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Literature Survey On Autonomous Uv Sanitization Robot

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ABSTRACT— In the context of global health and sanitation, the use of robotics and automation in healthcare environments has gained significant attention. This project proposes an Autonomous UV Sanitization Robot designed to effectively eliminate harmful germs and bacteria in hospitals and similar settings using UV-C light. The robot employs advanced technologies such as LiDAR-based navigation, autonomous path planning, and environmental monitoring. Enhanced safety measures ensure that the UV-C light automatically shuts off in the presence of humans, reducing risks. Preliminary results show the robot's ability to efficiently sanitize surfaces while optimizing resource use.

I. INTRODUCTION

Maintaining clean and safe environments is critical, especially in healthcare facilities. Traditional cleaning methods often fall short in ensuring thorough disinfection and may expose workers to hazardous chemicals. Autonomous robots equipped with UV-C light technology offer a non- contact, chemical-free solution to sanitization. Analysis of traditional cleaning methods reveals inefficiencies, such as incomplete coverage, human error, and the inability to disinfect inaccessible areas. These limitations have led to an increased focus on leveraging autonomous systems to address these challenges.

The **Autonomous UV Sanitization Robot** leverages autonomous navigation, environmental sensors, and deep learning to optimize sanitization processes. The robot maps the environment and plans optimal paths for cleaning while monitoring air quality and humidity to adjust UV exposure. Additionally, UV-C light's ability to disrupt the DNA/RNA of pathogens ensures that the system is highly effective against a broad range of microorganisms.

To further enhance its efficiency, the robot employs machine learning algorithms that enable continuous improvement of navigation and cleaning patterns over time. The integration of real-time monitoring and feedback mechanisms ensures that the sanitization process is both effective and adaptive to changing environmental conditions.

The system's ability to shut off UV-C light when detecting human presence ensures safety. This innovative project addresses the growing need for smarter, safer, and more efficient sanitization methods. It aims to redefine standards in hygiene and infection control across diverse settings, from hospitals to public transportation.

The rising prevalence of hospital-acquired infections (HAIs) has underscored the urgent need for effective disinfection technologies. Studies indicate that over 1.7 million HAIs occur annually, resulting in significant healthcare costs and adverse patient outcomes. The proposed robot offers a proactive approach to mitigating these risks by ensuring consistent and thorough sanitization of high-touch surfaces and areas.

In addition to healthcare facilities, the Autonomous UV Sanitization Robot has the potential to transform cleaning protocols in various industries. From public transport systems and educational institutions to hospitality and commercial spaces, the robot's versatile design and scalable features make it a valuable asset in maintaining hygienic environments globally. Its chemical-free approach aligns with sustainability goals, reducing reliance on harmful disinfectants and contributing to a greener future.

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II. LITERATURE PAPER

The rapid advancements in robotics and artificial intelligence (AI) have spurred research into developing automated solutions for sanitation and hygiene. In recent years, ultraviolet (UV) light-based disinfection systems have gained traction due to their ability to neutralize a broad spectrum of pathogens. The literature indicates that UV-C light, in particular, has proven effective in disrupting the DNA and RNA of bacteria, viruses, and fungi, thereby rendering them inactive.

[1] This paper discusses the development of an autonomous robot designed to address public health challenges posed by the COVID-19 pandemic, focusing on UV sanitization, social distancing monitoring, body temperature checks, and mask detection. It highlights the importance of integrating various control methods into a single versatile robot to effectively combat the spread of the virus. The paper emphasizes the need for a practical approach that balances features, size, and aesthetics,while utilizing advanced technologies such as deep learning frameworks and image processing to enhance the robot's functionality and efficiency in public spaces**.**

[2] The paper discusses the development and implementation of an autonomous robotic system designed for ultraviolet (UV) disinfection, particularly in the context of the COVID-19 pandemic. It highlights the increasing reliance on robotic technology in healthcare settings to mitigate the spread of infectious diseases, such as COVID-19, Ebola, and SARS, which are transmitted through respiratory droplets. The authors emphasize the importance of effective disinfection to maintain public health and socioeconomic stability, detailing the robot's design, functionality, and potential impact on enhancing cleaning protocols in hospitals and other high-risk environments.

[3] The paper discusses the significant impact of the COVID-19 pandemic on various sectors, including the economy, education, finance, and health. It highlights government measures such as commerce closures, social distancing, and travel restrictions aimed at preventing virus spread, which led to job losses and a shift to online education. Additionally, it emphasizes the scientific community's response in prioritizing vaccine research and developing norms to mitigate the virus's spread, alongside the emerging role of robotics in clinical care and logistics during the pandemic.

[4] This presents the design and functionality of an autonomous UV-C disinfection robot,named Ultra Bot, intended for indoor use in environments with human presence, such as warehouses and shopping centres. The robot features a unique mechanical structure with UV-C lamps positioned to minimize risk to humans while effectively sanitizing surfaces. It incorporates a high- level control system that allows for manual and autonomous operation, utilizing advanced navigation and localization techniques to ensure safe and efficient disinfection, achieving a significant reduction in bacterial counts during experimental trials**.**

[5] The paper investigates the effectiveness of a moving robot equipped with UV-C lamps for sanitizing surfaces contaminated with microorganisms, particularly in the context of the SARS- CoV-2 pandemic. It highlights the importance of reducing pathogen transmission through effective disinfection methods, comparing traditional chemical sanitization with the advantages of UV radiation. The study demonstrates that the robot can significantly lower microbial loads on surfaces, with its efficacy influenced by factors such as exposure time and the presence of obstacles, suggesting that automated UV systems can serve as a valuable addition to existing sanitation practices.

[6] The paper presents the development of a UV sterilization robot designed to enhance sanitization efforts, particularly in healthcare settings during the COVID-19 pandemic. This robot employs

UV-C light technology to effectively disinfect surfaces, minimizing the risk of pathogen transmission. It features dual operational modes—automated and manual—allowing for both autonomous disinfection and human-controlled operation via remote access. The integration of intelligent sensors for obstacle detection and real-time monitoring ensures safe and efficient navigation, making it a valuable tool in the fight against hospital-acquired infections. Overall, the robot represents a significant advancement in automated disinfection technology, addressing the challenges posed by traditional cleaning methods.

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[7] The paper discusses the development of UltraBot, an autonomous mobile robot designed for indoor disinfection using UV- C light, aimed at reducing the transmission of COVID-19 and other harmful pathogens. It highlights the robot's mechanical and electrical design, emphasizing its ability to perform effective disinfection while ensuring human safety through obstacle detection and emergency shutdown features.
The research includes experimental data demonstrating the robot's disinfection performance, particularly through a multi-pass technique that achieves significant bacterial reduction. The paper also outlines future research directions, focusing on improving path planning algorithms to adapt to dynamic environments and enhance the robot's operational safety.

[8] This paper presents the design and development of a cost-effective UVC disinfection robot aimed at combating the spread of Covid-19 and similar communicable diseases in hospitals and factories, particularly in resource-limitedsettings like Bangladesh. The robot utilizes UVC light for disinfection, featuring a mobile base controlled via an Arduino- based ESP32 module, which allows for remote operation and safety measures to prevent human exposure. The study highlights the urgent need for such technology in environments where traditional health precautions are often neglected, emphasizing the robot's potential to reduce cross-contamination and improve public health outcomes.

[9] The paper presents the development of an autonomous Ultraviolet Germicidal Irradiation (UVGI) robot designed to enhance hygiene and disinfection in environments at risk of pathogen transmission, particularly in the wake of the COVID-19 pandemic. It details the robot's design, which incorporates a Raspberry Pi for control, ultrasonic sensors for obstacle detection, and YOLOv4 for object recognition. The study emphasizes the robot's effectiveness in disinfecting surfaces by utilizing UV light, while also addressing safety concerns related to UV exposure for humans, ultimately contributing to improved public health measures.

[10] The paper presents the design and development of an Android-controlled ultraviolet (UV) sanitizer robot aimed at effectively disinfecting surfaces to combat pathogens, including those resistant to chemical sanitizers. It employs UVC light for disinfection, integrated with a human alert system using ultrasonic and PIR sensors to ensure safety during operation. The effectiveness of the UV sanitization was tested on agar samples at various heights, revealing that UV effectiveness decreases with increased height, with thehighest effectiveness observed at floor level. The system is controlled via a Blynk app, allowing users to receive notifications and manage the device remotely, while future enhancements are suggested to improve detection and sanitization efficiency.

[11] The investigates the effectiveness of a moving robot equipped with UV-C lamps in sanitizing surfaces contaminated with microorganisms, particularly in the context of the SARS-CoV-2 pandemic. It highlights the importance of reducing pathogen transmission through effective disinfection methods, comparing traditional chemical sanitization with the use of ultraviolet radiation. The study demonstrates that the robot can significantly lower microbial loads on surfaces, with results varying based on exposure time, distance, and the presence of obstacles, suggesting that automated UV sanitization can complement existing cleaning practices in high-traffic environments.

[12] This design and development of a cost- effective autonomous disinfection robot aimed at reducing human involvement in sanitization tasks, particularly in the context of the COVID-19 pandemic. The system comprises a transmitting section operated by a controller and a receiving section integrated into the robot, utilizing an Arduino development board and nRF24L01 module for wireless communication. The robot is equipped with Ultraviolet C (UVC) lights and a liquid sanitizer spray mechanism, allowing it to effectively disinfect surfaces while minimizing the risk of virus transmission to humans.

[13] This design and implementation of a sensor-based disinfection robot system utilizing Ultraviolet-C (UV-C) technologyaimed at improving hygiene in medical settings. The robot is capable of autonomously disinfecting rooms, measuring patients' body temperatures, and delivering medical supplies, thereby enhancing safety for both healthcare professionals and patients. Despite its innovative features and cost-effectiveness, the system faces challenges such as limited mobility on uneven surfaces and the inability to open doors independently, which are acknowledged as areas for

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future improvement.

III. CONCLUSION

The UV-C disinfecting autonomous robot offers a revolutionary approach to maintaining cleaner and safer environments, particularly in hospitals, healthcare facilities, and other high-traffic areas. By utilizing UV-C light to target and disrupt pathogens' DNA/RNA, the robot ensures effective sanitization without the need for chemicals or direct human contact, reducing the risk of healthcare-associated infections. Its autonomous navigation, combined with advanced sensors (LiDAR, cameras, environmental sensors, and human detection), allows for efficient path planning and optimized sanitization. Safety features, including automatic UV light shutoff when humans are detected, further enhance its effectiveness.

Real-time monitoring and control via live video feeds offer flexibility and transparency in the disinfection process, ensuring a verifiable and consistent level of cleanliness. This innovative robot provides a non-touch, chemical-free alternative to traditional methods, promoting a healthier and more hygienic environment in hospitals, hotels, offices, and other venues, while also increasing efficiency andprofitability in cleaning operations.

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