iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.53682

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Smart Hand-Free Trash Manager

Akshata Sabade[1], Abhijeet Wankhade[2], Mansi Wankhade[3], Prof. D. A. Itole[4]
[1, 2, 3]*Student, Electronics & Telecommunication Department, AISSMS Institute of Information Technology, Pune, India 411005*

Abstract: ***Indian Municipal waste management remains a main problem in urban areas, leading to consequential health and environmental issues. Therefore, trash bins are placed in many places to handle municipal solid waste, but dustbins can overfill and spread around the area, spoiling the environment, and creating disturbance to the public. Therefore, a real-time remote monitoring system is required that warns the level of garbage to the firm of waste management or municipality. The proposed structure consists of an ultrasonic sensor to measure the garbage level in the dustbin. ESP32 is a microcontroller board with integrated Wi-fi and Bluetooth that controls the system operation. It is supposed to display messages on the IOT Cloud server regarding the garbage level of the dustbin, whether it is full or empty, so the municipality or respective garbage monitoring company can take required actions in time. Also, there will be a Solar panel to generate the power required to run the system. Furthermore, a system is proposed to contribute to improving the efficiency of solid waste disposal management.***
Keywords: ESP32, Wi-Fi, IOT Cloud server, Real-time monitoring, Waste management, Automatic sealing.

I. INTRODUCTION

India is one of the most populated countries in which one-sixth population of the world resides. As the population is high, a large amount of waste is generated by houses and industries. Sometimes waste is decomposed and produces unhygienic gases which pollute the environment. Since smart cities are becoming the centre of attraction for the advancement of developing countries and without the removal or solution to the garbage problems these cities will not be that attractive. Therefore, this project is regarding managing this waste using Smart Dustbins. These dustbins can be used for household purposes and will be helpful in the work of the municipality as well. Smart Dustbin as its name represents is a fully automatic dustbin that includes all functioning from opening a lid of a dustbin to sealing the bin bag and displaying a message on the IOT Cloud server when it is full. The lid of the dustbin will automatically open itself using Servo Motor when it detects a person in front of it using an Ultrasonic Sensor. Using the ESP32 board a message will be displayed on the respective server regarding the level of the dustbin when it is full. That level will be measured with the help of an Ultrasonic Sensor. This ESP32-based system automatically monitors the real-time garbage level and presents an effective way of managing domestic waste using Smart Garbage Monitoring System.

II. LITERATURE SURVEY

An Arduino Uno microcontroller-based smart garbage monitoring system was introduced by Yusof et al. It measures the amount of waste in the trash can in real-time and warns the user before the trash can overflows so that it can be swiftly emptied and collected. **[1]** Rayabarapu Venkateswarlu, Jitesh R. Shinde, and D.R. Ramji. acted as an ambassador for the Smart Hands-Free Waste Compactor Bin for Public Places. to lessen issues with garbage management. By using an electrical actuator, the proposed Smart Hands-Free waste compactor Bin system reduces the size of used PET bottles and paper cups by 7 and 12 times, respectively. An IR sensor also uses a GSM module to verify the condition of the trash can and sends a notification to the control room. Arduino is interfaced with via LCD, GSM, sensor, and relay with actuator. By the user's selection in the LCD, the user may receive greetings or be given e-Wallet coupons. The general public can track the locations of nearby garbage systems using Google Maps. **[2]** N. Khadgi, M. Kasbe, T. Mujawar, R. Zade, Using Arduino and LabVIEW, a system for monitoring garbage online. This system keeps an eye on the trash cans, notifies users via a web page on the amount of trash being gathered in the cans, and buzzers and LEDs alert users. The system uses ultrasonic sensors (HC-SR04) to detect the level of trash that is positioned over the trash cans. After that, the depth of the trash-can is compared. The system's hardware architecture consists of an Arduino module, an LCD, a sensor, and a buzzer. The LCD panel shows the current status of the amount of waste being collected in the bins. Through a web page created using the LabVIEW VISA tool, the system is remotely monitored. When the amount of rubbish being collected exceeds the predetermined limit, the buzzer indication begins to operate. Therefore, by providing information about the rubbish levels in the bins, this method aids in keeping the city clean. **[3]** Prakasam P, Velmurugan T, Noor Mohammed V, and Saravana K. proposed an IoT-based smart waste monitoring and navigation system. Int J Innova Technol Explore Eng 8: 3992–3996. Sensors measure the amount of trash in the trashcan, and information is relayed to the official mobile station via a GSM and GPS module.

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A WIFI module is used to monitor the rubbish level online in the control room. The network modules and sensor system are connected by the Arduino CPU. This information enables contracted cleaners and those who supply garbage cans to immediately empty them in order to keep the area spotless. **[4]** Faisal, T.; Awadeh, M.; and Bashir, I. Design and creation of a system for intelligent trash cans that includes advertising. The Internet of Things and waste management work together to improvise the collection and management of waste by reducing the issues that would arise from waste accumulation. Additionally, a network-attached storage technology-based advertising solution is used to bring a novel feature that earns income and opens up new business prospects for waste management organisations. **[5]** Ilankoon, I. M., Kang, K. D., Kang, H., & Chong, C. Y. Internet of Things (IoT)-based systems for collecting electronic waste Management of household electrical waste in Malaysia. A smart household e-waste collecting box was created and equipped with sensors that assess the volume of e-waste and record disposal information. Public end users are advised to use a mobile application that was created to dispose of their household E-waste. [**6]**

III. PROPOSED METHODOLOGY

In this IOT-based Smart Dustbin, ESP32 (Integrated Wi-Fi and Bluetooth) microcontroller is used. It is also used to set a connection with the IOT Cloud server. Two Ultrasonic Sensors are used. One is used to detect the person in front of the dustbin. Another Ultrasonic sensor is used to measure the bin's garbage level to check whether the bin is filled with garbage or not. This Ultrasonic Sensor is installed at the bottom of the dustbin lid and will measure the distance of garbage from the top of the bin by setting a threshold value according to the size of the bin. If the distance is less than this threshold value, means that the bin is full of garbage and we will indicate it with the help of "Red LED" and the message will be displayed on the IOT cloud server. If the distance is more than the threshold value, then it will be indicated with the help of "Green LED" and the related message will be displayed. Here the threshold value is 5cm from the top side of the bin.

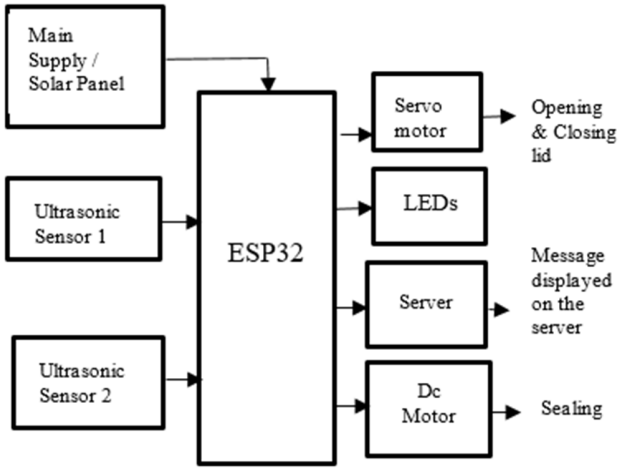


Fig. 1. Block Diagram of Proposed System

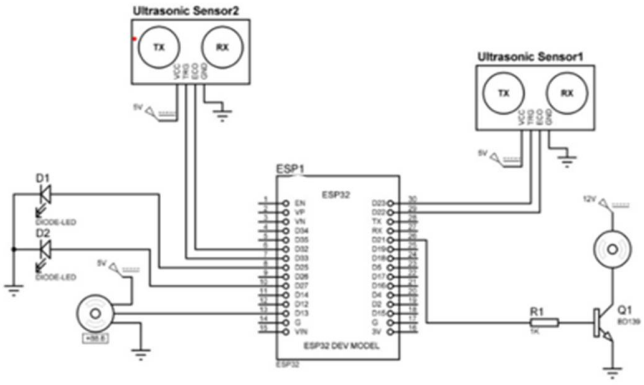


Fig. 2. Circuit Diagram

The IOT Cloud server will be used to monitor the working of the garbage monitoring system. The servo motor is used to open the lid of the dustbin when the Ultrasonic sensor detects the person in front of the dustbin. The lid will be opened for 10 seconds and then will get automatically closed. When the bin bag gets fully filled then the bin bag will be sealed and the lid of the dustbin will not open unless and until the fully filled bin bag is removed and the new bag is installed. This stage will be indicated by "Red LED." In this system servo motor is used to open and close the lid of the dustbin using motor gears and the DC motor is used to seal the bin bag using threads. The data displayed on the server is continuously real-time monitored. The displayed data on the IOT cloud server contains a message regarding the garbage level and the level will be displayed in the percentage form as well. The power supply to the system will be provided using the rechargeable DC battery. In addition to this, the power supply from the solar panel will also be connected.

IV. WORKING

The smart dustbin consists of a traditional dustbin integrated with sensors and an ESP32 microcontroller. This smart dustbin is fully automatic starting from opening the dustbin lid to sealing the bin bag after it is fully filled with garbage. Here is a detailed description of how a smart dustbin using ESP32 works:

In this system, the ESP32 microcontroller module is used and it helps connect to the IOT cloud server using Wi-Fi, as ESP32 comes with Wi-Fi and Bluetooth connectivity. This IOT Cloud server is used to display a message related to the garbage level. The work assigned to the ultrasonic sensor mounted on the front side of the dustbin is to detect the person that is in front of the dustbin and to trigger the servo motor to open the lid of the dustbin. The other ultrasonic sensor mounted at the bottom side of the lid of the dustbin measures the level of the garbage. These levels are indicated by Green and Red LEDs mounted on the dustbin. The servo motor is used to open and close the dustbin lid using motor gears and the DC motor is used to seal the bin bag using thread.

When the ultrasonic sensor will detect the person in front of the dustbin it gives a command to the servo motor to open the lid. But there is one more condition that is need to be checked is, while detecting the person standing next to the dustbin the other ultrasonic sensor also checks for available space in the dustbin by monitoring the garbage level. Therefore, to open the lid of the dustbin, two conditions must be satisfied simultaneously. If there is no space in the dustbin i.e., if the dustbin level is full then the lid of the dustbin will not open unless the fully filled bin bag is removed manually.

To consider a garbage level full or normal, a threshold value is set as per the size of the dustbin. If the garbage level is more than the threshold value it is considered normal and if it crosses the threshold point when the garbage level is less than or equal to the threshold value, it is considered as a dustbin is full. There are two LEDs mounted on the dustbin which helps the person standing next to the dustbin to understand the garbage level. The normal garbage level is indicated using the Green LED and when the garbage level crosses the threshold point i.e. when the dustbin is considered full, it is indicated using Red LED.

Messages related to the garbage level are generated in real-time monitoring whenever there is a change in the garbage level. This message is displayed over an IOT cloud server which is helpful for a user to monitor the garbage level who is away from the dustbin. When the garbage level is normal, a "Dustbin Level Normal" message gets displayed on the server, and it will remain the same till the garbage level crosses the threshold point. And when it does, "Dustbin Level Full" and "Dustbin Bag is Ready to Remove" these messages will be displayed on the server. The garbage level is also displayed in percentage form over the IOT cloud server. When the bin bag is fully filled with garbage, the DC motor will seal and pack the bin bag using thread. The dustbin lid will be locked and will not open in this situation whether there is a person standing in front of the dustbin or not unless the sealed bin bag is removed. This will be indicated using the message displayed on the IOT cloud server as well as the Red LED mounted on the dustbin. When the bin bag is sealed completely, the system will not be responsive to any change in the readings of the sensors. Therefore, the sealed bin bag is removed manually and the new bin bag is installed. After this the system will work as if it is in normal phase and the same process continues.

V. RESULT AND DISCUSSION

All the connections of ESP32 and all the used sensors are working properly. The garbage level is monitored on a real-time basis and corresponding messages are displayed on the IOT cloud server. It updates data on the cloud server as soon as there is a change in garbage level. It also displays garbage levels in percentage form. The simulation of this project is done on Wokwi and then implemented it on hardware. The coding part is completed on the IOT cloud server. Both the ultrasonic sensors are working normally. The garbage level is also indicated using Green and Red LEDs. After the garbage level crosses the threshold value, the bin bag gets sealed, at the same time the corresponding messages are displayed over the IOT cloud server and it is indicated using Red LED. Overall, all the parameters are giving the exact result which is expected.

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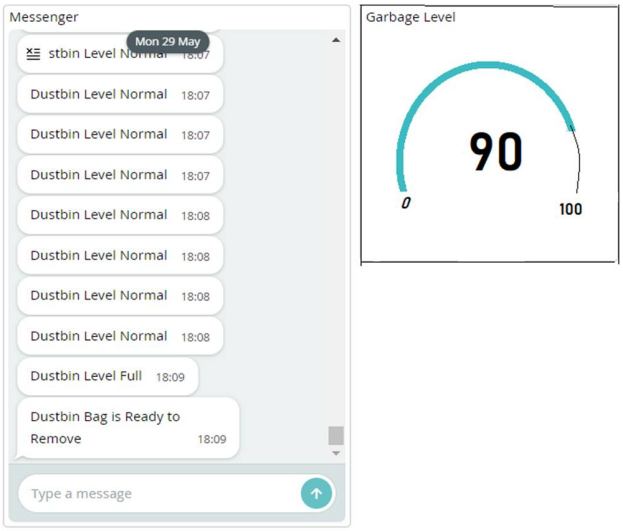


Fig. 3. Message Displayed on the Server



Fig. 4. Final Product

VI. CONCLUSIONS

An IOT-based innovative system called Smart Dustbin is designed and developed here to fulfill the luxurious needs of humans and save time for the busy world and give proper service to all without any delay.

The service includes: The lid of the dustbin stays closed and when you want to dispose of any waste, it will automatically open the lid. It will monitor the garbage level and will alert when the dustbin is full using LED as well as via displaying messages on the IOT cloud server. The bin bag will get sealed automatically when the bin bag gets fully filled, and the lid of the dustbin remains closed after the bin bag is sealed. The lid will remain closed till the sealed bin bag is removed and the new bin bag is installed. After this, the system will again work normally, and the process goes on.

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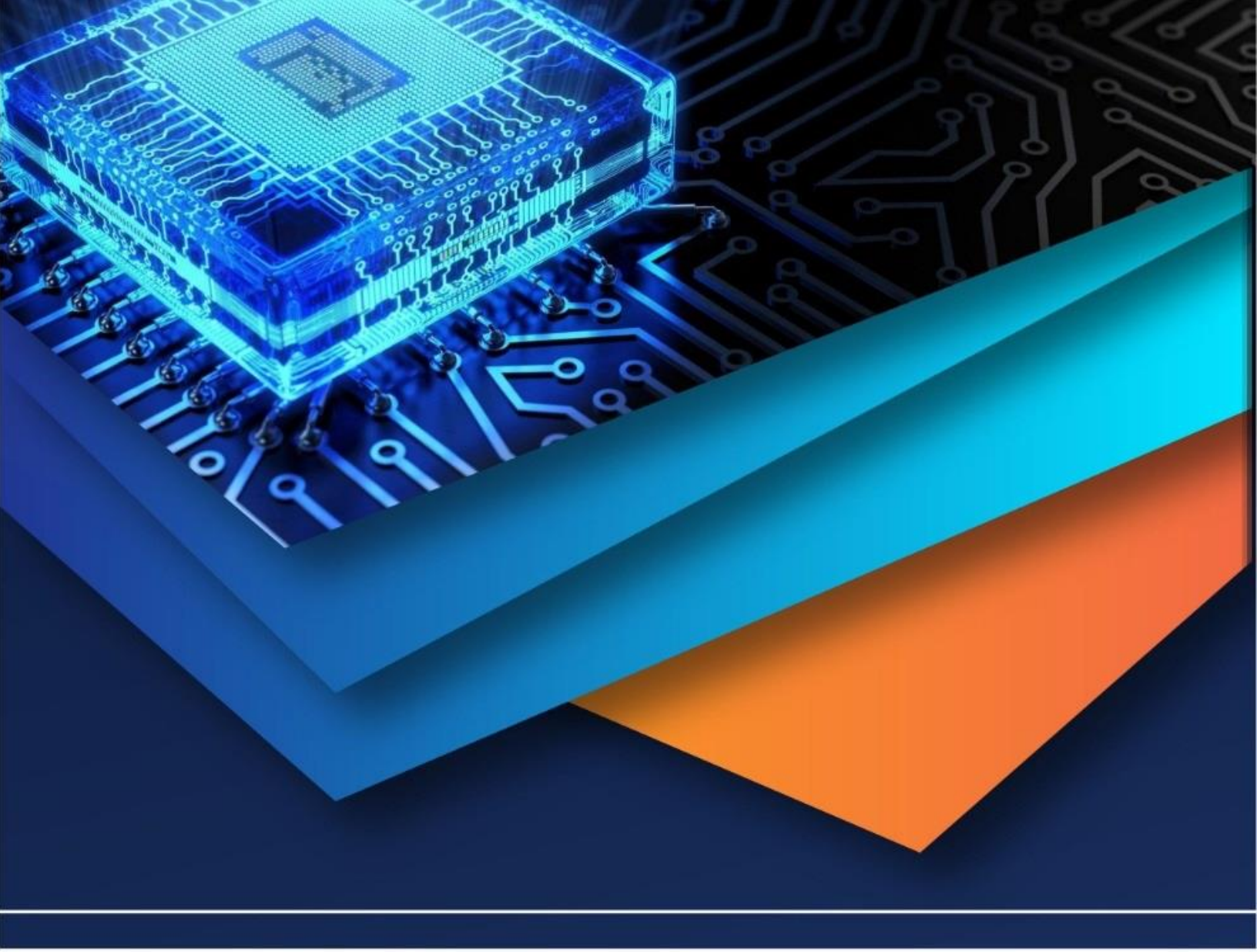
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