A Design of Intelligent Wardrobe Imitating Labyrinth

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Abstract. This paper presents a new type of intelligent wardrobe based on the application of family daily life. Through the innovation of mechanism combination and electronic control, the device realizes the imitation labyrinth design of the wardrobe, and realizes the user's intelligent access to clothes. The upper cabinet lattice is lowered to a position suitable for users to access clothes through a series of movable pulley structure in coordination with the horizontal movement of the lower cabinet lattice, so as to make rational use of the high space. The addition of intelligent electronic control module makes it easier for users to get the clothes they want. The device has excellent performance, simple operation process, low cost in space and economy, wide target audience and good market prospect.

1. Introduction

In order to achieve the predetermined scheme, on the basis of easy realization of the device mechanism, the device adopts the clothes storage grid to move according to the fixed running track to simplify the driving mechanism. The driving mechanism of the device is mainly driven by sliding block horizontally and vertically by steel rope. The operation scheme of the device is described in detail below.

2. Device function scheme

(1) The application of labyrinth principle can realize the horizontal movement of the lower storage grid in the process of use, ensure the independent lifting movement of the upper storage grid, make the upper wardrobe drop to the appropriate position, improve the utilization rate of upper space, and facilitate the access of upper and lower objects.

(2) It has the characteristics of simple structure and stable performance, in line with the concept of modern smart home life, which can bring great convenience to the activities of family members, optimize people’s lifestyle, and enhance the safety and comfort of home life.

(3) The mobile device takes up less space, which is convenient to access clothes without affecting the space utilization rate of the wardrobe.

(4) In 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 running track of the clothing storage grid is determined, and its motion track is shown in Figure 1 below.
2.1. Horizontal drive module
The horizontal drive module mainly relies on the motor and slider to drive the storage compartment to move horizontally. The device structure diagram is shown in Figure 2 below

In the horizontal driving module, three fixed sliders are arranged under the clothes storage compartment, which are connected with the guide rail below to limit the degree of freedom of horizontal movement. Slide guide rail is set in the middle, synchronous belt is placed at guide rail, middle wheel of synchronous belt regulator is placed at both ends, and stepper motor is on the left. The lower storage grid is connected with the sliding block by electromagnet adsorption, and the synchronous belt is driven by a stepping motor to drive the sliding block on the track to move.
2.2. Dimension design
Since the size of the model machine and the design object is scaled according to a certain proportion, the dimensions used after this manual are the dimensions of the scaled object. In the physical size, the transverse width, height and depth of the clothing compartment are 160mm, 178mm and 260mm respectively.

Figure 3. Schematic diagram of horizontal driving mechanism.

2.3. Design of vertical drive module

2.3.1. Structure design of vertical drive module. The function of the vertical drive module is to drive the clothing compartment to move in the vertical direction, so as to realize the position conversion of the clothing compartment. The model diagram of the module is shown in the following figure:

Figure 4. Model diagram of vertical lifting module.

In the vertical lifting module, the steel wire rope is driven by a stepper motor. Pulleys are set on both sides of the upper clothing storage grid, and a synchronous belt bearing is set between the adjacent pulleys of the two storage compartments, which is fixed on the aluminum profile bracket. The pulley block is composed of multiple pulleys as shown in the figure. A space is set in the lower storage grid. When the hoist motor drives the steel wire rope, only one storage grid can be completed. The lifting operation, combined with the horizontal movement of the lower layer, completes the lifting function of the specific upper layer.
2.3.2. **Dimension design.** In this device, the vertical movement of the storage grid is mainly divided into two forms: lifting and falling. In the vertical movement of falling, the descending movement is completed mainly by the gravity of the storage grid, and the lifting movement of the storage grid is mainly powered by the stepping motor. The stepper motor lifts the clothing compartment to the designated position through the fixed pulley block. In order to reduce the space occupied by the motor and adapt to the overall size of the wardrobe, the stepping motor with a width of 57mm and a length of 76mm is selected.

3. **Strength check of key parts**

After moving the guide rail, it is necessary to support all the storage compartments of the row, so the stress analysis should be carried out to ensure the safety and reliability. The summary of the analysis results and displacement nephogram are shown in Fig. 6 and Fig. 7. Through calculation, it is known that the deformation of the rear rail meets the working requirements within the deformation range, and the stiffness is qualified.

![Figure 5. Diagram of vertical driving mechanism.](image)

![Figure 6. Summary of results and displacement nephogram of moving guide rail.](image)
Figure 7. Summary of results and displacement nephogram of moving guide rail.

The lifting board main board is used to bear the lattice to be lifted. The upper layer of the storage grid is lifted by the roof. In the stress analysis, the four ends of the top plate are constrained, and the force is applied to the middle of the main board, as shown in Figure 8.

Figure 8. Displacement nephogram of main board of lifting plate.

The lifting winch shaft is used to bear the heavy load at the driving end of the lifting motor, which affects the stability of the lifting and descending of the storage compartment. Therefore, the stress analysis should be carried out to ensure the safety and reliability. The results are summarized in Figure 9. Through calculation, it is known that the deformation of the rear rail meets the working requirements within the deformation range, and the stiffness is qualified.
4. Conclusions

(1) Based on the principle of Huarong Road, a Chinese labyrinth, the clothes storage grid can be moved to the most suitable location of human body on the premise of reducing the occupation of extra space;

(2) The movement track of the clothing compartment is analyzed to simplify the complexity of the moving area;

(3) The series pulley block is combined with the labyrinth structure to realize the independent movement of multiple cabinets under single power input, and the mechanism is simple and stable;

(4) The stepper motor and pulley block mechanism realize the horizontal or vertical movement of the clothes storage grid, which simplifies the moving process and reduces the load of the clothes storage grid itself;

(5) The remote control of mobile phone can work in the state of no one, and reduce the influence of waiting time and noise on user experience.

Aiming at the problem that it is difficult for existing users to find clothes and unreasonable use of the top space of the wardrobe, the device can be widely used in home and living places. For families with more clothes, difficulties in finding clothes or insufficient storage space, the device has great advantages. Users only need to select the corresponding cabinet on the mobile app, which is convenient and quick to operate.

This storage mode can also be widely used in bookcases, lockers, shoe cabinets and other places where goods need to be stored at high places. It has a good application prospect.

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