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Abstract. The invention designs a smart storage shoe cabinet for the existing home storage shoes, which can bring convenience to the family to access the shoes. Mainly divided into storage module and shoe rack module, the two are independent of each other, according to the size of the household and the needs of the household shoe cabinet, the storage module and drive module for combined deformation and unitization treatment.

1. Introduction

In view of the current prevalence of the door entrance and entrance shoes at random drop problem, designed a smart access integrated shoe cabinet, mainly used for home storage, automatic finishing and family life casually dropped shoes, can bring convenience to life. The device is mainly divided into storage module and shoe rack module two separate modules, can achieve automatic access shoes through intelligent control, and according to the size of the household and the needs of the household shoe cabinet, the storage module and drive module for adaptive adjustment and modular work design, to achieve the effect of making full use of effective space, especially conducive to the use of existing high-rise housing space.

2. Function analysis

In order to solve the current majority of families in the door shoes placed casually, in the absence of manual finishing, resulting in insufficient space for shoes storage. This project designed an intelligent access integrated shoe cabinet, through the device's enclosure and intelligent control module to achieve automatic access to shoes, through the device's modular design so that the device can meet the custom needs of different decoration design of the home. The research of this device is to realize the effect of automatic finishing and collecting shoes, and to make full use of the effective space (especially the high-rise space of the house).

Figure 1. Smart shoe cabinet.

3. Design

The device consists of three parts: skeleton structure, motion module and control module. The tilt design of the shoe plate in the skeleton structure of the device saves the storage space of the shoes to a certain extent, and the design of the combed shoe plate ensures the degree of cooperation in the transportation process. The seat section has a connected design with the door, which is opened and turned out for the convenience of the user. In addition, the shoe frame structure of the device adopts a modular design, that is, the user can be more practical household type and decoration state, after considering its access efficiency needs, freely put together the shoe rack module and match the appropriate power drive motor, in order to achieve maximum use of space and height design performance. The lifting and panning of shoes is carried out by the drive module. The amount of the control system is added to realize the precise positioning of the device transportation.

3.1. Skeleton structure

3.1.1. Combined shoe cabinet frame. The combined shoe cabinet frame is designed with a unit structure to ensure maximum adaptability of the unit. With a single shoe board as the basic unit, the storage scheme can be designed according to the shoe storage needs of the home user. According to the use of the actual spatial structure of the home for horizontal and vertical adjustment, can be more user needs to choose external or wall embedded, with a strong designability. The entire combined shoe rack module is highly interchangeable and can be replaced and put together at any time during design.

Figure 2. Device deformation diagram.

In order to ensure that the modules can work effectively and at high quality, and can be adapted to a variety of occasions, adjustable mode design has been adopted in many mechanisms. Because the device

needs to pan, lift movement, comprehensive consideration of lift travel, carrying capacity, post-maintenance and other issues, decided to use "range movement", to each grid occupied space parameters (the plane is shown as long, wide) as the base, with its integer multiple as the moving unit distance, so as to improve the stability and efficiency of the device. In addition, in order to maximize the space utilization of the device, the comb support part of the device is designed with a fixed tilt angle. This device hides all the motors inside the machine, which facilitates the protection of the motor, and makes it more beautiful, in line with the contemporary furniture design, production concept. As shown in Fig. 2.

3.1.2. Shoe board. The overall structure of the shoe board is comb-shaped support plate, and the comb on both sides is slightly higher than the middle comb, in order to improve the anti-bending performance of the outer comb, but also to further protect the safety of the shoes put, to prevent the shoe accidentally sliding caused by falling off. When the mechanism completes the vertical and horizontal movement to reach the designated shoe position, the shoe plate moves in the vertical direction, completes the precise drop position through the algorithm, intersperses and falls through the comb meshing (there is a gap between the mesh combs to increase its fault tolerance), the shoe stays on the shoe board, at which point the shoe board moves horizontally, returns to the initial position, and the device completes a storage process.

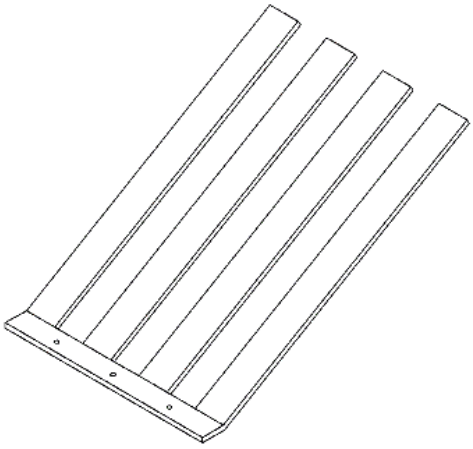

Figure 3. A structural diagram of the combed shoe plate.

3.2. Motion module

The motion module is the power source configuration of the device and the corresponding orbital structure design. The motion of the device can be simply realized by the two basic motion mechanisms of the "shoe plate" in the device: the horizontal moving mechanism drives the shoe plate translation into the lift column, and the lifting mechanism drives the shoe board into the correct horizontal position to complete the lifting action. The two movements are carried out by separate motion mechanisms and the entire access process of the shoe is coordinated by the control module.

One of the motion module units of the unit is shown. When using, put the shoe on the shoe board 1, the shoe plate design has a fixed angle, the angle and the friction coefficient of the surface of the shoe board so that the shoe can complete the "self-locking" on this slope, that is, along the slope direction of the downward force of 0. The illustration unit module consists of two stepper motors of the same power working simultaneously to complete the vertical, panning action. The motor, as the original power source of the unit, connects another motor by means of a wheel and a wedge belt 3, and the shoe plate 1 is fixed with the belt.

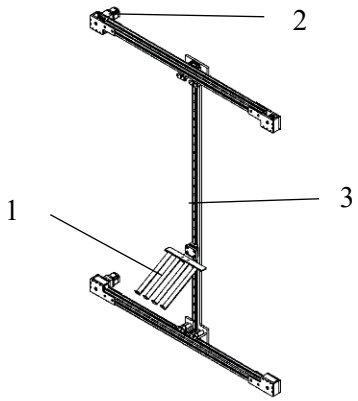

Figure 4. Dual motor drive mechanism

3.2.1. The principle of transverse motion and related structures. When the device is moving horizontally, the shoe plate and the vertical track move as a whole, the upper and lower symmetrical position of the "work" unit structure in Figure 4 is fitted with two stepper motors with the same performance parameters2, and the wedge belt connects the two motors through the vertical track, and the horizontal and vertical tracks have a card slot that maintains the belt fit and flatness, preventing the belt from deforming from the track during pressure or pull. The two motors move in the opposite direction when moving horizontally, i.e. the two motors "retract" or "push out" the wedge belt, the total length of the wedge belt present in the structure of the work type changes, this length piece hour, the belt to the left (with figure 4 as the front judge) "pull back" the vertical track. When this length increases, the pressure accumulated inside the belt pushes the vertical track to the right under the effect of the stability conduction performance of the wedge belt itself and the fixed effect of the card slot.

3.2.2. The principle of vertical motion and related structures. The vertical motion of the device occurs after the horizontal movement to the correct lateral position, when the lateral movement is completed, the simple hold clip at both ends of the vertical track is activated to avoid the effect of small horizontal force on the horizontal position of the shoe board during the movement of the device up and down. The transverse position of the fixture. At this point, the two-step motor movement in the same direction, that is, the two motors will achieve the belt "send" and "receive" work. When the upper motor controls the "retract" of the belt, the belt as a whole "flows" from the lower motor to the upper motor, at which point the shoeboard fixed to the belt in the vertical track moves. When the upper motor "sends" out of the track, the same shoe plate will move down. After the vertical movement is complete, the hold clip opens and the shoe plate is reset.

3.3. Control system design

The device is divided into mechanical system and control system, which covers the basic skeleton structure and the principle of motion of shoe cabinet. The control system can control the precise cross-vertical motion positioning of the shoe board, thus ensuring the meshing of the comb structure, while the control system will control the motor movement and holding structure when moving horizontally vertically, and so on, which basically lays the foundation for the normal operation of the device.
Specific implementations include:

(1) When accessing shoes, the user places the shoes on the shoe board, the pressure sensor transmits the pressure information to the tablet processing, the device will find the coordinates of the spare storage space on its own after the start of the storage process and plan the movement route, automatically place the shoes on the shoe cabinet or remove them;

(2) When taking shoes, the user in the mobile phone to choose the shoes you want to wear, the shoe cabinet automatically check the shoe coordinates, the shoes out, complete the shoe-picking operation. In addition, the device is positioned by matching the pressure value of the picture to the shoe.

3.3.1. Shoe sensing module. The device is equipped with a pressure sensor on the shoe board, if the pressure sensor detects that the pressure is not at the permitted value, that is, the shoe rack does not put shoes, will not perform the corresponding action. When the pressure is too small the device will stop the action, after a predetermined time will lock the mobile device and motor (to prevent accidentally press the start button after external factors affect the initial coordinates of the shoe board, the subsequent positioning movement caused error), the pressure exceeds the alert value when the device buzzer alarm, and lock the shoe board, in order to minimize damage to the track and other precision structures. When the pressure signal reaches the permitted pressure value, the microseat processes the signal and feedbacks it back to the motors to start accessing the work.

3.4. Highly designable features

Shoe cabinet can be based on the user's design requirements to flexibly design storage structure, taking into account the actual size of space, structural characteristics and user needs, can be device horizontal, vertical parameters selection adjustment. The unit can be placed more externally or mosaicly for the user's needs. And the structural characteristics of the whole unit module make the device more interchangeable, can be replaced and put together at any time at design time. This modular (unitized) combination method can be flexibly designed according to different family type and decoration style, the modular shoe board is deformed by building blocks, and then matching the corresponding height and width of the drive module, and according to the actual needs of shoe efficiency design shoe board and shoe board ratio.

3.4.1. The design of the frame. While designing the shoe rack, the relevant dimensions are specified, and the basic size of the device is specified.

Table 1. Basic dimensions.

Content.	Long /mm	Wide/mm	High/mm
The overall size of the shoe rack	1540	450	2000
Shoe board	230	284	155
Unit shoe rack	230	284	1650

At the same time, the mobile range of the device is limited, and the movement speed of the device is properly specified to meet the smoothness of the device's motion.

Table 2. motion parameters

Content	Adjustable range
The speed at which the rails move	0.5m/s
Tilt angle	0-30°
Shoe rack transfer range	1600mm
Can withstand weight	5kg
The maximum weight of the user	150kg

4. Conclusion

Shoe cabinet in the smart home occupies a position that can not be ignored, but the realization of the shoe cabinet is obviously not up to expectations. This design completes the automatic shoe storage, finishing, self-made shoes work, greatly convenient for users. So that users can easily take off their shoes after returning home, and by the shoe cabinet organized to the corresponding position, easy to

save effort, and achieved a beautiful effect. When you need to wear shoes when you go out, you can choose the shoes you want to wear at a glance, so as to avoid the difficulty of choosing because of the shoe mess. Compared with the existing intelligent shoe cabinet has a strong applicability, low cost, simple operation, high degree of integration advantages, at the same time has the function of auxiliary shoe stripping and finishing, can be widely used in a variety of work, living environment, improve the quality of life and work efficiency of the family, to achieve smart furniture. Therefore, it can be judged that the design has broad application prospects.

Acknowledgments
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