TECHNICAL ANSWERS FOR REAL WORLD PROBLEMS - EEE 3999

PROJECT TITLE

Self - Sanitizing Washroom

TEAM MEMBERS

A. Sri Krishna Govind- 18BEE1020
Srimathnath Thejasvi Vondivillu – 18BEE1107
Harini R - 18BEE1113
Kushika Sivaprakasam – 18BEE1118

SLOT - TF1

UNDER THE GUIDANCE OF THE FACULTY

DR. NITHYA VENKATESAN

WINTER SEM 2020- 2021

Table of Contents

Abstract:

Scientist study suggests that the hot spots for catching the virus, especially SARS-CoV-2 are confined spaces, including restrooms. To maintain bathroom hygiene in situations like pandemic, proper sanitation should be done after every single use. So, our ultimate aim is to come up with a solution that eliminates the exposure of harmful germs/virus through droplets in toilet seats, hand – held spray, door handles etc. The objective of the project is to develop a system that allows the washroom area to be cleaned and disinfected automatically after each use to improve the condition of public toilets, thus providing a strong sense of hygiene and clean washroom.

Literature Survey:

With the rapid development of technology, more and more homes around the globe are using self-cleaning toilets, which upon usage, clean the toilet bowl with liquid present inside, which is then mixed with water and swirled, and has features such as quick, deep clean. Several high-end models include disease detecting capabilities.

On a public scale, cities such as New York and several across France, have cleaning systems such as robotic arms that scrub the surface, water jets to clean the floor. The process is initiated once the system detects a usage cycle, then locks the restroom for a cleaning cycle.

Other existing technologies clean the toilet seat, and some models use a burst of ultraviolet light

Common companies include KOHLER, Sanitronics. Drawbacks of these are the high cost of the unit, usually above the 50,000 INR range.

In the Indian context, smart/self-cleaning toilets is an area of development, usually done under projects such as public restroom schemes.

Several innovations include, automatic flushing, water jets on the floor, converting the waste into biomass, solar powered toilets, remote monitoring via IoT methods.

Proposed work:
Features of the Self-Sanitising Washroom:
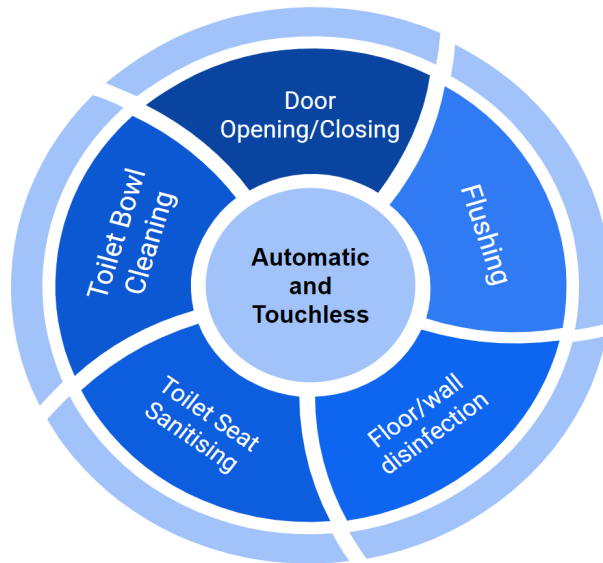
Working:
When a user approaches the washroom/stall, he/she must hold their hand in front of the ultrasonic sensor for 3 seconds placed on the door. Once the stall opens, the user must get in, and after the user is inside, the door closes automatically, and the sensor on the outer side of the door is disabled, and a small display on the outer side shows that the washroom is engaged/occupied.

For the purpose of touchless flushing, an ultrasonic/IR sensor is placed near the flush button, and when the user holds his/her hand in front of the sensor for 2-3 seconds, a motor attached to a CAM device activates and presses the flush button. Once the user is done using the washroom, he/she must hold their hand in front of the ultrasonic sensor present on the inner side of the door, and the door then opens. Once the user is outside, the door closes again automatically, and this time, the screen on the outer side shows that the washroom is in cleaning mode.

With the help of a timer, the cleaning process is carried out for a desired period (2 – 3 mins) after each person leaves the toilet. The process is terminated when the time period expires.

When the Washroom is in cleaning mode:

The stall goes into cleaning mode, the following subsystems are activated simultaneously:

1. <u>Wall Cleaning</u>: The sides of the walls of the washroom are cleaned by a pipe sprinkler system attached on the side top of each of the walls. Disinfectant solution is pumped into the pipe and allowed to flow along the walls of the washroom. This is done using a solenoid valve to control the entry of water/sanitizer. Future scope includes, using a compressor to pressurize the water flow, creating a cascaded network to allow multiple stalls to be integrated.

2. <u>Floor Cleaning</u>: Similar high-pressure jets are placed along the floor edges to clean the floor. The system is similar to wall cleaning.

3. <u>Toilet Seat Cleaning</u>: A shower head is attached on the ceiling to spray disinfectant solution onto the toilet seat. The shower is attached with a sensor and activated after the person goes out the toilet.

4. <u>Toilet Bowl Cleaning</u>: After every 8-10 uses, the toilet bowl is cleaned by the toilet bowl cleaning system, which soaks the toilet bowl in solutions such as harpic, for 10-20 minutes and then the flush is activated, to cleanse the bowl.

Hardware Implementation:
Technical Specifications:

1. **Ultrasonic Sensor:**

HC-SR04
Operating volt - 5V
Size - 45*20*15 mm

2. **DC motor:**

Orange OG555 High Torque DC Motor 12V 10RPM 680N-cm Encoder Compatible

Rated Voltage:12V
Rated RPM (at 12V):10
Gear Reduction: 810K
Rated Torque (N-cm): 680
Full Load Current (A): 2.047
No- Load Current (A): 0.4
Motor Body Length (mm): 94
Operating Temperature: -30℃ to 60℃
₹ 799.00

3. **DC motor PWM speed controller:**

12V-40V10A DC Motor PWM Speed Controller

Input supply voltage: DC 12V-40V
The maximum output power: 400W
The maximum continuous output current:8A
Static Current:0.02 A (Standby)
PWM frequency: 13kHz
Duty Cycle adjustable: 10%-100%
₹ 239.00

4. **Arduino:**

Arduino UNO

Operating voltage- 5v
DC current on I/p pin - 40mA

5. **CAM:**

It is a rotating mechanical device that converts rotational motion into linear motion.

6. **Solenoid Valve:**

12V DC 1/2″ Electric Solenoid Water Air Valve Switch (Normally Closed)

Rated Operating Voltage: 12V DC
Rated Current: 0.6A
Operation Mode: NC (Normally Closed)
Pressure: 0.02 – 0.8MPa
Max fluid temperature: 100°C
₹ 416.00

7. **IR sensor:**

Infrared Obstacle Avoidance IR Sensor Module
Detection distance: 2 ~ 30cm
Detection angle: 35 °
Comparator chip: LM393
3mm screw holes for easy mounting
₹ 35.00

8. **Relay:**
5V Dual Channel Relay Module

Low Level Trigger Relay Module
Two separate LEDs for On/Off indication of the Relay.
Triggering input voltage 3.3V – 5V
Two separate LEDs for On/Off indication of the Relay
Triggering input voltage 3.3V – 5V 4)
Back EMF protection

Back EMF protection 2 LEDs to indicate when relays are ON.
Works with logic level signals from 3.3V or 5V devices
Opto isolation circuitry
Module with diode current protection, short response time
AC Control Voltage: 250V @max.10A
DC Control Voltage: 30V @max. 10A
₹ 149.00

9. Pump:

15L High Flow 555 Vacuum Pump

Operating voltage: 12 VDC
Rated current: 800mA
Inflation time: <6 seconds (from 0 to 300 mmHg in a 1000CC closed container)
Minimum pressure: >400 mmHg (53.33KPa)
Hermeticity: <5mmHg (from 1000mmHg in 1000CC container min), airtight only for inflation
Flow rate: >15 L/Min
Noise: <55dB (test at 30cm distance)
Lifetime: 100,000 cycles tested
₹ 859.00

10. Servo motor:

 TowerPro MG996R Digital High Torque Servo Motor

Weight: 55g
Dimension: 40.7×19.7×42.9mm
Stall torque: 9.4kg/cm (4.8v); 11kg/cm (6.0v)
Operating speed: 0.19sec/60degree (4.8v); 0.15sec/60degree (6.0v)
Operating voltage: 4.8 ~ 6.6V
Gear Type: Metal gear
Dead band width: 1us
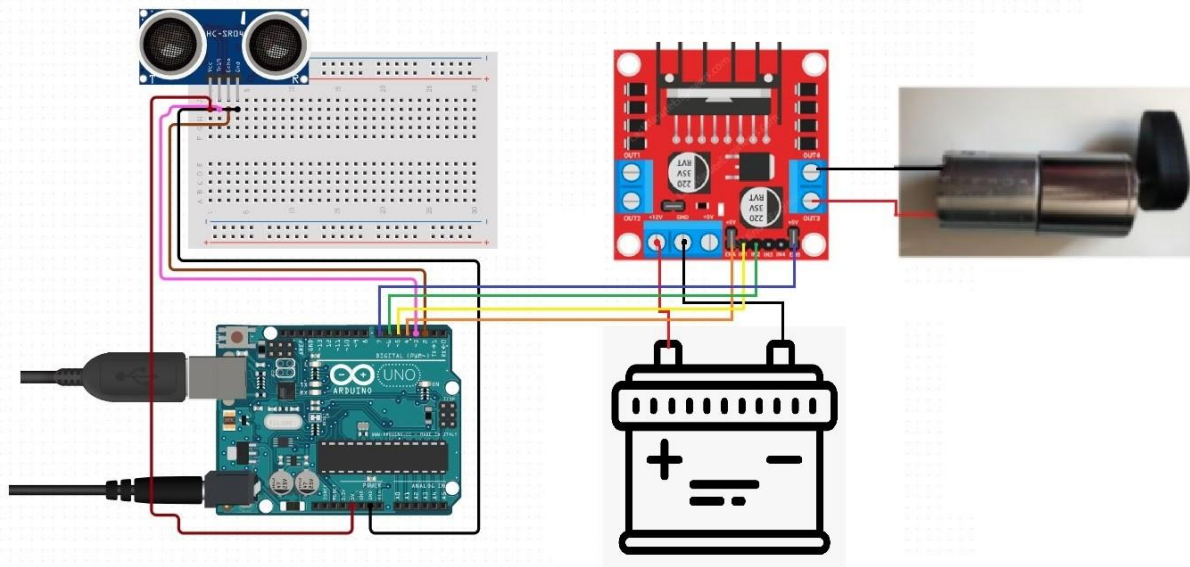Wire length: 32cm
₹ 599.00

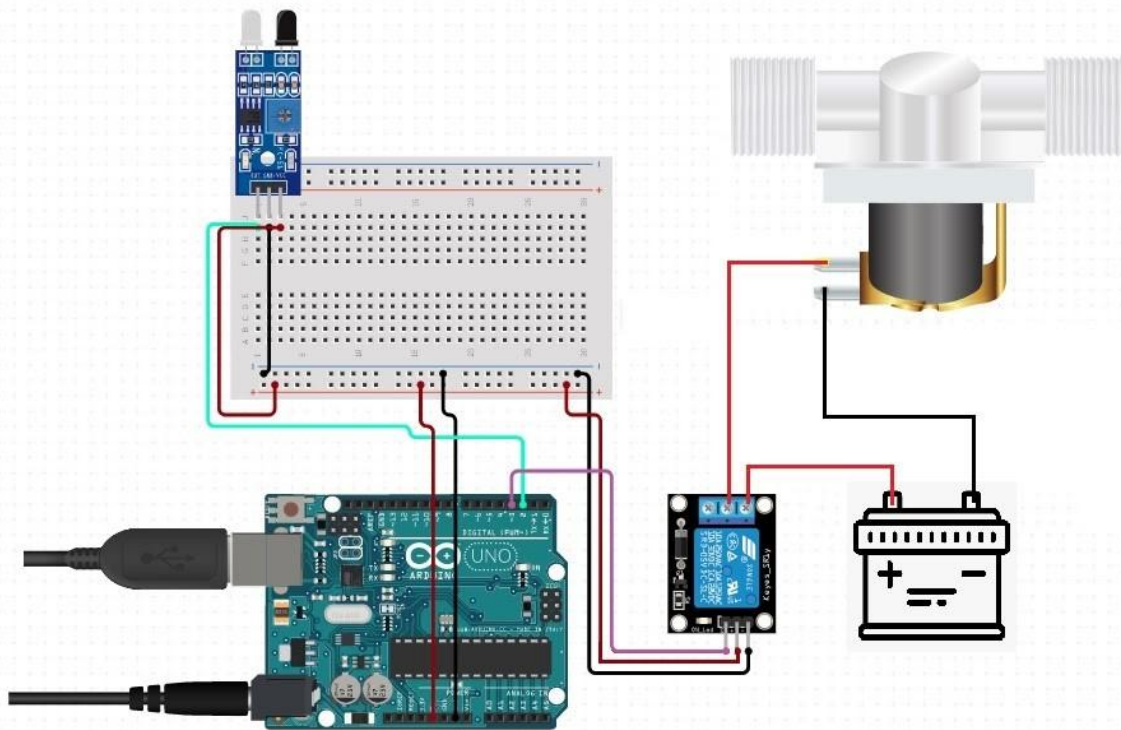**Circuit diagram:**

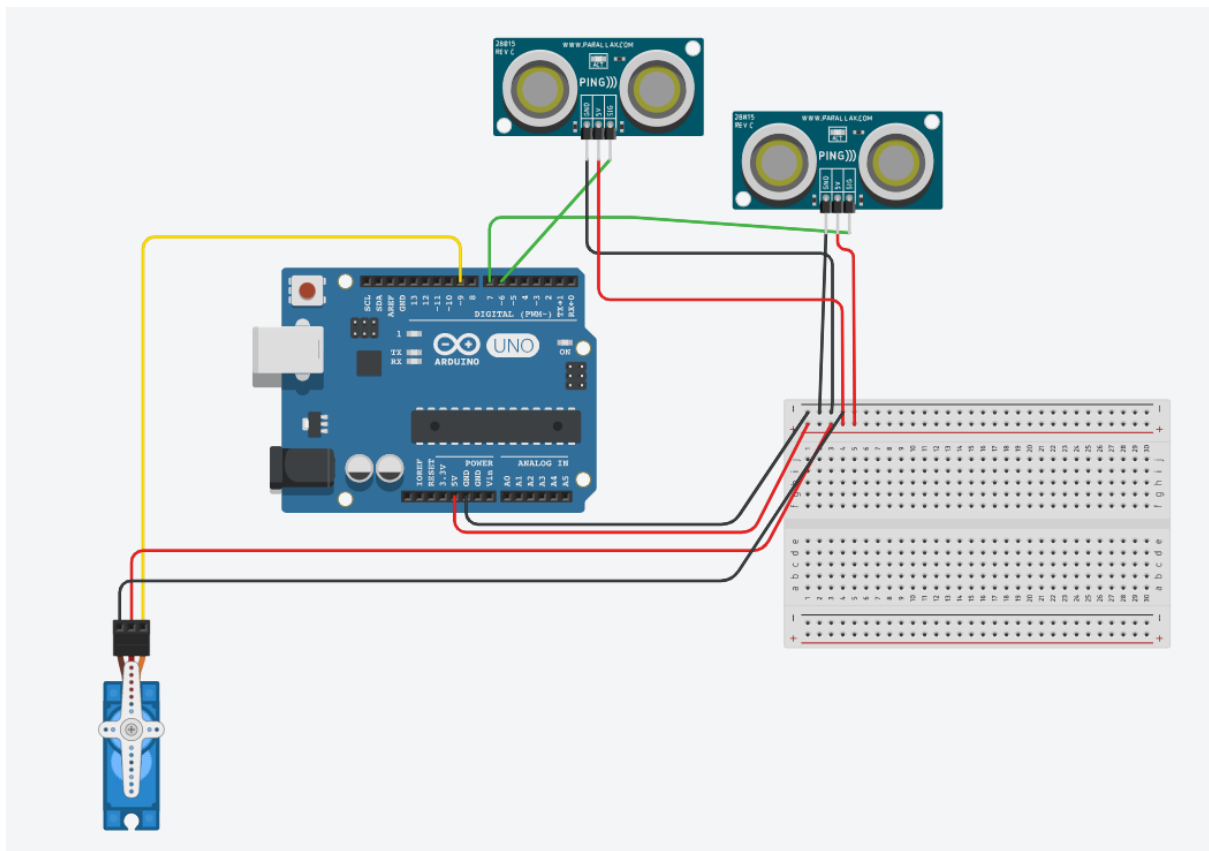Fig 1: Touchless flushing System
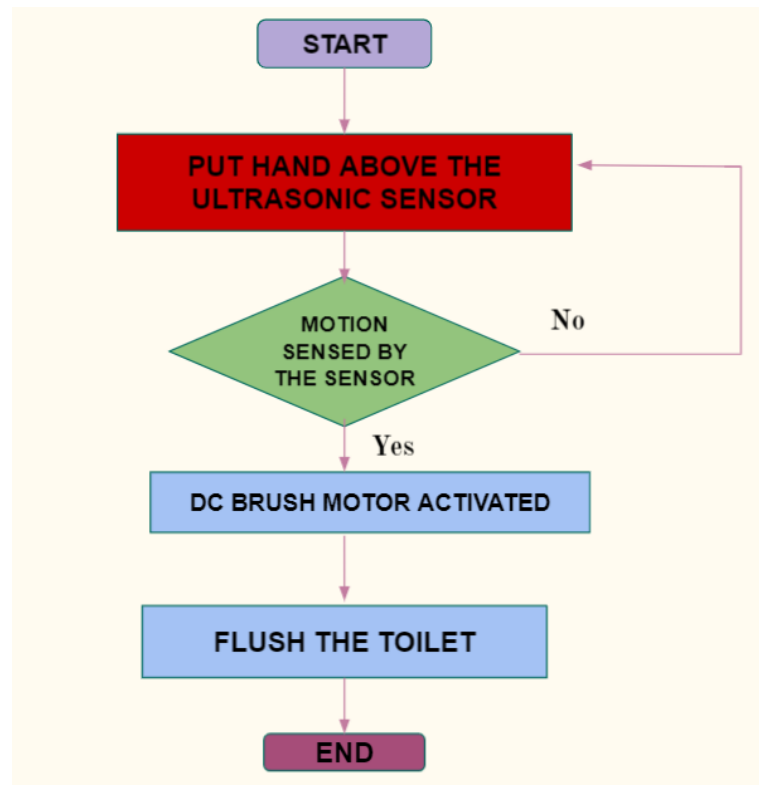

Fig 2: Floor/ wall sanitizing system

Fig 3: Automatic door opening/closing system

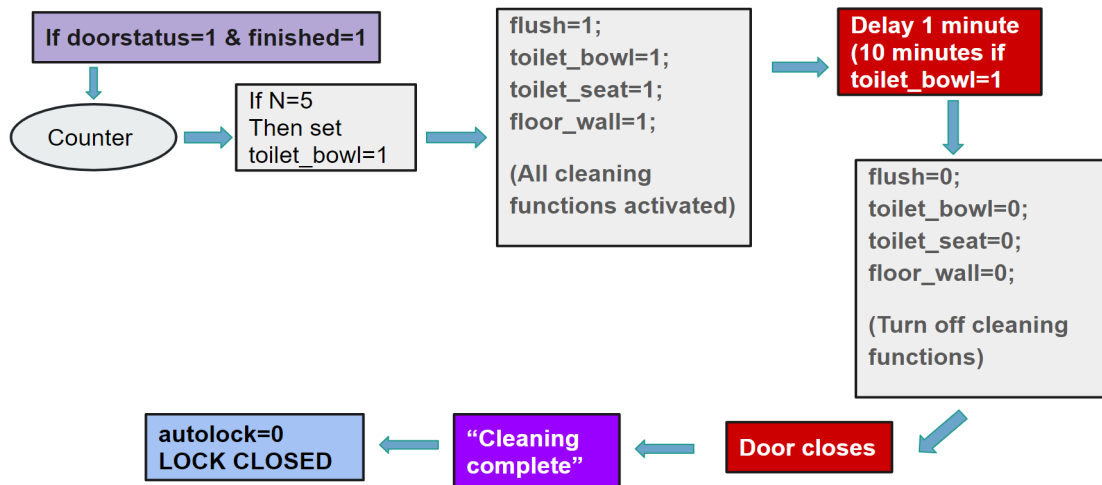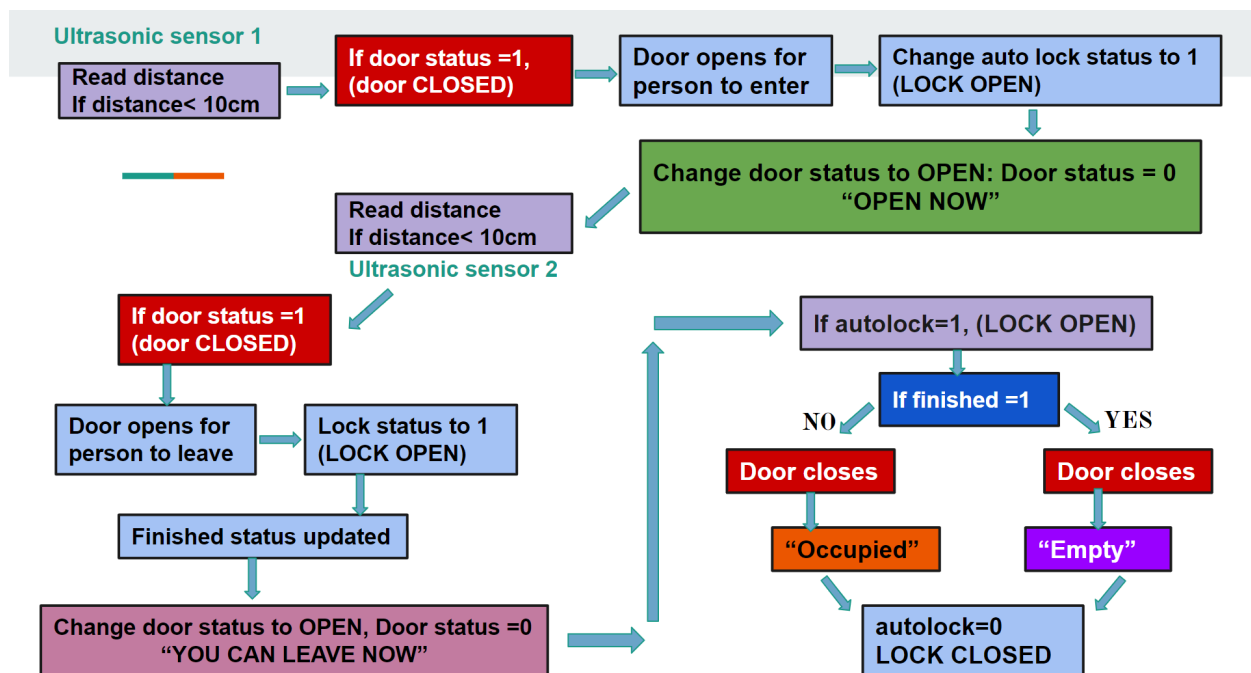**Flow diagram:**

Automatic flushing system

Software Implementation:

1. Algorithm for Automatic Door Opening and Closing:

```
If doorstatus=1 & finished=1
        ↓
    Counter  →  If N=5
                Then set
                toilet_bowl=1
                        ↓
            flush=1;
            toilet_bowl=1;
            toilet_seat=1;
            floor_wall=1;

            (All cleaning
            functions activated)
                        →
                            Delay 1 minute
                            (10 minutes if
                            toilet_bowl=1
                                ↓
                            flush=0;
                            toilet_bowl=0;
                            toilet_seat=0;
                            floor_wall=0;

                            (Turn off cleaning
                            functions)
                                ↓
autolock=0  ←  "Cleaning  ←  Door closes
LOCK CLOSED    complete"
```

2. Algorithm for clean( ) function:

Ultrasonic sensor 1

```
Read distance      →  If door status =1,  →  Door opens for  →  Change auto lock status to 1
If distance< 10cm     (door CLOSED)          person to enter     (LOCK OPEN)
                                                                        ↓
                            Read distance  ←  Change door status to OPEN: Door status = 0
                            If distance< 10cm              "OPEN NOW"
                            Ultrasonic sensor 2
                                ↓
If door status =1                                    If autolock=1, (LOCK OPEN)
(door CLOSED)                                                    ↓
    ↓                                                   If finished =1
Door opens for  →  Lock status to 1            NO ↙              ↘ YES
person to leave    (LOCK OPEN)            Door closes         Door closes
                        ↓                     ↓                    ↓
            Finished status updated        "Occupied"          "Empty"
                        ↓                        ↘              ↙
Change door status to OPEN, Door status =0          autolock=0
            "YOU CAN LEAVE NOW"                   →  LOCK CLOSED
```

Discussion:

The features of the proposed self-sanitizing washroom such as automatic flushing, disinfecting walls and floors of the washroom, toilet seat and bowl cleaning, Automatic door opening and closing are fully realised using hardware mentioned in the hardware specifications. The overall system could efficiently perform the above tasks for a specified time after the user uses and leaves the toilet.

Conclusion:

The proposed solution will maintain cleanliness with its autonomous cleaning process and help in reducing a lot of diseases that are caused through aerosols due to improper sanitation. It can be retrofitted with the existing washrooms.

Future Work:

The future work of the system includes an app/website that alerts the responsible person when the sanitizer tank in the toilet runs out of disinfectant solution and an app or website that tells the user if the restroom is in clean condition and available to use.

References:

1. [How to use the L298N Motor Driver - Arduino Project Hub](#)
2. [Controlling A Solenoid Valve With Arduino - BC Robotics (bc-robotics.com)](#)
3. [Arduino Solenoid Door Lock using RFID (circuitdigest.com)](#)
4. https://home.howstuffworks.com/home-improvement/household-hints-tips/cleaning-organizing/self-cleaning-toilets.htm
5. https://www.biorelief.com/blog/self-cleaning-public-toilets
6. https://popuptoilet.co.uk/public-toilets/star-series-public-toilets/5star-fully-automatic-self-cleaning-public-toilet/