UNIVERSITY OF LONDON

(CM3040)

Physical Computing and IoT Project Proposal Report

Smart Hygiene Station

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Table of Contents

Introduction

Background

Ensuring proper hygiene is a fundamental part of daily living, yet for individuals who are differently abled, traditional hand washing setups often present significant challenges. Physical barriers, the need for precise movements, or reliance on assistance can make this seemingly simple task both difficult and, at times, inaccessible. The Smart Hygiene Station aims to address this issue by leveraging IoT technologies to create an inclusive, user-friendly, and automated hand washing solution. Designed to support individuals with varying abilities, the system provides a seamless experience by automating the sequential dispensing of water, soap, and tissue in a contactless manner.

Aims & Objectives

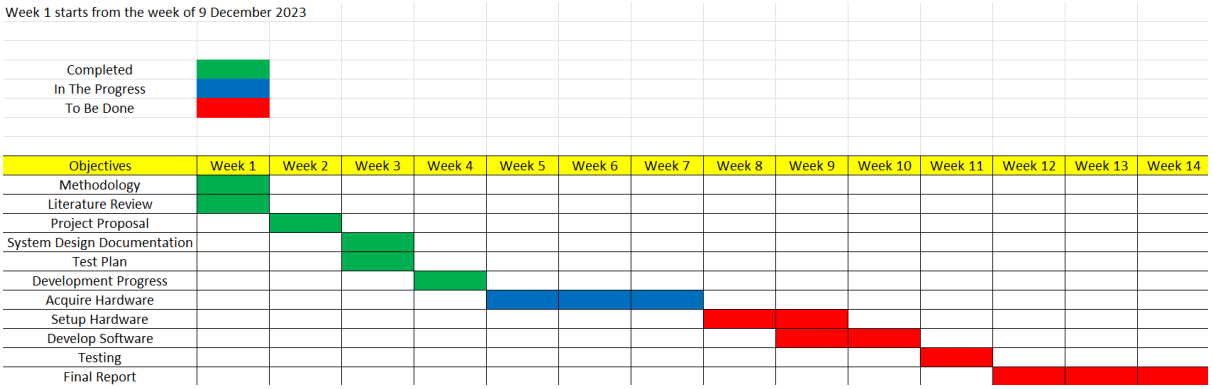
My aim for this project is to design and implement a portable, compact IoT-based handwashing system that can be easily installed at home or in any location with access to a water source. The system is designed to enhance accessibility for differently abled individuals by offering a fully automated, contactless handwashing process, while providing real-time updates for maintenance to ensure continuous and reliable operation.

The objectives of this project are:

- Conduct research to document existing automated hygiene systems.
- Develop a comprehensive understanding of the problem and analyze existing solutions.
- Identify key limitations or gaps in current solutions that the project can address.
- Determine specific usability features to enhance accessibility and user-friendliness.
- Establish a detailed timeline and resource allocation plan for the project.
- Create initial designs and define the system architecture.
- Specify the hardware and software requirements for the Smart Hygiene Station.
- Formulate a test strategy to evaluate the system’s performance and usability.
- Work towards producing a functional, working prototype of the Smart Hygiene Station.
- Conduct user testing and critically evaluate the prototype to identify areas for improvement.

Methodology

In this section, I will explore research papers, general articles, and official product websites to better understand the challenges faced by individuals with disabilities. I will also analyze IoT-based hygiene systems and accessibility solutions specifically designed for people with disabilities. Furthermore, I will review existing approaches to usability and inclusivity, aiming to identify gaps in current solutions that this project seeks to address. Additionally, I have created a Gantt chart to help manage my time effectively throughout the project.



Literature Review

Problem

Many individuals with disabilities still face challenges when using hygiene systems, as most existing designs lack inclusivity and ease of use. While IoT technology has the potential to address these issues, there is limited focus on creating hygiene solutions that are both accessible and user-friendly for people with disabilities.

Market Research

Meritech CleanTech® EVO Automated Hand Washing stations

The CleanTech® EVO from Meritech is a fully automated handwashing system designed to provide consistent and thorough hand hygiene through a touchless process. Using advanced technology, it ensures compliance with hygiene standards in industries such as healthcare and food safety. The system features a 12-second wash cycle that activates automatically when users insert their hands into the cylindrical chamber, delivering a seamless and efficient experience. It also includes state-of-the-art tracking software to monitor usage data, enhancing efficiency and maintenance. However, while effective in industrial or commercial settings, the CleanTech® EVO is not tailored for differently abled individuals, as its height and design may pose challenges for wheelchair users. Additionally, its high cost and fixed installation requirements limit its suitability for individual or residential use, reducing its broader accessibility and practicality.

Meritech Smixin Pro 3-in-1 Handwashing station

The Smixin Pro is a 3-in-1 handwashing station that automatically dispenses soap, water, and paper in sequence after sensor activation, all within a compact unit. It features remote system management through a smart dashboard that displays data and allows users to configure settings as needed. It offers a fully automated experience, dispensing the required amounts in a seamless process, making it ideal for offices, restaurants, and healthcare settings. However, its lack of height adjustability may limit usability for differently abled individuals, particularly wheelchair users. Additionally, its fixed installation and high cost restrict its suitability for residential or individual use, despite its efficient and hygienic design.

Independent Sensor-Activated Devices

Sensor-activated handwashing devices, such as soap dispensers, taps, and hand dryers, automate the handwashing process and reduce contamination risks by eliminating physical contact. Advanced versions offer features like remote monitoring, real-time usage tracking,

and maintenance alerts through connected dashboards. However, many of these devices still function independently, requiring users to move between separate units, which adds complexity for differently abled individuals. Additionally, they often lack adjustable height or ergonomic design, limiting their accessibility and inclusivity.

Challenges Faced by Stakeholders

Disabled individuals face challenges with existing handwashing systems, including fixed heights, lack of ergonomic design, and reliance on others for assistance. Mobility limitations also make operating standalone devices difficult. Caregivers often spend extra time and effort assisting with hygiene and face increased infection risks from improper hygiene practices at home.

Proposed Solution

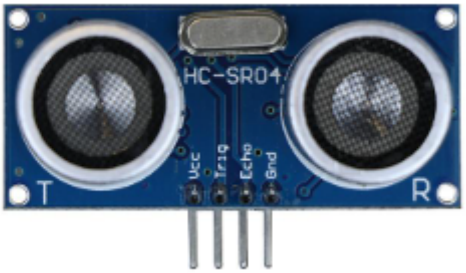
The proposed handwashing system addresses these challenges with a portable design that combines automation, accessibility, and IoT integration. The height can be manually adjusted by placing the station as needed, its fully automated and touchless operation ensures independence and ease of use. It also features a maintenance dashboard for caregivers, enhancing efficiency. By simplifying hygiene routines, it reduces caregiver intervention while maintaining hygiene standards, making it an affordable and practical solution for both home and public settings.

Project Proposal

Product

The Smart Hygiene Station tackles the accessibility challenges faced by differently abled individuals in maintaining hygiene. Current solutions lack integration, portability, and inclusivity. This project aims to create a portable IoT-enabled system that automates handwashing, enhances accessibility, and simplifies maintenance with a connected dashboard.

The first component is a sensor-activated water dispenser, utilizing ultrasonic sensors to detect hand movement and automatically dispense water, initiating the handwashing process.



The second component is a sensor-activated soap dispenser, which utilizes the infrared sensor to detect hand placement and automatically dispenses soap, initiating the next step of the handwashing process

The third component is a tissue dispenser that uses a servo motor to dispense tissue paper when the system signals the completion of the handwashing process, marking the end of the routine.

The last component is an IoT maintenance dashboard, accessible via a web interface, that displays real-time data on soap, water, and tissue levels, along with system status (e.g., soap or tissue dispensing). This enables remote monitoring and efficient resource management.

Requirements

Functional	Non-functional
Hand detection - Detect hands using sensors	**Portability** - The system should be lightweight and easy to move
Automated dispensing - Dispense water, soap and tissue paper sequentially based on detected hand placement	**Accessibility** - The design must accommodate differently abled individuals
Touchless operation - ensure the entire handwashing process is fully automated and contactless	**Usability** - The system should be easy to operate
Sequential operation - Maintain a predictable sequence of water, soap, water, tissue for ease of use	**Maintainability** - The system should be easy to refill and clean
IoT dashboard - Provide a dashboard accessible via mobile or web to display resource levels and system status	**Performance** - The system must respond to sensor inputs and dispense resources within 2 seconds of detection

System Design

Hardware

Water Dispenser	
Components	**Quantity**
ESP8266 WiFi Module	1
Ultrasonic Sensor	1
Water Pump	1
LED Indicator	1
Buzzer	1

Soap Dispenser	
Components	**Quantity**
ESP8266 WiFi Module	1
Infrared Sensor	1
Water Pump	1
LED Indicator	1
Buzzer	1

Tissue Dispenser	
Components	**Quantity**
ESP8266 WiFi Module	1
Limit Switch	1
Servo Motor	1
LED Indicator	1
Buzzer	1

Software

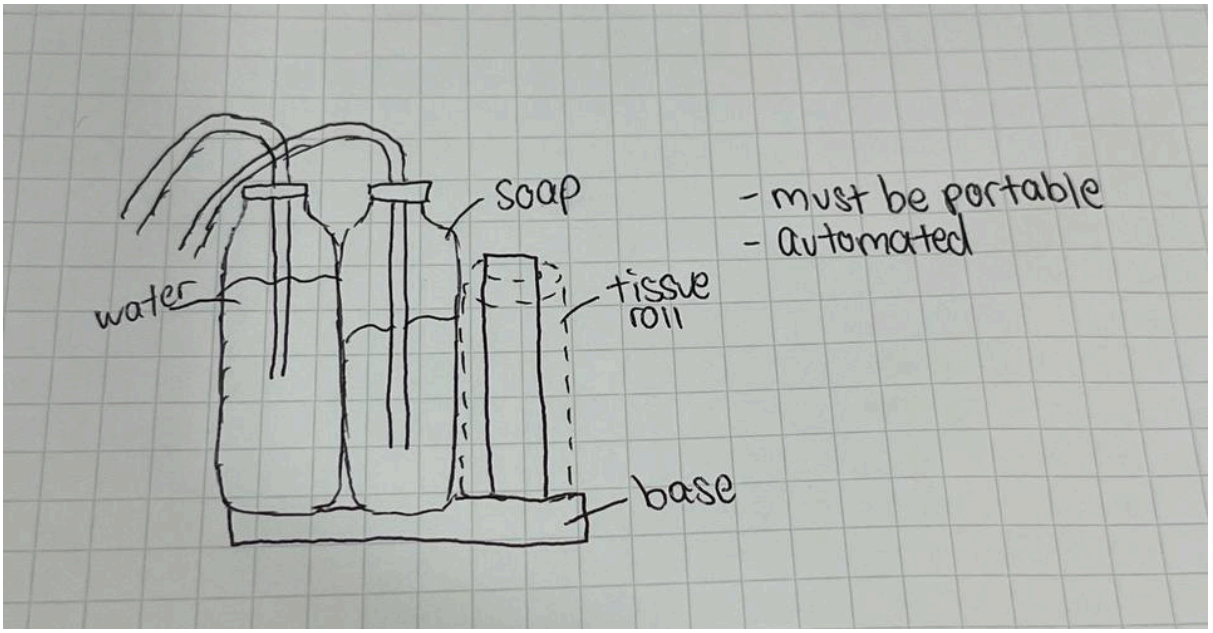
Software	Category	Purpose
Arduino IDE	Development Tool	Write and upload firmware to ESP8266 nodes
ESP8266WiFi library	Library	Enable Wi-Fi connectivity for the ESP8266
Home Assistant	Platform	Central hub for managing and automating IoT devices
ArduinoJson	Library	Parse and generate JSON data for REST communication

Test Plan

Unit Testing	● Test individual components, such as sensors and actuators, in isolation ● Validate the proper functioning of hardware modules using test scripts
Integration Testing	● Verify seamless interactions between hardware components, software libraries, and microcontrollers
System Testing	● Test the entire system under realistic conditions to validate overall functionality ● Simulate low soap levels, network outages, and user interactions for robustness.
Performance Testing	● Measure system response time for motion detection and data updates on the dashboard ● Test system operation under heavy network traffic and low Wi-Fi signal strength
Usability Testing	● Assess the user interface for ease of navigation and responsiveness on the dashboard
Security Testing	● Test for vulnerabilities, such as unauthorized access to the dashboard or firmware tampering

Development Progress

So far, I have been coming up with ideas for the prototype design and circuit layout, thinking about how everything will work together. I have also been learning more about the coding part, including the tools, methods, and programs needed to connect the hardware and make the system work smoothly



References

1. Meritech (2024) *Evo wall - Cleantech automated handwashing stations*. Available at: https://www.meritech.com/products/cleantech-automated-handwashing-stations/evo/wall (Accessed: 27 December 2024).
2. Meritech (2024) *Smixin Pro*. Available at: https://www.meritech.com/smixin-pro (Accessed: 27 December 2024).
3. Disability Evidence Portal (2024) *What are key considerations for including people with disabilities in COVID-19 hygiene?*. Available at: https://www.disabilityevidence.org/questions-evidence/what-are-key-considerations-including-people-disabilities-covid-19-hygiene (Accessed: 27 December 2024).
4. Hygiene Hub (2024) *What specific barriers might people with disabilities, older adults, and older adults with disabilities face in relation to handwashing with soap?*. Available at: https://resources.hygienehub.info/en/articles/4098112-what-specific-barriers-might-pe

ople-with-disabilities-older-adults-and-older-adults-with-disabilities-face-in-relation-to-handwashing-with-soap (Accessed: 27 December 2024).
5. Public Library of Science (2024) *Hand hygiene and infection prevention during the COVID-19 pandemic*. Available at: https://pmc.ncbi.nlm.nih.gov/articles/PMC8019492/ (Accessed: 27 December 2024).