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Corona destroyer based ultra violet sanitizing robot

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ABSTRACT

Every country in the globe has been profoundly affected by the coronavirus epidemic, and these countries are struggling with how to clean the affected areas quickly and effectively. This project aims to contribute to the fight against the spread of the coronavirus by quickly, safely, and effectively cleaning medical clinics. Regular cleaning and disinfection might reassure people and increase their confidence in the lessened risk of the spread of communicable diseases. Robots that use ultraviolet C (UVC) sanitizers can quickly and effectively clean the clinic rooms. In addition to cleaning patient seating areas, clinical equipment, restrooms, and above controls. The use of UVC technology effectively eliminates airborne germs in medical clinics. The results of UVC disinfection performance indicated a 92% reduction in the total bacterial count (TBC) at 0.5 metres from the robot after 8 minutes of UVC irradiation.

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1. INTRODUCTION

Since late 2019, people have been dealing with the coronavirus pandemic, which is perhaps one of the deadliest pandemics in recorded history. More than 4.5 million people had accepted passing as of September 30, 2021, bringing the total contaminated cases number up to almost 231 million [1]. Close physical contact, inhalation beads from infected people, Backhand contact with nearby surfaces, or use of contaminated objects are all ways that the SARS-CoV-2 (COVID) infection can spread [2]. Additionally, airborne transmission is a possibility while creating sprays [3]. While contamination from direct touch and breathing droplets may be lessened by being aware of the environment and careful of the situation, contamination from connection with contaminated exteriors is more complex to manage. This problem arises because strong surface sanitization needs more effort and resources. There are six sections in this study. A close market analysis of successful ultraviolet C (UVC) robots, studies related to the lethal component of UVC for SARS-CoV-2, and the limitations of current sanitization techniques are all part of Segment 2's background.

In this general pandemic situation, the advanced robot may be utilized,in any interior environment. It can also provide practical sanitization in medical offices against the prolonged aftereffect of the coronavirus in the post-pandemic period. A new COVID, known as SARS-CoV-2 (extremely acute respiratory disease COVID 2), was discovered in Wuhan, China, around the end of 2019. By Cov-19, it was already known. It now depicts a pandemic. It is an infection caused by a different subgroup of the COVID family [1]–[3]. It is generally agreed that the event started in the Chinese city of Wuhan [4]. Positive-sense RNA, which measures 60 to 140 nanometers wide, causes infectious illness. Its name comes from the fact that it has the appearance of a crown due to the spike projection that was seen when it was magnified [5]. Analysis of suggestive and asymptomatic people revealed increased viral loads in the nose when removed from the throat with no improvement in viral load [6]. For whatever length of time that the symptoms persist and to ensure clinical recovery, patients may be too many. The contamination was thought to be spread from person to person, which makes it plausible that it has spread. The patient falls during the hacking or wheezing procedure, which is where the transmissions begin. These droplets can remain in the air for a little period of time, to be sure, and spread the contamination to humans. Recent published investigations revealed the excitement of the disease on many surfaces and air, where contamination may linger for up to 3 hours in the air, 24 hours on cardboard, 4 hours on copper, and up to 3 days on hardened steel and plastic [7], [8].

The evaluation suggests employing biocidal professionals to address the contamination, such as alcohols, hydrogen peroxide, sodium hypochlorite or benzalkonium chloride [9], [10]. While the COVID scourge continues to plague the planet, several advancements are creating more effective ways to combat the illness. From a clinical perspective, IoT-based therapeutic administrations are regarded as front line since they contribute to the direction and the managers of clinical information. Currently being used in clinical contexts include telehealth, wearable sensors, clinical equipment, medical care data systems, enormous data analysis, cloud administrations, and other advanced IoT methods [11]–[14]. Mechanical technology is currently widely used in the modern world to carry out a large number of tasks [15]. It has emerged as one of the fastest-growing designing domains in the cutting-edge invention. Robots will likely eliminate humans, especially those who work in dangerous environments [16], [17]. In remote locations that are off-limits to people, robots may also be deployed [18]. In the domain of planned operations and administration, automated devices mostly use mobile and aeronautical frameworks for supply creation and delivery jobs. However, the ethereal robots might not be suitable for usage in hospitals. However, devices based on controllers and half-breed situations (such as portable bases and controllers) might be used in this sector, highlighting related responsibilities and assisting with patient administration.

Self-driving vehicles have also proven to be crucial in the fight against the global pandemic, reducing the burden of COVID by delivering medical supplies and food to healthcare providers and patients in infected areas and sanitising buildings and common areas to prevent the spread of the disease [19], [20]. The building blocks of medical treatment are essential in the fight against pandemics. In these circumstances, mechanical developments are essential because they replicate human jobs in hazardous environments while weakening interpersonal relationships [21]. Due to the emotional increase, most countries must ensure that different robots are transported to assist human labour force. The developed countries have the ability to dispatch a variety of robots swiftly that can clean, carry medications, and assess vital signs, among other things. Furthermore, the Coronavirus incident demonstrates how common robots may collaborate with cutting-edge medical workers when a dangerous scenario arises [22]. When the control dustbin is kept empty for an extended period of time or government healthcare wastes are not cleaned, the leaking aroma, irresistible, and dangerous wastes constitute a much bigger risk to people. In the unlikely event that 10% of the medical clinic employees come into touch with this harmful substance on a regular basis, 75-80% of them will get infected. A greater percentage of patients are segregated in each ward, and up to 50% of people might get contaminated. Therefore, safety precautions and efforts to reduce the risk should be taken to eradicate this illness. These irresistible wastes should be disposed of in a risk-free manner to limit the harm and cultural impact [23].

2. METHOD

With the intention of providing safe and knowledgeable sanitization in the middle of the coronavirus epidemic, UVC-cleanse was developed. The goal of the robot's design process was to create it as successful as possible with a small structural component to move in crowded locations that can be verified successfully using continuous video critique. Taking into consideration all of the discoveries of the necessity investigation. The robot should also guarantee UVC lighting equivalent to the reasonable lethal amount of 3.75 mJsec/cm^2 and contain a component for snag recognition to prevent collisions.

2.1. Design architecture and considerations

Figure 1 shows a PC supported drawing (solidwork) model of the developed framework with the key components of the robot highlighted. The semi-independent body and the UVC sterilisation module are the two key components of the automated design. The treated steel (SS) frame with driving subsystem, the handling unit, the correspondence subsystem, the route subsystem, and the power subsystem make up the solidwork-formed body. To ensure strength, the foundation structure was composed of soft steel. To recognise both vertical and level obstructions, it was thought that the octahedral form would allow for a 360-degree positioning of the obstruction avoidance sensors. The UVC sanitization module comprises six UVC light sources (mercury type TUV PL L 35W), which may mirror UVC radiation to produce a peak frequency of light at 254 nmt while also acting as real security for the lights. Additionally, the lights' strategic placement ensures stability and reduces jarring movements.

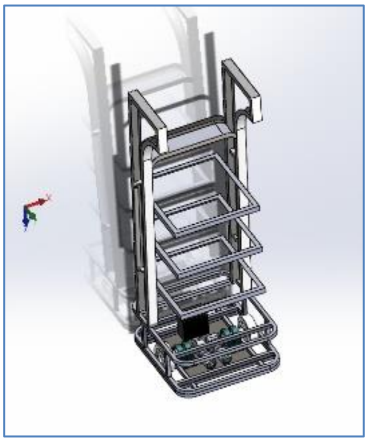

Figure 1. Full 3D view of the robot in design

2.2. Calculation of disinfection time

To determine the disinfection duration, a one square metre area was used as the unit of measurement. Initially, Stefan Boltzmann's (S-B) law of radiation flux was used to compute the total of the lamps' radiation flux [24]. The impact of temperature on the UVC lamps' ability to radiate was also taken into account. The time needed to disinfect a square metre of space was then determined using the equation for estimating irradiance, which will guarantee the logical fatal dosage of 3.75 $mJsec/cm^2$. Calculations revealed that the UVC-robot can deliver an effective fatal dosage for the 1×1 m square metre area by travelling at 1 metre in 5.19 seconds. The robot's top speed has been determined at 19.3 cm/sec, or 0.193 m/sec [25].

2.3. System components and integration

Figure 2 illustrates the robot's system design. The central computing unit of this robotic system is an Arduino Mega. The robot features motor drivers for its two-wheel drive system. The robot's navigational modes and inter-process communication have both been designed using the robot operating system (ROS). The robot has a specialised Bluetooth system built in.

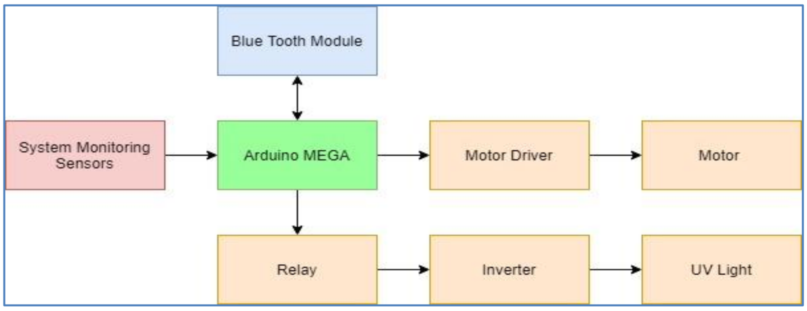

Figure 2. The robotic system architecture

Figure 3 showed the schematic design of the robot. By attaching it to the engines and moving it during the robot's development, the Arduino framework is used to operate the robot. The Arduino was also connected to the UVC lights. Additionally, buttons that controlled the lights' opening and closing were created and connected to the Arduino through a portable device, which was then used to operate the robot. Several engines and wheels were used thanks to the Bluetooth module's connection to the Arduino. Batteries were also employed to power the robot, which was used to carry out the task. Additionally, a temperature and humidity sensor are included.

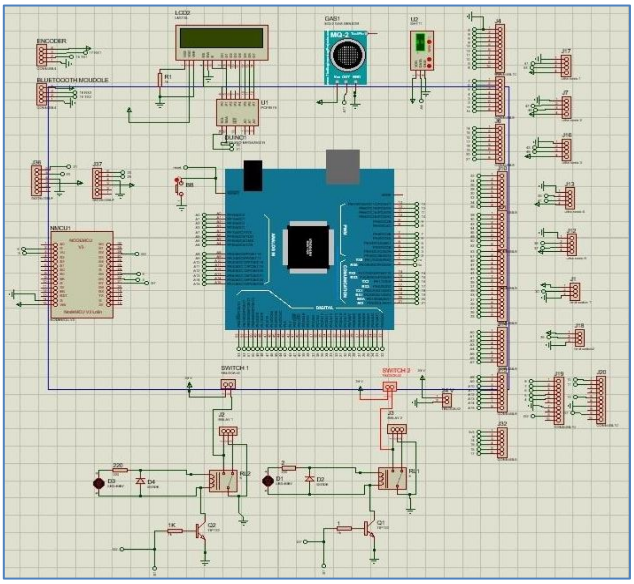

Figure 3. Proteus schematic of UVC robot

Figure 4 depicts the relay module that will use an H-bridge as a switch to turn on and off UVC lights. Only a signal from the node MCU will be able to turn on or off any desired device from anywhere. H-bridges can, as we all know, control the direction of motors, but when we link NC to GND, NO to VCC, and motor power pins to COM, we utilise two H-bridges to control a single motor. But in this case, we merely link the hardware we wish to control's two NO and VCC pins to two H-bridges, each of which may be used as a switch. Relay hardware will receive 24-volt electricity when it receives a signal from the node.

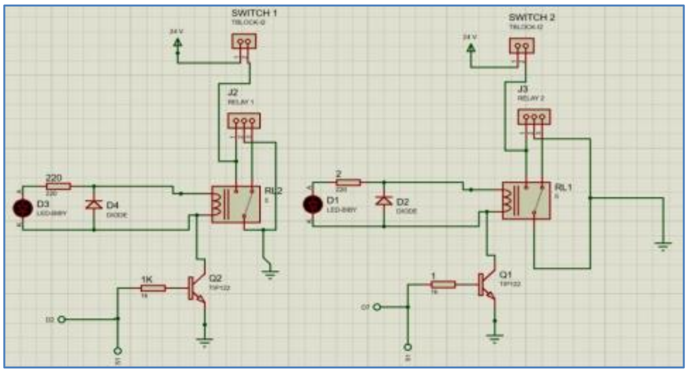

Figure 4. Relay modules schematic

To enable remote control of the robot, a portable application for android has been created. The maximum value in the application's speed bar allows the user to go one metre in 5.19 seconds, which ensures that SARS-CoV-2 will be killed off at the appropriate lethal dose (3.75 mJsec=cm^2). An online dashboard for cross-stage similarity has been created with similar components to enable hierarchical use, for example, of signal or clinic. With a 1,600 square foot inclusion zone, UVC-Cleanse is quite simple to grasp while being remotely confined by portable application. The key components of the framework are displayed in Figure 5.

The portable programme has two modes-ordinary and safeguarded-that allow users to explore restricted areas. In the safeguarded mode, the robot recognises obstacles as a result and defends itself by coming to a stop at a 0.5 m safety distance. However, this isn't really useful for exploring the robot in a closed off area. Therefore, the customer has the freedom to investigate it without restriction in the ordinary mode, reducing the safety distance to 0.15 m.

3. RESULTS

The final UVC robot evaluated in the hospital is shown in Figure 5. Through the interview, a very comprehensive and insightful interview dataset was created. According to the information gathered from the interview questions, the hospitals were required to fully clean all surfaces in the COVID-19 patient ward of any suspected patients. While working at the infected location to clean, the cleaning staff openly confessed their concern of contracting the disease. One of the hospitals was sterilising the equipment with a UVC unit. They assert, however, that a portable system will be efficient in cleaning the apparatus. They will choose a system that thoroughly cleans all surfaces in areas like COVID patient wards, intensive care units (ICU), and operating rooms (OR).

Figures 6 and 7 depict the UVC robot that is sentaizing the hospital’s laboratory and dentistry section. At a distance of 0.5 metres from the robot, the total bacterial count (TBC) reduced to 92%, according to the data. On longer distances, an average TBC drop was 90%, 61%, and 59% on 1, 2.5, and 3 metres, respectively as showen in Table 1. Surprisingly, the efficacy of UVC significantly declines between distances of 1 and 2.5 metres. In contrast to other ranges, the TBC drop in this area strongly depends on the range. This leads to the conclusion that 1 meter is the upper limit of the UVC range for 90% efficient disinfection. Figure 8 demonstrates the UVC robot’s capacity for transporting equipment while holding it in position.

Figure 5. Final shape of UVC robot

Figure 6. UVC robot sentaizing laboratory

Figure 7. UVC robot sentaizing dental unit

Figure 8. UVC robot holds different equipments

Table 1. UVC investigational findings

Distance (meters)	TBC before	TBC after	TBC reduction (%)
0.5	210	16	92
1	320	30	90
2.5	250	99	61
3	200	82	59

4. CONCLUSION

Health care facility maintenance personnel who use it to disinfect COVID patient wards, intensive care units, operating rooms, and other departments; Clerks who use it to disinfect workplaces. Maintenance personnel who use it to disinfect classrooms and laboratories. in educational/research facilities; members of the public who use it for daily personal hygiene. Moreover, in the post-pandemic world, IPC continues to be a major concern, especially for medical and biomedical research institutions.

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