UV Disinfection Robot with Obstacles Detection

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Abstract **-Ultraviolet (UV) sterilization technology is used to aid in reduction of microorganisms that may remain on the surfaces after a standard cleaning to the minimum number. Our research team developed a UV robot or UV bot for sterilization in an operating or a patient room. Our UV bot has three 19.3-watt of UV lamps mounted on top of the UV bot platform covering 180° direction. Our UV bot employed an embedded system based on a Arduino UNO to aid in navigation to avoid obstacles. In addition, we tested the effectiveness of eliminating Staphylococcus Aurous bacteria sample plates located 5 cm away from our UV bot to be within 8 seconds after UV light exposure**.

Keywords- Robot, Design, Fabrication, Sensor, Automa tion

I. INTRODUCTION

The ultimate aim of disinfection and sterilization is to inactivate or eliminate microorganisms in order to avoid the spread of airborne diseases and infections. Contaminated surfaces increase the threat of disease transmission through the spread of pathogens either by contact or through air. Proper disinfection and sterilization aids in reduced probability of disease transmission. Surface disinfection plays a vital role in disease prevention and transmission. Effective and frequent disinfection of surroundings ensures a safe life. For the purpose of disinfection, UV light is one of the best possible solutions. The disinfection of surfaces in hospitals or in any places is a very prominent example of ultraviolet germicidal irradiation (UVGI).

UV-C light has a diverse range of applications in the fields of disinfection and sanitization. One of the salient applications of UV light is 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 [7]. However, it is economical and environment-friendly to use UV light due to it's high replacement cycle. UV radiation spectrum is divided into three regions called UV-A, UV-B, UV-C. Nevertheless, UV-C radiation is used for the process of sterilization as it has a wavelength of 100-280nm 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 Corona virus.

II. OBJECTIVE

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 follow in 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 operator contorting device & operator turn off UV lights. The data sensed by the ultrasonic sensors is processed by the Arduino and a message is sent to the robot. The ultrasonic sensors checks for the presence of obstacle surrounding area of specific range. As soon as the ultrasonic sensors detects that there is no obstacle in its range, robot resumes-- which means the UV light gets turned ON by operator and finishes the process. After the complete disinfection of a room or a place.

III. PURPOSED SYSTEM

Ultra violet (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 pre-defined path. It was equipped with three 20W UV

lamps which radiates light in all directions. Given that UV light can be dangerous to humans, an embedded system based on Arduino along with ultrasonic sensors are employed on top of the robot that detects human or animal's motion and presence. So, one of the effective ways to avoid getting infected with SARS-COV-2 (Corona virus) is by sterilizing rooms using UV robot.

IV. LITERATURE REVIEW

An extensive overview of the literature is mentioned in this section. Aladdin Begin proposed the service disinfectant robots which are simple and effective in disinfection in medical institutions [1]. These are semi-automated systems that reduce the heterotrophic bacteria and MRSA on high-touch surfaces in rooms vacated by MRS Apatients. Implementation includes training personnel to operate the robots and the device should run when the room is empty. Pacharawan Chanprakon, Tapparat Seagoing, Treason Tree bupachat sakul, Pinkham Hannanta-anan, Wibool Piyawattanametha have developed an Ultra-violet sterilization robot for disinfection . This robot makes use of ultrasonic sensor sand webcam camera to avoid collision with obstacles. The signals from these sensors are used to navigate the robot. This robot uses 3 UV lamps to cover an angle of 360° for the purpose of disinfection. The movement, speed of this robot and UV lamp switching on-off can be controlled by the user via website with the same Wi-Fi network connected. Noriyuki YAGI, et al. have proposed Sterilization using 365nm UV-LED. This paper examines the sterilization effects of UV-LED and proves that UV-LEDis capable of sterilizing morbific bacteria. This paper postulates that UV-LED is smaller and brighter than low-pressure mercury lamp, so UV-LED can be used for the purpose of sterilization effectively Thomas Rubaek, et al. have developed a UV- Disinfection robot to reduce the outspread of diseases and Hospital- Acquired Infections (HAIs) . This robot is used to disinfect predetermined places in hospital and other environments. This robot is designed as an addition to the existing cleaning cycle. The test results of the designed robot are that the robot is able to destroy different types of bacteria. Jui - Hsu Anyang, et al. have implemented the Hyper Light Disinfection Robot that was successful in killing a number of multidrug-resistant bacteria and fungi that are commonly present in hospital. The effectiveness of the Hyper Light Disinfection Robot was very less on shadowed sites. This UV-C device may not be feasible to use in double or triple room because other patients who are admitted or present in the same room will get harm from UV exposure. This device cannot be used in crowded wards or large open spaces due to the consideration of safety measures.

V. PURPOSE

The motivation for the project is to build a voice-controlled robotic vehicle that will be helpful to disabled people because it can be used in wheelchairs. It also aims to make voice automation easier and use it in daily life to facilitate complex tasks. The main motive for building a voice-controlled robotic vehicle is to analyse the human voice and act according to the programmed commands. The vehicle can be controlled by the mobile application, so another motive is to use more wireless machines.

VI. SYSTEM ARCHITECTURE

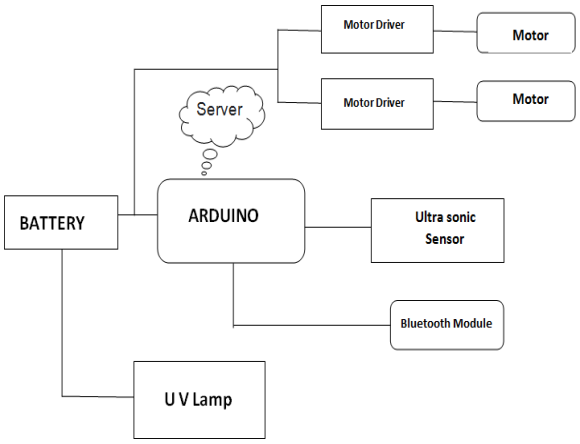

Fig. 1 Block Diagram of the Proposed system

VII. WORKING

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 follow in 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 operator contorting device & operator turn off UV lights. The data sensed by the ultrasonic sensors is processed by the Arduino and a message is

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A. Arduino UNO

UNO Board by Arduino Figure 4 depicts Arduino UNO is an open-source microcontroller board designed by Adruino.cc and based on the ATmega328p microcontroller. The board features 6 analogue pins and 14 digital pins that may be programmed using Arduino IDE and a USB Type B connector. It can be powered by a mains voltage battery.

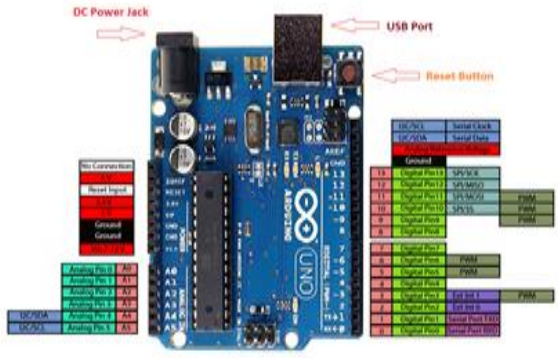

Fig. 2 Arduino UNO

B. L293D Motor Driver Shield

An L298 Driver is a high-voltage, high-current twin bridge driver that can drive inductive loads and accepts typical TTL logic levels. Each bridge's lower-level transistors' emitters are connected to the matching external terminal, which can be used to connect an external sensing resistor.

Fig. 3 Motor Driver Shield

C. Bluetooth module HC05

The HC05 module is a simple Bluetooth serial port protocol module designed for setting up a wireless serial connection. It has a modest footprint of 12.7mm x 27mm. It will make the entire design process easier.

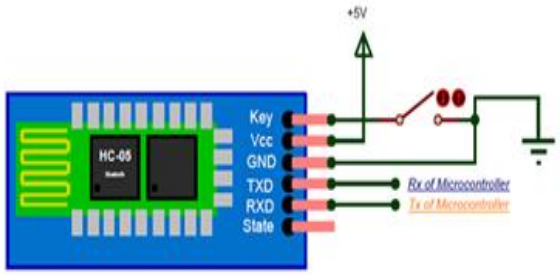

Fig. 4 Bluetooth Module HC05

D. DC Motor

This type of rotary electrical equipment that transforms direct current into mechanical energy. All types of DC motors contain an internal mechanism, either electronic or electromechanical, that allows it to change the direction of current flow in the motor's path on a periodic basis.

Fig. 5 D.C. Motor

E. Wheels

This are simple devices that consist of a circular block of sturdy and hard material that is put in an axil around which the wheel revolves when a moment is imparted by torque or gravity. The wheel turning on the horizontal axil allows huge loads to be transported when it is positioned under a load-bearing platform.

Fig. 6 Robotic Wheels

F. Ultrasonic sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect across boundaries to produce distinct echo patterns. Provides distance measurements to detect obstacles and enable navigation.

Fig. 7 Ultrasonic Sensor

G. UV LED's

UV LEDs are effective against eliminating harmful bacteria, fungi, and viruses such as COVID-19. They can be used in water purification systems, air purifiers, and surface sterilization devices to kill bacteria, viruses, and other microorganisms by damaging their DNA.

The UV light source serves as the primary mechanism for sanitizing the environment traversed by the robot. UV-C light, in particular, is known for its germicidal properties and is effective at destroying the DNA and RNA of microorganisms, rendering them unable to replicate and causing their eventual death.

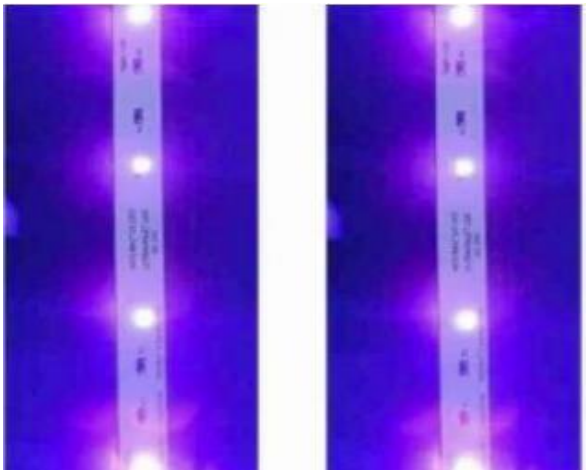

Fig. 7 UV LEDs

VIII. SOFTWARE DESCRIPTION

A. Arduino IDE Software

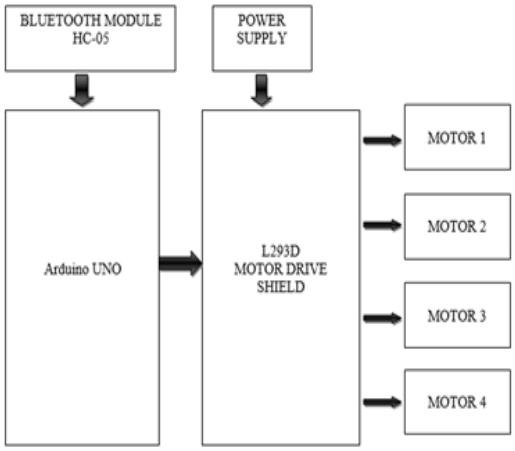

Fig. 7 Arduino Working Diagram

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches.

IX. RESULT AND DISCUSSION

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 microrganisms. 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 sterilise 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 sterilisation 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.

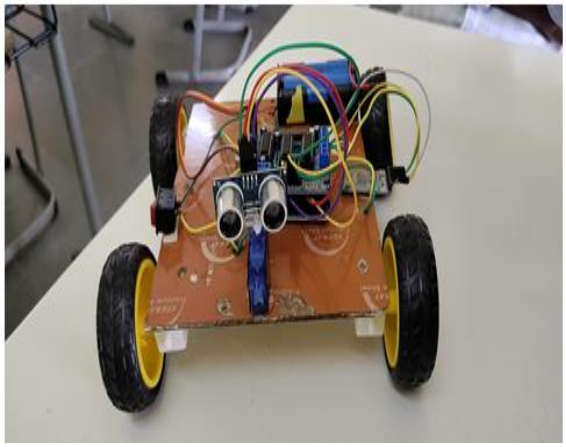

Fig. 8 UV Disinfection Robot with Obstacles Detection.

IX. CONCLUSION

In conclusion, UV sanitization robots present a cutting-edge solution to the pressing need for effective disinfection in various environments. These robots leverage the power of ultraviolet (UV) light to efficiently deactivate pathogens on surfaces, offering several key benefits.

Firstly, UV sanitization robots demonstrate remarkable efficiency by swiftly disinfecting large areas without the need for manual intervention. This efficiency makes them invaluable assets in environments such as hospitals, schools, airports, and public spaces where maintaining cleanliness is crucial. Moreover, the effectiveness of UV-C light in neutralizing a wide array of pathogens, including viruses and bacteria, underscores the importance of these robots in preventing the spread of infectious diseases. By providing a thorough and reliable disinfection process, UV sanitization robots contribute significantly to overall hygiene and public health. Safety is another critical aspect addressed by UV sanitization robots, with many models equipped with features to prevent exposure to harmful UV radiation. These safety measures ensure that users are protected while the robots perform their disinfection tasks.

Furthermore, the automation capabilities of UV sanitization robots streamline cleaning processes, reducing the need for manual labor and minimizing the risk of human error. This automation not only improves efficiency but also ensures consistent and thorough disinfection results.

Despite these benefits, it's essential to acknowledge the limitations and challenges associated with UV sanitization robots, such as their limited reach and maintenance requirements. Additionally, integrating these robots into existing cleaning protocols may require careful planning and coordination.

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