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AUTOCLAVING SYSTEM USING ULTRAVIOLET LIGHT

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Abstract — Hospitals are considered to be the hub for all the micro-organisms as; all the infected people are treated there. The risk of healthy people acquiring infections and diseases are also very high. Hence, the process of cleaning and sanitizing all the possible things such as syringes, surgical tools and instruments are highly necessary. The sanitizing process includes both physical and chemical ways by utilizing temperature and/or pressure and must be cautiously tested before it is put into use in healthcare settings. This process is done using UV-C light to eradicate the intervention of microbes during operations thus avoiding further infections.

Keywords— ultraviolet (UV), ultraviolet germicidal irradiation (UVGI)

I. INTRODUCTION

Sterilization is the process that eliminates, kills, or deactivates all forms of life and other biological agents present in the surface, object or fluid. The purpose of sterilization is not only to kill the prions but also eliminate the trace of it to prevent transmission of these to patients.

Primarily steam was used for sterilizing the instruments and tools used in the healthcare facilities as they were mostly heat resistance. However, since 1950, there has been an increase in medical devices and instruments made out of plastics which would melt in high temperature. So, ethylene oxide gas was used for heat- and moisture-sensitive medical devices. In the recent times, many new low-temperature sterilization systems like hydrogen peroxide gas plasma, peracetic acid immersion, ozone have been developed and are being used in healthcare facilities for steam sterilization.

In order to avoid the multiplication of microbes, the UV light is used to destroy them. However researches show that the wavelength required for disinfection is around 253.7nm which falls in the range of 200nm-280nm which is known as the UV-C light.

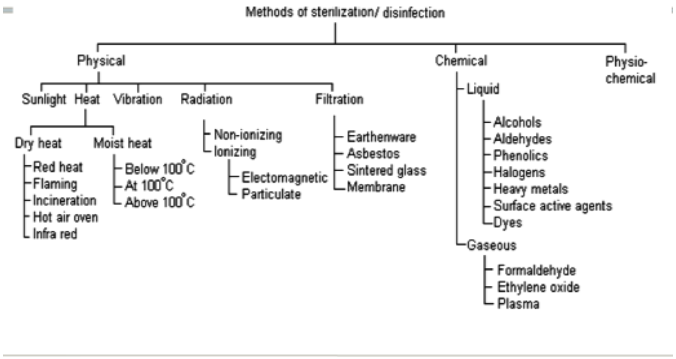

Figure.1

At present, instruments and other tools are placed in a 'surgical pack', which not only hold the instruments and supplies during the sterilization process, but also maintain the sterility of the contents until used the surgery.

A variety of packing methods exists, including:

- Instruments are rolled in a paper or cloth with or without a tray. Before wrapping, they are sealed with stream tape which indicates the completion of process by undergoing a color change.
- Peel packs are self-sealing 'envelopes' used for steam or gas sterilization. A sterilization indicator as mentioned above is placed on the envelope.
- Autoclaving is sterilizing equipment which uses pressurized steam for a set time, perhaps for 20 min at 121 °C, 15psig.

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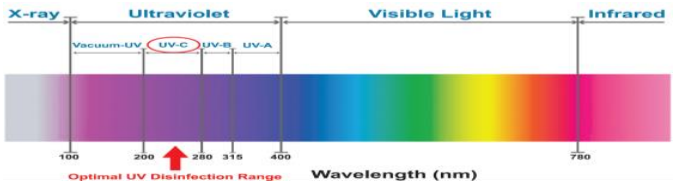

Figure.2

Since the ozone layer of the atmosphere blocks the UV-C light,it is very weak at the Earth's surface. So UVGI devices can produce powerful UV-C light in our systems to create unfriendly territory to microorganisms.
The higher the UV dose the higher will be the degree of inactivation by the UV radiation.
The UV dose is calculated by obtaining the product of the light intensity and the time the sample is exposed to that intensity. It is measured in microwatt seconds per square centimeter ($\mu W \cdot s/cm^2$).

II. EXISTING SYSTEM

There are different ways that are used, at present, to sterilize the surgical instruments. Autoclave is one such system which exploits steam to sterilize the instruments used in hospitals. The Ethylene oxide sterilizer is a chemical

way of sterilizing the instruments. These methods are available since 1950 and always require an indicator to know about its sterilization effect.

III. PROPOSED SYSTEM

The proposed system *AUTOCLAVING SYSTEM USING ULTRAVIOLET LIGHT* sterilizes the surgical instruments used in hospitals by upsetting the DNA, RNA and proteins in them by making use of UV-C light .The Arduino calculates the difference between the constant germicidal intensity value and the input it receives from the sensor which is placed below the sample. The dosage of UV-C light is varied based on the calculated difference, which is an indirect count of the microbes present. The LCD displays the intensity.

The DNA damage due to the application of UV light is depicted in the below figure:

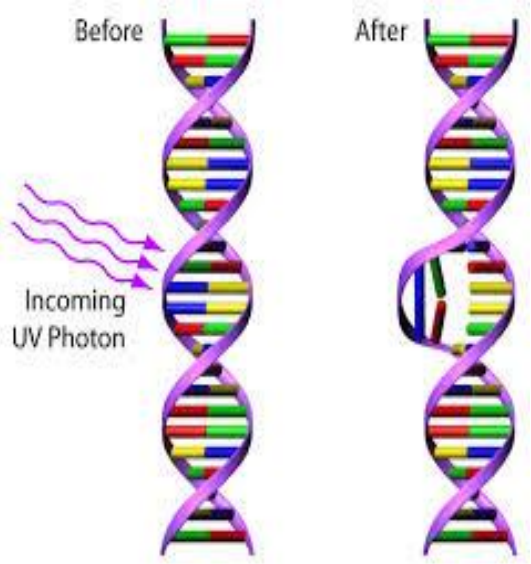

Figure.3

IV. FEATURES

Inputs:

The intensity of the light at 253.7nm, which is the germicidal value, is given as one of the input. The sensor provides the other input to the microcontroller. The difference between these two intensity values is calculated in order to find the indirect count of microbes present in the sample. This difference serves as the input to the driver circuit to provide a controlled voltage to the UV source to sterilize the sample.

Improvements:

The main idea of this system is to eliminate the excess or unnecessary voltage that is provided to the sample. Also there is no need of any indicators to ensure that sterilization is complete as it could be visually seen with the help of UV-C light. In addition the time required for sterilization can also be set manually.

The LCD shows the intensity value required to kill the microbes. The absence of microbes can be confirmed when the UV light turns off completely.

V. BLOCK DIAGRAM

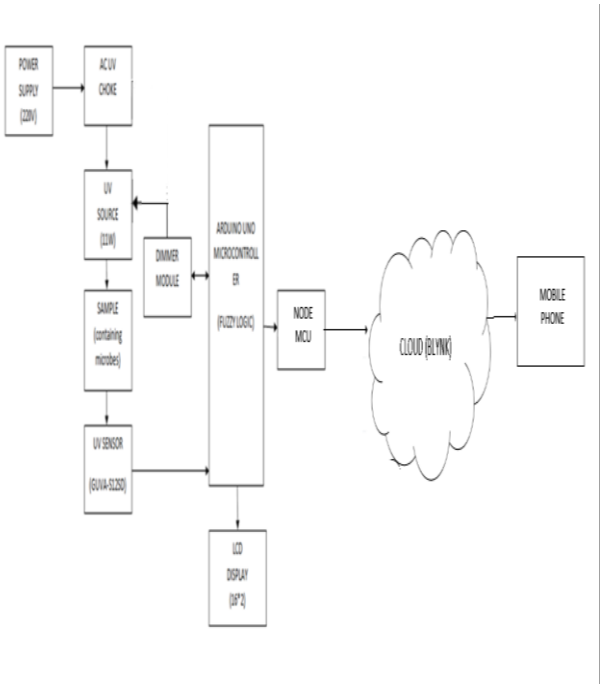

Figure.4

VI. WORKING

A. ARDUINO UNO MICROCONTROLLER
This board is based on Atmega328 which is developed by Arduino.cc. At present microcontrollers has become a mandatory part in embedded systems to meet various needs and requirements. Though there are various versions, such as Arduino Leonardo, Arduino Duo, the most common versions are Arduino Uno and Arduino Mega. It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality.

B. ULTRAVIOLET LIGHT SENSOR MODULE
The connections are straightforward and, we used 3.3v from the Arduino. This was mainly for compatibility with other development boards but the module works with 5v.

C. ULTRAVIOLET GERMICIDAL LIGHT These lamps play an important role in sterilizing workspaces and tools that are used in various laboratories. The applications that utilize this germicidal light include the identification of mineral samples. In addition they provide a helping hand in waste water treatment to produce water that is free from microorganisms.

D. AC UV CHOKE
In general, a choke consists of a coil of insulated wire or beads of ferrite often wound around a magnetic core. The choke allows higher frequencies of AC and lower frequencies of DC. The choke is basically an inductor whose impedance and frequency are directly proportional. It has low resistance which reduces the power loss. However the amount of AC passing through it is limited by the reactance present in it.

E. DIMMER MODULE

The aim of this module is to control the AC voltage. It is also predominantly used to turn ON or OFF electrical appliances such as lamps, fans, pumps and air cleaners. Furthermore they play a major role in smart home systems. For example they help in creating a smooth and comfortable atmosphere at home by changing the brightness in lamps. However it does not work to its full efficiency with low brightness LED and luminescent lamps as they do not support dimming.

The Arduino controls the dimmer module by obtaining help from the RBDdimmer.h library. This makes use of both external and process time interrupts which in-turn helps in writing simpler codes and minimizing the processing time. This feature is exploited to control multiple dimmers using the same microcontroller. The high current disruption is highly minimized since the power part and control part of the dimmer is isolated which is an added advantage.

VII. FLOW OF OPERATION

(i) The UV germicidal tube lights are turned ON.

(ii) The UV source emits light through the sample and further through the glass plate.

(iii) The emitted light reaches the UV sensor whose output values is received by the Arduino microcontroller and is displayed in the LCD (in mW/cm^2).

(iv) Based on the output, the microcontroller calculates the intensity of light required for sterilization and controls the UV light to produce light in the calculated intensity.

(v) The same procedure is repeated with other samples.

(vi) The microscope is used for visualizing the microbes before and after the application of UV light.

(vii) The Blynk software shows which case is active, the input time, displays the LCD information and a time vs. intensity graph.

VIII. TOOLS AND SOFTWARES

A. Ultraviolet germicidal light- It is the main source used to sterilize the sample.

B. Arduino Uno microcontroller- It is programmed to count the microbes and control the UV source.

C. Ultraviolet light sensor module- It provides the light intensity which is useful in calculating the amount of microbes present.

D. Aluminium enclosure- The entire process takes place within this so as to provide safety.

E. Software- Arduino IDE was used for programming. Blynk software is used for showing the results.

The pictorial representation of the proposed system is shown in Figure.5

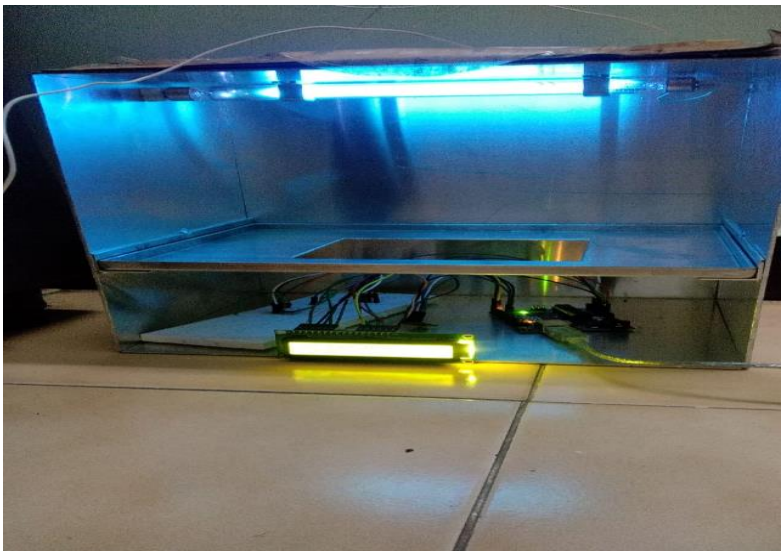

Figure.5

IX. RESULTS

The efficiency of this system is in the range of 80- 85%. The prototype has been submitted in TAMIL NADU TEST HOUSE for validation.

X. FUTURE DEVELOPMENT

The same ideology can be used to sterilize the entire hospital room with the help of multiple UV-C sources. Further, each UV-C source can be programmed to emit the required amount of light to sterilize the area rather than using all the UV light to sterilize one particular area.

XI. CONCLUSION

Ultraviolet sterilization is the newest technology that uses short-wavelength UV-C light to kill or inactivate viruses or bacteria by destroying nucleic acids and prevents harmful micro-organisms sustainable. This idea is exploited to kill microbes present in surgical instruments which otherwise may cause infections.

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