Home intelligent integrated wardrobe

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Abstract. With the development of Internet of Things technology, smart homes are increasingly entering the lives of the people. More and more families have put forward ironing, drying, disinfection and intelligent requirements for household wardrobes. However, most household wardrobes currently only have storage functions, which cannot meet people’s needs. Based on the above background, the project team designed a home smart integrated wardrobe. The household intelligent integrated wardrobe can be applied to most families. It has the characteristics of low price, rich functions, and convenient use. The home intelligent integrated wardrobe is conducive to improving people’s living standards and has good application prospects.

1. Research background and significance

1.1. Research background

With the advancement and development of science and technology, more and more smart products have begun to provide ordinary people with convenient services in life. As of 2018, the market size of my country's smart home industry is about 400 billion yuan. The sales volume in the first quarter of 2019 shows that the smart home market shipments reached 29.89 million units, a year-on-year increase of 26.3%. The rapid growth of shipments shows that smart The market potential of the home furnishing industry in my country is huge. In today’s rapid development trend, the use of smart homes can free people's hands and reduce the pressure of people's daily chores after work. Based on the above background, the project team designed and produced a home smart integrated wardrobe.

1.2. Research significance

At present, international smart wardrobes have begun to be popular all over the world. As a country with a huge consumer group, my country has a greater demand for smart homes, but smart home systems have not yet been fully developed. Therefore, the project team decided to design a home-style intelligent integrated wardrobe with a small footprint, relatively independent intelligent system, convenient operation and relatively low cost. Research on this smart wardrobe is of great significance.
to the cost reduction of smart wardrobes in my country and the development of domestic technology.

2. Overall design ideas

2.1. Mechanical structure design

The design of mechanical mechanism is the core of the research on the home intelligent integrated wardrobe. The research on the mechanical structure that meets the requirements of low-cost, maintenance-free and high space utilization is the focus of research. The mechanical structure of the system is divided into storage module, incense module, drying module, isolation module and ironing module for design. The storage module moves the dried clothes to the storage area of the closet through a fork mechanism composed of a screw slider and a steering gear. The incense module contains three different fragrances, which function as intermittent operation through incomplete gears, which can remove peculiar smells and keep clothes fresh. The drying module can make the clothes do a reciprocating linear motion, cooperate with the hot steam, and stretch the clothes. The hot air at a constant temperature of 56 degrees Celsius fills the wardrobe to avoid overheating and damaging the clothes. The clothes can be safely taken care of. At the same time, the humid air is exhausted by the fan. The isolation module isolates the steam and hot air on the right side of the closet by lifting and lowering the flexible waterproof cloth, and prevents damp water vapor from entering the storage area of the closet to damage the stored clothes. The ironing module is used to clamp the clothes through the ironing splint on the right side of the closet. The appropriate ironing mode is selected according to the material of the clothes, and the high temperature, high speed and high pressure water vapor sprayed from the pipe is used to iron and shape the clothes accordingly. And it can quickly remove wrinkles and remove bacteria and mites. The overall structure of the system is shown in Figure 1.

![Figure 1. The overall structure of the system.](image)

2.2. Control structure design

The control system of the home intelligent integrated wardrobe adopts the concept of modular design combined with main control and auxiliary control. The main control module adopts the single-chip STM32F103 development board to realize the collection of information on the raspberry pie touch screen, the corresponding response, the control of the motor and the generator; the information collection through ultrasonic, temperature and humidity sensors, complete the collection and processing of the travel switch information, etc. The wireless communication module and mobile phone APP control are supplemented. The main function of the auxiliary control module is to ensure the normal operation of the motor control module and improve the user experience. The core processor uses Raspberry Pi 3 generation B+, which has an integrated network card, integrated graphics card and sound card, which can realize intelligent interaction between the wardrobe and people through the network. It can also remotely control the wardrobe through the APP.
3. Module design

3.1. Drying module
The thermal drying mechanism is composed of a drive disc, a U-shaped groove, a guide rail and a sliding block, a reciprocating drying rack, a lifting plate, a screw sliding block, and a motor. When drying clothes, the swing of the sine mechanism composed of the disc and the card slot is used to realize the stable operation of the sine mechanism, so that the clothes can swing back and forth smoothly, and the anti-skid movement mechanism is designed to prevent the clothes from swinging back and forth. The schematic diagram of the drying module is shown in Figure 2.

![Figure 2. Schematic diagram of drying module.](image)

3.2. Storage module
The storage module moves the dried clothes to the storage area of the wardrobe through a fork mechanism composed of a screw slider and a steering gear. The storage mechanism is composed of a stepping motor, a screw rod, a steering gear, a guide rail slider and a shift fork. The guide rail is fixed on the top of the wardrobe, and the stepping motor is fixed on one side of the wardrobe by the motor frame. The screw rod drives the screw slider to realize the operation of the fork mechanism. The fork mechanism can move the clothes hanger on the thermal drying module to the storage area. The schematic diagram of the storage module is shown in Figure 3.

![Figure 3. Schematic diagram of storage module.](image)

3.3. Flexible isolation module
The flexible isolation module is mainly composed of a dual-axis self-locking motor, a rigid structure board, and a storage reel. The dual-axis self-locking motor is fixed on the top top plate to drive the reel to rotate. The traction line of the reel is connected to the rigid structure board, the schematic diagram of the rigid structure board is shown in Figure 4. The rigid structure board is connected to the isolation cloth of the storage reel, and the storage reel is partially isolated. The cloth, the remaining insulating cloth and the rigid structure board serve as the main spacers to provide isolation for the entire wardrobe. A U-shaped inner notch is designed in the middle of the rigid structure board to avoid interference with the clothes rail. Both sides are equipped with pulleys. Through the pulley guide, the spacer can be stably raised and lowered vertically.
3.4. **Steam ironing module**

The steam ironing module is mainly composed of a steam system, an exhaust system, and an ironing platen. The hot air blower, steam generator and water tank of the steam system are placed at the bottom of the wardrobe, and the hot air generated by the hot air blower and the steam generated by the steam generator are respectively passed through the pipeline. Steam can be used for ironing clothes, and hot air can dry clothes. The steam pipe leads the hot air and steam to the upper and lower care areas. Four solenoid valves are installed to control the hot air and steam in the steam pipe respectively. The steam pipe is provided with a certain number of vent holes, which can evenly spray steam and hot air to the ironed clothes, thereby improving the ironing and drying effect. The exhaust system can exhaust the excess heat and steam from the upper and lower care areas to the outside of the wardrobe after ironing or drying. The ironing pressure plate is installed on the inner side of the right side plate of the wardrobe, and one side is fixed and hinged with the right side plate of the wardrobe so that it can clamp ironed clothes. The ironing press plate is used to spread and clamp the clothes on one side, so that the steam system can better care for the clothes. The schematic diagram of the steam pipeline is shown in Figure 5.

![Figure 5. Schematic diagram of steam pipeline.](image)

3.5. **Incense module**

The incense module should consist of a fan, a four-division slot wheel mechanism, a stepping motor, and a spice box. When working, the fan rotates to blow the fragrance into the wardrobe, and the spice box cover is rotated 90 degrees through the slot wheel mechanism to switch the flavor of the spice, and the corresponding spice is moved to the hole of the spice box. It can hold three different spices to achieve the function of removing peculiar smell and keeping clothes fresh. The schematic diagram of the incense module is shown in Figure 6.
Figure 6. Schematic diagram of the incense module.

4. Project innovation points
(1) Operations such as drying, ironing, and sterilization can be realized.
(2) The thermal drying system adopts a sinusoidal mechanism for operation, which is more stable.
(3) Built-in spice box, through the incomplete gear to play the role of intermittent operation, quickly freshen clothes.
(4) The intelligent interaction between the wardrobe and the person is realized through the network connection, which provides more intelligent services than the traditional household wardrobe.

5. Conclusion
Through a large number of literature searches, visits and surveys, and analysis of the results of questionnaires, a home intelligent integrated wardrobe was designed, which integrates clothing care, clothing storage, clothing recommendation and other functions in one, simple control and convenient use. The clothes can be wrinkled, dried, sterilized and dust removed, refreshing and deodorizing. At the same time, reasonable mechanical modules are designed to improve the space utilization of the wardrobe. It can conduct human-computer intelligent interaction, check the working status of the wardrobe in real time, and recommend clothes according to different weather and user preferences. Hope this wardrobe can bring convenience to people.

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