Intelligent Drying Rack System based on Internet of Things

Xiao Xing, Chong Zhang, Jieming Gu, Yixin Zhang, Xinrun Lv, Zihan Zhuo
National Computer Network Emergency Response Technical Team/Coordination Center of China, Beijing, China
xingxiao@cert.org.cn, zhangchong@cert.org.cn, gujieming@cert.org.cn, zyx@cert.org.cn, lyuxinrun@cert.org.cn, zzh@cert.org.cn

Abstract. With the innovation and development of science and technology, the convenience and intelligence of home life has become a trend. This intelligent drying rack system based on the Internet of Things uses the OneNET cloud platform as the information port, and selects the STM32F103C8T6 single-chip microcomputer as the main control chip to read, judge and output the execution signal from the signal collected by the sensor. The smart drying rack can be operated manually and remotely through the touch screen, related hardware circuits and mobile phone APP, which can control the extension and recycling of the clothes drying rod, and the automatic drying and storage of clothes. It is convenient to use and improves the intelligent level of the drying rack. The problem that the drying rack cannot dry the wet clothes and needs to be stored manually is solved.

1. Introduction
Aiming at the inconvenience of the traditional outdoor drying racks in the current society that the collection of clothes to dry due to changes in weather is inconvenient, a smart drying rack based on the Internet of Things is designed and manufactured. It can be used in homes, hotels, hospitals, laundry shops and other places where a large amount of clothing needs to be washed frequently and outdoor drying is required [1]. It can quickly and effectively complete the automatic drying, recycling, drying and disinfection of clothing. Considering the defect that traditional clothes drying cannot realize automatic adjustment according to environmental changes, The main design of the smart drying rack is to consider the four aspects of remote one-button drying, automatic induction recycling, one-button undressing and remote sterilization [3]. The system Choose STM32F103C8T6 microcontroller as the main control chip, OneNET cloud platform as the information port, by processing and judging the data collected by the temperature and humidity sensor in the drying rack sensor module [3], the intelligent perception of the environment and clothing recycling of the smart drying rack can be completed. In addition to the manual control of the smart drying rack via the touch screen, the smart drying rack can also be remotely monitored and controlled through the mobile phone APP. The user can perform the actions of drying, collecting, drying and disinfecting the clothes of the smart drying rack system by operating the mobile phone APP [5]. The operation is simple and convenient to use, which greatly promotes the portability of smart homes. The overall design of the system is shown in Figure 1.
2. Hardware System Design
The first consideration when designing this smart clothes rack is the recycling of clothes. Here, the design adopts a diamond-shaped four-bar linkage mechanism combined with a spiral transmission mechanism. The thrust of the slider is used to obtain the initial speed of the connecting rod to realize the fixed-axis rotation of the rigid body, and the diamond-shaped four-bar linkage mechanism is stretched and retracted through the precise control of the stepping motor to achieve recovery. Secondly, consider the problem of automatic one-button fall off of clothes. Design the screw drive device according to the temperature and humidity data of the detected clothes, the clothes will enter the predetermined storage area when they fall off automatically. On this basis, this design adds the function of updating the weather conditions in the past three days in real time, which is convenient for users to choose the thickness index of clothes for drying clothes in time.

2.1 Mechanical Structure Design
The mechanical structure of this design is composed of a clothes-drying rod telescopic mechanism and a one-button undressing mechanism. The clothes drying rod telescopic mechanism can realize the drying and recycling of clothes. When there are more clothes to dry and the drying area is insufficient, with the assistance of an automatic telescopic mechanism, the double diamond-shaped mechanism of the clothes-drying rod telescopic duplex mechanism can realize the lateral expansion of the clothes-drying rod, so as to achieve the purpose of increasing the drying area. As shown in Figure 1 below, it is the assembly drawing of the telescopic duplex mechanism of the clothes drying rod. The compound rhombus mechanism is composed of two groups of hinged four-bar mechanisms, which can realize the horizontal extension of the clothes drying rod and realize the functions of automatic drying and collection of clothes. Automatic telescopic mechanism The automatic telescopic mechanism is composed of a guide rail, a sliding speed, a sliding table module, a ball screw, a 57-type stepping motor, a 42-type stepping motor, a rolling bearing and its accessories. The sliding table module and the sliding block are connected through the aluminum support aluminum plate to realize the expansion and contraction of the smart drying rack so as to meet the user's demand for larger drying space. Among them, the 57-type stepping motor drives the longitudinal expansion and contraction of the slide module, and the 42-type stepping motor realizes the horizontal extension of the lead screw. By clicking to drive the sliding module to move, the telescopic clothes rod in the compound diamond mechanism can be driven to extend, complete the longitudinal extension of the clothes rod, and achieve the purpose of increasing the drying area. The equipment diagram of the telescopic compound mechanism of the clothes drying rod is shown in Figure 2.
The one-button undressing hanger mechanism consists of a hanger bar, a hanger trigger, a hanger connector and a hanger shell. The one-button undressing hanger mechanism is fixed on the clothes rod compound telescopic mechanism, and the hanger bars on both sides are connected to the elastic clip. The hanger trigger completes the unfolding and closing of the hanger bar by squeezing the elastic shelf, and all parts are connected through the hanger shell. The structure diagram of the one-button automatic undressing storage mechanism is shown in Figure 3.

2.2 Design of Electrical Structure
The electric drive diagram of the intelligent drying rack is shown in Figure 4.

The system selects STM32F103C8T6 microcontroller as the main control chip to control the electrical part, completes the hardware interaction with the OneNET cloud platform, DHT11 temperature and humidity sensor completes the intelligent perception of the clothes drying environment, A4955 stepping motor completes the power supply of the drying rack, and DM542 limit The sensor completes the limit protection of the drying rack, and the touch screen realizes the manual operation of the terminal of the smart drying rack by the operator.
The environment and clothing status data obtained by the sensor monitoring are all transmitted to the single-chip microcomputer for processing and judgment, combined with the Internet of Things to manage the data, and finally output the execution command to the smart drying rack.

2.3 Controller Module Design
The STM32F103C8T6 microcontroller is based on the ARM Cortex-M core. It is an embedded microcontroller with small size and low energy consumption [5]. It can meet the requirements of long standby use. It has high integration of Wifi and dual-mode Bluetooth and high performance, simple and easy to use, good compatibility, can work in the environment of -40°C ~ 80°C [6], can meet the harsh outdoor application conditions. The STM32F103C8T6 single-chip microcomputer uses its own Wifi function to connect with the cloud, analyzes the data collected by the sensor [7], and transmits the output signal to the OneNET cloud platform [8]. The server side receives the control signal transmitted from the mobile phone APP side, which is finally processed by the single-chip microcomputer make feedback control to realize the intelligent remote control module of the intelligent drying rack system.

3. Software Design and Mobile APP Interface Display
The smart drying rack system not only supports the touch screen manual control mode, but also supports remote control by the user through the mobile phone APP operation [9]. The software can complete the user's real-time intelligent monitoring and perception of the intelligent drying rack, realize the data management and interaction of the intelligent drying rack system, the third-party API interface is open, and the system construction is convenient [10]. When the APP port interacts with the cloud platform port, you can control the mobile terminal for use. When the user selects the automatic mode, when the light sensor collecting light intensity does not reach the threshold, the control system is triggered to send the clothes collection command, and when the wind speed sensor collects the wind speed exceeds the threshold, the control system is triggered to send the clothes collection command. After the clothes are collected, when the humidity of the clothes detected by the temperature and humidity sensor reaches the threshold, the control system is triggered to send an automatic drying command, automatically enter the clothes drying and disinfection mode, and complete automatic undressing and storage. When the user selects the manual mode, the user can view the real-time status of the clothing on the APP and select the corresponding operation. All operations are manually triggered by the user. The user can choose whether to increase the drying area, whether to receive the clothes, drying time, drying temperature and disinfection time. After the controller receives the signal sent by the APP, it completes the end execution signal sending completion command via the STM32F103C8T6 microcontroller [11]. Figure 5 below shows the main program design flow chart.
Open the mobile phone APP operation terminal, you can view the humidity and light conditions of the clothes drying environment, complete the expansion or contraction of the clothes drying rack, realize the drying and collection of clothes, and carry out the drying, sterilization and storage of clothes. Each module can choose whether Open, close or enter automatic mode. Figure 5 shows the mobile APP interface of the smart drying rack system.

4. Conclusions

This intelligent drying rack combines the Internet of Things system to complete the intelligent drying task of clothes. It has a simple structure, no complicated parts, easy processing, low cost, good assembly and process performance; product operation is simple, reliable, fast, efficient, and accurate. High rate, it can complete the independent drying, drying and one-key automatic collection of clothes. The hardware part of the system is designed and produced, the Internet of Things technology and the cloud are used to realize remote data interaction, the software part is debugged, and the mobile phone APP is developed. The user can operate and control the use of this smart drying rack through the mobile phone, and adopt digital processing adjustment. The various parameters of the intelligent drying rack make the intelligent drying rack always work in an ideal state, improve the intelligent level of the drying rack, and solve the problem that the drying rack cannot be dried and needs to be stored manually.
5. References

[1] Li Liying, Zhang Jinhua, She Bo, Peng Jing, Zhang Lirui. Design of Smart Charging Pile Billing System for Electric Vehicles Based on STM32F103C8T6 Single Chip Microcomputer[J]. Southern Agricultural Machinery, 2020, 51(19):30-31+75.

[2] Nie Ru. Design of plant protection drone based on STM32F103C8T6[J]. Automation Technology and Application, 2020, 39(08):20-24.

[3] Feng Jun, Wu Jiawen. An interactive system based on STM32 and HMI configuration screen[J]. Computer Knowledge and Technology, 2020, 16(19):211-212.

[4] Li Shimo. Design of intelligent drying rack system based on 52 single chip microcomputer[J]. Computer Products and Circulation, 2019(09):120.

[5] Wang Fajie. Design and manufacture of smart drying rack based on STC89C52RC single-chip microcomputer[J]. Microcomputer Applications, 2019, 35(10):157-160.

[6] Lu Xiaoying. WiFi smart drying rack design based on mobile phone APP[J]. Information and Computer (Theoretical Edition), 2019(14):83-84.

[7] Yan Leng, Qiu Qi, Yepeng Liu, Fujian Zhu. Design of dry-type transformer temperature controller based on internet of things[J]. International Journal of Embedded Systems, 2020, 12(3).

[8] Gao Tian, Zhu Chenxu, Liu Botong, Wang Zhanbei. Design of a multifunctional anti-theft monitoring system based on OneNet cloud platform[J]. Electronic Production, 2020(07):25-28+51.

[9] Shengmin Zhang. Intelligent Backlash Control System Based on Laser Scanning[J]. Insight - Automatic Control, 2018, 1(1).

[10] Wang, Chao, Zhu, He, Chen, Zhu, Deng, Yan, Su, Enben, Xiao, Pengfeng. Control Methods of Mechanical Arms Motion for Automatic Nucleic Acid Detection System Based on Magnetic Nanoparticles[J]. Journal of Nanoscience and Nanotechnology, 2016, 16(12).

[11] Ying Zhi Wang, Jia Yang, Tai Lin Han. Design of a Pulse Oximeter Based on STM32 Microcontroller[J]. Applied Mechanics and Materials, 2015, 3744.