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SMART TOILET HYGIENE AND DISINFECTION: AN AUTOMATED SYSTEM USING IoT

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Abstract: Unhygienic conditions in public restrooms are frequently caused by things like unclean user behavior, insufficient cleaning procedures, and the limits of manual cleaning equipment. Skin infections, hepatitis, and diarrhea can all spread as a result of poor hygiene, which can also host dangerous germs and viruses. In addition, bad smells and unsightly surroundings might discourage individuals from using public restrooms, which can harm one's health and well-being as well as increase public health issues and decrease the use of public areas. These unsanitary circumstances are a major worldwide issue that needs creative solutions. Infrared sensors are used by the automated toilet system to detect user activity. Servo motors open the lid automatically when something enters. Hot air dryers use extra sensors to activate after use, drying the person and the toilet bowl at the same time. The lid shuts as the user leaves, and UV light disinfection starts inside the bowl to get rid of bacteria and smells. Features like extra flushes, air freshener dispensers, and emergency assistance are controlled by an intuitive interface with touchless buttons or voice commands. The system as a whole runs - smoothly and ensures a clean and comfortable user experience. There is yet more innovation, though. To enhance accessibility and convenience of use, the system integrates a touchless interface that is easy to use for emergency assistance, flushing, and other functions. Long-term functionality and uncomplicated upkeep are guaranteed by sturdy, easily-cleanable materials. Extensive testing will quantify bacterial and viral reductions, offering verifiable proof of its efficacy in reducing health hazards. There will be improvements in public health, user experiences, and overall well-being. With the help of this creative idea, everyone may look forward to a cleaner, healthier future free from filth and unhygienic conditions.

***IndexTerms* - Internet of Things (IoT), IR sensor, UV light.**

I. INTRODUCTION

Sensor-activated hot air dryers dry you and the toilet bowl simultaneously after use, eliminating any possibility of residual moisture and promoting a healthier atmosphere. When you leave, the lid automatically closes, and a UV light disinfection burst removes any last hazards, leaving the area completely clean. However, the creativity doesn't end there. This system is not just a touchless one. By completely doing away with the necessity for manual contact, it reduces the spread of germs and puts public health first.

An easy-to-use touchless interface that caters to the accessibility and convenience of use further improves the experience by providing intuitive control over emergency help, flushes, and other features. This system is sustainable in addition to being effective because it is made of sturdy, easily cleaned components that guarantee long-term operation and simple maintenance. Despite being fundamental components of public infrastructure, public restrooms frequently conceal a hidden threat: unsanitary conditions.

Hand cleaning methods can be uneven, surfaces can become contaminated by touch and harbor germs, and offensive smells can cling on, endangering public health and detracting from the user experience. The current methods are inadequate; touchless fixtures only marginally enhance hygiene consistency, and manual cleaning is difficult to maintain. An automated public restroom system that uses sensor-driven automation is the ground-breaking approach that this research suggests. Envision entering a bathroom where infrared sensors serve as your quiet protectors. The lid opens effortlessly as you get closer, reducing contact with potentially contaminated surfaces.

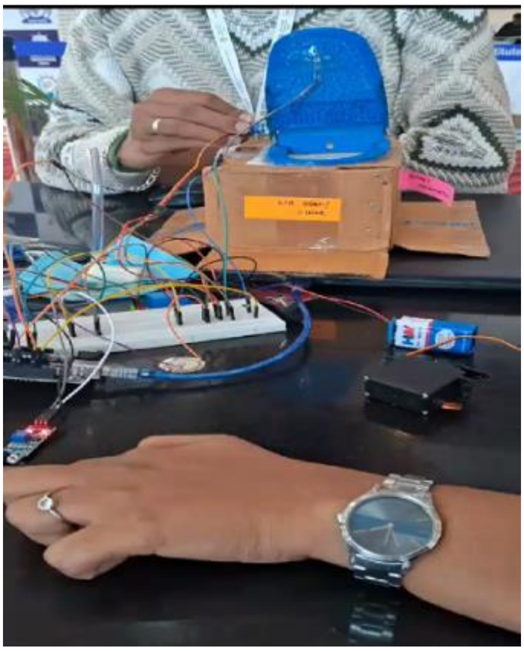

Fig. I. Lid open

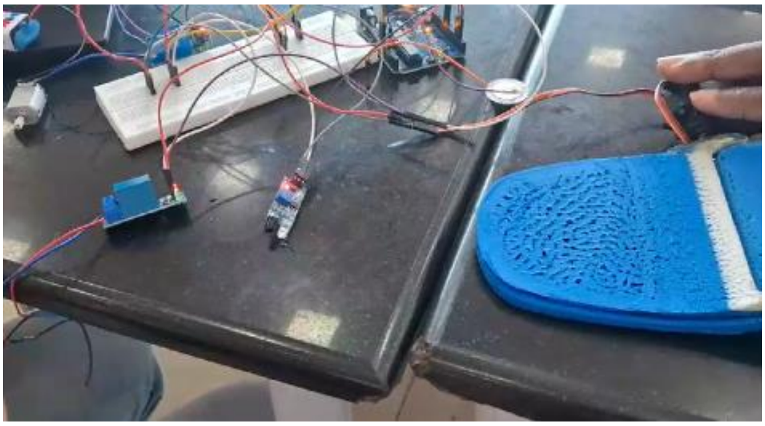

Fig. I. Lid close

II. RESEARCH

2.1 EXISTING SYSTEM

The existing systems for the e-toilet of automated public restrooms in India started in Kozhikode, where early attempts were met with complaints from patrons regarding broken green lights and the need for cash to enter. Even while these early "e-toilets" were a technological advance, they had several drawbacks. They did, however, open the door for more sophisticated systems that take advantage of the convergence of web-mobile, mechanical, and electronic technology. These cutting-edge automatic toilets offer a sustainable and hygienic alternative. Imagine going into a restroom where entry, usage, cleaning, and exit are all managed by sensors and are all tracked from a distance for maximum effectiveness.

Envision a utopia for public restrooms: touchless technology protecting your health, intelligent recycling of water, self-cleaning systems guaranteeing hygienic conditions, collected energy supplying the system, trash converted into revenue, and inclusive design embracing everybody.Fig.2.1, The possibility for sophisticated automated public restrooms that make use of attributes like sensor controls, intelligent water management, automated sanitation, renewable energy, waste-to-resource systems, and user-friendly interfaces is not a utopian idea. Along with better user experience and hygiene, these technologies also hold up the prospect of a sustainable public sanitation system in the future, promoting economic growth, environmental preservation, and public health.

These sophisticated automated toilets have the potential to completely transform public sanitation in India by eliminating the shortcomings of previous attempts and utilizing cutting-edge technologies. They promote resource generation and environmental sustainability in addition to bettering user experience and hygiene fully exploiting the promise of this technology, however, additional investigation and assessment are required. The efficacy of these systems about hygienic practices, user happiness, operational efficiency, and environmental impact must be evaluated through extensive testing. We cannot be certain that these automated toilets signify a stride towards a better, cleaner, and more sustainable future for India until we conduct extensive study and development.

Fig.2.1 e-toilet

III.PROBLEM SOLUTION

3.1 Workflow

The graphic displays an automated public restroom system that makes use of numerous sensors and actuators to offer a clean and convenient experience. An infrared sensor senses a user's presence when they enter the restroom, causing the system to open the toilet lid and turn on the hot air drier. The mechanism automatically closes the lid and activates the UV light to disinfect the bowl when the user is done using the restroom. Fig.3.1, To get rid of any smells, an air freshener is also turned on.

The user-friendliness of the system is a top priority. People of all abilities can operate the device because all of the controls are touchless. In addition to being energy-efficient, the device flushes the toilet using reclaimed water. Compared to conventional public restrooms, the automated toilet system is a huge advance. It is more sustainable, user-friendly, and hygienic. The technology may enhance public health and increase the appeal of using public bathrooms.

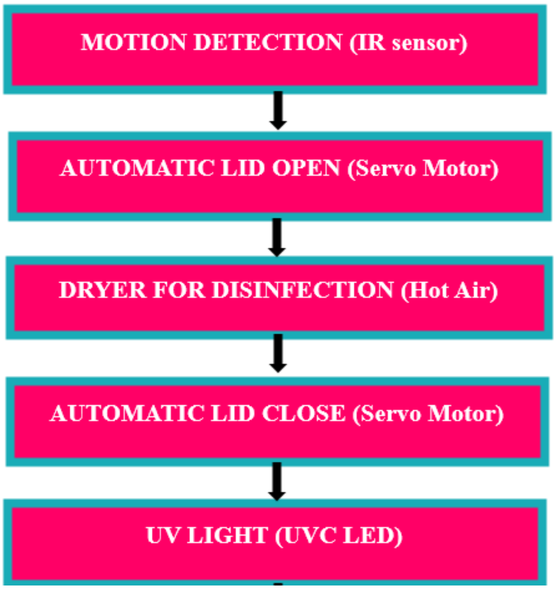

Fig.3.1 Workflow

3.2 Material Comparison

Vitreous Description It's highly possible that the toilet you use daily at home or work is composed of vitreous China. Because of its adaptable shape, shiny white appearance, and simplicity of cleaning, it's the most widely used material for toilets in both home and commercial settings. Fig. 3.2, This kind of ceramic is created using a method akin to glass blowing, in which the material is heated to extreme temperatures and then shaped into, um, a toilet. Benefits: hygienic, sound-absorbing aesthetic. The drawbacks are readily broken.

It is nearly impossible to distinguish porcelain toilets from vitreous Chinese ones. These are ceramic materials that have been flash-fired. However, because porcelain toilets contain clay, feldspar, and quartz, they typically have higher densities. Fig.3, Additionally, this material has a matte white surface as opposed to a glossy one. The second most widely used material for toilets is porcelain johns. advantages Durable Non-Porous Appearance. drawbacks that can easily be overcome.

Given their near indestructibility, stainless steel toilet fixtures are a great option for commercial and public spaces where they must endure heavy usage. Fig. 3.2, Advantages Extremely robust Minimal Upkeep Not prone to crime. drawbacks Looks and more difficult to design.

Plastic is inexpensive, lightweight, and portable, it is virtually usually used to make bathrooms. Fig. 3, They are frequently erected in isolated locations without access to restrooms, such as building sites and outdoor gatherings. advantages costly Adaptable straightforward. drawbacks Limited Lifespan.

Fig.3.2 Material Comparison

IV. RESULTS AND DISCUSSION

4.1 UV light

A brand-new disinfection system that makes use of UVC-LED irradiation was created. The device was affixed to the toilet seat, and it was challenged by three bacteria types. Different combinations were tested: 3-LEDs, 5-LEDs (two versions), and 8-LEDs. Two more variations of 5-LED configurations—uniform and concentrated (2-sided) distributions—were considered to identify the arrangement patterns of LEDs with the best efficacy. The number of LEDs was shown to initially improve the efficacy of disinfection; however, at eight LEDs, the trend for surface disinfection almost vanished and for airborne disinfection, it increased just a little.

For E. Coli, the mean disinfection efficiencies ranged from 55.17 ± 23.89% to 72.80 ± 4.13%; for S. typhimurium, they were 36.65 ± 2.99% to 50.05 ± 13.38%; and for S. epidermidis, they were 8.81 ± 3.23% to 39.43 ± 9.33%. The E. coli, S. typhimurium, and S. epidermidis mean disinfection efficiencies varied from 42.17 ± 8.18% to 70.70 ± 4.80%; 40.40 ± 17.90% to 58.31 ± 13.87%; and 24.16 ± 3.81% to 42.79 ± 10.20%, respectively. When tested against E. Coli, the uniform irradiation's efficacy was also nearly twice as high as the concentrated irradiation for surface disinfection and 17.70% higher for airborne disinfection.

Fig.4.1 Lid close with UV light

V. CONCLUSION

This research proposes and evaluates an innovative automated public toilet system. Using infrared sensors, the system automatically opens the lid upon user entry, minimizing touch points and reducing contamination risks. After usage, hot air dryers simultaneously dry the user and the toilet bowl, promoting rapid moisture removal and inhibiting bacterial growth. After the user leaves, the lid automatically closes, and UV light disinfection within the bowl eliminates any remaining pathogens and ensures a sanitized environment.

The system uses materials that are long-lasting and easily cleaned to provide long-term operation and effective maintenance. It also stresses accessibility with touchless control interfaces. The system's creation and extensive testing to assess its efficacy in enhancing user pleasure, operational efficiency, and cleanliness (bacterial/viral reduction) are presented in this study. The results show that the system has the potential to greatly improve user wellbeing, and public sanitation, and contribute to a cleaner, healthier future.

Imagine a completely different public restroom—one without unpleasant smells, germ-ridden surfaces, or difficult-to-clean surfaces. For the ultimate in hygienic use, our cutting-edge automatic toilet system makes use of sensor-driven technology. Infrared sensors detect when someone enters, opening the lid automatically. Hot air dryers minimize moisture-borne bacteria by drying you and the toilet simultaneously after use. Control is simple to use with a touchless interface. This solution reduces the need for manual disinfection for users and cleaners while prioritizing accessibility and convenience to ensure a clean and comfortable experience for all. This is a step toward a future where public sanitation is cleaner and healthier, not just a solution.

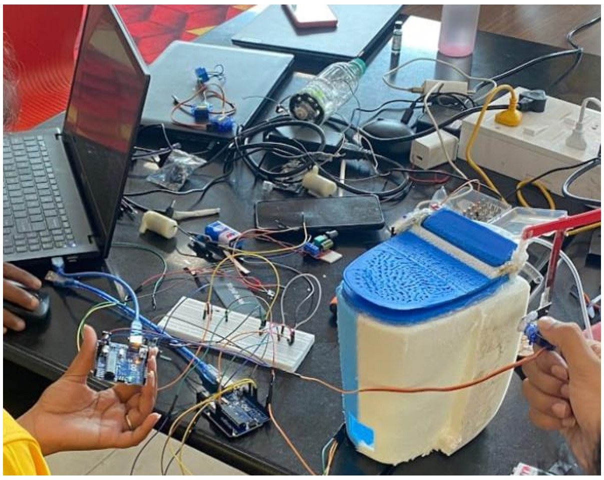

Fig .V. Working prototype

VI. References

[1] A Self-Sterilizing Toilet Seat with UVC Radiation (Tang-Jen Liu Dept and Shi-Hao Liu Dept 2021)

[2] Pilot study on the decontamination efficacy of an installed 222-nm ultraviolet disinfection device (Care222™), with a motion sensor, in a shared bathroom. (Yuki Kaiki, Hiroki Kitagawa, Kayoko Tadera, Keitaro Omori, Toshihito Nomura, Norifumi Shigemoto, Shinya Takahashi, Hiroki Ohge 2021)

[3] A new UVC-LED system for disinfection of pathogens generated by toilet flushing. (Alvin C. K. Lai, Sunday S. Nunayon 2020)

[4] Impacts of lid closure during toilet flushing and of toilet bowl cleaning on viral contamination of surfaces in United States restrooms. (Madison P. Goforth BS, Stephanie A. Boone Ph.D., Justin Clark MS, Priscilla B. Valenzuela MS, Julie McKinney Ph.D., M. Khalid Ijaz DVM, MSc (Honors), Ph.D., FRSPH, Charles P. Gerba Ph.D. 2024)

[5] Lifting the Lid Off the Toilet—Understanding the Indian Context and A Case on Samagra Empowerment Foundation. (Aparna Venugopal, David Foord, Muthu Singaram 2020)

[6] Microbiological Assessment of the Different Hand Drying Methods and Washroom Environment Cross-Contamination. (Fayza Kouadri 2020)

[7] The method used to dry wash hands affects the number and type of transient and residential bacteria remaining on the skin. (R. Mutters, S.L. Warnes 2019)

[8] Toilet Hygiene System. (Aniket Waje, Nooryan Shaikh, Prashant Pansare, Pradnya Kamble 2020)

[9] Determinant Effects of Using Toilet Cleaners on Indoor Air Quality. (Arpita Sarkar, Ranjitha Govindaraj, Jyotsna Rao J, Uttam Pal 2021)

[10] Bleach-containing automatic toilet-bowl cleaners as sources of VOCs, associated indoor air concentrations, and carcinogenic risk. (Ilknur Ayri, Sait C. Sofuoglu, Mesut Genisoglu, Handan Gaygisiz, Aysun Sofuoglu, 2020)

[11] Investigation of Toilets with Reduced Ventilation Frequencies and Odor Simulation. (M Kimura, T Akimoto, S Kato, N Hirasuga, Y Sakamoto, S Yamakita4 and H Sakakibara 2019)

[12] The Dirty Dozen Cleaning Products at Home. (Derrick A. Balladin, University of Trinidad and Tobago, O'Meara Campus, Arima, Trinidad and Tobago 2020)

[13] Isolation of ammonia gas-tolerant extremophilic bacteria and their application to the elimination of malodorous gas emitted from outdoor heat-treated toilets. (Saika Tada, Yugo Itoh, Keiji Kiyoshi, Naoto Yoshida 2021)

[14] Strain Detection Based on Breath and Motion Features Obtained by a Force Sensor for Smart Toilet Systems. (Rina Akaho, Mototaka Yoshioka 2022)

[15] Design for a Toilet Appliance that Automatically Closes the Toilet Lid before Flushing. (Agafiya Konnova Faris A. Shaikh Yin Zhang Kunjun Zou 2020)