Automatic Hand Sanitizer Dispenser

Alfred Ashley F. Andrion
Computers and Information Sciences
Mapua Malayan Colleges Mindanao
Davao City, Philippines
aaAndrion@mcm.edu.ph

Mohaimen L. Dampac
Computer and Information Sciences
Mapua Malayan Colleges Mindanao|
Davao City, Philippines
mDampac@mcm.edu.ph

Abdul Aziz M. Uy College of
Computer and Information Sciences
Mapua Malayan Colleges Mindanao
Davao City, Philippines
aamuy@mcm.edu.ph

ABSTRACT

In response to evolving global health challenges, this study investigates the integration of Arduino and Proteus in developing an automatic hand sanitizer dispenser. The dispenser utilizes an ultrasonic sensor for accurate hand detection, a PWM-controlled servo motor for sanitizer dispensation, and LED indicators for visual feedback. Calibration processes ensure precise performance, with a Virtual Terminal providing real-time data display. The simulation results demonstrate the system's efficiency in accurately detecting hands, dispensing sanitizer, and providing responsive LED feedback. Practical implications extend to community settings, promoting efficient hand hygiene practices. Recommendations for future work include exploring additional calibration parameters for enhanced adaptability. Overall, the study contributes to innovating an efficient and user-friendly automatic hand sanitizer dispenser with promising real-world applications.

I - Introduction

In the face of evolving global health challenges, maintaining stringent hygiene practices has become imperative for public health and well-being (Kumwenda, 2017). Among the various preventive measures, consistent hand hygiene remains a fundamental defense against the spread of infectious diseases. As such, using hand sanitizers, particularly in community and public settings, plays a pivotal role in reducing the transmission of pathogens (Bloomfield et al., 2007).

Automatic hand sanitizer dispensers offer several advantages over their manual counterparts. They provide a touchless experience, minimizing the risk of cross-contamination. Additionally, they are well-suited for deployment in high-traffic areas, such as healthcare facilities, schools, offices, and public transportation hubs. These devices are also designed for ease of use, making them accessible to individuals of all ages and abilities.

The conventional approach to hand sanitization involves manual dispensing, which, while effective, may introduce challenges related to contact-based contamination and accessibility. The development of automatic hand sanitizer dispensers has gained prominence to address these concerns and promote efficient hand hygiene practices.

The primary objective of this study is to thoroughly investigate the integration of Arduino and Proteus within the context of automatic hand sanitization, with the overarching goal of advancing public health and hygiene practices. The study aims to comprehensively understand how this innovative approach can elevate sanitation standards by delving into this integration. This research seeks to explore the potential benefits and challenges associated with this integration, offering valuable insights that can inform the development and implementation of such systems in real-world scenarios, ultimately contributing to creating safer and cleaner environments for individuals and communities.

Despite the promising potential of automatic hand sanitizer dispensers in revolutionizing hand hygiene practices, it is essential to acknowledge certain limitations within this field of study:

1. While touchless dispensers minimize cross-contamination risks, they require a power source, which might limit their deployment in remote or resource-constrained settings.
2. The effectiveness of such systems can be contingent on sensor accuracy and maintenance, which may raise concerns regarding their long-term reliability.
3. The cost of implementing and maintaining these automated systems should be carefully considered, as it may pose a barrier to widespread adoption, particularly in economically disadvantaged areas.
4. The user's willingness and ability to adapt to new technology could impact the success of these systems.

These limitations underscore the need for a comprehensive investigation, as proposed in this study, to evaluate both the benefits and challenges associated with integrating Arduino and Proteus into automatic hand sanitization systems to inform their practical applicability and ensure that advancements in public health and hygiene practices are both inclusive and sustainable.

II – Related Works

A. Safe and Effective Hand Sanitizer Formulations

Glycerol is a crucial ingredient used as a humectant to prevent moisture loss. It is readily available and affordable; people can easily mix it with water. Alcohol, which is non-toxic and does not induce allergies, can also be included. Hydrogen peroxide serves as an antiseptic to eliminate disease-causing microorganisms. All ingredients should be non-toxic to ensure safety in case of accidental ingestion.

Additionally, including a colorant for distinguishing the solution from other fluids is permissible if it does not introduce toxicity, allergenicity, or interfere with antimicrobial properties. However, it is not recommended to add perfumes or dyes due to safety concerns, as they may trigger allergic reactions (WHO, 2010). Apart from alcohols like 96% ethanol or 99.8% isopropyl alcohol, the World Health Organization (WHO) also recommends other ingredients. As the active principal ingredient, Benzalkonium chloride has demonstrated excellent antibacterial activity, while others have shown varying degrees of effectiveness in conducted assays (Chojnacki et al., 2021; Aodah et al., 2021).

B. The Role and Preference for Hand Sanitizers in Effective Hand Hygiene Practices: Insights from CDC and WHO Guidelines

The Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) endorse effective hand hygiene practices. They recommend either washing hands with soap and water for at least 20 to 30 seconds or using alcoholic hand sanitizers (AHS) containing either 80% ethanol or 75% isopropyl alcohol as a suitable alternative. This frequent practice is vital for reducing the presence of harmful microbes (WHO, 2020). The CDC and WHO prioritize using AHS over soap and water due to its convenient accessibility (Aodah et al., 2021). Many individuals prefer using hand sanitizers for several reasons, including their ready availability, especially when water is not easily accessible, and the time-saving aspect of their use (Singh et al., 2020).

C. Enhancing Hand Hygiene in Educational Settings: The Role of Hand Sanitizers in School Health Protocols

Schools must implement thorough and rigorous health protocols to promote a safe and healthy environment. Alongside ensuring the presence of soap and running water for handwashing, schools must also furnish readily available hand sanitizers in each classroom or frequently used area. Hand sanitizer plays a pivotal role in upholding hand hygiene by providing the convenience of germ elimination without the necessity of water, making it suitable for use at any time and in any location. (Saadat et al., 2020).

D. Design of Automatic Hand Sanitizer System

The study by J. Lee, J.-Y. Lee, S.-M. Cho, K.-C. Yoon, Y. J. Kim, and K. G. Kim, titled "Design of Automatic Hand Sanitizer System Compatible with Various Containers," addresses the growing importance of hand hygiene in global health challenges, particularly during the COVID-19 pandemic. It introduces an innovative solution by proposing an automatic hand sanitizer system compatible with various sanitizer containers, reducing the risk of viral transmission while enhancing user convenience and sustainability. This approach aligns with the objectives of our study, "Automatic Hand Sanitizer: Arduino and Proteus Simulation," which also aims to promote effective hand hygiene in community settings, highlighting the significance of technological advancements in improving public health practices.

Another study researched by Sitompul, B.P., Solikhun, S., Saputra, W., Gunawan, I., & Sumarno, S., titled "Design and build of automatic hand sanitizer using Arduino" presents a comprehensive exploration of the development process of an automatic hand sanitizer system, shedding light on the crucial components and techniques employed in its creation. The study centers on using an infrared (IR) sensor for detecting hand movements coupled with the Arduino Uno microcontroller as the central control unit. This innovative approach emphasizes the significance of IR sensor technology in enabling touchless hand hygiene solutions. The researchers provide an in-depth analysis of hardware and software aspects, including the hardware components and software application software required for programming and device operation. Incorporating data analysis techniques, particularly descriptive analysis presented in tabular form, enhances the study's clarity and comprehension. The research timeframe, spanning from July 30, 2020, to August 8, 2020, underscores this development's timely and responsive nature. Furthermore, the study demonstrates that the automatic hand sanitizer device, driven by Arduino Uno and IR sensors, functions effectively. This successful implementation validates the feasibility of using microcontroller components and IR technology in constructing touchless hand sanitization systems, reinforcing the role of emerging technologies in promoting public health.

III. MATERIALS AND METHODS

This study delves into designing, developing, and simulating an Arduino-based automatic hand sanitizer dispenser using Proteus. It explores the technical aspects of the system, including sensor integration, actuation mechanisms, and user interface considerations. Furthermore, it assesses the feasibility of such a system for community use, considering factors like user experience, maintenance, and cost-effectiveness.

Integrating microcontroller platforms like Arduino and simulation tools like Proteus have revolutionized the design and prototyping of automatic hand sanitizer dispensers. Arduino, a versatile open-source hardware and software platform, provides sensor-based operation's computational power and control. Proteus, a simulation software widely used in electronic design, allows for the virtual testing and validation of circuit designs before physical implementation.

The combination of Arduino and Proteus enables researchers, engineers, and developers to create innovative and cost-effective solutions for automatic hand sanitization. Communities can tailor these solutions to address their specific needs, thereby ensuring the widespread adoption of effective hand hygiene practices.

IV. RESEARCH METHODOLOGY

A. Simulation Setup

For the simulation setup, the Arduino-based automatic hand sanitizer dispenser was meticulously designed within the Proteus environment, incorporating the following materials:

(1) **POT-HG (High Granularity Interactive Potentiometer):** The system utilized this component to simulate the user's interaction, providing a virtual representation of hand proximity for testing responsiveness.

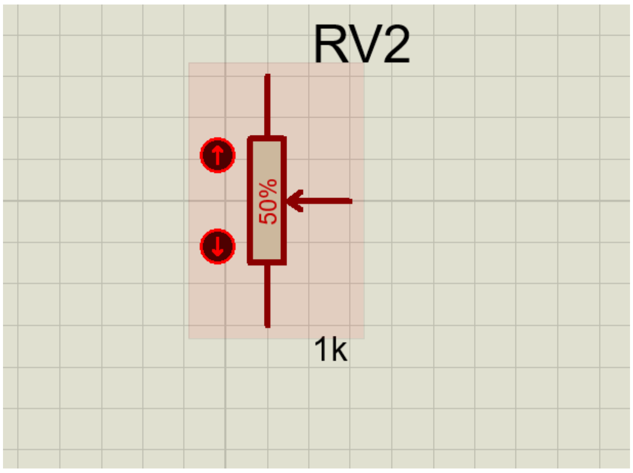


Figure 1. POT-HG

(2) **ULTRASONIC SENSOR (HC SR-04):** The ultrasonic sensor played a crucial role in detecting the presence of hands within the system. It simulated real-world conditions by emitting ultrasonic waves and measuring the time taken for the waves to return, enabling precise hand detection.

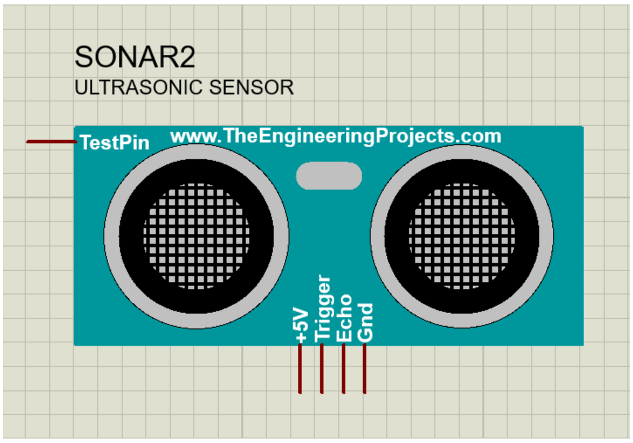


Figure 2. ULTRASONIC SENSOR

(3) **MOTOR-PWMSERVO:** This component simulated the actuation mechanism responsible for dispensing sanitizer. The servo motor, controlled by PWM signals, represented the real-world dispenser mechanism.

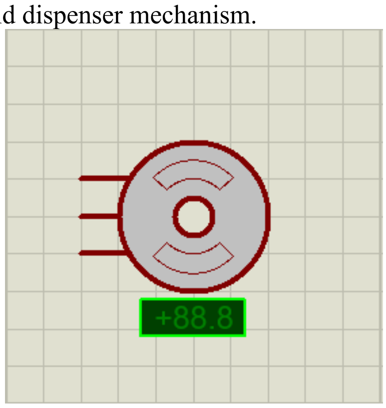


Figure 3. SERVO

(4) **Arduino Uno R3:** The heart of the system, the Arduino Uno R3 microcontroller, served as the central processing unit. It executed the decision-making algorithm based on inputs from the sensors and controlled the dispenser actuation.

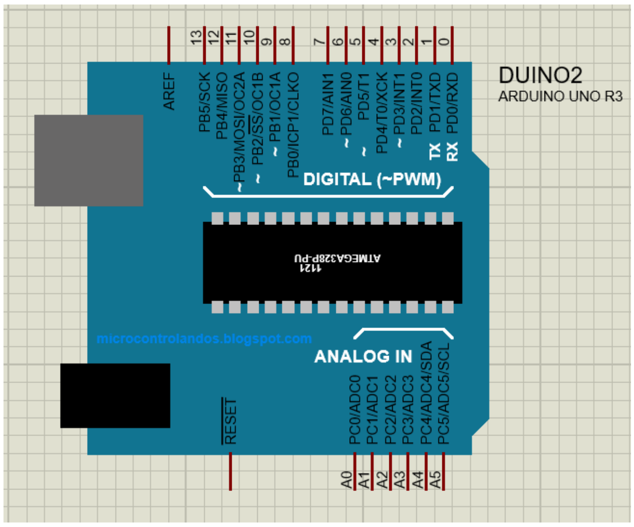


Figure 4. Arduino Uno R3

(5) **VIRTUAL TERMINAL (Virtual RS232):** The virtual terminal facilitated communication between the simulated system and the user. It provided a means to observe real-time data and feedback during the simulation.

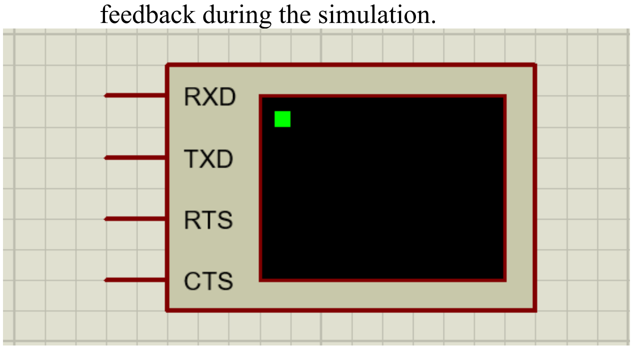


Figure 5. VIRTUAL TERMINAL

(6) **LED LIGHTS (RED AND GREEN):** The LED lights were integrated into the system to provide visual indicators. The red LED signaled standby mode, while the green LED indicated successful hand detection and sanitizer dispensing.

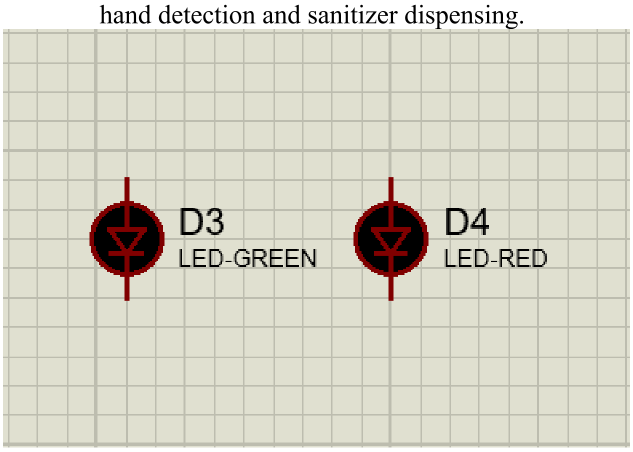


Figure 6. RED & GREEN LEDS

(7) SWITCH (Interactive SPST Switch): a component designed to simulate a single-pole, single-throw switch, allowing manual toggling between open and closed states for circuit simulation.

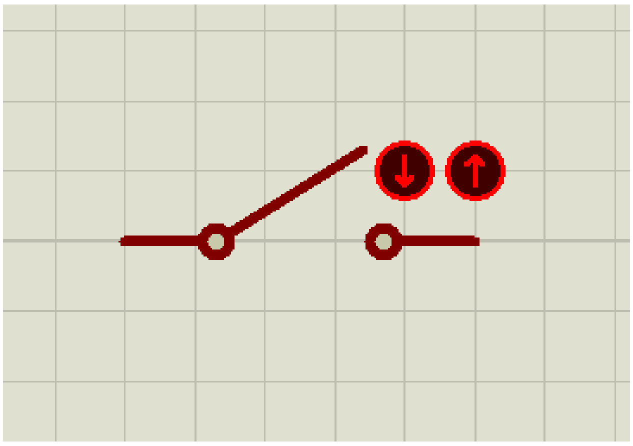


Figure 7. SWITCH

These materials collectively formed a comprehensive simulation setup that mirrored the components of a real-world automatic hand sanitizer dispenser. The virtual environment allowed for thorough testing and refinement of the system's functionalities.

B. System Calibration

- **Hand Detection Calibration:** We fine-tuned the set distance for hand detection using the POT-HG (High Granularity Interactive Potentiometer). When the ultrasonic sensor detected a virtual hand within this set distance, the system activated the green LED, indicating successful hand detection. Simultaneously, the red LED signaled standby mode, creating a visual indicator of the system's readiness.
- **Virtual Terminal Display:** The Virtual Terminal (Virtual RS232) played a crucial role in calibration by displaying real-time data during the simulation. Specifically, it showcased the distance sensed by the ultrasonic sensor, providing valuable insights into the system's decision-making process. This feature allowed for a comprehensive analysis of the sensor's accuracy and responsiveness.

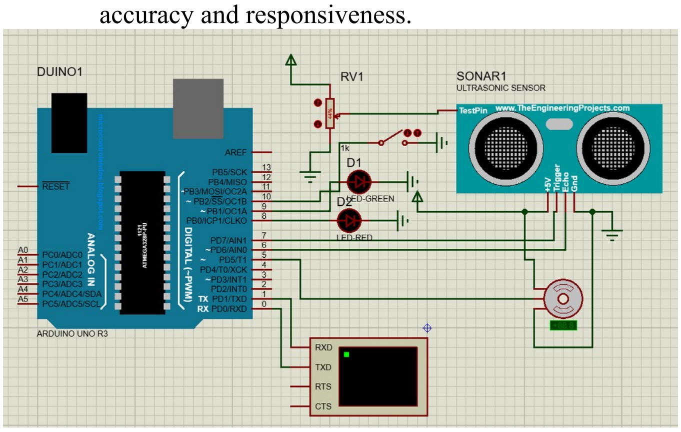


Figure 8. Proteus Schematic

V. RESULTS AND DISCUSSION

The simulation conducted under diverse conditions demonstrated the robust performance of the Arduino-based automatic hand sanitizer dispenser. Several vital aspects were analyzed to evaluate the system's efficacy:

- **Accurate Hand Detection:** The system consistently demonstrated precise hand detection within the calibrated set distance. As virtual hands entered the specified range, the ultrasonic sensor promptly and accurately detected their presence. This successful detection is fundamental to the overall functionality of the dispenser.
- **Effective Dispensation of Sanitizer:** Upon hand detection, the system swiftly activated the actuation mechanism, simulating the efficient dispensation of sanitizer. This action highlighted the system's ability to seamlessly integrate sensor inputs with the dispenser's actuation, ensuring a timely and effective response to user interaction.
- **Responsive LED Indicators:** The LEDs, serving as visual indicators, were responsive to the system's status. When a hand was detected, the green LED illuminated to signify active readiness, providing users immediate feedback. In standby mode, the red LED illuminated, indicating that the system was not actively detecting hands. This visual feedback contributes to user understanding and interaction.

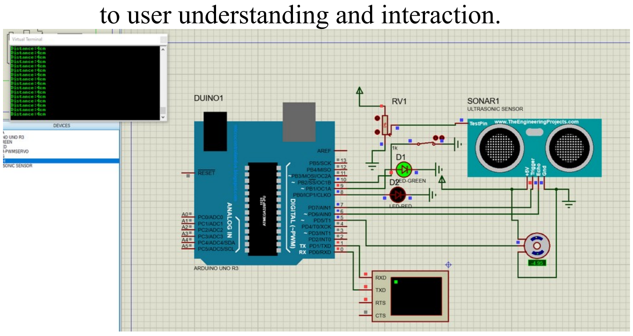


Figure 9. Green Light if Sensor detects

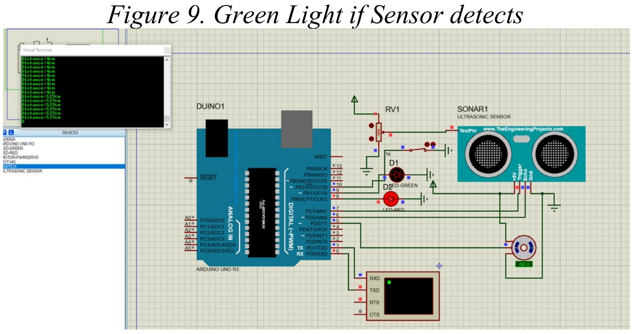


Figure 10. Red Light Simulation on Standby

- **Acceptable Response Times:** The system's response times, from hand detection to sanitizer dispensation, were within acceptable limits. The swift and accurate response adds to the overall efficiency and user-friendliness of the dispenser, ensuring a seamless experience for individuals interacting with the system.

Accurate hand detection, effective sanitizer dispensation, responsive LED indicators, and acceptable response times collectively demonstrated the system's proficiency in promoting touchless and efficient hand hygiene practices. The results obtained from the simulation lay a strong foundation for the practical implementation of the Arduino-based automatic hand sanitizer dispenser in real-world settings.

VI. CONCLUSION

In conclusion, the successful calibration of the system, with distinct LED responses and accurate distance measurement in the Virtual Terminal, contributes to the innovation of an efficient and user-friendly automatic hand sanitizer dispenser. The practical implications of this research extend to real-world applications, particularly in community settings where efficient hand hygiene practices are crucial. The calibrated system offers a reliable solution, enhancing public health and hygiene practices.

Looking forward, future research in this domain should explore additional calibration parameters for optimizing the system's adaptability in varied environments. Continuous refinement based on user feedback and technological advancements could enhance the system's performance.

VII. FUTURE WORKS

Hand detection using python algorithm can be added to this AI simulation through means of integrating it with the sensor. This hand detector can be used to accurately identify the hand structure and utilize hand gesture for innovative features such as controlling the number of pumps. Due to lack of resource, this may serve as a recommendation for future researchers.

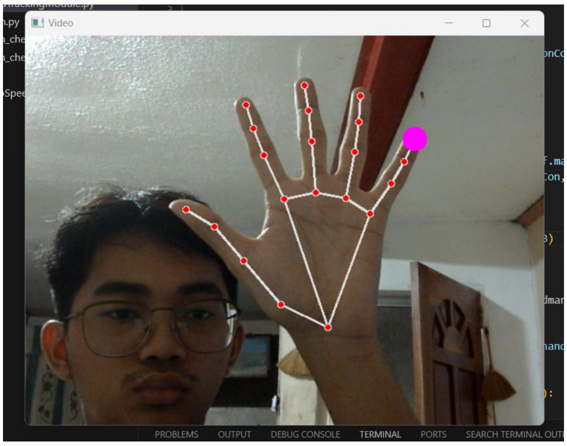


Figure 11. Hand – Palm Open

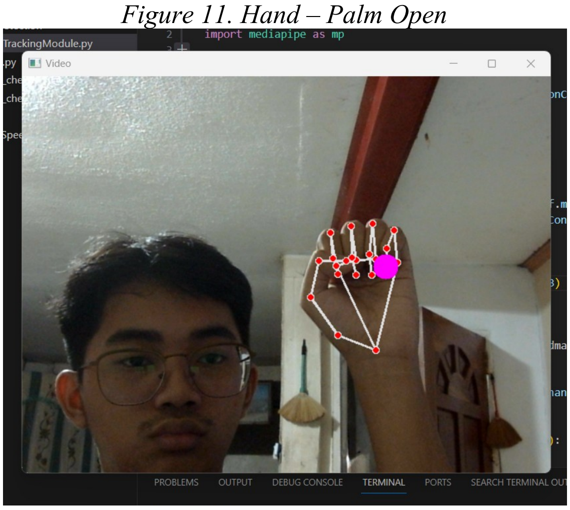
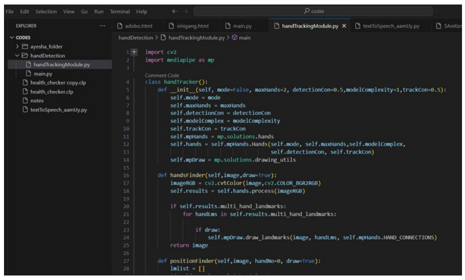
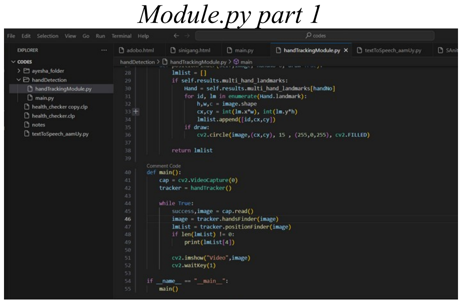


Figure 12. Hand – Fist

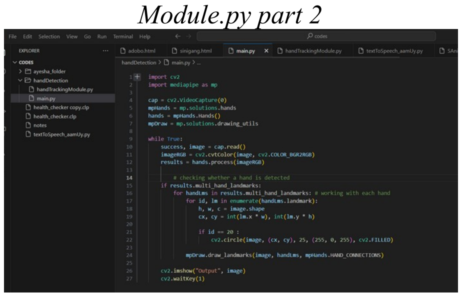
APPENDIX A – Hand Detector Python Codes



Module.py part 1



Module.py part 2



Main.py

References

[1] Aodah , A. H., Bakr , A. A., Booq , R. Y., Rahman, M. J., Alzahrani, D. A., Alsulami, K. A., Alshaya, H. A., Alsuabeyl, M. S., Alyamani, c, Essam J., & Tawfik, E. A. (2021, June 12). Preparation and evaluation of Benzalkonium Chloride Hand Sanitizer as a potential alternative for alcohol-based hand gels. Saudi Pharmaceutical Journal. https://www.sciencedirect.com/science/article/pii/S131901642100116X?via%3Dihub

[2] Bloomfield, S. F., Aiello, A. E., Cookson, B., O'Boyle, C., & Larson, E. L. (2007, December). The effectiveness of hand hygiene procedures in reducing the risks of infections in home and community settings including handwashing and alcohol-based hand sanitizers. American Journal of Infection Control. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7115270/

[3] Chojnacki, M., Dobrotka, C., Osborn, R., Johnson, W., Young, M., Meyer, B., & Dunman, P. M. (2021). Evaluating the antimicrobial properties of commercial hand sanitizers. MSphere, 6(2), e00062-21. Retrieved From: https://pubmed.ncbi.nlm.nih.gov/33658274/

[4] Kumwenda, S. (2019, April 3). Challenges to hygiene improvement in developing countries. IntechOpen. https://www.intechopen.com/chapters/63322

[5] Lee, J., Lee, J.-Y., Cho, S.-M., Yoon, K.-C., Kim, Y. J., & Kim, K. G. (2020, July 31). Design of automatic hand sanitizer system compatible with various containers. Healthcare Informatics Research. https://synapse.koreamed.org/articles/1144872?viewtype=pubreader

[6] aadat, S., Rawtani, D., & Hussain, C. M. (2020, April 22). Environmental perspective of covid-19. Science of The Total Environment. https://www.sciencedirect.com/science/article/pii/S0048969720323871?via%3Dihub

[7] Singh P, Potlia I, Malhotra S, Dubey H, Chauhan H. Hand Sanitizer an Alternative to Hand Washing—A Review of Literature. Journal of Advanced Oral Research. 2020;11(2):137-142. doi:10.1177/2320206820939403

[8] Sitompul, B. P., Solikhun, S., Saputra, W., Gunawan, I., & Sumarno, S. (1970, January 1). Design and build of Automatic Hand Sanitizer using Arduino. Eduvest. https://www.neliti.com/publications/345060/design-and-build-of-automatic-hand-sanitizer-using-arduino

[9] World Health Organization (2010). Guide to local production: WHO-recommended handrub formulations. Retrieved From:https://www.who.int/publications/i/item/WHO-IER-PSP-2010.5

[10] (WHO, 2020). Interim recommendations on obligatory hand hygiene against transmission of COVID-19.

[11] Retrieved From: https://www.who.int/publications/m/item/interim-recommendations-on-obligatory-hand-hygiene-against-transmission-of-covid-19