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Arduino - Based Automated Washroom Sanitizing System for Effective Utilization of Public Toilets

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ABSTRACT: As we know, usage of public toilets will be high. It is not an easy task for humans to clean several times in a day. Manual cleaning also causes harmful diseases to janitors. Providing the best solution to this issue is the aim of our project. So, we implemented three units of automated washroom sanitizing system. Automatic flushing unit includes a PIR sensor and an ultrasonic sensor. Whenever a person uses the washroom and don't flush, the controller activates servo motor based on sensor values and pushes the flush button down by rotating. Floor cleaning unit cleans the floor by using water pump and relay switch, which takes value from controller. Brushing unit is implemented to clean the bowl of a toilet using DC motor. It can also operate from outside of the washroom using blynk app. Hence, this methodology will increase the standard of public and community toilets and facilitate people to use these effectively.

KEYWORDS: Washroom Sanitizing System, Effective Utilization of Public Toilets, Automation

I. INTRODUCTION

According to the UN (United Nation) Water report as per the study done by the WHO (World Health Organization), nearly 4.2 billion people are living in this world without safely managed sanitation. Nearly 4,23,000 people are estimated to lose their lives on suffering from diarrhea every year simply due to the lack of sanitation. This may be one of the major problems in developing countries like India. As per the UN's latest reports, India has the largest number of people following open defecation (597 million, which is approximately 47 percent of the country's population). The analysis of the reason behind the non-usage of toilets in India includes sanitation issues also [1]. There are about 700 million people that haven't any access to toilets at home. Slum areas don't have toilets. People are thus forced to defecate within the open, which causes numerous diseases like diarrhea, cholera, dehydration, etc. Though 12 million toilets claim to possess been built under Swachh Bharat Abhiyan within the last five years, as per a UN report, 44% of the population continues to defecate within the open. Sanitation and hygiene still pose challenges in India. Inadequate sanitation means the shortage of enhanced facilities (toilets, drainage, and waste treatment systems, etc.), and hygienic practices (for example, hand cleansing, proper water handling, personal hygiene, etc.) that exposes people to human excreta and harmful pathogens through different transmission pathways.

To cope up with the problem of inadequate sanitation, the building of toilets would not only do. The people must be given proper awareness and knowledge about the necessity and the procedures to maintain and use the toilets neatly. The users control their urge to observing the pathetic condition of the toilets, which harms their kidney health and cause illness due to the spread of harmful germs, toilet lice, and bacteria. The manual cleaning done by janitors, which may not be even present in most of the public and community toilets of India, does not seem reliable. They find it extremely difficult to clean the washrooms due to several reasons including leaving closets used without flushing, dirty floors on frequent usage, inappropriate usage of toilet seats, etc. Their condition turns even more pathetic on considering the harmful diseases on coming in contact with the germs while cleaning.

Hence, it is necessary to ensure that public washrooms are maintained well. Innovations towards improving the route to reach complete proper sanitation are to be encouraged and seem to be a need for boosting several economic factors which include tourism, health, etc. Maintaining a public toilet as a janitor or a cleaner is considered a job that is degrading and not up to dignity. It is assumed that these jobs are to be handled by people of lowcaste. Dalits are

generally entrusted with the responsibility of public or community toilet maintenance. In most of the cases, it is observed that the janitors or cleaners are not paid adequately. They may not be even provided the safety equipment for doing the cleaning job properly. The cleaning tools may not be functioning properly.

All these imply the worsened condition of the public toilets. The health of the janitors is also one of the major concerns while cleaning the washrooms, especially the toilet closet bowls. The cost for proper operation of the restrooms as well as the capital re-investment that involves proper staffing, access to the utilities, and proper drainage cum sewage system are inadequately planned or never thought through at a huge depth.

II. LITERATURE SURVEY

Abhimanyu kumar, Anshu Taunk:

The study is related to the sanitation of lavatories used in elementary and senior secondary schools situated in the rural areas of Uttarakhand. The collected data were related to the use of toilets, maintenance of toilets, operation of toilets, cleanliness of toilets and techniques used in the construction of the toilets. It was found that 95% of elementary schools and 97.18% of senior secondary schools have toilets in them. The major finding of the study is that by the general analysis of the tabulated data it has seen that sanitation of toilets in senior secondary schools is better than in Elementary Schools. Therefore, best efforts are to be made by all sections of the society to improve the condition in coming years.

A. Adithya Bharadwaj, C. Arun Kumar, R. Balasubramanian, P. Gowtham:

The idea presented in this paper seeks to provide a convenient and a hassle-free means of cleaning public toilets whilst maintaining hygienic and sanitary standards. By using a counter to record the number of times of usage, a line follower mechanism to guide the robot and an RFID module to initiate the auto-flushing, the cleaning operation is fully automated and requires low operational power. Furthermore, a robotic arm is part of the module, so as to thoroughly clean the toilet bowl.

Margaret M. Quinn, Paul K. Henneberger, Alicia C. Stephens:

This article provides a multidisciplinary summary of current knowledge and knowledge gaps that can impact professionals, workers, researchers, and policymakers involved in infection prevention, control, and occupational safety and health in all types of health care settings, including hospitals, long-term care and home health care. This study gives information about the benefits and hazards of cleaning and disinfection environment surfaces, patient care items.

Gloria D. Scalar, Gauthami, Penakalapati, Sophie Boisson, Thomas Clasen:

This study addresses the impact of sanitation on the transmission pathway of fecal pathogens. This systematic review to assess the effectiveness of sanitation and sanitation interventions on fecal-oral transmission pathways, specifically – fecal pathogens or indicator bacteria in drinking water, hand contamination, sentinel toys, food, household and latrine surfaces and soil, as well as flies and observations of human feces.

Surya AV, Archana Vyas, Madhu Krishna, Naseem Abidi:

The study included quantitative and qualitative components. The quantitative component had two stages – (i) a household listing exercise; (ii) followed by the main household survey. The listing exercise was undertaken to arrive at a sampling frame from which the households were randomly sampled for the main household survey. The listing exercise only captured the basic household roster with details regarding access to toilet facility, the main household survey captured details regarding toilet construction, defecation practices and other sanitation related indicators.

Mrs. K. Elavarasi, Mrs. V. Suganthi, Mrs. J. Jayachitra:

This paper is based on IOT and image-processing concepts using different sensors like smell sensor, IR sensor, sonic sensor, RFID reader. By using these sensors, they created the smart toilets. This system is controlled and monitored by using programmable logic controller PLC Step 7-200 from Siemens and Supervisory Control and Data Acquisition SCADA systems respectively.

R. Sujeetha, Abhinav D, Rithik R, Abhishek S:

In this paper, sensors are used to detect smell, water level in the tank and presence of a body which trigger a fan, a water motor and an automatic flusher providing a comfortable experience to the user of the toilet. This project provides

comfort as well as good hygiene promotion. In this paper, RFID, IR sensor, Gas sensor and sonic sensor detect any presence of dirt or any foul smell in the toilet and send an alert to the management through a buzzer and an LCD display. It also includes an RFID scanner where the user can check how well the toilet has been cleaned with before and after images of the toilet. Numerous sensors are used to detect improper conditions of the toilet and a water monitoring system is used to check the amount of water used. This is connected to a water pump which provides water when the message is delivered.

Mithya V, DivyaPrabha N, SismaSamlein, Madhumitha M:

IR sensor is used to discover the dirt present in the toilet. Here set of sample images are given as input. After a person using the toilet, the sensor senses the basin of the toilet. Then it compared to the sensed image with the input image. If the dirt present, it gives the beep sound. Then the user wants to be clean the waste by flushing again. Through this activity, people can get the awareness about the toilet management system. In the second phase, gas sensor is used to detect the unwanted gases present in the toilet. In the gas sensor, a particular range is set to be stable earlier manner. If the range gets increased, it can send the alert message to the sweeper. Then they cleaned it by sweeper using proper fragrant.

In the third phase, turbidity sensor is used to sense the bacteria found in toilets, in case any bacteria found in the toilets it can send the alert message to the sweeper. It can be shown before and after cleaning the toilet. Then the first phase gets initiated and senses the dirt presence in the toilet. If the dirt gets noticed, it raises the alarm. Through this monitoring activity, the sweeper can realize their roles and responsibilities. Then they protect the people by disposing all the unwanted materials (dirt, unwanted gases) present in the toilet.

VenushiniRajendran, R. KanesarajRamasamy, Intan Soraya Rosdi, Ruzana Ab Razak:

This paper features the proposed Smart Toilet system, which is based on IoT technology and is designed to capture real-time data from sensors placed in toilet facilities towards the optimization of toilet cleaning resources and the sourcing of toilet peripherals.

Mr. Chaitanya, S. Telradhe, Mr. Kritik, a. Dhabliya:

The paper uses hub technology concept using different sensors like odour sensor, Ultrasonic sensor, RFID module, GSM module. When an object enters into a washroom the ultrasonic sensor will detect the incoming & outgoing of human being & give command to microcontroller. When an object enters a particular section, the ultrasonic sensor will detect the object. The main purpose of ultrasonic sensor is to detect the presence of object inside or outside the washroom. When the object is inside the toilet the flushing mechanism will remain off and the object will leave the washroom the flushing mechanism will remains on at particular time period. When the odor of washroom crosses a certain level, the odor sensor will activated & will give command to flushing mechanism through microcontroller and automatically activate odonil which will convert unpleasant smell to pleasant one. Side by side flushing mechanism will start, which will flush particular section where the object is not present that time. This will prevent the wastage of water. The main advantage of the system is that we can connect multiple toilets in multiple floors using HUB technology.

III. METHODOLOGY

Automatic Flushing Unit:

Arduino Uno works as the interface to control the components and to act as an output and input detector. PIR sensor is used to detect the presence of the human in the toilet. It is placed top to the seat so it can easily detect the presence. This sensor will be sensing the presence for a certain amount of time to generate a value, the generated value is sent to the controller.

Meanwhile, the ultrasonic sensor is also working as an input device. It is placed inside the water container cap. This will measure the distance between the cap and the water level. The sensor records the value and sends it to the controller. The controller is implemented with a program to receive the values from both of these sensors. There are two conditions to be satisfied. First, the presence of the human must be detected. Hence it says that humans had used the toilet for purpose.

Next, the state of the water in the container will be checked. Now the controller is connected with the servo motor. Servo motor is fixed on the top of the flush tank attached to the flush lever. When both the conditions are satisfied, the servo motor is rotated with each step pulling the flush lever down. Hence, automated flushing works. After that, the servo motor steps back to its original position.

Floor cleaning unit:

The purpose of this unit is to spray water from different angles of the bathroom floor. In this project, we have used a pump of 140 PSI (8.5 barcount) pressure pump. For better results pump with more pressure can be used. It is connected to a relay switch and it turns ON or OFF if the interface counts to a defined number. The needful water is taken from the tap valve within the bathroom. The water pump outlet is connected to different nozzles placed per the shape of the bathroom. When the water is pumped through the nozzle, washable dirt reaches the floor drain trap. It will clean the bathroom roughly for the next user.

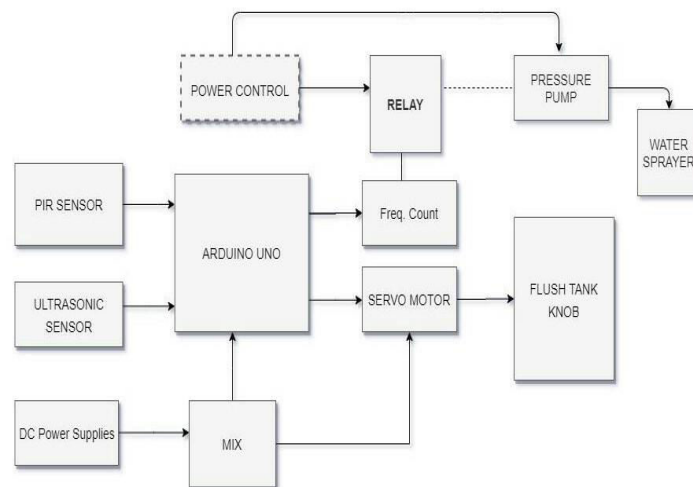


Figure 1 Block diagram of proposed system (automatic flushing unit and floor cleaning unit)

Brushing unit:

The third is a portable external unit. The main purpose of this unit is to clean the bowl without any human effort. The only work for the human is to pour the toilet disinfectant liquid solution into the bowl. Fig. 2 shows the brushing system which cleans the bowl with a rotation mechanism. It can be controlled by an app called Blynk. The controller used for the switch is ESP8266 / NODEMCU. This is a Wi-Fi module which is acting as a Wi-Fi switch in this project. This app is downloadable from the play store or apple store. It is used to control the brushing system. ESP8266 can be easily coded using Arduino software and uploaded. The main components used for the Wi-Fi switch are NODEMCU/ESP8266, relay switch, and power module. The components used include P203 block, pulley, plastic synthetic brushes, iron rod, bolt, and DC motor.



Figure 2 Three-dimensional model of the brushing unit

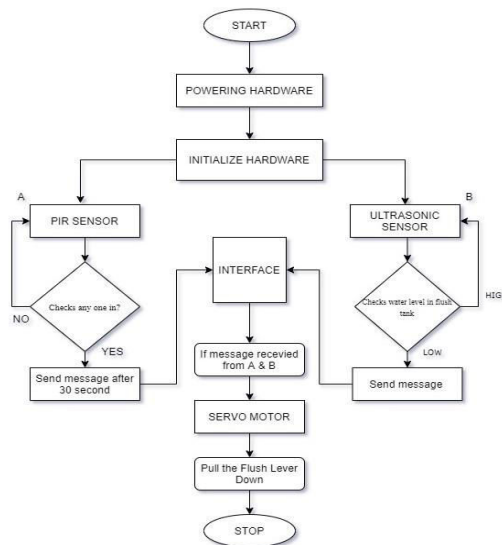


Figure 3 Flowchart of automatic flushing unit

IV. RESULTS

Experimental setup:

Experimental setup of Arduino-based Automated Washroom Sanitizing System is shown below.

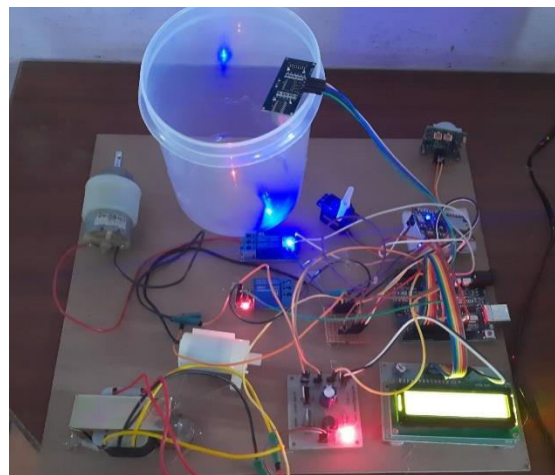


Figure 4 Experimental setup of Automatic flushing unit, Floor cleaning unit, Brushing unit

Automatic Flushing Unit:

- If a person present in the toilet, then PIR sensor value will be HIGH and displays “Man present in toilet” in LCD.



Figure 5 LCD displays “Man present in toilet”

- Otherwise LCD displays “No one in toilet”.



Figure 6 LCD displays “No one in toilet”

- Ultrasonic sensor records the distance between cap of the flush tank and the water level.
- If the person flushes the toilet i.e., water level in the flush tank is low, then this sensor records a high distance and LCD displays “LOW WATER LEVEL”.



Figure 7 LCD displays “LOW WATER LEVEL”

- If the person does not flush i.e., water level in the flush tank is high, then the sensor records low distance and LCD displays “



Figure 8 LCD displays “NORMAL WATER LEVEL”

- When man goes to toilet and don't flush, then both sensors will be HIGH and LCD displays “Man & water in toilet”.
- Then servo motor rotates and pushes down the flush button. After completion of flushing, servo motor will be back to its position.



Figure 9 LCD displays “Flushing over”

Floor Cleaning Unit:

- After flushing, it immediately starts floor cleaning using a relay.
- Relay will be switched ON and Dc pump starts pumping water to different corners of floor.
-



Figure 10 Working of DC Pump

Brushing Unit:

- When button is switched ON in Blynk App, then Dc motor (DC Motor connected with a brush) starts rotating 180° clockwise or anti-clockwise direction to clean the bowl.



Figure 11 Working of Brushing Unit

V. CONCLUSION AND FUTURE SCOPE

Most of the people are not using public toilets because of the unhygienic conditions. The main purpose of our project was to improve the hygienic conditions of public toilets. We have completed our project with a working model. By doing this project, we could learn a lot about the different aspects of a project. We have relied on Arduino due to its ease of programming. PIR sensor was preferred over IR (infrared) sensor for improved range of detection and better precision. We are looking forward to a world with better hygiene and reduced disease. Many add-ons or improvements could be included along with our project. Cleaning the bacteria based on the UV (ultraviolet) light disinfection mechanism. The liquid for toilet bowl cleaning could be poured along with the toilet bowl based on the usage of the peristaltic pump mechanism. The insect-repelling circuit can be added along for mainly keeping the flies and other germs away. The ways to reduce the odor using the activated carbon method can be incorporated. Activated carbon acts as an adsorbent and absorbs the odor particles.

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