Corridor Sterilization Device Based on STM32

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Abstract: Due to the large size and high cost of the existing disinfection robots，some specific spaces still need to be manually disinfected，such as the subway floor，the bottom surface of some factories，etc. Generally，specific staff members use disinfection spraying devices to carry out the disinfection on time and point by point. Disinfection on the ground leads to a higher risk of infection for protective personnel. At the same time，similar to the common disinfection robots in hospitals and shopping malls，the atomized disinfection robots that are large in size and move freely on the ground will become obstacles for people to walk; in order to reduce work The possibility of people being infected with viruses and improving work efficiency，a set of STM32-based corridor sterilization device is developed in this paper，which is a kind of circuit controlled by spring expansion and contraction，which can identify whether there are people nearby and make voice broadcasts，lightweight and simple atomization disinfection device，mainly used in public places with circular carriers.

Key Words： STM32; corridor sterilization; spring retractable

I. Introduction

Due to the sudden outbreak of the new crown epidemic, engineers have to rush to start the research and development of killing devices. Although many progress has been made in this area, the practical application of killing robots[1-3] is still quite limited. In order to expand the scope of application of the sterilization device, reduce the infection risk of epidemic prevention personnel, and popularize the sterilization device, it is necessary to design a simple, convenient and easy-to-operate sterilization device.

At present, large-scale sterilization and epidemic prevention vehicles have appeared on the market, which require sterilization personnel to drive, or use AGV cars [4-5] for automatic disinfection, or drones for long-distance disinfection[6]. The first category is used in large open areas, such as streets, squares and other public places. Compared with the first category, the third category does not need to wear protective clothing to drive in a hot car. It is necessary to use the remote control for remote control killing, but the disadvantage is that some closed areas such as corridors, warehouses and other places should not be used, and certain technology is required to control it, making it impossible for most people to use it. However, these devices have undoubtedly made a great contribution to the prevention and control of the epidemic, and can effectively and quickly disinfect and sterilize most areas. At the same time, anti-epidemic devices based on STM32[7-9] are also on the rise. Due to the powerful performance and lightness of STM32, some devices can be designed to carry out long-distance non-contact killing in some narrow spaces, and at the same time, the operation is simple and can be used to make Most people get started quickly.

The STM32-based corridor disinfection device in this paper uses a circular handrail as a carrier. When it has a disinfection device, it can judge whether to stop disinfection or reverse operation through radar ranging, and has human infrared induction[10-11] To judge whether there are people around, to decide whether to stop spraying, and to remind people by voice broadcast.

II. Mechanical structure of corridor sterilization device

As shown in Figure 1, the whole device is a box, with the handrail in the public place as the carrier, the device runs on it and sprays the mist-like disinfection water on the ground where people pass by for disinfection. Both boxes are powered boxes, and there are two U-shaped driving wheels at the bottom of each box, which are controlled by two DC

motors respectively. The motor is controlled forward and reverse through the stm32 development board, so that the whole device can move in both directions on the armrest.

The water bag is placed on both sides of the device and lower than the armrest, so that after the water bag is filled with water, the center of gravity of the entire device is under the armrest, which increases the stability of the device and allows it to walk more stably on the armrest. It is not easy to slip sideways and fall off the armrest. .

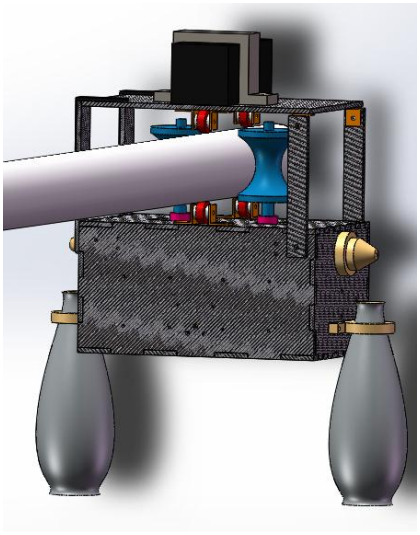

Fig. 1 Overall three-dimensional model of the device

The chassis of the box is shown in Figure 2. The two motors are respectively fixed to the two slide plates and there are two sliders on the rails under the slide plates. There is a gear in the middle of the chassis, and the two racks fit with the two slides respectively, so that the distances between the two slides to the middle position are equal, so that the center of gravity of the whole box is located on the middle line of the handrail as much as possible. , to increase the stability of the box. At the same time, the two skateboards are connected by a spring. The spring is at its original length. When the wheel is stuck on the handrail, the spring is stretched and deformed, and a force is generated to tighten the skateboards on both sides to realize the tightening between the wheel and the handrail. Since the diameter of civil handrails changes little, after investigation, most of the circular handrails have a diameter between 64-67mm. Even if the diameter changes, the device can still be tightened due to the elasticity of the U-shaped wheel to achieve automatic adjustment.

A small wheel is installed under the chassis, as shown in Figure 3. The function of the small wheel is to change the sliding friction to rolling friction, so that the device can walk on the handrail more smoothly. The small wheel and its fixed parts are connected by a thumb bearing, which can not only make the small wheel tightened and not easily shake during driving, but also make the small wheel roll smoothly without being stuck. The motor and the wheel are connected by a coupling, which can make the motor more stable when driving the wheel.

The sides and bottom of the box are not only connected by the tenon-and-mortise structure, but also stabilized by wrapping corners (the wrapping corners are shown in Figure 4), which can make the entire box more balanced and less concentrated.

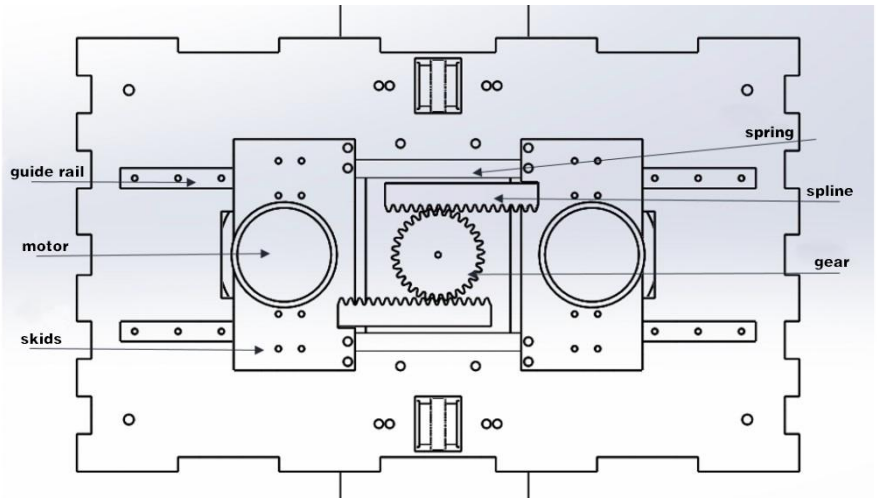

Fig.2 Chassis view

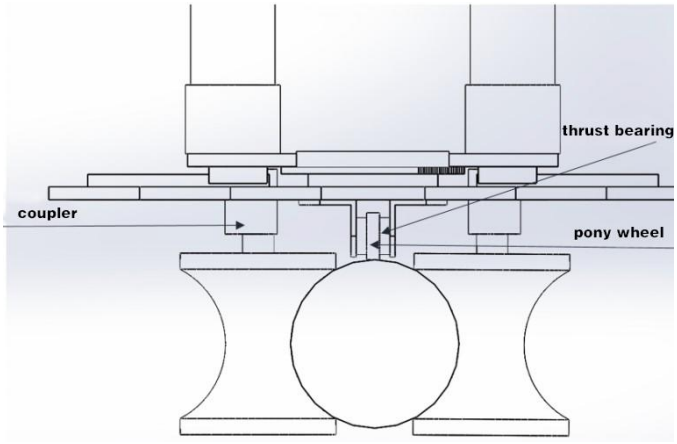

Fig.3 Chassis gear train

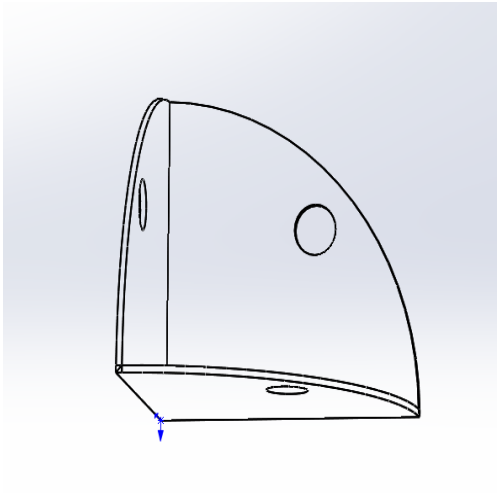

Fig.4 Three sided fixation

After calculation, the total mass of the whole device when fully loaded is 3.5kg. Motor Torque Formula is as follows.

$$T = \frac{9.8 \times (w - w_c)p_b}{2\pi R\eta} \tag{1}$$

after calculation, T<350N.m. By the following formula of physics：

$$\mu mg\cos\vartheta = mg\sin\vartheta \quad (2)$$

Friction Pad Factor is obtained.

$$\mu = \tan\vartheta \quad (3)$$

Check the relevant information about the angle between the handrail and horizontal plane, θ≈40o and μ=0.839. Therefore, the choice of ordinary well-known motor 20r/min can meet the speed regulation requirements.

Because the main difficulty of the device is: the smoothness of the device when it runs on the handrail and the friction between the wheels and the handrail. If the friction is too large, the device will not work, and if the friction is too small, it will easily slip. The force of this part is mainly provided by the spring, so the wheel surface material, motor and spring have certain special requirements, specifically:

1.Whether the wheel material is deformed and the rolling friction with the handrail.

2. Whether the center of gravity of the device is maintained on the vertical center plane of the handrail.

Wheel selection scheme：

Option One：Use ordinary U-shaped wheels. The advantages are that it is easy to use and can be directly installed and used（as shown in Figure 5）.

Option Two：Sand the surface of the U-shaped wheel with sandpaper, but the effect is not obvious（as shown in Figure 6）.

Option Three：Wrap a layer of hand glue on the surface of the U-shaped wheel. Advantages: Because the material of the hand glue is relatively soft, it can better contact the handrail on the handrail and increase the friction with the surface of the handrail.

Center of gravity stabilization plan：

Option One：Use only springs. Advantages: easy to use, easy to install. Disadvantages: The bottom plate is easy to shift as a whole, and the center of gravity should not be controlled.

Option Two：Use a two-way screw. Advantages: The center of gravity is easy to control. Disadvantage: There is a large error in separating the weight on both sides from the middle.

Option Three：With gears and racks. Advantages: The distance between the two wheels and the bottom plate is equalized by the mechanical structure, so that the center of gravity is on the vertical center plane of the handrail, and there is basically no deflection. The structure is shown in Figure 7.

The designs of the three schemes are compared, and two schemes are finally selected.

Fig.5 Ordinary u-wheel

Fig.6 Wrap hand glue

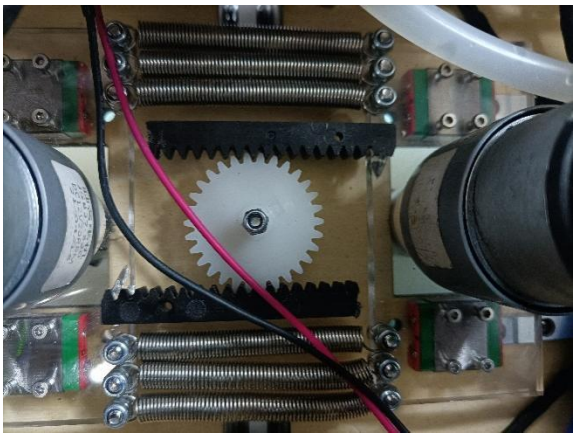

Fig.7 Gear and rack structure

III. The electronic control part of the corridor sterilization device

As shown in Figure 8, the main control chip of the control circuit adopts STM32F103ZET6 chip. It is a 32-bit microcontroller based on the ARM Cortex-M core STM32 series, with a total of 48 pins and a main frequency of 72M. It can output multiple PWM waves at the same time to control the speed of the motor. The relay main control chip on the board is SRD-05VDC-SL-C, which can complete the path and short circuit of 10A current, and can complete the switch control within 1S through the on-board 5V power supply. The driving part in the control circuit adopts L298N main control chip, the highest output current is 2A, it can drive two motors to rotate at the same time, and the power supply voltage is 5V to 12V. It can drive high-power DC motors, stepping motors, solenoid valves, etc., especially its input can be directly connected to the single-chip microcomputer, so that it can be easily controlled by the single-chip microcomputer. When driving a DC motor, the forward and reverse rotation of the motor can be realized only by changing the logic level of the input terminal. Each module motor in the system of the present invention is started by L298N. The two lateral drive motors are respectively connected with the PF8 pin, PF9 pin, PF10 pin and PF11 pin of the main control chip, and the middle axial motor is connected with the PD6 pin.

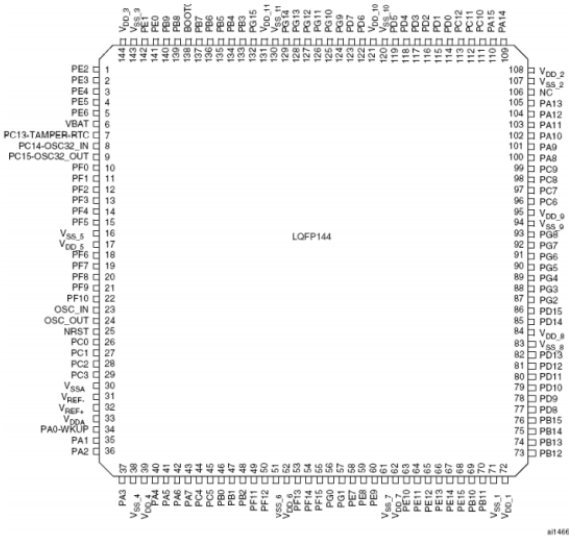

Fig.8 STM32 pin diagram

On the basis of STM32 control, a distance measurement sensor module is added to judge whether there are obstacles in front; the mini human body sensing module is used to sense whether there are people around to decide whether to stop spraying; a voice module is added for voice broadcast to notify surrounding people to avoid ; With the addition of a Bluetooth camera, the epidemic prevention personnel can view the surrounding situation from a distance. Figure 9 shows the main hardware.

Fig.9 Main hardware parts

The electronic control mainly adopts the sequence structure as shown in Figure 10 and Figure 11, and uses the serial port interrupt as the interrupt signal source. The device is divided into two modes: stop and work. In the work mode, the machine moves and sprays disinfectant water. In the stop mode, the machine is stationary and stops spraying. In terms of data acquisition, the software will use an infrared module as a sensing device. When it senses that someone is approaching, it will pull up the pin level to interrupt, and all work of the car will be suspended; the engine and water pump will be used as power output devices to spray disinfectant water. , The function of moving back and forth.

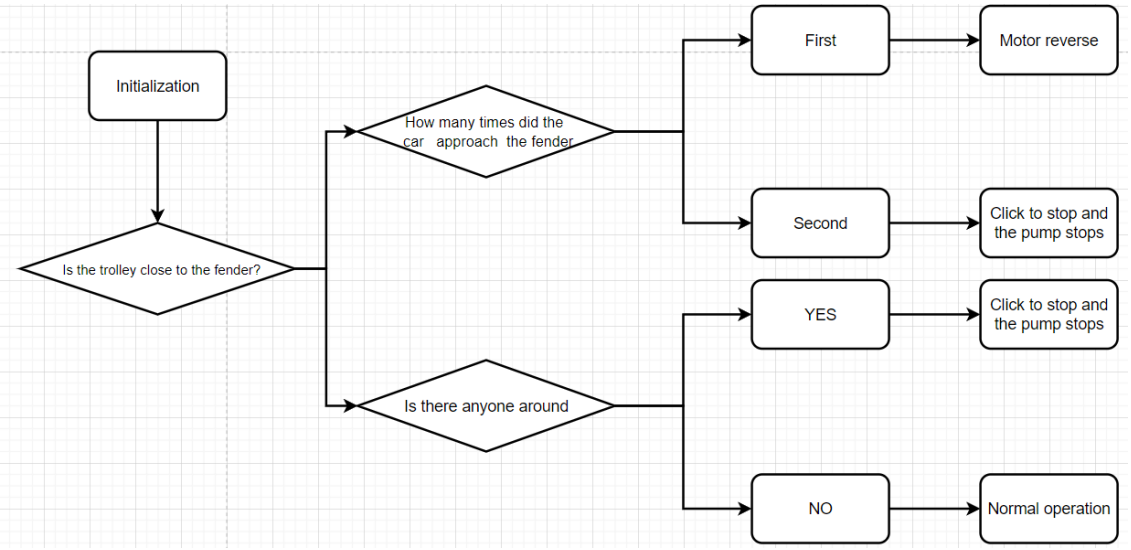

Fig.10 Electronic control flow block diagram

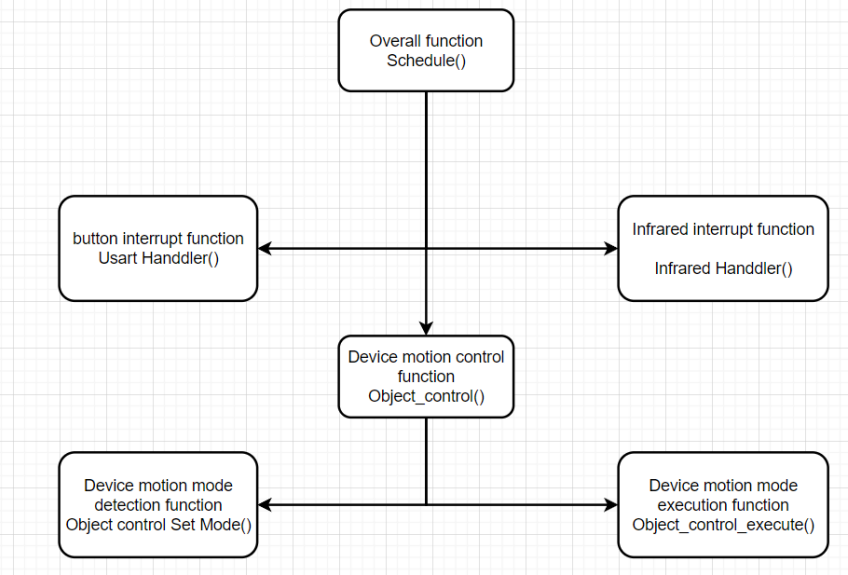

Fig.11 Program control chart

IV. The functional process of the corridor sterilization device

Figure 12 is a device appearance.Within eight seconds after the trolley is initialized (that is, the switch is pressed after an 8-second delay), through the 120°rotating conical surface space volume scan located under the infrared sensing device on the head of the box, it can sense whether there is anyone around, and if there is no one, the device will Start running; if there is someone, the device will not start and is in a standby state, and the device will start immediately after the person leaves. After the device is started, the water pump starts to run while the device is running. The water pump pumps water from the water bags on both sides. The water pipes of the two water bags are connected by a three-way pipe, and finally converge to the water pipe connected to the pump inlet, and the water pipe of the water outlet is connected to the atomizing nozzle. Finally, the disinfectant is sprayed out in the form of mist, and the sprayed space range is about 3m*2m*2m. The front and rear of the device are equipped with radar ranging modules. When the device approaches the baffle (the end of the journey) for the first time, the two motors rotate in the opposite direction at the same time, and the water pump does not stop working. When the device runs in reverse to the other side of the baffle, the motor stops rotating, at the same time the water pump stops running, and the entire device stops running, thereby achieving secondary disinfection. During operation, when someone around is approaching, it is detected by the infrared sensing module, the motor stops rotating at this time, and the water pump stops at the same time; when the surrounding people leave, the motor starts to rotate, and the water pump continues to work. In addition, the bluetooth camera installed above can project the surrounding picture to the user's mobile phone to realize real-time observation. In addition, the device is equipped with a voice broadcast module to remind people to avoid, and the Bluetooth camera also has a voice function to communicate over long distances.

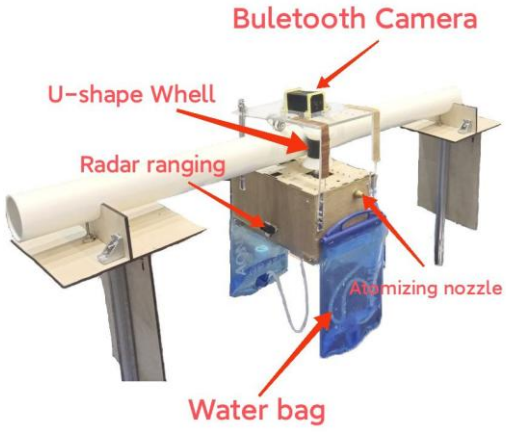

Fig.12 Device appearance

V. Conclusions

The device realizes a multi-functional disinfection system based on STM32, reducing the work burden of disinfection personnel. Combined with the prevention and control needs of the new crown epidemic, this device can change part of the manual disinfection to mechanical disinfection, replace some disinfection personnel to work, reduce

the infection rate of the staff and reduce their burden, suitable for a variety of occasions, can adapt to most public The specifications of the handrails for occasions improve the wide applicability of the device. Provide a convenient and practical device for disinfection personnel. Small and lightweight, easy to operate, easy to use, cheap, and convenient for sterilizers to use.

Acknowledgements

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References

[1] Cheng Yue. Challenges and opportunities of mobile disinfection robots under the new crown epidemic [J]. Robot Technology and Application, 2020, 4.47-48 .

[2] Ding Zhihu, Hu Guangkuo. Application of intelligent robots in hospital disinfection [J]. Medical Information, 2020, 33(5): 28-29.

[3] Zhang Xiong, Liu Hao, Zhong Zhouming, Qin Kunxue, Chen Yongqiang, Li Meng, Design of an intelligent inspection robot for disinfection and epidemic prevention [J]. Electronics Production, 2021, 1.23-24.

[4] Peng Miao, Zhang Teng, Liu Sijia. AGV system design based on lidar self-navigation [J]. Southern Agricultural Machinery, 2021, 52(9): 83-89.

[5] Lei Dan, Intelligent AGV obstacle avoidance car[J]. Mechanical Engineering and Automation, 2021(2):146-147.

[6] Yang Yang, Luo Ting, Tang Weige, et al. Application research of multi-rotor UAV in the field of medical rescue [J]. Medical and Health Equipment, 2018, 39(6):91-95.

[7] Li Wanyi, Xie Linxi, Xiao Feng, et al. Hardware design of intelligent car tracking and obstacle avoidance system based on STM32 [J]. Electronic World, 2019(7):196-197.

[8] Chen Lingling, Cao Zhongwei, Zhang Shuo, et al. Design of automatic tracking smart car based on STM32 [J] Electronic Testing, 2019(17):26-28.

[9] Zhou Dongyao, Shi Wenqing, Huang Jiang, et al. Design of WiFi smart car control system based on STM32 [J]. Equipment Manufacturing Technology, 2019(8):58-61.

[10] Chen Wenxing, Fu Jizong, Wei Jianying. Design of human body infrared sensor switch based on BISS0001 signal amplifier circuit [J]. Computer Development and Application, 2013(2):66-68.

[11]Wen Wu, Gu Peng. Design and Implementation of Infrared Induction Intelligent Switch Control System[J].Science and Technology Information, 2010(14):218-219.