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Self-Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration for COVID-19 Infectious Waste Prevention

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***Abstract* - This research project focuses on developing a Self-Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration for an efficient and effective method for waste management in preventing covid-19 infectious waste. The research project used ten (10) hardware components: Arduino Uno R3, Ultrasonic Sensor, Servo Motor, Jumper Wires, Solar Panel 10W 6V, Lithium battery, Breadboard, LED, LCD, and Buzzer. The system is an automated waste bin powered entirely by renewable solar energy. A smart bin's automated mechanisms allow users to prevent contamination. When a human hand places on the accepted parameters written on the microcontroller, the sensors detect it and automatically open the lid, allowing the user to throw waste without touching the smart bin cover. Once the person has thrown away the waste and exited the sensor's detection parameter area, the device closes the lid after 5 seconds. Furthermore, the attached sensors were in charge of self-monitoring through the use of LED indicators with corresponding colors for the specific status of the smart bin, which is also linked to a buzzer for the sound alarm mechanism when the smart bin is full. These indicators were visually reflected and can be displayed through an LCD attached to the system for real-time monitoring. The developed project design was proven to be a functional and well-working system after a series of trials and experiments. During the project design implementation, it was observed that it had contributed to the waste disposal method in preventing COVID-19 infectious waste contamination.**

Keywords: Self-monitoring, Automated, Real-Time, Solar Power, COVID-19 Infectious Waste.

I. INTRODUCTION

Since the dawn of time, the world has been submerged in ever-growing garbage heaps. Moreover, the emergence of the corona virus (COVID-19) pandemic creates additional waste management challenges in several nations. Health professionals now recommend that everyone wear a face mask in public to help prevent the disease's spread. However, many individuals fail to dispose of their face masks in an eco-friendly manner. The production of waste during COVID-19 has been a concern for both the environment and public health, especially the abandoned personal protective equipment (PPE) and single-use plastics. Since the beginning of the world's deadliest pandemic, the COVID-19 virus has become a grave threat to everyone on the planet. The concept of "survival of the fittest" is now supported by scientific evidence and is no longer merely a theory [1]. COVID-19 is a serious public health concern but can spur innovation. Few interventions focus on automated anti-COVID-19 technologies like body sanitizers, digital remote surveillance, solar-powered hand washing tools, and smart bins. Due to COVID-19, physical contact between people and items must be limited to improve cleanliness and prevent a local outbreak. Daily human interaction must be reduced, and novel methods must be developed to limit infection risk and avoid local outbreaks. Innovative and scalable automation technology helps mitigate COVID-19 risk and manage infectious diseases locally [2].

Ineffective waste management is at the root of numerous human issues, including pollution, illness, and poor sanitation. The disease has contributed to the risk that improperly discarded medical waste could harm the environment. If someone comes into direct contact with such waste, they may contract potentially fatal infections. People dispose of waste in a trash can, which is emptied when full. In this example, a standard trash can is utilized in the simplest way possible; no components are used, no coding is added, and everything is performed manually. In addition, manually inspecting trash cans is a laborious and time-consuming task. It necessitates more human effort, time, and expense, which is incompatible with the capabilities of the present technology. Moreover, Internet of Things (IoT) technology and other sensors are first utilized to monitor and provide status information on smart trash bin models, which is the primary focus of the research on those models. The concept of a Smart Bin was proposed, and the proposed model includes Android application-accessible features such as Trash Level, Flame Alert, and Live Map. In addition, a Trash Collection efficiency feature is incorporated,

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which may, for instance, identify and notify users of overflowing trash cans via an application [3].

Similarly, the development of the Self-Monitoring Automated Route Trash Bin (SMART Bin) was proposed as an additional innovative waste segregation method. The SMART Bin is a one-of-a-kind way to demonstrate that if the garbage disposal is not performed, the device will remind the user to dispose of the waste. In addition, the device will recognize any additional waste it receives and refuse to accept it. Additionally, it collects waste by driving through hallways and stopping at predetermined intervals in front of offices. Consequently, the device can perform two fundamental functions through the aid of sensors: (1) detecting and responding automatically when the trash can is full and (2) acting as an autonomous navigation system [4].The series of work continues as it develops more advanced waste segregation mechanisms, as evidenced by the development of smart trash can based on IoT on a platform based on an Arduino Uno board that was interfaced with a GSM modem and an ultrasonic sensor. The sensor was mounted to the top of the bin. A 10-centimeter barrier was erected. When the threshold is reached, the sensor activates the GSM modem, alerting the appropriate authority until the trash can is emptied. Finally, it was determined that various concerns such as affordability, maintenance, and durability were considered in designing these intelligent bins [5].

Likewise, in 2016, IoT-based waste management for smart cities was designed to address trash overflow, which causes unsanitary conditions and foul odor. The two components of this project are a transmitter and a receiver. On the dustbin was mounted an 8051 microprocessor, an RF transmitter, and sensors in the transmitter component. The receiver component is composed of an RF Receiver, an Intel Galileo, and a Web Browser. This technology can detect how much garbage is in the trash can and prevent it from overflowing [6]. Along with this was the Utilization of a trash can linked to a microcontroller-based system with IR wireless systems and a central system that displays the current trash status on a mobile web browser displaying an HTML page via Wi-Fi. As a result, the HTML page's status will be updated [7].It is essential to design an IoT waste monitoring system. In line with this, another proposed system is powered by a 12V transformer and includes a microcontroller Wi-Fi Modem from the AVR family. It monitors the trash cans and displays the waste level on an intuitive website. The website displays a graphical representation of the trash can and color-codes the collected garbage. Consequently, it employs a web development platform to display a graphical representation of the bin and informs residents about garbage levels to keep the city clean. This IoT waste monitoring system contributes to a spotless and sanitary environment as a result of the implementation [8].

Moreover, in urban and rural areas, waste management is a major issue. Overflowing trash cans cause pollution and disease. Dustbin overflow pollutes the environment. Manpower and equipment shortages prevent the city from collecting or transporting waste. In response, a waste segregation system is vital; the proposed design has two parts: automatic waste segregation and GSM Module alerting. IR sensor for detecting waste, an ultrasonic sensor for how full the dustbin is, blowers for removing plastic waste, a permanent magnet for segregating metals, a sieve, and a DC motor for running the conveyor. PIC Microcontroller controls the entire system. This project aimed is to monitor waste management, provide a smart waste system, reduce human time, and create a healthy, waste-free environment [9].

Waste management is one of the most significant challenges in urban areas across the globe, and it is becoming a pressing issue in developing nations where rapid population growth has been observed. Waste collection is a difficult process requiring large sums of money and intricate logistics management. Smart waste management necessitates the interconnection of heterogeneous devices and the sharing of data among many individuals. These issues are resolved by the Smart-M3 platform's high degree of decoupling and scalability. In-container sensors monitor the bins' fullness levels in real-time, allowing for efficient waste collection. This method eliminates the need to collect bins that are only partially full. In addition, decisional algorithms can be fed incoming data to determine the optimal number of waste vehicles or bins to distribute across the territory [10].

Further, due to the ongoing efforts of numerous researchers, an advanced Decision Support System (DSS) is designed for effective waste collection in Smart Cities with an advanced waste management strategy. The system includes a model for real-time data sharing between truck drivers to facilitate waste collection and dynamic route optimization. The system manages cases of inefficient waste collection in inaccessible Smart City areas. The problematic areas are captured by surveillance cameras that provide evidence to the authorities [11]. Additionally, a similar project was proposed using an IoT-based solar-powered smart waste management system that can ensure proper collection, transportation, and disposal of household and industrial waste with real-time remote monitoring. Regular garbage collection and disposal are needed to maintain a clean environment.

This project aims to provide a smart waste collection and disposal solution, ensuring a comfortable environment. The proposed system enables real-time remote monitoring of solar-

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powered smart bins located at different points in the city connected to the control station through a long-range (LoRa) communication device and supervises waste collector activities like collection and disposal time using the Automated Vehicles Locating System (AVLS) [12].There are numerous trash cans in cities and rural areas. However, the reality is that nobody uses it effectively. As observed in cities and streets, the trash can is present and all garbage is near it. The reason for this is that if one person deposits trash outside of the basket, the next person who comes along will also throw trash outside of the basket [13].

Above all, the mentioned projects were costly and very technical to implement in some areas of interest. As part of the project, researchers gave equal weight to the project's efficiency and budget-friendliness. Considering that the area often experiences power interruptions, the researchers developed a smart bin with solar power integration with batteries as backup power. Furthermore, in case of an insufficient solar power supply, the user can opt to connect the Arduino USB cable to a power bank or a charger adapter for the project to work correctly.

Hence, to overcome all these problems, the researchers are proposing the idea of a Self- Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration for Covid-19 Infectious Waste Prevention, which helps in waste management without human intervention to maintain a clean environment. This system helps monitor waste management and reduce human intervention; it is automatically operated without manual power and applies to rural and urban areas. Through this developed project, the waste disposal process is more manageable, and it can prevent the possible contamination of infectious waste.

1.1 Objective of the Project

This project generally aimed to develop a Self-Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration as an innovative solution for Covid-19 Infectious Waste Prevention. Specifically, it sought to create a prototype model system, test its functionalities through a series of experiments, and implement the project in a selected area to observe its effectiveness in waste disposal management and prevent COVID-19 infectious waste contamination.

1.2 Conceptual Design

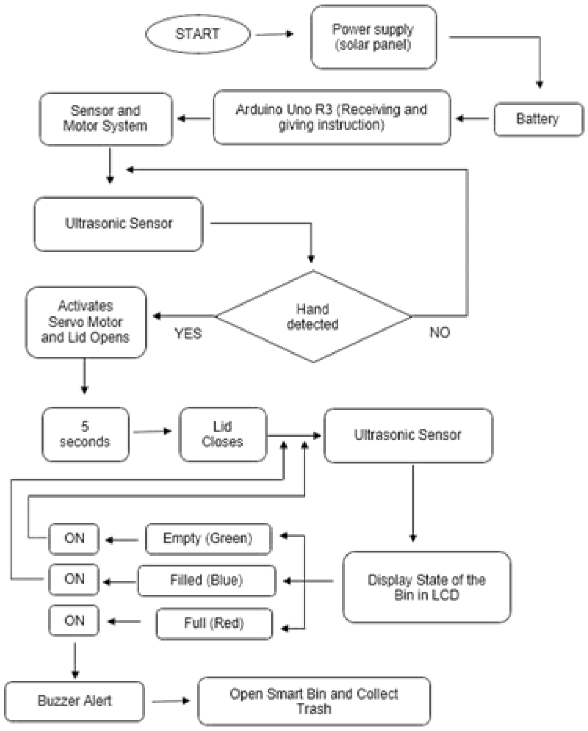

Figure 1: Conceptual Design of the Project

II. MATERIALS AND METHODS

In this section, you will find the utilized materials, system design, block diagram, and statistical analysis of the Project.

2.1 Materials

To design the project, the hardware components were carefully selected, evaluated, and tested for output validity and dependability. To accomplish the desired project the following materials were utilized: a.) Arduino Uno, b.) Ultrasonic sensors, c.) Servo Motor, d.) Jumper wires, e.) Solar Panel 10-W 6V, f.) Breadboard, g.) Lithium Battery, h.) LED light bulb, i.) LCD Monitor, and j.) Buzzer.

2.2 System Design of the Project

The proposed system is a Self-Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration, a novel COVID-19 infectious waste prevention solution. It comprises mainly two ultrasonic sensors that can operate as distance sensors. The ultrasonic sensor will be attached to a SMART Bin. The ultrasonic sensor is programmed to detect specific parameters and continuously measures the distance in front of the SMART Bin. For it to work and do what it intends, the presence of humans or an object must be detected by the ultrasonic sensor attached to the trash bin's lid. When it senses anything, such as garbage or a human hand, if it goes below a certain threshold, it sends a

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signal to the Arduino Uno R3 – the project's central processing unit, which interprets the signal and sends commands to the other components of the system like the servo motor causing the lid to open. As the SMART bin's lid opens, the person may throw the trash into the SMART Bin; it takes 5 seconds to dispose of the waste, then the lid will automatically close. To secure that the SMART Bin will not be over flown, the other ultrasonic sensor will monitor the waste level and link to the LCD to display the actual percentage level of the SMART Bin's waste content; the LED serves as the indicator for monitoring purposes of the current status of the SMART Bin including the content level. Likewise, a buzzer is also attached to serve as an alarm system for the SMART Bin when it is already full. The microcontroller will execute this automatically when the waste exceeds the maximum level set in the microcontroller. The LCD will display the status of the garbage in the SMART Bin, and the colors of the LED lights will be labeled as (green) empty, (blue) filled, and (red) full. A solar-powered integrated power supply will give energy to the entire system.

2.3 Block diagram

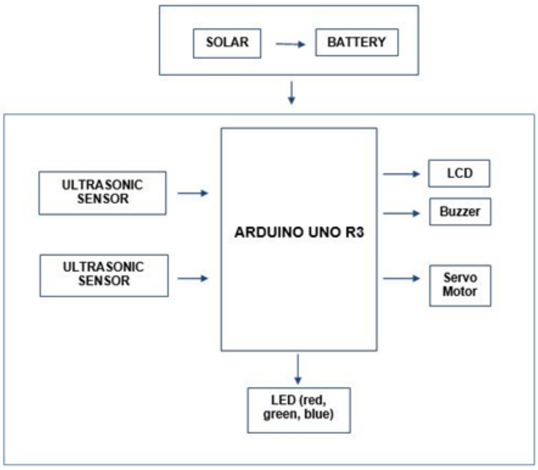

Figure 2: Block diagram of the project

2.4 Statistical Analysis

Several experimental tests were conducted to verify the accuracy and reliability of the design to collect the necessary data for this project, particularly to observe the design's functionality—this project utilized both descriptive and qualitative approaches to analyze and interpret the experimental results. Descriptive statistics were used to interpret the data collected through the trials the researchers made. Qualitative data is used to observe and describe the observed data to make sense of the gathered information. To test the readability and functionality range of an Ultrasonic sensor, Five (5) trials were set up to test its response, and the data from the series of trials were recorded and interpreted using qualitative descriptions to give meaning to the observations. Finally, overall functionality tests were analyzed and interpreted using descriptive statistics coupled with qualitative descriptions of the data obtained from the series of trials and experiments conducted and the actual observation of the researchers. All the data gathered were utilized and carefully analyzed and interpreted, which serves as the significant supporting data of the project design.

III. RESULTS AND DISCUSSIONS

This section describes the project's prototype design and hardware testing.

3.1 Prototype design of the Project

Figure 3: Prototype design

Figure 3 shows the Project's Actual Design. The Arduino UNO R3 is positioned correctly at the back of the bin, with the servo motor and breadboard at the front. All wires, including the microcontroller, were kept tidy to keep the prototype neat and easy to see. The SMART bin is fully equipped with an ultrasonic sensor that detects someone approaching the SMART bin and places his hand in front of the lid, along with other components such as an LCD monitor, LEDs, and a buzzer. On top of the lid, another ultrasonic sensor for the SMART Bin monitoring system was installed for real-time monitoring of the content level of the SMART Bin. The product's features were thoroughly tested and explained to ensure its accuracy. The SMART bin included a garbage monitoring system and an automated lid system powered by a solar panel connected to batteries. An Arduino board was programmed to control the entire system automatically. The distance between wastes from an ultrasonic sensor will be displayed on an LCD indicating the content level status of the SMART Bin. They were written on the Microcontroller. The distance between the waste and sensor will be sent to the

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Microcontroller as a float value and used to determine the waste content level of the SMART Bin to be displayed on the LCD monitor in real-time.

3.2 Functionality Test of the Project Design

Table 1: Project design Functionality Test

Status	Garbage Amount	Identification system	Automated lid system	Content Level
1	No amount of waste	Successful	Operate	0%
2	Small amount of waste	Successful	Operate	14%
3	Half-amount of waste	Successful	Operate	56%
4	Waste levels have increased	Successful	Operate	74%
5	Waste bin reached its maximum level	Successful	Operate	99%

Table 2 shows the result of five tests conducted to determine the functionality of the SMART Bin monitoring system with varying amounts of garbage. The first test was conducted with no waste, so the displayed measurement was zero percent. The second and third tests were conducted with half and a small amount of waste, resulting in a measurement of 14 percent and 56 percent in the display system. The fourth trial increased waste levels, and the display system indicated a 74 percent reading. A final test in which the SMART Bin was filled with waste yielded a 99 percent reading on the display system. The LED indicators will provide information regarding the real-time SMART Bin content level. The green LED indicator will illuminate when the bin is empty, the blue LED indicator when it is half-full, and the red LED indicator when it is full. The status labels 4 and 5 indicated that the SMART Bin was full, and when it was full, the red LED illuminated. Likewise, the buzzer will be activated to alert the person responsible for the garbage collection to collect the trash. In the first instance, the green LED illuminated because the bin was empty. The system will repeatedly do these routines.

3.3 Functionality Test of the Ultrasonic Sensor

Table 2: Ultrasonic reading test

Variables	Number of Trials				
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Distance	30 cm	60 cm	90 cm	91 cm	120 cm
Remarks	Opened	Opened	Opened	Did not Opened	Did not Opened

Table 2 presents the application of Ultrasonic Sensor Readings to Automatic Lid Opening. The ultrasonic sensor was installed next to the LED lights and LCD screen in front of the bin's lid. In the first three trials, a person was 30 cm, 60 cm, and 90 cm away from the sensor. The lid opened successfully during these tests. The sensor could detect the presence of waste or a person at distances of 30 cm, 60 cm, and 90 cm, respectively. In the fourth and fifth trials, the distances were 91 cm and 120 cm, and the lid did not open in either of the trials, indicating that it could no longer detect the presence of waste or a person at such distances. The sensor calculated the precise distance between itself and the object being measured by calculating the time elapsed between the first emitted signal and when it was detected, assuming the signal traveled at the speed of sound. Suppose the object's distance from the ultrasonic sensor is less than or equal to 90 cm or 0.9 meters. In that case, the SMART Bin's lid will operate automatically with 5 seconds interval for closing the bin's lid. However, it is noted based on the trials that the SMART bin lid will not open if the distance is greater than 90 cm or 0.9 m.

IV. CONCLUSIONS

The prototype design of the Self-Monitoring and Automated Real-Time Trash Bin (SMART Bin) with Solar-Powered Integration is highly effective at managing and monitoring waste disposal, particularly the COVID-19 infectious waste. Based on the series of trials and experimentations, this project was concluded to be effective in preventing the contamination of COVID-19 infectious waste materials, and an efficient and effective strategy of waste management during the pandemic, the modification of the method of waste disposal will ultimately prevent the spread of the diseases, particularly COVID-19.

V. RECOMMENDATIONS

The project lays the groundwork for several enhancements in developing a highly efficient and effective waste management system to aid in preventing COVID-19 contamination. The researchers suggested the following for the project's future development and improvement:

1. It is recommended that future researchers adopt and continue this study to further develop its system.

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2. Set up a health status monitor. It will aid in the early detection of malfunctioning systems and the system's long-term viability.
3. Install a disinfection system and an air filter to prevent odors and sort contaminants.
4. Create a self-sealing trash can to reduce contact with the waste can.
5. Install an alerting message system to improve smart bin status and update garbage levels. The update may be sent to the administrator or the users' phones.
6. Install an automatic trash separation system that separates biodegradable and non-biodegradable wastes, allowing a significant portion of the garbage to be recycled.
7. Future research should look into more Arduino-based projects.

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It is a difficult task to conduct a research study. It takes effort, resources, and the help of other researchers. The help of brilliant minds and helping hands made this study a success. The researchers would like to thank them for their contributions to this project, including their expertise, ability, and scholarly advice.

REFERENCES

[1] Centers for Disease Control and Prevention (2019). *Guidance for Wearing Face Masks. Retrieved on February 25, 2022.*

[2] K. Dham. (2020, August 5). How automation technology can help in COVID-19 management. *YourStory.Com; yourstory.com*.

[3] H. Sohail, S. Ullah, A. Khan,O. Samin, & M. Omar. (2019). Intelligent trash bin (ITB) with trash collection efficiency optimization using IoT sensing. *8th International Conference on Information and Communication Technologies (ICICT),* pp. 48-53. DOI: 10.1109/ICICT47744.2019.9001982

[4] M. Cabilo, & L. Gallardo. (2014). Self-Monitoring Automated Route Trash Bin (SMART Bin).

[5] K. Monika, N. Rao, S. Prapulla, & G. Shobha. (2016). Smart Dustbin-An Efficient Garbage Monitoring System. *International Journal of Engineering Science and Computing*, Vol. 6, [6] pp. 7113-7116. DOI: 10.4010/2016.1694

[6] P. Parkash. (2016). IoT-based waste management for smart city. *International journal of innovative research in computer and communication engineering*, Vol. 4, [2] pp. 1267-1274.

[7] S. Navghane, M. Killedar,&M. Rohokale. (2016). IoT based smart garbage and waste collection bin. *International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE),* Vol. 5, [5]pp. 1576-1578.

[8] A.Aishwarya,&K. Reshmi. (2016). IoT-Garbage Monitoring Systems. *International Journal of Pharmacy & Technology*, Vol. 8, [40].

[9] K. Banu, &M. Menaka. (2019). Solar Powered Smart Garbage Can for Waste Segregation. *International Journal of Engineering Science and Computing*, Vol. 9, [3] pp. 20163-64.

[10] V. Catania, & D. Ventura. (2014). An approach for monitoring and smart planning of urban solid waste management using smart-M3 platform. *Proceedings of 15th Conference of Open Innovations Association FRUCT*, pp. 24-31, DOI: 10.1109/FRUCT.2014.6872422

[11] A.Medvedev, P. Fedchenkov, A. Zaslavsky, T. Anagnostopoulos, & S. Khoruzhnikov. (2015). Waste management as an IoT-enabled service in smart cities. *In Internet of Things, Smart Spaces, and Next Generation Networks and Systems*, Vol. 9247, pp. 104-115.DOI: 10.1007/978-3-319-23126-6_10

[12] M. Kabir, S. Roy, M. Ahmed, &M. Alam. (2020). IoT-Based Solar-Powered Smart Waste Management System with Real Time Monitoring-An Advancement for Smart City Planning. *Global Journal of Computer Science and Technology.* Vol. 20, [5-G]. DOI:10.34257/GJCSTGVOL20IS5PG11

[13] J. Francis, T. Melbin, C. Praveen. (2015). Solar Power Smart Waste Bin. *International Journal of Computer Engineering in Research Trends*, Vol. 2, [12] pp. 1083-1086.

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