International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-4, November 2019

Cathartic Bot for Hospital Applications

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Abstract— ***Healthcare facilities are havens for recovery and rehabilitation. Infection prevention technologies are of great challenge to a new era of ultra-clean hospital's and emergency care facilities with the implementation of highly-efficient UV-disinfection robots. cathartic bot offer hospital grade full-room sterilization. In action, the UV-Disinfection Robot can significantly reduce populations of microbes in under five minutes. The UltraViolet light penetrates certain distance around the robot, sterilizing everything in its proximity. It can clean entire rooms better than humans, helping to eradicate HAI instances. The robot can carefully navigate around the room while using germicidal UV-C rays to disinfect equipment. The bot is controlled through mobile app to avoid direct contact.When the room has been cleansed fully ,the rate of light reflection will be reduced so the robot will be turned off automatically.***

Keywords—UV-disinfection robots, healthcare-associated infections (HAI),

I. INTRODUCTION

The main challenge of infection prevention technologies and practices for an ultra clean hospital is to eliminate the risk of the transmission of pathogens between patients and between patients and the health care worker in hospitals. The transmission of pathogens are mainly due to the equipments like hospital bed, BP reader ,crutches, health care monitors or hospital lifts which comes in contact with the body part particularly skin. There is a high risk of infections which could be transmitted due to direct contact by the health care person or from biomedical systems to the patient admitted in the hospital**.** Therefore Periodical cleaning and maintenance prevent the debris, dust or any other foreign material that can prevent pathogens which cultivate their growth. Effective practice of daily cleaning routine and disinfection of environmental surfaces and patient care equipment are of very important in reducing the transmission of pathogens to the patients.

Manuscript published on November 30, 2019.
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In today's scenario, almost in all hospital rooms bacteria and virus multiply in seconds.This may further cause infection to the patient.In order to avoid this,we use UV-C lights to disinfect them. There are three grades in UV lights. They are as follows:

1. UV-A(200nm-315nm)
2. UV-B(280nm-315nm)
3. UV-C(200nm-280nm)- 253.7nm has germicidial disinfection effect

Based on a United States hospital survey,it has been found that 1 : 25 patients in hospital has infection which is associated with hygine and health care . Also about seventy thousand patients died due to the infections in the year 2011.

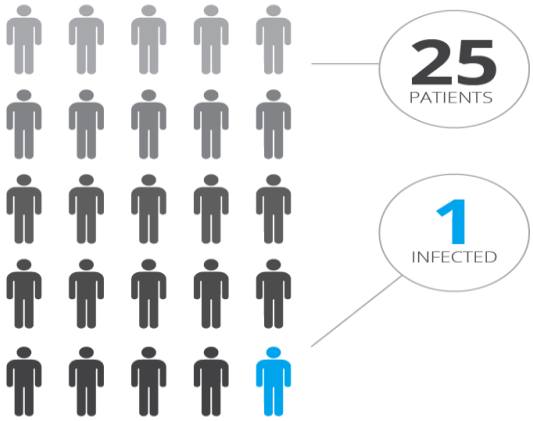

Figure.1Healthcare associated Infected ratio

II. EXISTING SYSTEM

UVC dosage can not be calculated for Xenon flash lamps and other lamps This dosage is needed for each location to determine the position as well as time needed for disinfection. Another existing system is CLEANSEBOT which is bacteria killing travel bot for cleaning the hotel beds.It can also be used in handled mode to clean any small items like toys,phones,keyboards,tablets etc.It is mainly used for hotel beds,so they designed it with edge sensors as it can not fall off from the bed during the operation.It is expected to come as a product to world by the end of year 2020.

III. PROPOSED SYSTEM

The proposed system *CATHARTIC BOT* employs the use of UV-C lights to kill all the bacteria,viruses and fungus present in the hospital rooms and also stops further growth of them.The intense UV-C light kills the pathogens present in the disinfecting room.This energy passes through the walls of bacterias and viruses.

The DNA,RNA and proteins present in the micro-organisms absorb the energy and further can not reproduce.By this,their growth is controlled and they can no longer infect the patient.

The process is depicted in the below figure:

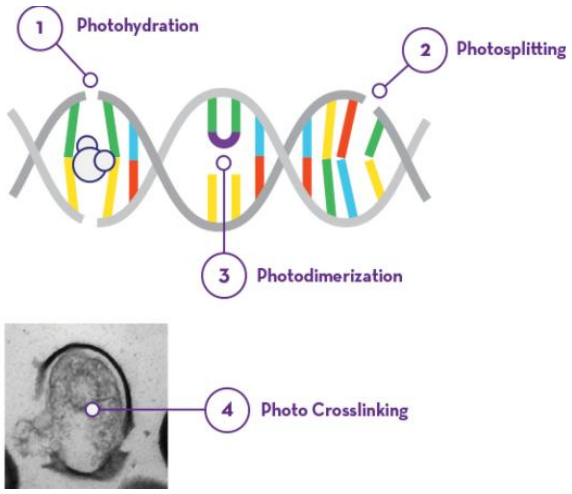

Figure 2.Process of the proposed bot

IV. FEATURES

A. Inputs:

The user have to select the size of the room according to that the bot will be programmed to operate.For example,if the user clicks small button then the bot will be turned on and it will be in operation for 10 minutes. After the completion of disinfection the bot will turned off automatically.Accordingly it is programmed for the operation time for different sizes of rooms.

B. Upgradation:

The main advantage of CATHARTIC BOT is the use of colour sensor which detect the reflected rays of light.If the disinfection is not yet completed then rays of reflection will be less as bacteria and virus will be abosrbing the UVC light energy.Once the disinfection is over there will be no more bacteria and viruses to absorb the light hence the reflection rate will be increased. So based on the rate of reflection also the bot can be turned off.

C. Safety measures for UV-C Light:

The usefulness of Ultra violet lights is restricted s and doubted since it could cause any harm to humans. Researchers have found a safe narrow band wavelength that can be safely used for operation .

Overexposure of UV to body particularly, eyes may cause irritation, hardness sensation, tears or even eye bleeding within four to thirteen hours. In some cases,that is persons with less immunity , it may incur skin damage with in five to six hours of exposure.However these effects can be prevented with proper medication.

Inorder to avoid such effects ,a PIR sensor in the doors of hospital rooms which can detect the motion of human beings.Through this sensor,if a person tries to enter the room when the bot is in operation, the bot will be automatically turned off so that the person need not be exposed to the UV-C lights.

D.Outputs:

After the completion of disinfection,the report will be sent to the hospital portal for further analysis.

V . BLOCK DIAGRAM –PROPOSED SYSTEM

The cathartic bot has a simple set up as shown in figure 3.

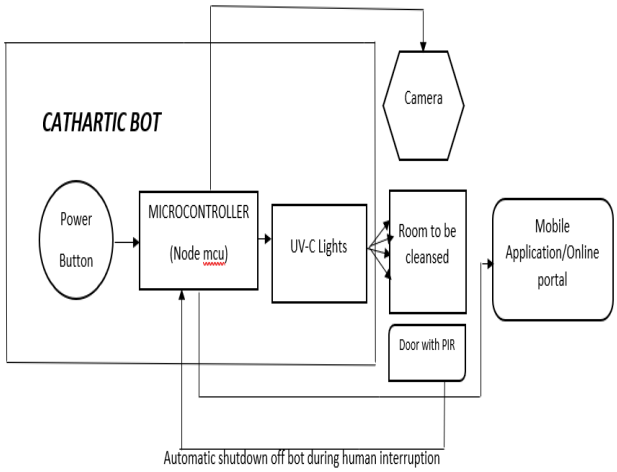

Figure 3.Block diagram description

A..UV-C Lights:

The main functionality of the proposed system is to kill the bacteria and viruses present in the hospital room .After a patient has been discharged, and before the next patient is admitted, the room will be cleaned manually. But the efficiency is very less and also it does not stop the bacteria and virus growth. In the proposed system the light energy from UV-C tube lights kills all the micro organisms present in the ward room. Also further growth of pathogens is completely prevented.

1. Range:

The nominal disinfection range is *253.7*.Only UV-C has the nominal range hence the proposed system used these lights to kill the RNA and DNA of the micro-organisms.

B. Controlling unit:

The controller of the proposed system is *NODEMCU* which controls the on/off operation of UV-C lights. This microcontroller is programmed with predefined room size and corresponding time of operation.Node MCU has an in-built wifi module through which the robot can be controlled outside the room. It includes firmware which runs on the ESP8266 Wi-Fi SOC, and hardware which is based on the ESP-12 module. It has the capacity of storing upto *4MB Bytes* .Memory size of the microcontroller is about 128KB.It is powered by USB cable.

D. 4-Channel Relay Module:

It is a 5V four -channel relay interface board, and each channel needs a 15-20mA driver current. It can be used to control various appliances and equipment with large current.

It is equipped with high-current relays that work under AC250V ,10A or DC30V, 10A. It has a standard interface that can be controlled directly by microcontroller. This module is interfaced with Node MCU microcontroller. The line of all the UV-C tube lights is connected with the relay module through which on/off control is performed.

E. Interruption:

As UV-C is harm to our eyes and skin during the operation of robot no human being should present in the room. To avoid such critical situations, a PIR motion sensor is installed to detect the motion of human beings. When a person tries to enter into the room which is disinfecting,the robot will be automatically turned off , so that it doesn't cause harm when a person enters unknowingly. Whenever the output of PIR motion sensor is high the relay output will become low and thereby all the lights will be turned off by the lack of supply from the relay.

F. Rotating Mechanism:

In order to pass the UV-C light energy in all the sides of the room we employed a servo motor in the proposed system.A servo motor is a rotary or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.It has been interfaced with Nodemcu and programmed for 360 rotation to cover the entire room.

G. Bot Control Via Mobile:

Blynk is a software which operates with android Platform to control Node MCU.It helps to establish communicate between smartphone and hardware. Using this application user can choose the required room size along with the duration of operation.

VI. FLOW OF OPERATION

(i)The supply towards the lights is given and it starts to Glow. The UV lights spread over 360 degree throughout the room.

(ii)It disinfects the entire area ensuring a safe environment. This system delivers the disinfection data automatically to your secure online portal or mobile application.

(iii)Its inherent controller makes easy and efficient way of the disinfection process.

(iv)Further, to avoid human intervention,PIR sensor is placed on the door handle.

(v)And when the PIR turns high , the bot gets Turned off automatically.

VII. TOOLS AND SOFTWARES

*A.UVC lights:*They are major components used for destruction of bacteria.

B. Controller: Node MCU is the main controller used here to process the data's.

C. Software: Blynk is the software that are used to support the hardware.

D. Relay module: It helps to provide the electrical isolation between two circuits.

VIII. RESULTS

The proposed system is estimated to have 80-85% efficiency. The prototype had been validated by Government testing center, TAMIL NADU TEST HOUSE for effiency.

IX. FUTURE DEVELOPMENT

The device can be further enhanced to detect and measure the dimensions of the room using the structure sensor. Legocolour sensors can be used to sense light reflection from the walls, if the reflectivity exceeds the threshold , then it automatically tuned off.

The pictorial representation of the proposed system is shown below:

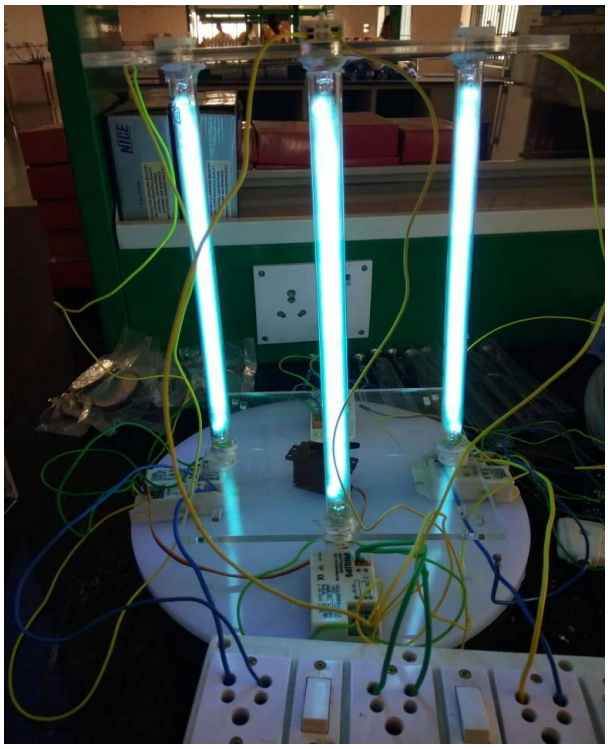

Figure 4.Hardware

The output of the system is shown below:

i) Before application of UV-C lights:

j)

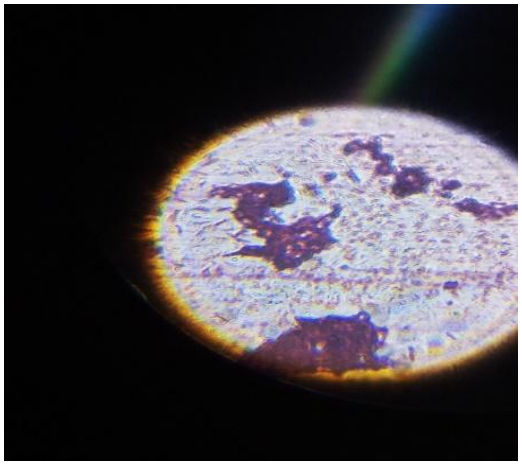

Figure 5.Before application of UVC light

Figure 6. After application of UV-C Lights

X. CONCLUSION

UV sterilization is the newest infection prevention trend, and one that appears to be of increasing importance. The first thing patients have it on their mind is if they are going to be worse off after being in a hospital. However, with HAI rates on the rise, there are more possibilities now than ever before. Test after test, and study after study, has shown that UV disinfection is the most advanced weapon available on the market today. Thus the healthcare facilities are havens for recovery and rehabilitation .This prototype gives about 80-85% of efficiency of UV disinfection.

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