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UV-C DISINFECTION ROBOT

[1]**Pallavi A. Jadhav,** [2]**Sayali N. Kagankar,** [3]**Aishwarya B. Shinde,** [4]**Amarsinh B. Farakte**
[1, 2, 3] Final Year Engineering Students, [4]Assistant Professor
[1,2,3,4] Department of Electronics and Telecommunication Engineering, Sant Gajanan Maharaj College of Engineering, Mahagaon, Maharashtra, India.

Abstract: —Sanitization with human efforts is not an easy task. Chances of contracting infections increases which leads to additional spread of bacteria. Currently, normal cleaning robots are used in most of the places but looking at the current situation the sanitization techniques need to be improved. The robot uses radiation of UV rays to kill the microorganisms. It gives a live video streaming of its surrounding using a Wi-Fi based camera. With the help of Bluetooth module and android mobile, we can control the movement of the robot inside the room without being physically present. It is built with PIC Microcontroller and Ultraviolet-C (UVC) Sanitization LED. UV-C has bandwidth range of 200-280nm and is most powerful when it comes to killing pathogens in the room. This allows us to sterilize the room effectively. By killing the germs, the UV light restricts their multiplication by destroying their reproductive system. Thus use of this robot lowers the threat of infection, cost of traditional cleaning and sterilization and increases security in medical facilities. Thus, we are trying to implement a more efficient way of sanitization by building a Low cost UV sanitization Robot which can be used in small clinics and for household purpose.

***Index Terms* - Arduino Uno, UV Disinfection robot, UV lamps, PIR sensor, Sterilization.**

I INTRODUCTION

The Covid-19 pandemic due to the novel coronavirus SARS-CoV-2 has led to more than 2.5 million deaths and has infected more than 103 million people worldwide, which makes us rethink how organizations and societies can work with minimum or no physical contact. The economic and social loss caused by the epidemic are horrific: Millions of people at risk of falling into extreme poverty. Adherence to safety and work to create and promising them decent work and protection of employees rights in all industries is important. The actions aimed at saving lives and livelihoods should include expanding social protection with regard to the provision of universal health care and income support to the most respected [1].The spread of infection has increased due to microorganisms, bacteria, viruses in public places, operating system and hospitals. The growing demand for wellness and health products with a rising rate of diseases has increased the demand for sanitizers and disinfecting systems in market. Alternate option for sanitizers is UV light Radiation which has a power to kill the microorganisms in air. The ultimate goal of environmental control in the hospital operating room or patient room setup is to avoid microorganisms including drug-resistant bacteria to a irreducible minimum in order to provide a safe environment for the patient and healthcare worker. Therefore, both daily perioperative and terminal cleaning of the OR environment is one of the major effective infection control methods used to accomplish the goal in minimum optimizing the number of microorganisms, dust, and organic debris present in environment. The specific point of sanitation and disinfection is the inactivity or disposal of microorganisms to stay away from the spread of airborne diseases and pollution [2].

II LITERATURE SURVEY

Literature survey is very important while defining the novel approach. It helps to understand the extensive survey done by various authors reading the proposed topic and describe the methodology used with their pros and cons.

Table No.1- Literature Survey

Ref.	Objectives
[1]	Reviewing the current state-of-the-art in UVC disinfection robots: • This objective involves identifying and summarizing the most recent and relevant research studies, patents, and products related to UVC disinfection robots. • It may include evaluating the effectiveness of different UVC wavelengths, doses, and exposure times, as well as the design and functionality of different types of robots.
[2]	Enhance cleaning efficiency: • UVC disinfection robots can increase the efficiency and effectiveness of cleaning and disinfection processes by eliminating bacteria, viruses, and other harmful microorganisms on surfaces and in the air. • This can help reduce the risk of healthcare-associated infections and improve overall hygiene.
[3]	Reduce costs: • UVC disinfection robots can reduce costs by decreasing the need for manual cleaning and disinfection procedures, as well as by preventing healthcare-associated infections and related healthcare costs. • This can help healthcare facilities save money and improve their bottom line.
[4]	Enhance environmental sustainability: • UVC disinfection robots can enhance environmental sustainability by reducing the use of chemical disinfectants, which can have negative impacts on the environment and human health. • UVC disinfection is a non-toxic and eco-friendly alternative to chemical disinfection.
[5]	Reduce costs: • UVC disinfection robots can reduce costs by decreasing the need for manual cleaning and disinfection procedures, as well as by preventing healthcare-associated infections and related healthcare costs. • This can help healthcare facilities save money and improve their bottom line.
[6]	Investigating the challenges and opportunities of UVC disinfection robots: • This objective involves exploring the obstacles and opportunities of UVC disinfection robots, in terms of their deployment, acceptance, regulation, and integration into different settings and scenarios. • It may include identifying the barriers to adoption, such as cultural, social, and economic factors, as well as the potential benefits, such as reducing healthcare-associated infections, improving air quality, and enhancing public safety.
[7]	Examining the ethical and social implications of UVC disinfection robots: • This objective involves assessing the ethical and social implications of UVC disinfection robots, in terms of their impact on human dignity, privacy, autonomy, and justice. • It may include examining the potential risks of UVC exposure on humans and animals, as well as the potential biases and inequities in the distribution and use of UVC disinfection robots.
[8]	Proposing the future directions and innovations of UVC disinfection robots: • This objective involves envisioning and discussing the future directions and innovations of UVC disinfection robots, based on the current trends and challenges in the field. • It may include proposing new designs, features, and functions of UVC disinfection robots, as well as identifying the gaps and opportunities for further research and development.
[9]	Increase accessibility: • UVC disinfection robots can increase accessibility to effective disinfection methods, particularly in low-resource or remote areas where access to traditional disinfection methods may be limited. • This can help ensure that even underserved populations have access to safe and effective disinfection technologies.

III METHODOLOGY

The Fig. No.1 shows the circuit diagram of the implemented work which includes hardware components such as Arduino UNO, UV lamps, PIR sensor and many more devices. The circuit diagram is an implementation of components on PCB board. Here the Arduino UNO is the main component which acts as the brain of the system which controls all the functions regarding its input

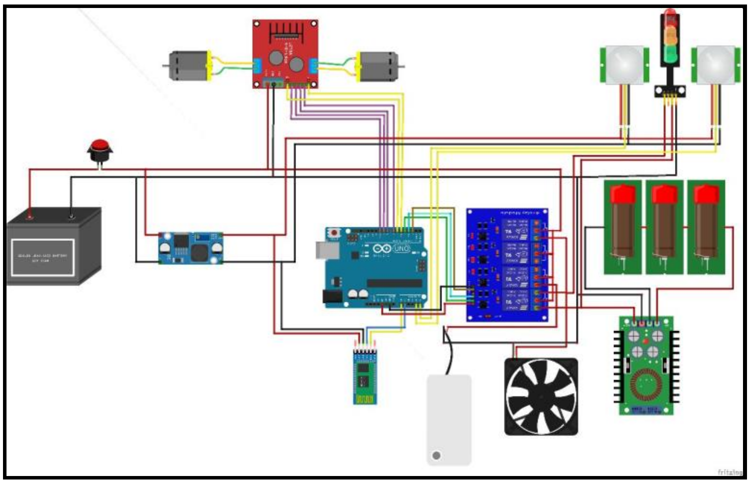

Fig. 1 Circuit Diagram

A circuit diagram of a UVC disinfection robot would typically include the following components:

1. Power Supply: A power supply is used to provide the necessary voltage and current to the robot's circuitry and UVC lamps [3].

2. Arduino UNO: An Arduino is used to control the robot's movement and the timing of the UVC lamps. It may also be used to monitor the robot's battery level and other sensors [4].

3. Motor Driver: A motor driver is used to control the robot's motors and enable it to move around the area to be disinfected.

4. Ultraviolet Lamps: The UVC lamps emit short-wavelength

Ultraviolet light that is effective in killing bacteria, viruses, and other pathogens. The lamps are typically arranged in an array to provide maximum coverage of the area being disinfected [5].

5. Sensors: PIR sensor can detect human or animal motion. Humans emit infrared radiation. When a human comes into the sensing range of the PIR sensor, these changes in radiations are detected by the PIR sensor [6].

6. Batteries: Batteries are used to power the robot's motors and circuitry, as well as the UVC lamps. The batteries are typically rechargeable to enable the robot to be used multiple times.

7. Charging Circuit: A charging circuit is used to recharge the robot's batteries when they become depleted, typically using a charging adapter that is connected to a power outlet.

Overall, the circuit diagram of a UVC disinfection robot is designed to provide a safe and effective means of disinfecting areas and surfaces using UVC light, while also ensuring that the robot is easy to control and maintain [7].

The following section gives the details regarding hardware implemented.

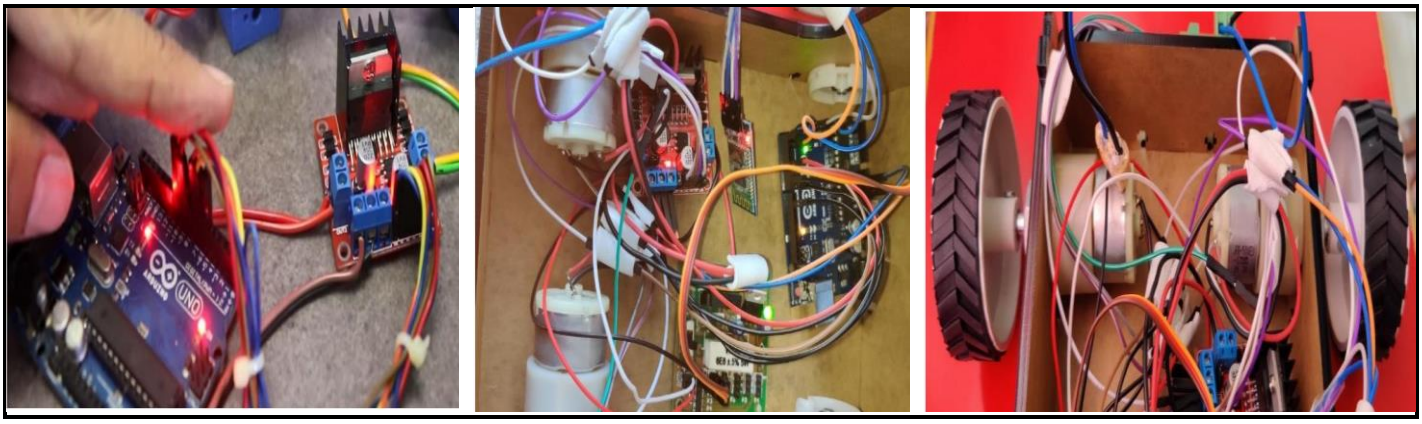

Fig. 2(a) **Fig. 2(b)** **Fig. 2(c)**

Fig. 2 Hardware Implementation

- Interfacing of Arduino with motor driver is depicted in Fig. (a) The main purpose of the driver is to amplify the received signal and drive servo motor, hence preventing Arduino board from being damaged from overload.
- Fig. (b) Shows how the DC motors that have been interfaced with the robot wheels to provide power for its movement.

- The overall interfacing of Arduino Board with other devices have been reflected in Fig.(c) UV-C LEDs have been mounted on the bottom of the robot to provide direct access of the surfaces to be disinfected. Similarly, the dispenser unit has been mounted on the top of the robot for efficient delivery of the desired medical items.

The following section gives the details regarding software implemented.

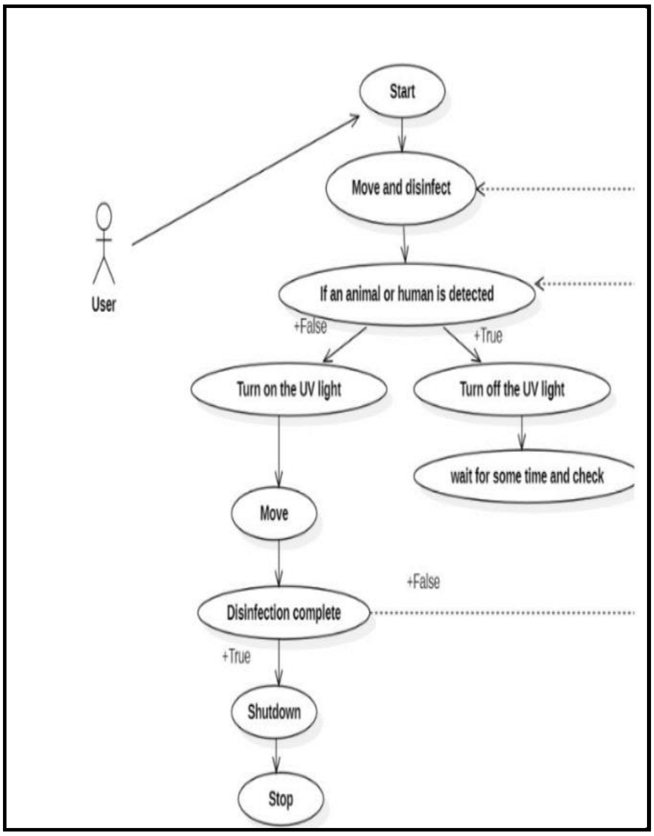

Fig. 3 Flowchart of PIR sensor module

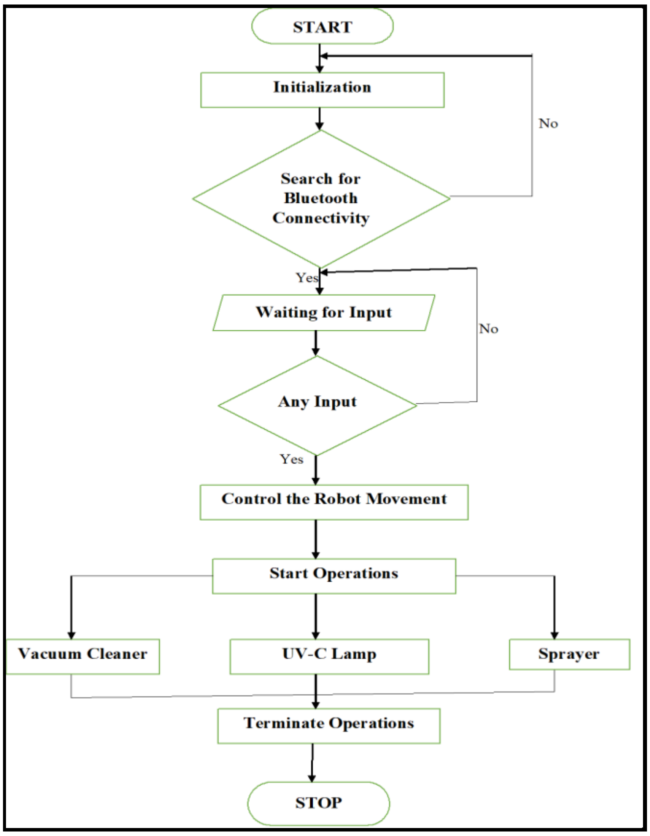

Fig. 4 Flowchart of UV Android Application module

Fig. 3 represent the flowchart of the PIR sensor module and the algorithms begins with 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 is 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 few seconds, the PIR sensors checks for the presence of human, in general, detects infrared radiation from surrounding area of specific range. As soon as the PIR sensors detects that there is no person or an animal in its range, 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. Finally, after completing all the required operations, the algorithm reaches its end, concluding the sequence of steps.

Fig. 4 represent the flowchart of the UV android application module and the algorithms begins with an initialization step then search for Bluetooth connectivity, if yes then wait for input, if no then goes to initialization. If Bluetooth connectivity is present, the robot will move to wait for input, where if it discovers any, it will move to control the robots movement otherwise it will move to wait for input. After controlling the robots movement, it will start operation. There are three operations in it. A vacuum cleaner, a UV lamp and a sprayer. If click in any of these operations, it will start operation. Finally, after completing all the required operations, the algorithm reaches its end, concluding the sequence of steps.

IV RESULTS

The results of the implemented system tested for following Modules:

- UV-C Disinfection Module
- Vacuum Cleaning Module

The results are discussed as below:

The Fig.5 shows the OFF mode of the UV-C tube of the robot at that time before result of a UV-C disinfection robot refers to the condition of the area or surface before the robot has been used to disinfect it. Fig. 6 shows the bacteria are presented on the surface without use disinfection. This may include the presence of bacteria, viruses, and other pathogens that can cause infectious diseases and pose a risk to public health. It may be determined through various means, such as visual inspection, microbial swab testing, or other methods of detecting pathogens. Overall, the result of a UV-C disinfection robot highlights the potential risks and hazards present in the environment, and underscores the importance of effective disinfection practices to prevent the spread of infectious diseases.

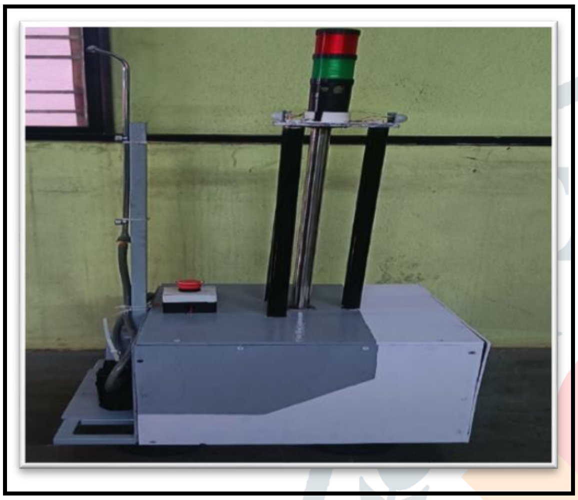

Fig. 5 Off Mode of UV-C Tube

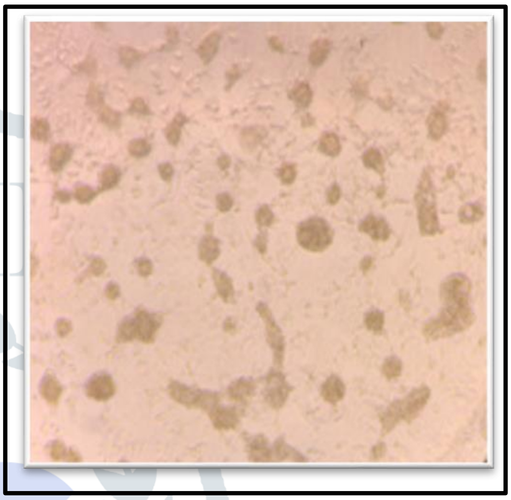

Fig. 6 without a disinfected Area

Fig. 7 shows the ON mode of the UV-C tube of the robot. The after result of a disinfection robot refers to the condition of the area or surface after it has been disinfected by the robot using UV-C tube. Fig. 8 shows the shows the bacteria being removed from the surface using a disinfection robot. The purpose of using a disinfection robot is to eliminate or reduce the presence of bacteria, viruses, and other pathogens that can cause infectious diseases and pose a risk to public health. It may be determined through various means, such as visual inspection, microbial swab testing, or other methods of detecting pathogens. A successful disinfection cycle should result in a significant reduction or elimination of pathogens, leading to a safer and healthier environment. Overall, the after result of a disinfection robot highlights the effectiveness of the robot in promoting a safer and healthier environment, and underscores the importance of effective disinfection practices to prevent the spread of infectious diseases.

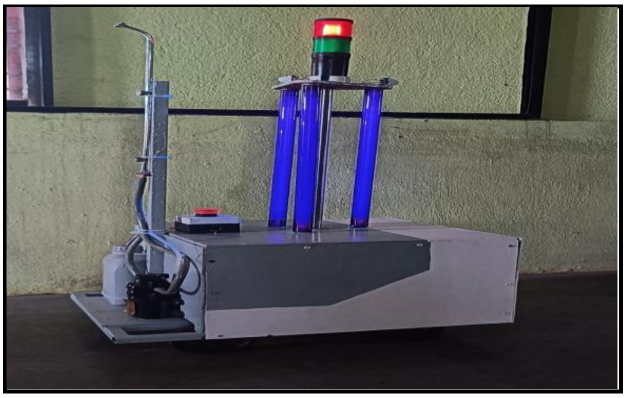

Fig. 7 ON Mode of UV-C Tube

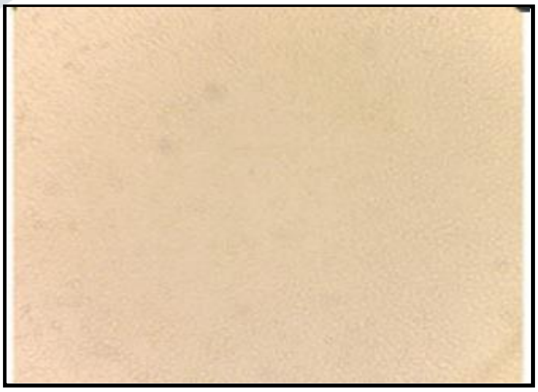

Fig. 8 Disinfected Area

The Fig. 9 shows the state of the area or surface prior to cleaning and disinfection is referred to as the before consequence of employing a hoover cleaner in conjunction with a UV-C disinfection robot. This could involve the presence of trash, dust, and other impurities that could house infections like germs and viruses. A UV-C disinfection robot should be used in conjunction with a hoover to clear any loose dust and debris from the surface so that the UVC light can disinfect the area more thoroughly and effectively. In general, emphasizes the possible risks and hazards existing in the environment and emphasizes the significance of efficient cleaning and disinfection practices to support a safer and healthier environment.

Fig. 9 Vacuum Cleaning Module

Fig. 9 shows the vacuum cleaning module. Using a vacuum cleaner after a UV-C disinfection robot has sterilized the area can help to remove any debris or particles that may have been left behind. While UV-C light is effective at killing microorganisms, it does not remove physical debris or particles from surfaces. Using a vacuum cleaner can help to ensure that the area is thoroughly cleaned and free of any contaminants. The after result of using a vacuum cleaner in conjunction with a UV-C disinfection robot should be a clean and disinfected area that is free of debris and other contaminants. This can help to reduce the risk of infection and promote a safer and healthier environment.

V CONCLUSION

As the tested results shows that the implemented system is useful for creation of clinical robotics has appreciably increased the safety and standard of health control systems due to Healthcare digitization. The technology is effective at reducing overall bacterial counts and significantly more successful than liquid sanitization which can be used in all public places or hospitals. The system presented in this article make the process of sanitization easy and reduces the time taken for the sanitization. The web application used in the implementation makes it more effective and easy to handle from anywhere. Ultraviolet sanitization is the latest disinfection technology with increasing importance. The main aim of this article is to support health workers.

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