Republic of the Philippines
Western Mindanao State University
INSTITUTE OF COMPUTER STUDIES
DEPARTMENT OF COMPUTER TECHNOLOGY

DEVELOPMENT OF ARDUINO DISINFECTION DEVICE WITH UV-C LIGHT FOR MATERIALS AND OBJECTS

A Capstone Project

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EXECUTIVE SUMMARY

Hygiene and sanitary factors are important factors in keeping our household, workplace and community clean and safe from contaminants like bacteria and viruses. In the Philippines, hygiene and sanitation are one of the most important issues to be discussed. These entities will cause harm and illness to people and these entities are not visible to the naked eye. They can only be detected using special equipment. UV-C light is more successful in removing bacteria from surfaces and objects compared to other disinfectant methods, like using chemicals. The researcher aims to develop a hardware device that can help users sterilize or disinfect objects using germicidal UV light. This project has successfully developed an Arduino project that can successfully disinfect and sterilize objects using UV-C Light. The machine has also successfully integrated push buttons that will set a timer so the user does not have to monitor the disinfection process while the device is running. It will turn off automatically based on the time being set. The study made use of the RAD methodology model where the project underwent a series of analysis, design, testing and implementation. During the implementation, the researchers conducted a series of testing of the user design based on the datas that were collected to fulfill what most potential users desired. Moreover, the researchers conducted an evaluation of the prototype to the Western Mindanao State University to evaluate the efficiency of the project. The evaluation showed that the sample microbes from the biology department were tested before exposing the substance to the project's device and exposing the substance to the project's device. As per analysis by Mrs. Almost 95% percent of microbes died after exposing the substance to the UV-C.

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CHAPTER 1

INTRODUCTION

1.1 Project Context

Hygiene and sanitation are critical components in keeping our homes, workplaces, and communities clean and free of contaminants such as bacteria and viruses. These entities will cause harm and illness to people and these entities are not visible to the naked eye. They can only be detected using special equipment. According to the Durham Region Paper (2016), frequent cleaning and disinfecting are recommended, and these are critical in preventing the spread of germs that carry diseases.

In the Philippines, hygiene and sanitation are one of the most important issues to be discussed. Since the Philippines is part of a third world country, sanitation is the main problem. According to the data gathered by the United Nations Children's Emergency Fund (UNICEF) last 2019, over seven million urban Filipinos are unable to wash their hands due to lack of access to a handwashing facility, water and soap, which increases the chances of acquiring diseases.

Currently, the pandemic brought by the COVID-19 virus that has already taken millions of lives-based on the data from the World Health Organization, has also tested the sanitary and hygiene level of the country in terms of how the citizens apply proper hygiene and sanitation to avoid contamination with the deadly virus. The World Health Organization (WHO) has been spreading propaganda that will help people avoid the virus: The basics are handwashing with soap and water, and sanitizing. This could lessen the chances of contaminating and spreading the virus.

People are not just vulnerable to the COVID-19 virus, but there are numerous types and variants of viruses and bacteria. As stated by Centers for Disease Control and Prevention(CDC) and confirmed by National Center for Immunization and Respiratory Diseases (NCIRD), Division of Viral Diseases in 2020 that COVID-19 are constantly changing through mutation, thus new variants are expected to occur that leads to severe disease to people. To address these issues, the researchers developed a device using Arduino hardware that will use germicidal UV-C light to disinfect objects.

1.2 Purpose and Description

According to the Food and Drug Administration (FDA), UV-C lights or lamps are known as a disinfectant tool that can help disinfect air, water and nonporous surfaces.

Linda Lee, an Environmental Health Expert and Chief Medical Affairs and Science Officer

at UV Angel, says UV light and chemicals such as bleach or ethanol, according to the study, are equally efficient in disinfecting surfaces. Lee recommends using whatever washing procedure is accessible to you, but points out that UV treatment can be preferable in some cases. "For instance, chemical treatment might be difficult for a baby's pacifier, because of the way chemicals work, there's residual left behind that continues to treat the surfaces."

According to Eric Lee, a St. Louis based physician, says that "UV light, the type used in most common devices on the market to clean household objects, has been shown to be effective in laboratory studies at killing bacteria on computer screens, toothbrushes, and other objects. It has also been shown to be effective in affecting bacteria." This claim was also supported by Alex Berezow, a Microbiologist, saying that "UV light is lethal to bacteria and viruses because of its high frequency that scrambles and damages the DNA code of these pathogens. It also triggers lethal mutations that prevent them from reproducing properly."

To destroy germs and bacteria in our homes, schools, communities, and hospitals, disinfecting is necessary. A very common disinfectant component is chlorine bleach. According to the Michigan State University (2020), using chlorine bleach as a cleaning solution will disinfect surfaces from more than only the COVID-19 virus, and will aid in the prevention of flu, foodborne sickness, and other diseases, all of which will benefit the healthcare system. On the contrary however, chlorine bleach is corrosive and can damage the skin, eyes, and lungs if it is used as a cleaning solution. The person needs to take precautionary measures like wearing gloves while using the product and ensure a well-ventilated area.

Based on the experts, employing UV-C light as a disinfectant is more successful in removing bacteria from surfaces and objects. Compared to other disinfectant methods like using chemicals to clean a surface, there are chances that residues of the chemicals used still remain on the surface and may irritate the skin when in contact.

1.4. Objectives

1.4.a. General Objective

This study aims to develop an innovative way to disinfect materials and objects such as gadgets and other handy objects

1.4.b. Specific Objectives

- To integrate a program commands in C language into the Arduino Uno hardware as a central processing unit of the project.
- To integrate the UV-C light bulb as a disinfectant tool.

- To integrate a user-inputted timer for the duration of the disinfection and can monitor the time by using an I2C 16x2 LCD screen monitor.
- To incorporate the IR Sensor, which provides additional UV-C radiation protection.

1.5. Scope And Limitations

1.5.1 Scope

This project aims to develop a device that will provide an innovative way to disinfect objects using UV-C light as the main component. It is also developed for people who want to disinfect surfaces or objects without doing so manually.

The researchers used UV-C light, an LCD timer and 4 push pin buttons for this project. The buttons serve as the controller of the project. The light emitting from the device will expose all the above angles covered by the device in order to disinfect the surface of the object at the same time. Whenever the user places an object on the device and the system is running for disinfection, IR sensors can detect who is nearby to the box. The UV-C will automatically turn off and will pause the timer and will stop the disinfection process. It will only be resumed if the IR sensor will no longer detect nearby presences.

The UVC-Light device can disinfect all kinds of objects and every material, but it will all depend on the size of the disinfection box and design approach. This is to ensure that disinfection is applied to all objects, especially those which are used all the time or have come in contact with people all the time.

There should also be no outside light to pass through the device to achieve its effectiveness. For the purpose of disinfection, the project will not require high quality light materials found at home to be used.

Once installed, students, faculty, and staff may benefit from this by using it to disinfect their belongings.

Finally, once the project is completed, it will be implemented in Western Mindanao State University - Main Campus.

1.5.2 Limitations

Although UV-C light can be effective in disinfecting surfaces and objects, there are some components that are sensitive to the light, such as the skin because it may cause irritation to the skin when exposed to the light. In disinfecting mobile phones, users should take off its protective case-because of its component, the jelly case will melt if exposed to

UV-C light for a period of time. In addition, the device will only disinfect a part of an area which the device covers and not entirely the whole surface.

Upon deployment, should there be a need to acquire more UV-C light devices for disinfection, the university will shoulder its cost and not the researchers.

1.6. Significance Of the Project

Bacterial growth in natural environments is often associated with attachment to surfaces. According to Anna Ahveninen in 2016 in her research about micro-bacterial growth and SARS-COV, Communications Officer, Australian Academy of Science, Scientists have found that many potentially infectious bacteria, viruses, yeasts and molds can survive on surfaces for considerable amounts of time. A lot of people think that diseases often spread by direct contact with other people, but for a person to feel sick or get infected with a bacteria, a pathogen needs to find its way to the victim in clusters to survive the initial assault of a person's immune system, and then multiply. Moreover, surfaces add a new level of difficulty. A pathogen must land on a surface and be able to survive on it until a person is in contact with it. After that, it still has to make it from the touch point to whatever area of the body the pathogen targets before it can thrive.

A 2016 study by the Society for General Microbiology showed that most contaminated objects are found at home. According to the study, over 340 different bacteria on 30 different objects were present, thus the cause of flu and other diseases. Scientifically basis from Dr. Debra Rose Wilson a health psychologist, not all variants of bacteria are harmful, but people should always be wary of the following variants: Staphylococcus aureus, or staph, yeast and mold; Salmonella; Escherichia coli; and fecal matter; the SARS-Cov-2 virus; and the new coronavirus. Because these types of bacteria have a long lifespan, they stay on surfaces for a long time unless the surface or object is disinfected properly.

To introduce an innovative way to disinfect surfaces and objects, the researchers have found a new way of disinfecting objects which are always with people, like mobile phones, keys and other personal belongings, without spending more money on regular disinfectants by the help of UV-C Light and Arduino devices.

1.7 Definition of Terms

COVID-19 - Coronavirus disease (COVID-19) is a newly found coronavirus that causes an infectious illness.

Germicidal UV-C light - It's a sort of lamp that emits UV light with wavelengths less than 290 nm and is supposed to have "germicidal" properties, meaning it may kill germs.

VIRUS - an infectious agent that comprises a nucleic acid molecule encased in a protein sheath, is too tiny to be visible under a microscope, and can only replicate within the live cells of a host.

Pathogens - Pathogens are organisms that have the potential to cause illness.

FDA - The Food and Drug Administration is in charge of guaranteeing the safety, effectiveness, and security of human and veterinary pharmaceuticals, biological products, and medical equipment, as well as the safety of our country's food supply, cosmetics, and radiation-emitting items.

IR Sensor - Infrared (IR) sensor is an electronic device that measures and detects infrared radiation in its surrounding environment.

SARS-COV- severe acute respiratory syndrome coronavirus.

UV-C - Ultraviolet C: One of the three types of invisible light rays

CHAPTER 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the related literature and existing research studies of the research project. The researchers gathered literature regarding the use and effectiveness of using UV-C Light as disinfectant and using Arduino devices and how the two components will correlate in the development.

2.1 Introduction

Since the beginning of time, people have always had to deal with bacteria or diseases. However, things tend to evolve with technology. With the help of germicidal UV light, people can lessen the chances of getting infected with any bacteria or virus.

According to Mike Elgan, The University of Arizona found that telephones are the most germ-infested objects in our lives, followed by desktops, phones, and keys. To develop the system, the researchers have gathered insights from similar technologies.

2.1.1 Ultraviolet LEDS prove effective in eliminating coronavirus from surfaces and, potentially, air and water

According to a study conducted by Sonia Fernandez from University of California – Santa Barbara, as COVID-19 continues to wreak havoc on the world's population, the world's attention is solely on discovering strategies to combat the unique coronavirus. Solid State Lightning and Energy Electronics at UC Santa Barbara is one of them. Researchers are working on producing UV LEDs that may disinfect surfaces, as well as perhaps air and water, that have been exposed to the SARS-CoV.

2.1.2 UV Exposure Box Project with Timer

Elias Zacarias built a small UV exposure box using UV LEDS and Arduino. The box she uses for the machine has two sections: a lid covered compartment where the exposure "bed" will be, and a control "panel" under which the electronics will be installed. Everything should be easily removable for repairs and debugging. For the exposure bed, she uses a small piece of glass, the board held 0.7cm/tan (10) = 4.25 cm above the LEDS. She designed the box so the PCB with the LEDs could be installed 5cm under the glass (using 5mm PCB spacers).

2.1.3 The Basics of Arduino: Adjusting LED Brightness

Last Jan, 2018, Ade Vickers and Solution Engineers Ltd developed an Arduino Nano controlled double-sided LED UV exposure box. The project is capable of evenly exposing Eurocard sized PCBs (160mm by 100mm); version 2 will increase the maximum size to 320mm by 200mm (4x Eurocards). Each 160x100 UV light card consists of 150 LEDs, connected in series strings of 6, with a 220R resistor to limit current to a shade under 20mA per LED. Total power consumption is approximately 12 watts per panel (0.5amps @ 24V), including the timer electronics (roughly 100mA @ 5v). The unit is built into a standard aluminum tool case.

2.1.4 PCB Exposure Timer

Buraks also developed the same machine. He built a UV exposure unit made of ultraviolet LEDs. He used 18x24 LEDs to make the exposure area. All LEDs are controlled using a single MOSFET. The gate is connected to an Arduino so that it can drive LEDs with PWM and thus control brightness and timing.

2.2 Cleaning and Disinfecting Materials/Objects

Using such chemicals for cleaning and disinfecting materials is a common thing nowadays. This is one of the major problems when it comes to disinfection. Depending on the dose, household bleach (chlorine as sodium hypochlorite) is effective against most germs, including bacterial spores, and can be used as a disinfectant or sanitizer. Although chemical disinfectants and sanitizers are essential to control communicable diseases, they are potentially hazardous to children, particularly if the products are in concentrated form. High concentrations of bleach can harm your skin and can irritate your eyes.

2.3 Definition of UV-C

Ultraviolet light is a type of electromagnetic radiation which is emitted at various wavelengths and frequencies in the form of waves or particles. UV light ranges between visible light and x-rays in the context of the EM spectrum. The amount of UV radiation a microorganism is exposed to is determined by the intensity of UV radiation and the length of exposure. For the most common target bacteria in disinfection, a number of biological investigations have developed widely accepted typical UV dose requirements. For example, a 60 mJ/cm2 treatment is required to achieve a 3-log decrease (99.9%) of B. Subtilis.

2.4 Viral/Bacterial Contamination

In any environment, including soil, air, water and food, as well as on environmental surfaces or artifacts, microorganisms which cause infections can be found. The infection will spread to humans in various ways; through inanimate objects called vectors, directly or indirectly; (Neely and Sittig,2002). For susceptible, immune-compromised individuals, the presence of pathogenic bacteria on environmental surfaces such as door handles poses a potential danger. Hard, non-porous surfaces, such as door handles, have been shown to have the highest bacterial transfer rates to hand (Rusin, et al.,2002). There are microorganisms everywhere and they make up a big part of every ecosystem. They live either freely or as a parasite in these conditions (Sleigh and Timbury, 1998). In certain instances, they live in fomites or hands as transient pollutants where they pose a significant health risk as sources of population and hospital acquired infections (Pittet et al., 1999). While the risk of infection in the general population is accepted to be lower than that associated with hospital patients, the annual rise in food poisoning cases in which household outbreaks are a major factor demands an examination of the possible causes and sources (Scott et al., 1982). Fomites are the primary cause of the spread of community-acquired diseases besides the day-to-day contact of individuals, which constitutes one way of transmitting disease (Prescott et al.,1993). Fomites are a significant source of infectious diseases transmitted when the pathogenic organism is in close contact with humans or natural habitats (Osterholm et al., 1995)

2.2 Summary

In preventing illness, ensuring a safe work environment is important. On unsanitary surfaces, bacteria may develop and then contaminate foods. Just because it looks clean on a work surface does not mean that it is sanitary. Cleaning with soap and other detergents is just one step in the process of cleaning. Sanitizing is also important. Cleaning will eliminate any dirt or grease, but no bacteria or other pathogens will necessarily be destroyed. Only a sanitizer will kill bacteria and guarantee that the area is clean.

Many research studies and reports state that DNA, RNA, and proteins are consumed when all biological species are exposed under deep UV light in the range of 200 nm to 300 nm. Protein absorption contributes to the bursting or cracking of cell walls, resulting in the death of the organism, while absorption by DNA or RNA induces inactivation, thereby disrupting the replication process. Besides this, irrespective of anybody using the project, the sanitation cycle is automatically activated 20 minutes from the last time it was used and every 20 minutes after that. To ensure proper adjustment, the unit itself was fitted with hinges.

2.3 Synthesis

The table below shows the synthesis of the related literature and studies of the Development of Arduino Disinfection Device With UV-C Light for Materials and Objects. It demonstrates the characteristics, applications, and similarities and differences between other existing studies and the proposed study.

Table 2.3: Synthesis Table

Existing Study	Features	Uses	SIMILARITY with the proposed study	DIFFERENCE with the proposed study
Ultraviolet LEDS prove effective in eliminating coronavirus from surfaces and, potentially, air and water	Solid State Lighting UV for surfaces, air and water	Solid State Lightning and Energy Electronics at UC Santa Barbara is one of them. Researchers are working on producing UV LEDs that may disinfect surfaces, as well as perhaps air and water, that have been exposed to the SARS-CoV.	Eliminate bacterial growth from the surface.	We are only focusing on bacterial infections not mainly in coronavirus and surfaces or objects. We are also not using LEDs.
UV EXPOSURE BOX PROJECT WITH TIMER	Exposure box with UV-C small LEDS with reflection glasses	The box she uses for the machine has two sections: a lid covered compartment where the exposure “bed” will be, and a control “panel” under which the	Exposure device having a disinfection timer	We are not going to use small UV-C LEDs and glasses.

		electronics will be installed		
The Basics of Arduino: Adjusting LED Brightness	Arduino Disinfection using LEDs that can adjust its brightness up to 400 nm	The project is capable of evenly exposing Eurocard sized PCBs (160mm by 100mm); version 2 will increase the maximum size to 320mm by 200mm (4x Eurocards). Each 160x100 UV light card consists of 150 LEDs	The same UV-C power at 0 - 256nm	We are fixing the nanometer as it is an exact nanometer for UV-C.
PCB Exposure Timer	UV-C controlled by MOSFET and using 18x24 LEDs lights	The gate is attached to Arduino to Arduino which can drive LEDs using PWM and thus control brightness and timing.	Exposure Timer and Arduino microcontroller.	We are also not using MOSFET as the controller instead we will be going to use push buttons as for convenience

Figure 2.3: Synthesis Table

CHAPTER 3

TECHNICAL BACKGROUND

This chapter discusses the technologies that will be used in the project's development as well as the project's technical development.

3.1 Technologies Used for The System

This study was conducted to introduce an innovative way to disinfect objects and surfaces using UV-C Light.

The Arduino Disinfection Device With UV-C Light for Materials and Objects is a system that uses UV-Light to disinfect objects and surfaces. The system can detect whether an object is scanned and will automatically turn on the UV-C light and turn off upon removal of the object.

The researchers used Germicidal UV light installed in a device powered by Arduino. Once the user puts the object in the disinfection box, it starts to disinfect the object. Its effectiveness is up to 95%. The device also uses a sensor that will detect if a person is within the range of the machine and automatically turns off the light to prevent infection or skin reactions caused by the light. Germicidal UV light is harmful to human skin when exposed to too much.

3.2 Conceptual Framework

The diagram below shows the conceptual framework of the project:

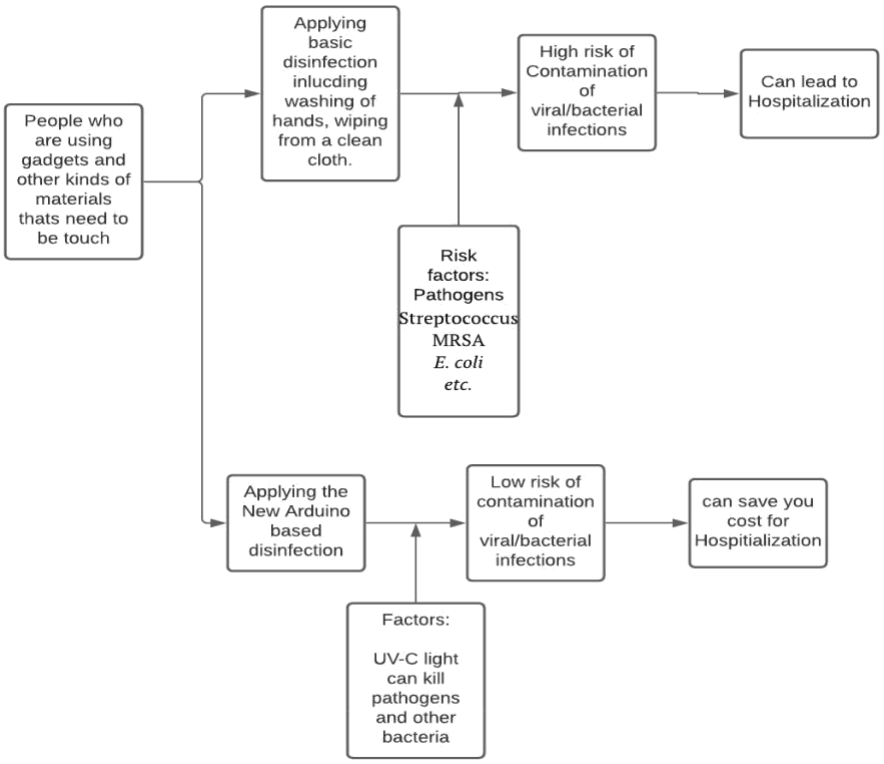


Figure 3.2: Conceptual Framework

The conceptual framework shows that you can still have a higher chance of contamination in just a basic simple disinfection by wiping or cleaning using clean cloth or washing using water. In this study applying new technology that can be sure to be effective in disinfecting bacteria giving a low risk of contamination and safe from viral/bacterial infection.

3.3 Flowchart

The diagrams shown below are the flowchart of the project:

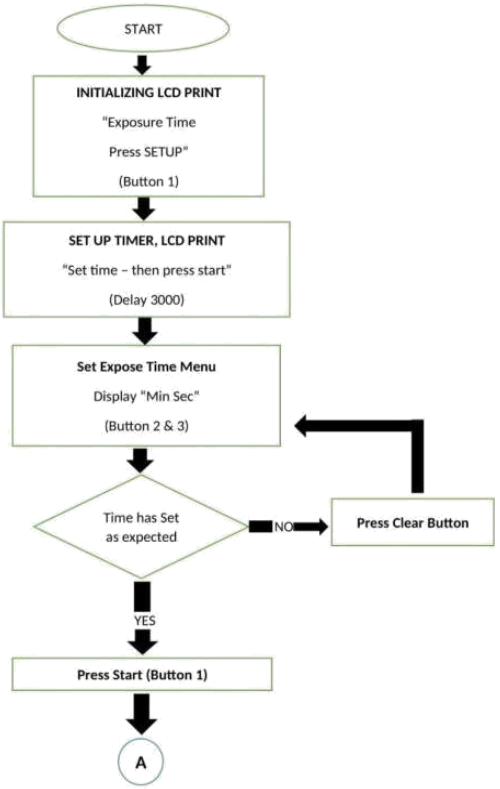


Figure 3.3 : System's Flowchart

The figure shows that after pressing the start button, the LCD displays an initial text instructing users to enter their desired time for disinfection and after the set-up the start button needs to be pressed again.

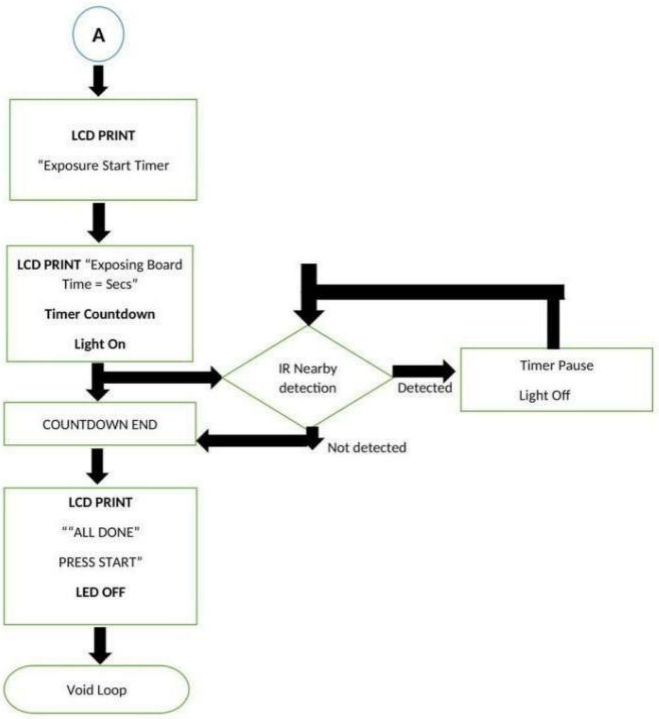


Figure 3.3 : System's Flowchart

Figure shows after the initialization of the timer, the LCD will print the setup timer and the light of the UV-C will turn into correlation with the timer. During the exposure if the detection detects someone is nearby, the timer will pause and the light will turn off. it will resume if the detection will no longer detect someone.

3.4 System Components

The researchers will need the following software components to develop the device:

- **Arduino IDE** - The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits

3.5 Hardware Components

The researchers will need the following hardware components for the development of the device:

- **Arduino Uno** - The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button.
- **IR Sensors** - The function of an IR sensor is to detect the motion on the door knob/handle. It has a range of 10-15 cm with input supply voltage of 5V DC. It is operated at 6.5V and has output voltage for logic one(+3.5V) & logic Zero (0.0V).
- **Diode 1A** - A diode is a semiconductor device that functions as a current one-way switch. It allows current to flow freely in one direction while severely restricting current flow in the other.
- **USB Cable** - Universal Serial Bus (USB) is an industry standard that establishes specifications for cables and connectors and protocols for connection, communication and power supply between computers, peripherals and other computers.
- **Wires** - A wire is a single usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals.
- **Two-pins Push buttons** - A 2 pin switch looks like this and its working is simple.

It's mainly used to close or open a circuit. It has 2 legs and one small button. When the 2 PIN push button is clicked, the led lights up else it's off.

- **Breadboard** - a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate.

- **I2C Liquid Crystal 16x2 Display** - I2C Module has an inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version, you have checked the black I2C adaptor board on the underside of the module.

- **UV-C Light Bulb -** a known disinfectant for air, water, and nonporous surfaces. UVC radiation has effectively been used for decades to reduce the spread of bacteria, such as tuberculosis. For this reason, UVC lamps are often called "germicidal" lamps.

3.6 Integration

This section describes how the hardware components are being assembled and implemented to develop the system.

3.6.1 Hardware Components Integration

The diagram below shows how the hardware components of the system are being assembled.

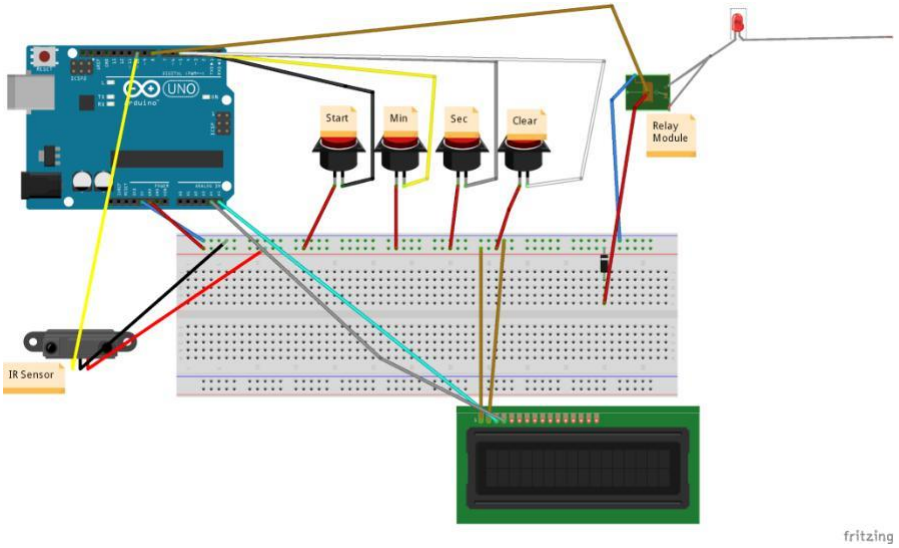


Figure 3.6.1: Hardware components Diagram

3.6.2 UV Light

It has frequencies ranging from about 8 x 1014 to 3 x 1016 cycles per second or hertz (Hz) and from about 380 nm to about 10 nm wavelengths.

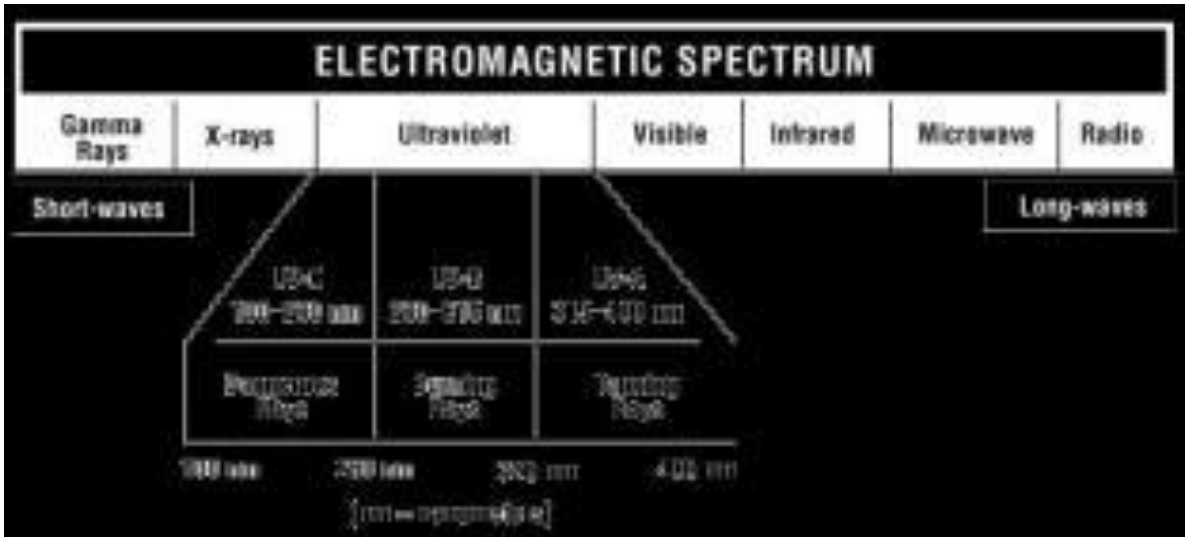


Figure 3.6.2: Electromagnetic Spectrum

UV-C light is a short wavelength light that is used for the purpose of sanitation. The DNA of bacteria, viruses and other pathogens is deactivated by UV-C light to prevent them from working or reproducing. It dies as the organism attempts to replicate. Many research studies and reports state that DNA, RNA, and proteins are consumed when all biological species are exposed under deep UV light in the range of 200 nm to 300 nm. Protein absorption results in the bursting or cracking of cell walls, resulting in the death of the organism.

Table 3.6.2: UV-C wavelength

UVC Light will be used in the device for disinfection. The connection for the UV-C, 1 wire is connected to the 5V relay module in common and normally closed connections in the 5V relay module. The other wire is connected to the power source. The

Wavelength (nm)		275±2	
Model		TY-UV275nm SMD	
Encapsulation mode		SMD	
Optical power [mW]	**IF = 20mA**	**Min**	1.0
		Max	1.5
Forward Voltage V_F[V]		**Min**	5.50
		Max	6.00
Beam Angle		120-140	

UV-C light will be located at a distance which can disinfect an object and also the UV-C LED light can cover the overall surfaces. It has a minor ill effect on human skin so the UV-C lights are directly projected on the object and automatically turn off if the sensor senses someone approaching the door handle.

3.6.3 Arduino Uno as a Microcontroller

The researchers used Arduino Uno as the microcontroller. This microcontroller will help the device to control all the necessary functions as per the instructions given. The microcontroller which can be used have following specifications:

Figure 3.6.3: Arduino IDE

To integrate the Arduino Uno microcontroller, we will use Arduino IDE that has the Integrated Development Environment common to all Arduino boards. The USB connection with the PC is necessary to program the board and not just to power it up. The Uno automatically draws power from either the USB or an external power supply. Connect the board to your computer using the USB cable. The green power LED (labelled PWR) should go on.

3.6.4 Infrared Sensors for Detection

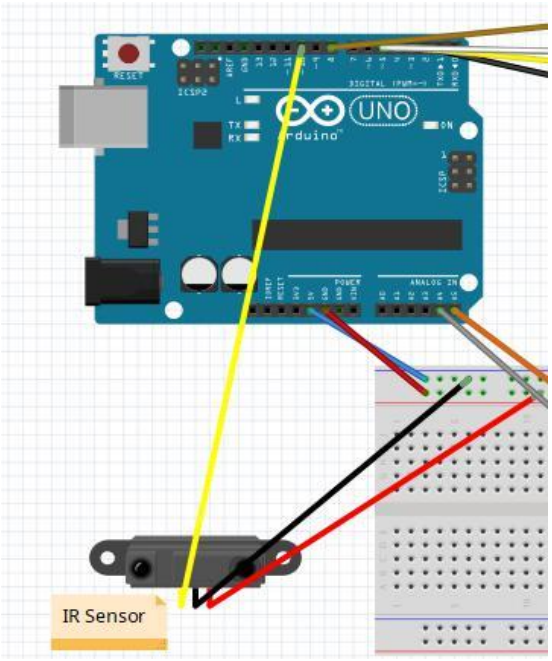


Figure 3.6.4: IR sensor with Arduino

The researchers used IR Proximity Sensor for this device. The function of an IR sensor is to detect the motion on the project. It has a range of 10-15 cm with input supply voltage of 5V DC. It is operated at 6.5V and has output voltage for logic one(+3.5V)& logic Zero (0.0V). The connections for the IR sensor with the Arduino are as follows: Connect the negative wire on the IR sensor to GND on the Arduino. Connect the middle of the IR sensor which is the VCC to 5V on the Arduino. Connect the signal pin on the IR sensor to pin 10 on the Arduino (see figure 3 for the visual representation)

3.6.6 5V Relay Module

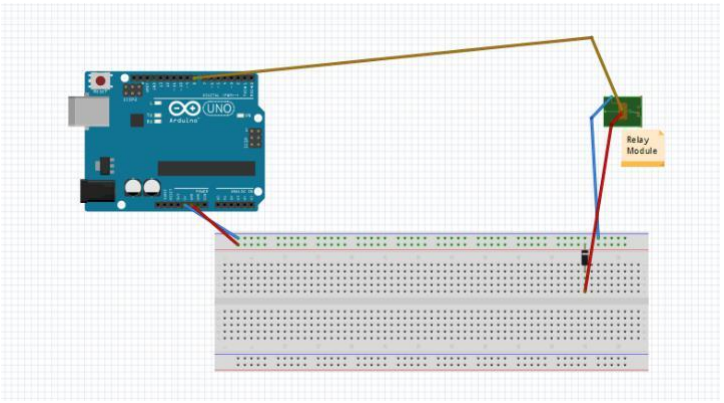


Figure 3.6.6: Relay module wiring diagram

The integration of the Relay module starts by connecting the VCC pin on the Diode A1 and connecting it to 5V on the Arduino and GND pin to ground. Connect the digital pin 8 to the IN1 input pin for controlling the first relay. You'll also need to place the relay module in line with the AC powered device (UV-C light bulb in our case) that we are attempting to control.

3.6.7 Two Push-Button Pins

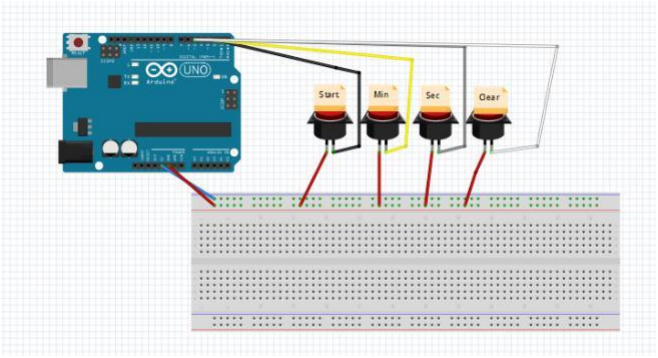


Figure 3.6.7: Push buttons wiring diagram

The integration of push buttons simply connects the Arduino GND to a terminal on the button and connects a digital pin to the other button terminal.

3.6.8 I2C Liquid Crystal 16x2 Display

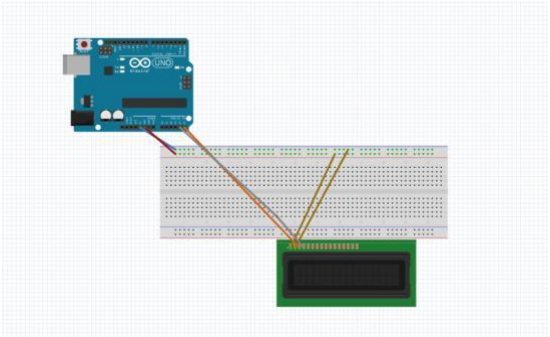


Figure 3.6.8: LCD Display wiring diagram

The Arduino Board is connected to the LCD display. The VCC is connected to the module to 5V on the Arduino and a GND pin is used for the ground. The SDA is connected to analog pin A4 on the Arduino and lastly, the SCL is for pin A5 on the Arduino.

3.6.9 Breadboard

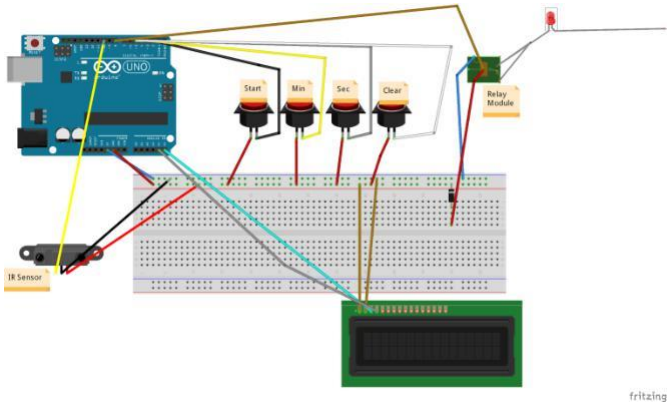


Figure 3.6.9: Breadboard wiring diagram

The breadboard helps construct a better electronic circuit diagram for less wiring problems.

CHAPTER 4

DESIGN AND METHODOLOGY

4.1 Requirement Analysis

In this phase, the researchers did a gathering of different ideas on disinfecting tool requirements to be used in developing the system. The researchers gathered data through existing studies of disinfection related to the project. The researchers reviewed, defined and analyzed the requirements. As part of the project, the researcher requested help from professionals of Western Mindanao State University-College of Science and Mathematics Biology Department to test the effectiveness and accuracy of the project.

4.2 Requirement Documentation

These are the disinfection concepts that the researchers acquired from the data, which they reviewed, characterized, understood, and documented:

- A device that will help lessen the use of alcohol for disinfection
- A device that is innovative, not costly and also a handy disinfection device
- A device that accurately disinfects materials and goods.
- A device that is not harmful in any manner, like skin allergy, skin irritation, and not chemically produced.

This section describes the system's functional and non-functional requirements.

4.2.1 Goals

The main goal of this project is to offer an innovative way to disinfect or sterilize objects and materials. Users can also have clean materials and objects without having to do so manually. And lastly, to give the user at least another way of protection against bacterial infections.

*4.2.*2 Scope

The following are the scope of the project:

The users can disinfect objects and surfaces by scanning the object through the UV-C Light. After which, the light turns on when an object is detected and turns off when there is none.

Moreover, the project will not be able to scan large objects at once since it is designed for handy objects like mobile phones, keys, gadgets, pens etc.

Lastly, the project will be placed inside the University as a disinfectant device.

*4.2.*3 Functional Requirements

The functionalities of the project are described in this section:

FR1 - The system is able to manually operate the device by using buttons.

FR2 - The system should be able to detect if there is a person near the device.

FR3 - The system has a protection measure so that the user will not have to worry about skin irritation from UV light.

FR4 - The system is able to set a timer to disinfect the object/surface.

FR5 - The system has an automatic disinfecting process, while the device is running the system will turn off automatically based on the time being set.

*4.2.*4 Non-Functional Requirements

This section describes the non-functional requirements of the project and that are not directly related to the functionality of the device.

*4.2.*4.1 Usability Requirements

The following are the usability requirements of the project:

- The system can navigate the buttons without the help from the developer himself.
- The system used some common symbols and icons so that it can be easily read and understood.
- The system has the LCD monitor so the user can easily read and understand the message from the system.
- The system can easily open without using much force.

*4.2.*4.2 Operational Requirements

The following are the operational requirements of the project:

- The device will be available in any indoor facilities in Western Mindanao State University.
- All users can use the disinfection device without the need of manual.

4.2.4.3 Security Requirements

The following are the security requirements of the project:

- The users can use the device at ease without having inflicted damage to the skin.
- The general users cannot alter the wirings that are inside the hardware box.

4.2.4.4 Legal Requirements

The following are the legal requirements of the project:

- The users are not allowed to change the user interface of the device.
- The users nor the stakeholders are not allowed to change the source codes.

4.2.5 Coding and Implementation

The study used pre-built libraries for IR Proximity Sensor modules, Wire libraries and Liquid Crystal libraries. Make sure to download the Arduino IDE for the specific operating system. Then define the pins for the IR sensor, Push buttons, LCD and relay module and initialize all the things in the setup. Then, in a loop, it will use the IR sensor function to determine if there is no nearby human and will send the data to display/turn on the UV-Light bulb. The following code should properly run the device.

Table *4.1*: Setup Main Implementation

```
void setup()
{
          // initialize the
LCD lcd.begin();
lcd.clear();
lcd.setCursor(0, 0);
  // Turn on the blacklight and print a
message. lcd.backlight();
lcd.print("-Exposure Time-
"); lcd.setCursor(0, 1);
lcd.print("- Press SETUP -");
```

```
Serial.begin(9600);}
```

Figure *4.1*: Setup Main Implementation

These lines of codes determine the booting up or initializing the LCD when turning it on. It will print the initiating message of commanding the user to press the "Setup" button to start the program.

Table *4.2*: Setup Timer Implementation

```
void setupTimer()
{
lcd.clear();
lcd.setCursor(0, 0);
lcd.print(" - Set Time - ");
lcd.setCursor(0, 1);
lcd.print("Then Press Start");
delay(3000);

lcd.clear();
lcd.setCursor(0, 0);
lcd.print(" Set Expose Time");
lcd.setCursor(0, 1);
lcd.print("Min: ");
lcd.setCursor(9, 1);
lcd.print("Sec: ");

while(startCountdown == false)
  {
    logic2 = digitalRead(button2);
    if (logic2 == LOW)                // SECONDS ADJUST
    {
      seconds ++;
delay(300);

       if (seconds >= 60)
       {
         seconds = 0;
         minutes ++;
       }
    }
   char buffer[3];
sprintf(buffer, "%2d", seconds);
lcd.setCursor(14, 1);
lcd.print(buffer);

   logic3 = digitalRead(button3);
   if (logic3 == LOW)                // MINUTES ADJUST
   {
     minutes ++;
delay(500);
   }

lcd.setCursor(6, 1);
lcd.print(minutes);
```

```
  logic4 = digitalRead(button4);
if(logic4 == LOW)                // clear timer
  {
   seconds = 0;
   minutes = 0;
  }

  logic1 = digitalRead(button1);
  if (logic1 == LOW)               // START
  {
startCountdown = true;
  }
 }

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Exposure Start");
lcd.setCursor(0, 1);
lcd.print("Timer = ");
lcd.setCursor(8, 1);
lcd.print(countdown);
lcd.setCursor(12, 1);
lcd.print("Secs");

StartTime();
}
```

Figure *4.2*: Setup Timer Implementation

These codes are for setting up the timer after pressing the “Setup” button. it will automatically print the seconds and minutes if the user presses the “minute” button and the “second button”. This is where the logic begins in computing the numbers by adjusting it to seconds and minutes because the program can only read milliseconds, so it needs to convert to the appropriate conversion. Then after the conversion and the user presses again the “Setup” the setup function will call the StartTimer function.

The code used are the main commands that get the user’s input time, that sends commands to the relay module to turn off/on the UV-C, that retrieves data if the IR sensor detects presence nearby, that sends text to display on the LCD monitor.

Table *4.2*: Setup Start Timer Implementation

```
void StartTime()
{
 countdown = ((minutes * 60) + seconds);
digitalWrite(lightBoardPin, HIGH);

lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Exposing Board");
lcd.setCursor(0, 1);
lcd.print("Time:");
```

```
lcd.setCursor(11, 1);
lcd.print(" Secs");
  for (int timer = countdown; timer >= 0;)
  {
    if(digitalRead(pirSensor) == LOW){ // detect if there's a motion

Serial.println("pir detected");

      char buffer[6];
digitalWrite(lightBoardPin, LOW);
sprintf(buffer, "%4d", countdown);
lcd.setCursor(7, 1);
lcd.print(buffer);
    timer = countdown;
    }
else{
      char buffer[6];
digitalWrite(lightBoardPin, HIGH);
sprintf(buffer, "%4d", countdown);
lcd.setCursor(7, 1);
lcd.print(buffer);
delay(1000);
    countdown = countdown - 1;
       timer--;
      }

  }
digitalWrite(lightBoardPin, LOW);


lcd.clear();
lcd.setCursor(0, 0);
lcd.print(" * ALL DONE *");
lcd.setCursor(0, 1);
lcd.print(" Press START");


  logic1 = digitalRead(button1);
while(logic1 != LOW)
  {
    logic1 = digitalRead(button1);
  }

startCountdown = false;
  minutes = 0;
  seconds = 0;
  countdown = 0;
}
```

Figure *4.2*: Setup Start Timer Implementation

This function is where the program will display the countdown process setup by the user. The main purpose of these lines of codes is to manipulate the imputed desired

numbers of the timer by decreasing it by 1second until it becomes 0 hence, the program will also stop. One function added is that it will also catch the censoring part of the program where if there's nearby presence the flow of the program will automatically pause; it will just function again if the sensor will not detect something nearby.

4.3 Design of System, Product and Processes

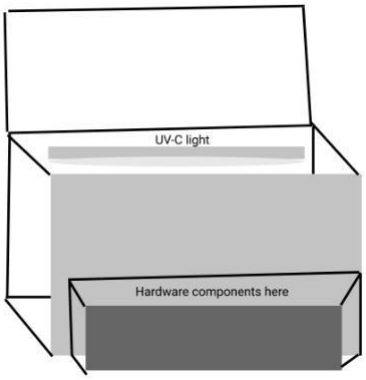


Figure *4.3*: Initial Plan

One of the most critical aspects of the production of any new product is design. When designing this product, various factors such as protection, aesthetics, ergonomics, etc. are put into consideration. The device's design was structured as, UV-C light is mounted at a distance that can disinfect the objects/materials very effectively, and the UV-C light can also cover the objects/materials all above angles. UV-C lights are projected directly onto the objects/materials and there is limited user input time exposure beyond the target objects/materials.

4.3.1 System Development Life Cycle

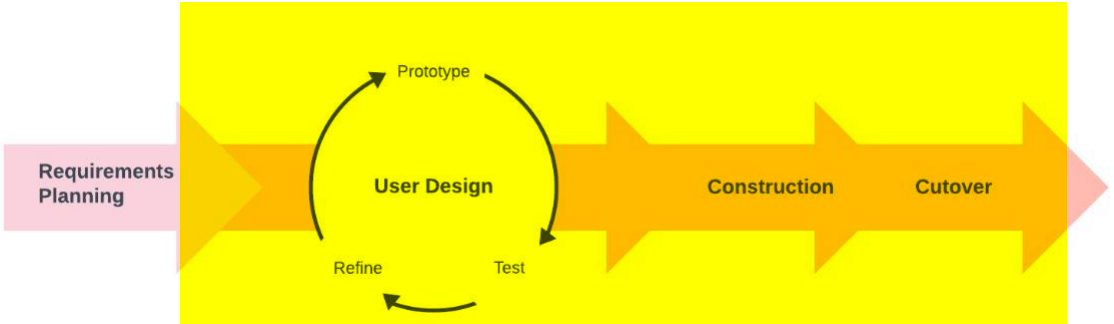


Figure 4.4: RAD Phases

4.3.2 Different Phases of RAD Methodology

4.3.2.1 Requirements Planning Phase

The researchers planned the needed requirements that will be used in developing the project. The team set the date for the start or end of each of the tasks to get a clear understanding of what is required, what time frames are being worked on, the costs of materials and what resources we will need to supply to get the project done. The requirements of the new project were identified. All the requirements for the project were gathered from existing studies related to pathogens or bacteria that can be found on surfaces and studies related to using UV-C light as a disinfectant. All the information was analyzed and all the functional and non-functional requirements of the project were engineered.

The researchers analyzed the project's technical approach and how it should be implemented during the implementation phase. The project was then carried out according to the recommended functions. The researcher also analyzed whom should the project be targeted and which or what data should be used for the project.

4.4.2 User Design Phase

In this phase, the researchers collaborated with users (who we conducted surveys on) to ensure that their conditions are addressed at every stage of the design process. Similar to custom software development, in which users may evaluate each product prototype at each level to verify it fulfills their needs. The researchers designed possible prototypes for the project. The researcher searched for important data that provided the project with an effective architecture and project design. To achieve a more user-friendly design, the researchers designed the project using light materials, making sure that the UV-C light is installed securely and ensuring that the case or the box is strong enough to withstand the other components.

4.4.3 Construction Phase

This is the stage at which all designs are converted into machine-readable code. The code was done with future enhancements and system dependability in mind. The Complete Project was tested to ensure that it meets both functional and non-functional criteria. To ensure error-free machine and component integration, each component of the program was tested separately.

The testing activity includes the involvement of the users and the project. During this activity, the project was tested in the Biology Laboratory of the Western Mindanao State University – College of Science and Mathematics.

The testing log included tested items, expected action or value and remark criteria. The testing in this study was based on actual data to determine the project's performance in a real-world working environment. The test reports were properly documented throughout this phase.

4.4.5 Cutover

The effect of the project on the project development is discussed at this stage of the research. The new project was reviewed to measure the project's performance. The feedback of the project was analyzed, and was acknowledged as an input to the next step. And lastly, decisions were made on the project's implementation in project development.

CHAPTER 5

DEVELOPMENT AND TESTING

5.1 Description of Prototype

The team created a Prototype to help the team visualize how the device should look like. The prototype is made up of Carton Cardboards with corresponding buttons and we integrate it with used materials, and we put the UV light inside the handmade prototype.

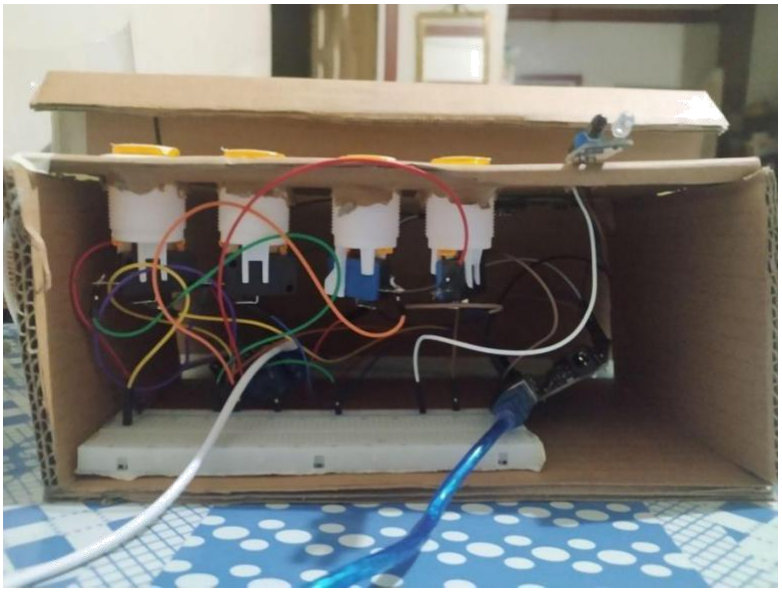


Figure 5:1: Actual Design of the Project

The prototype shown depicts the initial UI plan where there will be two boxes: 1 for the disinfection area and the other 1 is where the hardware components build up. Buttons, LCD and the IR sensor are located at the top of the hardware box for easier navigation and monitoring on the screen. The two boxes are packed together so that they will be carried as one and for easier handling.

5.2 Development

The development of the Arduino Disinfection Device With UV-C Light for Materials and Objects and the procedures that were used to achieve the objectives of the study are as follows:

5.2.1 Design Stage

In this stage, several parameters were tested in order to achieve a successful output. The presentation of the project's design layout was one of these factors. The proponents used manual operation, and the design was developed after comprehensive system considerations and preparations.

5.2.2 Fabrication Stage

At this stage, the fabrication of the prototype was done. Fabrication was based on the design and material specifications of the said project that are only available during the designing stage.

5.2.3 Preliminary Testing Stage

The design of the project was established by preliminary testing. It was conducted in order to identify if all the components of the machine are functioning properly or damaged.

5.3 Testing

Preliminary testing was done to determine the project's final design. It was conducted in order to identify if all the components of the project are functioning properly.

Preliminary testing was conducted to evaluate the prototype's performance and evaluate if it is performing as expected. It completed the following tests: unit testing, integration testing, system testing, and end-user evaluation.

5.3.1 Unit Testing

The researchers conducted a test for the UV-C light and buttons function of the device. The button function triggers and sends data commands to the Arduino and gives instructions to the relay module that turns on and off of the UV-C light. Another function for IR sensors is to have a minimum centimeter to trigger the sensor, and the next test is to use the sensor to determine the distance of the person from the device. The final test was to determine the accuracy of the sensor to send the command on to the Arduino and make the light bulb turn off.

5.3.2 Integration Testing

To verify whether the units are working and whether the software is compatible with the hardware, the researchers performed a test wherein it installed the software Arduino IDE, which helped us determine whether there are bugs present in the software produced or if there was a faulty material in the system.

5.3.3 System Testing

After the program has been completed and installed in the Arduino UNO, a device testing was conducted by the researcher to verify whether the final product works properly and has the functionalities defined in the documentation. This test was intended to ensure that the finished product can be transported to where it will be used.

5.3.4 End-User Testing

The tester performed a graded test to ensure that the device followed the specified solution to the problem of bacteria present in an object. The tester assessed the difference

in bacterial growth of the object before and after it was placed under the UV-C light using a microscope. There was a significant difference in bacterial growth, indicating that the final determination is whether the device is approved by the end user.

5.4 Implementation Plan

5.4.1 Introduction

This section discusses the implementation of the project. It provides technical information about the project, including the design and the structure of the project.

5.4.2 The project

On May 25,2021, the team installed the Arduino project (disinfecting objects with UV Light) at Mr. Elvin Rey Saavedra's residence to test the initial hardware components.

And on May 27, 2021, the effectiveness of the UV-C light was tested at the WMSU-CSM Biology laboratory for the accuracy rate.

5.4.3 Scope

The implementation of the project is to provide the user with an efficient project that would keep the materials/objects at least 20% clean and uninfected from bacteria and viruses.

5.4.5 Methodology

The programmer collaborated closely with the project manager and tester. This ensured that the software's implementation went smoothly.

5.4.6 Action plan

The table below shows the milestones during the development of the project:

Table 5.4.6: Action Plan Table

Action	Assigned to	Deadline	Progress
Finalize all necessary tools needed in project	DamharPahalawan	May 1, 2021	**Done**

Schedule the implementation process	Elvin Rey Saavedra	May 10, 2021	**Done**
Running the project properly	Elvin Rey Saavedra and DamharPahalawan	May 20,2021	**Done**
Final Preparations, checking, and testing the project functionality	DamharPahalawan and Dominique Eijansantos	May 25, 2021	**Done**

Figure 5.4.6: Action Plan Table

CHAPTER 6

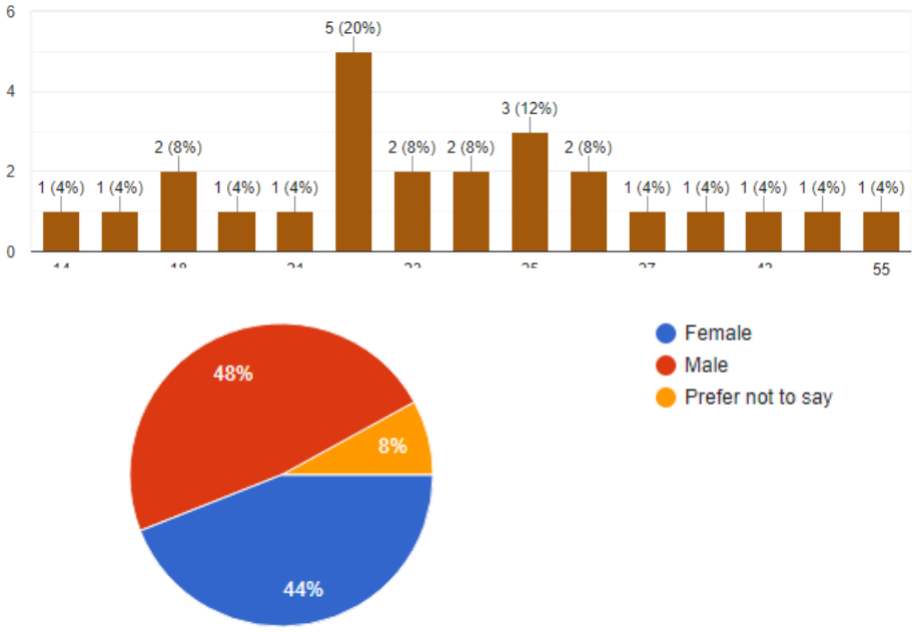
Analysis, Presentation and Interpretation of data

6.1 Introduction

This chapter shows the result of the study of UV-C Light as a Disinfectant for Materials and Objects as perceived by twenty-five (25) selected fourth year students of Western Mindanao State University who are taking up Bachelor of Science in Information Technology for the school year 2020-2021.

The analysis, presentation, and interpretation of the study's findings are presented in this chapter. The data is based on the results of the questionnaire dealt with quantitative analysis data.

6.1.1 Age and Sex of the Respondents



Figures 6.1.1: Respondent's Age and Sex Chart

Respondents from ages 14 to over 55 were represented, with slightly larger numbers in the lowest age bracket, 18-25 and 27-55 categories accounting for 5 (20%) and 3 (12%) of the respondents, respectively (Table 4.1). The respondents' sex orientation was collected also and there were 12 males (48%), 11 Female (44%) and there were 2 (8%) who preferred not to say their gender. The need to gather the age corresponds to the specific objectives for observing the security measured by IR sensors. It depends on their age whether they are fully aware of the UV-C radiation.

6.1.2 Usability of the Project

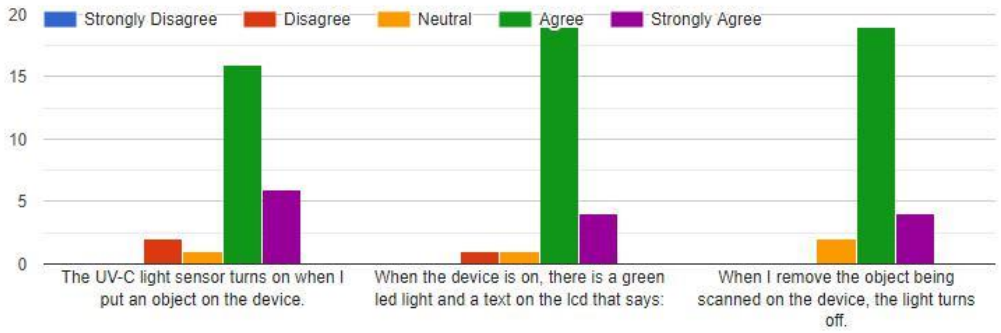


Figure 6.1.2: Usability Bar Graph

The findings of this study showed that the majority of the respondents agreed to the usability of the project, specifically the UV-C light on and off and the IR sensors that are detected if there is someone nearby. This is subject to the specific objectives of integrating the UV-C and the integration of the IR sensor is fully functional. Hence, the project's usability has garnered a 95% total satisfaction for the project's usage. The number exceeds the researchers' expectations for its development.

6.1.3 Design of the Project

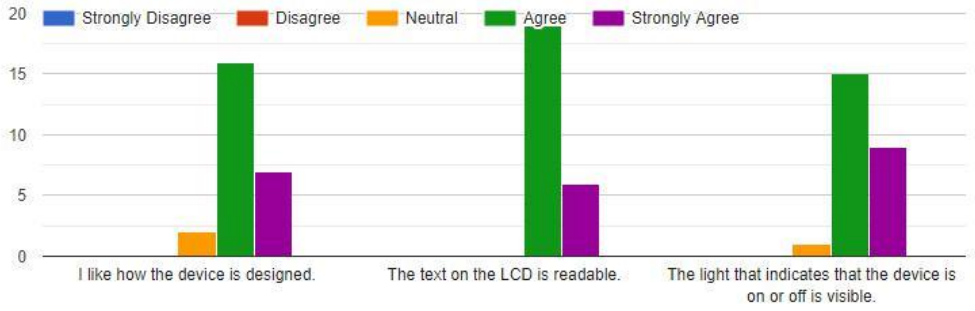


Figure 6.1.3: Design Bar Graph

Studies shown above show that they are quite fond of the design and the visibility of the LCD monitor. Out of 20 respondents, 16 (69.56%) agree and 7 (30%) strongly agree with how the device is designed. The next graph shows that 83% were able to read properly on the LCD monitor. The last graph shows that the light indicators were visible, which gives about 90%. In accordance with the specific objectives in the design approach on how the system gives feedback from the user. The percentile satisfaction gave the researcher an idea on how the design had a greater impact for the project. Wherefore, this will help to fully analyze on how to improve the design of the project more and innovatively.

6.1.4 Navigation of the Project

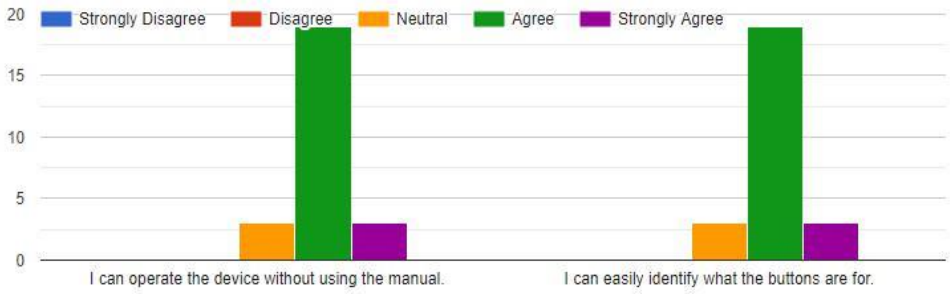


Figure 6.1.4: Navigation Bar Graph

The chart shows that the navigation process of operation and identifying the use of buttons in the project agrees with the respondents. 91% said they could operate it without consulting a manual, and 91% said they could easily identify the buttons. Based on the specific objectives that incorporate the push buttons for the navigation process, these statistics placed a high value on how useful the buttons are. Overall navigation percentage gave a normal statistic, by this it can be helpful to improve the navigation status of the project in the next thorough investigation. But nonetheless still it is in a good percentile so the researchers concluded that the project is in good condition.

6.1.5 Overall Project

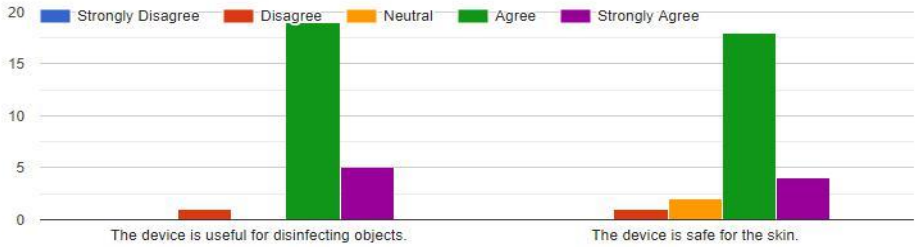


Figure 6.1.5: Overall Satisfaction of the Project Bar Graph

Overall, the device is useful for disinfecting objects, and we learned from the respondents that they are safe from radiation to the skin. That is 95% safe for skin, with 18 agreeing and 4 strongly agreeing and 96% agreeing and strongly agreeing about the effectiveness of the device.

6.1.6 Effectiveness of the Project on disinfecting Bacteria and other Pathogens

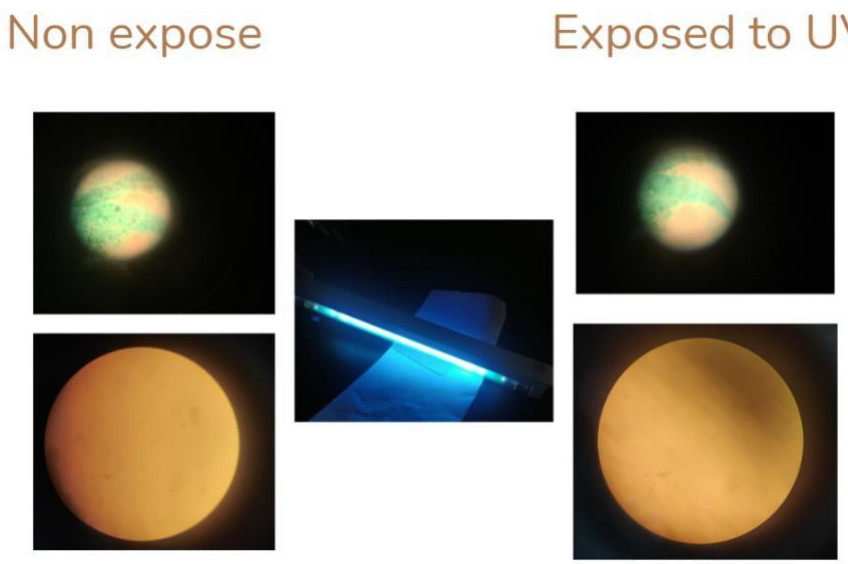
Healthcare related diseases caused by pathogens and other bacteria significantly associated with the increase of mortality and morbidity based on Journal of Microbiology, Immunology and Infection (June 2019, Pages 487). Cleaning and disinfection are very

important to reduce the transmission of these pathogens. These led to this study to furthermore study the effectiveness of the UV-C as a disinfectant tool. The effectiveness of the UV-C can be determined by using a microscopic lens because bacteria and pathogens are not seen through the naked eye. In that way, we can be sure that using UV-C as a disinfectant tool can be justified.

To fully test the efficacy rate of the project in reducing pathogens the team held an experiment by using sample of microbes from the Biology Department of Western Mindanao State University College of Science Mathematics with the help of Mr. Ochotorena, and Mrs. Balolot, who assisted the team in using the Microscope.

The findings of the experiment conducted last May 27 2021 shown below:

Figure 6.1.6: Microscope Findings



As shown in the figure 6.1.6, the sample microbes from the biology department were tested before exposing the substance to the project's device and exposing the substance to the project's device. As per analysis by Mrs. Balolot, almost 95% percent of microbes died after exposing the substance to the UV-C.

6.1.6.1 Recommended Time Exposure for the Some Common Gadgets and Materials

Based from the research we conducted these are the recommended time frame for disinfection:

Recommended Time Exposure		
Type ofGadgets/Materials	**Time Exposure**	**Source**
Cell Phone, iPad, Tablets	7 min	nbcnews.com
Face Mask	5 min	bioline.org.br
Cloths	5 min	bioline.org.br
Earphones	3 min	bioline.org.br
Laptops	10 min	nbcnews.com
Pens, Pencils	2 min	bioline.org.br

Table 6.1.6.1: Recommended Time Exposure

These are the common materials and objects that need to be disinfected in the present situation. Based on the source the time exposure varies depending on the type of objects or materials. This will help the users to be fully aware of the duration of what they want to disinfect.

CHAPTER 7

Summary of Findings, Conclusion and Recommendations

7.0 Introduction

This chapter concludes the study by dealing with a summary of findings, conclusions and recommendations of the project.

7.1 Summary of Research Findings

7.1.1 Age and Sex of the Respondents

Respondents of all ages were represented in the survey. From the findings of the study. The extent to which kids are conscious of UV-C light is dependent on their age; this results in successfully installing the security measures by using IR sensors to pause the disinfection process if there will be nearby presence present in the device.

7.1.2 Usability of the Project

The usability of the project has received a 95 percent overall satisfaction rating. The number much exceeds the researchers' predictions for its growth. It depicts the quality of the UV-C as a disinfectant and on how the users handle the device.

7.1.3 Design of the Project

Out of 23 respondents 16 (69.56%) agrees and 7 (30.44%) strongly agrees to how the device is designed. 83% were able to read properly on the LCD monitor. These findings depict that the design perspective of the project is much more conveniently good for some users and they can easily notice and detect what are the functionalities that they need to do. Results of the study demonstrated that some respondents are not satisfied with their current disinfection method used, because some of the respondents doubted whether their disinfection method is effective or not. Some of the respondents are satisfied because they are confident that their disinfection methods are effective and can really reduce bacteria/pathogens on surfaces/objects.

7.1.4 Navigation of the Project

The project’s navigation is in good shape, based on the findings. 91% stated they could operate it without consulting a manual, and 91% said the buttons were easy to recognize. The overall percentage of navigation yielded a normal result. This led to the

finding that the device is safe from radiation to the skin and also the device is fully functional and not having hardware component irregularities.

7.1.5 Effectiveness of the Project on disinfecting Bacteria and other Pathogens

After conducting an experiment on our UV-C Light in the Biology Department of Western Mindanao State University College of Science Mathematics last May 27 2021 because germs and pathogens cannot be seen via the UV-C, its effectiveness can be tested using a microscopic lens. As per analysis by Mrs. Almost 95% percent of microbes died after exposing the substance to the UV-C. This led to the final overall project that the device is useful and effective in reducing pathogens and bacteria.

7.2 Conclusion

This research has come to a conclusion that based on the findings in chapter 6; the team has successfully developed an Arduino project that can successfully disinfect and sterilize objects using UV-C light. With an integration of the IR sensor, the machine can detect if there is a human presence in front of the project, the UV-C Light will turn off automatically since the UV-C Light is harmful to the skin. The machine also has a secured box to prevent the UV-C Light being leaked outside the box. The machine has also successfully integrated push buttons that will set a timer so the user does not have to monitor the disinfection process while the device is running since it will turn off automatically based on the time being set. The machine has also integrated a screen i2c LCD that will display the time being set by the user, so the user will know the remaining time has been left on disinfecting their objects/goods.

7.3 Recommendations

Recommendations for future planning and implementation are as follows:

- Some of the respondents recommended the material used to develop the project, they recommended that the researcher should improve the design and suggested to use metal/plastic as a protective cover.
- Some of the respondents recommended that the researcher should use an alternative power source such as a power bank or rechargeable batteries.
- Some of the respondents recommended that the researcher should improve the design, especially the color of the box, some of the respondent says that the color of the box looks so simple and plain and they recommend the team to paint it in to white or blue.
- Some of the respondents also recommended using a glass as the cover of the project so they can confirm if the UV-C Light is really working and they could also see the processing when disinfecting an object/surface.

- Since the project can only disinfect small objects such as keys, masks, phones, some of the respondents recommend making the size of the box a little bit bigger so the user can disinfect bigger objects like bags, caps, or shoes in the project, and according to some of respondents, with a bigger box (where the team put the objects/goods to disinfect) the user can disinfect a lot of objects/goods at the same time.
- Some of the respondents recommend using a secured lock on the box so if some toddler or a child tries to open the box, it will not be easily opened.

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UV-C light

https://www.genengnews.com/topics/translational-medicine/uv-light-that-is-safe-for-humans-but-bad-for-bacteria-and-viruses/#:~:text=Scientists%20have%20known%20for%20decades,that%20hold%20their%20DNA%20together.

APPENDICES

APPENDIX A

A. Survey Questionnaire

SURVEY QUESTIONNAIRE

This questionnaire is intended to collect data about how the citizens of Zamboanga City sterilize or disinfect their goods or materials. The data collected will be used as the basis for the researchers' CAPSTONE project. All information gathered will be kept confidential by the researchers.

Name (Optional):

Age:

Instructions: Please respond to the following questions by placing a check mark (✓) in the answer box that corresponds to your response. If your answer is not on the choices provided, you may write them under "*Others*".

1. How do you currently disinfect your goods/gadgets/surface? (Please check all that apply)

   ☐ Household disinfectant sprays (Lysol, Clorox, Purell, etc.)
   ☐ Baking Soda
   ☐ Dryer Sheets
   ☐ UV Light
   ☐ Disinfectant wet wipes (Lysol wipes, Wet Ones, etc.)
   ☐ Water based solutions (baby wipes, alcohol or vinegar solutions)
   ☐ I do not clean my goods/gadgets/surface

2. How did you come to the cleaning method you're currently using?

   ☐ General knowledge of cleaning products

APPENDIX B

B. Evaluation Form

SYSTEM EVALUATION

NAME: _____

This evaluation form is intended to collect information and feedback about the (name of system). The data collected will be used as a basis for improvement for the researcher's CAPSTONE project.
All information gathered will be kept confidential by the researchers.

Instructions: Please respond to the following questions with a check (✓) in the boxes that correspond to your answer.

Part I. Usability	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. The UV-C light sensor turns on when I put an object on the device.					
2. When the device is on, there is a green led light and a text on the lcd that says:					
3. When I remove the object being scanned on the device, the light turns off.					
4.					
Part II. Design	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. I like how the device is designed.					
2. The text on the LCD is readable.					
3. The light that indicates that the device is on or off is visible.					

Part III. Navigation	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I can operate the device without using the manual.					
2. I can easily identify what the buttons are for.					
Part IV.Overall	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. The device is useful for disinfecting objects.					
2. The device is safe for the skin.					
3. I would recommend this system.					

CURRICULUM VITAE

A. Elvin Rey Saavedra

ELVIN REY SAAVEDRA

GET IN CONTACT

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Mango Drive, Sta. Maria , Zamboanga City , Zamboanga Del Sur , Philippines, 7000

PERSONAL PROFILE

A Web Programmer design and update websites and online applications using various programming languages and design tools

WORK EXPERIENCE

WEB PROGRAMMER

Debug.Go | 2019 – Present
- Design the architecture of the components of an application.
- Created Website Using ReactJS , ExpressJS and NodeJS.

AREAS OF EXPERTISE

- Hands-on SQL experience
- Java and JavaScript and NodeJS
- VB.NET, Web API experience,React Native and ReactJS
- Working knowledge of C++ and C#

EDUCATION HISTORY

WESTERN MINDANAO STATE UNIVERSITY

Bachelor of Science in Information Technology, 2017-2020
- Auditor, WMSU-Philippine Society of Information Technology Students
- Representative of Gender Club Institute of Computer Studies

Bachelor of Science in Mathematics, 2015-2017

DON PABLO MEMORIAL HIGH SCHOOL

Graduated Class of 2015.

OTHER SKILLS

- The ability to analyze complex technical information
- Can analyze, design and implement database structures
- Detail oriented
- Excellent problem solver

REFERENCE

Mr. Salimar B. Tahil
Instructor,WMSU
Co-Lead GDG Zamboanga
Moderator, DSC Crimson
+6391-7177-7654

ACHIEVEMENTS

UnionBank U:Hackademia Hackathon 1st Placer
UnionBank, KCC, PLDT, Zamboanga ICT Council
October 11-12, 2019

Google Developer Student Clubs Crimson External Vice-President

B. Pahalawan, Damhar

DAMHAR KARING PAHALAWAN

IT PRACTITIONER

PERSONAL INFORMATION

NATIONALITY: Filipino
GENDER: Male
CIVIL STATUS: Single
DATE OF BIRTH: September 19, 1997
PLACE OF BIRTH: Isabela City, Basilan, Philippines

ACADEMIC HISTORY

Western Mindanao State University
BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY
June 2017 - PRESENT

Western Mindanao State University
BACHELOR OF SCIENCE IN MATHEMATICS
June 2015 - March 2017

Claret School of Lamitan
SECONDARY
June 2011 - March 2015

Jose Rizal Elementary School
ELEMENTARY
June 2005 - March 2011

HONORS AND AWARDS

Microsoft Certified Technology Special
2018

Most Outstanding Youth Leader
2015

Class Salutatorian
2011

Outstanding Boy Scout of the Philippines
2010

OBJECTIVES

A youth leader, volunteer and a tech advocate, inquisitive, energetic IT specialist skilled leadership, with a strong foundation in math, logic and cross-platform coding. Seeking to leverage social skills in collaboration, communication, and development as a tech specilist.

CONTACT INFO

Personal Phone: 975 3944 850

Email: damhar.pahalawan@gmail.com

Address: Barangay Sabong, Lamitan City, Basilan Province, Philippines, 7000

AREAS OF EXPERTISE

Data Protection
Hands on SQL
Microsoft Office
PC Troubleshooting
Adobe Photoshop

C. Eijansantos, Dominique

DOMINIQUE KAYE EIJANSANTOS

PROFILE

Hardworking Student seeking employment. Ready to use my skills and passion further the mission of the company. Technologically savvy, experienced with many social media platforms, office technology
programs, and advanced computer skills. With a positive attitude and the willingness and motivation to learn new programs.

OBJECTIVES

I seek challenging opportunities where I can improve and fully use my skills for the success of the organization.

CONTACT

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Allysa Vance Baguio
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+639-953-272-071

Salimar B. Tahil
Faculty, ICS
DSC Crimsons
Moderator

EDUCATION

WESTERN MINDANAO STATE UNIVERSITY
Bachelor of Science in Information Technology
2015-Present

MANICAHAN NATIONAL HIGH SCHOOL
2011-2015

WORK EXPERIENCE

DEBUG.GO ZAMBOANGA CITY
Front End Developer
2020-Present
Debug.Go is an IT Company that leading IT staffing, IT talent and an IT services firm. As a front-end developer, my core activities include: -Recommending a new user-friendly interface with the design team. -Debugging.
-Creating a new features and functionality.
-Ensuring proper documentation and reports.

SKILLS

+63917-177-1654
Google Slides
MS Excel
Programming
MS Word
Document Processing
PC Troubleshooting