Effect of Automatic Disinfection Box Using Ultra Violet Light on Microbial Growth of Microorganisms

John Christopher B. Bagas[1], *, Charles Adriane S. Guerrero[2], Marcus M. Saralde[3]

[1]Department of Computer Engineering/ Research Institute for Science and Technology, Polytechnic University of the Philippines, Philippines (John Christopher B. Bagas, Charles Adriane S. Guerrero, Marcus M. Saralde)
[2]Department of Computer Engineering/ Research Institute for Science and Technology, Polytechnic University of the Philippines, Philippines
[3]Department of Computer Engineering/ Research Institute for Science and Technology, Polytechnic University of the Philippines, Philippines (Engr. Jonathan C. Manarang, Engr. Pedrito M. Tenerife Jr.)

ABSTRACT

Researchers aim to determine the effectiveness of ultra violet lights in disinfecting using an automatic disinfection box. Researchers ought to find the significant difference for disinfecting between UV-based disinfectant and alcohol-based disinfectant, the significant effect of UV intensity, and the difference among the different duration in terms of its effectiveness. Researchers conduct streak plate and spread analysis on four similar pens under normal condition. Effectiveness of UV based and Alcohol based disinfectant were measured based on number of colonies in different treatments. Different treatments were replicated thrice and were compared to a baseline treatment wherein the agar plate was not exposed to UV or Alcohol. Gathered data are analyze using Two-sample & one-sample Wilcoxon test and Kruskal-Walis test. Four-point Likert scale are use to describe the device in terms of necessity, quality, price-quality ratio and approval. Results revealed that the baseline treatment was relatively higher compared to Alcohol based and UV based treatments. This suggests that Alcohol based and UV based disinfectant were more effective in terms of bacterial inhibition. Study shows that there is enough evidence to conclude that UV and Alcohol based disinfectant exhibit no significant difference when it comes to their effectiveness, UV intensity has a significant effect in terms of effectiveness, the different durations (10, 20, 30 seconds) of UV exposure show no significant difference in terms of effectiveness. Responses shows that the automatic disinfection meets current pandemic situation extremely well, has a very high quality, in terms of price has an above average value for money and the respondents are very satisfied using the device. The researchers recommend develop a real-time UVC dosage monitor module that shows the current UVC dosage of the device producing and a proper item counter.

1. INTRODUCTION

In December of 2019 in Wuhan, China, an outbreak occurred due to the spread of the Novel Coronavirus. The virus spread at rapid rate and infect many people. Causing a great number of hospitalizations and casualties. The virus spread through-out the globe and recognized as global pandemic affecting more than 220 countries (Worldometer, 2021).

According to Kodoth et. Al. (2020), the society need to be cautious of other dangerous microorganisms that spread illness in addition to viruses. Humans are constantly in contact with germs and bacteria. Many surfaces and objects we come in contact with every day are covered in microorganisms that are potentially harmful to normal people with normal immunity. When poor hygiene habit is practiced,

microorganisms can be passed from person to person (Francisco, 2022). These could potentially cause sickness and may escalate to something serious.

The Coronavirus cause a significant impact on disinfectant industry. Sudden rise in demand for sanitizers and disinfectant as a preventive measure against the virus has change the dynamic of the market (Reports and Data, 2020). The disinfectant demand imposes a challenge and concern to supply chain.

According to NationalAcademies (2021), ultraviolet lights specifically UVC, have the trait to inactivate SARS-CoV-2 and shows effectivity against reducing germs and inhibits microbial growth (Francisco, 2022). Cognizant of the growing problem, the researchers develop and design an automatic disinfecting box with UVC lamps as treating agent to disinfect materials and objects.

1.1 Scope and Delimitation of the Study

The device will have a dimension of 72cm in height, 84cm in length, and 54cm in width. The entrance clearance of the frame will have a dimension of 68cm in height and 78cm in width. The device will have a PIR sensor to detect if and object is ready inside the device.

The study will be limited to the comparison of effectiveness of ultraviolet-based disinfection with alcohol-based (70% alcohol content, isopropyl) disinfection, determining if there's a significant effect of ultraviolet intensity to be use in terms of its effectiveness, determining the significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness, and determining the overall user rating of the device in terms of necessity, quality, price-quality ratio and approval.

The study will be limited to the effect of automatic disinfection box using ultra violet light on microbial growth of microorganisms, not determining the microorganism that grow on the nutrient agar, and not determining the UVC dosage and irradiance of the automatic disinfection box.

The study will not cover the comparisons of effectiveness of ultraviolet-based disinfection and specific brands of alcohol. The study will not cover the comparisons of the effectiveness of ultraviolet-based disinfection and different alcohol content (beside 70% alcohol content) of specific brands of alcohol.

1.2 Significance of the Study

The Corona Virus Disease 2019 pandemic has increased the need for human disinfection. It is important to avoid reducing transmission risk. Thorough and efficient disinfection procedures must be implemented to return to our day-to-day operations cost-effectively.

Humans are constantly in contact with germs and bacteria. Many surfaces and objects we come in contact with every day are covered in microorganisms that are potentially harmful to normal people with normal immunity according to Kodoth et. Al. (2020).

When poor hygiene habit is practiced, microorganisms can be passed from person to person (Francisco, 2022). These could potentially cause sickness and may escalate to something serious.
Cognizant of the growing problem of stress, this study will be significant to the following:

To the Users. Reduce potential risk of illness by promoting good hygiene practice and limiting your exposure to others' germs critical for the user's wellbeing. UV sterilization on objects effectively destroys bacteria and molds such as mites, E. coli, mucor, staphylococcus aureus etc.

To the Users Groups/Workmates. At the workplace, in the classroom, or in any space with heaps of foot traffic, germs spread rapidly, reduce transmission risk by destroying microbial growth on surfaces and inhibits from passing from one person to another. Eliminate germs occasionally for the duration of the day without leaving their study hall or work area. Eliminates harmful microorganisms from inanimate objects and surfaces such as documents, bags, parcels, etc.

To the Environment. This study recognized its unique position to help fight COVID-19 by and destroy microbial growth on microorganisms using its produce disinfection feature to disinfect. The Automatic Disinfection Box is a reusable disinfection device. This feature aids the environment by reducing plastic wastes from alcohol and sanitizer containers, the device promotes cleanliness and germicidal sanitizer prevents formation or reproduction of future causing disease.

To the Future Researchers. This study readily permits and encourage innovations. The study leads and inspires the future researchers to innovate disinfection technologies. The current researchers encourage the future researchers to rally this technology due to current pandemic.

2. METHODOLOGY

2.1 Research Design

The researchers use quantitative experimental research design for statement of the problem 1, 2 and 4 in the study. According to Bhandari 2021, quantitative experimental research systematically tests causal relationships, collect and analyze numerical data and generalize results. Qualitative research design is used for statement of the problem 3. According to Acasestudy (2020)," Qualitative research targets on conveying meaning and comprehension via detailed description". The research designs will be used in the study.

Two-Samples Wilcoxon Test, One-Sample Wilcoxon Test, Kruskal-Walis Test, Four-point Likert scale are used for the statistical analysis of the study. Spread plate and streak plate microbiological culture technique are used in the field experiment. The alcohol sample for the experiment is 70% isopropyl alcohol.

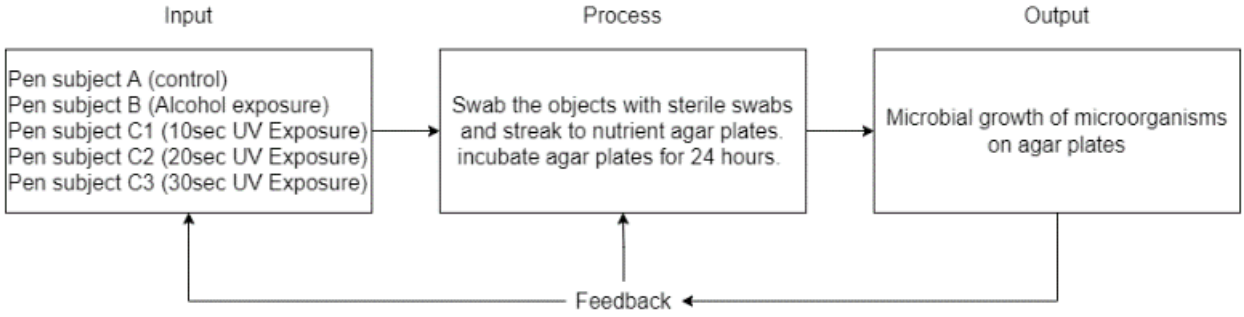


Figure 2.1.1. Conceptual Framework

The researchers lead up to the following hypothesis. There is no significant difference between ultraviolet-based disinfectant and alcohol-based disinfectant in terms of their effectiveness. There is no significant effect of ultraviolet intensity to be use in terms of its effectiveness. There is no significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness. The automatic disinfection box does not meet current pandemic situation extremely well. The automatic disinfection box has a very low quality. The automatic disinfection box in terms of price has a poor value for money. The respondents are very dissatisfied using the automatic disinfection box.

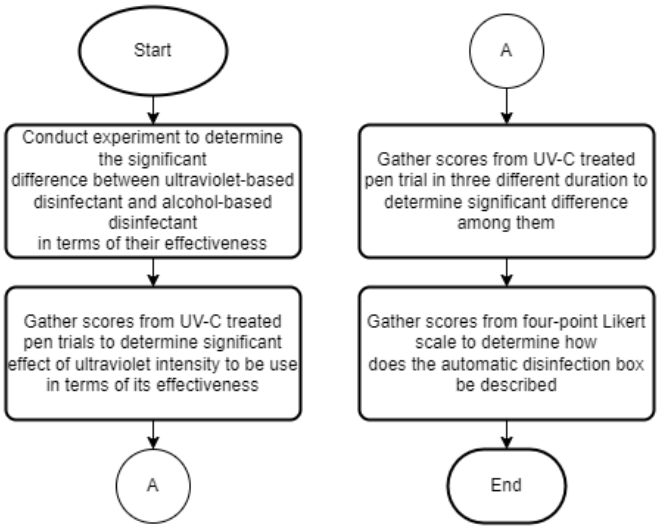


Figure 2.1.2. Research Design Flowchart

2.2 Data Gathering

The data for the statement of the problem number three are collected using a google form survey questionnaire after the device is implemented. The survey questionnaire created have questions modified from related research formed by the researchers. The survey covers the necessity, quality, price-quality ratio and approval. The survey was conducted for one month and the researcher's assured confidentiality of their survey since the identities are not a requirement. The gathered data are used for the research after analyzing the survey answers.

The model development stage consists stages of modeling, design and analysis. The researchers study different sanitation chamber, ultra violet chamber and sanitation device. The researchers ponder that the chamber must have the capability and strength to hold and sanitize objects with size of at least 50cm in height and width. After studying different sanitation chamber models and considering the researchers requirements, the researchers come up with the following model dimension.

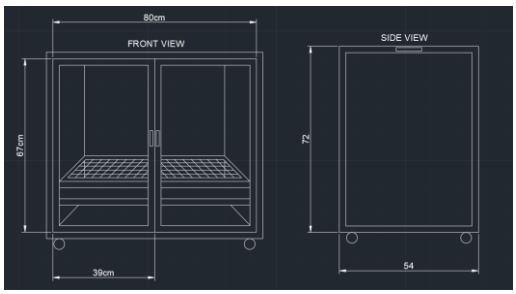
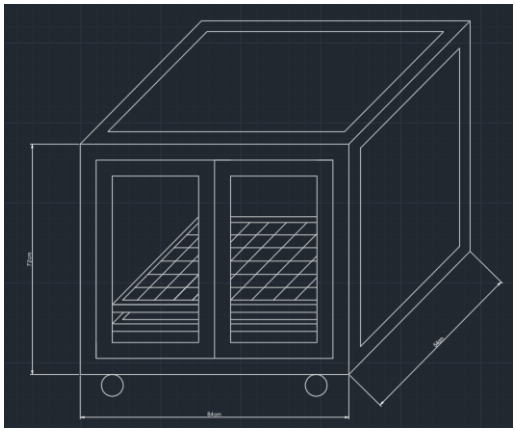


Figure 2.2.1. Front and Side View of the Device

Figure 2.2.1. 3-Dimensional View of the Device



The researcher's requirement must have also that the device is mobile and have the capability to move around effortlessly. the device must also have the capability to smoothly insert objects inside the chamber. The device must also conform to quality standards and have the capability to blend to commercial sanitation chambers in market. The researchers come up with the design in figure 14.

The design analysis data are gathered from the four-point Likert scale Specifically, how does the automatic disinfection box be described in terms of necessity, quality, price-quality ratio and approval.

2.3 Materials and Specifications

The following are the materials used for the disinfection box.

a) L- bracket or angle bar ¼ x 1 in size.
b) Galvanized steel sheet with measurement of 4x8 in 0.9 thickness.
c) Flat steel bars.
d) Nylon caster wheels (swivel).
e) Galvanized steel matting.
f) ¼ thick clear glass.
g) Stainless cabinet handle.
h) Cylindrical hinges 3/8.
i) Roller catches.
j) Glass silicone sealant.
k) Teks screw.
l) Reflective Insulation foam.
m) Rugby glue.
n) Aerosol paint color white and clear for coating

2.4 Detailed Procedure of Device Implementation

Angle bars with measurement each of 72, 84 and 54cm. are prepared using angle grinder. A welding machine is use to weld the pieces together into the shape of the frame.

Figure 2.4.1. Welding of Angle Bars

Having the rigid frame, the frame is turned upside down to weld the caster wheels on each corner of the frame as to give the frame maneuverability.

Figure 2.4.2. **Rigid Frame**

A 39 and 67cm angle bars are prepared using the angle grinder and welded into shape of a door frame.

Figure 2.4.3. Rigid Frame Upside Down

The door was fixed to the frame using cylindrical hinges. Roller catches are fixed onto the front top and bottom center of the frame.

Figure 2.4.4. Welding of Door Frames

After turning the frame upright, galvanized steel walls are cut and prepared. Using the welding machine, the steel walls are fixed onto the frame reinforcing with flat bars.

Figure 2.4.5 Attaching of Door Frames

Using a measuring tape to have the center of the door frame, two holes were drilled. The aluminum handle bars are screwed onto the frame. Using the same technique, two holes were drilled on the side of the frame and aluminum handle bars are fixed using screws onto the frame.

Figure 2.4.6. Steel Walls

Using the angle grinder, the frame was sanded off of sharp edges. After smoothing the frame, using aerosol paint, a white coat was applied inside and outside the frame.

Figure 2.4.7 Sanding of Rigid Frame

A clear coat was applied after drying of the primer. A two 49 and 81cm angle bar are prepared and welded into a shape of rectangle and galvanized wire mesh are cut accordingly to the dimension and welded onto the shape. The mesh, who serves as the object holder are coated with primer and clear coat also.

Figure 2.4.8. Applying Aerosol Paint

The wire mesh and the circuit chamber divider are fixed onto the inside of the frame using teks screw.

Figure 2.4.9 Mesh Panel

¼ inch thick clear glass are fixed onto the door frame using glass silicon putty.

Figure 2.4.10 Fixed Mesh Panel

Figure 2.4.11 Applying Silicon

Figure 2.4.12 Automatic Disinfection Box

2.5 Block Diagram

The figure below shows the block diagram of the circuit.

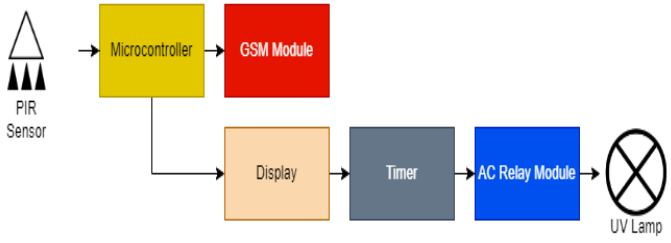


Figure 2.5.1. Block Diagram

2.6 Flow Chart

The figure below shows the flowchart of the circuit.

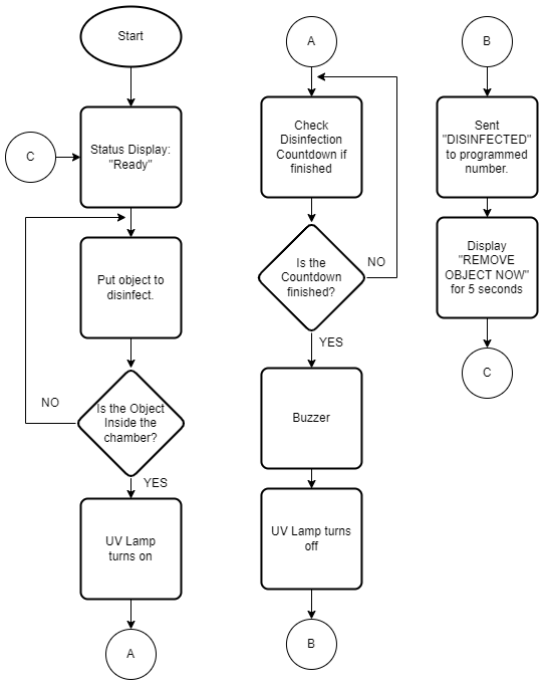


Figure 2.6.1. Circuit Flowchart

2.7 Component Analysis

The researchers' components of the proposed system are Arduino uno r3 for microcontroller board. AC relay module kit with outlet plug and wire for Arduino control of 220v AC load, 10 ohms and 100 ohms resistors, passive infrared sensor, a I2C LED display 16x2 IC2, GSM module, sim900 GPRS shield, wire, 5v power supply and Firefly Yellow Shield Antivirus and Germicidal UV Tube Set.

Arduino Uno R3 is a 14 input/output pinned microcontroller which has a 16-Megahertz ceramic resonator, USB connection, a power jack, an ICSP header and a reset button. This is a microcontroller that can be programmed and as such, can be the only microcontroller you will ever need in creating complicated systems.

Arduino Uno can only handle up to 5 volts and can malfunction when applied at a higher voltage, much more when using 220 AC volts into it. The AC Relay module kit helps the microcontroller to handle up to said voltage that is in the description of the module. In the module used in the project, the researchers specifically used a 220v AC load.

Resistors are static components that help regulate the current running in a circuit. The higher the resistance(ohms), the lesser the current(amp). In the project, the researchers specifically used 10 ohms and 100 ohms values of resistors.

Passive Infrared Sensors or PIR Sensors is used to detect an object that is in front of it and act as a switch to a circuit. It activates the circuit when the object is detected by the infrared. This is commonly used in automatically triggered lighting devices and protection systems. In the project, the

researchers used it as a detector for the object or item placed inside the chamber to automatically start the disinfection process.

LED Displays are displays that are commercially used in the market because of their efficiency and low-energy consumption. These displays are made up of a series of LED panels which contain LEDs that can be used in a variety of ways from providing light to sending a message. The researchers used a Grove, 16x2 LED display which can be programmed with the use of Arduino Uno and is used to display the status of the disinfection process.

GSM (Global System for Mobile Communications) Module is a chip that can be used to provide the option to send SMS (short messages service) messages in a system. This chip has an antenna to receive and send out transmissions and a slot for the sim card which will be used to send out messages to other devices. The sim900 GPRS shield is the specific model used by the researchers. Despite the small size of the model, this packs many features and is one of the latest models.
The circuit created by the researchers is connected by copper wires. Copper wires are most commonly used in circuits for its conductivity and these wires are covered by rubber for insulation.

Power supplies are components that supply power to at least one load. This is used to provide and regulate a consistent value of current to a load to avoid any inconsistency to the load that can cause complications and malfunctions for the load. The researchers used specifically a 5v power supply that is used to supply power to the Arduino Uno.

UV lights are lights that are capable of disinfecting surfaces within a prolonged period of time under a specific range of intensities. The researchers used Firefly Yellow Shield Antivirus and Germicidal UV Tube Set which has an intensity of 222 nm, operates at a 230 V at 60 Hz, and covers the range of 15 to 20 square meters.

According to felcostore (2022), the FYL201 disinfects, sterilizes, kills bacteria, germs and viruses, coronavirus, influenza virus, mites, anthrax, Hepa B, and dysentery bacteria. The FYL201 disinfecs e-coli, staphylococcus aureus, candida albicans, pseudomonas aeruginosa.

The FYL201 is a quartz lamp cap, filament core, mercury pill lamp type with a UVC length of 222nm. It has an operating voltage of 230V - 60Hz. With an 15-20 sqm coverage area and a dimension of 624 x 48 x 70mm (felcostore, 2022).

According to the Americanultraviolet (2022), Germicidal UVC lamps do not produce much heat and about the same as fluorescent lamps. fluorescent lamps don’t use resistance to emit light, they emit about 75% less heat than an incandescent bulb. As a result, they save energy and keep whatever room they’re in at a cooler temperature.

2.7 Schematic Diagram

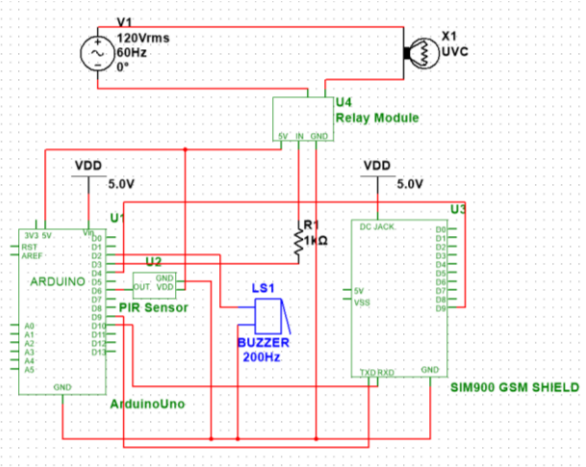


Figure 2.7.1. Schematic Diagram

2.8 Fabrication of the Device

Connect the GND pins of PIR Sensor, Buzzer, SIM900, and Relay Module to the GND pin of Arduino. Then, connect the source pin of PIR Sensor and Relay Module to the 5V pin of Arduino. After that, connect the TXD and RXD pins of SIM900 to pins 9 and 10 of Arduino respectively. Connect pin 2 of Arduino to the positive pin of the buzzer, then connect the OUT pin of PIR Sensor to pin 6 of Arduino. After that, connect the pin 9 of SIM900 to pin 4 of Arduino. And then connect the pin 3 of Arduino to a 1k resistor then connect the other end of the resistor to the IN pin of Relay Module. Lastly, connect an AC source to the relay module to power up the UVC lamp. The circuit is soldered in a printed circuit board and placed in the circuit box of the automatic disinfection box.

2.9 Field Experiment

To compare the effectiveness of alcohol-based and UV-based disinfection, Ms. Jerimi Francisco together with the researchers conduct streak and spread plate analysis on an empty sterile room in Camp Tinio, Nueva Ecija. Four similar pens are prepared a day before and equally exposed to normal condition. Nutrient agar is prepared by adding 17.5g of premixed nutrient agar and 482.5mL of distilled water to obtain 500g agar solution. The solution is mixed and bring to a boil. After 5mins of non-stop stirring, the pot is removed from the heat to cool poured the solution to jars and pressured cook for 45mins at 15psi. The jars are removed from the pressure cooker, let it cool to 50 C and poured to prepared petri dishes. Five agar plates with three replications are prepared. Agar plate A (control), plate B (Alcohol exposure), plate C1 (10sec UV exposure), plate C2 (20sec UV exposure) and plate C3 (30sec UV exposure).

For plate A, pen 1 is not exposed to alcohol and UV disinfection. Using sterile medical swab, pen 1 surface is swab. After the hardening of the agar, using streak plate method, the agar is swab with it. The plate is secured then with cling wrap. The same procedure is done with the replications.

Figure 2.9.1. Swabbing of Pen 1

For plate B, pen 1 is swab with sterile L-shaped rod, using the rod, agar plate is prepared using spread plate technique. After the hardening of the agar, four paper filter punchlets soaked in 70% isopropyl alcohol are put to the four quadrants of the agar (disk diffusion method). The same procedure is done for the replications.

Figure 2.9.2. Disk Diffusion on Plate B

Figure 2.9.3. Alcohol Punchlets on Plate B

For plate C1, pen 2 is disinfected using the automatic disinfection for 10 seconds. Using sterile medical swab, the surface of the pen is swab. The plate C1 is swab using streak plate technique. The plate is secured with cling wrap. The same procedure was done with the replications.

Figure 2.9.4. UVC Exposure of Pen 2

Figure 2.9.5 Swabbing of Pen 2

For plate C2, pen 3 is disinfected using the automatic disinfection for 20 seconds. Using sterile medical swab, the surface of the pen is swab. The plate C2 is swab using streak plate technique. The plate is secured with cling wrap. The same procedure was done with the replications.

Figure 2.9.6. UVC Exposure of Pen 3

Figure 2.9.7. Swabbing of Pen 3

For plate C3, pen 4 is disinfected using the automatic disinfection for 30 seconds. Using sterile medical swab, the surface of the pen is swab. The plate C3 is swab using streak plate technique. The plate is secured with cling wrap. The same procedure was done with the replications.

Figure 2.9.8. UVC Exposure of Pen 4

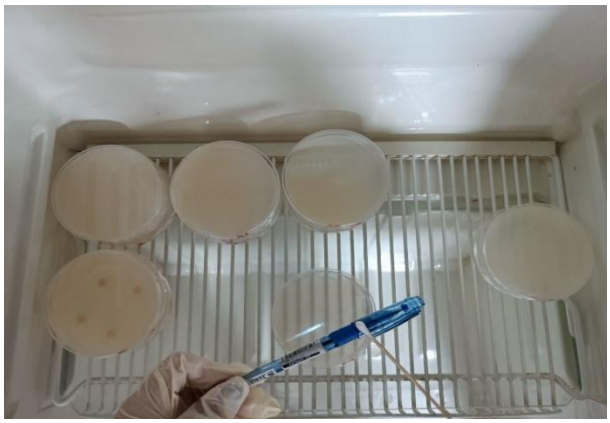


Figure 2.9.9. Swabbing of Pen 4

3. RESULTS AND DISCUSSION

All statistical analyses were performed using R Studio v 4.2.1 and all test of significance were evaluated at 5% level provided by Cuevas R. V. (2022). Effectiveness of UV based and Alcohol based disinfectant were measured based on number of colonies in different treatments. Different treatments were replicated thrice and were compared to a baseline treatment wherein the agar plate was not exposed to UV or Alcohol. Results revealed that the baseline treatment was relatively higher compared to Alcohol based and UV based treatments. This suggests that Alcohol based and UV based disinfectant were more effective in terms of bacterial inhibition.

Statement of the Problem 1. What is the significant effect of ultraviolet intensity to be use in terms of its effectiveness?

***Null Hypothesis*.** There is no significant effect of UV intensity to be use in terms of effectiveness.

***Alternative Hypothesis*.** There is a significant effect of UV intensity to be use in terms of effectiveness.

Result of One-Sample Wilcoxon Test.

```
        Wilcoxon signed rank test with continuity correction

data:  UV
V = 45, p-value = 0.008789
alternative hypothesis: true location is not equal to 0
```

Figure 33. **One Sample Wilcoxon Test**

Conclusion. Since the One-Sample Wilcoxon Test resulted a p-value of 0.0088, and is less than 5% level of significance (0.05), it was therefore concluded that UV intensity has a significant effect in terms of effectiveness. This result supports the comparison of findings of Baseline treatment and UV based treatments in terms of bacterial inhibition since number of colonies from UV based treatments were lower than those from the former.

Statement of the Problem 2. What is the significant difference among the different duration in terms of its effectiveness?

***Null Hypothesis*.** There is no significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness.

***Alternative Hypothesis*.** There is a significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness.

Result of Kruskal-Walis Test.

```
        Kruskal-Wallis rank sum test

data:  colony by group
Kruskal-Wallis chi-squared = 3.0175, df = 2, p-value = 0.2212
```

Figure 34. **Kruskal-Walis Test**

Conclusion. Since the Kruskal-Walis test yields a p-value of 0.2212, and is greater than 5% level of significance (0.05), therefore, the different durations of UV exposure show no significant difference in terms of effectiveness.

Statement of the Problem 3a. How does the automatic disinfection box be described in terms of necessity, quality, price-quality ratio, and approval?

Statistical Analysis of Responses in terms of Necessity.

The following table shows the statistical mean of the responses.

Response Mean in terms of Necessity

Survey Question	Weighted Mean	Verbal Description
How well does the device meet current pandemic situation needs?	1.36	Extremely Well

In terms of necessity, the mean value of 1.36 falls under the statistical range of 1 – 1.74 with the verbal interpretation of Extremely Well.

Statistical Analysis of Responses in terms of Quality.

The following table shows the statistical mean of the responses.

Table 3

Response Mean in terms of Quality

Survey Question	Weighted Mean	Verbal Description
How would you rate the quality of the device?	1.43	Very High Quality

In terms of quality, the mean value of 1.43 falls under the statistical range of 1 – 1.74 with the verbal interpretation of Very High Quality.

Statistical Analysis of Responses in terms of Price-Quality Ratio.

The following table shows the statistical mean of the responses.

Response Mean in terms of Price-Quality Ratio

Survey Question	Weighted Mean	Verbal Description
With a price of 9,500 PHP, how would you rate the value for money of the device?	2.15	Above Average

In terms of price-quality ratio, the mean value of 2.15 falls under the statistical range of 1.75 - 2.49 with the verbal interpretation of Above Average.

Statistical Analysis of Responses in terms of Approval.

The following table shows the statistical mean of the responses.

Response Mean in terms of Approval

Survey Question	Weighted Mean	Verbal Description
Overall, how satisfied or dissatisfied are you using the device or if you use the device?	1.49	Very Satisfied

In terms of approval, the mean value of 1.49 falls under the statistical range of 1 – 1.74 with the verbal interpretation of Very Satisfied.

Statistical analysis of Statement Problem 3.

The following table shows the summary of the statistical mean of the responses.

Overall Survey Question Response Mean

Statement of the Problem	Corresponding Survey Question	Weighted Mean	Verbal Description
How does the automatic disinfection box be described in terms of necessity?	How well does the device meet current pandemic situation needs?	1.36	Extremely Well
How does the automatic disinfection box be described in terms of quality?	How would you rate the quality of the device?	1.43	Very High Quality
How does the automatic disinfection box be described in terms of price-quality ratio?	With a price of 9,500 PHP, how would you rate the value for money of the device?	2.15	Above Average
How does the automatic disinfection box be described in terms of Approval?	Overall, how satisfied or dissatisfied are you using the device or if you use the device?	1.49	Very Satisfied
Overall Mean	1.61		
Respondents	114		

Device Description Analysis.

The researchers use convenience sampling as a non-probability sampling method due to resource limitation in collecting feedback. The method yields a total 114 responses. The researchers adapt Cuevas R. V (2022) four-point Likert scale, where value one leans to strongly agree and value four leaning to strongly disagree.

Statement of the Problem 4. Is there a significant difference between ultraviolet-based disinfectant and alcohol-based disinfectant in terms of their effectiveness?

Null Hypothesis. There is no significant difference between UV based disinfectant and Alcohol based disinfectant in terms of their effectiveness.

Alternative Hypothesis. There is a significant difference between UV based disinfectant and Alcohol based disinfectant in terms of their effectiveness.

Result of Two-Samples Wilcoxon Test.

```
        Wilcoxon rank sum exact test

data:  uv_data and alc_data
W = 0, p-value = 0.1
alternative hypothesis: true location shift is not equal to 0
```

Figure 32. **Two Sample Wilcoxon Test**

Conclusion. Since the p-value of 0.1 is greater than 5% level of significance (0.05), there is enough evidence to conclude that UV and Alcohol based disinfectant exhibit no significant difference when it comes to their effectiveness.

4. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

4.1 Conclusion

The following conclusion were made based on the findings, proof of effectivity of the device such as certificate of analysis of Automatic Disinfection Box and Certification of Statistical Treatment

There is enough evidence to conclude that UV and Alcohol based disinfectant exhibit no significant difference when it comes to their effectiveness. UV intensity has a significant effect in terms of effectiveness and this result supports the comparison of findings of Baseline treatment and UV based treatments in terms of bacterial inhibition since number of colonies from UV based treatments were lower than those from the former, and the different durations of UV exposure of 10, 20, 30 seconds show no significant difference in terms of effectiveness.

Based on the statistical analysis, the automatic disinfection meets current pandemic situation extremely well, the automatic disinfection box has a very high quality in terms of quality, have an above average price-quality price ratio and the respondents are very satisfied using the automatic disinfection box.

4.2 Recommendation

The researchers recommend the following suggestions to further develop and revolutionize the study.

1. Make a real-time UVC dosage monitor module that shows the current UVC dosage of the device producing.
2. Develop a BIOS of the system to save the current settings, device health, UVC lamp life.
3. Improve by letting maintainer input their mobile phone number where the device is going to send the message. The length of the message can also be improved by adding more information to the message.
4. Add feature that when the registered number of the device received a “STATUS” the device will send the current status of the device.
5. Expand device by a self-disinfect feature on the device handles to reduce transmission of virus and microorganisms.

6. Construct buttons to the device like power switch to make it more intuitive.

4.2 REFERENCES

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ACKNOWLEDGEMENTS

The proponents would like to express their deepest gratitude to their research advisers, Engr. Jonathan C. Manarang and Engr. Pedrito M. Tenerife Jr. for giving the opportunity to conduct the study with proper guidance and support.

The proponents would also like to extend their gratitude to Department of Science and Technology SEI for their support in our research. Mr. Alberto De Guzman and Samuel M. Saralde, Ms. Jerimi F. Francisco, Reynaldo T. Cuevas V and Hillary Mae L. Almonte for their guidance throughout the duration of the study.

The proponents would also like to thank their families and friends for their unending love, support, and assistance. Lastly, to almighty God for providing the proponents the wisdom, courage, and strength during the study.

APPENDICES

REPUBLIC OF THE PHILIPPINES
POLYTECHNIC UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Mr. Alberto De Guzman
Professional Welder
Hermogenes Concepcion
Cabanatuan, Nueva Ecija

Dear Mr. De Guzman:

Greeting in unvarying pursuit of academic excellence.

We, John Christopher B. Bagas, Charles Adriane S. Guerrero and Marcus M. Saralde, are bonafide 4th year Computer Engineering student from Polytechnic University of the Philippines and currently enrolled in Computer Engineering Practice and Design 1. The major requirement of this course is to identify possible research problems within the area and propose a solution to the identified problems.

On this note, we want to humbly ask you to be the beneficiary of our study. The students will develop a device for their Design Project entitled **Effect of Automatic Disinfection Box using Ultraviolet C Lights on Microbial Growth of Microorganisms** which aim to reduce transmission risks and promote disinfection procedures. We are also respectfully requesting your assistance by allowing us deploy our prototype in the third floor of the college of engineering. In addition to that, we would also conduct interviews and or questionnaires if needed.

Should this request merit your considerate approval, be assured that any information shared by your institution will be treated with strict confidentiality.

We are hoping for your appropriate action and favorable response upon this matter.

Respectfully Yours,

John Christopher C. Bagas
Researcher, Computer Engineering Student

Charles Adriane S. Guerrero
Researcher, Computer Engineering Student

Marcus M. Saralde

Researcher, Computer Engineering Student

Noted By:

Engr. Pedrito M. Tenerife Jr.
Adviser, Computer Engineering Practice and Design 1

DESIGN PROJECT PROPOSAL DEFENSE 2021

SUMMARY OF COMMENTS

REPORT

NO.: CPERC-2021-PROP-POE-R-000060

GROUP CODE	3609	**ADVISER**	Engr. Pedrito M. Tenerife Jr.
SECTION	BSCpE 3-6		

THESIS TITLE	Development of Automatic Covid Disinfection Box Implemented with Arduino (ADB Automatic Disinfection Box)

	NAME OF PANEL
PANEL CHAIR	Dr. Remedios G. Ado
PANEL MEMBER 1	Engr. Arlene B. Canlas
PANEL MEMBER 2	Engr. Jonathan C. Manarang

	COMMENTS	**RECOMMENDATIONS**
PANEL CHAIR	Consider the comments and suggestions of the panel of evaluator to improve the project.	think of an alternative application solution to justify the need of this project & with 4 members in a team.
PANEL MEMBER 1	-	Consider adding how to verify the effectivity/ effectiveness of your disinfection device. Maximize the use of Arduino (example: sending sms about the status of the disinfection and the device)
PANEL MEMBER 2	Add gsm shield for sending message to the owner of the item being sanitized. Apply this prototype to laboratory subjects, include the counting of object being sanitized. Provide clinical lab test result in front of your subject to denote that it is calibra.	

NOTE: The data shown above are acquired from the filled-out Panel Evaluation Form in Google Forms. Should there be any error on this report, please notify the CpE Research Committee for verification.

REPUBLIC OF THE PHILIPPINES
POLYTECHNIC UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

_____, 2022

Jerimi F. Francisco
Biotech
BS Biology Major in Biotechnology

Ma'am Francisco,

We, John Christopher B. Bagas, Charles Adriane S. Guerrero and Marcus M. Saralde, are bonafide 4th-year Computer Engineering student from Polytechnic University of the Philippines currently enrolled in Computer Engineering Practice and Design 2. Our thesis entitled "Effect of Automatic Disinfection Box Using Ultra Violet Light on Microbial Growth of Microorganisms" have led us to develop a prototype.

In connection with this, we are asking for your assistance to conduct the necessary laboratory or field experiment and testing for our prototype.

We are hoping for your kind consideration regarding the matter stated above. Thank you and God bless.

Sincerely,

John Christopher B. Bagas
Researcher, Computer Engineering Student

Charles Adriane S. Guerrero
Researcher, Computer Engineering Student

Marcus M. Saralde
Researcher, Computer Engineering Student

Approved by:

Engr. Jonathan C. Manarang
Adviser, Computer Engineering Practice and Design 1 & 2

Engr. Pedrito M. Tenerife Jr.
Adviser, Computer Engineering Practice and Design 1 & 2

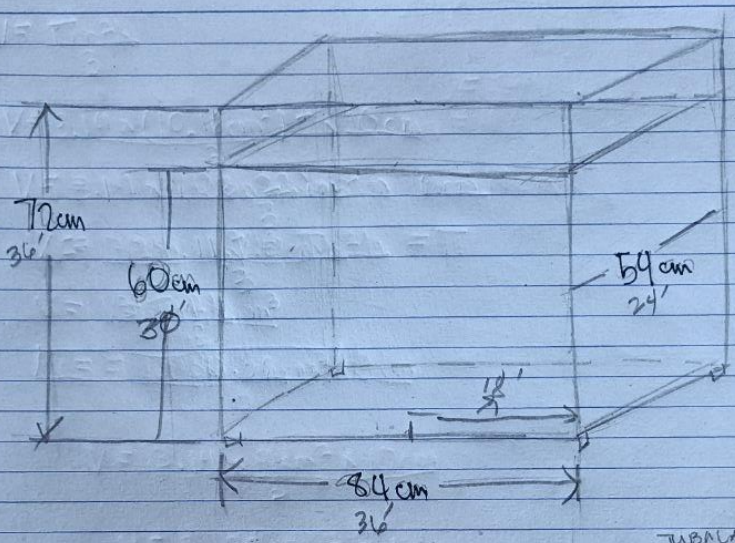
Noted by:

Engr. Julius S. Cansino
Chairperson, Computer Engineering

(全長)4215

No:

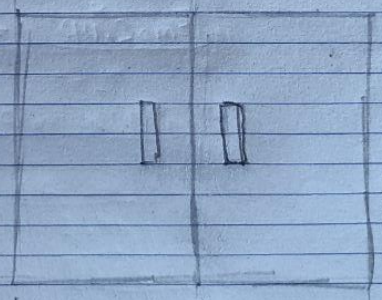
Date:



TUBULAR
1"X1"X1/4" = 20FT

144'

TUBULAR GI
1"X1"X1/4" = 4
WELDING ROD = 1/2 kg
INSULATOR = 3m
HINGES = 4pcs



27/04/2012
PERSPECTIVE

ADB

SARAUSE, MARCUS M

Effect of Automatic Disinfection Box Using Ultra Violet Light on Microbial Growth of Microorganisms

Good day.

We are fourth year computer engineering students from Polytechnic University of the Philippines - Manila currently working on a research project entitled "Effect of Automatic Disinfection Box Using Ultra Violet Light on Microbial Growth of Microorganisms."

The Corona Virus Disease 2019 pandemic has increased the need for human disinfection. It is important to avoid reducing transmission risk. Thorough and efficient disinfection procedures must be implemented to return to our day-to-day operations cost-effectively. Cognizant of the growing problem of stress, the research intends to develop automated disinfection to promotes contactless and alternative ways of disinfection.

As such, we would like to request all of you to answer all the following questions to help us produce with the necessary data and information needed for the completion of our project. Rest assured that any information given will be kept strictly confidential.

Thank you for your kind consideration in this research project.

Regards,

John Christopher B. Bagas
Charles Adriane S. Guerrero
Marcus M. Saralde

PRIVACY NOTICE in compliance with RA 10173 - Data Privacy Act of 2012

By voluntarily accomplishing this questionnaire, the participant consents to the collection, storage, and processing of the following information via Google Form: full name, PUP webmail address, student number, year and section, and others. These information will be solely used for research purposes by the proponents of the study. The information will be only used according to the needs of the study, and the same will not be shared with outside parties. The participants are assured that the researchers pursuant to prevailing privacy laws, shall uphold the rights of the data subjects, implement the appropriate security measures, and will remain adherent to the general privacy principles of transparency, legitimate purpose, and proportionality, in processing their personal information.

*Kinakailangan

Effect of Automatic Disinfection Box Using Ultra Violet Light on Microbial Growth of Microorganisms

Please answer the following questions kindly to produce the necessary data and information. The video demonstration of the device can be seen and watched below.

How well does the device meet current pandemic situation needs?

- ◯ 1 - Extremely well
- ◯ 2 - Very well
- ◯ 3 - Not so well
- ◯ 4 - Not at all well

How would you rate the quality of the device?

- ◯ 1 - Very high quality
- ◯ 2 - High quality
- ◯ 3 - low quality
- ◯ 4 - very low quality

With a price of 9,500 PHP, how would you rate the value for money of the device?

- ◯ 1 - excellent
- ◯ 2 - above average
- ◯ 3 - below average
- ◯ 4 - poor

Overall, how satisfied or dissatisfied are you using the device or if you use the device?

- ◯ 1- very satisfied
- ◯ 2 - somewhat satisfied
- ◯ 3 - somewhat dissatisfied
- ◯ 4 - very dissatisfied

Source Code

```
#include <Wire.h>
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>

SoftwareSerial mySerial(9,10);
char msg;
char call;
LiquidCrystal_I2C lcd(0x27, 16, 2);
int ledPin = 3;
int buzzer = 2;

byte zero[] = {
  B00000,
  B00000,
  B00000,
  B00000,
  B00000,
  B00000,
  B00000,
  B00000,
  B00000
};

byte one[] = {
  B10000,
  B10000,
  B10000,
  B10000,
  B10000,
  B10000,
  B10000,
  B10000,
  B10000
};

byte two[] = {
  B11000,
  B11000,
  B11000,
  B11000,
  B11000,
  B11000,
  B11000,
  B11000,
  B11000
};

byte three[] = {
  B11100,
  B11100,
  B11100,
  B11100,
  B11100,
  B11100,
  B11100,
  B11100,
  B11100
};

byte four[] = {
```

```
  B11110,
  B11110,
  B11110,
  B11110,
  B11110,
  B11110,
  B11110,
  B11110
};

byte five[] = {
  B11111,
  B11111,
  B11111,
  B11111,
  B11111,
  B11111,
  B11111,
  B11111
};

void setup() {
  digitalWrite(4, HIGH);
  delay(1000);
  digitalWrite(4, LOW);
  delay(5000);
  lcd.init();
  lcd.backlight();
  digitalWrite(ledPin, HIGH);
  pinMode(ledPin, OUTPUT);
  pinMode (buzzer, OUTPUT);
  lcd.createChar(0, zero);
  lcd.createChar(1, one);
  lcd.createChar(2, two);
  lcd.createChar(3, three);
  lcd.createChar(4, four);
  lcd.createChar(5, five);
  mySerial.begin(9600);
  Serial.begin(9600);
}

void loop() {
  int pirState=digitalRead(6);

  if (pirState == LOW) {
    lcd.setCursor(0,0);
    lcd.print("PUT OBJECT");
    lcd.setCursor(0,1);
    lcd.print("TO DISINFECT");
    delay(500);
  }

  else if (pirState == HIGH) {
    delay(3000);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("DISINFECTING:");
    delay(500);
    digitalWrite(ledPin, LOW);
```

```
for(int i=0; i <= 100; i++) {
    lcd.setCursor(0,1);
    updateProgressBar(i, 100, 1);
    delay(100);
     }

    delay(1000);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("DONE!!!!");
    digitalWrite(ledPin, HIGH);
    digitalWrite(buzzer, HIGH);
    delay(1000);
    digitalWrite(buzzer, LOW);
    delay(1000);
    digitalWrite(buzzer, HIGH);
    delay(1000);
    digitalWrite(buzzer, LOW);
    delay(1000);
    digitalWrite(buzzer, HIGH);
    delay(1000);
    digitalWrite(buzzer, LOW);

    SendMessage();
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("DISINFECTION");
    lcd.setCursor(0,1);
    lcd.print("COMPLETE");
    delay(2000);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 5");
    delay(1000);
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 4");
    delay(1000);
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 3");
    delay(1000);
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 2");
    delay(1000);
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 1");
    delay(1000);
    lcd.setCursor(0,0);
    lcd.print("PLEASE REMOVE");
    lcd.setCursor(0,1);
    lcd.print("OBJECT NOW 0");
```

```
        delay(1000);
        lcd.clear();
        digitalWrite(pirState, LOW);
        delay(5000);
        }
  }

void updateProgressBar(unsigned
long count, unsigned long totalCount,
int lineToPrintOn) {
        double factor = totalCount/80.0;
        int percent = (count+1)/factor;
        int number = percent/5;
        int remainder = percent%5;
        if(number > 0) {

 lcd.setCursor(number-
1,lineToPrintOn);
       lcd.write(5);
    }


lcd.setCursor(number,lineToPrintOn);
       lcd.write(remainder);
 }

 void SendMessage()
{
  mySerial.println("AT+CMGF=1");
  delay(1000);

mySerial.println("AT+CMGS=\"+63975
0710500\"\r");
  delay(1000);

  mySerial.println("DISINFECTED");
  delay(100);
   mySerial.println((char)26);
  delay(1000);
```

Bill of Materials

Item	Quantity	Price
Angle bar, cutting disk, welding rod, rubber wheels	1	1690
Galvanized Steel sheet .9 (4x8)	1	1200
Flat bar kilo	5	200
Insulation and stainless handles	1	350
Clear coat	1	120
Rugby,	1	70
Roller Catches	4	205
Labor assistance	1	1000
1/4 thick glass	1	200
Steel Matting	1	430
Bosny Spray Paint White	6	600
Fyl201	1	1700
Petri dish	20	202
Premixed nutrient agar	1	257
Cling wrap	1	79
Cotton swab	1	54
16*2 LCD Display i2c	1	146
Arduino Uno r3 kit	1	1200
Sim900A	1	270
Total		9,973.00

REPUBLIC OF THE PHILIPPINES
POLYTECHNIC UNIVERSITY OF THE PHILIPPINES
COLLEGE OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

June 26, 2022

Engr. Julius S. Cansino
Chairperson, Computer Engineering Department
Head, Design Project Committee

Subject: Request to rename the Thesis Title

Dear Sir,

Greetings of peace.

This to let you know that we have been currently conducting research work on **THE EFFECTIVENESS OF UV LIGHTS IN DISINFECTING USING AN AUTOMATIC DISINFECTION BOX IMPLEMENTED WITH ARDUINO** to be able to complete our Computer Engineering Practice and Design 2.

We have no issues with the topic. However, we would like to rename it to **EFFECT OF AUTOMATIC DISINFECTION BOX USING ULTRA VIOLET-C LIGHTS ON MICROBIAL GROWTH OF MICROORGANISMS** which we think as the most appropriate title of the research.

Hence, we would like to request to rename our thesis title as mentioned above so that we can continue to finalize the research work.

Thank you very much for your kind support.

Sincerely yours,

John Christopher B. Bagas

Charles Adriane S. Guerrero

Marcus M. Saralde
Researchers
.

Checked by:

Engr. Pedrito M. Tenerife Jr.
Adviser

Engr. Jonathan C. Manrang
Adviser

CERTIFICATE OF ANALYSIS

Name of Client :**MARCUS M. SARALDE**
Name of Institution :**POLYTECHNIC UNIVERSITY OF THE PHILIPPINES**
Institution Address :1016 Anonas, Sta. Mesa, Maynila, Kalakhang Maynila
Contact Number :0933 654 2264

Sample Description

Date of Sampling: 05/16/2022 Sample taken by: Marcus M. Saralde
Date received: 05/16/2022 Time of Sampling: 1:42 PM
Source of Sample: Four random ballpoint pen

Agar Plate	Microbiological Culture Technique	Colonies	Colony Average	Colony Size Average	Zone of Inhibition Average
A1	Streak Plate Method	44	22.66	0.36	
A2		7			
A3		17			
B1	Spread Plate Method	9	9.66	0.193	0.681 cm
B2		13			
B3		7			
C1	Streak Plate Method	6	4.33	0.126	
C1		5			
C1		2			
C2	Streak Plate Method	4	3.66	0.1	
C2		3			
C2		4			
C3	Streak Plate Method	3	2.33	0.87	
C3		2			
C3		2			

Remarks:

****End of Report****

Analyzed and checked by:

Jerimi F. Francisco
Biotech, *BS Biology Major in Biotechnology*

CERTIFICATION OF STATISTICAL TREATMENT

Date Printed: 07/14/2022

This it to certify that the paper entitled "**THE EFFECT OF AUTOMATIC DISINFECTON BOX USING ULTRA VIOLET LIGHT ON MICROBIAL GROWTH OF MICROORGASNIMS"** has employed correct statistical treatment data as edited and validated by the undersigned.

This certification is issued upon the request of **Marcus M. Saralde** in Computer Engineering Practice and Design 2 for whatever purpose that may serve them.

REYNALDO T. CUEVAS V
Statistician

Statistical Analysis of UV Based and Alcohol Disinfectant Data

All statistical analyses were performed using R Studio v 4.2.1 and all test of significance were evaluated at 5% level.

Effectiveness of UV based and Alcohol based disinfectant were measured based on number of colonies in different treatments. Different treatments were replicated thrice and were compared to a baseline treatment wherein the agar plate was not exposed to UV or Alcohol. Results revealed that the baseline treatment was relatively higher compared to Alcohol based and UV based treatments. This suggests that Alcohol based and UV based disinfectant were more effective in terms of bacterial inhibition.

Statement of the Problem 1

What is the significant difference between ultraviolet-based disinfectant and alcohol-based disinfectant in terms of their effectiveness?

Null Hypothesis: There is no significant difference between UV based disinfectant and Alcohol based disinfectant in terms of their effectiveness.

Alternative Hypothesis: There is a significant difference between UV based disinfectant and Alcohol based disinfectant in terms of their effectiveness.

Result of Two-Samples Wilcoxon Test

```
        Wilcoxon rank sum exact test

data:  uv_data and alc_data
W = 0, p-value = 0.1
alternative hypothesis: true location shift is not equal to 0
```

Conclusion

Since the p-value of 0.1 is greater than 5% level of significance (0.05), there is enough evidence to conclude that UV and Alcohol based disinfectant exhibit no significant difference when it comes to their effectiveness.

Statement of the Problem 2

What is the significant effect of ultraviolet intensity to be use in terms of its effectiveness?

Null Hypothesis: There is no significant effect of UV intensity to be use in terms of effectiveness.

Alternative Hypothesis: There is a significant effect of UV intensity to be use in terms of effectiveness.

Result of One-Sample Wilcoxon Test

```
        Wilcoxon signed rank test with continuity correction

data:  UV
V = 45, p-value = 0.008789
alternative hypothesis: true location is not equal to 0
```

Conclusion

Since the One-Sample Wilcoxon Test resulted a p-value of 0.0088, and is less than 5% level of significance (0.05), it was therefore concluded that UV intensity has a significant effect in terms of effectiveness. This result supports the comparison of findings of Baseline treatment and UV based treatments in terms of bacterial inhibition since number of colonies from UV based treatments were lower than those from the former.

Statement of the Problem 3

What is the significant difference among the different duration in terms of its effectiveness?

> **Null Hypothesis:** There is no significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness.
> **Alternative Hypothesis:** There is a significant difference among the duration of 10 seconds, 20 seconds, and 30 seconds in terms of its effectiveness.

Result of Kruskal-Walis Test

```
        Kruskal-Wallis rank sum test

data:  colony by group
Kruskal-Wallis chi-squared = 3.0175, df = 2, p-value = 0.2212
```

Conclusion

Since the Kruskal-Walis test yields a p-value of 0.2212, and is greater than 5% level of significance (0.05), therefore, the different durations of UV exposure show no significant difference in terms of effectiveness.