1. Introduction

**Problem:** Taking a bath could be one of the most soothing times of the day. Many people enjoy playing music while taking a bath. However, it becomes very inconvenient and even dangerous when we want to skip to the next song in the middle of the shower: using wet finger on a touch screen could damage the phone and even cause electricity accident. Therefore, we need to find a way to interact with the playlist without any physical contact. Furthermore, it would be even better if ambient lights are added for creating a more immersive, joyful shower experience, and temperature and moisture information could be also added to give user a better understanding of the current environment.

**Solution Intention:** To solve the problem, we could implement an interactive system that integrates all of the features mentioned above: playing music, illuminating ambient lighting, displaying temperature and moisture information, and being able to change songs and lighting with gesture (without any physical contact, which is the main idea of this project.) We plan to make this a portable device so the user could bring his or her favorite bathroom interactive system to any bathroom in the world. Indeed, the usage of this device is not limited to bathroom only. In addition to solving the crucial problem of the inconvenience and danger of phone usage during shower, this device makes our lives easier, more enjoyable, and provide information about the environment at any given circumstance.

**Solution Components:**

- **Software Component:**
  - Music: Music is played from the user’s phone to the speaker using Bluetooth connection. Flipping hand up/down would go to the next/previous song in the playlist.
  - Lighting: The color ambient lighting would change as the user flip his or her hand left/right.

- **Hardware Component:**
  - **HAND GESTURE RECOGNITION (HGR)**
    - Using inertial measurement sensor that is installed in a wrist band to detect the movement of user’s hands. These data are gathered together using a micro-controller connected to solve for the trajectory of hands movement. Then the board will analyze the result and match a certain light mode or skip to another music in the list. The measured results will broadcast through LCD screen. Although the result can be collected by microcontroller, it should be general enough for other systems to easily utilize the data.
  - **INTERACTIVE SYSTEM**
    - Interactive light (intentionally WS2812b): This module allows programmable light control to interact with captured gestures and played music beats. The light cell will change the amplitude and frequency with beats profile adjusted. Apart from that, when we enter special mode or encounter unexpected events, they can give some feedback on our controller.
    - Bluetooth module: The Bluetooth module transfers data from music playlists in mobile, and fetch data from
    - Temperature sensor: This module allows we collect the room temperature and display on the LCD.
    - Display: Majorly, the LCD screen serves as a display, indicating the humidity, temperature, and music playlist. The controlled by 4-bit dribbles signal from microcontroller, with the function of scrolling marquee and delayed input.
**Features:** The features of this device include a distance and gesture sensor, a speaker, an LCD screen for display, and lighting.

**Expected look of the device:**

![Device Diagram]

**High-Level requirements list:** The catching point for this project is contactless, enjoyment, and portable. There are some products on the market that has similar ideas as ours but none has the exact same feature and functionalities as ours.

Shower Power Pro from Ampere:

This device is placed on top of the shower head and is able to play music and emit lighting while taking a shower.

--; This device is not contactless, no gesture recognition, and it doesn't provide any information about temperature and moisture.
Lighted Mirror from Kohler:

This product is used as the mirror in the bathroom and is able to work with Alexa to play music and get environment information.

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This product is not portable. It has to be used at a specific bathroom. This product is not contactless/no gesture recognition. And it doesn't have the ambient lighting (white light only).

We believe in the success of this device because:

1. Being able to change music/lighting without physical contact is enjoyable and safe during shower.
2. This device makes our lives easier, and it is portable to bring to anywhere.
3. There is no existing product on the market that has the exact same features.

2. Design

Block Diagram:
**Subsystem Overview and Requirement:**

User Interface: The User interface is mainly composed of an Inertial measurement sensor and a Bluetooth module that is connected with the microcontroller in the form of a wrist band. The data (movement of the user) that is collected by the inertial measurement sensor would be sent directly to the microcontroller to perform further action. It is powered by a battery, and the choice of charging or replacing with a new battery is to be determined by the difficulty of designing the band.

Controller: The controller is constituted of Microcontroller, and Bluetooth module. The signal input from User I/O gets back to microcontroller through Bluetooth module. The microcontroller will control the signal output to each device in output for utility cases through SPI protocol.

User I/O: The input from user will only be the motion that the user provides. The output to the user will be speakers that play the songs being transferred from user’s phone to the main device. The LCD screen is designed to display power, connection of Bluetooth, current song name and the command detected by the inertial measurement sensor. The mood light LED is designed to constantly display mood light around the bath area that can be changed by certain motion signal detected.

Power: The Power will provide speakers, Mood Light LED with household 110V outlet along with a waterproof plug and encapsulate then convert the AC power source into DC power supply to power the microcontroller, which powers Bluetooth module and LCD screen.

**Tolerance Analysis:**

One aspect of our design that poses a risk to successful completion of the project is not being able to find the correct microcontroller that is able to perform that task required. As shown in the block diagram, all of the user interface and I/O components are connected to the microcontroller, therefore it is crucial to find a piece of microcontroller that actually
works for these functions. If we are not able to do so, the project overall will not success.

3.Ethics and Safety

- Contribution to society: Our project aim in making people's lives easier. Therefore, we believe this project contributes to the society in a way that it simplifies lives and make people's shower experience more enjoyable.
- Avoidance of harm: This device is designed to use in a bathroom setting during shower, therefore it is crucial to be waterproof. Not being able to do so will not only result in failure of the project, but also arouse serious electricity safety concerns.
- Legal and Discrimination concerns: There is no legal or discrimination concern related to our project. Our project doesn't break any existing law; our project serves audience of all gender, age, and racial groups.