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HygieniTech – The Smart Toilet

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***Abstract*: This project presents a novel smart toilet system designed to enhance hygiene and optimize restroom maintenance. The system automatically dispenses a biodegradable seat cover using an infrared sensor upon user entry. Following this, ultraviolet light disinfects the seat, ensuring cleanliness for the next user. An MQ2 sensor continuously monitors air quality, transmitting real-time data to a website accessible by janitorial staff. Additionally, the system tracks seat cover availability and triggers alerts when replenishment is required. Utilizing an ESP32 Wi-Fi module, data seamlessly uploads to the website, empowering proactive maintenance efforts. Furthermore, an automatic flush initiate after use, promoting sanitation and user convenience. This innovative system offers a multifaceted approach to restroom hygiene, combining automated cleaning processes with data-driven maintenance insights, leading to a cleaner and more efficiently managed restroom environment.**

***Keywords*: Hygiene, Internet of Things, Enhanced hygiene, Efficient water management, Arduino, Smart devices, Smart toilet, Message Queue Telemetry (MQTT).**

1. Introduction

Public restrooms often struggle with hygiene and cleanliness, raising concerns about disease transmission and user comfort. Existing smart toilet solutions offer promising technological advancements, but often lack user-centric design and comprehensive data-driven functionalities. This paper presents a novel smart toilet system designed to address these challenges. Our project integrates user-friendly features like automated seat cover dispensing and UV disinfection with real-time air quality monitoring and data reporting. By leveraging the Internet of Things (IoT) technology, the system provides valuable insights for optimized maintenance and improved user experience. While studies like \cite{paper1} highlight user perception towards smart toilets, our project focuses on our project focuses on providing a safe and hygienic restroom experience using IoT devices. Through comprehensive testing and analysis, we demonstrate the effectiveness of our system in promoting Hygiene, efficiency, and user satisfaction.

2. Literature Review

Smart toilets offer opportunities for automated measurement of biomarkers and other data, but their successful adoption depends on understanding user perceptions and barriers. A study investigated participants' experiences using a smart sensor-equipped toilet seat in their homes. Participants found the everyday use of the toilet relatively easy but mentioned issues related to the design of the prototype, technology, and mismatches with normal practices. Use cases mentioned included signaling health conditions, documenting physical data, and measuring biomarkers. Participants varied in their willingness to share the seat with others, emphasizing the importance of ownership and control over their data. The study concluded that smart toilet seats could be acceptable and effective if they fit everyday practices and ensured privacy and control over disclosure and data [1]. The application of micro-controllers and the Internet of Things can be used to check restroom status in department stores. The system includes modules for counting the number of users, verifying sink and toilet status, and controlling and monitoring through a mobile application. The proposed system successfully functions and receives high user satisfaction ratings. It can be applied to create smart rooms in daily life [2]. To address hygiene and cleanliness issues in public toilets, a proposed idea suggests using smart testing tool kits installed in public toilets. These tool kits, supported by the Internet of Things, aim to prevent the transmission of diseases caused by ill-maintained public toilets. The implementation of this idea can contribute to the health and well-being of the nation [3], [4].

Smart toilets are being developed to address hygiene and cleanliness issues in public toilets. These toilets utilize advanced technologies such as the Internet of Things (IoT) to ensure proper maintenance and prevent the transmission of diseases. By installing smart testing tool kits in public toilets, people can safely use them without fear of getting infected or falling sick [5], [6]. These smart toilets contribute to the health and well-being of the nation by converting public toilets from disease transmitters to hygienic facilities [7], [8]. Additionally, the flush temperature performance of smart toilets is crucial for user experience and health. A smart toilet water temperature detection system has been designed to accurately measure and analyze the water temperature, improving detection efficiency compared to manual methods [9].

Smart toilets are a key tool for enabling precision health

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monitoring in the home, but they also raise ethical considerations [10]. The recent proliferation of Internet of Things (IoT) sensors has led to the development of proactive maintenance management systems in industrial and urban settings [11]. A smart portable toilet bowl has been designed with features such as deodorizing, antibacterial materials, and cleaning mechanisms to enhance user experience [12]. A safe smart toilet has been developed with a steam-generating mechanism for high-temperature sterilization and improved cleanliness [13]. An AI-based smart toilet concept has been proposed to support older or disabled individuals by automatically adjusting the height and tilt of the toilet seat [14]. Smart toilets are a growing area of research and development. They have the potential to improve public health by monitoring COVID-19 surges through the detection of SARS-COV-2 RNA in human stool [15]. Additionally, smart toilets can contribute to better sanitation and maintenance in public spaces by utilizing IoT technology, predictive maintenance, and scheduling algorithms [16]. These advancements can enhance the accuracy and cost-effectiveness of sensors, as well as optimize the cleaning and maintenance of bathroom facilities. Furthermore, smart toilets can greatly benefit elderly and disabled individuals by providing them with increased independence and comfort in public spaces [17]. The development of intelligent toilet systems, equipped with air quality monitoring and adjustable features, can further improve the quality of life for these individuals. Overall, smart toilets offer a range of benefits, including improved disease surveillance, enhanced sanitation, and increased accessibility for vulnerable populations [18].

3. Methodology

Constructing the HygieniTech model, the essential hardware components include a sanitary cover offers biodegradable toilet seat protection, contributing to the hands-free washroom experience by providing a fresh, clean, and untouched hygienic surface for each use, DC motor controls the movement of the sanitary cover, transporting it from the starting point to the end point of the seat, 6V 4.5A Rechargeable battery is used in the mechanism for rotating the sanitary cover, Arduino Uno is the controller, used to control all the activities in the model, MQ2 sensor is used to detect the methane, smoke, Butane gas in the restroom, NodeMCU ESP32 is used to update the live data on the web-page so that we can analyze the provided data and take the required actions on time such as determining the cleaning schedule for the washroom and monitoring the toxicity level within the restroom, water pump is used to operate the auto-flush system, IR sensors serves the purpose of detecting the availability of sanitary cover role, activating the auto-flushing system and signaling the system to change the cover when the next person arrives, UV light to disinfect the seat, push button, connecting wires, AC to DC power supply, and a 5V single-channel relay module is used to control the flushing motor. The required software encompasses the Arduino IDE, and Fast2sms (a third-party SMS generator).

In the initial phase of our project, an IR sensor is deployed to detect the entrance of an individual into the washroom. Upon detection, the biodegradable seat cover undergoes an automatic change. Simultaneously, the MQ2 sensor constantly monitors gas levels, updating the information on a dedicated website. If the seat cover is unavailable, the system promptly updates this status on the website and triggers an SMS notification to the administrator through the Fast2sms third-party SMS provider. This data-uploading process involves the utilization of the ESP 32 WiFi module.

Furthermore, the automatic flush mechanism is activated when the toilet seat is used, ensuring a clean environment for subsequent users. In periods of restroom inactivity, a UV light initiates the cleansing process for the seat, turning off when a new person enters. A convenient push button is provided for janitorial staff, who can press it after completing restroom cleaning duties. This button press is recorded as attendance and promptly updated on the website.

4. Result

The HygieniTech model boasts a hands-free, hygienic experience with a biodegradable seat cover automatically changing upon entry. A DC motor handles the cover movement, powered by a rechargeable battery. Arduino controls everything, while the MQ2 sensor monitors gas levels, sending live data to a website for analysis and action.

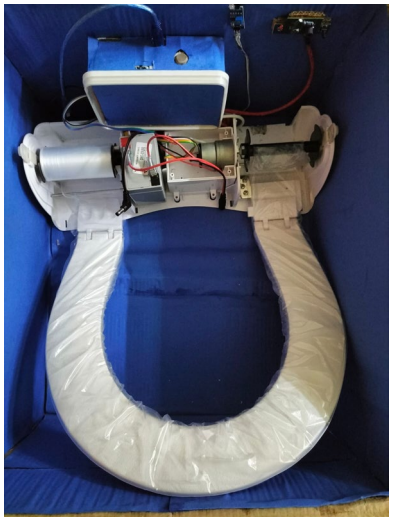

Fig. 1. HygieniTech model

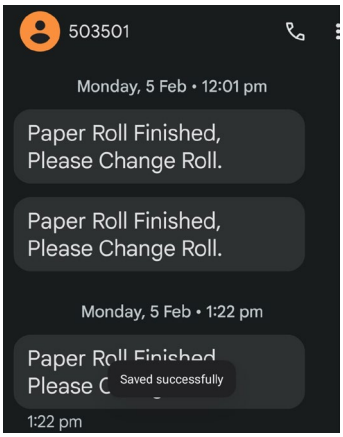

Fig. 2. Result output on SMS

An IR sensor detects user presence, triggering the automatic flush and UV disinfection when the seat is unoccupied. A push button lets janitorial staff log their cleaning activity online. This automated system ensures a clean, safe, and monitored restroom environment.

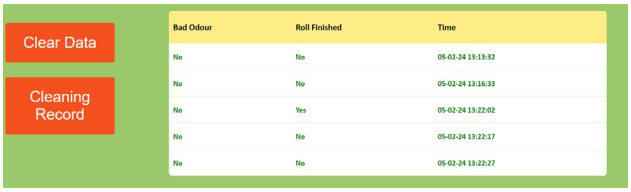

Fig. 3. Hygiene data on website

Fig. 4. Janitor attendance data on website

5. Conclusion

In sum, the HygieniTech project is a big step in making public restrooms cleaner and more user-friendly. By using smart technology, motion sensors, and data-driven solutions, it ensures high cleanliness standards and a better experience for users. The automatic dispensing of Sanitary covers, UV sanitation, and real-time air quality monitoring make it a complete solution.

This project can be customized for different needs in areas like healthcare, hotels, and transportation. There's also potential to take it beyond borders to address global hygiene concerns in public places.

In addition to its focus on hygiene, the project is looking into using Eco-friendly materials for sanitary covers and sustainable UV sanitation methods. This aligns with a commitment to being responsible and sustainable. In a nutshell, HygieniTech isn't just about fixing current restroom issues; it's about creating a future where public restrooms are not only clean but also a part of smarter and more sustainable facilities worldwide.

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