MULTI-FUNCTIONAL DRYING RACK DESIGN BASED ON INTERNET OF THINGS

JiaXin Luo*, Shuo Yang
School of Business, Guilin University Of Electronic Technology, Guilin, 541004, Guangxi Zhuang Autonomous Region, China.
Corresponding Author: JiaXin Luo, Email: 879471242@qq.com

Abstract: Intelligent home products are emerging, for the southern region of the climate is humid clothing easy to mold and bacteria, sudden changes in the weather can not collect clothes in time, the different orientation of the house leads to uneven light clothes, clothes for a long time without storage by the second pollution, this paper designs a QINHEALTH CH32V307 as the main control chip, combined with the temperature and humidity sensors, light sensors, humidity sensors to collect the environmental parameters and Bluetooth module, with automatic lifting, chain rotation, drying sterilization and other functions, users can monitor the clothes drying through APP intelligent, automated, multi-functional intelligent clothes airer. Supplemented with Bluetooth module, the multi-functional intelligent drying rack with automatic lifting, chain rotary, drying sterilization and other functions, realizes the intelligentization and automation of clothes drying, and the user can monitor the drying environment parameters and the state of clothes drying through APP. With the advantages of intelligence, automation and environmental protection, this drying rack provides convenience for contemporary urban life, meets the drying needs of different weather in different areas, and fills in the gaps for the smart home system.
Keywords: Smart clothes drying rack; Sensor; Automatic storage; Smart home; Artificial intelligence

1 INTRODUCTION

With the rapid change of science and technology, people's pace of life is significantly accelerated, and the practicality and intelligent requirements for daily necessities are also increasing, so the demand for smart home systems is constantly rising. Especially in the southern region of China, as the climate is mostly dark and humid, which brings considerable challenges to clothes drying, not only drying difficulties, but also easy to lead to moldy clothes[1] . Traditional drying methods are increasingly unable to meet modern people's pursuit of convenient, efficient and comfortable living due to poor ventilation, low automation levels and difficulties in adapting to complex and changing weather conditions.

In recent years, a large number of scholars at home and abroad have conducted relevant research on intelligent clothes drying racks. Based on STC89C52 microcontroller, scholars such as Xu Dongxue and Wei Fang designed an outdoor intelligent drying rack[2] which can dry clothes intelligently according to the weather change, it emphasizes the importance of the combination of hardware selection and software programming, which is of great significance to promote the development of intelligent drying rack technology. Scholars, such as Mr. Gan, Mr. Mu and other scholars designed an intelligent drying rack system with STM32 microcontroller as the main body[3]. The rack structure is simple, which solves the problems of high cost, complicated structure and difficult maintenance. Zhang Wei scholars proposed the optimization design of automatic rain control drying rack algorithm based on Arduino, which provides reference value for improving the automatic rain control system[4] . These researches provide important reference value for the intelligent drying rack designed in this paper, but for the existing intelligent drying rack there are problems such as single function, high energy consumption, and low degree of automatic control.

Therefore, this paper researches and designs an innovative multifunctional intelligentized clothes drying rack, which uses Qinheng CH32V307 as the main control chip and integrates temperature and humidity sensors, light sensors and other environmental monitoring devices, and is able to collect the surrounding environmental parameters in real time. When the weather conditions are detected to be unfavorable for clothes drying, the system will automatically activate the hood lifting mechanism and activate the drying and sterilization functions to ensure that the clothes can reach the ideal drying state in the shortest possible time while preventing the growth of mold[5] , as shown in Figure 1.
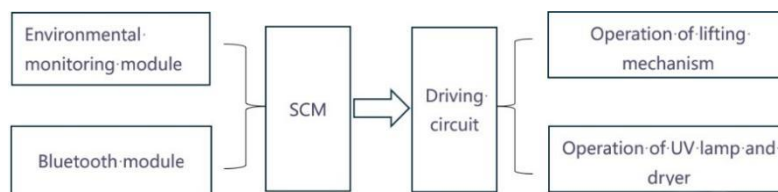

Figure 1 System Design Principle

2 SYSTEM HARDWARE DESIGN

2.1 Main Control Chip

This product uses the full-featured Qinheng CH32V307 as the main control chip, as shown in Figure 2.

Figure 2 CH32V307 Chip

2.2 Temperature and Humidity Sensors

The temperature and humidity sensor used is the DHT11 digital temperature and humidity sensor. The DHT11 digital temperature and humidity sensor is a temperature and humidity composite sensor containing a calibrated digital signal output, which applies dedicated digital module acquisition technology and temperature and humidity sensing technology to ensure that the product has a high degree of reliability and excellent long-term stability. The sensor consists of a resistive humidity sensing element and an NTC temperature sensing element, and is connected to a high performance 8-bit microcontroller. It has the advantages of excellent quality, ultra-fast response, strong anti-interference ability, cost-effective and so on, so it meets the requirements of temperature and humidity detection in this system.DHT11 adopts single-bus communication, i.e., there is only one data line to transmit the data, and the single-bus usually needs to be connected to an external pull-up resistor so that the state is high when the bus is idle. One pin of the microcontroller is connected to the data communication pin interface DATA for communication, as shown in Figure 3.

Figure 3 DHT11 Digital Temperature and Humidity Sensor

2.3 Temperature and Humidity Sensors

The raindrop sensor is made of high-quality FR-04 double-sided material with an extra-large area of 5.0 x 4.0 cm and a nickel-plated surface, which provides superior performance in terms of resistance to oxidation, conductivity, and longevity. The sensor can be used for monitoring various weather conditions, detecting whether it is raining and the size of the rainfall through the window, and converting it into a digital signal (DO) and analog signal (AO) output. This allows people to determine whether there is rain according to the high and low level of the output, and can also connect to the analog interface, which can detect the size of the rain, as shown in Figure 4.
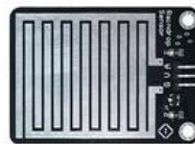

Figure 4 Raindrop Sensor

2.4 Light Intensity Sensor

The light intensity sensor uses a photoresistor module to detect light intensity. Inside the photoresistor module, the photoresistor is made of semiconductor material. The photoresistor utilizes the photoelectric effect of semiconductors, and its resistance value is inversely proportional to the light intensity. The photoresistor is very sensitive to ambient light, the stronger the light, the lower the resistance value, with the increase in light intensity, the resistance value decreases rapidly. Photoresistor module analog output AO can be connected to the AD module, through the AD

conversion, microcontroller AD acquisition can be obtained from the environmental light intensity of the precise value, and then according to the size of the value to determine the light intensity, as shown in Figure 5.

Figure 5 Light Intensity Sensor

2.5 Wireless Communication Module

The wireless communication module adopts HC-05 module, a high-performance master-slave integrated Bluetooth serial module, which can be paired with various computers with Bluetooth function, Bluetooth hosts, cell phones and other smart terminals. The advantages of this module are sensitive, easy to develop and cost-effective. When our cell phone APP is paired with the Bluetooth module, the microcontroller and the cell phone can communicate with each other, as shown in Figure 6.

Figure 6 Wireless Communication Module

2.6 Drying Systems

The module adopts the PTC heater it uses the fan to drum the air flow through the PTC electric heating element forced convection, as the main heat exchange mode, this high efficiency and excellent drying effect, fast warming and power consumption is small, with automatic thermostat function, there is a malfunction can be automatically disconnected, high security, and the PTC element generally has a waterproof function, as shown in Figure 7.

Figure 7 PTC Element

2.7 Weight Sensing

The weight sensor will record the weight of the clothes when they are hung up, and the intelligent sensing system will judge whether they are wet or dry, and the clothes will reduce their weight in the process of drying, and will remain unchanged after reaching a certain level. The gravity sensor judges whether the weight remains unchanged for a period of time, and if so, the clothes are judged to be dry, as shown in Figure 8.

Figure 8 Weight Sensor

2.8 Chain slewing system

Chain drive to achieve the clothes drying process of yin and yang conversion is the core system of this project, by the main control chip control motor driven chain to achieve directional timing fixed distance turnover, thus significantly improving the utilization of natural light and natural wind on the balcony, speeding up the speed of clothes drying at the same time, cleaner and more environmentally friendly. Its main working principle is. By the environment detection module to determine the current environment suitable for clothes drying, or by the cell phone to send a signal, the main control chip control motor to start working, the motor drives the gear and chain to complete the meshing, through the cell phone to set the turnover cycle and drying length, the chain drives the drying hooks in the hanger slots to achieve the balcony yin and yang side of the conversion cycle, as shown in Figure 9.
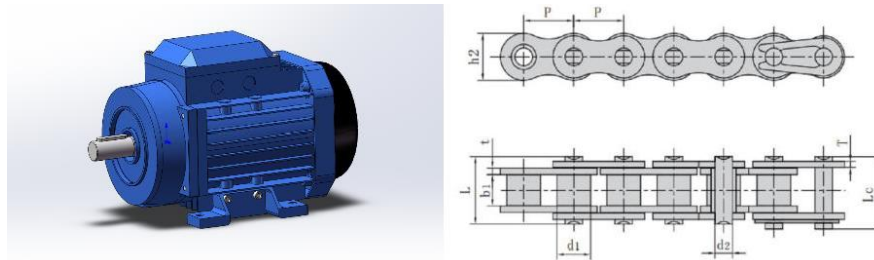

Figure 9 Schematic Diagram of the Motor and Chain Used

3 PRODUCT SOFTWARE DESIGN

3.1 Intelligent Automatic Mode

This product can be combined with the environment monitoring module, weight detection module feedback environment and clothing information, to realize the complete automation of clothing drying intelligent, drying is completed automatically lower the hood to achieve the temporary storage of clothing.

3.2 APP Remote Control Mode

Users can observe the clothes drying situation in real time through the cell phone APP, and adjust the working status of the drying rack remotely at any time[6] .

3.3 Remote Control Mode

In order to solve the situation that some elderly people have difficulty in using intelligent collection, this product can also use the simplified operation of the remote control to the product related remote control operation.

4 PRODUCT FUNCTION AND BASIC MODELS

4.1 Hanger Lifting System

Through the motor traction traction rope, both sides of the scissor frame to maintain the balance of the hanger, to achieve the hanger lifting and lowering, convenient for people to hang or remove the clothes on the hanger, at the same time after the rise of the hanger is also visually for the balcony to provide more space for indoor lighting.

4.2 Hood Lifting

When the weight detection system judges that the clothes are finished drying, the hood is automatically lowered to prevent the clothes from being polluted twice; when the environment monitoring module judges that the current environment is not suitable for drying, the system automatically lowers the hood and opens the drying system to avoid bacteria breeding and odor.

4.3 Chain Slewing System

Our products through the motor driven gears and chains to achieve clothing in the balcony yin and yang side of the cycle of rotation, so that the balcony yin and yang side of the clothes drying speed is the same, to solve the yin and yang side of the uneven drying of clothing problems. At the same time, it improves the utilization rate of natural resources such as sunlight and natural wind in the balcony, which is more energy- saving and green and environment-friendly than direct drying.

4.4 Drying Systems

In order to solve the user in the south wind days or rainy season and other cloudy and wet weather clothing is difficult to dry, easy to breed bacteria acidic and smelly problem, this drying rack using fans and sterilization ultraviolet lamps on the failure to dry the clothes in time for drying sterilization treatment, to ensure that the quality of the clothes drying (See Figure 10 and 11).
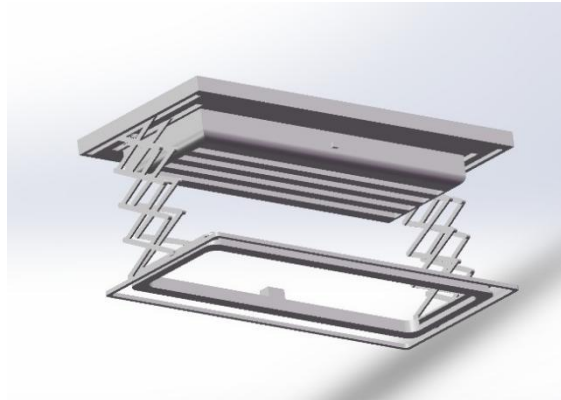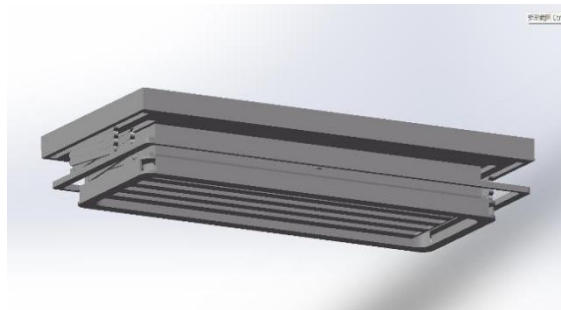

Figure 10 Unfolding of Drying Rack

Figure 11 Drying Rack Storage

5   PRODUCT INNOVATION POINTS

This product cleverly combines the functions of drying, sterilizing and air-drying, and realizes the complete intelligence and automation of household drying racks through the environment detection module and Bluetooth system. In order to adapt to the big climate difference between north and south of China, such as rainy season and south wind weather, insufficient sunlight resources, air humidity, frequent precipitation, clothes drying will encounter long-term not dry, breeding bacteria, discoloration and mildew. As well as the user's residential floors and houses facing different directions lead to differences in lighting, clothes on different sides of different humidity and other issues.

5.1 Environmental Monitoring Systems

Through the temperature and humidity sensor, raindrop sensor, light sensor and other environmental monitoring modules, this product can monitor the clothes drying situation, outdoor weather conditions, etc. in real time through the cell phone APP, and can realize the complete intelligent automation of the clothes drying process through the main control chip.

5.2 Weight Monitoring System to Determine Whether Drying is Complete or Not

For users who have good drying environment and do not need to use the dryer, we have added a weight detection module, when the clothes are hung on the drying rack, the weight detection module automatically records an initial weight, when the weight of the clothes is reduced to a certain value and does not fall for a long time when the clothes calculate a final weight, the main control chip calculates the standard index of dryness of the clothes according to the two values, and when the index reaches 70-90%, the main control chip determines that the clothes have been dried. When this index reaches 70%-90%, the main control chip judges that the clothes have been dried, and transmits the message of clothes drying completion to the user's cell phone through the wireless communication module, and automatically lowers the garment cover to realize the temporary storage of clothes. If the index does not reach 70%, it will judge that the clothes are not dry, lower the hood and turn on the dryer for drying, until the index reaches 70% and the humidity in the hood is not higher than 40%, then the clothes will be judged dry.

5.3 Chain Slewing System

The use of motor-driven chain, through the main control chip to control the motor direction, timing, fixed- distance slewing so as to realize the clothing balcony small area of limited sunlight resources, can be faster to make the clothes drying. At the same time, compared with direct drying of clothes, it can increase the utilization rate of sunlight, natural wind and other clean energy.

6 CONCLUSION

According to the different weather conditions around the world, for the traditional drying racks with poor ventilation effect, low automation degree, to cope with the complex and changing climate and other problems and facing the rise of lazy economy, the multi-functional intelligent drying racks designed by QINHENG CH32V307 chip as the main control chip, combined with temperature and humidity sensors, raindrop sensors, light intensity sensors, and weight sensor are conducive to the timely collection of weather data, and the dryer and UV lamp can be opened to assist drying and sterilization. Under the environment not suitable for drying, the hood is lowered to realize clothing storage, and the dryer and ultraviolet light are opened to assist in drying and sterilization. This product is cleverly equipped with a fan and a sterilization ultraviolet light, which provides timely sterilization and drying treatment for the clothes, prevents bacteria from breeding and producing bad smells, and broadens the use of the product to increase the product's cost-effectiveness. In terms of intelligent remote control, this drying rack uses Bluetooth module to connect with cell phone or use the remote control to manually adjust or select the intelligent mode of the drying rack, and the drying rack automatically completes the whole process of clothes drying. Compared with the various brands of drying racks on the market, this product greatly improves the intelligence of the clothes drying process, adding convenience to modern urban life.

FUNDING

CONFLICT OF INTEREST

The authors have no relevant financial or non-financial interests to disclose.

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