

## **Disinfecting Handheld Devices And Objects With Uv-C In A Public Setting**

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### **Abstract**

In public many people are using handheld objects without any cleaning in which spread of germs takes place in the people. The primary objective is to kill the germs on handheld objects. People who use mobile devices and items during their everyday activities are included in the future before-and-after analysis. The fabrication of disinfecter device is done with the help of E-waste. It has features like 360° disinfection, automatic flip over and touch free mechanism. To implement these feature IOT devices, sensors and software were used. Handheld devices and objects underwent two 120-second UV-C disinfection cycles. To evaluate germicidal growth, samples are taken before and after a UV-C disinfection cycle. Swabs are tested in both pre UV-C exposure and post UV-C exposure. Once after the UVC test, it is observed that the percentage of germs is very less in handheld devices and objects. Ultra Violet-C appears to be effective at killing germs on handheld objects. It is operated automatically and touch free from start to the end. It is an effective disinfection device in a public setting.

**Key words:** Ultra Violet Lamp (UV-C), E-Waste, Touch Free Mechanism

### **1. Introduction**

Ultraviolet germicidal irradiation is the process of using the disinfectant to remove the various germs on various surfaces (UVGI).It is a form of radiation generated by electromagnetic waves which has more energy than visible light. The ultra Violet rays have classified into three types, Ultra Violet-A has a wavelength of 315 to 400 nanometre's, Ultra Violet-B has a wavelength of 280 to 315 nanometre's, and Ultra Violet C has a wavelength of 100 to 280 nanometre's. UVGI uses UV-C wavelengths of 150 to 200 nm. UV-C rays with a higher energy cross-link thymidine and uracil nucleotides, respectively, destroying DNA and RNA and preventing bacteria and viruses from replicating. The dose of UV radiation at the appropriate wavelength is directly proportional to the amount of pathogen inactivation. The dose is calculated by multiplying the severity ( $\text{W/m}^2$ ) by the exposure time. UVGI is a sanitation process that does less harm to the respiratory system and lungs and is commonly used in disinfectant processes.The UV dose needed to inactivate the virus is calculated to be 1.323.20 MJ·cm<sup>2</sup> for RNA viruses. Using related methods, 254 nm UV-C light was used to investigate the wavelength used to kill the germicidal virus on external surfaces. UVGI was developed by a team at the University of Nebraska Medical Centre to sterilise N95 respirators. The object will be disinfected with 60MJ·cm<sup>2</sup> of irradiation energy in this step so that it can be used for other purposes. In the hair saloon, UV-C light is used as a steriliser for combs, scissors, and trimmers, which are disinfected according to the appropriate temperature. This technique has been implemented in various hospitals for the sterilisation of various objects such as scissors, forceps, aprons, oxygen concentrators, and so on.[1] Hiroki Kitawaga, explains that the Ultra Violet-C Disinfection in which the UV-C kills the germicidal bacteria and virus in a wavelength of 190-300 nanometres of range. It is used to kill the virus on the surface contamination.[2]Walid H.D.Alrazni, This is a reference author book which gives the details on Design and construction of the buildings with IAQ in which people are protected from Germicidal Infections in buildings. The buildings are protected with Indoor air quality with E -waste and fresh air filtration. [3]Andrew G. Buchan, LiangYang & Kirk D. Atkinson tells that far UV-C produces a wavelength of 222nm which kills 99% of germs in most populated areas like hospitals, schools etc. It tells us about the killing of germs in the hospital rooms, hotels, restaurants and lodges. We can learn UV-C bond is broken and its mechanism. [4] Abba Amsami Elgujja tells that UV-C is used for the surface

decontamination in Hospitals and on the things like needles, syringe, gloves etc. [5] Micheal Tarato conveys that the UV-C light helps to disinfect the intensive Care units(UV-C), Mortuary , Waiting Halls, operation Theaters, Baby Care Centre. The UV-C is used on the critical areas of the different materials like contaminated bins, foot path , bus stop, malls etc..[6] Steven Clarke and William Bettin tells the UV-C disinfection which is used in the water purification Devices. It helps to purify the water by passing the rays at different wavelengths in between 200nm-300nm. This UV-C disinfection process is used in purification of water in the different ranges.[7] Nozomi Yamano tells us the long term use of 222 nanometres of ultra violet C and its long run on the different things. He also explains the use of UV-C in the sterilization processes. [8] Badar J. Kayani, Davis.T. Weaver tells us the filtering face piece respirators (FFR) which has been re used and de-contaminated with the help of UV-C

## **2. Experimental Part**

The manufacturing is made from e-waste; the component gathering is the initial stage in fabrication.



**Fig. 2.1 Fabrication Work- Outer Case**

An old CPU Case, Sheet metal, Geometry box, Sheet metal is fixed with draw sliders in the CPU case. The stepper motor, which is used to move objects both inside and outside the device, is connected.



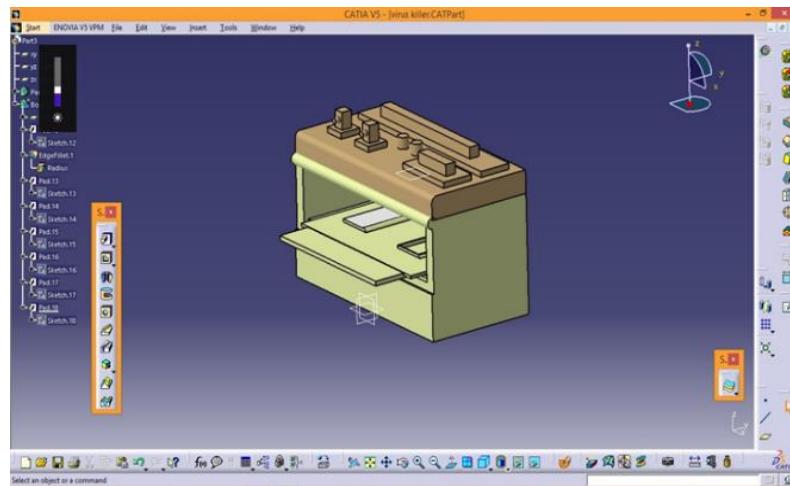
**Fig. 2.2 Fabrication work- Flip Mechanism**

The wires are attached to the stepper motor so that the length of the wire should be enough to connect the connections. Then a limit head is fixed at the end of the base so that it can determine the position of the scan head straightens the MCU. The Geometry box must be separated to the lid and base in which both are connected to the servo motor. It helps to flip the items during the disinfection process. The front portion of the CPU case is

removed; leaving one side fully exposed, and connects the bottom part of the case with screws and drills. At last all the Arduino NANO, Micro Controller and sensors are connected. The UV-C light has to be placed in such a way that the maximum light should be exposed to the object on the tray.

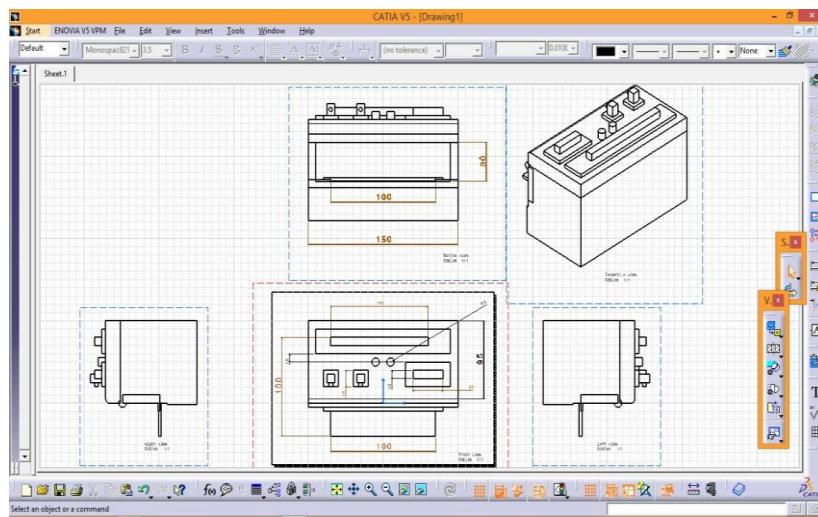
### 3. Working Mechanism

The test object needs to be placed in such a way that the maximum light should be exposed to it on the tray.



**Fig.3.1. Design of UVC machine**

The test objects are kept in the tray before starting the device, and then coding's to run the Arduino Nano to get the final result. The microcontroller constantly scans the area around the IR sensors for any obstruction. When there is a blockage in the vicinity, an event is activated and displayed on the LCD for the appropriate period of time.



**Fig.3.2. Part Design of UVC machine**

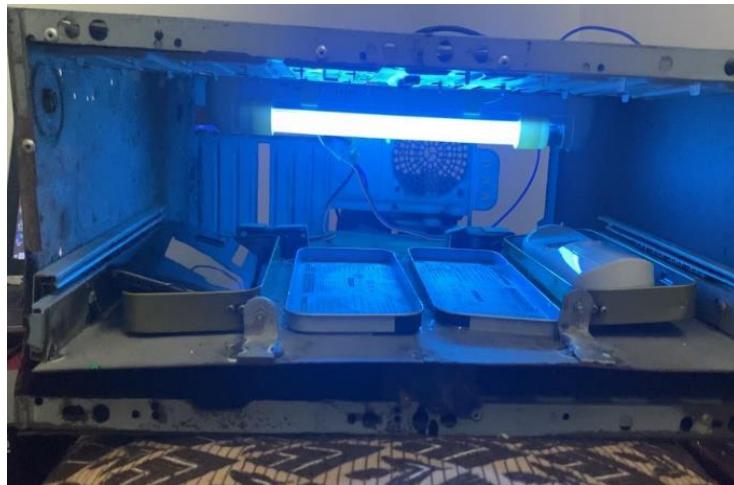
The stepper motor is powered the necessary number of steps to open the tray when the open tray event is triggered. The stepper is operated until the limit switch switches state, signalling that the tray is closed, when the close tray event is triggered.

Measure the distance between the ultrasonic sensor and your palm to set the timer. When the disinfect alternative is selected, the relay is turned on, which turns on the UV-C light. The products are automatically

flipped using servo motors while the UV is still on, and the tray is opened by a stepper motor after disinfecting one surface.

#### **4. Results and Discussion**

The final UV-C disinfection machine is obtained and is used to disinfectant the surfaces of the objects.



**Fig. 4.1. Testing under UVC Light**

The UV-C produces in the range of 100 to 280 nanometres of wavelength and it is used to kill the germs on the different surfaces. It has a wide application in household Applications, Industries, and Hospitals etc. The UV-C gives a better efficiency in which 99% of germs are killed in between 90-120 seconds. The results are taken before and after testing of the machine on different objects in which the surfaces are exposed to UV-C. The testing is done according to the time required for the particular object. The test time can be provided according to the size of the object.



**Fig. 4.2. Outer View of UVC machine set up**

The research output is achieved by exposing various items to UV-C, such as cell phones, pockets, belts, earphones, saloon trimming equipment, and so on in which it is obtained 99% of disinfectant after exposing to UV-C. The tests are done on the different hand held appliances and results are obtained in which there is removal of 99% germs on the objects.

## **5. Conclusion**

Thus, the presence of UV-C rays gives a better efficiency in which 99% of germs are killed in between 90-120 seconds. In this study the new features like implementation of IOT, 360 degree disinfectant and touch free mechanism, made this setup easy to operate and portable. This set up has wide range of advantages like it is made from E-waste, CPU's outer case and sheet metal. Therefore the final UV-C disinfection machine is obtained with low-cost in terms of budget.

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## **References**

1. Kitagawa, H., Nomura, T., Nazmul, T., Omori, K., Shigemoto, N., Sakaguchi, T. and Ohge, H., 2021. Effectiveness of 222-nm ultraviolet light on disinfecting SARS-CoV-2 surface contamination. *American journal of infection control*, 49(3), pp.299-301.
2. Alrazni, W., 2016. Improving Indoor Air Quality (IAQ) in Kuwaiti Housing Developments at Design, Construction, and Occupancy Stages (Doctoral dissertation, University of Salford).
3. Buchan, A.G., Yang, L. and Atkinson, K.D., 2020. Predicting airborne coronavirus inactivation by far-UVC in populated rooms using a high-fidelity coupled radiation-CFD model. *Scientific reports*, 10(1), pp.1-7.
4. Elgujja, A., Altalhi, H.H. and Ezreqat, S., 2019. Review of the Efficacy of UVC for Surface Decontamination.
5. Casini, B., Tuvo, B., Cristina, M.L., Spagnolo, A.M., Totaro, M., Baggiani, A. and Privitera, G.P., 2019. Evaluation of an ultraviolet C (UVC) light-emitting device for disinfection of high touch surfaces in hospital critical areas. *International journal of environmental research and public health*, 16(19), p.3572.
6. Clarke, S. and Bettin, W., 2006. Ultraviolet light disinfection in the use of individual water purification devices. *Army Center for Health Promotion and Preventive Medicine Aberdeen Proving Ground MD*.
7. Yamano, N., Kunisada, M., Kaidzu, S., Sugihara, K., Nishiaki-Sawada, A., Ohashi, H., Yoshioka, A., Igarashi, T., Ohira, A., Tanito, M. and Nishigori, C., 2020. Long-term Effects of 222-nm ultraviolet radiation C Sterilizing Lamps on Mice Susceptible to Ultraviolet Radiation. *Photochemistry and photobiology*, 96(4), pp.853-862.
8. Kayani, B.J., Weaver, D.T., Gopalakrishnan, V., King, E.S., Dolson, E., Krishnan, N., Pelesko, J., Scott, M.J., Hitomi, M., Cadnum, J.L. and Li, D.F., 2021. UV-C tower for point-of-care decontamination of filtering face piece respirators. *American journal of infection control*, 49(4), pp.424-429.