UV- C LIGHT MOBILE ROBOTICS SYSTEM

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ABSTRACT

UVC light and chemical-based treatments are two of the many techniques developed in response to the pressing need to clean enclosed areas. But there's a chance that these methods could endanger people's health and the environment. To solve this, a novel approach combines features for cleaning and drying with UVC disinfection technology. With the combination of mopping and drying tasks, this method attempts to eliminate contaminants while simultaneously improving cleaning efficacy. Beyond the constraints of conventional techniques, intelligent navigation algorithms guarantee that every surface is directly exposed to UV-C lamps. An Android software with Bluetooth control is used to operate the system, which has three UV-C lamps and can disinfect an area 360 degrees. Enhanced safety against UV exposure is made possible by the robot's safe external control by its operators. This system has an automatic self-timer that turns off the UV-C lamps, making it safe and effective. It provides an all-encompassing solution for efficient, ecologically friendly sanitation and is implemented in a variety of contexts, including our Lab.

Keywords: UVC disinfection technology, Teleoperated robot, Surface disinfection, Intelligent navigation, Autonomous lamp shutdown, Pathogen eradication.

1.INTRODICTION

Semiconductors with a stable structure doped with precious metals are utilized in UVC-LEDs. The type and nature of the power supply for these sources determine the emitted light, lifespan, and emission spectrum. These sources can be powered either continuously or pulsed. Conventional UVC lamps, primarily medium or low-pressure ones, remain prevalent in disinfection units. However, they come with inherent drawbacks such as mercury usage, low mechanical stability, and ozone production. Their lifespan is typically around 8000 hours, with a peak emission at 254 nm at 30 W power. Short-duration flashes are generated using polychromatic sources employing high-intensity pulsed xenon lamps, providing high-intensity, broad-spectrum UV light with a wavelength of 200–300 nm. UVC-LEDs are emerging as replacements for traditional bulbs, being four to nine times more efficient in water treatment, smaller, and requiring less energy. However, their adoption is still limited due to their higher cost. Several studies have compared the efficacy of various disinfection units. Comparisons have been made regarding surface cleaning and microbe inactivation using pulsed light sources and conventional lamps. In studies examining pulsed xenon systems versus ordinary lamps for reducing healthcare-associated microorganisms in hospital rooms, pulsed UV light proved more effective. It has been found that both pulsed xenon and mercury lamps are equally effective in brief exposures, around 10 minutes, in inactivating bacteria in ambulances. Reports indicate that such devices can reduce environmental illnesses within 30 minutes without the need for chemical agents. Despite the trend towards smaller, mercury-free disinfection units, UVC mercury lamps remain popular due to their low cost.

2. LITERATURE REVIEW

2.1. Automatic Waste Segregating and Self-Sanitizing Dustbin

Keeping ourselves healthy is vital to our existence. As infectious diseases spread and reemerge, nations all over the world are dealing with health-related issues. Though innovations are put forth to handle waste collection and disposal, a safe and intelligent waste management system still needs to be designed. We have created a system known as the "Automatic Waste Segregating and Self Sanitizing Dustbin" to achieve this. This initiative operates on the fundamental principles of sensor technology to achieve its objectives. Its primary aim is to establish clean, sanitary, and disease-free environments, with a focus on waste separation and sanitization, all without human intervention. Additionally, it aims to prevent the release of toxic gases from decomposing waste. The technology is capable of identifying waste and automatically notifying the recipient when the bin reaches full capacity. This feature enables its use as a versatile trash can for both individual homes and community settings. Effective trash management, encompassing waste generation, collection, disposal, and transportation, is crucial for maintaining a healthy environment. Waste generation is a major challenge in metropolitan settings, where population growth is the primary factor contributing to an inadequate waste management system. Serious health hazards and the spread of infectious illnesses can arise from improper waste management. Those who labor in the community and maintain public areas are at a higher risk of catching the global pandemic of 2019. We are all aware that the infection can enter our bodies through our mouths, noses, and eyes after we come into contact with contaminated surfaces or objects. Although humans take every precaution possible, more security measures are needed. The people who serve their community and environment housemaids, cleaning staff, and public trash collectors—are the main victims of this significant issue. Consequently, a structure that can lessen the severity of this issue needs to be constructed.

2.2. Characterization Of Encapsulant Degradation in Accelerated UV Stressed Mini- Modules With UV-Cut And UV-Pass Eva.

Encapsulate browning and delamination are two common deterioration processes observed in crystalline silicon field-exposed modules that use ethyl vinyl acetate (EVA) as the encapsulate material. To study these processes, six mini-modules were subjected to accelerated UV testing at various temperatures, with two types of encapsulates—UV-cut (UVC) EVA and UV-pass (UVP) EVA. Overall, 800 kWh/m² of UV light (between 300 and 400 nm) was administered. During testing, the UVC mini-modules, maintained at temperatures of 61°C, 67°C, and 70°C, exhibited an increase in the degree and intensity of browning, as observed in UVF pictures. In contrast, the UVP mini-modules showed delamination instead of browning. Additionally, there was an increase in reflectance in the wavelength range of 500–700 nm for the UVC mini-modules. Characterization results indicated that EVA browning and delamination are the main degradation mechanisms in UVC and UVP mini-modules, respectively. Ethylene vinyl acetate (EVA) is the industry-standard encapsulant for crystalline silicon solar modules. It contains UV absorbers, UV stabilizers, peroxide curing agents, and antioxidants. UVC EVA absorbs light below 350 nm, while UVP EVA transmits light below 350 nm. Over time, UVC EVA turns yellow and then brown due to chromophore production caused by main chain degradation and/or additive degradation. Conversely, UVP EVA does not experience encapsulant browning since it lacks UV absorbers. Delamination occurs due to inadequate adhesion between the solar cell, glass, and encapsulant, particularly when exposed to UV light at higher temperatures. The UV preconditioning specified by IEC 61215, with a total UV exposure of 15 kWh/m², assesses the interfacial binding strength of the encapsulant with glass and silicon cells, equivalent to approximately 45 days of field exposure.

2.3. Cathodoluminescent UV-Sources Using Carbon Fiber Field Emission Cathodes

Prototypes of cathodoluminescent UV radiation sources utilizing field emission cathodes are constructed using carbon fiber. These sources exhibit varying UV spectra depending on the phosphors employed. With the emergence of ultraviolet (UV) assisted printing as a promising additive manufacturing (AM) technology, there is a growing demand for UV light sources capable of focused emission. Unfortunately, current UV LEDs available in the market lack the ability to sufficiently focus UV radiation for printing applications. To address this limitation, a UV LED package with concentrated UV emission utilizing MEMS (Micro-Electro-Mechanical Systems) technology was proposed and developed. The concentrated UV emission optical model for the UV LED package was created, envisioning a design where a silicon reflector is stacked on top of itself. This design, coupled with hemispherical quartz lenses, facilitated the effective production of the UV LED package with concentrated UV emission. The resulting narrow beam at the focal point, at 0°, exhibited an intensity exceeding 1000 mW/cm², with a beam angle between half maximum intensity of 16°. Furthermore, multiple prototypes of cathodoluminescent UV sources with diverse spectra and field emission cathodes based on carbon fiber have been developed. These sources employ a triode lamp configuration consisting of the cathode, modulator, and anode.

2.4. From One to Another: How Robot-Robot Interaction Affects Users' Perceptions Following a Transition Between Robots

Many human-robot interactions are becoming increasingly prevalent, necessitating an understanding of how to transition users between different bots and alter messaging between them. To explore these inquiries, a researcher devised a mixed-methods study incorporating tasks for participants. Participants engaged with mobile robots devoid of social barriers to facilitate interaction with stationary robots. Each participant encountered three types of bot-to-bot interactions: social (a stationary robot initiating a request to a mobile robot in a social context), direct (a stationary robot directly communicating with a mobile robot upon request), and agent (a stationary robot making a request directly to a mobile robot). Each participant was exposed to only one form of robot communication: verbal (stationary robot audibly conveying the request), open (robot visibly acknowledging communication), or silent (robot covertly communicating). The findings reveal that enabling a social robot to interact socially with a functional robot can promote social behavior in the robot and enhance its likability. Additionally, it was discovered that verbally reciting information is preferable to covertly exchanging information.

2.5. Design of Intelligent Watering Robot

To create an intelligent watering robot capable of autonomously and efficiently watering bonsai trees, reducing the need for labour-intensive manual spraying and minimizing overall human resource requirements, several components were carefully selected. The control center of the mobile robot is based on the stm32f4, leveraging the ARM Cortex-M4 core. A linear CCD image acquisition sensor serves as the line patrol module, while a microcontroller-based soil moisture detection sensor functions as the soil moisture detection module. Additionally, a wireless transceiver chip enables wireless communication. The robot is designed to navigate predetermined paths and water bonsai trees requiring hydration. A coordinate system was established for the RPP spray manipulator on the robot's mobile platform. Utilizing the Varangian technique, the dynamic model of a three-degree-of-freedom (DOF) manipulator was derived. Dynamic simulation analysis was conducted to offer a theoretical foundation for the manipulator's dynamic design and control, examining the force/torque change curve. As science and technology continue to advance, robots are increasingly integrated into our daily lives, serving various purposes and enhancing efficiency.

3. EXISTING SYSTEM

The existing system you mentioned is a robot that disinfects surfaces, especially in homes, offices, hospitals, and other buildings, using ultraviolet-C (UV-C) technology. It is operated by a Bluetooth wireless interface with an Android app. With its three UV-C lamps, this robot can successfully disinfect an area that is 360 degrees around. It also features a self-timer that shuts off the UV-C bulbs automatically. By employing UV-C radiation to damage the DNA of viruses like the coronavirus and other infections, this technology stops their reproduction and the spread of illness. The robot is teleoperated, allowing operators to control it from outside the room, which is crucial for safety during the disinfection process. The technology used in this system includes UV-C disinfection technology and an Android app for control. It has been deployed in various settings, including medical facilities, to sanitize patient rooms and restrooms. The system seems to integrate elements like cryptography, IR communication, keypad testing, transmitter, and receiver, although their specific roles in the system are not detailed in this description.

4. PROPOSED SYSTEM

The proposed robot operates autonomously, utilizing ultrasonic sensors for obstacle detection and avoidance. This choice is made due to the longer range of ultrasonic sensors compared to IR sensors. The robot incorporates ultraviolet LEDs for sanitization, effectively eliminating viruses, and is also equipped with a sanitizer spraying mechanism. Motor control is facilitated by a dual-channel motor driver connected to a Node MCU, enabling both remote operation and autonomous navigation. An inverter, managed by a relay switch connected to the Node MCU, regulates the power supply to the UV lights from the battery. The primary function of the robot is sanitation through ultraviolet germicidal irradiation (UVGI), which helps prevent the transmission of infectious diseases. UVGI typically utilizes low-pressure mercury discharge lamps or LEDs emitting shortwave ultraviolet-C radiation, often at a wavelength of 254 nm. The robot is equipped with mopping and drying capabilities, enhancing its cleaning solutions. A dedicated motor controls the water reservoir and mop attachment for mopping operations. To ensure thorough mopping coverage, the robot intelligently dispenses water and cleaning solution while traversing the floor. The robot also features a drying system that utilizes hot air and airflow to accelerate the drying process. This drying mechanism activates once the mopping operation is complete, ensuring the floor remains dry and free of moisture. The robot's autonomous navigation system seamlessly integrates with both the mopping and drying functions. Depending on user preferences and detected cleanliness levels, the robot automatically switches between mopping, drying, and sanitization modes. By combining mopping, drying, and sanitization functions, the robot provides a comprehensive cleaning solution. This guarantees that floors are thoroughly cleaned, dried, and sanitized, promoting a sanitary and germ-free environment.

4.1. PROPOSED BLOCK DIAGRAM

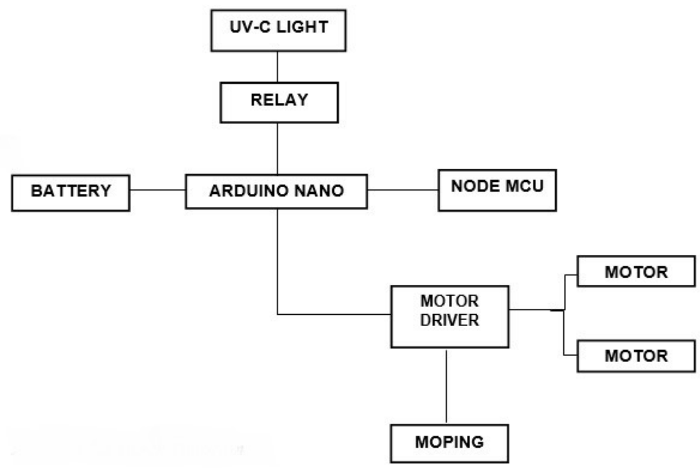

Figure 4.1.1 Block Diagram

5. DESIGN AND IMPLEMENTATION

5.1 Arduino Microcontroller Integration

Arduino Nano is one type of microcontroller board, and it is designed by Arduino.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also used in Arduino UNO. It is a small size board and also flexible with a wide variety of applications. Other Arduino boards mainly include Arduino Mega, Arduino Pro Mini, Arduino UNO, Arduino YUN, Arduino Lilypad, Arduino Leonardo, and Arduino Due. And other development boards are AVR Development Board, PIC Development Board, Raspberry Pi, Intel Edison, MSP430 Launchpad.

5.2 IR Proximity Sensors

IR technology is used in daily life and also in industries for different purposes. For example, TVs use an IR sensor to understand the signals which are transmitted from a remote control. The main benefits of IR sensors are low power usage, their simple design & their convenient features. IR signals are not noticeable by the human eye. The IR radiation in the electromagnetic spectrum can be found in the regions of the visible & microwave. Usually, the wavelengths of these waves range from 0.7 µm 5 to 1000µm. The IR spectrum can be divided into three regions like near-infrared, mid, and far-infrared.

5.3 Motor Control System

We can only have full control over a DC motor if we can control its speed and spinning direction. This is possible by combining these two techniques.

5.3.1 PWM – to control speed

The speed of a DC motor can be controlled by changing its input voltage. A widely used technique to accomplish this is Pulse Width Modulation (PWM). PWM is a technique in which the average value of the input voltage is adjusted by sending a series of ON-OFF pulses. This average voltage is proportional to the width of the pulses, which is referred to as the Duty Cycle.

5.3.2 H-Bridge – to control the spinning direction

The spinning direction of a DC motor can be controlled by changing the polarity of its input voltage. A widely used technique to accomplish this is to use an H-bridge. An H-bridge circuit is made up of four switches arranged in a H shape, with the motor in the center. losing two specific switches at the same time reverses the polarity of the voltage applied to the motor. This causes a change in the spinning direction of the motor.

5.4 Cleaning Mechanism

The cleaning mechanism of the rover operates as Water from the reservoir is dispensed onto the mop as per requirement. The motorized system drives the mop across the floor, effectively cleaning the surface.

5.4.1 Submersible Mini Water Pump

Mini submersible type water pump that works on 3-6V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe to the outlet and power the motor with 3-6V to start pumping water. Great for building science projects, fire-extinguishers, firefighting robots, fountains, waterfalls, plant watering systems etc.,

5.4 UV Light System

UV-C light technology is a radiation method that makes use of a specific wavelength of ultraviolet light to neutralize microorganisms. UV-C light is germicidal, which means it deactivates the DNA of microorganisms like bacteria, viruses, and other pathogens, disrupting their ability to multiply and cause disease. UV-C light technology is defined by a range of terms, including germicidal irradiation, UVGI, and UV-C radiation. All of these terms refer to the same, ultraviolet-c light that reduces the spread of pathogens.

5.5.1 UV-C Refers to A Specific Ultraviolet Wavelength

There are three categories of ultraviolet light wavelengths, UVA, UVB, and UVC. UV-C wavelengths are between 200 and 300 nanometers and are proven to be harmful to microorganisms.

5.5.2 UVGI stands for ultraviolet germicidal irradiation

It is often used interchangeably with UV-C technology or UV-C light and refers to the same technology of utilizing UV-C wavelengths to neutralize pathogens.

6. RESULT

The Arduino-based Obstacle Avoidance Rover has diverse applications to home cleaning to Provides an efficient solution for floor cleaning and air disinfection. office environments to Maintains cleanliness in shared spaces and enhances indoor air quality. Public areas to Offers a cost-effective and autonomous cleaning solution for high-traffic areas.

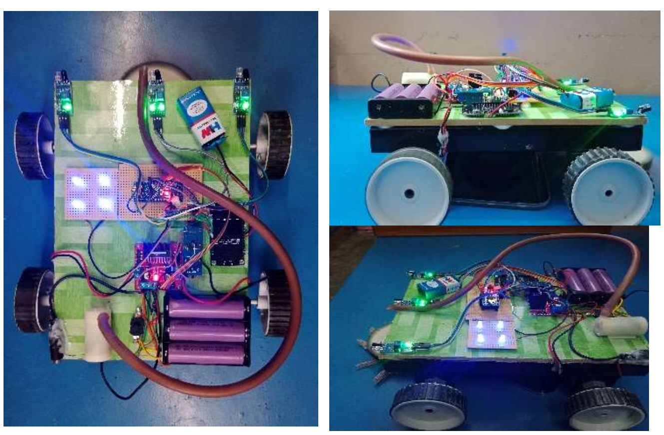

Figure 6.1 Robot images

5. CONCLUSION

The UV sanitization robot uses the power of UV rays to kill germs and bacteria. The robot can also give a live video stream of its surroundings. With the help of we can control the robot and its MCU allows us to drive the robot inside a hospital room without physically being there. All this enables us to sanitize the hospital room as per our requirements. By killing the germs, the UV light restricts their multiplication by destroying their reproductive system. The robot can disinfect and kill diseases, viruses, bacteria, and other types of harmful organic microorganisms in the environment, with ultraviolet light, by breaking down their DNA-structure. Currently, several countries have tested these robots successfully to disinfect their hospitals, public transports, office spaces, and other public places. We have implemented this UV robot in a cost-effective way to expand the disinfection process to public places. The most common and popular method to disinfect public places is to spray disinfectant liquids which are 70% alcohol-based liquids. Recently, the World Health Organization (WHO) has announced that it is really harmful to use disinfectant liquids regularly in public places. This can cause problems in the respiratory system due to their strong scent, cause skin irritation, and may lead to the unbalances in the environment.

6. FUTURE ENHANCEMENT

UVD Robots, a subsidiary of Blue Ocean Robotics, are able to disinfect patient rooms and operating theaters in hospitals. The robots consist of a mobile base equipped with multiple lidar sensors and an array of powerful short wavelength ultraviolet-C (UVC) lights. The operators deploy the robot using a computer. The robot scans the environment using its lidars and creates a digital map. The operator can then annotate the map indicating all the rooms and points the robot should not disinfect. After that, the robot relies on simultaneous localization and mapping (SLAM) to navigate. The UV sanitization robot uses the power of UV rays to kill germs and bacteria. The robot can also give a live video stream of its surroundings.

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