IJAAR PUBLISHING®
DOI: 10.46654

Engineering Research Journal | ISSN: **2782-8212**
Vol. 2, Issue 11 (November, 2022) | www.ijaar.org/erj

SIMULATION OF AN AUTOMATIC DISINFECTION CHAMBER AT KANO STATE POLYTECHNIC, NIGERIA

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ABSTRACT

Many researchers are still working on multiple aspects of the COV-19 pandemic which include treatment, disease detection, or vaccination. It's expected that there will be a significant increase in the number of a student when school resume and in other public places. This article proposes a solution to reduce the transmission of diseases through interaction with one another, and also to reduce the infections of contagious diseases around the environment and the world. Disinfection chambers are set up at disinfection stations, public health disinfection centers, hospitals, tertiary institutions, industrial concerns, airport and train stations, as well as on automobiles, for mobile disinfection chambers. Disinfection is highly recommended on entering risk areas; walk-in disinfection chambers can be installed in such areas to enable full-body disinfection and decontamination.

KEYWORDS: - Disinfection Chamber, Disinfection Spray, PIR Sensor, Arduino Uno.

I. INTRODUCTION

A disinfection chamber or tunnel is a technology, designed to provide maximum protection to people passing through the tunnel within some certain time or seconds around. This can help the community to fight against the COVID-19. The novel coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome coronavirus 2(SARS-CoV-2). As human coronaviruses can remain infectious on inanimate surfaces for several days; surface disinfection with chemicals is inevitable. Covid-19 is a serious pandemic that the entire world is facing at present. As a measure of prevention from the deadly virus whose vaccine is not yet available, WHO recommends the application of alcohol-based sanitizers (60% alcohol content) to parts that are exposed to the virus. People are using hand sanitizers to wash hands frequently which have been proved effective to date. Since sanitizers are effective in preventing covid-19, it would be a good idea to sanitize the whole body. [1]

There are different types of disinfection chambers, depending on the features, structures, working principles, and installments. Some are movable or portable disinfection tunnels or fixed at the entrance, some use electricity or solar as their power supply and some are specifically used in different places or stations. Automatic disinfection chambers or tunnels can be in the disinfection of medical clothing, medical equipment, and medical waste. This kind usually conducts a temperature check before entering the closed tunnel for the disinfection procedure. The mobile disinfection chamber maintains a negative pressure to prevent cross-contamination between the external and internal environment. It also consists of some features such as a face recognition system, external personnel screening; identification of authentication, and file storage in areas with security and large population, such as stations, shopping malls, and community factories to time and record employee's body temperature. [2]

Some are used for disinfection of airport trolleys, supermarket shopping malls, luggage and baggage, and other objects in public space entrances when emergency public health events occur. A trolley disinfection machine is the operation of the equipment is under intelligent control, and there is no need for specialized personnel to operate. [3]

Nowadays, an automatic disinfection chamber has a lot of advantages, benefit in which some of which are:

- Utmost safety from infection for health personnel working in hospitals and having regular contact with various persons.
- Faster, effective, and efficient process to disinfect a body.
- Physical safeties for staff from the unruly crowd/quarantined people.
- Do not need the help of any other person in this process.
- Takes the provided certain time or seconds to complete the disinfection process.
- The sanitizer will be easily available in the market hence there will be no shortage of sanitizer.
- Very handy and can be used by any health professional.

At a time only one person can use this chamber hence, the principle of social distancing is strictly followed.

II. LITERATURE REVIEW

An infection occurs when another organism enters the body and causes diseases. The organisms that cause infections are very diverse and can include things like viruses, bacteria, fungi, and parasites. Infection can be acquired in many different ways, such as directly from a

person with an infection, via contaminated food or water, and even through bites of an insect. Viral infections; as in viruses, are very tiny infectious organisms. [4]

The coronavirus disease 2019 (COVID-19) is a communicable respiratory disease caused by a new strain of coronavirus that causes illness in humans. Scientists are still learning about the disease, and think that the virus is in animals. At some point, one or more humans acquired infection from an animal, and those infected humans began transmitting the infection to other humans. The disease spreads from person to person through infected air droplets that are projected during sneezing or coughing. It can also be transmitted when humans have contact with hands or surfaces that contain the virus and touch their eyes, nose, or mouth with the contaminated hands.COVID-19 was first reported in China, but it has now spread throughout the world. [5]

Disinfection is the process of killing, removal, and deactivation of harmful microorganisms. It also involves the elimination of most pathogenic microorganisms (excluding bacterial spores) on inanimate objects. Chemicals used in disinfection are called disinfectants. Different disinfectants have different target ranges, not all disinfectants can kill all microorganisms. To minimize the number of organisms in the population worldwide. The method of disinfection is used internationally for the safety of humans, and to decrease the scale of transmission of diseases.

Disinfectants are chemical agents designed to inactivate or destroy microorganisms on inert surfaces. Disinfection does not necessarily kill all microorganisms, especially resistant bacterial spores; it is less effective than sterilization, which is an extreme physical or chemical process that kills all types of life. Disinfectants are generally distinguished from other antimicrobial agents such as antibiotics, which destroy microorganisms within the body, and antiseptics, which destroy microorganisms on living tissue. Disinfectants are also different from biocides—the latter are intended to destroy all forms of life, not just microorganisms. Disinfectants work by destroying the cell wall of microbes or interfering with their metabolism. It is also a form of decontamination and can be defined as the process whereby physical or chemical methods are used to reduce the number of pathogenic microorganisms on a surface. [6]

Many disinfectants are used alone or in combinations (e.g. hydrogen peroxide and peracetic acid) in the healthcare setting. These include alcohols, chlorine and chlorine compounds, formaldehyde, glutaraldehyde, hydrogen peroxide, iodophors, peracetic acid, phenolic, and quaternary ammonium compounds. Disinfectants are not interchangeable, and incorrect concentration and inappropriate disinfectants can result in excessive costs. Because occupational diseases among cleaning personnel have been associated with the use of several disinfectants (e.g. formaldehyde, glutaraldehyde, and chlorine), precaution (e.g. gloves and proper ventilation) should be used to minimize exposure, asthma and reactive airway disease occur in sensitized persons exposed to any airborne chemical, including germicides.

Disinfectants can also be used to destroy microorganisms on the skin and mucous membrane, as in the medical dictionary historically the word simply meant that it destroys microbes. [7]. Sanitizers are substances that simultaneously clean and disinfect. Disinfectants kill more germs than sanitizers. Disinfectants are frequently used in hospitals, dental surgeries, kitchens, and bathrooms to kill infectious organisms. Sanitizers are mild compared to disinfectants and are used majorly to clean things that are in human contact whereas disinfectants are concentrated and are used to clean surfaces like floors and building premises.

III. METHODOLOGY

The design and implementation of this work can be achieved by the following methods:

A. AUTOMATIC DISINFECTION CHAMBER

A disinfection chamber works by spraying humans with safe disinfectants in a bid to kill disease-causing organisms that may be on their safety gears and even on the surface of their skin. Ideally, it will have an entry point, an enclosed chamber where the human disinfection takes place, and the exit point as shown in fig. 3.1. Other important components that make the process efficient include power supply, solvent supply, chemical chamber/mixer, air supply, and a spray pump mechanism. A Pump machine is placed on each side of the tunnel or chamber that takes the solution of some certain percentage of Sanitizer solution from the tank. As the machine is automatic it senses whether anyone is entering the tunnel. Once individuals enter the chamber, the LED light would turn ON and the content (a safe disinfectant) is sprayed over their entire body for about 5 seconds. So that the user can pass through that chamber or tunnel and if there is no one in the chamber or tunnel the spray pump will be off to save the disinfectant and power supply.

The misty disinfectant spray protects citizens from catching bacteria for a period of at least 20 minutes (Approx*). As it disinfects the air, exposed skin, and human clothing. Some optional features that can enhance the functionality of a decontamination unit include an in-chamber power outlet, lighting features, temperature scanner, chemical atomizer, and audio/visual fixtures.

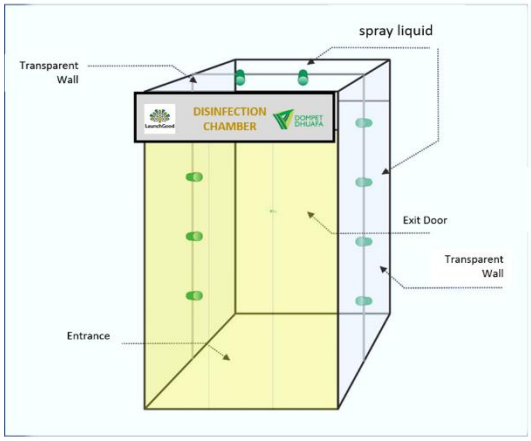

Figure 1: Automatic Disinfection Chamber

In this research, a motion detection circuit that sprays sanitizer when it detects the presence of a human in a chamber is designed. The details of the components and methods required for the development of the circuit are discussed below.

B. MATERIALS AND COMPONENTS USED

The material used was Proteus 7.6 ISIS Professional for designing, simulation, testing, and analysis of the results, and Arduino for Programming and coding processes. While for the components used were PIR sensors, which allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use, and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. Its operating voltage ranges

from 5V to 20V, power consumption is 65mA, delay from 3 to 5 minutes and its sensing ranges about 120 degrees and 7 meters.

Arduino UNO (means “one” in Italian) is an open-source electronics platform based on easy-to-use hardware and software. Arduino senses the environment by receiving input from many sensors and affects its surrounding by controlling lights, motors, and other actuators. Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), and a USB connection, a power jack, an ICSP header, and a reset button. In this project, digital input/output pins of the Arduino are used as the controller (ON or 5V/OFF or 0V) of the LED light and Motor.

C. L293D MOTOR DRIVER

L293D is a basic motor driver integrated chip (IC) that enables us to drive a DC motor in either direction and also control the speed of the motor. The L293D is a 16-pin IC, with 8 pins on each side, allowing us to control the motor. It means that we can use a single L293D to run up to two DC motors. L293D consist of two H-bridge circuit. H-bridge is the simplest circuit for changing polarity across the load connected to it. Wide voltage supply ranges from 4.5V to 36V, uses logic supply as its separate input, output current ranges from 600mA to 1.2A peak output voltage.

IN1, IN2, and IN3, IN4 are input pins used for providing a control signal from the controller to run the motor in different directions. If input logic at IN1, IN2 is (HIGH, LOW) the motor rotates in one direction (clockwise). If input logic at IN1, IN2 is (LOW, HIGH) the motor rotates in the other direction (anticlockwise). EN1 and EN2 are enabled pins. Connect 5v DC to EN1 and EN2 pin to operate the motor at its normal speed.

- LED light (Green color)
- DC Motor (as the disinfection spray and pump)
- Logic toggle
- 5V DC Battery

D. MOTION DETECTION CIRCUIT

A motion detection circuit is designed using Proteus 7.6 ISIS Professional to detect whether or not a human is present inside the chamber or tunnel. If a human is present, the motor (as in the disinfection spray) would start working (spraying) for about 5 seconds. It stops spraying as soon as the chamber or tunnel is empty.

IV. SIMULATION

The Motion detection circuit comprises of PIR sensor, a control unit, and the DC motor. I used Proteus 7.6 ISIS Professional to design and simulate the circuit. The figure below shows the schematic diagram of the motion detection circuit in Proteus 7.6 ISIS Professional.

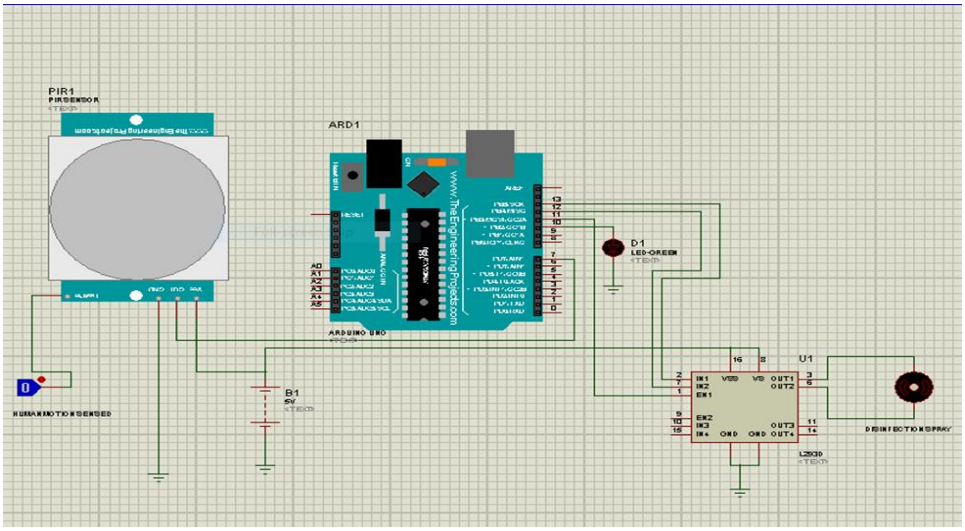

Figure 2: Schematic Diagram of the M-D-C

V. CIRCUIT OPERATION

Motion detection can be realized using a PIR sensor. The module is compatible with the Arduino UNO board, acting as the controller of the circuit. The Vcc of the PIR sensor is connected to the 5V battery, its output is connected to digital pin 7 of the Arduino board, LED light is connected to digital pin 10, and digital pin 13, pin 12 and pin 11 are connected to IN1, IN2, and EN1 of the L293D motor driver respectively. The DC motor is connected to OUT1 and OUT2.

The circuit operates in such a way that when the logic toggle connected to the test pin of the PIR sensor is pressed (sets to HIGH(5V) value), the LED light would automatically turn ON and the sensor gives a HIGH (5V) signal through the output pin. The HIGH (5V) signal is then read by the Arduino. So if Arduino reads a HIGH (5V) signal, it gives HIGH (5V) signals to the IN1 and IN2 pins, as such the OUT1 becomes HIGH which enables the motor to rotate until it reaches 5 seconds. Similarly, if the Arduino reads a LOW (0V) signal, it would make the IN1 and IN2 pins LOW (0V) and as result, the motor will remain OFF.

VI. RESULT

When the Logic toggle is pressed, it indicates 1 as shown in the fig. below (motion detected) and it sets a HIGH signal, the LED light automatically turned ON indicating that motion was detected. The sensor gives a HIGH signal to the digital I/O pins of the Arduino UNO which is acting as the controller of the circuit, then, the Arduino would send the HIGH signal to the IN1 and EN1 pins of the L293D motor driver which enables the OUT1 to be HIGH, as such servo motor would automatically start operating until it reaches to the provided time (5 seconds) and then stop. When it stopped, the logic toggle would then indicate 0 (no motion detected) as shown in figure 3.

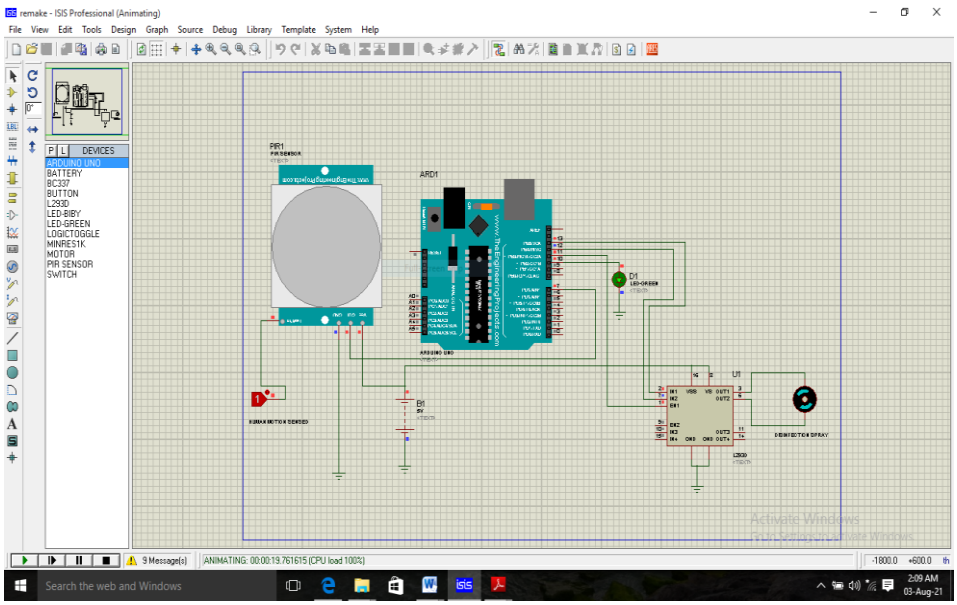

Figure 3: Simulation Result of the A-D-C

VII. DISCUSSION

The Motion detection circuit was designed using Proteus 7.6 ISIS Professional to detect whether or not a human is present inside the chamber or tunnel. As the logic toggle was pressed, the motor (as in the disinfection spray) operated (spraying) for about 5 seconds. It stops spraying as soon as the Arduino reads low (0V) value i.e. the chamber or tunnel is empty

VIII. CONCLUSION

In this project, a motion detection circuit for an automatic disinfection chamber was simulated using Proteus 7.6 ISIS Professional. The circuit works when the logic toggles were pressed (indicates that motion was detected), the LED light automatically turned ON and the motor (disinfection spray) rotates for about 5 seconds. It stops operating when it reaches the time (indicates that motion was absent).

IX. RECOMMENDATION

The chamber was designed for only one person to use it at a time. When two or more people are present in the chamber, the system may not operate properly, as such, the time provided for the spraying may be increased due to the intruding of more than one person inside the chamber or it may not even work.

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