

Disinfection methods and applications of intelligent disinfection robots

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Abstract

Through the analysis of the research status of disinfection robots at home and abroad, this paper summarizes the disinfection methods commonly used on the market, expounds the principles of various disinfection methods, and summarizes the actual use needs of the epidemic prevention site. The application of disinfection robots was discussed and summarized.

Keywords

Disinfection robot; Disinfection method; Application prospects.

1. Development status at home and abroad

In foreign research, Singaporean experts proposed a control method for wall disinfection robots using fuzzy control, using sensors to judge the distance between the robot and the wall, and ensuring that the robot drives according to the expected predetermined route through fuzzy algorithm calculations. A U.S. company has developed a robot that specializes in disinfecting the cabins of large passenger aircraft, using medical ultraviolet lamps to disinfect seats, restrooms and storage rooms. Indian experts have developed a robot that automatically switches UV disinfection by detecting nearby humans through three PIR sensors equipped on the fuselage, when there are humans in their working range. The robot will automatically turn off the ultraviolet disinfection lamp, and when there is no human in its working range, it will automatically switch to disinfection mode and continue disinfection. Malaysian experts invented a spray disinfection robot, which has a pharmaceutical spraying device, also has a navigation function, can be remote detection control, installed with an ultrasonic sensor at the bottom of the robot, installed with an integrated camera at the top, which can be done by ultrasonic sensors. Determine the distance from the obstacle, and the range of spray disinfection can be seen remotely through the camera, so that the disinfection situation can be monitored remotely.

Shanghai Songtong Biotechnology Co., Ltd. in China has studied a disinfection robot that uses rapid evaporation of hydrogen peroxide water to produce disinfection mist to achieve the effect of disinfecting and sterilizing the environment. Xianzhi Robot Company has developed a disinfection robot, equipped with ultraviolet disinfection lamps, ultra-dry fog hydrogen peroxide disinfection fog nozzles, negative oxygen ion generators and other devices, the robot is mainly used for operating rooms, intensive care units, laboratory departments and other closed indoor disinfection, but also can be used in railway stations, airports, office buildings and other environments. The robot enables contactless disinfection to minimize the risk of infection.

2. Disinfection principle of disinfection robot

At present, there are many kinds of disinfection methods used by disinfection robots on the market, mainly chemical methods, which are roughly divided into the following ways:

(1) Ultraviolet disinfection

Ultraviolet disinfection is a physical disinfection method, through the high energy of ultraviolet radiation to the bacteria, will cause severe damage to their cell membranes and genetic material. The effect of ultraviolet disinfection is positively correlated with the power of the ultraviolet emission lamp and negatively related to the distance of action.

(2) Hydrogen peroxide disinfection

Hydrogen peroxide disinfection is a chemical method, so hydrogen oxide has strong oxidation, its molecular activity is strong, can quickly destroy the cell membrane of bacteria to kill germs. Existing disinfection robots often vaporize or atomize hydrogen peroxide and spray it into the air, and spray small droplets in the air to do irregular movements, which can increase the area of disinfection.

(3) Ozone disinfection

Ozone is as highly oxidizing as hydrogen peroxide, and ozone can chemically react with the cell membranes of bacteria, destroying their cellular structure, preventing their growth and eventually causing the bacteria to die. However, it should be noted that ozone can cause harm to the human body, so ozone should be used to ensure that it will not affect people's lives, and it can enter this area after adequate ventilation after use of disinfection.

(4) Liquid chlorine disinfection

Liquid chlorine disinfection technology is to produce hypochlorous acid by chemically reacting chlorine with water, and chlorine atoms enter bacteria, undergo chemical reactions, reduce their physiological activity, and finally cause them to die.

(5) Sodium hypochlorite disinfection

Sodium hypochlorite disinfection is currently a disinfection method widely used in sewage treatment in China, sodium hypochlorite disinfection is mainly derived from the oxidation of hypochlorous acid, sodium hypochlorite in water can be converted into hypochlorous acid, oxidation of bacteria protein to make it change Sexual death.

(6) Chlorine dioxide disinfection

Chlorine dioxide is a kind of green disinfectant, can safely complete the disinfection work, in industry and life has been widely used, chlorine dioxide can be chemically reacted with the cell wall of the pathogen, and penetrate the cell wall of the pathogen, and then oxidize the enzymes in the cell, block the production process of the protein in the cell of the pathogen, reduce the physiological activity of the pathogen, thereby destroying the germ, to achieve the purpose of disinfection.

(7) Alcohol disinfection

Alcohol disinfection is a commonly used disinfection method, medically will generally use a concentration of 60% to 80% of alcohol for disinfection, which has a strong penetrating function, can enter the inside of the bacteria, damage the physiological structure of the bacteria, resulting in the bacteria being lysed to death, in order to achieve the purpose of disinfection. It should be noted that the alcohol concentration should not be too high, when the alcohol concentration is higher than 90%, the protein shell outside the cell membrane of the pathogen will degenerate to form a protective film, which will reduce the disinfection effect.

3. Application analysis of disinfection robots

Since the outbreak of the new coronavirus epidemic in 2019, the world has fallen into a stagnation in development, hospitals in various countries are overcrowded, and as the main battlefield against the epidemic, in order to prevent the spread of the epidemic centered on hospitals, the disinfection work of hospitals has always been a topic of great concern, and China's current disinfection robots can already be achieved , can preset the disinfection time,

place and path, process quantitative management, equipped with autonomous charging system, can achieve the whole process of unmanned operation, autonomous movement, no need to be on duty. A disinfection robot can carry a sufficient amount of disinfectant and has the ability to work continuously for more than 8 hours at a time.

The traditional method of manual disinfection, this method is inefficient, and because it is manual operation, the waste of artificial resources is more serious, and the quality of the sanitization is prone to occur sanitization is not complete, and there are omissions in the killing area. In the epidemic prevention and control area, the isolation between personnel is also very important, compared to the traditional way, the use of disinfection robots, to a large extent, reduces the risk of human infection with the virus, can be applied to hospitals, schools, office buildings, production workshops and other places with dense personnel or large flow.

4. Summary

Through preliminary research, it was understood that the design of medical disinfection robots is not a single discipline can be solved, which involves the knowledge of medicine, mechanics, dynamics and other fields, and in hospitals, transportation hubs, schools and other places, it is necessary to choose the right way to combine functions according to different environments and combine the actual situation to achieve the best disinfection effect.

The spread of the epidemic in public places has become an increasingly prominent public health problem in the world, and with the impact of the new coronavirus in 2019 so great, public environmental health problems and infection problems have become the focus of everyone's attention. Because the disinfection robot can cut the chain of pathogen transmission, can effectively prevent and control infection in public places, and is efficient and reliable, I believe that in the future of continuous development of technology, this new type of equipment will have a broader prospect.

Acknowledgments

This work is supported by the National Innovation and Entrepreneurship Training Program for College Students of Shandong University of Science and Technology, project number: S202110424045.

References

- [1] Zhang Xiong, Liu Hao, Zhong Zhouming, et al Design of disinfection and epidemic prevention intelligent inspection robot_Zhang Xiong[J]. Electronics Production, 2021, (1): 23-24, 42.
- [2] Ding Zhihu, Hu Guangkuo Application of intelligent robot in hospital disinfection operation_Ding Zhihu[J]. Medical Information, 2020, 33(5): 28-29.
- [3] Yuan Peng Research on the design and development of epidemic prevention and disinfection robot_Yuan Peng[D]. Shandong University, 2021.
- [4] Xiao Zhiqiang, Zhou Shumin, Wang Zhicheng Design of epidemic prevention and disinfection automatic navigation trolley system_Xiao Zhiqiang[J]. Instrumentation Technology, 2022, (2): 30-33.