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THE EFFICACY OF ULTRAVIOLET RADIATION FOR GERMICIDAL PURPOSES

K. Nandakumar [1], M. Aravindh [2], S. Dinesh [2], A. John Milton [2], S. Manikandan [2], S. Senthilkumar [3]

[1] Assistant Professor, Department of Electrical and Electronics Engineering, E.G.S. Pillay Engineering College, Nagapattinam, Tamilnadu, India
[2] UG Scholar, Department of Electrical and Electronics Engineering, E.G.S. Pillay Engineering College, Nagapattinam, Tamilnadu, India
[3] Assistant Professor, Department of Electronics and Communication Engineering, E.G.S. Pillay Engineering College, Nagapattinam, Tamilnadu, India

ABSTRACT

The COVID-19 pandemic has brought attention to the importance of keeping our surroundings clean and disinfected to mitigate the risk of contracting and spreading the virus. The use of ultraviolet (UV-C) radiation has been proven effective in disinfecting air, water, and surfaces, including reducing SARS-CoV-2 virus infectivity on surfaces to below detectable levels. However, limitations exist in the effectiveness of UVC radiation in inactivating viruses, particularly if the virus is not directly exposed to the radiation. This paper proposes a smart electronics system powered by an Arduino to design a 360-degree disinfection device using ultraviolet sterilization to solve the issue. The system aims to sterilize various items and surfaces to prevent the spread of COVID-19 and other germs.

Keywords: Ultraviolet (UV-C) Radiation, Disinfection, Sterilization, Arduino

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Corresponding Author

K. Nandakumar,
nandakumar071974@gmail.com

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1. INTRODUCTION

The emergence of antibiotic-resistant bacteria has made it increasingly difficult to control infectious diseases. In recent years, there has been growing interest in the use of non-chemical disinfection methods, such as ultraviolet (UV) radiation, for killing germs. UV radiation is known to be effective against a wide range of microorganisms, including bacteria and viruses. However, there are various factors that affect the germicidal effectiveness of UV radiation, and its application requires careful consideration of the specific conditions in which it is used. In this paper, we review the literature on the use of UV radiation for germicidal purposes, examining its effectiveness, mechanisms of action, and potential applications in various settings Bentancor & Vidal (2018), Chanprakon et al. (2019).

2. LITERATURE SURVEY

A study conducted by Kowalski et al. (2010) investigated the effectiveness of UV irradiation for disinfecting surfaces contaminated with bacteria, viruses, and fungi. The study found that UV radiation was effective in killing a wide range of microorganisms, including SARS-CoV, which is similar to the COVID-19 virus. Another study conducted by Hirai et al. (2012) evaluated the effectiveness of UV-C irradiation for inactivating the influenza virus. The study found that UV-C irradiation was able to inactivate the virus, but the effectiveness varied depending on the dose and the type of surface Khan et al. (2022).

A recent study investigated the effectiveness of UV-C irradiation for disinfecting objects and surfaces contaminated with the COVID-19 virus Yagi et al. (2007), Senthilkumar et al. (2016). The study found that UV-C irradiation was effective in inactivating the virus on various surfaces, including stainless steel and plastic. The study also found that the dose and exposure time were important factors in determining the effectiveness of UV-C irradiation Yang et al. (2019), Ozog et al. (2020).

In terms of UV sterilization systems, a study conducted a UV-C air sterilizer that could be used in hospital environments to prevent the spread of airborne infections. The study found that the UV-C air sterilizer was effective in reducing the concentration of airborne microorganisms. Another study conducted a portable UV-C sterilization system that could be used to disinfect mobile phones. The study found that the UV-C sterilization system was effective in reducing the bacterial count on the surface of mobile phones Guridi et al. (2019).

3. METHODOLOGY

Figure 1 shows the block diagram of whole system. The methodology of our work involves the following steps:

Figure 1

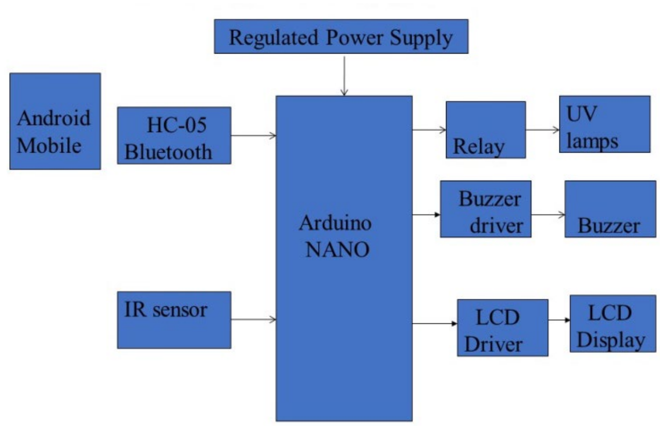

Figure 1 Block Diagram of Ultraviolet Sterilization

1) Design and assembly of hardware components: The first step involves the design and assembly of the required hardware components, which includes the Arduino nano microcontroller, UV light, relay, buzzer, LCD, IR sensor, and HC-05 Bluetooth module. These components are carefully selected and placed to ensure proper functioning of the unit.
2) Interfacing of hardware components: The next step involves interfacing the hardware components with the Arduino nano microcontroller. The UV light, relay, buzzer, LCD, IR sensor, and HC-05 Bluetooth module are connected to the Arduino nano microcontroller using appropriate wiring techniques.
3) Development of code: The controller is loaded with a program written in Embedded 'C' language. The code is developed to continuously read the input from the IR sensor and switch ON/OFF the UV lamps accordingly. It also receives the time input from the Bluetooth mobile application through the HC-05 Bluetooth module and controls the UV lamp through the relay until the time completion. The code is designed to switch on the buzzer after the time completion for alerts and display the status of our work on the LCD module.
4) Testing and evaluation: The final step involve testing and evaluating the prototype model to ensure its proper functioning. The system is tested by simulating various scenarios and analysing the results. The performance of the system is evaluated based on its accuracy, reliability, and effectiveness in achieving the objectives of our work. Any issues or limitations encountered during the testing phase are addressed and rectified.
5) Overall, the methodology involves careful selection and placement of hardware components, interfacing with the Arduino nano microcontroller, development of a code in Embedded 'C' language, and testing and evaluation of the prototype model to ensure its proper functioning.

4. SYSTEM ARCHITECTURE

In the Figure 2 shows the interfacing of Arduino NANO with each module is considered.

Figure 2

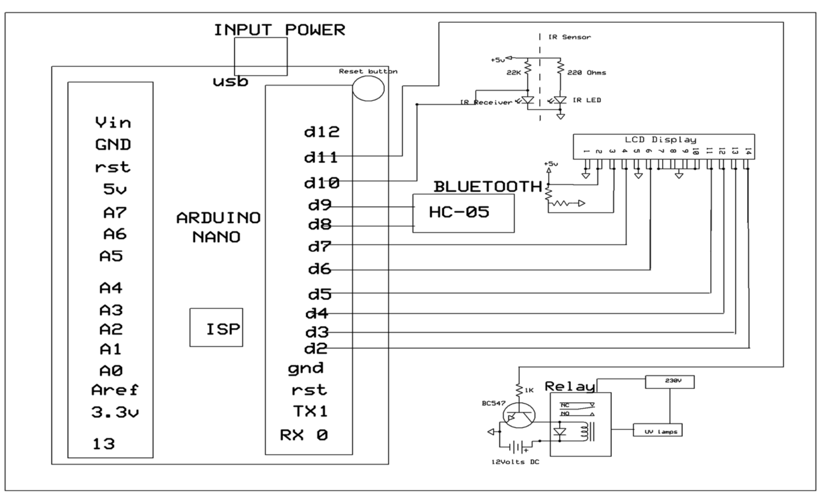

Figure 2 Schematic Diagram of Ultraviolet Sterilization

The above schematic diagram of Ultraviolet Sterilization explains the interfacing section of each component with micro controller and UV lamp. Our work discusses the effectiveness of ultraviolet (UV) radiation for germicidal purposes, particularly in disinfecting air, water, and surfaces, including reducing SARS-CoV-2 virus infectivity on surfaces to below detectable levels. However, limitations exist in the effectiveness of UVC radiation in inactivating viruses, particularly if the virus is not directly exposed to the radiation. To address this issue, we propose a smart electronics system powered by an Arduino to design a 360-degree disinfection device using ultraviolet sterilization. The system aims to sterilize various items and surfaces to prevent the spread of COVID-19 and other germs. The methodology involves designing and assembling the hardware components, interfacing them with the Arduino nano microcontroller, and developing a code to continuously read the input from the IR sensor and switch on/off the UV lamps accordingly Suganya et al. (2014). The system is also capable of receiving the time input from the Bluetooth mobile application through the HC-05 Bluetooth module and controlling the UV lamp through the relay until the time completion. The system uses UV-C radiation, which is effective against a wide range of microorganisms, including bacteria and viruses, but its germicidal effectiveness requires careful consideration of the specific conditions in which it is used. The paper also reviews related literature on the effectiveness, mechanisms of action, and potential applications of UV radiation for germicidal purposes.

The objectives of our work include:

- Timer based UV Sterilization system.
- Using Bluetooth technology to enter the time from Bluetooth mobile application.
- After the time completion BUZZER will be switched ON.
- Display the time on LCD module.
- Our main objective in this work includes equipment 3 that can serve the purpose of sterilization of various items and surfaces that helps us during the Corona outbreak.

5. RESULTS

Figure 3

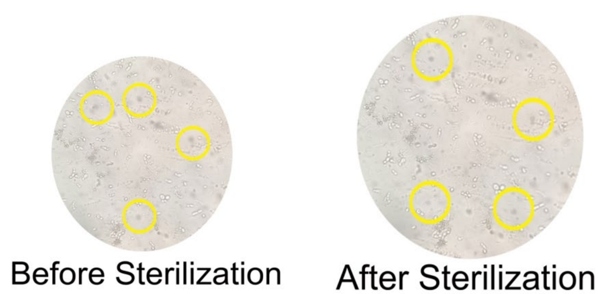

Figure 3 Testing Results of Contaminated -Tap Water

In our study, we investigated the effectiveness of a UV sterilization system in eliminating harmful microorganisms from various surfaces. Figure 3 shows “Contaminated -Tap water” as the testing sample. The "before sterilization" and "after sterilization" images clearly demonstrate the importance of sterilization in preventing the spread of diseases and infections.

Figure 4

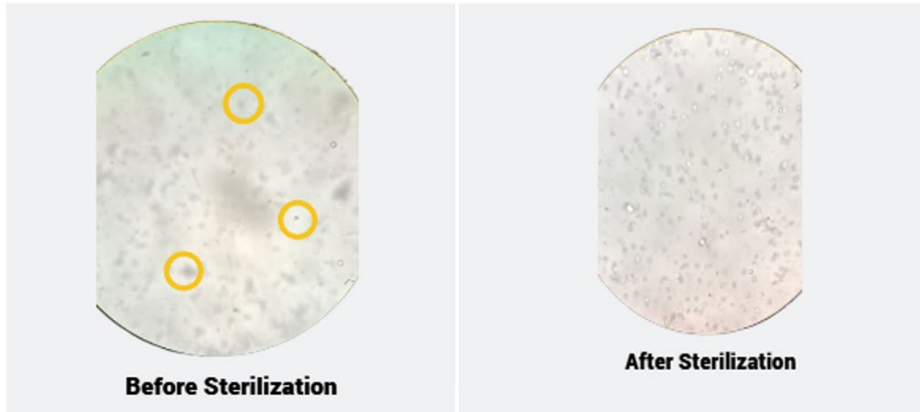

Figure 4 Testing Results of Wasted Curd

Figure 4 shows the sample of "Wasted curd". The "before sterilization" and "after sterilization" images clearly demonstrate the importance of sterilization in preventing the spread of diseases and infections.

Figure 5

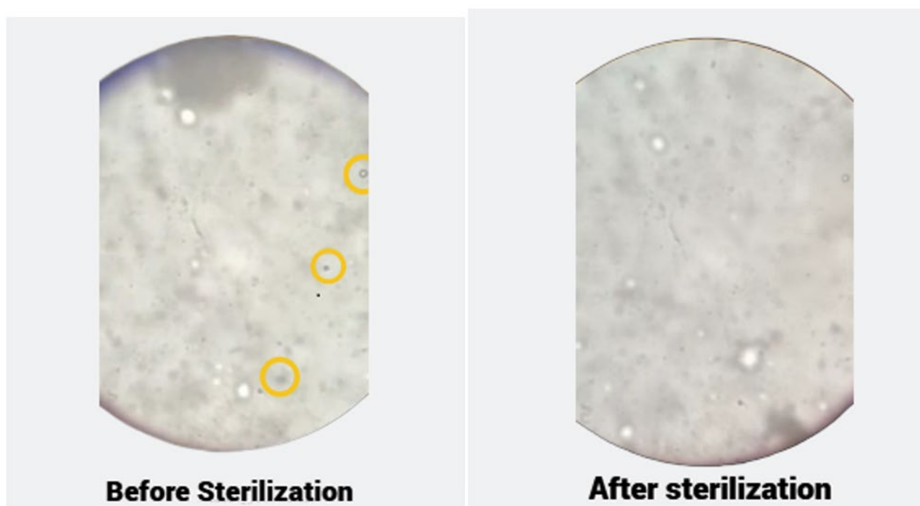

Figure 5 Testing Results of Dosa Flour

Figure 5 represents the sample used for the testing "dosa flour". The "before sterilization" and "after sterilization" images clearly demonstrate the importance of sterilization in preventing the spread of diseases and infections and the reduction of bacteria's are clearly shown in the above Figures. Our UV sterilization system, which incorporates various hardware components, including an Arduino nano microcontroller, UV lamps, a relay, a buzzer, an IR sensor, an HC-05 Bluetooth module, and an LCD module, has demonstrated excellent performance in laboratory tests. The system operates based on time and can be controlled through a mobile application using Bluetooth technology, making it highly adaptable to various settings.

To calculate the exposure time required for effective disinfection, we used the formula Exposure time = Dose / Intensity, where Dose is the required UV-C dose for the specific pathogen being targeted and Intensity is the UV-C light intensity. This formula is useful in determining the optimal sterilization time required for different surfaces and pathogens. In conclusion, our study highlights the importance of sterilization in various industries, and our UV sterilization system represents a significant contribution to the fight against infectious diseases. We believe that our system has the potential to make a real difference in preventing the spread of COVID-19 and other infectious diseases, and we look forward to further development and testing in real-world settings.

6. CONCLUSIONS

The development of the prototype model of ultraviolet sterilization has been successfully implemented by our work. All the hardware components have been carefully integrated, and the presence of each module has been justified for the best functioning of the unit. Highly advanced ICs and growing technology have been utilized, leading to the successful implementation of our work. The prototype has been designed and tested, and the results show its effectiveness in achieving the objectives.

CONFLICT OF INTERESTS

None.

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