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DESIGN AND DEVELOPMENT OF A PORTABLE HANDHELD UV STERILIZATION RACKET

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Abstract: Viral infestation can develop from the arrival of new variants of infectious viruses. Due to the lack of antiviral treatments for these new types of viral infections which coupled with community spread often results in the loss of financial and human life. These viral transmissions can occur via close community transfer through human contact or via contacted through a contaminated surface. Thus, careful disinfection or sanitization using chemicals like Sodium Hypochlorite can eliminate the risk of infection to some extent but cannot be possible to use all the time on all the surfaces due to its nature, residue, and side effects. So, Ultraviolet-C light which is short wavelength at 253.7nm inactivates viruses by damaging their RNA and DNA. It leaves no residue and can be used on almost all surfaces including food except medicinal compositions. In Portable handheld UV sterilization racket the same technology is being used to inactivate viruses. It is designed in such a way that it is a handheld device and portable, it ensures the harmful UV-C light is not exposed onto humans and pets (i.e., through human/pets' motion detector), also ensures the range of distance between objects and lamp, it has the flexibility in opting orientation and it also includes real time status indicator.

Keywords: Viral Infection; contamination; Ultraviolet-C light; sanitization; sterilization racket.

Introduction:

The current Corona Virus infects people's respiratory droplets, and aerosol particles exhaled during speech play a critical role in disseminating the infection. COVID 19 viruses can be transmitted in three separate ways from an infectious person to a healthy person. Strong communication, indirect contact, and airborne transmission are the three options. The virus is transmitted via the droplet spray produced during normal human exhalation flows via direct, indirect, and airborne transmission routes. Breathing and speaking deliver a significant number of highly infectious aerosols. While social distancing has kept the virus from spreading as a passive mechanism, a realistic look at the method of disinfecting and deactivating the virus is needed. However, chemical disinfectants must be used in specific settings to ensure sanitation and reduce the significant risk of infection of this potentially lethal respiratory virus. Sanitation also aided in the containment of the outbreak and the restoration of normalcy, but on a smaller scale. UV rays from the sun, which are most important for modern disinfection technologies, are currently only used in applications with a small number of people present at the time of disinfection [1]. By preventing the use of harsh chemicals, rapid cleaning can be accomplished in a matter of minutes with the UV Racquet, particularly at home, on small surfaces, materials, and small spaces. Even though the whole UV range may destroy or inactivate various microorganisms, UV energy (between 100 and 280 nm) is the most powerful for germicidal action. The SARS-CoV-2 virus, like other coronaviruses, is enveloped by a porous outer lipid shell, rendering it more vulnerable to disinfectants than non-enveloped viruses like rotavirus, norovirus, and poliovirus. SARS-CoV-2 also survives for a long period on soils, allowing rapid dissemination [2]. Many microorganisms, including viruses, bacteria, fungi, algae, and others, are believed to be inactivated by UV radiation.

Based on current disinfection data and observational results published for other viruses, the International Ultraviolet Association (IUVA) believes UV disinfection technologies may play a significant role in reducing the spread of the virus that causes COVID 19. When appropriately used, UV (200–280 nm) has been widely researched for its power to disinfect or sanitize the air, water, and surfaces and reduce the risk of infection. Furniture such as desks, benches, partitions, and other stationary objects within patient-care rooms and washrooms and surfaces of non-critical medical devices are examples of environmental surfaces in hospitals and at home[3]. In a pandemic case, used patient beds and rooms will be quickly decontaminated before the entry of the next batch of patients, which is a significant necessity in most hospitals owing to the reduced supply of beds and the growing number of patients.

The "Portable Handheld UV Sterilization Racket" is a portable UV sanitization device that can be treated like a bat. This substance is versatile in orientation and can sterilize any material, regardless of height, surface orientation, or other factors, without leaving any residue. In addition to being run like a bat, it will use a passive infrared sensor to ensure that there are null living beings nearby, providing protection [4-8]. It can be used for all objects, regardless of their orientation, and the apparatus can be rotated around to sanitize them with only one UV-C light source. This is mainly for the average man, where it will be accessible, convenient to transport, and safe to use by humans, allowing it to be used regularly to sanitize the everyday items we

use and bear. So, in pandemic cases, this system can be used in any home, as it can keep their environment clear of microbes like the coronavirus, which is well known for its dissemination by touch and its existence of remaining on non-living surfaces for different periods based on the surface it is on. However, since UV light may be absorbed by organic molecules and inflict harm to the skin and retina, caution should be exercised while using the UV-light disinfection device in unoccupied spaces, after the patient has been discharged and in the absence of healthcare staff. Fig.1. shows the flow chart of portable digital device sanitizer. The surfaces of portable digital devices tend to attract and harbor potentially harmfulorganisms, such as microbes, pathogens, viruses, bacteria, and the like. Current work provides for charging the portable electronic devices while the portable electronic devicesare being sanitized. In some representations, the portable electronic device is sanitized using electro-optical (EO) radiation. Specific wavelengths of Ultraviolet (UV) radiation may be used to sanitize Portable Electronic Devices.

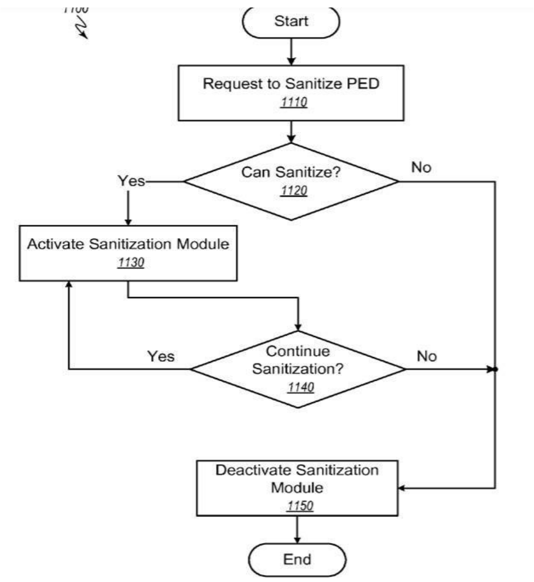

Fig 1: Flow Chart of Portable Electronic Device Sanitizer

Design and construction:

Design requirements for portable handheld UV sterilization racket model is shown in Fig.2. consists of sensors such as

- Passive infrared sensor (PIR) of 5 volts positive DC supply which attached to the ground terminal with a resistor. It’s a rectangular shape with output range of digital high 3V and up to 20 feet 110^0 x 70^0 detection range sensitivity. It is used as a sensor to transform infrared radiation from humans into electricity. If human infrared radiation is irradiated directly on the detector, it can, of course, induce a temperature difference, resulting in the output of a signal. However, thedetection gap would not increase.
- Ultrasonic sensor of 5V mainly used as an I/O trigger with a high-level signal of at least 10 seconds. The HC-SR04 is an ultrasonic tracker that uses sonar to determine the object's distance from the sensor. HC SR04 ultrasonic sensor produces ultrasonic waves at a frequency of 40kHz. The acoustic wave signal has a high-frequency ultrasonic wave thattravels above 18 kHz.
- MPU6050 sensor module is a 6-axis motion tracking device in one package. It has 3-axis accelerometer and 3-axis gyroscope and a digital motion processor and a on-chip temperature sensor. 3-axis accelerometer uses micro electromechanical technology (MEM). The amplitude of the output is proportional to the acceleration. The output is digitized using a 16-bit ADC. Full-scale acceleration ranges are +/- 2g, +/- 4g, +/- 8g, and +/- 16g. It was calculated ing (gravitational force) units.

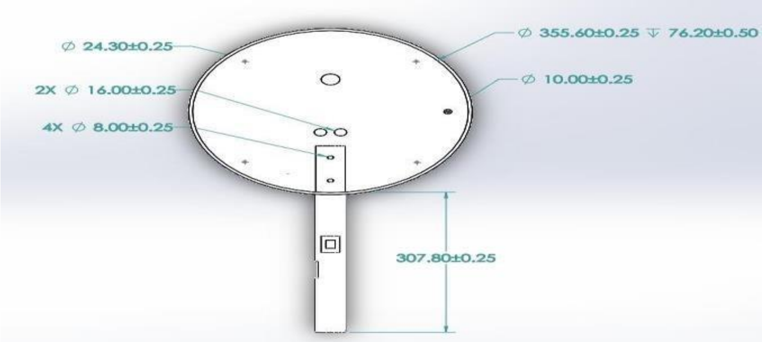

Fig 2: Model of portable handheld UV sterilization racket

- Actuators, microcontrollers, and UV -lamp for disinfection. Its additional energy than radio waves, however, less energy than x-rays or gamma rays. Ultraviolet light radiation has been used for medical care since the mid-20th century, even earlier once daylight was investigated for disinfectant effects within the mid-19th century. It is used for drinking and waste matter treatment and air purification. Ultraviolet light technology has advanced in recent years to become additional reliable [8]. We tend to start exploitation of Ultraviolet radiation light to kill germs like bacterium and viruses. The ultraviolet light spectrum is higher in frequency than actinic radiation and lower in frequency compared to x-rays. This additionally means the ultraviolet light spectrum incorporates a larger wavelength than x-rays and a smaller wavelength than actinic radiation and therefore, the order of energy, from low to high, is actinic radiation, Ultraviolet, then x-rays. Ultraviolet exists at intervals in the spectrum of sunshine between ten and four hundred nm. The germicidal ultraviolet light is at intervals of 100-280nm wavelengths, that is additionally referred to as Ultraviolet- C, with the peak wavelength for germicidal activity being 265 nm. The polymer absorbs this varying of light and ribonucleic acid of microorganisms that causes changes within the polymer and ribonucleic acid structure, rendering the microorganisms incapable of replicating. A cell that cannot reproduce is considered dead, as it is unable to multiply to infectious numbers at intervals in a bunch, it'll not damage the host. Therefore, ultraviolet light medical care is typically referred to as ultraviolet germicidal irradiation (UVGI). Our ultraviolet light systems use low-pressure, mercury-arc germicidal lamps that is designed to supply the very best amounts of ultraviolet light radiation - wherever 90% of energy is often generated at 254nm. This radiation is incredibly getting ready to the height of the germicidal effectiveness curve of 265nm, the foremost fatal wavelength to microorganisms. The employment of ultraviolet light has recently full-grown at intervals to produce medical care of area surface disinfection and existing improvement strategies. The employment of ultraviolet for surface medical care at intervals analysis facilities has begun to increase.
- Additionally, thanks to its easy use, short dose times, and broad effectualness. The designed prototype of portable handheld UV sterilization racket is shown in fig.3. UV (Ultraviolet) light could be a form of radiation.

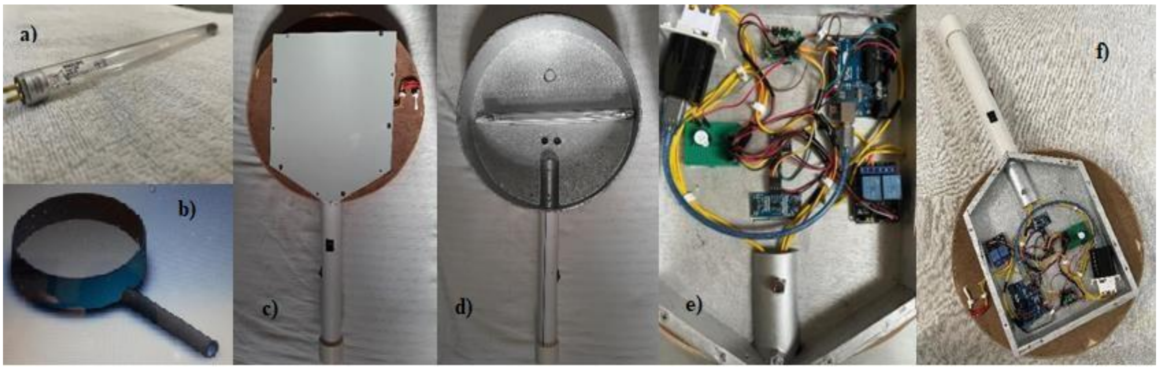

Fig 3: Assembly of UV sterilization racket a) UVC lamp (G16T5) b) & c) design model of racket

d) front and rear view of circuit

The schematic block diagram of the working circuit is displayed in fig.4. The ac supply of 220 Volts is given to the racket. This supply is then split into two ways, one through the ac-dc converter for the microcontroller and the other for the UV lamp through a magnetic relay. The AC-DC converter converts the alternating current to direct current for the microcontroller as it needs 12 volts. The microcontroller is connected to a buzzer, a red led, a white led, as the outputs, which tell the user different indications while using the racket. The operating principle is, when the racket is supplied with 220 Volts the power is divided into two ways, one goes through the ac to dc converter, and is directly supplied to the microcontroller. The analysis of the conditions is done through four steps as explained below.

Step 1: The microcontroller first checks the state of the switch 2 which is used to swap between enabling and disabling the accelerometer and gyroscope module. If the switch is in the on state, a red LED is made to glow, and the condition of the passive infrared sensor is checked. Whereas, if the switch state is off, then the accelerometer and the gyroscope module is checked. A condition is applied, where the available angles in the X-Y plane are compared with the pre-defined angles. If the angles are not in the range of the predefined angles, the state of switch 2 (used to swap between enabling and disabling the accelerometer and gyroscope module) is checked again and the step 1 is repeated. If the angles in the X-Y plane are available in the pre-defined angle range, then the state of the passive infrared sensor is checked.

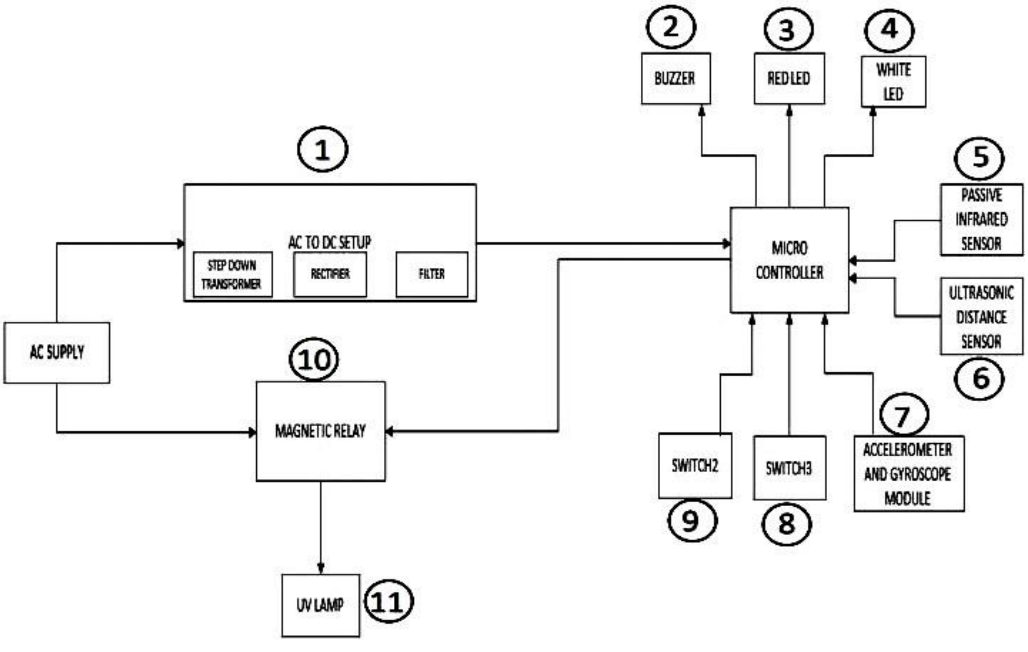

Fig:4 Schematic block diagram of the working circuit

Step 2: The condition of passive infrared sensor is checked in two cases: if the switch 2 (used to swap between enabling and disabling the accelerometer and gyroscope module) is in ON state and if the angles examined by the accelerometer and gyroscope module are within the pre-defined range as shown in the schematic working flow chart in fig.5. If the output from this sensor is given as high; that means, there is a possibility of a radiating object in the way of the UV light radiation. Hence, the microcontroller is instructed to check the state of switch 2 again, changing the angles of the racket. Whereas, if the infrared sensor gives off a low signal as the output, the microcontroller is instructed to check the output from the ultrasonic sensor, described in step 3.

Step 3: The output from the ultrasonic sensor is checked in this step3. The microcontroller is instructed to go through with this step if the output from the infrared sensor is low. In this step, the distance output from the ultrasonic sensor is verified. If the distance is out of the predefined range, the microcontroller is instructed to go to step 1. Otherwise, if the detected distance is within the pre-determined range, state of switch 3 (used to swap between auto and manual modes.) Is checked.

Step 4: The state of switch 3 is checked after the output distance from the ultrasonic sensor is within the pre-determined range. If the state of the switch is OFF, the microcontroller sends the signal to the magnetic relay, which turns on the UV lamp, while giving a signal to the buzzer, as a precautionary action. The microcontroller constantly checking the state of switch 2 and the outputs from the accelerometer and the gyroscope module. On the other hand, if the switch 3 (used to swap between auto and manual modes) is in the ON state, a white LED is switched on, with the magnetic relay, the UV lamp, and the buzzer ON simultaneously. In addition to this, the microcontroller calculates the sterilization time, based on the distance given by the ultrasonic sensor. After the lamp has been ON for the pre-determined time, it switches OFF automatically.

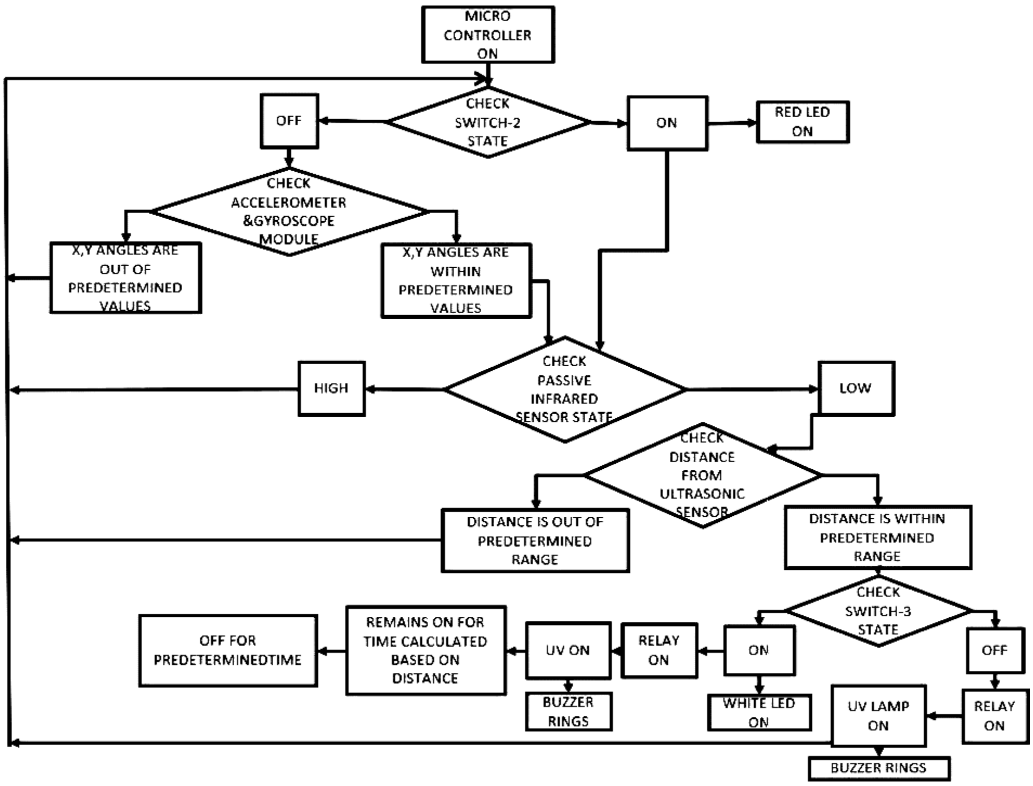

Fig:5 Schematic diagram of working flow chart

Results and discussions

Though there are many inventions, the present work carried out on "Portable Handheld UV sterilization bat" is a handheld UV apparatus for sanitization, which is portable easily and can be handled easily like a bat. This product is flexible regarding orientation and can sterilize any kind of objects (irrespective of size, surface orientations etc.) without leaving any residue. In addition to being operated like a bat it can ensure that there are no humans or animals around using a passive infrared sensor, thereby considering safety. It can be used for all objects however, their orientation is, the apparatus can be moved around to sanitize them with only one source of UV-C light. This is mainly to focus on commonman where it could be affordable, easy to carry, and safe to use by humans, thereby sanitizing the usual things we use and carry often. So, the focus is to have a device which every household can afford and use it daily in the pandemic situations and can make their space be free from microbes like corona virus, which has been well known for its widespread through contact and its nature of being on non-living surfaces for varying duration depending on the surface it is upon.

As we all have seen and experienced the ongoing pandemic firsthand, we can understand how critical it is to keep us and all the things around us clean and sanitized as much as possible. The transmission of this highly transmissible infection is very high, and we also know that how important it is to be varied. Too much use of alcohol-based sanitizers can dry out the skin and can also damage the objects. And use of harsh chemicals like hypochlorous acid with ammonia can release chloramines which can often cause neurological problems. The UVC germicidal racket leaves no such residue proving it to be eco-friendly. Thus, UVC light short wavelength at 253.7 nm is used to inactivate the virus as fast as possible by killing their DNA and RNA.

Conclusions:

Infection control programs must provide hand washing and disinfection of environmental places in medical facilities. Since various reasons render it impossible to obtain high levels of efficient disinfection on a regular and consistent basis, attempts to increase the efficiency and effectiveness of conventional cleaning and disinfection procedures must continue. Given the many obstacles to achieve desired degrees of surface disinfection, new technology should be used in addition to conventional approaches. The following conclusions can be drawn based on prototype model designed and developed:

- It can be employed in all homes to clean daily things like keys, currency, grocery packets, ecommerce parcels,stationary, bags, wallets, ecards like debit and credit cards, newspaper etc.
- UV-C Racket also can be employed by tiny business/shops homeowners to clean their commercialism merchandise, place of exchange of commercialism merchandise and services like in grocery we can clean all the home staples like dals, pulses, food product packs, juices, beverages etc.
- This can be used in service places like gyms will clean their instrumentation, seats, dumbbells, etc.
- Small scale salons can clean their tools like scissors, washbasin, combs etc.
- Taxi cars and tempo buses where many individuals employ throughout the day, risk of transmission is terribly high. This can be used to sanitize it accordingly.

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