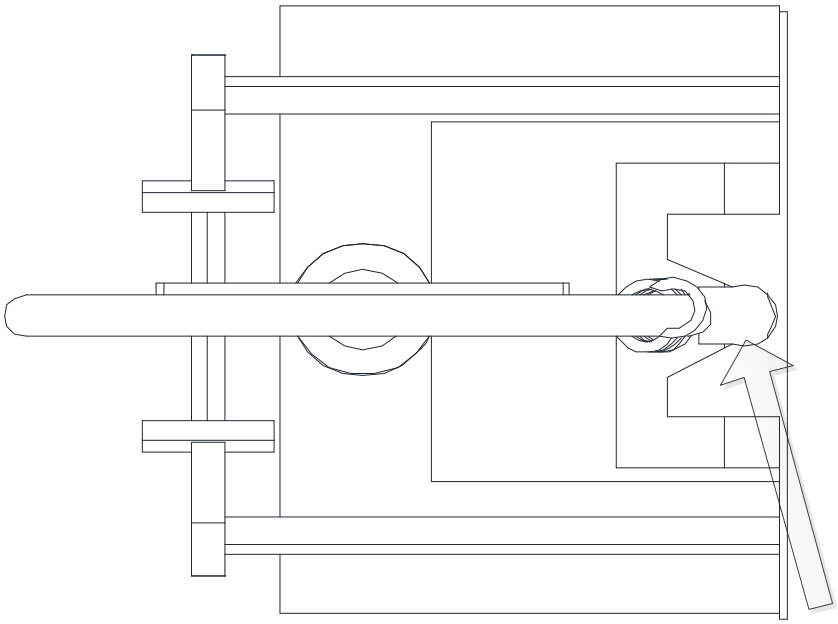

Fig.10 Schematic diagram of picking up bike

As shown in Fig.10, when you pick up your bike, the delivery platform will find the target under the control of the control system. Then the delivery platform aligns with parking station, the location of the parking station should be higher (shown by arrow in Figure 10), to prevent the parking station touching the L-rod. Otherwise, the hands would not grip the bike tightly. Then the delivery platform will move towards the parking station by motor. The motor would reverse rotate when the hands gripped to take the bike out from parking station to delivery platform. After that, the bike will be sent to the entrance of the bike library and waits for its owner to take it away.

4. Conclusion

In this paper, we analyzed the problems of the underground bike library clamp-type hands and made some improvements. The structure was optimized. Through stress analysis, we get a clear choice of specific parameters. We also introduced the working principle under the new structure. The clamp-type hands have been improved in practicality, economy, versatility and other aspects .I hope that in the near future, after the popularity of underground bicycle storage, this improvement can be widely used.

Acknowledgements

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