# An Ultraviolet Disinfecting Robot

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***Abstract*: Ultraviolet sterilization technology is used to minimize the number of microorganism and viruses. A UV disinfecting bot is developed which has 12watt of Far UV-C lamps of wavelength 207nm to 222nm which is an embedded system utilizing Raspberry Pi 4 and SVM Technique (Hyperplane). The system is endorsed by a Web API Progressive Web APP(PWA) which provides uninterrupted surveillance of the robot which moves around the area to be covered (Patients room and Public places), the bot navigates as per the admin commands through the web API and also objects detection and live streaming is acknowledged to the admin. Live streaming is done using Open CV, Flask and Python Programming in order to monitor the behaviour of movement and obstacles recognized by the bot.**

***Index Terms*: *Far* UV-C *Lamp, Disinfecting, robotic system***

## I. INTRODUCTION

The spread of infection has increased due to microorganisms, bacteria, viruses in public places, operating system and hospitals. The growing demand for wellness and health products with a rising rate of diseases has increased the demand for sanitizers and disinfecting systems in market. Alternate option for sanitizers is UV light Radiation which has a power to kill the microorganisms in air.

### *A. UV LIGHT SPECTRUM*

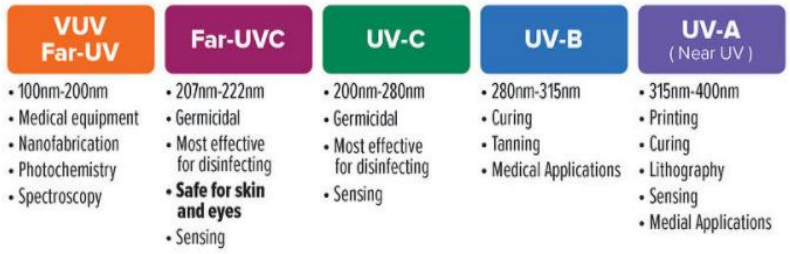


Figure 1. UV Light Spectrum

*i.* UV-A and UV-B

UV-A and UV-B are the rays that hit the Earth's surface from the sun and the reason doctors recommend we wear sunscreen.

ii. UV-C

UV-C, also known as germicidal UV, includes wavelengths from 200 to 280 nm. UV-C is effective at destroying and deactivating all kinds of pathogens like viruses, bacteria, mold, and fungus. While UV-C is an extremely effective option for disinfecting, it does come with a safety warning. Many UV-C products use 254 nm, which can penetrate the skin and eyes. Exposure to UV-C can cause burns. Most products should only be used in empty rooms, which can be challenging for specific industries where there is little downtime.

iii. Far-UVC

Far-UVC is a smaller segment of UV-C, specifically the wavelengths between 207 and 222 nm.

Here's what makes far-UVC different: It's believed to be safe for us to be around. This specific range of light has a very narrow bandwidth that cannot penetrate past the outer layer of our skin, but it can still inactivate viruses and bacteria.

One benefit of far-UVC fixtures is the ability to constantly fight germs within a space.

The Far UV-C light in the above wavelength does not harm humans like other rays and hence this wavelength of UV-C light is used in the system.

### *B. UV DISINFECTING BOT*

The bot, which is controlled through a web application, will navigate the room and can sterilize up to 99.99% of bacteria and viruses in the air and on surfaces using Far UV-C light(207nm-222nm) 360° disinfection spray-heads . The sterilization process can take as little as 10 minutes depending on the size of the room. Considering the constant values to disinfect the areas studied through the facts in research paper[5].It takes 25 mins for public places to disinfect 99.9% viruses and lower dosage of about 8/10 minutes in a small room. Live streaming of the process will display the bot activities and also give the acknowledgment of the process on same web application. The fig below shows the structure of the system.

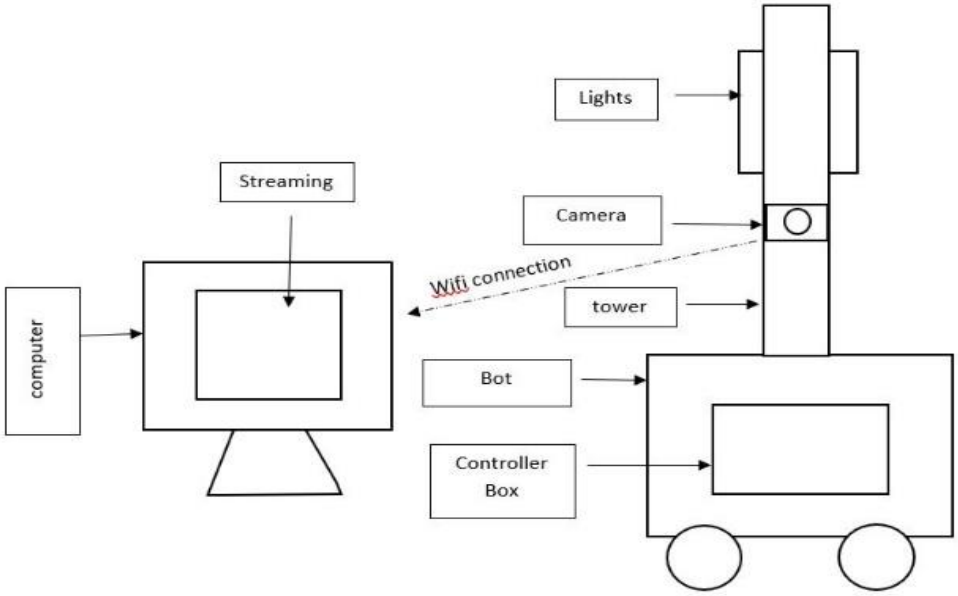


Figure 2. Structure of the system.

### *C. PURPOSE OF THE SYSTEM*

1. Disinfection can be thoroughly done anywhere to kill the microorganisms and thus help in decreasing the spread of diseases.
2. Robotic disinfection will work in an unmanned and standardized fashion, without the need for ongoing human presence at the disinfection site. Therefore, exposure of health care workers to harmful UV radiation can be avoided during the process.
3. The bot can be moved as per admin command from a remote location and simultaneously admin can monitor and checks how well it works.
4. Far UVC lights in the range of 207-222 are used in the system which are not harmful to skin if any human interaction takes place like other UV rays which have adverse effects.
5. The system is Environment friendly and no carbogenic products released during the process.
6. Reduces manual work required in spraying the liquid sanitizers.
7. It can be also be operated through mobile device and feedback of the process can be reflected on device.

## II. METHODOLOGY

### A. ARCHITECTURE

The robot has three main components –

1) Controller:

The bot will be operated using Android through a web application which will exists outside the room or other room. The robotic bot/ground vehicle will be connected to a application via wifi which is implemented using python and flask. Open CV is used to collect the data from raspberrypi which will have data captured from raspberrypi camera. The application will have controls to give commands to the bot to move it in different directions. The bot can be stopped immediately at emergency situation. Live streaming will be done through same application to monitor the bot and get the acknowledgment of the bot activities (started from the source, area covered, object detected in the room, disinfection process completion).

2) Ground Vehicle:

The bot is embedded on raspberrypi which is connected to motor drivers which inturn help to rotate two gear motors. The movement of gear motor will make the Wheels move and navigate the bot around the room. The components are charged up using 12V battery which will be fitted on the bot itself. The raspberry pi will require wifi connection to start and operate.

3) UV Light Tower:

The tower is mounted on the ground vehicle. The two Far UV-C lamps each of 6watt are fitted at the top of the tower which are charged up by the battery. Raspberry Pi camera is fitted at the top of the tower which is connected to Raspberry Pi that captures the data in the room. The rays reflected by UV lights are used to disinfect the room.

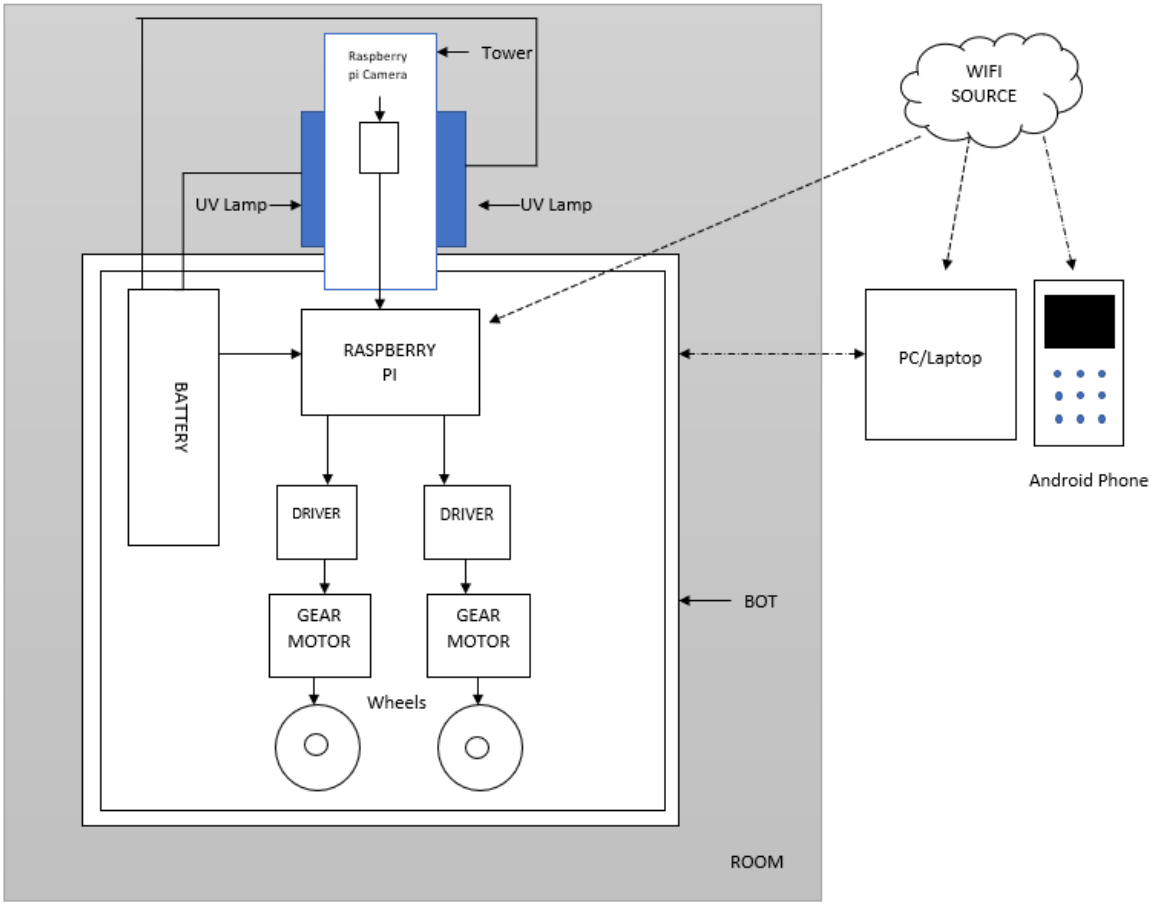


Figure 3. System Architecture

**B. SYSTEM FLOW**

- Admin will activate the Raspberry Pi and gear motors of the bot and inlet of Far-UVC lights.
- Admin will run the Web API in PC/laptop/Android and simultaneously initializes the components.
- Live streaming will start on the Web application and it will detect the objects in the room.
- Admin acknowledges the default area to be covered by bot and control the navigation of bot through same live streaming Web application.
- Admin checks the area covered by bot to be disinfected.
- Admin can either continue or stop the bot under emergency situation.
- At the end the bot acknowledges the area covered to admin.
- Admin stop the bot and UV simultaneously.

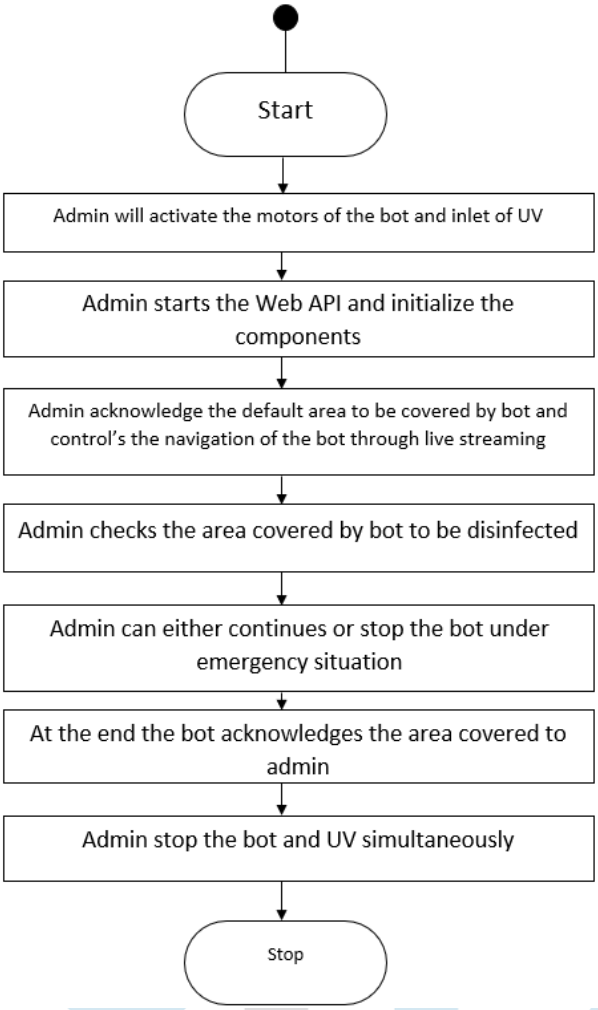


Figure 4. Flowchart of system

**C. UV DISINFECTING SYSTEM ALGORITHM**

**Step1:** Admin/ controller will activate the components of the bot and UV lights
**Step2:** initialize the Web API on laptop/Android
**Step 3:** The data captured through raspberry pi camera is sent to Web API through open CV to Python Web application.
**Step 4:** Live streaming will get started and Admin will enter the default area of the room.
**Step 5:** Configurations will be acknowledged and detected on live stream.
**Step 6:** Admin will control the navigation of the bot to move in different directions.
**Step 7:** Admin will disinfect the room with the Far-UVC lights till the motors are active.
**Step 8:** Admin will continue to control and monitor the robot and can stop the bot at any emergency situation till the whole room is disinfected.
**Step 9 :** Completion of the disinfection process will be acknowledged on the Web application.
**Step 10:** Admin stops the robot.

**D. RESULT**

The Fig 5. is the output of the Live streaming and Bot controls through web application (PWA).

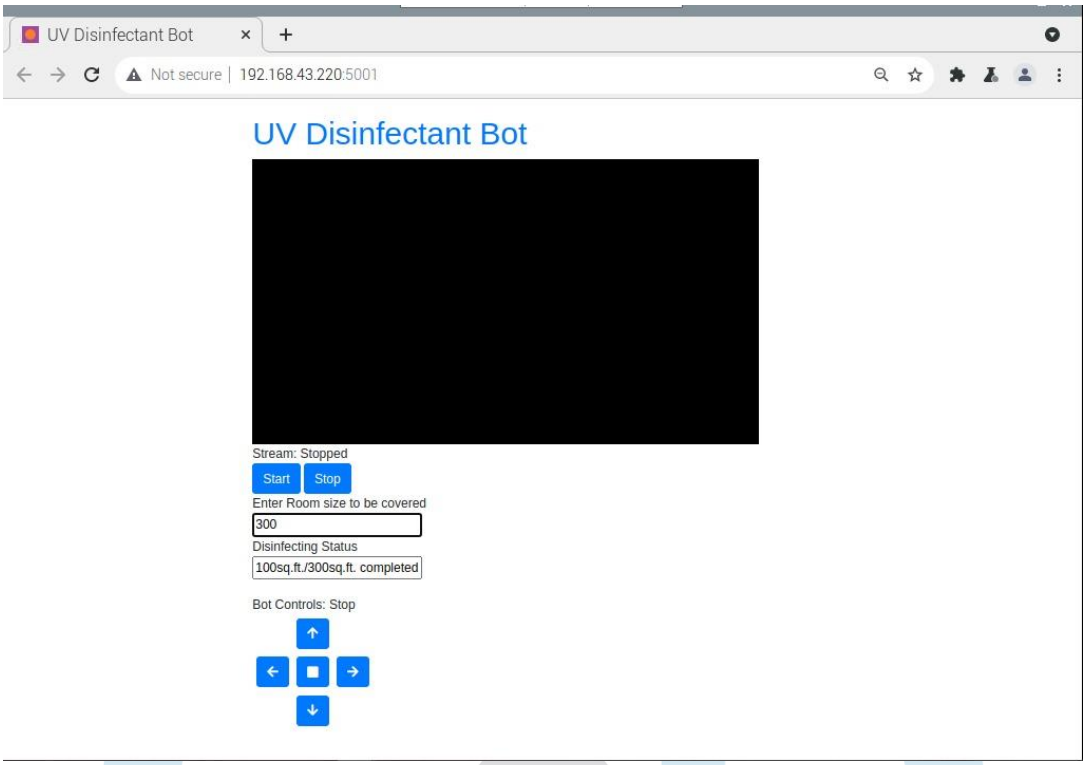


Figure 5. Live streaming and Bot controls web application

## III. APPLICATION

**1.** We are building a robotic platform to improve human productivity, reduce risk to workers, and ensure that the disinfection process is thorough.

**2.** This project will make the process of sanitization easier than the manual sanitizers. The main aim is to fight against the viruses, bacteria by reducing the spread in hospital, public transport, rooms, and enclosed areas.

3. UV is a cost effect disinfection alternating as it does not have the potential to create or release carcinogenic products into the environment.

**4.** A help to fight against covid-19 by rapid cleaning of the hospital environment it elements up to 97.7 percent harmful pathogens in the environment and hence it will reduce the spread of various infections.

**5.** It is an efficient portable device, also the safest and quickest way to disinfect surfaces of various sectors It does not require human presence at the disinfecting site and is operated by android**.**

**6.**The system is operated using Android phones hence it can be operated from anywhere with our ease and system is user friendly as admin can give any command to bot on urgent bases as required.

**7.** One time investment as we does not use liquid sanitizers to disinfect which has to be refilled.

**8.** It can cover large area in less time.

## IV. FUTURE SCOPE

- The UV disinfecting robot can be fully automated in the future.
- The sensors like ultrasonic sensors, PIR can be used to detect obstacles and individuals while navigating.
- We can renovate the bot for larger areas with more enhanced features.
- UV system can be used in different sectors like pharmaceutical, cosmetics, water disinfection, food disinfection etc.

## V. CONCLUSION

The technology is effective at reducing overall bacterial counts and significantly more successful than liquid sanitization which can be used in all public places or hospital room. The project is effective and enhances infection control strategies by reducing healthcare association phrases. It will also make the process of sanitization easy and will reduce the time taken for it.. This project can play a great role in COVID-19 Pandemic. The project is operated using web application which makes it more effective and easy to handle from anywhere. The project is basically based on robotics hence it has scope and it can also be enhanced further with more features.

## VI. ACKNOWLEDGMENT

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