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## UV-C 360° Sterilization System

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### ABSTRACT -

In the year 2020, Covid19 had a profound impact on humanity. We were compelled on using face-appropriate personal protective equipment to shield ourselves from anything we touched due to its rapid and efficient spread.

We can wear masks outside to protect ourselves, but what about the items we bring home from the market or trade with others?

We cannot use disinfectant on fruits, vegetables, packaged meals, batteries, or other items purchased from outside, nor can we disinfect files, paperwork, or other items that doctors or staff share with one another.

When we are in a public location and do not disinfect our everyday accessories, we may be contributing to the spread of the virus. Our main goal was to create something that would allow individuals to sanitize their basics without having to touch the disinfection equipment.

This project is based on repurposing e-waste to the greatest extent possible.

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### 1. INTRODUCTION

UV light is a well-studied and reliable antibacterial technique. It mostly kills bacteria, viruses, and fungi by damaging their DNA. UV-C, the high-energy part of the UV spectrum, is the most effective. UV-C light has been used to disinfect industrial surfaces and purify drinking water for decades. It's especially useful in hospitals because it kills *Clostridium difficile*, a spore-forming bacterium that's a major source of hospital-acquired diseases. UV disinfection systems for the entire room were first deployed to hospitals in the United States in 2007. Since then, their popularity has grown as a result of their ability to sanitize nearly all of the surfaces in a space at once, with no effort and without the use of toxic chemicals. Even chemical disinfection firms have entered the whole-room UV disinfection industry.

The UV wavelength is heavily used in the disinfection action on bacteria and virus DNA and RNA. Within the ultraviolet range of UV-A, UV-B, and UV-C, UV-C has the shortest wavelength and can inactivate bacteria and viruses the most effectively. It has a 1,000-fold stronger effect than UV-A and a 50-fold stronger effect than UV-B.

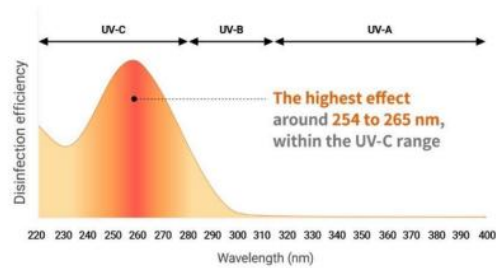
In addition, we can see from Fig.3 that among the UV-C wavelengths (100 nm to 280 nm), a wavelength of roughly 265 nm gives the best inactivation efficiency.

UV-C LEDs emit light with a peak wavelength of 265 nm, the most effective disinfectant wavelength.

The amount and conditions of ultraviolet irradiation required to vary depending on the bacterium, disease, as well as other microbes being targeted. In general, its disinfection impact is calculated by adding the light intensity (intense) and also the time UV light is delivered onto the object (the cumulative light quantity or ultraviolet dosage) (irradiation time).

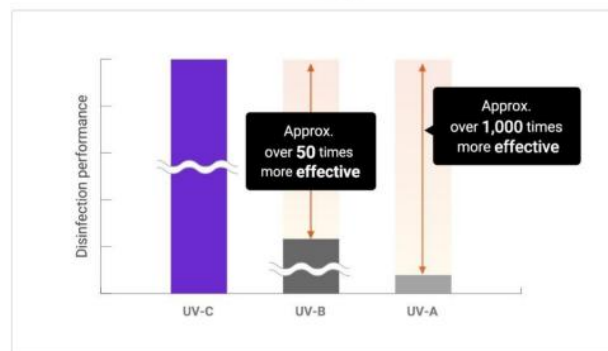
The sum light amount increases as the irradiation time advances, resulting in a larger disinfection impact. When disinfecting for a short period of time, however, a high output UV intensity is required. In the days, weeks, and months since the current epidemic began, there has been a concentrated effort to develop practical techniques to maintain Protective Equipment, including sterilizing after use. While some hospitals have started utilizing UV-C light to sanitize N95 respirators, many others lack the room or equipment to do so. We describe a method for sterilizing N95 respirators using ultraviolet (UV) light in this paper.

Fig.3: Inactivation efficiency by wavelength



Microbial deterioration is very common in fresh fruits and vegetables. With the use of surface treatments, this can be avoided. To preserve the integrity and authenticity of fruits and vegetables, the surface must be treated as gently as possible. These parameters are met using minimum processing methods including ultraviolet (UV) light treatment. UV light treatment was found to help in lowering pathogen microbial burdens upon fresh produce. This paper seeks to examine the relevant literature and provide a broad overview of the use of UV radiation to decontaminate, prevent disease, and improve the shelf life and quality of fresh produce.

Fig.2: Comparison of disinfection performance by UV wavelength



## 2. LITERATURE SURVEY

Paper [1] "UV Sterilization of Protective Gear with Idle Laboratory Biosafety" — An open-source UV-C room disinfection equipment with functions similar to private commercial systems was created in this study. The presented model may be readily scaled up by changing its structure (including additional UV-C lamps) and programming (altering the open-source software of the Arduino board and/or the Android application), resulting in savings of over 80% compared to comparable proprietary commercial equipment.

Paper [2] "A Critical Review of Ultraviolet Disinfection Systems in the Face of a COVID-19 Outbreak: Applicability, Validation, and Safety Issues" - This paper, along with the accompanying graphics, will be critical in the development and manufacture of effective, dependable, and safe UV disinfection systems for reducing viral transmission in the current COVID-19 pandemic, as well as future epidemics.

Paper [3] "Enforcement Policy for Sterilizers, Disinfectant Devices, and Air Purifiers During the Public Health Emergency of Coronavirus Disease 2019 (COVID-19)" - During the COVID-19 public health emergency, the enforcement policies stated in this guideline apply to specific devices and their accessories.

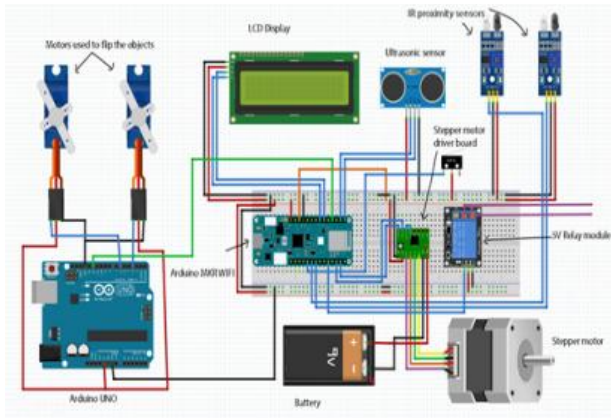
Paper [4] "A low-cost, programmable ultraviolet room disinfection equipment" - The purpose of this study was to assess the disinfecting ability of such a portable ultraviolet C device (UV Sanitizer Corvent® -UVSC-) designed to disinfect a variety of objects.

Paper [5] "Disinfectant Activity of a Portable Ultraviolet C Equipment" - The purpose of this paper is to describe the current state of the art for UV-C sterilization in masks and filtering facepiece respirators.

This literature review is a compilation of research methods and findings from academic papers that report on the current study, which intended to design a simple prototype to check the efficiency of germicidal UV tubes, normalize the position, distance, and time for UV light, and also determine its effectiveness against medically important bacteria as well as the Covid-19 virus.

In our paper, we propose an electronic system powered by Arduino and using Ultraviolet sterilization to help people avoid germs by disinfecting their essentials without touching the disinfecting machine itself. Also, to assist people by providing a less expensive way for them to protect themselves against germs, bacteria, and various viruses.

### 3. CIRCUIT DIAGRAM



The Arduino MKR WiFi 1010 will be the primary microcontroller board, and the Arduino Uno will be the secondary microcontroller board. The main microcontroller is in charge of the entire circuit, from the stepper motor to all of the sensors.

The servo motors that flip the objects inside the tray are controlled by the secondary microcontroller, as is the relay that switches on and off the UV lamp.

The stepper motor that opens and closes the tray is controlled by the primary microprocessor. It also manages the infrared and ultrasonic sensors. It is in charge of the display that shows the project's current status.

### 4. METHODOLOGY AND WORKING

Because this project is based on e-waste, a scanner from a printer will serve as a tray, and also an old CPU box will serve as the project's foundation. Remove the lower half of the scanner so that a stepper motor may well be connected to it. Make a connection to the stepper with solder.

to connect the motor to the breadboard To flip the goods, use two servo motors. Fix it to the tray so that it can lift and flip the objects. Remove the front half of the CPU casing after mounting the trays to the scanner head.

Using a drill, join the lower half of the scanner to the CPU case. To disinfect the objects, IR sensors are placed at the front of the top panel, ultrasonic in the middle, and a UV-C light is placed beneath the top panel.

The principal microcontroller, the Arduino MKR WiFi 1010, is coupled to the ultrasonic sensor. The core microprocessor also is connected to the LCD through an I2C module.

A 9V power supply is linked to a Stepper motor driver, and the Stepper motor is attached to a stepper motor driver. A secondary microcontroller, the Arduino UNO, is connected to the Arduino MKR WiFi 1010. The secondary microcontroller is connected to the servo motors.

The relay is connected to the first microcontroller, which turns on or off the UV lamp.

The microcontroller constantly scans the area around the IR sensors for any impediments. When an obstacle is detected in close vicinity, a response is activated for the specified amount of time, based on what is presented on the LCD.

The stepper motor is driven by the needed number of steps to open the tray when the open tray event occurs.

Whenever the close trays action is initiated, the stepper is pushed till the limit switch displays a red flag (the state of the switch changes) and the tray is closed.

The timer can be set to the default setting or by calculating the length between both the ultrasonic sensor as well as the hand.

The UV-C lamp is activated after the disinfect option is selected. While the UV is still turned on, the items are automatically switched after disinfecting one surface.

Finally, the stepper motor is used to reopen the tray after disinfection.

### 5. CONCLUSION

COVID-19, a recent epidemic, has been declared a worldwide health emergency. Staying at home alone will not be enough to stop the spread of COVID-19, hence, in addition to traditional preventive measures, novel disinfection methods such as UV radiation have gotten a lot of attention. From viewpoint of the COVID-19 pandemic, we present our project on the application, verification, functioning, and protection of UV disinfection devices. We anticipate that our research will spark a conversation about the importance of thorough validations for UV disinfection equipment before they are made accessible to untrained users.

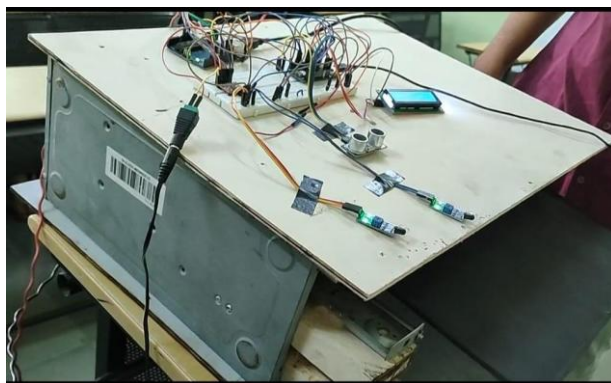
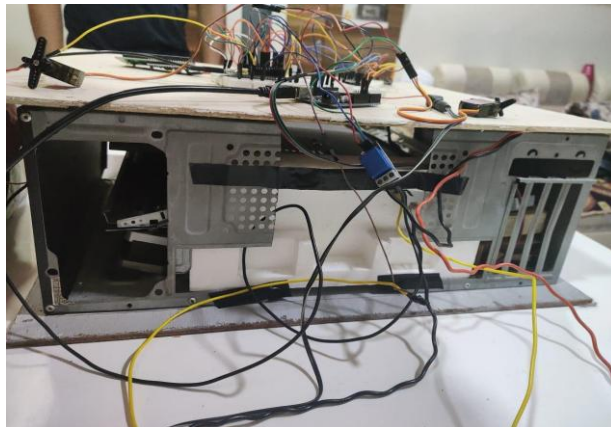
As a result, researchers and industry are expected to be very interested in designing and producing new viable UV air and surface treatment devices for current and future epidemics.

## 6. RESULT

This is our final project model which is working properly and disinfecting the item completely. The main objective was to provide an alternative for chemical sanitizers to disinfect the edible products and other household accessories easily which would require minimal human assistance. The whole project is covered with the CPU Case used from the PC and Tray is used from the printers to make proper use of E-waste. The wooden Block is soldered to the CPU Case which is attached to the Tray for proper weight distribution.

The Code was executed successfully in the Arduino IDE in which we used the C programming language. With the help of two Microcontrollers: Arduino Uno and Arduino MKR WiFi the whole circuit is powered up. The 2 IR sensors are working properly for opening and closing the tray with the hand motion and the Tray is triggered by the stepper motor which is connected to the battery. UV-C light is turned on while disinfecting the item by relay module.

The ultrasonic sensor is detecting the hand motion to set the time for disinfection. For complete 360° disinfection, the Servo motors play a crucial to flip the items. We've performed Experiments on different items to get to know about the end result of the item disinfection.



### 6.1 UV Light Experiment:

#### 6.1.1 Household Accessories (Keys)

We have performed the UV-C test on keys to disinfect them. So after disinfecting it for 2 minutes we can see a slight fluorescent green color on the keys with the help of tonic water to show that it is completely disinfected with the help of UV-C.

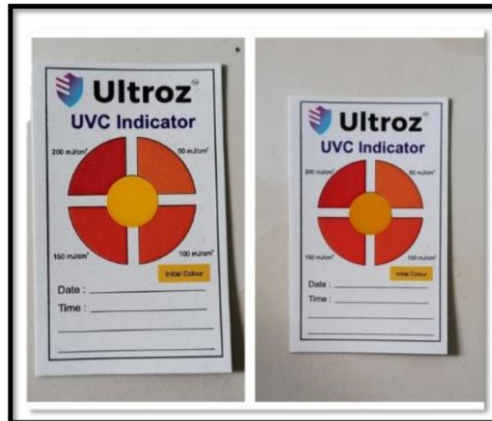
Once the Sterilization process is complete all the germs and bacteria present on the items are eliminated with the help of UV-C.

As household accessories don't take much time to disinfect, setting the timer for not more than 2-3 min is recommended.

After complete disinfection, the item can be used without any harm as we've used 254nm wavelength of UV-C, which is considered the optimal wavelength and is not harmful.



### 6.1.2 UV-C Dosimeter Test



This is a UV-C Indicator card for testing to show whether the UV light is working properly.

Once this card is placed under the UV-C light it shows the change in color with the UV radiation reflecting on the card and it changes from yellow to orange color after a period of time.

So this is the perfect example to show the working of UV-C for the Sterilization of items.

### 6.1.3 UV-C test on Banana





The third test is performed on bananas for decontamination of the fruit. Various microorganism lies in edible products which are difficult to eliminate. Using chemical Sanitizer on fruits and vegetables is not recommended which can cause serious health issues.

The Bacteria mostly found on bananas is E.Coli. So after performing a test on a banana for disinfection purposes, it is seen that after a certain period of time we can see black spots on certain areas of the banana. It shows that the banana is completely disinfected by using the UV-C Sterilization and the tape was used to cover the banana to show a specific line near the top side of the banana. After the tape was removed, the banana which was covered with tape is light in color while the rest of the part is darkened by UV-C.

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## 7. FUTURE SCOPE

UV-effectiveness C's as a potent disinfectant for air, surfaces, objects, and water is well known today. It's also been shown to be extremely effective against all infections tested so far, especially SARS-CoV-2, the virus that causes COVID-19.

As a result of the COVID-19 outbreak, UV-C lighting has become increasingly popular. We need to think beyond COVID-19. It's past time to take virus mitigation seriously, and UV-C lighting is a powerful tool for doing so.

It can help keep offices, supermarkets, gyms, public transportation, and other high-contact situations safe by minimizing the need for chemical disinfectants when used in conjunction with other disinfection methods.