Faculty of Electronics and Computer Technology and Engineering

SMART SELF-HYGIENE DOOR (SSHD) USING ARDUINO SOFTWARE FOR PUBLIC TOILET DOOR

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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SMART SELF-HYGIENE DOOR (SSHD) USING ARDUINO SOFTWARE FOR PUBLIC TOILET DOOR

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A project report submitted
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DEDICATION

Dedicating this bachelor's degree project to my Creator, Allah s.w.t the Almighty, my steadfast support, the wellspring of my inspiration, wisdom, knowledge, and understanding. He the one who has been my source of resilience, empowering me to complete this project during my academic journey. Additionally, I extend this dedication to my parents and family who have provided unwavering support, encouraging me to persist in my endeavors. I am grateful to all my friends and lecturers for their consistent encouragement, guidance, and advice, contributing significantly to the success of this project.

ABSTRACT

In the post COVID-19 era, it has become imperative and adviced for individuals to prioritize self-hygiene and adhere to pandemic standard operating procedures (SOPs) eventhough it is not a compulsory matter anymore. This necessitates the implementation of self-hygiene practices, particularly in public spaces, with special attention to areas that frequently involve physical contact, such as door handles. Moreover, regarding of the current cleaning system, there is a lot of improvement that can be made since there is lot of factors such an inconsistence of the cleaning patterns and the unnecessarily manual labour systems. Thus, this project focuses on designing and implementing an innovative solution that reduces the risk of viral transmission or any bacteria spreading through door handles. By incorporating modern technologies and advanced materials, the contactless self-hygiene system aims to promote hygienic practices among individuals. In terms of the project compability, the project consists of using Arduino UNO as micrcontroller along with the wifi module that uses for solution monitoring and also the Diaphragm Waterpump that executes the sanitation process. For the overall process, the sanitation process depends on three main condition which when the door is stay opened, stay closed and lastly when the door is opened and then closed back which the last one is the only one that triggers the system to executes the sanitation process. After all, the design was scalable and adaptable to various public places, including hospitals, shopping centers, educational institutions, and offices.

ABSTRAK

Dalam era pasca COVID-19, adalah menjadi satu kemestian dan dinasihatkan bagi individu untuk mengutamakan kebersihan diri dan mengikuti prosedur operasi standard (SOP) pandemik walaupun ianya tidak lagi wajib bagi semua pihak. Ini merangkumi pelaksanaan amalan kebersihan diri, terutamanya di ruang awam, dengan perhatian khusus kepada kawasan yang kerap melibatkan sentuhan fizikal, seperti pemegang pintu. Oleh itu, projek ini memberi tumpuan kepada mereka bentuk dan melaksanakan penyelesaian inovatif yang mengurangkan risiko penularan virus atau mana-mana bakteria yang mampu merebak melalui pemegang pintu. Dengan menggabungkan teknologi moden dan bahan termaju, sistem kebersihan diri ini bertujuan untuk menggalakkan amalan kebersihan di kalangan individu. Dari segi keserasian projek, projek ini menggunakan Arduino UNO sebagai mikrokontroler bersama modul wifi yang digunakan untuk pemantauan kandungan cecair dan juga Pam Air Diafragma yang melaksanakan proses sanitasi. Untuk keseluruhan proses, proses sanitasi bergantung kepada tiga keadaan utama iaitu apabila pintu kekal dibuka, kekal tertutup dan yang terakhir apabila pintu dibuka dan kemudian ditutup kembali yang mana keadaan yang terakhir itu adalah satu-satunya yang akan mencetuskan sistem untuk melaksanakan proses sanitasi..Reka bentuk projek ini dilihat lebih berskala dan boleh disesuaikan dengan pelbagai tempat awam, termasuk hospital, pusat membeli-belah, institusi pendidikan dan pejabat.

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CHAPTER 1

INTRODUCTION

1.1 Background

Traditional door handles have long been recognized as potential sources of bacterial and viral contamination due to frequent touching by multiple individuals. In response to this challenge, the Self-Hygiene Door Project aims to develop an innovative solution that addresses the risk of pathogen transmission through door handles while promoting hygienic practices among individuals. The project proposes the integration of sensor-based technology that detects the presence of individuals touching the door handle. It triggers the system to be operated with all the related mechanism to start the door handle sanitation process with the certain amount of time and gap for the user. This system applies at the back surface of the door as the user exit from the toilet.

1.2 Problem Statement

Nowadays, it is shown that the door handle in the public area, especially at the public toilet, is the bacteria agent transmitter that might easily affect other people throughout the area [1]. Thus, it is needed to always clean the public door handle to prevent it. Moreover, the door handle also needed to be cleaned manually with the assistance of manual manpower to maintain cleanliness and hygiene, which might be time-consuming or inconsistent along the way of the sanitation and cleaning process. After all, it is almost impossible to actually predict that out of all people who use the toilet, not everyone was practicing self-care hygiene consistently.

1.3 Project Objective

The objective of this Smart Self-Hygiene Door for Public Toilet door is :

a) To develop current cleaning system using Arduino Uno to automate the door handle cleaning system that clean the door handle regularly to make it stay hygiene.

b) To develop the door self-sanitizing monitoring system using Blynk app

c) To evaluate the functionality and performance of the proposed system.

1.4 Scope of Project

The scope of this project are as follows:

a) The project's emphasis on door handles is a strategic decision aimed at maximizing the accuracy, responsiveness, and overall effectiveness of the contactless system. By leveraging the simplicity and consistency of the handles, the project aims to create a seamless and user-friendly experience for individuals while promoting self-hygiene and minimizing the risk of viral transmission in public toilet door handles.

b) Using Arduino UNO microcontroller for Alarm Magnetic sensor data processing to trigger the Diaphragm Waterpump motor for the sanitation process execution.

c) Using Blynk app for condition monitoring developments.

1.5 Report Outlines

Chapter 1 introduces the project on developing an automated door handle cleaning system for public toilet door. It outlines as a whole the background of the systems, the significance of the it in various usage due to its capability and ranges. The problem statements focus on the developing an automated system that regularly cleans the door handle to make it stay hygiene and also highlights the evaluation of the current manual cleaning processes that need unnecessarily manpower that might not be consistent with the cleaning patterns and the labor factors. In terms of the objectives, developing current cleaning system using Arduino Uno to automate the door handle cleaning system that clean the door handle regularly to make it stay hygiene, developing the door self-sanitizing monitoring system using Blynk app and evaluating the functionality and performance of the proposed system.

Chapter 2 summarizes the analyses and methods used for the smart self-hygiene door. It highlights the advantages of the self-hygiene door in terms of the automated system and the cleaning patterns system. The review summarizes along with the analysis of the various cleaning system technologies that used for the public areas, certain surfaces cleaning and hygiene practicing. Overall, the chapter provides an overciew of the advancements in self-hygiene door for door handle cleaning purposes.

Chapter 3 details the development of the self-hygiene door for the public toilte door handle which, emphasizing the involved techniques and the cleaning system execution methods. The methodology was divided into three parts which hardware developments, software developments and evaluating the perfomances of the self clean system of the door handle. Also, gantt charts are utilized for visualizing the project timeline.

Chapter 4 presents the comprehensive results and discussions derived from the developments of the self-hygiene door, along with a specific focus on its potential applications in public areas. This chapter also explains into various tests conducted to evaluate the sensor's performance, sanitation usage, execution ranges and operational capabilities. Including, the tests between full and half of the sanitizer tests. Thus, the chapter concludes with a summarized table presenting the sanitation process ranges and comparison between manual and automated cleaning process ranges in various of conditions.

Chapter 5 concludes the project findings in this report. Suggestions for future work directions and potential commercialization are also provided

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A literature review summarizes the analysis and research conducted for a thesis. Its primary purpose is to convey the information and ideas that have been generated on a particular topic. To prioritize this study, a literature review was conducted to gather information on the available technology and approaches used by other researchers who were also working on the same subject. This chapter details the project, which includes an in-depth explanation of the optimal method for designing Smart Self-Hygiene Door using Arduino Software for Public Toilet Door.

2.2 Structure of Smart Self-Hygiene Door

2.2.1 Arduino

Arduino is an open-source electronic board and programming software. Its goal is to make electronics available to a wide range of people, including creators, designers, amateurs, and anyone keen in creating interactive objects or environments. Because the hardware design is open-source, one can purchase a pre-assembled Arduino board or build one from scratch. The board's flexibility allows users to tailor it to their specific needs, and they can even update and distribute their own versions.

2.2.2 Alarm Magnetic Magnet Contact Sensor

An alarm magnetic contact sensor is a security device designed to detect the opening or closing of doors and windows. Comprising two components a magnet and a sensor this system is typically installed on doors or windows. The magnet is affixed to the moving part (e.g., the door), while the sensor is attached to the frame. When the door or window is closed, the magnet aligns with the sensor, creating a magnetic circuit. If the door or window is opened, the magnetic field is disrupted, triggering the sensor to send a signal to the alarm system, which then activates an alert. This type of sensor is widely used in home security systems to detect unauthorized entry and can be a crucial component in safeguarding properties against intrusion.

2.2.3 12V Diaphragm Waterpump

A 12V diaphragm water pump is a pump that runs on 12 volts of direct current (DC). These pumps are widely used in a variety of applications, including recreational vehicles, boats, camping setups, agricultural irrigation, and other situations that necessitate a portable and low-voltage water pumping solution. A diaphragm pump (also known as a membrane pump) is a positive displacement pump that pumps a fluid by combining the reciprocating action of a rubber, thermoplastic, or teflon diaphragm with appropriate valves on either side of the diaphragm (check valves, butterfly valves, flap valves, or other types of shut-off valve).

2.3 Study related to Self-Hygiene Door

2.3.1 Dry Toilet Sanitation Research and Development

This paper examines the current state of sanitation in rural Ethiopia, including the national approach, citizen perceptions, the practical situation, and cleanliness interactions between health extension professionals and rural people **[2]**. The qualitative methods used in the study include interviews with rural residents and field observations. A 1524-person household survey was conducted to collect data on sanitation procedures such as hand washing, toilet use, defecation in public, and daily use of water. In addition, the author observed sanitation facilities and how they were used. The paper also includes a review of existing literature on the subject as well as the national government's strategy. Dry toilets are suggested as an alternative sanitation solution in the paper.

2.3.2 Human Support Robot for the Cleaning and Maintenance of Door Handles Using a Deep-Learning Framework

The paper describes a powered by artificial intelligence framework for automating cleaning tasks with a Human Support Robot (HSR) **[3]** . The process of cleaning involves the robot moving around, detecting door handles, and completing cleaning tasks with its manipulator. To classify the image space and provide coordinates for the robot, a deep learning technique is used. The spraying and wiping actions of the robot are controlled in the Robotic Operating System using data from the detection module. The control module creates a task space for the robot and evaluates the desired position of the manipulator. The framework is put to the test on a Toyota HSR platform using numerical simulations and experiments.

2.3.3 Food safety attitudes and practices of chefs in Cappadocia region, Turkey

This study investigates the chef attitudes and methods regarding food safety and hygiene in the Cappadocia region of Turkey [**4]**. The goal is to comprehend how the chef approaches and apply food safety measures. The information was gathered from 108 chefs who worked in various establishments between September and November of 2018. According to the findings, the vast majority of chefs (79.6%) had received basic food safety training. In terms of attitudes and practices, the study finds significant differences between demographic groups. It also demonstrates a positive relationship between chefs' attitudes and practices. According to the study, chefs who have received food safety training tend to have better results in both attitudes and practices than those who have not. The study recommends that all chefs should be able to participate in food safety training programs to enhance their knowledge and implementation of food safety measures.

2.3.4 Governing with Clean Hands: Automated Public Toilets and Sanitary Surveillance

This article investigates the impact of Automated Public Toilets (APTs) on North American city streets, as well as their relationship to the concept of re-democratization **[5]**. It is divided into two parts: privatization and automation. Privatization, which is common in APT operations, has the potential to exclude certain groups and contradict the democratic nature of public spaces. Automation, such as auto-flush and automated faucets and dryers, aims to eliminate biases while concealing the social decision-making that goes into their design. Both privatization and automation, according to the article, contribute to a broader sanitary regime that imposes moral standards on users. Users have few options for using the loo and may resist by challenging the devices themselves. The article demonstrates the importance of sanitary surveillance by contrasting automated and attendant-based toilets.

2.3.5 Design of Automatic Hand Sanitizer System Compatible with Various Containers

The present article presents the conceptualization of an automatic hand sanitizer system that can work with a variety of sanitizer storage containers **[6]** . The system is described in two stages, the first outlining its framework and control components. The goal of this project is to use pump elasticity to improve people's access to the device. The results show that it has been successfully developed an automated hand sanitizer system that can accommodate a variety of containers. When a user's hand comes close to the sensor, the system dispenses sanitizer from the container. Finally, the device's goal is to promote contactless hand disinfection in public places while also preventing virus transmission. It is also cost-effective and environmentally friendly because it reduces waste emissions.

2.3.6 Automated Sanitizing Machine for Recording Thermal Detection and Hygiene Application

This paper proposes the design of a the multipurpose automatic disinfection booth that was an alcohol-based disinfection station that operates without physical contact **[7]**. It is designed for use in hospitals, workplaces, offices, schools, and other relevant locations. This booth serves multiple purposes by sanitizing both the human body and the items they carry. It utilizes UV lights to disinfect objects and accessories. Additionally, it offers an automated hand sanitizing mechanism and measures the person's temperature upon entry. Equipped with smart sensors, the booth can make appropriate decisions. For security, it has a barricade to prevent unauthorized access and stores a person's image data. Furthermore, it provides free energy.

2.3.7 Use of thermal imaging to measure the quality of hand hygiene.

Promoting hand hygiene has long been recognized as an effective strategy for reducing infection transmission **[8]**. However, previous studies have revealed poor compliance and hand hygiene quality, necessitating ongoing surveillance among healthcare workers. This study investigates the feasibility of using a combination of thermal and RGB cameras to determine the extent of hand coverage with alcohol-based formulations, providing a method for monitoring the efficacy of hand rubbing.

2.3.8 Design of Automatic Hand Sanitizer with Temperature Sensing

This design depicts global preventive measures for the COVID-19 pandemic. Sanitizers are currently the most significant commodities **[9]**. According to WHO regulations, strict sanitation is necessary for survival. The design provided a solution to the problem stated. The design includes an automatic hand sanitizer and temperature sensing system, allowing users to sanitise their hands whenever they want without having to touch the machine. When touched, the temperature sensor measures the person's body temperature.

2.3.9 An Automatic Hand Sanitizing and Temperature Measuring System using RFID Technology with Special reference to the Higher Education Institutes (HEIs) in Sri Lanka

The study aims to evaluate and select the best system development methodology for maintaining hygiene and safety on premises **[10]**. Methods include calculating healthy attendance, identifying infected guests, and eliminating germs/viruses from hands. The study aims to use RFID technology to create an automatic hand sanitising and body temperature measurement system for Higher Educational Institutes (HEIs) in Sri Lanka.

2.3.10 Hand sanitizers: A review of ingredients, mechanisms of action, modes of delivery, and efficacy against coronaviruses

This review conducted an extensive literature search to succinctly summarise the primary active ingredients and mechanisms of action of hand sanitizers, compare the effectiveness and compliance of gel and foam sanitizers, and predict whether alcohol and non-alcohol hand sanitizers would be effective against SARS-CoV-2 **[11].**

2.3.11 Inactivation of multiple human pathogens by Fathhome's dry sanitizer device: Rapid and eco-friendly ozone-based disinfection

To investigate the potential of novel sterilisation techniques, this study measured the disinfection efficacy of Fathhome's ozone-based, dry-sanitizing device using dose and time response **[12]**. Human pathogen inactivation was tested on nonporous (plastic) surfaces. These findings strongly support the hypothesis that Fathhome's commercial gas-based disinfection system is capable of rapidly decontaminating a wide range of pathogens on PPE and other industrial materials.

2.3.12 Tribo-sanitizer: A portable and self-powered UV device for enhancing food safety

Food safety remains a major concern around the world. Every year, hundreds of millions of people become ill as a result of eating contaminated food, resulting in economic losses worth hundreds of billions of dollars **[13]**. To address these issues, Tribo-sanitizer has been created, which uses a freestanding rotational triboelectric nanogenerator (FSR-TENG) to convert mechanical energy into long-lasting, low-cost, or free electricity that powers an ultraviolet-C (UVC) lamp for food-safety applications.

2.3.13 COVID-19 clinical waste reuse: A triboelectric touch sensor for IoT-cloud supported smart hand sanitizer dispenser

This study introduces the concept of a waste-to-energy conversion approach to reusing COVID-19 scraps for green and sustainable development **[14]**. Furthermore, this work plays an important role in disaster management by reducing microplastic pollution in the environment by reusing pandemic wastes for energy harvesting and sensing applications, as well as preventing the spread of coronavirus through proper hand hygiene.

2.3.14 Self-sanitizing reusable glove via 3D-printing and common mold making method

The study describes reusable self-sanitizing gloves made with 3D printing and common hand moulding methods **[15]**. The most significant contribution is frequent self-sanitization of gloves without any manual intervention. The gloves can be customised to improve comfort by fabricating them from a 3D-printed mound designed based on the user's palm size. Individuals working in hospitals, transportation, delivery units, schools, offices, industries, and other settings can benefit from the developed technology.

2.3.15 Prevalence of alcohol-tolerant and antibiotic-resistant bacterial pathogens on public hand sanitizer dispensers

Since the COVID-19 pandemic, most public and clinical settings have installed alcohol-based hand sanitizer dispensers (HSDs) for hygiene and ease of use **[16]**. Thus, the purpose of this study is to see if sanitizer-tolerant bacterial pathogens can colonise HSDs, spreading diseases and developing antibiotic resistance.

2.4 The comparison of Selected Literature Review

Table 2.1 shows the comparison of the chosen literature review based on previous research paper and related journals.

Table 2.1: The table of literature review comparison

Title of Journal	Author	Description
[1] Dry Toilet Sanitation Research and Development, 2015	Beshah M. Behailu	The study employs qualitative methods such as interviews with rural residents . **Advantages :** Explore and observed about sanitation process of the rural areas. **Disadvantages:** The gaps between introducing dry toilet sanitation to the ground.
[2] Human Support Robot for the Cleaning and Maintenance of Door Handles Using a Deep-Learning Framework, 2020	Balakrishnan Ramalingam, Jia Yin, Mohan Rajesh Elara, Yokhesh Krishnasamy Tamilselvam, Madan Mohan Rayguru, M. A. Viraj J. Muthugala and Braulio Félix Gómez	This work introduces an AIpowered framework that uses a Human Support Robot (HSR) to automate cleaning tasks. **Advantages:** A novel technique for automated

		door-handle cleaning was proposed. **Disadvantages:** Takes time to develop the algorithm.
[3] Food safety attitudes and practices of chefs in Cappadocia region, Turkey, 2020	Reha Kılıçhan, Harun Çalhan & Mehmet Umur	This study investigates how chefs in the Cappadocia region, Turkey approach and implement food safety measures. **Advantages:** Improve their knowledge and implementation of food safety measures. **Disadvantages:** The derivation of the findings has limitations.
[4] Governing with Clean Hands: A erning with Clean Hands: Automated Public Toilets and Sanitary Surveillance, 2010	Irus Braverman	This article discusses the impact of Automated Public Toilets (APTs) in North American cities and their relationship to the concept of democratization. **Advantages:** Promote a double form of sanitation. **Disadvantages:** Users have

		limited options in how they use the restroom and may resist by challenging the devices themselves.
[5] Design of Automatic Hand Sanitizer System Compatible with Various Containers, 2020	Juhui Lee1, Jin-Young Lee, SungMin Cho, Ki-Cheol Yoon, Young Jae Kim & Kwang Gi Kim	The article suggests an automatic hand sanitizer system that is designed to work with various sanitizer containers. **Advantages:** Device pump elasticity with low cost production. **Disadvantages:** None
[6] Automated Sanitizing Machine for Recording Thermal Detection and Hygiene Application, 2022	Prashant D. Kamble, Ketan Fulzele, Nikhil Shahare, Ritik Rane, Shilpa B. Sahare and Yashika Gaidhani	This paper introduces a multipurpose automatic disinfection booth. **Advantages:** Able to make an informed decision systems. **Disadvantages:** Might require a lot of certain spaces.

[7] Use of thermal imaging to measure the quality of hand hygiene.	C. Wang, W. Jiang, K. Yang, Z. Sarsenbayeva, B.Tag, T. Dingler, J. Goncalves, V. Kostakos	Promoting hand hygiene has been a longstanding strategy to effectively curb infection transmission **Advantages:** Longterm planning systems **Disadvantages: N**ot able to evaluate the efficacy of handwashing with water
[8] Design of Automatic Hand Sanitizer with Temperature Sensing	Abhinandan Sarkar	This design depicts global preventive measures for the COVID-19 pandemic. Sanitizers are currently the most significant commodities **Advantages:** Non-contact sanitizing machine **Disadvantages:** Power distribution hindrance
[9] An Automatic Hand Sanitizing and Temperature Measuring System using RFID Technology with Special reference to the	Chamod Hansajith, Samanthi Wickramasinghe	The study aims to evaluate and select the best system development methodology for maintaining hygiene and safety on premises

Higher Education Institutes (HEIs) in Sri Lanka		**Advantages:** An efficient sanitizing technology **Disadvantages:** None
[10] Hand sanitizers: A review of ingredients, mechanisms of action, modes of delivery, and efficacy against coronaviruses	Andrew P. Golin, Dexter Choi, Aziz Ghahary	Compare the effectiveness and compliance of gel and foam sanitizers **Advantages**: Further research of sanitizer ingredient for enhancement **Disadvantages**: None
[11] Inactivation of multiple human pathogens by Fathhome's dry sanitizer device: Rapid and eco-friendly ozone-based disinfection	Ryan Kenneally, Quentin Lawrence, Ella Brydon, Kenneth H. Wan, Jian-Hua Mao, Subhash C. Verma, Amir Khazaieli, Susan E. Celniker, Antoine M. Snijders	To investigate the potential of novel sterilisation techniques **Advantages:** Slowing and chronic overuse and misuse of antibiotics in healthcare settings, the past ten year **Disadvantages**: Undermining the benefits of sterilization and reuse
[12 Tribo-sanitizer: A portable and self-powered UV device for enhancing food safety	Zhenhui Jin, Fujunzhu Zhao, Longwen Li, Yi-Cheng Wang	Uses a freestanding rotational triboelectric nanogenerator (FSR-TENG)

		to convert mechanical energy. **Advantages:** Solution to some intractable global food-safety problems. **Disadvantages:** High Cost
[13] COVID-19 clinical waste reuse: A triboelectric touch sensor for IoT-cloud supported smart hand sanitizer dispenser	Sayyid Abdul Basith, Arunkumar Chandrasekhar	This study introduces the concept of a waste-to-energy conversion approach to reusing COVID-19 scraps for green and sustainable development **Advantages:** Solution to some intractable global food-safety problems. **Disadvantages:** High Cost
[14] Self-sanitizing reusable glove via 3D-printing and common mold making method	Kishor Kumar Sadasivuni, Muni Raj Maurya, Mohammad Talal Houkan, John-John Cabibihan, Mithra Geetha, Somaya Al-Maadeed, Hafsa Omar, Noor Asnida Asli	The study describes reusable self-sanitizing gloves made with 3D printing and common hand moulding methods. **Advantages:** curtailing the spreading of infectious diseases through cross-contamination.

		Disadvantages: None
[15] Prevalence of alcohol-tolerant and antibiotic-resistant bacterial pathogens on public hand sanitizer dispensers	Y.W.S. Yeung, Y. Ma, S.Y. Liu, W.H. Pun, S.L. Chua	Developing antibiotic resistance **Advantages:** Prevent emergence of alcohol-resistant pathogens. curtailing the spreading of infectious diseases through cross-contamination. **Disadvantages:** None

2.5 Summary

Overall, this chapter focuses on reviewing of current and past analysis of the existing cleaning system in various types and conditions that have certain pros and cons in it which might be imbalance and have a lot of improvement in it for a better outcome in terms of cleaning systems. Thus, this smart self-hygiene door project proposes few methods as an alternative to evaluating all of the improvements that can be made in certain ways and conditions.

CHAPTER 3

METHODOLOGY

3.1 Introduction

Introduction to Research Methodology provides a thorough overview of various research paradigms, methodologies, and related tools and techniques. The primary goal of this chapter is to delve into the overall research and hardware process flow, as well as the methodology for designing a study. This section provides readers with guidance on developing a research design for their own study. This chapter provides an essential review of the research methodologies section of a study proposal, followed by data analysis templates for various types of designs. These methodologies adhere to a well-defined plan that includes several key steps. These steps include selecting a suitable project title, conducting research in scholarly journals and articles, planning the necessary project design and components, integrating hardware and software into the project, testing its functionality, troubleshooting any issues that arise, and finally documenting the findings in a report. A project requires an organised approach, and to that end, a comprehensive flow chart is created, illustrating the necessary processes from the project's inception to its completion. Furthermore, before beginning this project, you must have a thorough understanding of the hardware and software tools that used.

3.2 Selecting and Evaluating Tools for a Healthcare Development

When designing and implementing an automated self-hygiene door project tailored for the healthcare sector, it is critical to carefully select and evaluate the tools and technologies used for data collection and analysis. This process entails taking into account a variety of methodological aspects, such as sensor precision and dependability, assessing the compatibility of different tools and software, and reflecting on the project's potential environmental implications. Furthermore, equal attention should be paid to the social and economic consequences, such as ensuring that diverse stakeholders have access to and understand the data, as well as weighing the costs and benefits of various tool options. Several approaches can be used to support these methodological considerations, including conducting field tests to evaluate sensor accuracy, using open-source software to increase transparency and accessibility, and conducting life cycle assessments to assess the project's environmental impact. Researchers and practitioners can ensure the efficiency, sustainability, and impact of their efforts by carefully selecting and evaluating tools for an automated self-hygiene door project.

3.3 Project flowchart

In order to ascertain and guarantee the effectiveness of a project, it is crucial to establish a well-structured and streamlined workflow chart. A meticulously organized and carefully devised plan is imperative for the accomplishment of any undertaking. Once the planning phase is completed, the subsequent step involves conducting thorough research. To streamline the process, project implementation becomes essential. A comprehensive investigation helps identify and preemptively address potential issues during the project execution. After the project concludes, an analysis is conducted to evaluate its effectiveness.

3.3.1 Project Implementation Flowchart

The primary goal of project methodology is to guarantee that specific processes, procedures, techniques, methodologies, and technologies are followed by allowing for effective decision making and resolving issues throughout the management procedure. Firstly, looking for existing self-clean door or more specifically door handle sanitation that might be used today and looking for the weakness and then planning to improve that system. Then, we create new design of self-clean/sanitation door with extra features and going to do the simulation using Arduino UNO. The implementation of program was done by Arduino UNO software Then, fabricated to get the equivalent hardware. For the last step, the simulation results have been compared to validate the hardware performance. The flowchart below shows how to write a report, which includes designing a project, deploying the necessary hardware and software, and analyzing the project's overall success. Also provided is a qualitative method for locating project-related information.

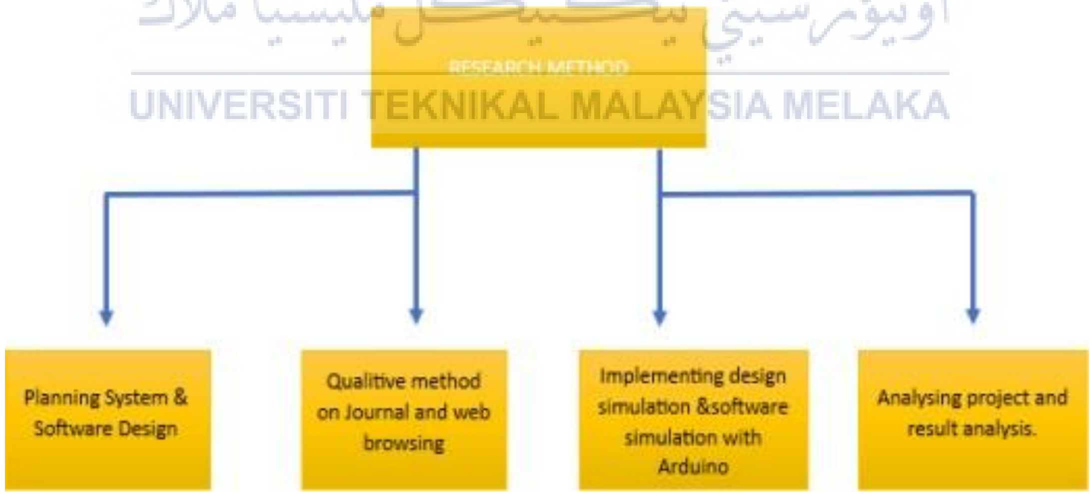

Figure 3.1: Research Method

3.3.2 Proposed system’s process flow

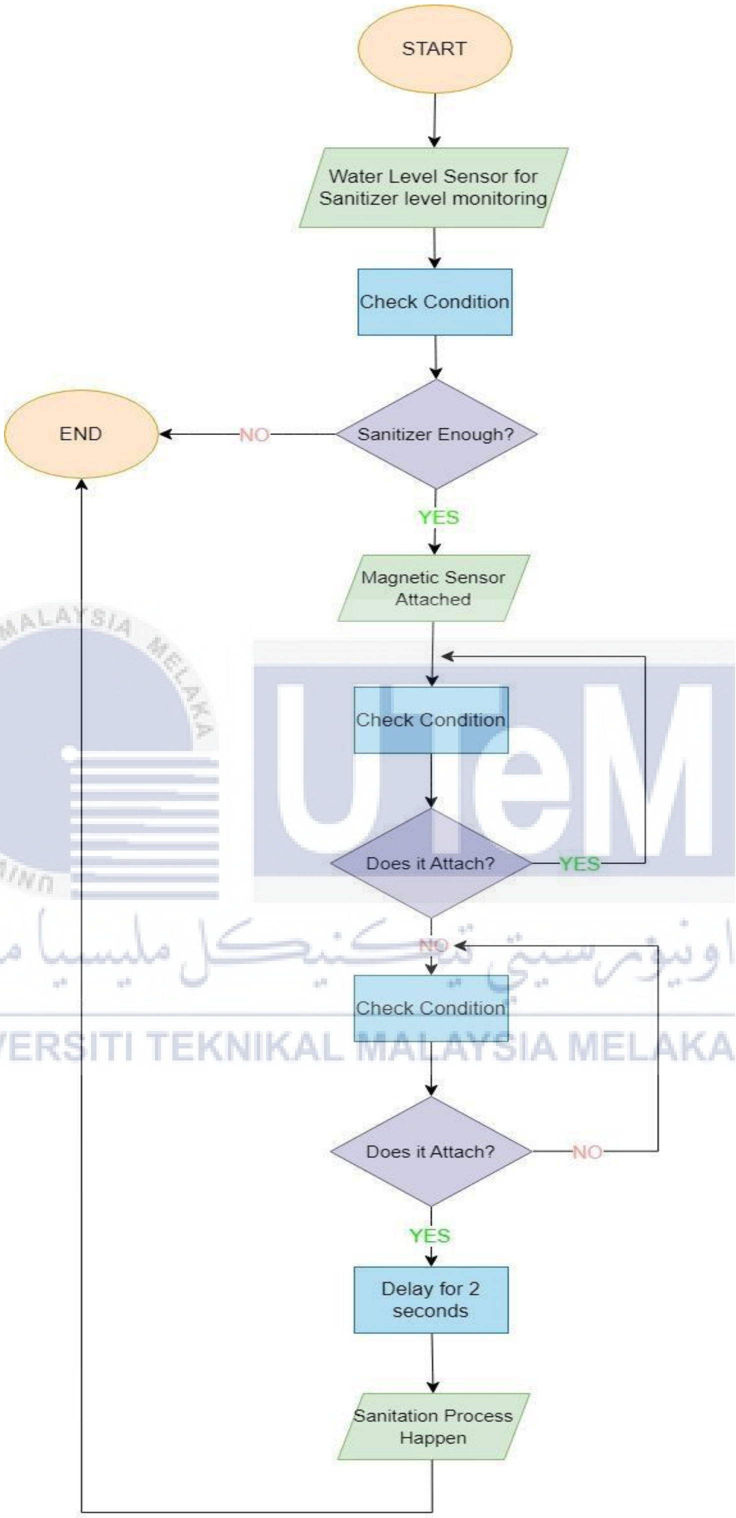

Figure 3.2: Flowchart of the project

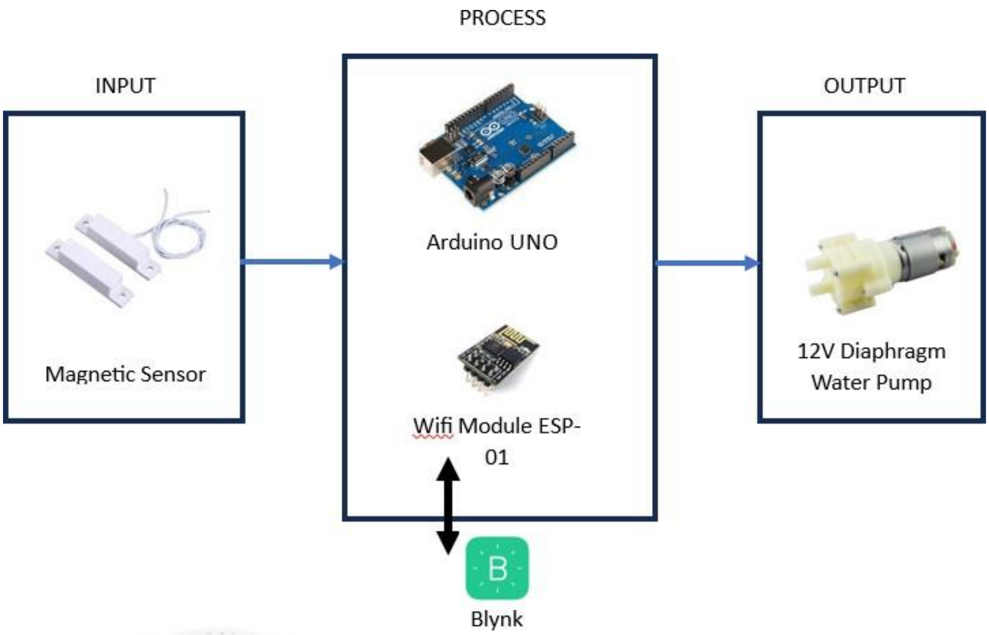

Figure 3.3: Block Diagram of the project

Based on the figure 3.2 above, it explains the how process on how the systems operated sequencely. It started with when the water level sensor for sanitizer level monitoring checking the condition either the sanitizer level is enough or not, if it do enough then the process continues but if it's not the process ended. What happen next is the magnet sensor checked it's condition that rely under three main condition which, the magnet sensor is attached, the magnet sensor is unattached and when the magnet sensor is attached then unattached back. So the process only continues for the last condition which when the magnet is attached then unattached then attached back. Next, when the last condition meets and the system triggers, with the delay of 2 seconds the sanitation process executes. After the sanitation process ended it returns back to the END process and on idle mode until the system triggers back.

In Figure 3.3, the magnetic sensor triggers the system whenever there is motion at the door. The condition of the door itself depends on three conditions: when the door stays open, when the door stays closed, and lastly, when the door opens and then closes. The last condition, when the door is opened and then closed back, the only one that triggers the whole system. What happened next was that the Arduino UNO processed the data and transferred the related information. Lastly, what happened was that the transferred data triggers the DC motor to be operated, which then proceed to the cleaning process, which is the sanitation process.

3.4 Software Implementation

3.4.1 Arduino

Figure 3.4: Arduino Software

Arduino is an electronic board and accompanying software that is open-source and used for programming. Its aim is to make electronics accessible to a wide range of people including artists, designers, and anyone who intend to create some sort of innovative objects or designs. One can buy a pre-assembled Arduino board or build one by hand as the hardware design is open-source. The flexibility of the board allows users to adapt it to their specific needs, and they can even update and distribute their own versions. [Refer **Appendix B** for full coding references]

3.4.2 C++ Programming Language

C++ is an object-based programming language created by Bjorne Stroustrop as a successor to the C language. It offers developers greater control over memory and system resources, supports object-oriented programming paradigms, and provides efficient performance. These features make C++ a versatile language for a wide range of software development applications.

3.4.3 Blynk Application

Figure 3.5: Blynk Application Icon

Blynk allows you to quickly create interfaces for controlling and monitoring hardware projects using iOS or Android mobile devices. After installing the Blynk software on the device, it can create a project. Dashboards can be used to display widgets such as buttons, sliders, graphs, and so on. The widgets allow you to control pins and display sensor data.

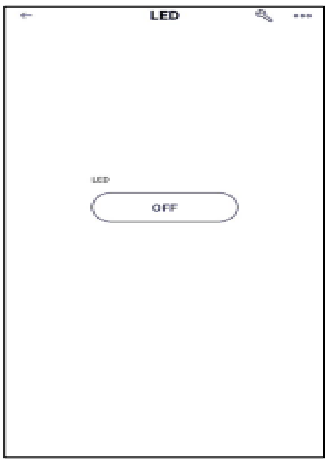

Figure 3.6: An example of the project dashboard that can be used

3.5 Hardware Implementation

3.5.1 Arduino UNO

Figure 3.7: Arduino UNO

The ATmega328P-based UNO version of the Arduino is a microcontroller board. It has 14 digital I/O pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a ceramic resonator operating at 16 MHz, a USB connection, a power jack, a header for ICSP, and a reset button. It comes with everything that needed to operate the microcontroller; only connect it to a computer via USB or power it via an AC-to-DC adapter or battery to get launched.

3.5.2 Magnetic Sensor (Door Alarm Sensor)

Figure 3.8: Magnetic Sensor

A door alarm sensor consists of two components, a magnet and a switch, and is designed to activate an intrusion detection alarm control panel whenever a door is opened or closed. The magnet is attached to the door, while the switch is connected to a wire that connects back to the control panel.

3.5.3 DC Relay Switch Driver

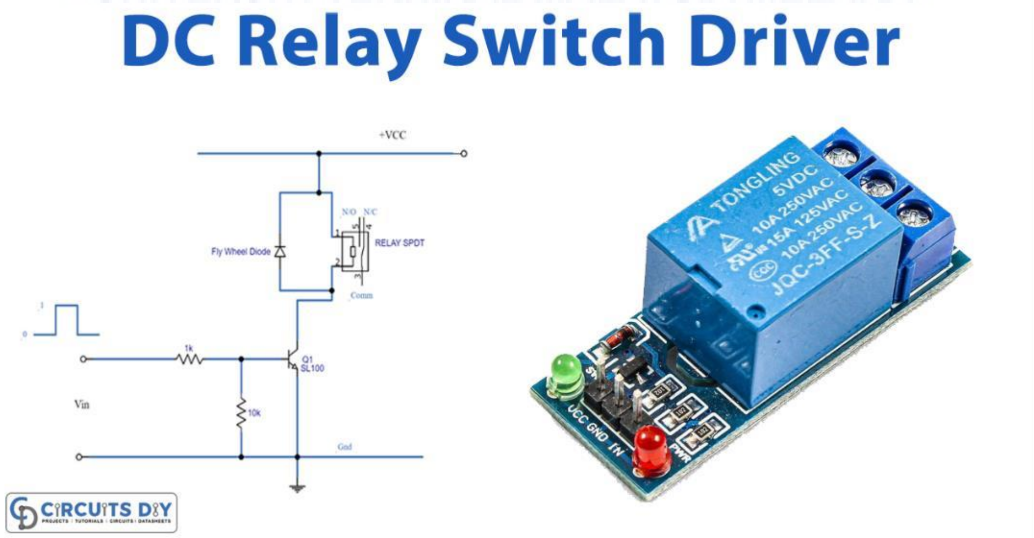

Figure 3.9: DC Relay Switch Driver

A DC relay switch, also known as a relay, is an electromagnetic switch that uses a small electric current to control a much larger current. A relay's primary function is to control high-voltage or high-current circuits by sending a low-voltage or low-current control signal. A DC relay switch is used to manage DC power in electrical systems.12V Diaphragm Water Pump

Figure 3.10: 12V Diaphragm Water Pump

A 12V diaphragm water pump is a pump that runs on 12 volts of direct current (DC). These pumps are widely used in a variety of applications, including recreational vehicles, boats, camping setups, agricultural irrigation, and other situations that necessitate a portable and low-voltage water pumping solution. A diaphragm pump (also known as a membrane pump) is a positive displacement pump that pumps a fluid by combining the reciprocating action of a rubber, thermoplastic, or teflon diaphragm with appropriate valves on either side of the diaphragm (check valves, butterfly valves, flap valves, or other types of shut-off valve).

3.5.4 Wifi Module ESP-01

Figure 3.11: Wifi Module ESP-01

The ESP-01 is a popular Wi-Fi module designed by Espressif Systems, a company known for its contributions to IoT and wireless communication technologies. The ESP-01 module is part of the ESP8266 family, which is commonly used to add Wi-Fi functionality to a wide range of electronic projects. The ESP-01S ESP8266 WiFi Module is also a self-contained SOC with an integrated TCP/IP protocol stack, allowing any microcontroller to connect to your wireless network. The ESP8266 can either host an application or delegate all Wi-Fi networking functions to a separate application processor.

3.5.5 Circuit Diagram connections

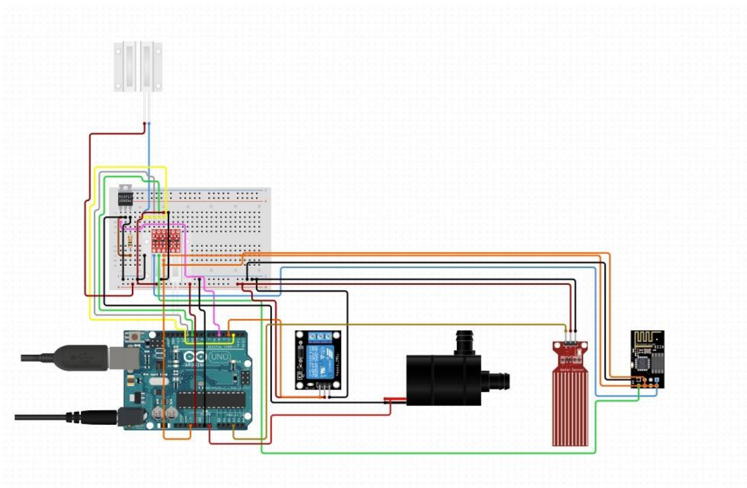

Figure 3.12: Circuit Overall Connections

Based on the Figure 3.12 above, it describe as a whole of the circuit connections between the arduino uno, wifi module, waterpump and the sensor itself. Below is the further details on each pins that connected that link to each other.

- **Arduino Uno and ESP-01:**
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
- **Arduino Uno and Alarm Magnet Sensor:**
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
- **Arduino Uno and Water Pump:**
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.
  - Connect the VCC of ESP-01 to 3.3V on Arduino Uno.

3.6 Prototype Development

Figure 3.13 illustrates that this prototype incorporates a variety of sensors to gather data on important parameters. It triggers and deployed the magnetic sensors that attached and meet certain condition to be actually operated.

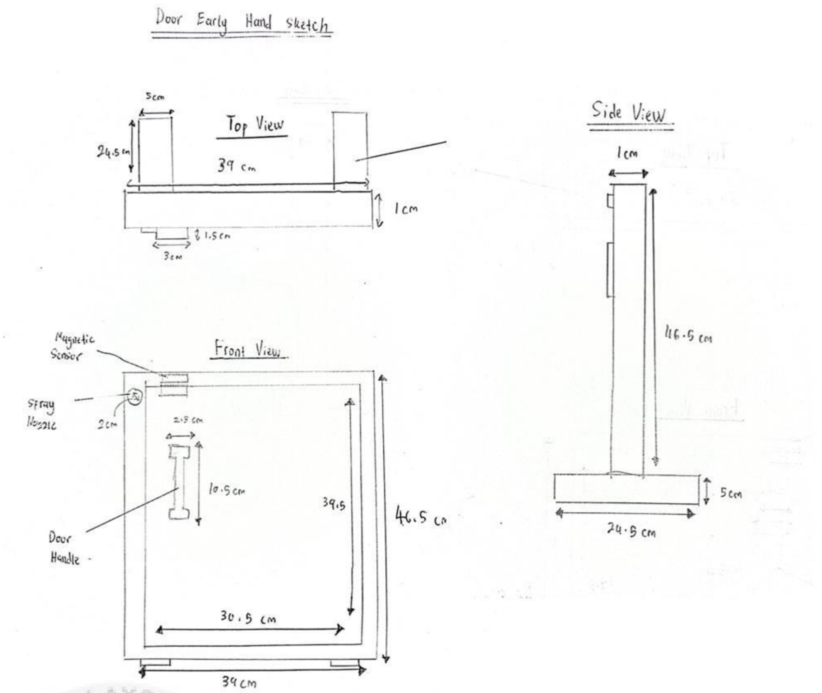

Figure 3.13: Early sketch of the project prototype

After that a further improvement have been made in order to come out eith the actual proper project prototype including the cutting, joining and finishing it from the raw material and resources. Also it had been added with some door hinge on the corner of the door so that it can be opned and closed as it shown in Figure 3.14

Figure 3.14: Final prototype design

3.7 Summary

This chapter presents a suggested approach for devising a novel, efficient, and cohesive strategy for the creation of an automated self-hygiene door system. A project progression flow chart has been devised to guarantee the seamless execution of the project implementation process. The choice of methods and components has been finalized prior to the commencement of the project, encompassing both software and hardware considerations. A comprehensive exploration of the operational principles of hand signals has been undertaken to ensure the achievement of the project's objectives. Subsequently, the project is poised to advance to the final report stage.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Introduction

Automated self-hygiene doors involve the identification and interpretation of data collected about the system's functionality. The process entails reviewing the data collected during the automated door's operation and using it to improve the system's overall efficiency. The primary goal is to use the data to create a model capable of producing meaningful results. These outputs may respond accurately to new inputs or make predictions based on a previously trained dataset. Once the predicted outcomes for the door's performance have been obtained, an analysis is carried out to determine the model's effectiveness. This assessment may include calculating metrics such as accuracy, precision, and recall, as well as visualising the results using techniques such as a confusion matrix.

4.2 Experimental setup

The apparatus of the smart self-hygiene door system as shown below in Figure 4.1 is a setup to conduct the experiments and process to test the sanitation process and the funcctionally of the system which it is consist of:

1) Wifi Module ESP-01
2) Magnetic Alarm Sensor
3) Arduino UNO
4) DC Switch Relay
5) 12V Diaphragm Waterpump

Figure 4.1: Smart Self-Hygiene Door system experimental setup

Figure 4.2 below shows the parts of the water pump in the system that are used for the sanitation process. The pump activated by the sensor data that is sent through the Arduino when it meets a certain condition that triggers the system. The waterpump then suck the sanitizer solution in the container and flow through the tube, which then flow through the tip of the spray to complete the sanitation process.

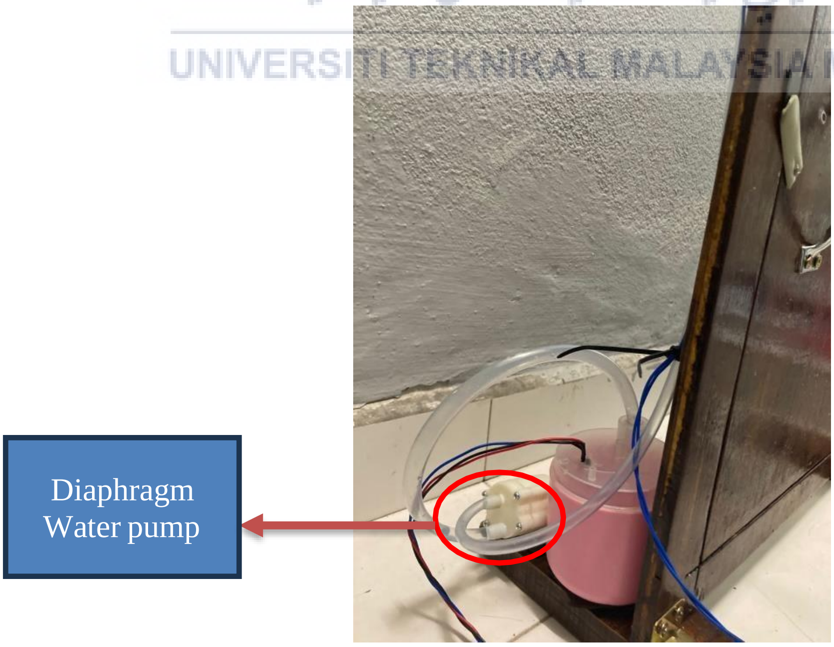

Figure 4.2: The waterpump system

Hence, Figure 4.3 shows the sensor system setup for the door system, which started with the magnetic sensor that was attached and meet certain conditions to actually activate the system, which, when the door is closed, opened, and then closed back, it triggers the system. The condition data next, sent to the Arduino to be processed, which also trigger the relay switch to process the whole system and start the sanitation process.

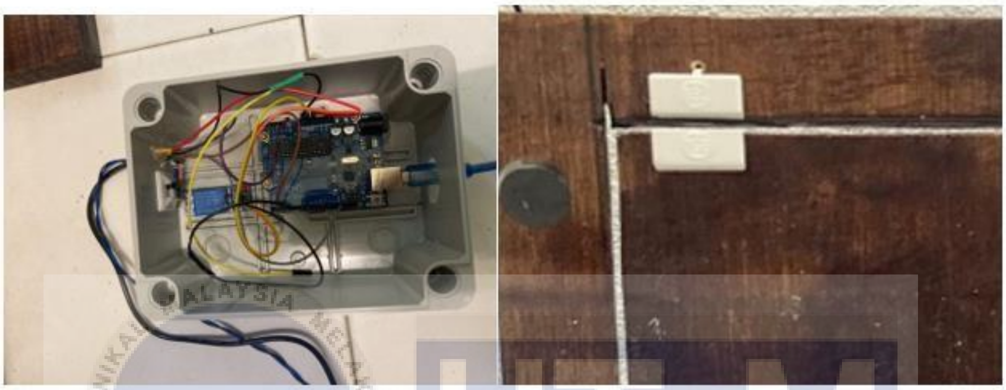

Figure 4.3: The sensor setup and the Arduino setup for the door system.

4.3 Hardware Development

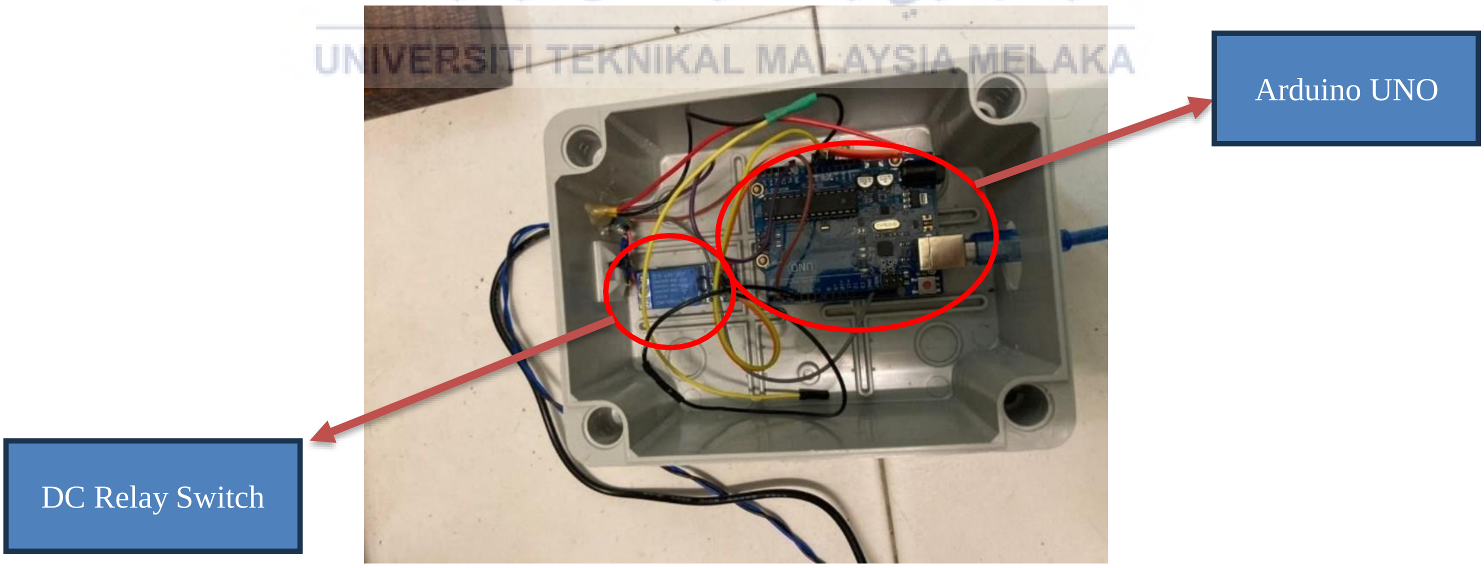

Figure 4.4: Hardware configuration of the project

Figure 4.4 shows the hardware configuration of the project, which has been linked up and bound together based on the connections and pins involved. As seen in the container box, a minor hole has been made to let out an external cable for plug-in supply to make it easier and more portable for the hardware to be carried on or be more moveable based on certain situations.

4.4 Software Development

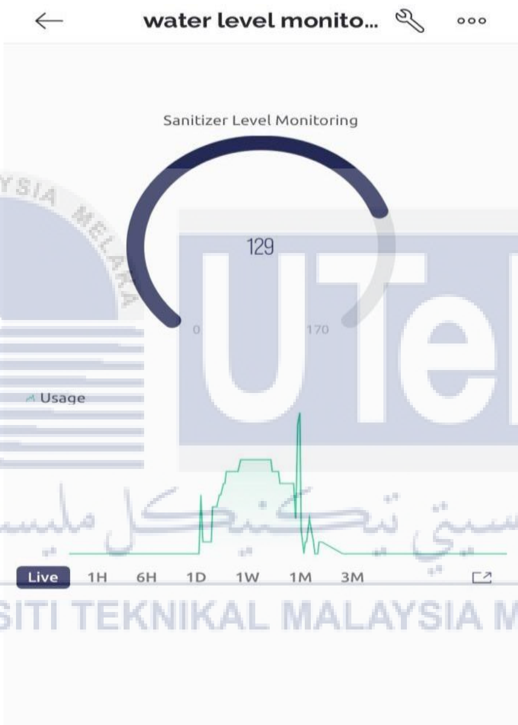

Figure 4.5: Project Dashboard on Mobile Application

Figure 4.5 shows the project dashboard on the mobile application, which is Blynk. The Blynk is an application that is developed to remotely operate hardware, show data from sensors, store it, and then visualize it. In this project, Blynk is utilized to display values obtained from the input sensors and monitor the level of any solution in the container accordingly to notify the user of its status. Blynk can communicate with what we programmed in the Arduino IDE by using an authentication token that is suited only for one device. Once the Blynk is connected, the value from the sensors is collected and immediately displayed in the Blynk application, which can be used for data collection or outcome monitoring.

4.5 Sensor Calibration

4.5.1 Alarm Magnetic Sesnor Calibration

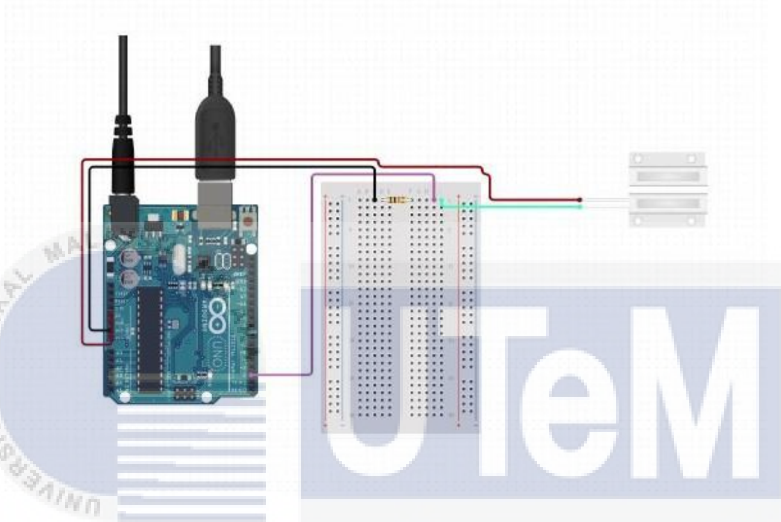

Figure 4.6: Alarm Magnetic Sensor with Arduino UNO connection

For checking the precision of the alarm magnetic sensor and its functionality, the magnetic sensor must be calibrated. When the sensor is in contact, the results of the reading must be stated if the door is closed. Meanwhile, if the sensor was not in contact, the results must indicate that the door is open. This result is important since it is able to determine a certain condition for the system to tally with the condition to be triggered.

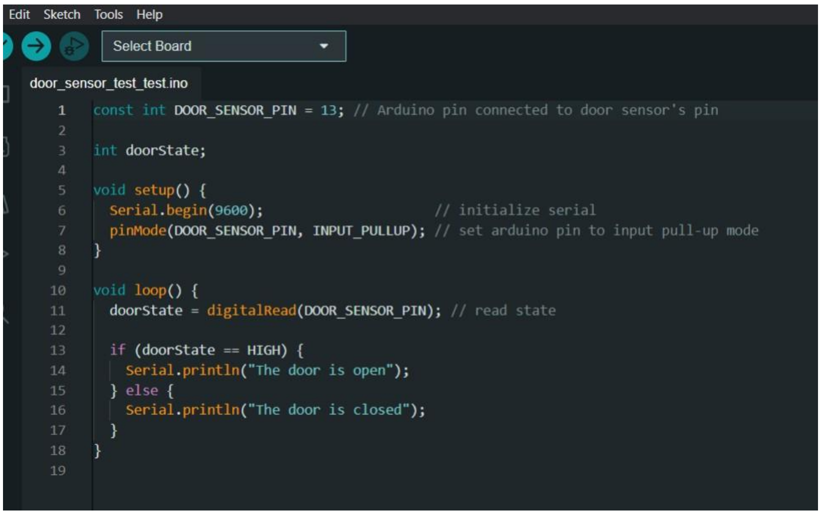

Figure 4.7: Alarm Magnetic Sensor Calibration code

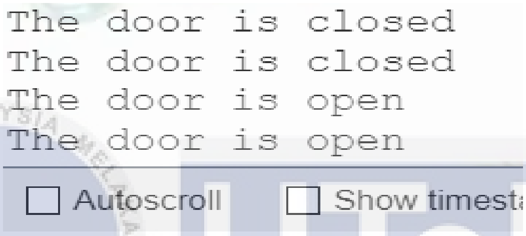

Figure 4.8: Results of Alarm Magnetic Sensor calibration

By referring to Figure 4.7, it shows the coding and setup for the sensor calibration process, and as supposedly shown in Figure 4.8, the actual output of the calibration process has to appear on the serial monitor. When the sensor is in contact, the output shows that “the door is closed," while if the sensor is not in contact, the output showed that “the door is open.”.

4.5.2 Water Level Sensor Sesnor Calibration

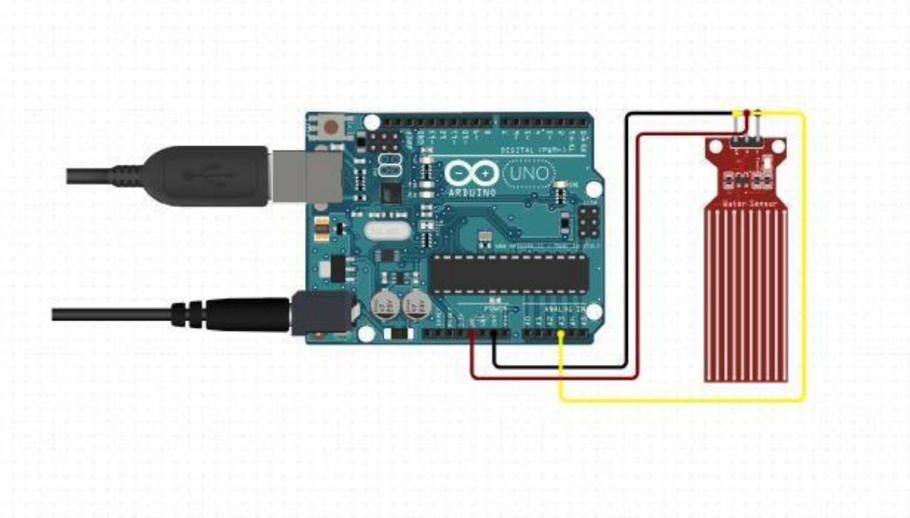

Figure 4.9: Water Level Sensor with Arduino UNO calibration

Figure 4.9 shows the checking of the water level sensor precision and its functionality; it must be calibrated. When the sensor is submerged in water, the results of the reading must be stated as different levels of numbers, which started with 0 until a certain amount, to ensure the sensor is fully submerged in the water. This result is important since it is able to determine the level of the solution in the sanitizer container.


```
// Sensor pins
#define sensorPower 7
#define sensorPin A0

// Value for storing water level
int val = 0;

void setup() {
  // Set D7 as an OUTPUT
  pinMode(sensorPower, OUTPUT);

  // Set to LOW so no power flows through the sensor
  digitalWrite(sensorPower, LOW);

  Serial.begin(9600);
}

void loop() {
  //get the reading from the function below and print it
  int level = readSensor();

  Serial.print("Water level: ");
  Serial.println(level);

  delay(1000);
}

//This is a function used to get the reading
int readSensor() {
  digitalWrite(sensorPower, HIGH);  // Turn the sensor ON
  delay(10);              // wait 10 milliseconds
  val = analogRead(sensorPin);    // Read the analog value form sensor
  digitalWrite(sensorPower, LOW);   // Turn the sensor OFF
  return val;             // send current reading
}
```

Figure 4.10: Water Level Sensor calibration code

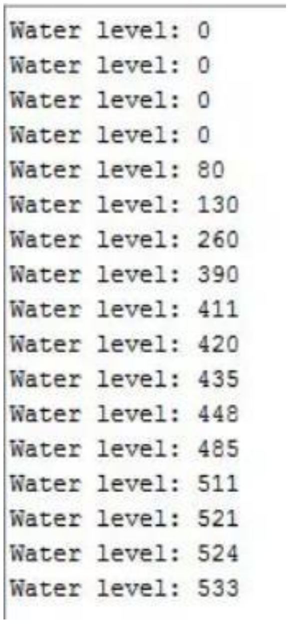

Figure 4.11: Results of the Water Level Sensor calibration in serial monitor

By referring to Figure 4.10, it shows the coding and setup for the sensor calibration process, and as supposedly shown in Figure 4.11, the actual output of the calibration process has to appear on the serial monitor. When the sensor is not submerged yet, the water level stated as 0, and when it is fully submerged, the water level stated as 533 which reach the 250 ml value with the percentage of 100%, which shows that the sensor is already fully submerged.

4.6 Circuit Design

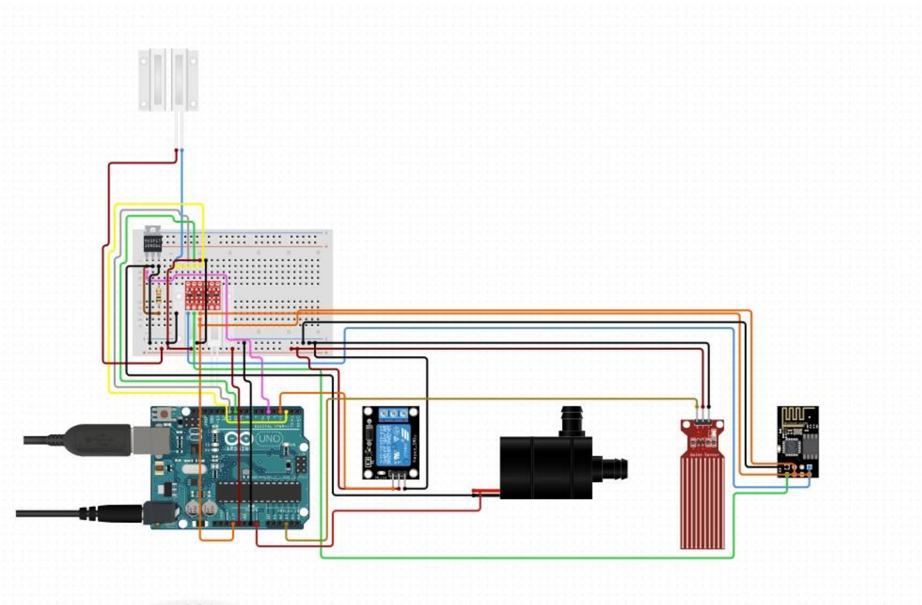

Figure 4.12: Design Circuit of the Self-Hygiene Door system

Figure 4.12 shows the circuit design for the entire sensor and system link-up of the project, and as a whole, it shows the actual installation of the components that were used in the project. Initially, it can be seen that the Arduino UNO is an important and core component for the whole system since it collects all of the sensor data for the whole system process.

4.7 Results

The data from all of the sensors that were used directly transferred into the Arduino UNO, and the output shown in the Arduino IDE through the serial monitor. From there, the water pump operated accordingly so that the sanitation process can be performed to complete the whole cleaning process. Some of the data from the sensors that were collected transfer to the cloud, where it transferred to the user interface and application, which is the Blynk app on the phone. This type of data is used for monitoring and data recording for user usage.

4.8 Analysis

4.8.1 Collective data between certain amount of sanitizer solution for certain number of usage.

In order to determine the daily usage of the door, along with tracking the current number of users that came in as well as how much sanitizer solution was left during that time, a test and experiment were done to determine it with some collective data provided to see the average pattern between the user and the sanitizer solution level for daily usage. Figure 4.13 below shows that the container of the sanitizer that can be filled has a maximum capacity of 220 ml and is used for the whole project and experiment.

Figure 4.13: The sanitizer container that can filled maximum of 220ml

Table 4.1: Sanitizer Solution and user usage Test result (150 ml)

TEST	SANITTIZER SOLUTION: 150 ml
1	101 user
2	98 user
3	100 user
4	102 user
5	99 user

Table 4.2: Sanitizer Solution and user usage Test result (220 ml)

TEST	SANITTIZER SOLUTION: 220 ml
1	196 user
2	200 user
3	198 user
4	204 user
5	202 user

Based on the both table above it is shown the results of the tests that done for both 150 ml and 220 ml sanitizer content level. Therefore:

- For 150ml: 101+98+100+102+99 = $\frac{200}{5}$ = 100 user per average for 100ml, thus $\frac{150}{100}$

  = 1.5ml per user

- For 220ml: 196+200+198+204+202 = $\frac{1000}{5}$ = 200 user per average for 220ml, thus

  $\frac{150}{200}$ = **0.75ml per user**

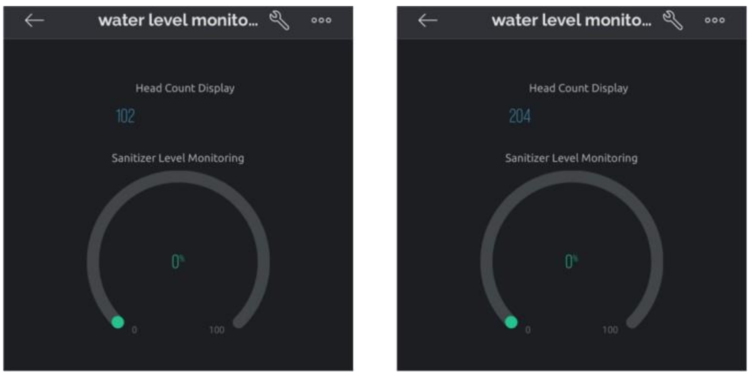

Figure 4.14: The headcount displays used to monitor the user total

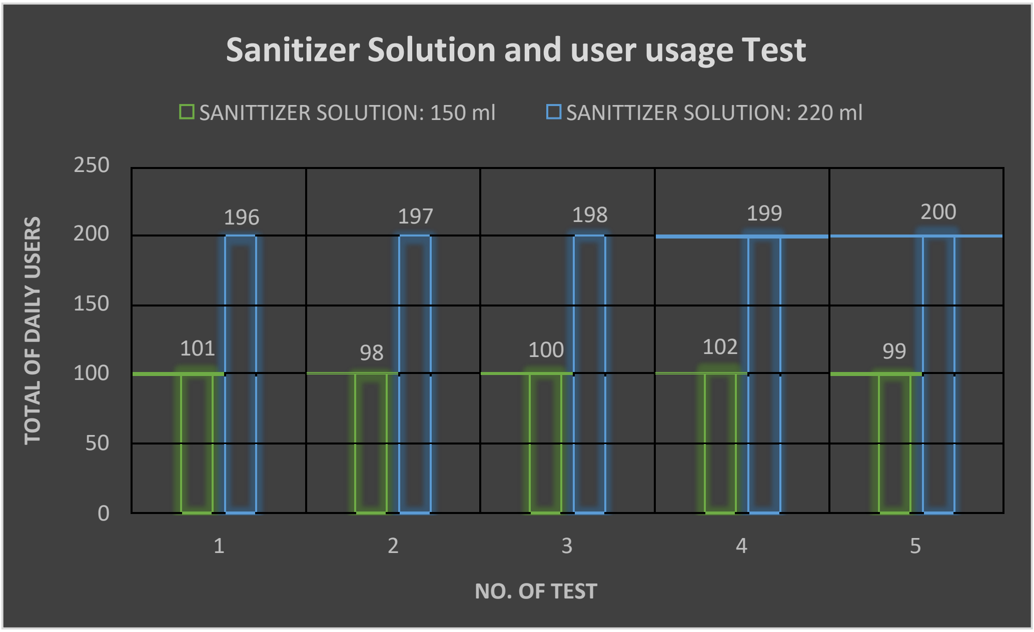

Figure 4.15: The graph for the taken data comparison

Overall there is slightly differences between the data that has been measured between those two level which shows that certain amount of level can effects the total quantity of sanitizer per user. This tests purposes is to observe either if there is an error or missreadings between the calculated prediction measurements and the actual measurements itself for half of the container level and the full level of the container. Which by mathematically logically, when the full container average is 0.75 ml per user so supposedly it multiplies by 2 to get the half level amount of ml per user which 1.5 ml but to prove this value, the tests has been done to see actually either if there is slightly error or missreadings of the measurements along the way to get that multiple value which 1.5 ml per user for the half container. However, the system succeed on getting the actual value which also 1.5 ml per user as same as the mathematically prediction calculation which justifies that the system was overall operated precisely.

4.8.2 Collective data between SSHD and manual cleaning process.

To achieve the main objective of the project, which is to overcome the manual cleaning process, a test has been made to see the spray patterns and the polarity between those two methods of sanitation. Table 4.3 below shows both results of the conducted test:

Table 4.3: Collective data between SSHD and manual cleaning process

TEST / TEST TYPE	1 (220ml)	2 (220ml)	3 (220ml)	4 (220ml)	5 (220ml)
Manual Process	190	188	194	197	196
SSHD	196	200	198	204	202

Based on the Table 4.3 above, there is slightly different between both methods that has been used for the sanitation process that can be observed. Overall results shows that:

- The average results for manual cleaning process: 190 + 188 +194 +197 + 196 = $\frac{965}{5}$

  = 193 pumps spray per 220ml

- The average results for SSHD cleaning process: 196 + 200 +198 +204 + 202 = $\frac{1000}{5}$

  = 200 pumps spray per 220ml

Figure 4.16: The spray that used to execute the manual cleaning process

Figure 4.17: The Smart Self-Hygiene Door(SSHD) cleaning system

Thus, these differences happened because of a few factors that contributed to the odds in the results taken. The first factor is the inconsistent pattern of the spray between the workers or the cleaner itself since every single one of them had a different type of grip style, capability to execute the spray, and handling of the bottle spray itself. Secondly, the non-constant refilling of the sanitizer content in the container can also be one of the factors since when there is not too much sanitizer in the container, it somehow relates to the air pressure in the container, which might be interrupted to execute the sanitation process, and also because there is no sensor detection in it to precisely detect the actual level of the sanitizer solution in the container. Lastly, the working ethics of the cleaners and workers can also be a part of the main reasons why there is an oddity in the results; some of the workers might not follow the timetable of the cleaning prices accordingly, which definitely defeats the purpose of making the door handle stay hygienic and clean. After all, the current system of the project can cover all the main factors as a whole since it is more precise in detecting and consistently doing the sanitation process, and there are no work ethics issues with it.

4.9 Summary

The purpose of this chapter is to show that the overall system can supposedly perform an automated self-hygiene system using door sensors, which processed by the Arduino itself. In summary, the functionality of the project can be considered as precisely well and able to get the tests results that need to be achieve in order of the data and measurements acuquiring. After all, the test that has been done itself shows that the project systems and fnctionality works properly for certain range and emphasizing its compability on certain conditions and processes.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, the project aimed to improve hygiene and prevent the spread of germs by creating an automated door handle cleaning system with Arduino Uno. In addition, a door self-sanitizing monitoring system was integrated with the Blynk app, giving users real-time monitoring and control capabilities. The primary objectives were met, and the proposed system was tested for functionality and performance.

Furthermore, the use of an automated door handle cleaning system demonstrated efficiency in maintaining hygiene by cleaning the door handles on a regular basis. The Arduino Uno played an important role in automating this process, ensuring that the cleaning system runs smoothly. The Blynk app's integration with the door self-sanitizing monitoring system provided users with an easy-to-use interface for monitoring and controlling the system remotely. This feature gives users more convenience and flexibility by allowing them to stay informed about the sanitising process and take appropriate actions as needed. The proposed system's functionality and performance were evaluated, and the test results were positive. The system consistently performed its intended tasks, and the automated cleaning process was effective in maintaining a clean environment. The Blynk app successfully enabled remote monitoring, which increased overall user satisfaction and ease of system management.

To summarise, the developed automated door handle cleaning system, combined with the door self-sanitizing monitoring system, has proven to be an effective solution for promoting hygiene and reducing the risk of germ transmission. The positive results of the evaluation phase indicate that the system is ready for deployment and could make a significant contribution to creating safer and cleaner environments.

5.2 Potential for Commercialization

The Smart Self-Hygiene Door project aims to revolutionize hygiene practices while also making a significant contribution to public health and safety. The primary goal is to develop an advanced automated cleaning system for public door handles, addressing the critical need for novel solutions to disease transmission. This system aims to be commercially viable, with a focus on public areas where people are particularly susceptible to bacteria and germs.

The commercialization strategy includes partnerships with healthcare facilities, educational institutions, transportation hubs, and other public institutions that value health and safety. The project hopes to establish itself as a key player in the healthcare technology market by incorporating the Smart Self-Hygiene Door into these environments. Potential revenue streams include product sales, maintenance services, and data analytics, in which the system can provide valuable insights into hygiene trends and usage patterns.

Furthermore, the project intends to follow sustainability principles, ensuring that the automated cleaning system is both effective and environmentally friendly. Partnerships with healthcare regulatory bodies and endorsements from health organizations pursued as part of the commercialization strategy to validate the project's efficacy and ensure compliance with industry standards. This strategic approach increases not only the project's credibility in the healthcare sector, but also the trust and acceptance of potential users.

To summarize, the Smart Self-Hygiene Door project intends to commercialize its innovative solution in the healthcare sector, providing a valuable tool for improving hygiene, reducing disease transmission, and creating safer environments. The project aims to establish itself as a significant contributor to the advancement of healthcare technologies through strategic partnerships, adherence to sustainability principles, and validation from healthcare authorities.

5.3 Future Works

For future improvements, accuracy of the Smart Self-Hygiene Door sanitation process results could be enhanced as follows:

i) **Container Capacity**: The current container or bottle might have some limitations in terms of the sanitation liquid volume and amount. This happened because of the limitations of the container placement.

ii) **Alarm notification for safety purposes:** The current system has only the features to notify the cleaner regarding whether the condition of the door is okay or not, and it does not have any specific safety measures in terms of directly notifying the user or the cleaner without even using the monitoring app. It might be an alarm sound or LED notifications for the immediate response to ensure the user is always aware of the door safety condition or the sanitation process itself.

iii) **Smooth snitation spray execution:** The current sanitation process was not that smooth in terms of the spray execution since it’s more like a little bit of moisture at the door handle surface after the sanitation process happened for about a few seconds. Future improvements should come with some spray execution that is able to let the sanitizer solution be more absorbable, and it might also be related to finding a door handle material that can easily absorb any sanitizer solution with an immediate absorb response so that there are no issues whenever the process happens with the occupied toilet since the process is more tidy and neat in terms of the door handle surface for the user to use it.

iv) **Energy Efficiency:** Optimise the cleaning mechanism's energy consumption. To power the system, use energy-efficient components and consider renewable energy sources like solar panels. This make the door more eco-friendly and sustainable.

v) **Backup Supply:** Since one of the project objectives is to ensure the door handle is always in a good condition, it is important that the system be able to operate 24 hours a day since we cannot predict when or what time the user uses the door. So the backup supply is needed in case there are some blackouts or electrical supply cutoffs that might interrupt the system's process.

vi) **Customizable Cleaning Solutions:** Allow users to choose or customise the system's cleaning solution. Some people prefer eco-friendly or hypoallergenic cleaning agents, so providing options allows for a diverse range of user preferences.

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APPENDICES

Appendix A   Gantt Chart PSM 2

PSM 2 PLANNING GANTT CHART 2023														
MONTH	OCTOBER		NOVEMBER				DECEMBER				JANUARY			
ACTIVITIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PSM 2 Briefing														
Supervisor discussion														
Hardware design and coding research														
Component testing and circuit design														
Coding testing and troubleshooting														
Hardware construction														
Prototype Testing and troubleshooting														
Finalizing Prototype														
Chapter 4 &5														
Final verification and supervisor final update														
Final report submission														
Presentation PSM 2														

Appendix B Source Code

```
#define BLYNK_TEMPLATE_ID "TMPL6Pezo9FTk"
#define BLYNK_TEMPLATE_NAME "water level monitoring"
#define BLYNK_AUTH_TOKEN "UL2YFqv6U_8DdlGVQFwrhHtLjyPmaBIB"

/* Comment this out to disable prints and save space */
#define BLYNK_PRINT Serial
#define WATER_LEVEL_MAX 400 // Maximum value from the water level sensor

#include <ESP8266_Lib.h>
#include <BlynkSimpleShieldEsp8266.h>

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Mizehhh";
char pass[] = "1sampai9";

// Hardware Serial on Mega, Leonardo, Micro...
//#define EspSerial Serial1

// or Software Serial on Uno, Nano...
#include <SoftwareSerial.h>
SoftwareSerial EspSerial(2, 3); // RX, TX
// Your ESP8266 baud rate:
#define ESP8266_BAUD 9600

ESP8266 wifi(&EspSerial);
const int doorSensorPin = 4;    // Example pin for the door sensor
const int pumpRelayPin = 5;     // Example pin for the pump relay
const int waterLevelPin = A0;  // Example pin for the water level sensor

int previousDoorStatus = LOW;
int doorClosedCount = 0;
int display;

// Constants for readability
const int CLOSED_COUNT_THRESHOLD = 1;
const int SECOND_COUNT_DELAY = 2000;  // 2000=2-second delay after the second
count. ..adjust here for close door then pump on
const int SPRAY_COUNT = 1;//ni untuk brapa kali spray
const int PUMP_ON_DURATION = 200; // Time to keep the pump on in milliseconds (1
second)..pump on for how long
const int PUMP_OFF_DURATION = 200;  // Time to keep the pump off between spray patterns
in milliseconds (0.5 second)
```

```
void setup()
{
  // Debug console
  Serial.begin(115200);

  // Set ESP8266 baud rate
  EspSerial.begin(ESP8266_BAUD);
  delay(10);

  //Blynk.begin(BLYNK_AUTH_TOKEN, wifi, ssid, pass);
  // You can also specify the server:
  Blynk.begin(BLYNK_AUTH_TOKEN, wifi, ssid, pass, "blynk.cloud", 80);
  //Blynk.begin(BLYNK_AUTH_TOKEN, wifi, ssid, pass, IPAddress(192,168,1,100), 8080);
  pinMode(doorSensorPin, INPUT_PULLUP);
  pinMode(pumpRelayPin, OUTPUT);
  pinMode(waterLevelPin, INPUT);

  // Ensure the relay is initially in the deactivated state (active-low)
  digitalWrite(pumpRelayPin, HIGH);
}

void loop()
{
  Blynk.run();
  int doorStatus = digitalRead(doorSensorPin);
  int waterLevel = analogRead(waterLevelPin);

  // Adjusting the mapping based on the actual sensor range (0 to 400)
  int waterLevelPercent = map(waterLevel, 0, 730, 0, 100);

  // Send water level data to Blynk app
  Blynk.virtualWrite(V0, waterLevelPercent);

  if (doorStatus == HIGH && previousDoorStatus == LOW) {
    // Door has transitioned from closed to open, turn off the pump
    Serial.println("Door opened, turning off the pump");
    digitalWrite(pumpRelayPin, HIGH);  // Deactivate the relay to turn off the pump
  }

  if (doorStatus == LOW && previousDoorStatus == HIGH) {
    // Door has transitioned from open to closed
    Serial.println("Door closed");
    doorClosedCount++;
    display++;
    Blynk.virtualWrite(V10, display);
```

```
if (doorClosedCount == CLOSED_COUNT_THRESHOLD) {
      // Introduce a delay after the second count
      delay(SECOND_COUNT_DELAY);

      // Spray pattern - activate the pump in a pulsing manner
      for (int i = 0; i < SPRAY_COUNT; i++) {
        digitalWrite(pumpRelayPin, LOW); // Activate the relay to turn on the pump
        delay(PUMP_ON_DURATION); // Keep the pump on
        digitalWrite(pumpRelayPin, HIGH);  // Deactivate the relay to turn off the pump
        delay(PUMP_OFF_DURATION);  // Keep the pump off between spray patterns
      }
      doorClosedCount = 0;  // Reset the count
    }
  }
  previousDoorStatus = doorStatus;
  delay(100);  // Add a small delay to avoid rapid triggering
}
```