Iot Project
Team: Playbook
Smart Bathroom

Team Members:
Sriya Venepally
Mukta Chanda
Anush Anand
Ronak Dhingra

Project Idea:
A “smart” bathroom with automated light, flushing, and lid actuating mechanisms. The bathroom can also be controlled via a mobile application.

How it works:
The proposed model makes use of an ultrasonic sensor to detect the user entering the bathroom, switches on the light and makes use of a servo motor to automatically lift the toilet lid. When the user leaves the bathroom, the light will switch back off, the lid will be closed, and the flush will get activated. In case the flush doesn’t work, a message is sent to the bathroom organizer. Statistical data will be sent to the organization.

Why we chose this idea:
People usually try to avoid public bathrooms as much as possible (for obvious hygiene reasons), but they still encounter situations where they are forced to use them. The purpose of the smart bathroom is to reduce the amount of contact between the user and the toilet so that their hygiene is maintained. In the wake of Covid pandemic, the need for such a concept is even greater.

Required Components:
1. Ultrasonic Sensor
2. Water Level Sensor
3. Servo Motors
4. LEDs
5. ESP32 Module

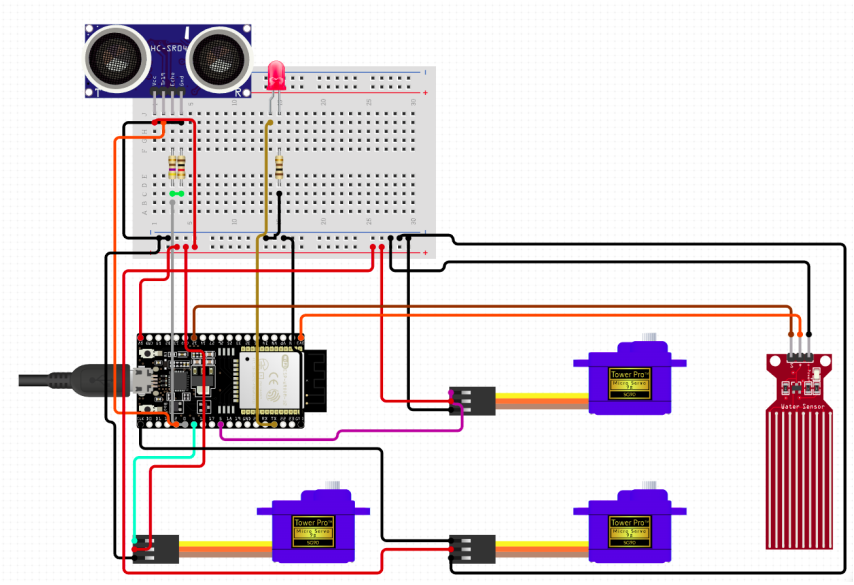
Inputs/Physical Quantities measured:
1. Distance of user (in cm) from ultrasonic sensor.
2. Water level in flush tank (in mm) from water level sensor.

Using the inputs:
1. Number of users: When the distance from the ultrasonic sensor exceeds some threshold distance (15 cm), we increment the number of users.

2. Number of flushes: When the distance from the ultrasonic sensor exceeds some threshold distance (15 cm), we increment the number of flushes.
3. Water consumption: We can compute the amount of water consumed over some time period given the amount consumed per flush.
4. Light switching: When the distance from the ultrasonic sensor exceeds a different threshold distance of 25 cm, we turn on or off the LED based on whether the user enters or exits.

Output:
Detailed statistical data about bathroom usage. We obtain the number of users, flushes and amount of water consumed over a given time interval.

Circuit Diagram:



Initial Objectives:

1. Using a PIR motion sensor to detect the user entering the bathroom.
2. Turning on the light and using a servo motor to lift the toilet lid.
3. Sending a user a reminder (using buzzer) if they forget to flush.
4. Turning off the light and closing the toilet lid after the user leaves the bathroom.
5. Sending statistical data to the organization to monitor and control the bathroom facilities.

Implementation:

1. When the user's distance is less than the threshold distance, the LED turns on and the servo motor rotates leading to the opening of the toilet lid.

2. Then when the user's distance exceeds the threshold distance, the LED turns off, the servo motor rotates again leading to the closing of the toilet lid, and another servo motor rotates leading to the activation of the flush.
3. Initialize a WiFi client to connect the ESP32 with onem2m server. Store content instances based on ultrasonic sensor readings in a resource tree inside the server.
4. Initialize a Bluetooth client to connect the ESP32 with a mobile application . Send data through bluetooth to the ESP32 when an on-click event occurs in the app leading to control of the hardware.
5. In the event that the user does not flush after leaving the toilet, the water level sensor detects this invariance in flush tank level and sends a message to the bathroom organizer.

App:
Made using MIT App Inventor. Communicates with the hardware via bluetooth serial library. Every button click in the app corresponds to some unique data value which is then sent to the ESP. Based on condition codes, the LED and servo motors are controlled providing the functions of light switching, flush and lid actuating mechanisms respectively. In the case that the ultrasonic sensor doesn't work, using the app proves to be beneficial as bluetooth has a fairly reasonable range (upto 9m) and it provides a simple clicking mechanism to control all hardware components.

Challenges:
1. The PIR sensor was not suitable for our requirements.
2. Difficulty with faulty components and connections.
3. Showing the implementation of lid and flush using cardboard in the prototype.
4. Corrosivity of water level sensor.
5. Bluetooth and WiFi clients can't work simultaneously.

Application Scenario:
Measuring data like number of flushes and users, and amount of water and electricity consumption is beneficial to organizations to monitor and control bathroom facilities. For example, pay toilets would want to keep track of the number of users in a given day.

Links to Research Papers:
Automatic flush system: https://ijrbat.in/upload_papers/03122015081500ET%2013.pdf
Automatic toilet seat system : https://patents.google.com/patent/US20030154541A1/en