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A COMPREHENSIVE AND ECONOMICAL SOLUTION FOR DISINFECTION AND SANITIZATION

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ABSTRACT

Since December 2019, an acute respiratory disease, Covid-19 has been prevailing around the globe. It is caused by the newly discovered novel corona virus (SARS-CoV-2, previously known as 2019-nCoV). The virus originated from Wuhan in China and gradually took the whole world into its grip. According to the director of World Health Organization (WHO), Dr. Tedros Adhanom Ghebreyesus, Coronavirus vaccine alone will not end the virus. So, we must ensure the safety of ourselves and other people by washing our hands frequently by soap by some alcohol-based rub, especially after touching any surface. The Covid-19 virus primarily spreads through droplets of saliva or discharge through nose when an infected person coughs or sneezes. But when we consider practical scenario, it becomes quite unfeasible and inconceivable to go to a sanitizing facility to sanitize our hands. Also, normal cleaning of floor and other surfaces through detergents or phenyl do not have any impact on the virus. In order to destroy the virus from the non-living surfaces and floor and to make the sanitization process more convenient and effective, we have come up with a solution named- Automatic Disinfecting Robot. This paper presents a solution proposed by us for solving the purpose of sanitization and disinfection which will help us in the fight against the deadly COVID-19 and outlines the crucial roles of technologies such as Internet of Things (IoT) in this unprecedented battle. It is envisaged that this study will cater the current status of sanitization which exists and motivate the researchers in fighting against COVID-19.

Keywords: Covid-19, WHO, Ultraviolet-C, UV-C, SARS-CoV-2, RX, TX.

1. INTRODUCTION

Due to Covid-19 pandemic, a nation-wide lockdown was implemented due to which the food and livelihood security of the citizens of country has been on stake. Particularly, the daily wage earners and casual labourer and migrant workers suffered a lot because of the shutting down of industries and offices in which the used to work.

The government has the started the procedure of unlocking in all the states gradually but the danger of getting infected by the virus is still there. So, to ensure the safety of the workers, the concerned factories, industries and public places must be sanitized properly, and the workers should also sanitize themselves after some period of time.

As per the guidelines by WHO people are required to sanitize their hands regularly but the sanitization tunnel and solution are kept at a fixed place. This robot provides a complete dynamic sanitization solution for keeping the environment safe for working and traveling.

We have divided our entire research work into – sections. In the first section we have introduced our research and the motivation for to work on this project. In section 4, we have described the solution that we have proposed. Section 5 includes the implementation details of the proposed robot (hardware and

software). In section 6, there are actual images of the robot and in section 7 we have concluded the research work.

2. NEED OF THE PROJECT

Coronavirus has put the world at risk of putting the health of its people ahead of its own economic health. The only effective ways to combat the virus are, at present, social isolation and social isolation that has almost 'shut down' the world.

The government has started the procedure of unlocking in all the states but the danger of getting infected by the virus is still there. Usually, frontline workers get infected during the sanitization process. So, to ensure the safety of the workers, the concerned factories, industries, and public places must be sanitized properly, and the workers should also sanitize themselves regularly after some time.

As per the guidelines by WHO people are required to sanitize their hands regularly but the sanitization tunnel and solution are kept at a fixed place due to which either they get neglected or peoples don't bother to go to them again and again to sanitize themselves at regular interval and hence they become ineffective.

Previously a sanitizing robot "UVC Disinfection Robot" has been proposed by Moez Guettari, Ines Gharbi and Samir Hamza which can disinfects rooms and equipment with ultraviolet light and shuts down when humans are around to keep them safe.[11]

However, it is inefficient in terms of sanitizing human beings and a bit expensive according to Indian market. In order to overcome this, we have proposed a wholesome solution which provides an effective sanitization for human beings also and is economical.

3. OBJECTIVE

As a solution to this problem, we proposed an Automatic Disinfectant Robot, the primary goal of this robot is to provide an effective and economic sanitization solution.

It sanitizes the complete space as well as people around by its movement and controls the spread of the virus. The multiple trials of different vaccines have been done but none of them claims 100% efficacy. According to "Centre for Disease Control and Prevention" the only way to protect ourselves and others from the virus we must maintain social distancing and must sanitize ourselves after every 20 minutes. Which is served by this bot perfectly.

The non-living things such as furniture, walls, windows, etc. must also be sanitized because the virus can survive on a non-living surface for at least 2-3 days, for serving this purpose and disinfecting non-living surfaces, public places, and floors we have used Ultraviolet-c light, and for humans, we provide alcohol-based automatic sanitizer system. Acting on the robot this dual hybrid disinfecting solution sanitizes the space as well as people and stop the spread of the virus.

4. PROPOSED SYSTEM

The foremost functionality of Automatic Disinfecting Robot is to prevent the spread of virus (threatening to humankind). In this robotic system, we have divided the process of sanitization into two parts depending upon whether it is a living or non-living thing. For sanitization of the workers and employees, there is a provision of alcohol-based sanitizer. Whenever a person brings his hand near the robot (range between 10 to 15 cm), the robot offers sanitizer to him. For the sanitization of non-living things UV-C is used and the bot is operated completely contactless thru Bluetooth.

4.1 Alcohol as Disinfectant

Many compounds have been utilized for the disinfection of human beings that kills microbes. They include alcohols, chlorhexidine, hexachlorophene, cetrimide, povidone-iodine, triclosan, chloroxylenol and benzalkonium chloride. The alcohols used are ethanol and isopropanol. They are mostly used for the disinfection of skin due to their action against bacteria, viruses and fungi. They also provide protection against the enveloped virus as demonstrated in fig.1 below.[2]

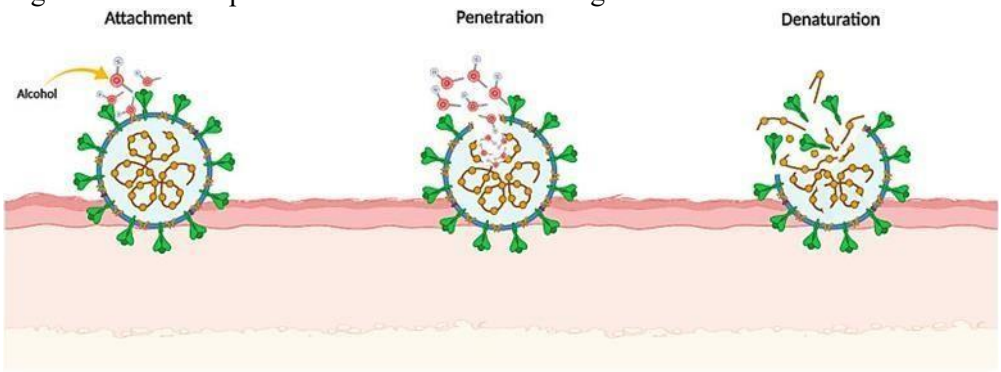

Fig 1 Alcohol acting on Corona Virus[2]

Alcohols have both the properties, hydrophilic and lipophilic (hydrophobic), that is why they are also known as amphiphilic compounds. SARS-CoV-2 virus' external membrane consists of lipids which are bound by an alkane chain which is made up of hydrophobic fatty acids. When the virus comes in contact with alcohol, it leads to alteration in its membrane fluidity. The oxygen atoms (polar) weakens the lipophilic interactions which is present between the non-polar residues and this increases the internal affinity of the water membrane. This destabilizes and denatures the protein structure. The antimicrobial action of alcohol against those viruses that are enveloped is quite similar to that of bacteria because both of them have a lipid-rich outer membrane. The virus which is not enveloped is relatively more resistant to this method of disinfection because it lacks lipid membrane.[2]

4.2 UV-C as Disinfectant

Ultraviolet C (UVC) light emitted by the sun with a wavelength of 222 nanometres can destroy coronavirus. The 222 nanometre UVC is also safe for humans, according to the scientists at Hiroshima University. The researchers conducted an in-vitro experiment to show that 99.7 per cent of the SARSCoV-2 viral culture can be effectively destroyed after a 30-second UVC exposure. Author Hiroki Kitagawa from Hiroshima University stated in the study: "This study shows the efficacy of 222-nm UVC irradiation against SARS-CoV-2 contamination in an in vitro experiment." According to a research, wavelength of UVC rays is 222nm. So, it is unable percolate the outer layer of the human eye and skin because this layer is non- living. Hence, it will not cause any harm to the living cells.[10]

5. IMPLEMENTATION DETAILS

In this automatic disinfecting robot, we have made use of technologies such as:

1) Internet of things (IoT)

2) Robotic and process automation

In this, we have divided the process of sanitization into two parts depending upon whether it is a living or non-living thing. For sanitization of the workers and employees, there is a provision of alcohol-based sanitizer. whenever a person brings his hand near the robot (range between 10 to 15 cm), the robot offers

sanitizer to him. And for the sanitization of non-living things UV-C is used and the bot is operated completely contactless through Bluetooth.

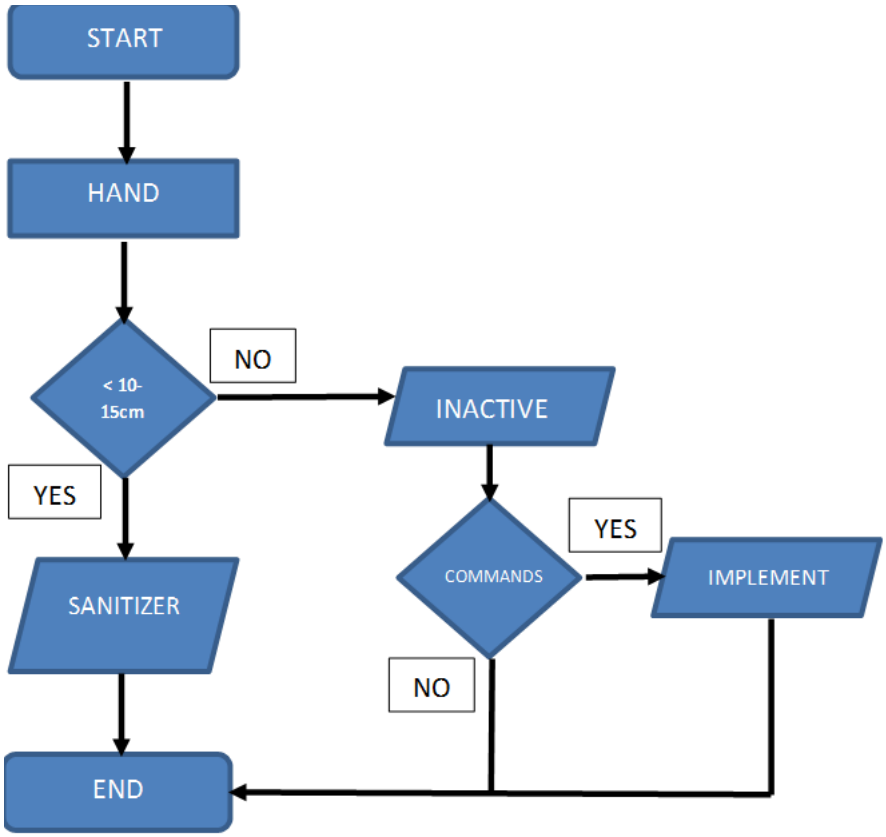

Fig 2 Flow Chart of Robot

This Automatic Disinfecting Robot is powered by a 12V battery which is connected to the system by a switch. When we turn on the switch, the system gets activated. The movement of robot is Bluetooth controlled and is equipped with an ultrasonic sensor. Whenever it detects hand in the vicinity of 1015cm then it dispenses the alcohol-based sanitizer. When there are no human beings around the bot, the ultrasonic sensor does not detect anything and remains inactive. Meanwhile, the UVC lights attached to the system remains ON and continue to disinfect the floor, surfaces, windows, furniture and all the non-living surfaces. The flowchart of the whole process is presented in figure 2.

Wherever this robot goes, it keeps on disinfecting the floor because of the UVC lights attached below the chassis of the robot. The block diagram of the system is shown in figure 3.

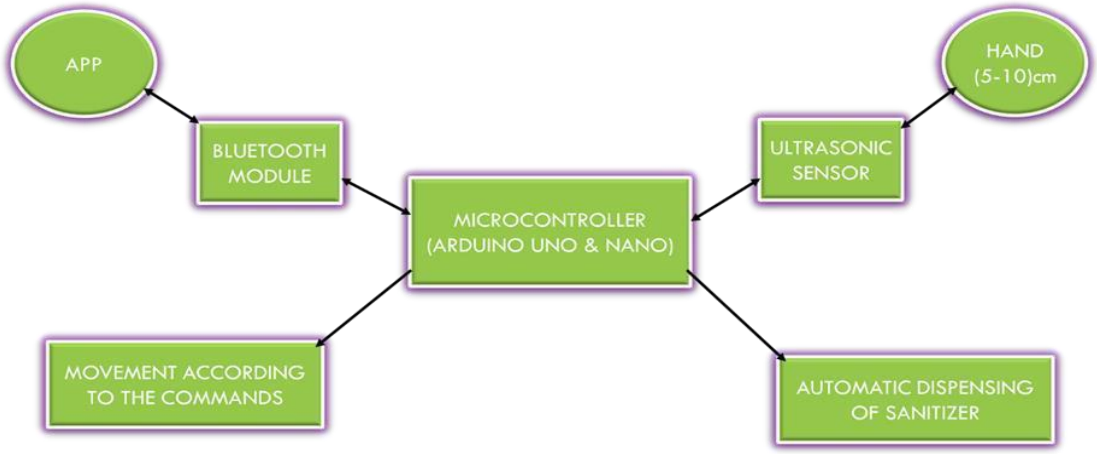

Fig 3 Block Diagram of Robot

The microcontrollers used in the project to control and monitor the system are Arduino UNO and Arduino NANO. Arduino UNO is used to give power and instructions to the Bluetooth module which controls the Motor driver IC and is connected by the android mobile phone of the user through an app. It is responsible for controlling the movement of the chassis. On the other hand, Arduino NANO is used to give instructions to ultrasonic sensor. Whenever it detects human movement in the radius of 5-10cm, it dispenses the sanitizer and remains inactive if no movement is detected. The entire process of sanitization conducted by this robot is touchless.

5.1 HARDWARE IMPLEMENTATION

Circuit Design of the Setup

This is an Arduino-based Automatic Disinfecting Robot. This project is entirely based on an Arduino controller and this paper will give you a good understanding this system. In this paper, we have provided a step-by-step method so that you can construct this system.[20]. The circuit implementation of the proposed work is shown in figure 4.

Sensor to controller pin information

The sensor has four pins: VCC, Trig, Echo, and GND. Connect:

- VCC pin to 5V on controller (Nano)
- GND pin to GND on controller (Nano)
- Trig pin to pin D_2 on controller (Nano)
- Echo pin to pinD_3 on controller (Nano) **Motor Driver to controller pin information**

Motor Driver has four input pins:

- Pin I_1 is connected to pin-10 on controller (UNO)
- Pin I_2 is connected to pin-11 on controller (UNO)
- Pin I_3 is connected to pin-12 on controller (UNO)
- Pin I_4 is connected to pin-13 on controller (UNO) Motor Driver is Powered by a 12v Battery.

Motor Driver has 2 output port on which four motors are connected in parallel respectively.

Bluetooth to controller pin information Bluetooth has 6 pins:

- VCC pin to 5V on controller (UNO)
- GND pin to GND on controller (UNO)
- RX pin is connected to TX pin of controller (UNO)
- TX pin is connected to RX pin of controller (UNO) **Relay to controller pin information** The Relay has 6 pins:

- VCC pin to 5V on controller (Nano)
- GND pin to GND on controller (Nano)
- OUTPUT pin to D_7 on controller (Nano)

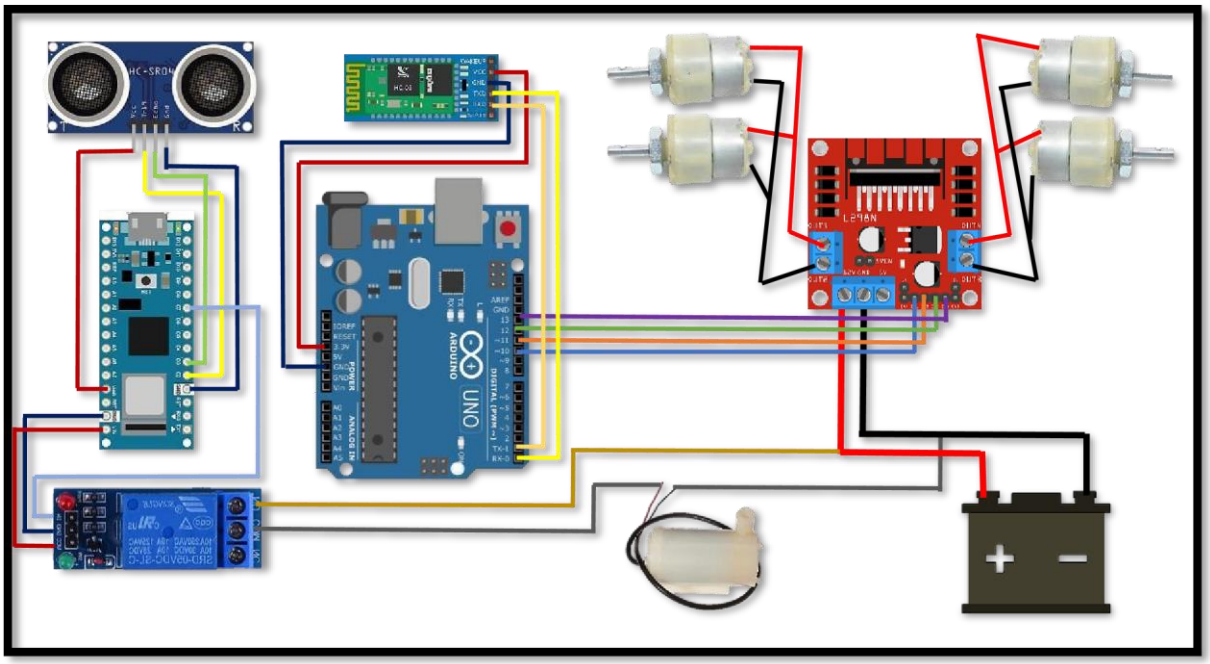

Fig 4 Circuit Diagram of the Setup

5.2. SOFTWARE DESIGN

Arduino Bluetooth RC Car for Android open-source application available on google play store by Andi.Co. This application is designed to be compatible with MODIFIED RC car. The application allows us to control an Arduino based RC car over Bluetooth. This is done using a Bluetooth enabled Android phone. Through this app we can control the movement of the robot with either buttons or the phone's accelerometer. A slider bar allows us to control our robot's velocity, if the robot's control circuit has this feature. A flashlight lets us know when the phone is connected to the robot, and arrows light up lets us know the robot's driving direction.[19]

6. RESULTS AND DISCUSSIONS

In fig 5, we have demonstrated that the Robot is controlled by the operator wirelessly through a smartphone via Bluetooth. The UV-C LEDs are installed on the hardware and beneath the chassis of the robot. Fig.6 shows that this robot is sanitizing the floor through the UV-C LED installed beneath the chassis. For the sanitization of human beings, the robot automatically dispenses an alcohol- based sanitizer whenever it senses the proximity of 5cm-10cm, as shown in fig. 7. The entire process of disinfection of non-living as well as living beings is completely touchless, thus, making the robot highly efficient for sanitization.

Fig. 5: Automatic Disinfectant Robot Sanitizing the Hall and Operator controlling it via Smartphone.

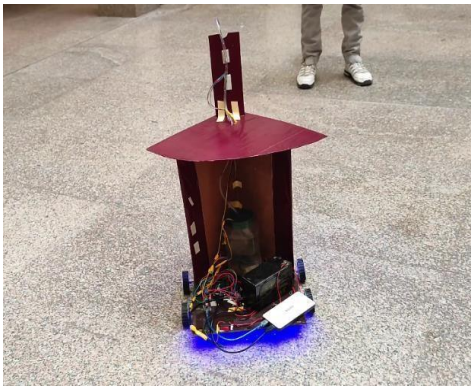

Fig. 6: Robot Disinfecting the Floor of the Hall by its Movement.

Fig. 7: Robot Providing Alcohol Based Sanitizer to the Person.

7. CONCLUSION

The increase in the number of patients having coronavirus is driving the growth of the Cleaning and Disinfecting Solutions market as the need for fast and effective disinfection methods are required to ensure a safe environment. The outbreak of COVID-19 pandemic has resulted in the increase adoption of robotics and IoT for hospital-acquired infection (HAI) and increasing end-user applications of disinfecting robots. Although the disinfecting robot market was rapidly expanding in the past but COVID-19 outbreak has provided a massive impetus to it. These robots witnessed a drastic increase in demand from hospitals, in the past months.

8. FUTURE SCOPE

There is an increase in zoonotic diseases from the last three decades. Moreover, various studies also reveal that there is a trend of increasing viral and bacterial infection in the future. Certainly, the demand for these robots will also increase. Also, various startups and different companies are also working in developing new technologies to boost up robotics in the health care sector, many of the governments around the world are also showing their keen interest towards flourishing it.

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