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Solar based Smart Sanitizer Dispenser System with Internet of Things (IoT) Technology

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ABSTRACT

In response to the growing demand for efficient and sustainable hygiene solutions, this project introduces a Solar-Powered Smart Sanitizer Dispenser System leveraging IoT technology. The system aims to address the need for touchless and accessible hand sanitization in various environments, including public spaces, healthcare facilities, and commercial establishments. By integrating solar power as the primary energy source, the system offers autonomy and eco-friendliness, reducing dependency on conventional electricity grids and minimizing environmental impact. The core components of the system include a smart dispenser unit equipped with sensors for detecting hand proximity, a reservoir for storing sanitizer solution, and a microcontroller unit responsible for data processing and IoT connectivity. Through the IoT interface, users can remotely monitor sanitizer levels, receive real-time usage statistics, and manage dispenser settings, enhancing operational efficiency and maintenance. Furthermore, the incorporation of solar panels ensures continuous operation even in off-grid locations, making the system suitable for deployment in remote or outdoor settings where access to electricity may be limited. Maximizing the efficacy of solar power conversion and extending operational uptime.

Keywords : Solar Power, Smart Sanitizer Dispenser, IoT Technology, Touchless Hygiene, Sustainability, Remote Monitoring, Energy Efficiency, Environmental Impact, Public Health, Renewable Energy Integration.

I. INTRODUCTION

The global spread of the Covid-19 virus has triggered a swift response worldwide, with numerous cases and fatalities reported. Alongside the devastating impact on public health, the pandemic has inflicted substantial economic losses across nations. In light of these challenges, countries are actively seeking effective measures to combat the epidemic. Adhering to guidelines set by the World Health Organization (WHO), hand sanitization has emerged as a crucial preventive method. Hand sanitization proves highly effective in eliminating various viruses and bacteria, while being gentle on the body and evaporating automatically.

To contribute to the implementation of an automated and intelligent sanitization approach within our BSIT building. The project team is set to leverage a Raspberry microcontroller, motor, and sensor. This initiative aims to transform the conventional sanitization process into a smart, automatic sanitizer dispenser system. Additionally, we incorporate a solar panel in the sanitizer device to harness sustainable power sources for the efficient operation of the sanitization machine.

This cutting-edge proposed device merges solar power and IoT capabilities to create an innovative, hands-free sanitization solution. Designed for efficiency and sustainability, it offers automated dispensing, real-time monitoring, and contributes to a safer and environmentally conscious space.

II. METHODS AND MATERIAL

A. Domain

Figure 1.1 shows the current manual sanitizer system implemented within the University Campus. In this setup, individuals are required to manually dispense sanitizer from stationary dispensers placed at various locations throughout the campus premises. While this traditional approach has served its purpose to some extent, it often presents challenges such as inconsistent usage, dependency on individuals to refill the dispensers, and difficulty in monitoring sanitizer levels. The term Internet of Things (IoT) pertains to a network of physical objects, commonly referred to as "things," equipped with sensors, software, and diverse technologies to enable connectivity and data exchange with other devices and systems via the internet. This interconnected system involves numerous computing devices and machines designed to autonomously transmit data through a network, eliminating the necessity for direct human intervention.

Figure 1.1 present manual Sanitizer system in the University Campus.

The integration of Internet of Things (IoT) technology into smart sanitizer dispenser systems, coupled with solar power, presents a revolutionary advancement in public health infrastructure. By harnessing IoT capabilities, these dispensers are not only capable of dispensing sanitizer automatically but also gather invaluable data in real-time, such as usage patterns and sanitizer levels. This data enables efficient management and restocking, ensuring continuous availability. Moreover, solar power ensures sustainability and autonomy, making these systems ideal for deployment in various environments, including remote or off-grid locations. The synergy between IoT and solar power enhances the reliability, accessibility, and environmental friendliness of smart sanitizer dispensers, marking a significant stride towards promoting public health and hygiene on a global scale. Figure 1.2 depicts an IoT technology-based model sanitizer dispenser system, displaying a significant advancement over traditional manual systems. In this model, smart sanitizer dispensers equipped with IoT capabilities are strategically placed across the University Campus. These dispensers are designed to automatically detect the presence of individuals and dispense sanitizer accordingly, promoting a touchless and hygienic experience.

B. Objective and key goals of this project work

The primary goal of this project is to develop a solar-powered based smart sanitizer dispenser device using Internet of Things (IoT) technology.

Key Goals

- Implement motion sensors for touchless operation, enhancing user safety and hygiene.
- Integrate a liquid level sensor to prevent wastage and ensure timely refilling of the sanitizer reservoir.
- Enable remote management and monitoring through an IoT-based platform for efficient administration.
- Design a user-friendly interface for easy interaction and maintenance of the sanitizer dispenser.
- Creating green energy technology by utilizing solar based power, thereby decreasing support on conventional electricity sources

C. Background Study

Hygiene involves adopting practices that promote health and prevent diseases, with a particular emphasis on activities such as handwashing. Sanitizers are typically dispensed by pressing a pump with one's hand, releasing the liquid sanitizer. Using hand sanitizer outdoors is a crucial protocol to follow, as it effectively eliminates bacteria and viruses.

Various companies manufacture hand sanitizer systems with both manual and automatic operation, commonly found in shopping malls and buildings. However, these machines typically lack remote monitoring, control capabilities, and rely on electricity for operation. In an effort to introduce an innovative model, our project team has opted to develop a smart solar-based sanitizer system incorporating IoT technology. This solution aims to offer automatic monitoring and control features, distinguishing it from traditional systems."

D. Review of Literature

The integration of solar power in sanitation systems has gained attention as a sustainable and eco-friendly solution. Sekhar et al. (2018) explored the design and implementation of a solar-powered automatic hand sanitizer dispenser. Their study demonstrated the feasibility of harnessing solar energy to power a dispenser, showcasing the potential for reduced reliance on conventional energy sources.

Sharma et al. (2019) focused on the implementation of an IoT-enabled smart hand sanitizer dispenser. Their work highlighted the significance of real-time monitoring and control facilitated by IoT technology. The smart dispenser, equipped with sensors, provided insights into usage patterns and dispensing efficiency. This study serves as a foundational reference for the integration of IoT in sanitizer dispensing systems.

Rahman and Hossain (2019) discussed sustainable practices in the health sector, emphasizing the need for eco-friendly solutions. The paper highlighted the importance of adopting renewable energy sources and efficient technologies in promoting public health. Their insights contribute to the understanding of the broader context within which solar-based smart sanitizer dispenser systems align with sustainable development goals.

Kumar et al. (2020) conducted a comprehensive survey on IoT-based solutions in healthcare, discussing challenges and solutions. The paper delves into issues related to connectivity, security, and interoperability—crucial considerations in implementing IoT technology in healthcare applications. Understanding these challenges is vital for the successful integration of IoT in solar-based smart sanitizer dispenser systems.

E. Programming Used

Python programming plays a crucial role in the implementation of a "Solar-based Smart Sanitizer Dispenser System using Internet of Things (IoT) Technology." Python is a versatile programming language known for its readability, ease of use, and extensive libraries, making it an excellent choice for developing various components of the system. Here are key roles Python can play in this project:

Python can be used to program the microcontrollers or processors embedded in the smart sanitizer dispenser units. Libraries such as MicroPython or CircuitPython can simplify programming for microcontrollers, allowing seamless integration with IoT components.

Python can facilitate integration with external APIs for features such as weather data retrieval or connectivity with third-party services.

Python can be employed to create automation scripts for routine tasks like system maintenance, backups, and updates.

Python's versatility, extensive community support, and a rich ecosystem of libraries make it a suitable choice for developing various aspects of the "Solar-based Smart Sanitizer Dispenser System with IoT Technology." It allows for efficient and rapid development, ensuring that the system is robust, scalable, and capable of meeting the project requirements.

F. Closed-Loop Completion

The feedback loop is complete, and the system continues monitoring and dispensing based on user interactions. This closed-loop diagram emphasizes the continuous feedback and control mechanisms within the system, ensuring that it responds to changes in sanitizer levels, user interactions, power sources, and connectivity, while also monitoring for maintenance needs or malfunctions. Each step is interconnected, creating a closed-loop system that maintains the desired operation of the sanitizer dispenser.

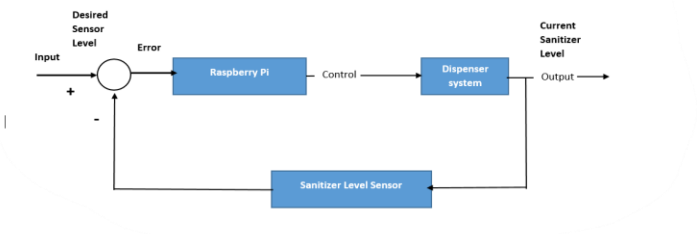

Figure1. Closed-Loop Design

Figure 1 illustrates the closed-loop design for sanitizer level monitoring, presenting a comprehensive solution to ensure continuous and efficient operation of the sanitizer dispensing system. In this design, sensors are deployed within the sanitizer reservoir to constantly monitor the sanitizer level. These sensors communicate with a central control unit, which processes the data and initiates actions based on predefined thresholds. When the sanitizer level drops below a certain point, the control unit triggers an alert for refill or maintenance, ensuring timely intervention to prevent interruptions in service. Moreover, the closed-loop nature of this design enables feedback mechanisms to optimize sanitizer usage and resource allocation. By implementing a closed-loop approach to sanitizer level monitoring, this system enhances reliability, minimizes downtime, and promotes proactive maintenance, contributing to a seamless and effective sanitization process.

In Figure 2, the block diagram process of the proposed design is outlined, offering a succinct overview of its operational framework. The diagram illustrates the sequential flow of information and actions within the system.

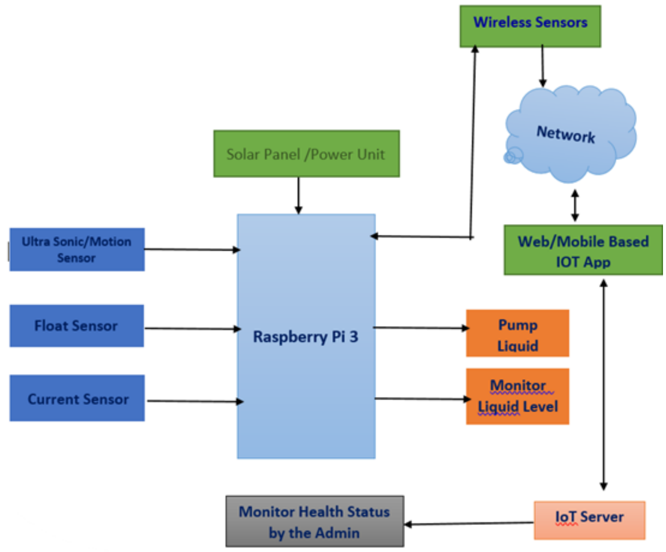

Figure 2 Block Diagram of the proposed Smart Sanitzer System with IOT

G. System Implementation

The implementation of a smart sanitizer dispenser system utilizing IoT technology typically involves integrating various components for seamless operation. Central to this setup is a Raspberry Pi, serving as the brain of the system. Proximity sensors are employed to detect user presence, triggering the dispenser to release sanitizer fluid. A relay module acts as a switch to control the motor pump, which facilitates the dispensing mechanism. Cables are intricately wired to connect these components, ensuring smooth communication and operation. Additionally, a solar panel is integrated to reduce reliance on traditional electric sources, enhancing sustainability by harnessing renewable energy. This holistic approach optimizes efficiency, enabling autonomous and eco-friendly sanitization solutions

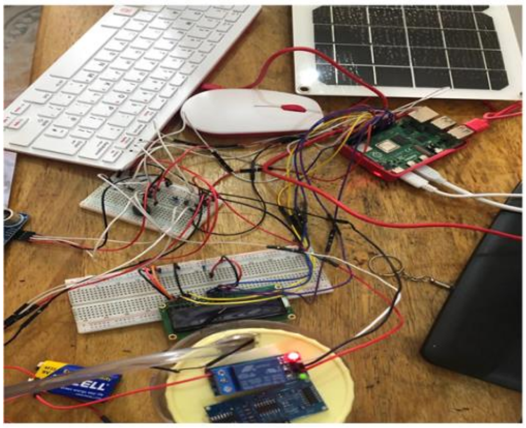

Figure 3: Standard Structure of the Smart Sanitizer System Implementation

Figure 3 illustrates the standard wiring structure of the Smart Sanitizer System implementation, incorporating connections to a solar panel for sustainable power supply. This picture delineates the arrangement of electrical components, including the smart sanitizer dispensers, solar panel, battery storage, charge controller, and inverter. The wiring configuration ensures seamless integration of the solar panel into the system, allowing for the harnessing of renewable energy to power the dispensers and associated electronics. By incorporating solar power, the Smart Sanitizer System becomes more environmentally friendly and resilient, reducing dependence on traditional grid electricity and enabling operation in off-grid or remote locations. Figure 4.Shows the execution of programming during the testing of working model.

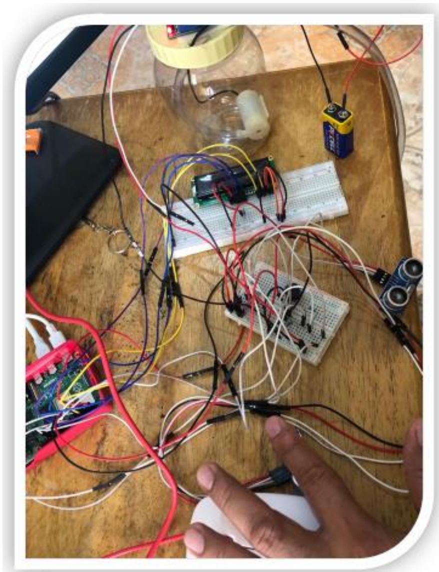

Figure 4. Python Code Execution with working model smart sanitizer system development

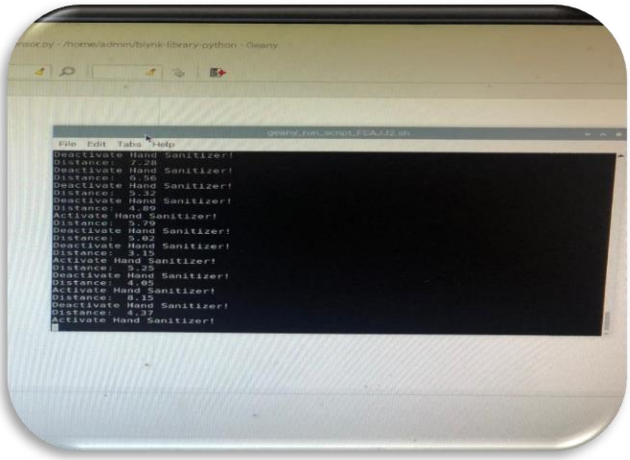

Figure 5: Presence of hand motion deduction in Plants with Pump hand sanitizer Activated

Figure 5 illustrates the detection of hand motion in plants with the activation of a pump hand sanitizer, displaying the outcome of this activation process. This diagram depicts the integration of motion sensors within the vicinity of plants, capable of detecting the presence of hand motion. Upon detecting motion, the system triggers the activation of a pump hand sanitizer, dispensing sanitizer automatically.

Figure 6: Absence of not detecting Hand motion detection with Pump to sanitizer deactivated

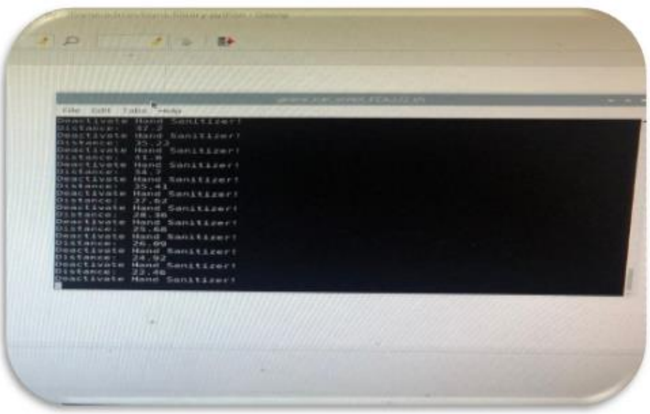

Figure 6 depicts the scenario where hand motion is not detected, leading to the deactivation of the pump and displaying a corresponding output on the screen. In this illustration, motion sensors installed within the designated area fail to detect any hand motion. As a result, the system initiates the deactivation of the pump responsible for dispensing sanitizer. Simultaneously, the output displayed on the screen confirms the absence of detected hand motion, ensuring transparency regarding the system's response

H. Remote Monitoring of Sanitizer Level Status via Blynk App"

By utilizing the Blynk app, users can easily monitor the liquid level status in terms of percentage calculation. This functionality allows users to track the remaining quantity of liquid in real-time and take appropriate actions when necessary. By accessing the Blynk interface, users can view the percentage of liquid remaining in the container, enabling them to make informed decisions about refilling or replenishing the liquid as needed. This convenient feature enhances user convenience and ensures that supplies are adequately maintained, contributing to efficient management of resources.

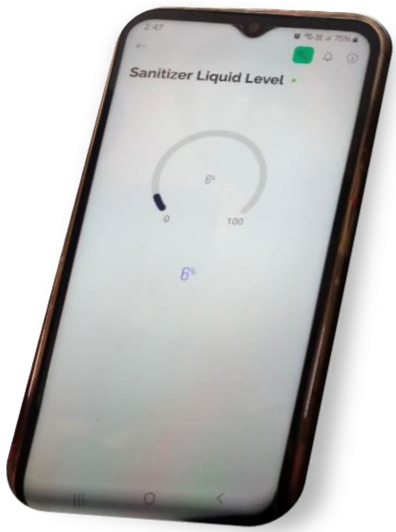

Figure 6: Remote monitoring of Sensor Values via Blynk Server using Blynk in Mobile

Figure 5.11 exemplifies the remote monitoring of sensor values via the Blynk Server using the Blynk mobile application. This visualization illustrates the seamless integration of IoT technology into the Smart Sanitizer System, enabling users to monitor sensor data from anywhere with internet connectivity

III.CONCLUSION

In conclusion, hands serve as a significant medium for the transmission of diseases, including skin ailments, diarrhea, and respiratory infections. The importance of hand hygiene cannot be overstated as it plays a crucial role in preventing the spread of germs and bacteria that can lead to various illnesses.

The findings from our analysis study demonstrate the effectiveness of the automatic hand sanitizer system with IoT technology. This system operates seamlessly, automatically dispensing sanitizer when the sensor detects an object, such as a hand gesture. The relay mechanism facilitates the activation of the mini water pump, ensuring the efficient spraying of sanitizer. Conversely, when no object is detected, the system deactivates, conserving resources.

This innovative tool holds great potential for placement in front of classrooms and staff offices at our university, providing a safe environment without the need for physical contact with the dispenser. To address the issue of electricity dependency, we have incorporated solar power consumption into the device's operation. While we have completed the analysis phase of the project, the implementation phase is slated for the upcoming project cycle during our next academic year. This progression marks a significant step toward creating a safer and more hygienic environment within our university community. The project has been effectively executed, achieving specific sub-goals, and the prototype has been thoroughly tested, demonstrating successful functionality within the system.

IV. Future work: Using AI

Future work for the Solar-based Smart Sanitizer Dispenser System with IoT Technology could involve incorporating advanced features to further enhance user convenience and hygiene. Integration of machine learning algorithms for predictive sanitizer usage patterns could optimize refill scheduling, ensuring that the dispenser is always adequately stocked. Enhanced user authentication methods, such as facial recognition or biometric sensors, could add an extra layer of security and personalization. Additionally, the system could evolve to include real-time monitoring of sanitizer effectiveness, providing users with insights into the sanitizer's germ-killing efficacy. Implementing these advanced features would not only elevate the system's functionality but also contribute to a more intelligent and adaptive smart sanitizer dispenser.

J. Recommendation of the project

The Solar-based Smart Sanitizer Dispenser System with IoT Technology presents an innovative and sustainable solution for touchless hand sanitization. To enhance the project further, consider the following recommendations:

Implement data analytics tools to gather insights into sanitizer usage patterns. This information can be valuable for optimizing refill schedules, anticipating high-demand periods, and improving overall system performance.

Explore integration possibilities with smart building systems to enable seamless communication between the sanitizer dispenser and other building components.

Allow users to customize sanitizer dispensing options based on personal preferences. This could include adjustable dispensing volume, different sanitizer types, or even the option for scented sanitizers, catering to diverse user preferences.

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