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Automatic Lavatory Hand Hygiene System Controlled Using Arduino Microcontroller (Robotics)

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***Abstract**: Practicing good hand hygiene stands out as a highly effective approach to reducing the spread of pathogens and preventing outbreaks, including those caused by the COVID-19 virus. A lot of people forget about washing their hands before touching any other things that are exposed at the surface as well as the foods that they bought (Jolan B. Sy1, 2020).*

Automatic handwashing has a number of advantages, including improved cleanliness, lower expenses, and less waste production. Arduino is a microcontroller system that programmers use as their first piece in creating robotic outputs and other creations that use electronics and programming. Arduino boards can read inputs, such as a light on a sensor, a finger on a button, or a Twitter message, and turn it into an output - powering a motor, turning on an LED. In using Arduino UNO, you can decide anything you want to put on your board and what to do by sending a set of instructions it will be sent to the microcontroller on the board and this will be your
command. To make an Arduino Uno-Based Automatic Hand Sanitizer Using the HC-SRO4 Infrared Sensor, this is done in several stages, namely making a program with Arduino IDE to provide instructions that will be programmed inside the Arduino board as this will make it easier for users.

***Keywords:** Arduino Uno (IDE), Microcontroller, HC-SR04.*

I. Introduction

Background of the Study

Hand Hygiene is one of the most effective strategies to mitigate the transmission of pathogens and avoid outbreaks, such as the virus COVID-19. A lot of people forget about washing their hands before touching any other things that is exposed in the surface as well as the foods that they bought (Jolan B. Sy1, 2020). Promoting the practice of handwashing with soap, water and dryer is one of the simplest, low tech and most cost-effective public health measures to prevent transmission of COVID 19 as well as many other communicable diseases. Schools and universities can implement this kind of automatic lavatory hand hygiene system for students to keep them clean and away from hand-borne diseases.

People frequently use cloth or tissue to dry their hands as it appears less hygienic, efficient, and practical. Furthermore, some dining establishments continue to use tissue or cloth for hand dryers. Although they can dry hands but it cannot eliminate bacteria or germs (Padang, 2019). On the contrary, the prevalence of soap use and important public health instances have proven to be highly reliable. The accessibility of handwashing facilities is viewed as a simple act of personal hygiene with a favorable externality that is advantageous to public health. Getting to it is also reliant on the availability of a reliable enough water supply (Arifudin Arifudin, Erfan Subiyanta, Muhamad Soleh, 2021).

However, schools have this simple lavatory that are freely to be use of students inside campus. These lavatories are useful for students who travelled distance from their house up to their schools. Lavatories in some campuses are often use because of its malfunctions in terms of good flow and enough supply of water in its faucet. Moreover, hand soaps that students use to clean their palms and nails are not that safe as well as the way of students drying their hands. They basically just wiped their hands in their shirts or other clothing they have with them, which is not preferably healthy and safety for them.

Automatic handwashing has a number of advantages, including improved cleanliness, lower expenses, and less waste production. Arduino is a microcontroller system that programmers use as their first piece in

creating robotic outputs and other creations that uses electronics and programming. It's an open-source electronics platform based on easy-to-use hardware and software (Arduino, 2018). To make an Arduino Uno-Based Automatic Hand Sanitizer works Using the HC-SRO4 Infrared Sensor, this is done in several stages, namely making a program with Arduino IDE to provide instructions that will be programmed to make it easier for users.

Arduino boards can read inputs, such a light on a sensor, a finger on a button, or a Twitter message and turn it into an output - activating a motor, turning on an LED and publishing something online. In using Arduino UNO, you can decide anything you want to put in your board and what to do by sending a set of instructions and it will be sent in the microcontroller on the board and this will be your command.

The researchers developed a project that will automatically wash hands and be integrated with a hand dryer via all those documents that were studied. The researchers proposed a design that will lessen the possibility of disease transmission and address the difficulties associated with drying and washing hands. Additionally, this will raise people's awareness of similar designs and their degree of personal hygiene and fight against COVID-19.

Objectives of the Study

The researchers aim to assess the effectiveness of Automatic Lavatory Hand Hygiene System Using Arduino UNO (IDE). Specifically, the study aims to:

1. Determine the materials needed to create a working prototype;
2. assemble the components of Arduino UNO (IDE);
3. design a schematic diagram of the prototype;
4. create a working prototype of Automatic Lavatory; and
5. assess the effectiveness of Arduino Uno in terms of Sensor testing.

Significance of the Study

This study was conducted to create an Automatic Lavatory Hand Hygiene System for students coming for school and to avoid covid-19 and other hand-borne deceases. This study will give significant benefits to the following:

Bayugan City Public and Private Schools. This study is significant and will benefit the Bayugan City Public and Private Schools because these Automatic Lavatory will give a lot of contributions to students and teachers to avoid having hand-borne deceases inside the campus.

Future Researchers. The findings of this study can be used as a guide for future researchers studying programming commands in Arduino uno Software system. This study's findings may also provide preliminary data that the future researchers can use in their future research.

Scope and Limitation

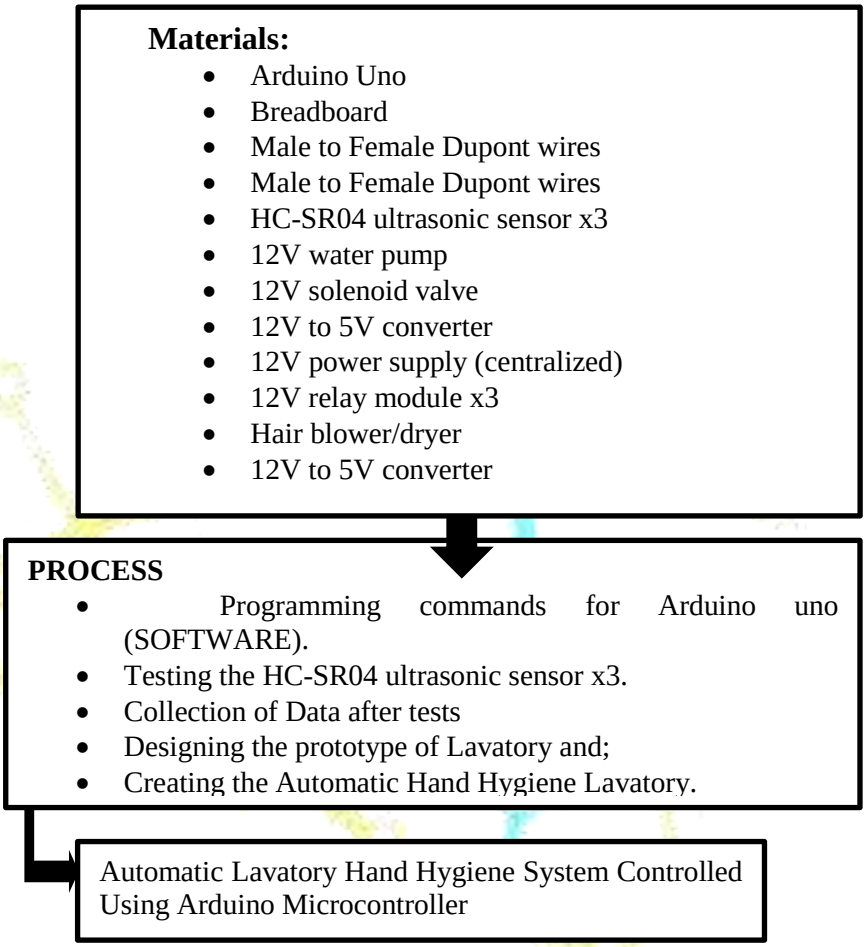
This study limits its coverage of Bayugan City Farmlands and the use of PMFC systems for electricity generation. This study only aims to assess and investigate the capability of the area's sludge to generate electricity. Thus, the researchers shall neglect any other alternative methods of electricity generation that are applicable in the area. Specifically, the study will only take place in the municipality of Bayugan City, Agusan del Sur of which also touches the farmlands. The collection of the sludge will only take place in the pit lands of the farmlands in Bayugan City, Agusan del Sur where there are less risks.

Conceptual Framework

Shows the output in conducting the programming of Arduino Uno and creating the working prototype of Automatic Lavatory.

This diagram depicts the entire process of this study. The materials used in conducting the study to the process and result of this study. Finally, data from the conducted study will be collected.

Research Paradigm



II. Review Of Related Literature

2.1 Foreign Studies

Study of Arduino microcontroller board

This paper will address Arduino microcontroller working principles and applications. We will also go over how the Arduino microcontroller may be utilized as a tool for research and study in this paper. A quick tool for creating simple sensor-based projects is the Arduino microcontroller. Programming the Arduino microcontroller is simple and straightforward to learn. The Arduino IDE allows for microcontroller programming. A tool for writing programs for Arduino boards is the Arduino IDE. Open-source software called the Arduino IDE is free to download and set up on a computer. Many ready-to-use libraries are available in the Arduino IDE. Arduino developers will save a ton of time by utilizing these libraries. The type of Arduino boards, operating concepts, software implementation, and Arduino applications are all briefly discussed in this paper (Alisher Shakirovich Ismailov and Zafar Botirovich Jo‘rayev, 2022) .

Automated Hand Washing System with Hand Dryer

Fighting COVID 19 and developing methods to lessen the catastrophic impact it has on the community are vital needs. This study focuses on a dryer-equipped automatic handwashing system that might be used in either public or private spaces. The system includes a single Arduino UNO, an ultrasonic sensor, a fan blower with a heating element for the hand drier, a relay, a motor pump for water and soap, containers for the water and soap, and the system frame. The fact that the two systems—hand dryer and hand wash—operate practically independently despite being controlled by the same micro-controller is a key aspect of the system.The system

encourages the user to follow the correct WHO protocol for handwashing by delivering water, soap, and water in that order. The distribution of soap and water is made in accordance with schedules and the intervals between delivery of each. In order to ensure that all bacteria have been eliminated, a hot drier was employed to dry the washed hands. The risk of any virus spreading increases when no contact is made. Proteus is used to test the system's functionality and responses in accordance with the system requirements. 2020 (Jolan B. Sy1).

The system encourages the user to observe the proper WHO protocol in handwashing through a sequence of water-soap-water delivery. Appropriate amounts of soap and water are delivered within allotted times, and time gaps between soap and water deliveries. The hot dryer used to dry the wash hands to make sure that all bacteria will be removed. The no-contact system decreases the possible viral transmission of any virus. Proteus is used to test its functionality and responses based on the requirement of the system. (Jolan B. Sy1, 2020).

Design and Implementation of an Automatic Indirect Hybrid Solar Dryer for Households and Small Industries

Post-harvest losses, which are mostly caused by the use of improper drying and storage facilities, have a significant negative influence on the agricultural industry in the majority of developing countries. This study describes the design, the construction, and the testing of an indirect hybrid solar dryer for domestic and industrial applications in light of the aforementioned limitations. Axial fans, photovoltaic solar panels, axial fans, a battery, and automatic control mechanisms make up the dryer. It also has a drying chamber. Slices of tomatoes were used to test the effectiveness of the drier in sun drying and hybrid solar drying. In the hybrid mode, a maximum chamber temperature of 46°C was recorded at an average insolation of 318.74W/m2, whereas a maximum chamber temperature of 39.9°C was reached in the solar mode at an average insolation of 303.7W/m2. While 10.5g/h was produced in solar mode with 4.8% efficiency, the average drying rate in hybrid mode was calculated to be 19.7g/h with 6.83% efficiency. Leonard Akana Nguimdo, Noumegnie Kembou, and Valdo, 2020).

Comparison of Automatic Water Taps Using Ultrasonic Sensors and PIR Sensors

Comparison of Automatic Water Taps Using Ultrasonic Sensors and PIR Sensors

All life on earth relies on water, so efforts must be made to conserve it. Installing automated water taps is one way to reduce consumption of water. Here, the terms "automatic water taps" refer to both sink-mounted and bathroom water faucets. Both taps operate on the same concept, which is that they will open if a human or other object is seen in front of them. The Arduino mega 2560 microcontroller serves as the data processor in this autonomous faucet system, processing data from passive infrared receiver (PIR) sensors and ultrasonic sensors. The results of the two sensors are compared in order to ascertain the difference in response time. According to the studies that have been conducted, the ultrasonic sensor opens or closes the water tap more quickly than the PIR sensor. The difference in timing between the two sensors while opening the tap is only 4ms, or almost the same. While the PIR sensor requires more than 4 seconds to respond when the tap is closed. This is because it takes longer for the sensor to return to normal when it is not looking for human presence, or, to put it another way, when it is not looking for infrared rays. Because the distance is what the ultrasonic sensor detects, the object moves. When something approaches the tap's front, the distance detected will immediately change, causing the tap to close once more right away (Widyaningrum, 2020)

2.2 Local Studies

Automatic Plant Watering System

According to the study of (Elleine Jhane Abargdon et al, 2022) wich is titled Automatic Plant Watering System, The primary objective of the study was to create a device that could assist in the care of household plants by automatically providing them with water using a microcontroller. This device operates based on the moisture levels in the soil. When the moisture sensor detects that the soil is becoming dry, it activates a motor to start pumping water into the soil. As soon as the sensor registers that the soil has reached an adequate moisture level, it signals the motor to cease water pumping. Following the construction of the device, it underwent thorough testing and evaluation to assess its functionality and reliability. The results of these tests concluded that the device functions effectively and is proficient at identifying the moisture requirements of plants. Additionally, the study offers recommendations for potential improvements and innovations for this device in the future.

Automation of motorized water pump with LED and buzzer using Arduino

According to the study of (Anneah Gallardo et al, 2023 This study delves into the utilization of automation within the field of agriculture, specifically concentrating on motorized pumps that are controlled by an Arduino-powered LED system. Through the implementation of a structured experimental approach, the research team designed a product aimed at automating the water pumping process. They gathered data through a combination of observations, experiments, and surveys. The results of their investigation indicate a substantial contrast between the automated pump system and manual operation. The automated system significantly reduces the need for frequent manual intervention by farmers, making the process more convenient. Additionally, the system is equipped with a buzzer and LED, making it suitable for use both during the day and at night, assisting farmers in monitoring the watering process. As a recommendation, the researchers suggest the adoption of this automated system, particularly in larger agricultural settings, employing a Motorized Water Pump with a high-capacity Relay Module for optimal performance.

Arduino Automatic Sprinkler Watering System for Solanum Lycopersicum (Tomato) Using Soil Moisture Sensor

According to the study of Angelo Alibangbang and colleagues in 2022, titled "Arduino Automatic Sprinkler Watering System for Solanum Lycopersicum (Tomato) Using Soil Moisture Sensor," the primary objective was to assemble an automated sprinkler watering system designed for tomato plants and utilizing a soil moisture sensor. The research aimed to assess the effectiveness of this automatic sprinkler system in adequately hydrating Solanum Lycopersicum (Tomato) plants. The purpose of this study was to determine if the system could accurately gauge and provide the appropriate amount of water for the soil of tomato plants. Additionally, the research involved the cultivation of three tomato plants with varying growth heights, intending to investigate the hypothesis that there is a notable difference in the growth height of Solanum Lycopersicum (tomato) plants when watered using the Arduino Automatic Sprinkler Watering System.

III. Materials And Methods

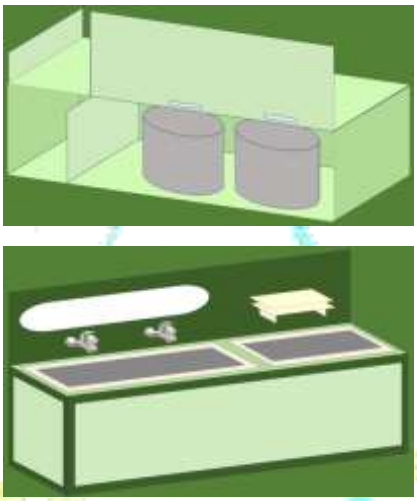
3.1 Materials

Prototype:

Arduino Uno	Programmed commands
Breadboard	For prototype
Male to Male Dupont wires	Connects to one another wirings
Male to Female Dupont wires	Connects to one another wirings
HC-SR04 Ultrasonic Sensor x3	For sensors such as, eyesight and touch
12v Water pump	To pull water easily
12v Solenoid valve ½ inch	Covers the pump
12v Power supply (centralized)	For current supply of the wires
12v Relay module x3	
Hair blower/dryer	Alternative hand dryer
Power outlet	
12v to 5v converter	

Schematic Diagram of the Prototype

Prototype [LAVATORY]



3.2 Research Design

The analysis of variance (ONE PUZZLED ANOVA), a statistical tool that divides an observed aggregate variability discovered inside a data set three parts (Water, Soap and Dryer): The presented data set is statistically online by the systematic factors but not by the random ones. The ONE PUZZLED ANOVA test is use by analysts to evaluate the impact of independent factors on the dependent variable in a regression analysis.

3.3 Research Instrument

Arduino Uno, Bread board and HC-SR04 Ultrasonic Sensor x3 were the only components of the instrument(s) employed in the Automatic Lavatory. Arduino Uno served as the software where commands are made and programmed. The Automatic Lavatory was created by placing the Arduino Uno attached to the Bread Board with the HC-SR04 Ultrasonic Sensor for it to work and test the Sensor in each faucet if it really works.

3.4 Data Collection

The data of the Arduino Uno outputs will be gathered after the making of the prototype and such tests in each faucet that contains of water, soap and dryer. The efficiency of the device will be assessed by the materials prepared for the research. The whole procedure will be guided by the conceptual framework of the study. The Arduino Uno (IDE) output of the device will be tested by testing the HC-SR04 Ultrasonic sensor and will be observed thoroughly.

3.5 Research Locale

The conduction of the study only takes place in Bayugan National Comprehensive High School, in the locality of Bayugan City, Agusan Del Sur due to the safety protocols brought by the pandemic and for student's safety not to go beyond other places that may serve as another way for conducting and assembling the prototype. The study only aims to succeed the programming of HC-SR04 Ultrasonic Sensor using the Arduino Uno Microcontroller for the Automatic Lavatory that may serves as an additional help for students to keep away from viruses and other hand-borne diseases.

IV. Results and Discussions

The following data shows the results and discussions of the research. The results can be observed from the conclusions of related literatures and will serve as great advantages for future research studies.

4.1 Automatic Lavatory

The automatic lavatory has three sets of outputs, water faucet, soap faucet and hand dryer. These outputs are individually placed on the lavatory with different functions but has the same brand of sensors. The sensor works as the main eye of the three outputs as the message it received will be pass on the brain which what we called the Arduino board, where we programmed codes for sensor commands. Each outputs contains different attached wirings to avoid malfunctions of wires and grounding of current once used.

As for the trial and error testing for the lavatory prototype. The outcome of the trial and error shows how effective an automatic lavatory is and how it is ready to be used. In the process of testing the lavatory, it was conducted manually and was first tested by the researchers to avoid and to assure that the created prototype is safety and won't harm others once used in actual.

The faucet of water, faucet of soap and lastly the dryer for hand shows a good state and success. With the enough water it released it satisfies the normal release of water with the control of HC-SRO4 Infrared sensor. The gentle pours of soap in hands and the enough heat that the dryer gives to dry hands in a short period of time satisfies the normal temperature of a dryer as it is also proven that it can't burn hand skin once used.

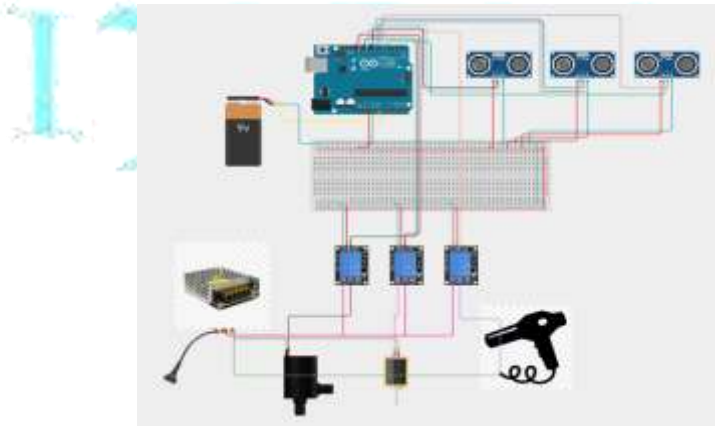
4.2 Arduino Uno Software (IDE)

Arduino Uno software programmed hundreds of codes for connections to the Arduino board. This Arduino board will receive the message coming from the HC-SRO4 Infrared Sensors and once the Arduino relay lights up it only means that the Arduino board receives the exact message with the correct commands. Arduino is very particular in accepting commands as it has its own language to use for decoding commands and that is the C++ language.

4.3 HC-SRO4 Infrared Sensor.

With the use of trial and error, the sensors were tested on how wide it covers an area. Each sensor in the lavatory contains the same commands with flexible adjustments on the space it covers to avoid malfunction at the other sensors. The more that the sensors cope the wide area, the more it will cause malfunctions to the other sensors beside it. From adjusting the spaced it copes with the use of commands encoded in Arduino software and directly programmed in Arduino board.

Figure 1. Arduino connections/Three outputs



V. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter summarizes the researcher's findings, conclusions, and recommendation based on the findings of the study.

5.1 Summary of the Problems, Methods and Findings.

The Automatic Lavatory System is designed to promote and facilitate proper hand hygiene practices among students, faculty, and staff in educational institutions. The finished prototype which undergoes testing and evaluation was effectively utilized in school. Using the automatic lavatory system, the researchers figured

out that Automatic Lavatory Hand Hygiene System using an Arduino Microcontroller is a favorable aid to mitigate hand hygiene issues, making it an effective contribution to stimulate better hand hygiene practices and reducing public health risks and threats.

An extensive literature review was conducted before the study to understand the significance of hand hygiene. An Automatic Hand Hygiene Sanitizer using an Arduino Microcontroller system integrated with a hand dryer was designed and prototyped to demonstrate its feasibility and functionality. To show the viability and operation of the device, a prototype of an automatic hand hygiene sanitizer using an Arduino microcontroller system coupled with a hand dryer was created.

1. The Automatic Lavatory Hand Hygiene System effectively addresses the issue of insufficient hand hygiene. The system enables students, faculty, and staff in educational institutions to perform proper hand hygiene as it is a convenient solution for health risks.

2. Individuals inside school provide insufficient hand-drying options, including the use of paper towels of low standard. This option can deter individuals from drying their hands properly after washing.

3. The study suggested an innovative approach to improve hand hygiene practices. The Automatic Lavatory Hand Hygiene System using an Arduino Microcontroller. This technology combined a high-speed hand dryer with an automatic dispenser of hand sanitizer and water. It makes practicing good hand hygiene easy and effective. The Automatic Lavatory Hand Hygiene System in situations related to education, it works as an easy solution to an ineffective hygiene and the outcomes were encouraging. Users liked how simple the method was to use and how quickly and efficiently the hands dried.

5.2 Conclusion

In conclusion, this research set out to comprehensively evaluate the efficacy of an Automatic Lavatory Hand Hygiene System utilizing Arduino UNO (IDE) within educational institutions, particularly focusing on schools and universities. The study successfully accomplished its objectives, encompassing the identification of materials essential for constructing a functional prototype, meticulous assembly of Arduino UNO components, meticulous schematic diagram design, the successful creation of a fully operational Automatic Lavatory prototype, and a comprehensive assessment of the Arduino Uno's performance in sensor testing.

Based on the results carried out during the research, The researchers conclude that the Automatic Lavatory Hand Hygiene System Controlled Using Arduino Microcontroller is an effective way in promoting sufficient practice of proper hand hygiene in school institutions. This Prototype features; automatic hand wash and automatic hand dryer which makes the practice of proper hand hygiene more efficient and easier, It provides a positive impact by fostering enhanced hand hygiene practices and reducing the attendant risks linked to inadequate hand hygiene within these educational environments. This study stands as a pivotal step towards healthier and more hygienic educational institutions, thus safeguarding the well-being of students and staffs.

5.3 Recommendations

Creating an automatic lavatory hand hygiene system controlled by an Arduino microcontroller involves integrating various components for efficient operation. Here are some recommendations to consider:

Sensor Selection: Use appropriate sensors to detect hand presence and motion. Infrared or ultrasonic sensors can work well for this purpose.
Soap Dispenser: Integrate a soap dispenser that can be controlled electronically to dispense soap when hands are detected.
Water Flow Control: Implement a solenoid valve to control water flow. It should open when a user's hands are detected and close after a set duration to conserve water.

Hand Dryer: Include a hand dryer with a heating element and a blower, which can be activated when a user's hands are in the drying area.
Arduino Microcontroller: Choose an appropriate Arduino board (e.g., Arduino Uno, Arduino Mega) to control all components. Program it to manage the timing and coordination of the system.
Power Supply: Ensure a stable power supply for your system. Battery power or an uninterruptible power supply (UPS) can be useful to prevent disruptions.

Human-Machine Interface: Consider integrating a user interface such as an LCD screen or LED indicators to

provide feedback to users about the system's status.

Hygiene Monitoring: Optionally, incorporate sensors to monitor soap and water levels, allowing for timely refills.
Safety Features: Implement safety features, like emergency stop buttons and fail-safes to prevent accidents.

Data Logging: If necessary, add data logging capabilities to record system usage and monitor consumable levels.

Wireless Connectivity: Consider adding Wi-Fi or Bluetooth connectivity to enable remote monitoring and control of the system.

Maintenance Plan: Develop a maintenance plan to regularly inspect and service the system to ensure its proper function and hygiene.
User Instructions: Provide clear instructions for users on how to use the system effectively and hygienically.

Hygiene Compliance: Ensure that your system complies with local hygiene regulations and standards.

Testing and Iteration: Thoroughly test the system, collect user feedback, and be prepared to make improvements and updates as needed.

Cost Considerations: Keep an eye on the budget, as some components and features can be costly. Balance functionality with affordability.
and troubleshooting.

Environmental Impact: Consider the environmental impact of your system, such as water and energy efficiency, and aim for sustainability.
Remember that building such a system involves electrical and mechanical work, so it's essential to prioritize safety and hygiene at all stages of development and installation. Additionally, consulting with experts in plumbing, electrical engineering, and sanitation may be beneficial for a project of this nature.

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