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IOT ENABLED SMART WASHROOM

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Abstract*— In the cutting-edge world, the advances are definitely grown, yet at the same time the cleanliness in our nation is under risk. The abstract of this paper is to deliver clean and hygiene toilets. All the public toilets should be clean and hygiene. In our country, our government has introduced the scheme called "Swachh Bharat" (Clean India). Keeping the toilets uncontaminated is the one of the objectives of Clean India scheme. This paper can be helpful to encourage the clean India project. In future, it can show the major part in clean India scheme. The smart bathroom system integrates features like an automatic water tap for hands-free operation, water leakage detection to prevent waste, and an exhaust fan with odor sensing for improved air quality. It dispenses auto air freshener based on bad smell detection linked to overall air quality monitoring. Users can control and monitor these functions through a mobile app. Additionally, an auto-cleaning mechanism activates after every 10 entries to ensure a hygienic space. This system aims to enhance efficiency and convenience in the bathroom environment.

I. INTRODUCTION

When it comes to confusing and ever-changing terminology, nothing really comes close to digital technology. From dongles to routers, smart hubs to podcasts, the technology world certainly has no shortage of jargon. However, one phrase might just be worth knowing, that is, IoT. It is certainly one of the more unusual turns of phrase, but WLAN (wireless local area network) or WPAN (wireless personal area network) enabled products could end up in every home in the world, by monitoring objects and tracking behaviours in various settings. However, studies on enhancing the bathroom experience are rare. Based on our previous publication in the conference proceedings, this article describes the development and implementation of a smart health-monitoring bidet with full details including additional and new contents we did not report earlier bidets are used to clean and maintain the perianal area of a toilet seat.

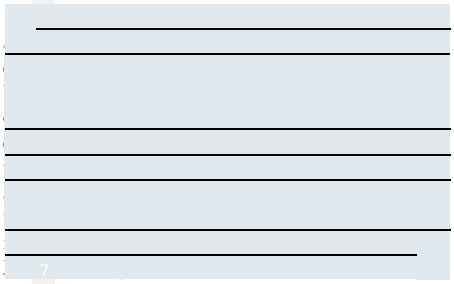
In basic bidets, a high-pressure water jet is utilized to clean the anus and genital areas. However, in recent models, the jets can also function autonomously. The project was developed to increase productivity and working convenience during an AI summer internship. At the start of the internship, there was a noticeable problem with the restroom: there was only one toilet on the floor where more than twenty people work. This proved to be an inconvenience because people would often walk to the restroom, only to find it occupied. However, if there was a way to detect the occupancy state of the restroom, people would not have to constantly check whether the restroom was occupied, improving working efficiency.

A. *Internet of Things*

Fig1. IoT

has been considered a misnomer because devices do not need to be connected to the public internet, they only need to be connected to a network, and be individually addressable.

The Internet of Things (IoT) describes the network of physical objects "things" that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools. With more than 7 billion connected IoT devices today, experts are expecting this number to grow to 10 billion by 2020 and 22 billion by 2025. Over the past few years, IoT has become one of the most important technologies of the 21st century. Now that we can connect everyday objects—kitchen appliances, cars, thermostats, baby monitors—to the internet via embedded devices, seamless communication is possible between people, processes, and things.



By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things. The physical world meets the digital world—and they cooperate. While the idea of IoT has been in existence for a long time, a collection of recent advances in a number of different technologies has made it practical.

1. *Connectivity.*

A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other "things" for efficient data transfer.

2. *Cloud computing platforms.*

The increase in the availability of cloud platforms enables both businesses and consumers to access the infrastructure they need to scale up without actually having to manage it all..

3. Industrial IoT

Industrial IoT (IIoT) refers to the application of IoT technology in industrial settings, especially

The following are some common uses for IIoT:

- Smart manufacturing
- Connected assets and preventive and predictive maintenance
- Smart power grids
- Smart cities
- Connected logistics
- Smart digital supply chains

II. Problem Statement

The current restroom environment lacks efficiency and hygiene, prompting the need for a smart bathroom system. Users face challenges with manual water taps, potential water wastage due to undetected leaks, and unpleasant odours affecting air quality. The absence of a systematic approach to address these issues leads to discomfort and inconvenience. To tackle this, there is a need for an integrated solution that includes automatic water taps for hygiene and conservation, water leakage detection to prevent waste, and an exhaust fan with odor sensing for improved air quality. The implementation of a mobile app for monitoring and control adds convenience, while an auto-cleaning mechanism ensures ongoing hygiene. The problem lies in the inefficiency and discomfort caused by the current restroom setup, emphasizing the necessity for a comprehensive smart bathroom system to enhance user experience and promote cleanliness.

III. Objectives

- To develop a smart washrooms prototype model for society.
- To develop an automated model to enhance user hygiene and convenience, reducing the reliance on manual operation and minimizing the risk of germ transmission.
- To integrate water leakage detection mechanisms and alert users about potential leaks, preventing prolonged water flow and reducing water wastage.
- To monitor and control the various functionalities of the smart bathroom system, providing real-time information and enhancing user control.

IV. Methodology

A. *Proposed System*

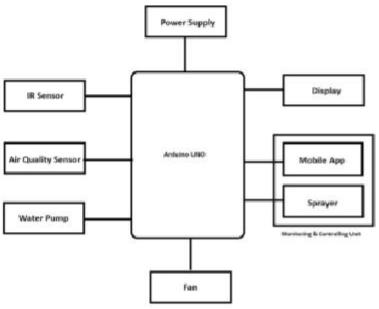


Fig2. **Proposed System**

The proposed smart bathroom system uses Arduino which integrates several features to enhance user experience and promote efficiency. Firstly, an automatic water tap is incorporated using the pump to facilitate hands-free operation, promoting hygiene and water conservation. Secondly, IR sensor is utilized by the system for water leakage detection. This feature not only helps in preventing water wastage but also aids in early detection of potential plumbing issues. The bad smell detection is linked to the overall air quality monitoring within the bathroom. Users can monitor and control these functionalities through a mobile application, providing convenience and real-time management. Furthermore, to maintain cleanliness, an auto-cleaning mechanism is activated entry of every 10 members, ensuring a hygienic space for each user. This comprehensive system aims to blend automation, convenience, and cleanliness in the bathroom environment.

B. *System Requirements*

[redacted]

1. *Hardware Requirements*

i. Node MCU

Fig3. Node MCU

The development board equips the ESP-12E module containing ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor which operates at 80 to 160 MHz adjustable clock frequency and supports RTOS. There's also 128 KB RAM and 4MB of Flash memory (for program and data storage) just enough to cope with the large strings that make up web pages, JSON/XML data, and everything we throw at IoT devices nowadays.

ii. Submersible Water pump

Fig4. Submersible Pump

[redacted]

iii. IR Sensor

Fig5. IR Sensor

Infrared technology addresses a wide variety of wireless applications. The main areas are sensing and remote controls. In the electromagnetic spectrum, the infrared portion is divided into three regions: near infrared region, mid infrared region and far infrared region.

iv. Air quality sensor

Fig6. Air Quality Sensor

The MQ Air Quality Sensor Module a lowcost semiconductor sensor which can detect the presence of Ammonia (NH_3), Mono-nitrogen oxides (NO_x), Alcohol, Benzene, Smoke, Carbon-dioxide (CO_2) etc.

v. Exhaust Fan

Fig7. Fan

Exhaust fans are used to facilitate the removal of odours, fumes and smoke from an area. They draw air out of the room entirely and expel it to the outside to accomplish this task.

vi. Buzzer

Fig8. Buzzer

A **buzzer** is a small yet efficient component to add sound features to our project/system.

vii. Ultrasonic Sensor

Fig9. Ultrasonic Sensor

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do.

viii. Li-Ion Battery

Fig10. Li-ion Battery

The Li-ion battery is a high-performance 3.7V 2600mAh Li-Ion Battery. Its cylindrical design and 2600mAh capacity make it suitable for various devices.

2. Software Requirements

i. BLYNK IoT App

Fig11. Blynk

When a user opens a mobile app, the app communicates with the device's operating system and other built-in software components to access the device's hardware which can control the various operations.

ii. Arduino IDE

Fig12. Arduino IDE software

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino board are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. can tell board what to do by sending a set of instructions to the microcontroller on the board. To do so use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

C. System Design

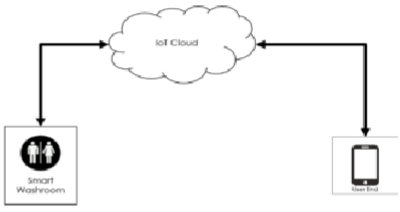


Fig13. System Design

The above figure shows the IoT system design of the proposed system. One end of the system consists washroom which is installed with the various sensors which leads the washroom to be smart. These various sensors used for number of actions. The sensors are synchronized or integrated

to IoT cloud ie., Think speak. Next the whole system will be communicating to the user end where the user can operate and take required actions for the washrooms.

D. *Data Flow Diagram*

Fig14. Data Flow Diagram

The figure 15. shows the data flow diagram for the proposed system. Firstly, when the power supply is given to the system the Arduino initializes all the sensors interfaced. Each sensor will start with their actions as and when required. All the data are collected and sent to the IoT cloud. These values are enabled at the end user who will have internet connection. These steps of data flow are continuously followed till the system is powered on.

E. *UML Diagram*

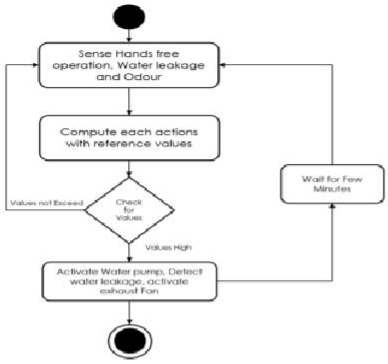


Fig15. *UML Diagram*

The UML diagram is as shown in fig 4.3 smart bathroom system uses Arduino which integrates several features to enhance user experience and promote efficiency. Firstly, an automatic water tap is incorporated using the pump to facilitate hands-free operation, promoting hygiene and water conservation. Secondly, IR sensor is utilized by the system for water leakage detection. This feature not only helps in preventing water wastage but also aids in early detection of potential plumbing issues. Additionally, the system incorporates an exhaust fan equipped with an odour sensor, automatically activating when bad smells are detected.

V. RESULTS AND DISCUSSIONS

Fig16.Smart Washroom Hardware Model

The above Fig 16 shows the Hardware Model of proposed system.

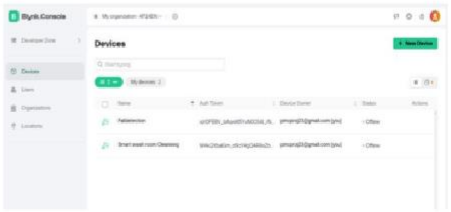


Fig17. Blynk IoT Application dashboard

Fig 17. shows the dashboard of the project where the NodeMCU devices connected are seen and are synchronised with the sensors of the model.

Fig18. Floor Cleaning

Since our project is automated, first feature included is floor cleaning. The hardware is connected with IR sensors at the entry and exit levels where the LCD displays number of members as in fig 18.

Fig19. Tap water level

Next feature which we have concentrated on is tap water level. Here ultrasonic sensor has been utilised to detect the water level in a tank. If water

is sensed it has gone below certain level then an email notification will be sent to the admin. The distance part which is seen on the LCD of Fig 19, shows the water level.

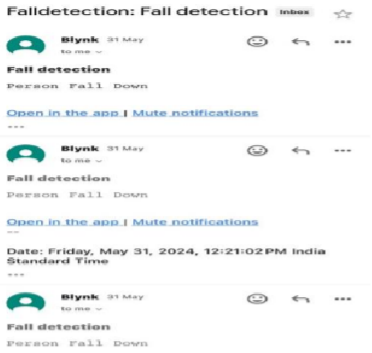


Fig20. Fall Detection

The sensor senses if the person is lying on the floor more number of seconds, through which an email will be sent to the admin immediately as in fig 20, further help can be given as soon as possible.

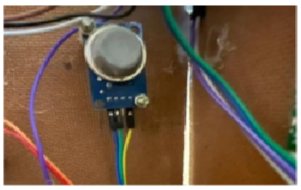


Fig21. Gas Level

In the model, gas sensor has been integrated for odour detection feature. The sensor has been programmed to sense three levels of odour. Further it is connected to Fan and a pump which sprays room freshener. According to the level of odour, the fan and sprinkler runs for longer time like in the Table 1.

Odour level	Fan & Sprinkler ON (seconds)
Mild Odour (Level 1)	5 secs
Moderate Odour (Level 2)	10 secs
High Odour (Level 3)	15 secs

Table 1. Odor Levels

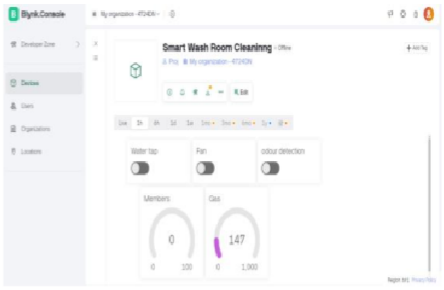


Fig22. Manual controlling dashboard in BLYNK app

The first row has three buttons where we can control water tap, fan and freshener sprinkler manually. The second row shows the number of members' entry and exit in real time. Gas block shows the gas sensor level in real-time.

VI. CONCLUSION

In conclusion, the development of a smart bathroom system offers significant advantages in enhancing the cleanliness and hygiene of public restrooms. By integrating advanced features such as automatic water taps, odour-sensing exhaust fans, water leakage detection, and auto-cleaning mechanisms, this system aligns with the objectives of the "Swachh Bharat" (Clean India) initiative. It ensures efficient water use, reduces maintenance efforts, and provides a convenient and user-friendly experience. Despite potential challenges such as high initial costs and technical maintenance, the benefits in promoting public health and supporting sanitation initiatives are substantial. This project represents a vital step towards improving sanitation standards and fostering a healthier community.

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