Household intelligent storage wardrobe based on the principle of Huarong Road

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Abstract. A new type of intelligent wardrobe is proposed based on the application of home daily life. Through mechanism combination innovation and electric control, the device realizes the design of imitating Huarong lane of wardrobe, and realizes the intelligent access of users. Each storage rack moves to a place suitable for users to access clothes through the coordination of the moving pulley and the rack and pinion structure, and makes reasonable use of the space at a high place. The addition of intelligent electronic control module makes it more convenient for users to get the clothes they need. The device has superior performance, simple operation process, low cost in space and economy, wide target audience and good market prospect.

Keywords: Smart home, smart wardrobe, Huarong Road design, movable pulley, gear rack.

1. Introduction

The wardrobe is widely used in people's daily life, which takes on the role of clothing storage and creates a relaxed life for people. But with the rapid development of people's economic level, the quality of material life is further improved, and the number of people's clothes is increasing, which also causes a lot of problems for people in the use of wardrobe.

First of all, with the increase of the number of clothes, the closet space is relatively reduced, so it needs to expand or use the closet space more efficiently. There are two types of wardrobe by height at present:

(1) There is a certain distance between the top of the wardrobe and the ceiling, which leads to low space utilization;

(2) The top of the wardrobe is connected with the ceiling, which makes it very inconvenient for the upper space of the wardrobe to access the items. It takes a lot of time and effort to get and use the items, and it is inconvenient to operate, so there is a certain security risk. Second, when the number of clothes in the home is increasing, people often find it difficult to find a certain clothing in a short time, which takes a lot of time.

Based on the above background, a kind of home intelligent wardrobe is designed, which can help users locate their clothes more quickly, make more efficient use of high space and improve the space utilization rate. The device is composed of a horizontal moving part, a vertical moving part and a control part.
2. Project design
In order to achieve the predetermined scheme, on the basis of easy realization of the device mechanism, the device adopts the clothes storage lattice to move according to the fixed running track to achieve the purpose of simplifying the driving mechanism. The driving mechanism of the device is mainly composed of rack and pinion horizontal driving and motor vertical driving. The overall model of the device is shown in Figure 1. The operation scheme of the device is described in detail below.

![Figure 1](image1.jpg)

**Figure 1** overall model of the device

2.1. Preliminary plan of device function
The primary functions of the device are as follows
(1) The application of huarongdao like principle can realize the function that the upper and lower level lockers can move to the fixed space for picking through combination arrangement in the process of use, improve the utilization rate of the upper level space, and facilitate the access of the upper and lower level items.
(2) With the characteristics of simple structure and stable performance, it is in line with the concept of modern smart home life. It can bring great convenience to the activities of family members, optimize people's life style, and enhance the safety and comfort of home life.
(3) The space occupied by the mobile device is small, which is convenient for the access of clothes and does not affect the space utilization of the wardrobe.
(4) In terms of size, it conforms to the size of modern furniture.
In order to realize the simplification and effective operation of the driving mechanism of the device, the device determines the operation track of the clothes storage lattice, and its movement track is shown in Figure 2 below:

![Figure 2](image2.jpg)

**Figure 2** Schematic diagrams of the movement mode of the clothes storage case
3. Horizontal drive module

3.1. Structural design
The horizontal drive module mainly relies on the rack and pinion to drive the clothes storage grid to move horizontally, and its device structure is shown in Figure 3 below:

![Figure 3: Model of horizontal drive module](image)

1: Rack fixing block 2: Motor bracket 3: Motor 4: Clothes storage rack 5: Rack 6: Rear rail bracket

In the horizontal driving module, the clothes storage grid is fixed by the front and rear guide rails, the front rail mainly determines its movement track, and the rear rail is fixed with the motor, which provides the driving force of the clothes storage grid movement. The motor is fixed by the motor bracket which is fixed on the rear rail. The motor is connected with the gear through the coupling and external shaft, and the gear drives the rack to move. The movement direction of the rack is constrained by the rack fixing block, which is also fixed by the rear rail. The external push plate on the rack moves with the rack to drive the clothes storage grid.

3.2. Dimension design
The horizontal drive module is placed on the rear support rail of the clothes storage grid. The rear support rail is made of 30 × 30 angle aluminum. Therefore, the width of the horizontal drive part is not more than 30mm. Since the size of the model machine and the designed object is scaled to a certain scale, the dimensions used after this manual are all the dimensions of the scaled object. In the physical dimension, because the horizontal distance of the storage rack is 174mm, the length of the rack should be greater than 174mm to reach the next designated position. After investigation and comparison, we selected 0.5-mode rack and pinion, the length of the rack is 200mm, the outer diameter of the gear is 15mm, the diameter of the graduation circle is 14mm, and the distance between the center and the outer edge of the rack is 11.5mm. The specific model drawing and dimension drawing are shown in Figure 4 below:

![Figure 4: Schematic diagram of horizontal drive mechanism](image)
4. Design of vertical drive module

4.1. Structure design of vertical drive module
The function of the vertical driving module is to drive the clothes storage grid to move in the vertical direction, so as to realize the transformation of the clothes storage grid position. The model diagram of the module is shown in Figure 5 below:

![Figure 5 model of vertical lifting module](image)

1: Front rail 2: Clothes storage rack 3: Rear rail bracket 4: Clothes storage rack 5: Motor bracket 6: Side plate 7: Bearing bracket 8: Connection 9: Lifting plate 10: Planetary reducer DC motor 11: Gear set

In the vertical lifting module, the driving wheel is driven by the motor, and the driven wheel is followed by the driven wheel. The optical shaft on the driven wheel is wired. The wiring goes up through the hole of the rear rail, bypasses the U-shaped bearing on the bearing bracket, returns through the carriage of the clothes storage grid, and finally is fixed on the fastening screw of the front rail. Thus, a fixed pulley mechanism is formed, the motor drives the optical shaft to rotate, tightens the wiring, and raises the clothes storage lattice. On the contrary, the connection line is loosened and the clothes storage lattice is lowered, thus completing the lifting function of the clothes storage lattice.

4.2. Dimension design
In this device, the vertical movement of the clothes storage grid is mainly divided into two forms: lifting and falling. In the vertical movement of the falling, it mainly relies on the gravity of the clothes storage grid to complete the falling movement, while the lifting movement of the clothes storage grid is mainly powered by the deceleration DC brushless motor.
In order to reduce the space occupied by the motor and adapt to the overall size of the wardrobe, it is proposed to select a 57mm diameter, 42mm length cylindrical DC motor.

5. Epilogue

1) The device adopts the imitative Huarong Road design, which can greatly reduce the disadvantages of the reserved space for the existing lifting wardrobe, improve the space utilization rate, solve the problems existing in the existing wardrobe, and have a broad market space;

2) The device optimizes the function configuration on the premise of meeting the basic needs of ordinary users. Compared with the current wardrobe, the device has lower cost, including space cost and economic cost, and has a wider target audience;

3) The upper mobile area can store season changing clothes or be used as an ordinary storage cabinet, the lower hanging area can hang regular clothes or large clothes, and the storage area can place common goods, the combination of the three can expand the use scope of the device;

4) In the intelligent control part, the device uses the camera to collect clothing features, build a database, and realize clothing positioning. It adopts the combination of Internet of things hardware analysis system and user preference analysis system to realize intelligent access scheme recommendation. Users can use mobile app for remote control, convenient operation and optimization of user experience.

References

[1] Zhong Kaiyang, Cai Yunwu, Huang Yi, Wu Jujin, Zhou Yuexia. Embedded intelligent wardrobe based on deep learning [J]. Science and technology innovation, 2019 (35): 51-53

[2] Wen Jianping, Zeng Zhuangbao, Yuan Wenzhao. Progressive die design of pulley frame [J]. Forging technology, 2019,44 (09): 118-121

[3] Qiao Shimin, Liao Xiang, Chen Weijia, Shan Zun, Chen Xinyi, Wang Peiyuan. Intelligent wardrobe system based on WiFi [J]. Electronic production, 2019 (17): 38-40

[4] Xu Baishuang, Zhang Jing, LV Xiang, Yang Weiqi. Cause analysis and control method of abnormal noise of rack and pinion steering gear [J]. Times automotive, 2019 (12): 70-72 + 75

[5] Wang Keqiang, Feng Ding, Shi Lei, he Liang, Kang Bowen, Xu Jun. the influence of rack side deformation on rack drive [J]. Petroleum machinery, 2019,47 (06): 55-60

[6] Jiang Bojun. Design of progressive die for guide pulley bracket [J]. Die manufacturing, 2019,19 (03): 12-15