IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

UV Disinfection Robot with Automatic Switching on Human

(A Novel Approach To Prevent The Spread Of COVID-19)

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ABSTRACT

Ultraviolet (UV) light is used for the purpose of disinfection or sterilization of rooms and surfaces. UV-C is employed as it has germicidal properties, in particular - bacteria and viruses, but it is detrimental to human beings as well. So, for the purpose of disinfection without human interference, a UV Robot has been designed and implemented that follows a predefined path.
It was equipped with three 20W UV lamps which radiate light in all directions. Given that UV light can be dangerous to humans, an embedded system based on Arduino along with PIR sensors is employed on top of the robot that detects human or animal motion and presence. So, one of the effective ways to avoid getting infected with SARS-COV-2 (Coronavirus) is by sterilizing rooms using a UV robot.

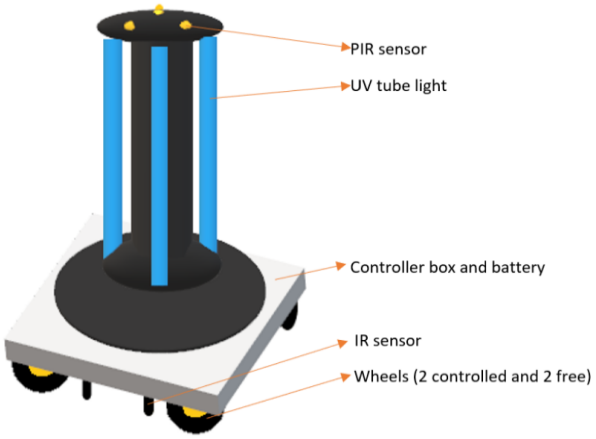
***Index Terms*– Ultraviolet Light, UV Disinfection**

I. INTRODUCTION

Contaminated surfaces increase the threat of disease transmission through the spread of pathogens either by contact or through the air. Proper disinfection and sterilization aid in reducing the probability of disease transmission. UV disinfection performs an important function in disease prevention. Powerful and frequent disinfection of the environment ensures a secure life. UV light is one of the nice viable solutions for disinfection. The disinfection of surfaces in hospitals or in any place is a very prominent example of ultraviolet germicidal irradiation (UVGI). UV-C light has a various range of programs within the fields of disinfection and sanitization. One of the salient applications of UV light is the sterilization of surgical instruments and medical equipment. Low-pressure mercury lamps which are a cheaper way to generate disinfecting UV light can also be used for this purpose. However, it is economical and environment-friendly to use UV light due to its high replacement cycle. Nevertheless, UV-C radiation is used for the process of sterilization as it has a wavelength of 100-280 nm and the energy is large enough to destroy the bacteria. As UVC light has significant use in the field of sterilization, it can be used as a key element to fight the novel Coronavirus. Till now, a fixed UV sterilization system has been employed. But there are a few limitations to using a fixed UV sterilization system. That is, because of their bulky length it is difficult to navigate through crowded places and reach shadowy areas. A cost-efficient and effective UV robot has been designed to limit the spread of bacteria and viruses, which goes along the given path and has the capacity to reach inaccessible areas for effective disinfection. When skin is exposed to Ultraviolet rays, the skin cells get damaged by absorbing the Ultraviolet rays and resulting in skin reddening, itching, and skin peeling. The subjection of skin to Ultra Violet radiation also results in cell damage, tissue damage, DNA damage, and skin cancers. Ultraviolet rays on the eye cause many eye problems such as Photokeratitis, Photo conjunctivitis, and cataracts and may also result in eye cancers and blindness. Ultraviolet radiation not only affects the skin and eye but also the immune system. These PIR sensors are mounted on the top of the robot to sense any movement (human/animal) so that it turns OFF the UV light by itself. The robot is designed in such a way that it follows a pre-defined path.

II. METHODOLOGY

The UV sterilization robot has a small form factor and can be turned ON/OFF automatically when a human or animal is detected so that no damage is done. The key components of the robot are three PIR sensors, three UV lamps, a controller box, a power source (which is free of electrical wires) – a battery, an Arduino, and two IR sensors. The height of the robot is about 123 centimeters.



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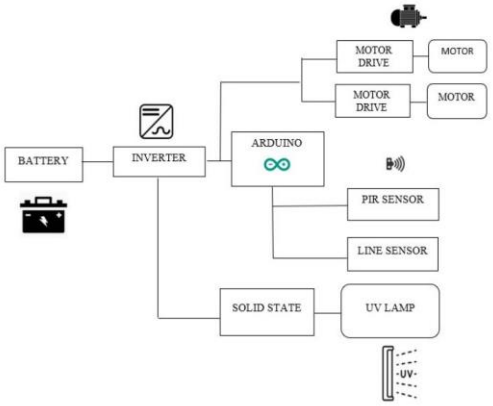
The main command center of the robot is the microcontroller. It is programmed to detect human beings /animals with the help of three PIR sensors or IR motion sensors which are mounted on top of the robot to cover a total angle of 360°. If a person is detected while the disinfection process is going on, the robot comes to a halt and the UV light gets turned OFF. Once the person leaves the room or operating area, the UV lights which were OFF get turned ON automatically and the disinfection process goes on until the process is complete. The robot has two IR sensors at the bottom of the base to follow the predefined path. The microcontroller controls the wheels of the robot by motor drivers in the path.

III. BLOCK DIAGRAM



IV. CALCULATION

Calculated Time for Disinfection: As a matter of fact, all virus species of the comparable kind have a similar structure and a similar RNA strand length. UV light experiments conducted in the past were used to determine the UV radiation dose required for 90% virus reduction (log-reduction dose). Dosages for a 90% destruction of most bacteria and viruses range from 2000 to 12000 µW/cm2. The robot utilizes 3 UV lamps in a circular pattern to cover 360° and maximize efficiency. Each lamp has a 20-watt output power.

$$\text{Brightness} = \frac{20*3(W)}{4*\pi*(158.49)2(cm2)}$$

$$=0.00018886 W/cm^2$$

$$=188.86\ \mu W/cm^2.$$

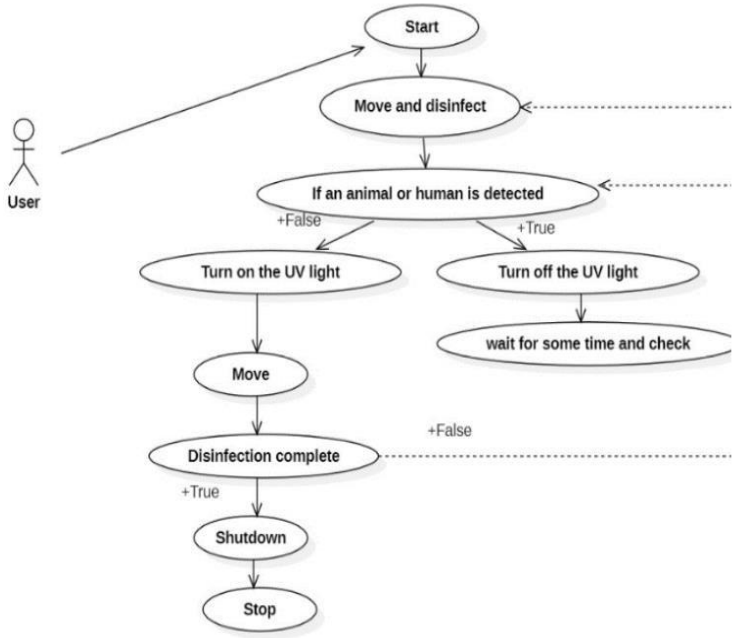
A UV dose of 10,600 µW. sec/cm2 is required for 90% virus reduction which can be considered as upper limit of log-reduction median dose (in low absorbance media). Therefore, the required time for germs elimination is expressed as:

$$\text{Time} = \frac{10{,}600(\mu W.sec/cm2)}{188.86(\mu W/cm2)}$$

=56.12 sec.

V. WORKING PRINCIPLE

Disinfection starts the moment the robot is turned ON. After the disinfection of a particular place is complete, the robot moves to the next directed position by following the line marked. This process continues till the disinfection of the entire room or place is complete. During the disinfection process, if a human or an animal approaches the operating area, then a command is sent to turn OFF the UV lights automatically. The data sensed by the PIR sensors are processed by the microcontroller and a message is sent to the robot. The robot remains in the same position if disinfection is not completed. After a delay of a few seconds, the PIR sensors check for the presence of a human, in general, to detect infrared radiation from the surrounding area of a specific range. As soon as the PIR sensors detect that there is no person or an animal in its range, the robot resumes-- which means the UV light gets turned ON automatically and finishes the process. After the complete disinfection of a room or a place, the robot can be scheduled for disinfecting another room or can be turned off.



VI. RESULT

The height of the robot designed is 26-28 centimeters. Its weight of it is about 800grams.
The robot that was designed and constructed is used for the purpose of surface disinfection. We have tested the efficiency of our robot considering a 12X12 feet room and 15x15 feet room. The time taken by our robot to disinfect a 12X12 feet room without any obstacles and human or animal detection is 10 minutes. The time taken for disinfection of a 15x15 feet room is 16min 49sec. In the case of human or animal detection, the robot takes much more time to disinfect as the disinfection process pauses during their presence. The time depends on the relative distance between the robot and the person, and the speed with which the person is walking.
Unfortunately, there are a few limitations. The first critical consideration is that UV light does not penetrate through furniture, laminated glass, or other objects. The second one is regarding distance, farther the robot lesser the disinfection, and the robot can disinfect only up to some height, the area above its height is not disinfected.

VII. CONCLUSION

In this report, the design and implementation of a fully autonomous and cost-effective UV disinfection robot are presented which has huge potential to guard people against coronavirus by sterilizing surfaces with the help of 20W UV lamps. The disinfection is done along a pre-defined path without human intervention as UV is deadly and dangerous to all living beings along with microbes. The UV robot requires at least 57 seconds for the inactivation of coronavirus present on the surface.

The robot will be able to move around the room and on detecting humans or animals with the help of IR motion sensors, it turns OFF the UV lights automatically making it safer and feasible to operate everywhere and from anywhere by scheduling the period of disinfection. The UV robot often works in peopled surroundings.
Therefore, this robot should not only clean efficiently but also harmoniously integrate with humans. Hence, cognitive abilities can be added to this robot by very simple and efficient theoretical approaches. The cleaning efficiency of the robot can be greatly

improved by understanding the environment along with the safety enhancement. To make it more environmentally friendly, the robot can be made to run on a renewable power source such as solar energy.

VIII. REFERENCES

[1] noriyuki yagi, mirei mori, akiko hamamoto, masayuki nakano, masatake akutagawa, souko tachibana, akira takahashi, toshitaka ikehara, yohsuke kinouchi, "Sterilization Using 365 Nm Uv-Led", 29th Annual International Conference of the IEEE EMBS Cité Internationale, 2007.
[2] Jui-HsuanYang, Un-InWua Huei-MinTai, Wang-HueiSheng, "Effectiveness Of An Ultraviolet-C Disinfection System For Reduction Of Healthcare-Associated Pathogens", Journal of Microbiology, Immunology and Infection , Volume 52, Issue 3, June 2019, Pages 487-493.
[3] G Katara, N Hemvani, S Chitnis, V Chitnis, "Surface Disinfection By Exposure To Germicidal Uv Light", Indian Journal of Medical Microbiology (2008)26(3):241-42.
[4] DISINFECTION OF AIRBORNE VIRUSES USING UV https://spectrum.ieee.org/techtalk/biomedical/devices/ultraviolet-revolution-could-faruv-lightprovide-widespread-safe-disinfection-of-airborne-viruses
[5]World Health Organization: Health Effects of UV Radiation. https://www.who.int/uv/health/uv_health2/en/

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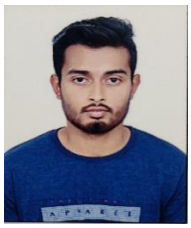

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