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Optical Filter Enabled Continuous Disinfection of Hospital Rooms Using Multi-Sensor Feedback Aided Light Source

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Abstract

In this paper, We have implemented an efficient technique for the inactivation of pathogens in the air and on the surfaces of the hospital rooms. These rooms are the main source of the bacterial diseases spreading in the locality and thereby contaminating the environment. So, a new method is taken into account which uses the wavelength light centered at 405 nm for the disinfection process. The inactivation process of bacteria's is caused by the 405 nm light which targets the intra-cellular porphyrin of the pathogens which absorbs the light and bacteria's are eliminated due to the generation of reactive oxygen species in their body. This process has been successfully achieved by the proposed model system. This system uses the light source assembly as a primary source that emits the white light in the broad spectrum which ranges from 450-475 nm that lies in the visible spectrum region. Then this broad spectrum white light is passed through the high-intensity narrow band pass optical filter which reduces the wavelength in the range of 400-410 nm having wavelength centered at 405 nm. Along with this, a multi-sensor adaptive feedback network is also applied to the system which changes the intensity level of the disinfecting light depending on the density of the bacteria's present in the room. This adaptive nature of the system helps in reducing the power consumption by the system which is necessary in case of continuous disinfection process. This method holds an upper hand over the ultraviolet light devices (UV-C) technique which uses the wavelength in the range of 254-360 nm for the disinfection process. Since the 405 nm light lies in the visible spectrum, hence it is safe to use in presence of a person in the room, thus making the system a continuous process for the disinfection.

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Keywords: Continuous Disinfection; Surrounding Cleaning; Visible Light; High-intensity narrow spectrum light; Health Care Associated Infections(HCAIs); Narrow Band-pass Optical Filter; Multi-sensor Feedback Network; Adaptive Light Assembly.

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1. Introduction

Nowadays, environmental infection is one of the major concerns for the health care domain as these bacterial pathogens are easily transmitted to water, food and other surrounding sources, these later becomes the main cause for

the illness and serious health issues throughout the world. HCAIs is one of the major challenge faced by the hospitals for patients being admitted to the facility and in the operation theater of the hospital. This emerges a special need and attention for surrounding cleaning action in the patient care areas, which are the main source of bacterial infections in the environment. The pathogens in these areas can be spread easily from one person to another. Since the person in their treatment phase goes from a weak immune system which makes it easy for the bacteria's to attack the body and spread rapidly in the area. One of the traditional and most commonly used method for antimicrobial process includes the use of light system in the wavelength range of $240 - 260$ *nm* which falls under UV and UV-C radiation category, but this light system cannot be used in the presence of the person in the room and this is the major drawback of the technique. So, this emerges a need for a more safe technique which can be used in presence of a person in the room and making the disinfection system continuous in nature. An effective and low-cost implementation method is achieved by using the new day modern technology of multiple senors and feedback network, existing light source and high intensity narrow band-pass optical filter [1].
This technique can be used for the surrounding decontamination application in the hospitals and clinics. Apart from the surrounding decontamination application, the tool emitting violet-blue light can be used in wound and skin related treatments but for now these application are out with the scope of current view.

1.1. Motivation

There already exist some of the techniques for disinfecting the hospital surroundings and hence making the environment clean and safe for the treatment, but all techniques which are mentioned below lacks in a common parameter of continuous disinfection operation and power consumption issues. As in case of UV-C technique which in toady's era is a dangerous issue because of its harmful radiation which can not be used in a presence of person, thus making it a discontinuous process. So, this emerges a need of a system which will provide continuous disinfection at low cost and with less power consumption. Most common traditional methods involved are:

- *Self-Disinfecting Surface:* This method involves coating of surfaces with heavy metal such as silver or copper which exhibit antimicrobial property and thus prevent the growth of bacterial pathogens on the surface. The problem with the technique is that its efficiency of preventing the growth of bacteria kept on degrading as the time passes and may last for only few weeks with a very low efficiency which is also not very cost effective to use.
- *Light-activated photosensitizers:* This method involves the use of nano-size titanium dioxide on the surface along with the UV light to generate reactive oxygen species that disinfects the surface. This method shows varying antimicrobial activity,with relative susceptibility of agents against pathogenic bacteria's.
- *Aerosolized hydrogen peroxide:* This method involves 3 to 7 percent use of hydrogen peroxide with silver ions and also without it resulting a significant reduction in bacteria at the surface of the facility.
- *Hydrogen peroxide Vapor:* This method uses a dry gas of 30 percent hydrogen peroxide resulting in inactivation of bacteria's but due to its long cycle it is difficult to implant this system in the health-care facilities.
- *Photocatalytic Disinfection:* This method uses titanium dioxide to oxidize the bacteria's present in the air and on surfaces. The technique is costly to use for health care facility but gives better results.

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