Automatic UVC Disinfection Robot

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Abstract- Automatic Disinfection or Sterilization Robot can specifically design to be an effective solution in disinfecting contaminated areas without human interference. This robot help us to reduce the risk of infection spreads and to lower the burden on the healthcare system and most important to save human lives. The healthy thought of implementing a healthcare robot using modern technology will assist to disinfect open spaces. The sterilized surface areas have been automatically calculated by sensors which is installed on this robot. A specially developed radio-controlled application used in the robot with navigation detection that will identify robot orientations, directions and positions tracking. So, an automatic disinfection robot will help to protect the health care operation using modern technology to fight against COVID -19 or unwanted posterior infections.

Keywords: UVC;Sanitizer;Sensor;COVID-19.

I. INTRODUCTION

Automatic robots are increasingly present in all fields of medicine and public areas. Use of the disinfection robots decreases the hazard of illness, price of usual maintenance and disinfection, and most significantly obtains confidence and safety in medical amenities and protection of existence. The pandemic has come at an embarrassed time, technologically speaking. Tru-D Smart UVC is a most important ultraviolet disinfection system and is changing the way of caring health of human being by providing leading-edge technology for terminal disinfection of health care environments. Tru-D Smart UVC is the only elegant UVC disinfection device on the market and powered by Sensor360™ technology.Tru-D' is used in real-time data-tracking software application, Tru-D sets the gold standard of care for the health care disinfection market with innovative, high-efficiency capabilities. Newly, few hospitals have taken on portable improved ecological disinfection systems with ultraviolet-C (UV-C) light or hydrogen peroxide vapor (HPV) to fight hospital area which is already acquired with Clostridium difficile (C. diff), methicillin-resistant Staphylococcus aureus (MRSA), and other multi-drug-resistant organisms. Disinfection robotics evolved out of the need to reduce Healthcare associated infections(HAIs) without inviting extra labour expenses.[1-2] Though disinfection robots are current technology, the two methodologies are implicated for disinfecting rooms through terminal cleaning procedures using hydrogen peroxide spray and ultraviolet procedures. UV-C light has been utilized to disinfect drinking water and air management systems for more years. UV-C and HPV have been used to clean room by the pharmaceutical industry for more than a decade.

Whatever the techniques, check that the existing "non-touch" techniques like UV-C light irradiation and vaporized/ aerosolized hydrogen peroxide can be used only for room disinfection because they are hazardous to patients and staff.
In addition, the quantity of robots we decide to obtain must be determined according to room turn over times and the time required to disinfect. This is one of the ways to develop the new disinfection multi purpose robots which will capable to work with human help without making any collision and also it is eco-friendly.

II. FEW ISSUES AND KEY FACTS OF AUTOMATIC DISINFECTION ROBOT

Robotics in healthcare is still a system controlled by human. The real enchantment of the 21st-century is robot-doctor which will come from artificial intelligence systems so that they can perform as best doctor by combining all the available knowledge in all medical prospects. Some medical robots assist patients in addition to medical staff all around the world. Proper training to staff for appropriate terminal cleaning, infection avoidance and robotic cleaning practices are solution to a victorious infection avoidance plan. A area of patient may be sanitized well by using disinfection robot, but if a staff member follow appropriate infection prevention protocol, and touches patient area may be decontaminated[3-4]. In Covid-19 situations disinfection robots can serve as auxiliary robots that not only serve for hospitals but also surrounding of us.

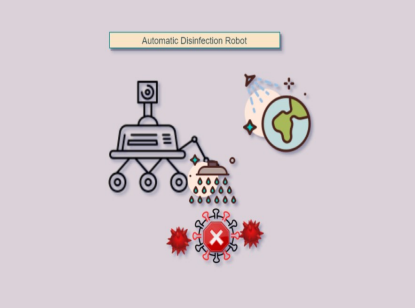

Fig 1. Disinfection process

III. AUTOMATIC DISINFECTION ROBOT SCHEME

Automatic disinfection robot is manufactured to sterilize hospital places, equipment, and vehicles placed in the open space regions. They can do this by spraying liquid based fog, disinfection is carried out through the usual movement of robot beside a preprogrammed path with some futuristic health care features. In this robot we have implemented practically some new ideas with robot autonomy. The main feature of this Disinfection robot is –

3.1 Autonomous Robot operation without human interferences using Global Positioning Systems.
3.2 Automatic Liquid Based Disinfectant Spraying System.
3.3 Adaptive UV-C disinfection light operations.
3.4 Non-Contact Body Thermal scanner with OLD screen.
3.5 Solar powered operation.
3.6 Real-time Video transmission facility.
3.7 Low Levels Refill Alarms System.
3.8 Remotely Robot Manual Operations.
3.9 Anti-Collisions Alarm
3.10 Internal Diagnosis of Automatic Detecting Robot**.**

3.1 Autonomous Robot operation without human interferences using Global Positioning Systems

This disinfection robot is specially developed using microcontroller.It can run fully autonomous missions that are defined using mission planning software or pre-recorded by the driver during a manual run.A ground station is typically a software application, running on a ground-based computer, that communicates with disinfection robot via wireless telemetry. It displays real-time data on the robot performance and position and can serve as a "virtual cockpit", showing many of the same instrument.A well radio-controlled receiver is placed in this robot to receive the auxiliary signal, which operate disinfections sprayers or UV-C lights. A telemetry radio allows this robot to communicate with ground station remotely using the MAVLink protocol.This allows to interact with our missions in real time and receive streaming data from this robot cameras and other components.

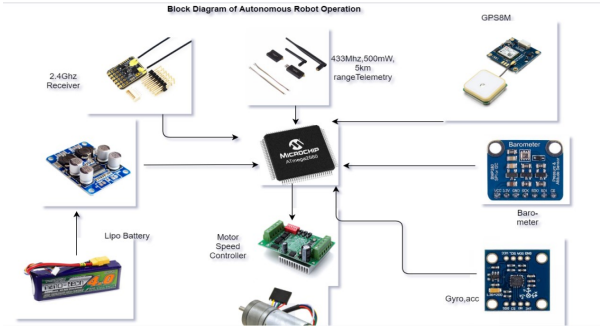

Fig 2. Autonomous Robot operation

3.2 Automatic Liquid Based Disinfectant Spraying System

Automatic disinfection robot is mainly developed for spraying liquid based disinfectant. Presently disinfectant have become a part of our life due to the recent pandemic of COVID-19. During this time, we need to keep ourselve safe by sanitizing our hands, floors and hospitals with alcohol-based disinfectant. Our aim is that, the sterilization process is to be dispense by this automatic robot. The entire dispensing processes are possible by using high pressure reverse osmosis booster pump and atomizer nozzles. The control process of the disinfectant spray is by using same onboard microcontroller with radio link and some actuators. In this process we used auxiliary radio signal which helps to turn on the dispensing systems when robots move and navigate itself[5].

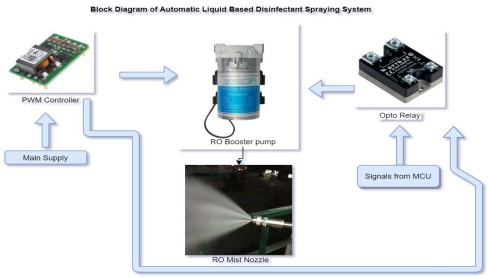

Fig 3. Automatic liquid based operation

A suitable calculation used to measure the amount of sanitizer in specific time. In this robot the robust part is calculating sanitizer amount using float sensors. However, it helps to preserve the disinfection according to predefined robot's navigations.

Calculation: - We know that,

$$P = \left(\frac{m}{t}\right) g\Delta h \quad = \left(\frac{1000ml}{60\sec}\right) \times 9.81 \times (0.45 - 0.308) \text{ =23.25 psi =(23.25 *0.06) bar = 1.39 bar (for 1000mL)}$$

where, P = pump pressure, m = mass of liquid, t = time, g = gravity of earth, Delta (h) = difference height between hoist and suction. Also, work done (W) = FdCos (45) = 1.39x45.72x0.707 = 44.94 joule/kg.m^2/s^2

Where, W = work done,F = force ,d= displacement (Hoist to endpoint) = 1.5 feet approx.

Cos (45) = angle between hoist to nozzles Disinfectant dispensing for each 5 seconds,

$$\text{Pa} = \frac{W}{t} = \frac{44.94}{5} = 8.9860 \text{ mL /nozzle}$$

3.3 Adaptive UV-C disinfection light operations

The UVC robots belongs to mobile base equipped with situations tracking and a range of dominant small wavelength ultraviolet-C (UVC) lights, which capable to move around a particular direction. The operator deploy the robot using onboard microcontroller system. The robot scans the environment by using its self-timer. The axial movements of the UV-C lights are depending upon auxiliary channel of radio controller. The robot then disinfect hospitals by producing 254-nanometer light to eradicate bacteria and other injurious microorganisms. As a effect, hospitals or others places can assure a 99.98 percent disinfection rate dropping the hazard for patients, staff of constricting dangerous diseases.

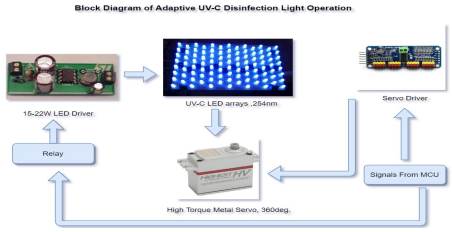

Fig 4. Adaptive UV-C disinfection light operation

In disinfecting robot, UVC light can operates very smoothly along with sanitizer spray to reduce infection using both the disinfectant at the same operations.

3.4 Non-Contact Body Thermal scanner with OLED screen

Automatic disinfection robot has another important feature of using infrared thermometer (MLX90614), which is capable to detect and monitor regular thermal index of human bodies. The process is that in a particular area

when disinfection robot is used, it will also monitor human body temperature during this operation. The control operation can happen by using radio signals and wireless connection of Organic LED display.Temperature describes the average kinetic energy of molecules within a material or system and is measured in Celsius (°C), Kelvin(K), Fahrenheit (°F), or Rankine (R). It is a measurable physical property of an object also known as a state variable. Common symptom that have been specifically linked to COVID-19 is a low-grade fever that gradually increases in temperature.

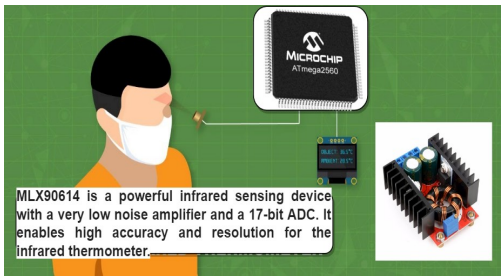

Fig5.contact body thermal scanner operation

3.5 Solar powered operation

At the time when pump will turn on to spray ,the biggest amount of current drawn from main supply.On these purposes, when the robot will serve the open areas and sun light covers the robot body and if we can forecast the amount of light source where we can change the battery at the service conditions. Here we can use low power solar cell about 6V ,1000mA.The reason behind using low power solar cell is that, if the high-power solar cell is to be used the dimensions of the structure will be increases and it also may happen of extra payload of the device. But here we can boost up the low power solar to rated maximum power using dc-dc current gain, voltage gain boost converter. In a boost converter, switched mode supplies can be used for many purposes including DC to DC converters[6].

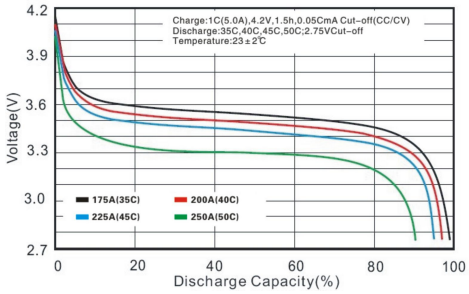

Fig6.Graph between voltage and discharge capacity

In this robot cn6009 and lm2596 booster converter are used to increase dc to dc levels and it is connected to pin of Microcontroller (ADC) which converts the signal to digital.It takes the references voltage to trigger the threshold levels means when the output from the panels remains high, charging module turn on. The out levels when is to be high due to light intensity the microcontroller analog Read (5.00V) as reference level and measure the battery voltage levels. Generally, the boost converter preset the voltage limit 05v to 12v dc, when the light flow through panels the boost converter increases the voltage limit and charge the battery. The overall charging process will help disinfection robot charging up automatically and also serves for long period.

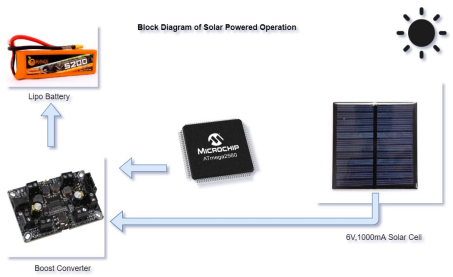

Fig7. Solar powered operation

3.6 Real-time Video transmission facility

An automatic disinfection robot includes live A/V broadcast systems. The additional arrangement will provide us the information of what a robot actually doing during the operation time. When the predefined data is loaded to the robot and it will start to move as per the given data and also first person view camera (1500TVL) which gives the real time vision. First-person view (FPV), also known as remote-person view (RPV), or simply video piloting, is a method used to control a radio-controlled vehicle from the driver or pilot's view point. Most commonly it is used to pilot a radio-controlled aircraft or other type of unmanned vehicle (UV).More sophisticated setups include a pan-and-tilt gimbaled camera controlled by a gyroscope sensor in the pilot's goggles and with dual onboard cameras, enabling a true stereoscopic view. For live forecasting we have used a PAL /NTSC based fpv camera for better performance. The camera mounted on the front of the robot . When the camera is switched on, it has options to record the operational video which will help to identify the scenario of the whole operation. If any kind of error rises on the robot the view of the camera will help us to resolve the error and also will help to locate positions of the robot. The camera will be able to connect with the smart phone or monitor.

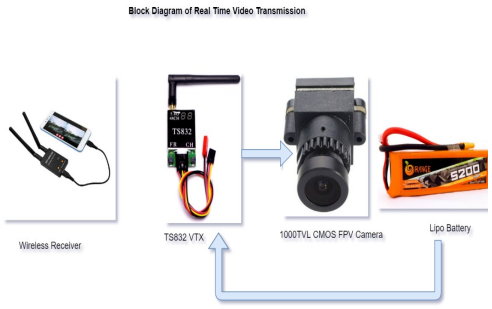

Fig8. Real time video transmission

3.7 Low Levels Refill Alarms System

When the pump turns on, the spraying process will start to works and distribute the disinfectant in hospitals or public areas. But we should always think about what are the tank capacity or overall capacity of the tank which mounted on the robot's body. The main reason behind the low level refilling alarm is that, when the robot is working initially the liquid levels always monitored and this data will be operated through wireless telemetry. On the ground control station or any person controls the robot, data will be visualized in front screen. We have used a water float sensor measuring the liquid sanitizer or disinfectant levels of the tank and connected to the onboard microcontroller. When the level of the tank gradually decrease the float, sensor sense the level and read the digital signal of the onboard microcontroller and send the signal on the main system . Buzzer will create sound and alarming the low level of liquid disinfectants. In this way we can identify the refill or low levels liquid alarms with using liquid-based float sensor.

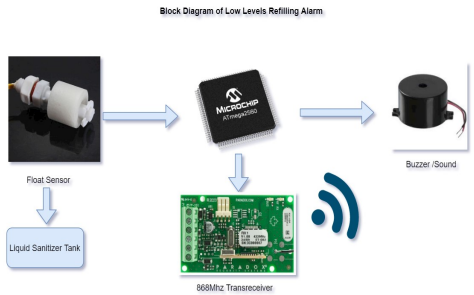

Fig9. Low levels refill alarm operation

3.8 Remotely Robot Manual Operation

When the disinfection area is limited or finite the robot can manually operate by any person easily. This control process is very easy to access and non-technical persons can do it. We have used the radio link remote or transmitter (2.4Ghz) with analog joysticks for control purposes.The radio controller has some essential channel which can be used for control of the robots. In this robot we have used 5 channel transmitters for control operation. Radio transmitter in a communication system is very simple and basic.
It is generalised for AM and FM or AFHDS (Automatic Frequency Hopping Digital System) types of modulation and consist of four subsystems. Changing input of the radio transmitter will effectively change the output .In manual operation the control channel and output responses are given:
Channel 1 (Roll/Aliron) = Steering moves left / right.
Channel 2 (elevator/ pitch) = Robot moves forward/ backward
Channel 3 (Throttle) = Robot speed up/down
Channel 4((yaw/rudder) = yawing of the Robot)
Channel 5 (Aux1) = Mode switch of Arming
Transmitter transmit pulses and receiver receive pulses, each channel sends PPM (Pulse Position Modulation) with range of 1100-1900 micro-sec. The incoming pulse read the onboard microcontroller and write the control.

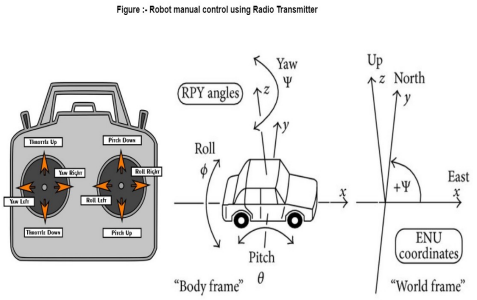

Fig10. Block Diagram of Remotely Manual Operation

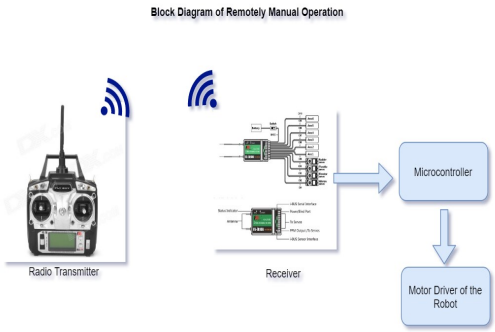

Fig11. Robot manual control using Radio Transmitter

3.9 Anti-Collisions Alarm

Any automatic system need advanced cruise control or collision avoidance system. A collision avoidance system (CAS system designed to prevent or reduce the severity of a collision.In its basic form, a forward collision warning system monitors a robot's speed / directions, the speed of the robot in front of it, and the distance between the avoidance , so that it can provide a warning to the user if the robot get too close, potentially helping to avoid a crash. Various technologies and sensors used which includes radar (all-weather)and sometimes laser (LIDAR) and camera (employing image recognition) to detect an imminent crash. In this disinfection system we have implemented anti-collisions alarm, if the robot incidentally failed to specific operations. If unwanted objects come across robot surroundings ,the robot will be capable to detect the avoidance and the total system managed by the microcontroller using the sensors.The Sharp distance sensors are a popular choice for many projects that require accurate distance measurement. This IR yet it provides much better performance than other IR alternatives.

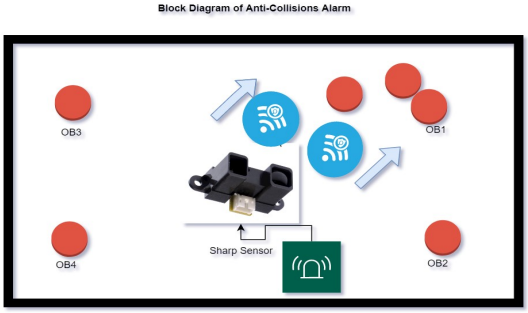

Fig12.Block Diagram of Anti -collisions Alarm

From the above block the sensor always spread the infrared spectrum, if any object comes near the robot (> 15cm), the sensor detect the object and direction will change as per the position of object . If the unwanted object is discovered by the robot it will generate the alarm or warning of the main system.

3.10. Internal Diagnosis of Automatic Detecting Robot

Robots are everywhere from science fiction to our local hospital, where they are changing healthcare. For the most part, these robots resemble R2D2 from Star Wars more than they do a humanoid, but they are making a big impact on the field of medicine. They can also perform accurate surgery in tiny places and convey dangerous substances. Every medical robot should have identical and efficient performances as a medical support. Due to the programming robot must also have extra capability to detect the internal error and send to the ground or mission control rooms. In this robot some advanced command is used in the microcontroller programming. If any fault occurs due to sensors or any issues the robot will not take arming. If the internal compass or gyroscope calibrate error, it will detect the error. If the RTL mode set on the robot it will help the robot if battery voltage goes down and get back the initial state. In this way a robot can lead long life cycle with detecting internal diagnosis.

III. PURPOSE OF USING AUTOMATICS DISINFECTION ROBOT

Robotic technologies appear in many field and also in medical sector. An automatic disinfection robot can be used to disinfect patient rooms and operating suite, reducing risk for patient and medical personnel. In this pandemic time, this robot can carry emergency medicine or food or even meals from floor to floor, riding elevators and managing through automatic doors. The safety precaution will reduce the spread of any fatal infections. The UV-C disinfection Robot, thermal scanning are useful in this COVID-19 pandemic time. For futuristic application any uncertain purposes disinfection robot will preserve the health care issues and thereby it may also be used in others application.

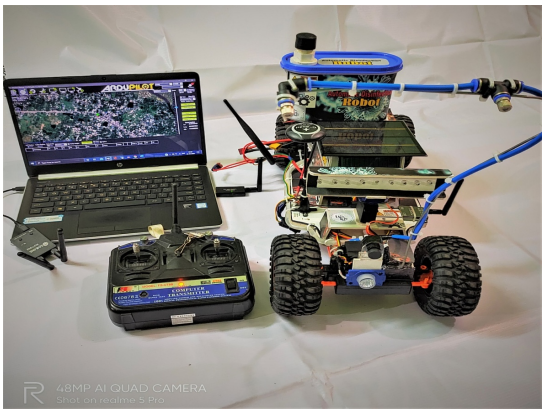

Fig13. Automatic disinfectant Robot

IV.CONCLUSION

Automatic Disinfection Robot or Service robot is very important applications for fight against COVID-19. Though the contamination increases, we can use automatic disinfection robot to prevent the spread of COVID-19 and other contaminant infection with replacing human interactions.

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