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# Intelligent Waste Management System using IOT

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**Abstract:- The escalating population density in urban areas has fueled a surge in waste generation, underscoring the urgent need for effective waste management solutions. In response to this challenge this study proposes an innovative approach to waste management through the integration of IOT components. The system focuses on real-time monitoring and segregation of dry and wet waste using a network of sensors. The system also leverages platform to automate data logging and notification processes ,ensuring seamless oversight of waste collection operations.**

**Our Proposed Intelligent Waste Management System employs IOT components such as sensors ,detectors, actuators to optimize waste collection and route planning. This integrated IOT-based approach represents a promising avenue for sustainable waste management in both large and small urban environments , paving the way for enhanced city livability and environmental stewardship.**

***Keywords:-*** *Segregation, Monitoring, Sensors, Sustainable, Stewardship.*

## I. INTRODUCTION

With urban and rural areas witnessing a surge in population, the issue of solid waste management has become a global concern, necessitating informed decision-making. Solid waste emanates from residential, commercial, and industrial sources, including restaurants, malls, and construction sites. The adoption of Internet of Things (IoT) technologies has revolutionized waste management by facilitating real-time monitoring, data collection, and processing through interconnected physical and virtual devices. Inefficient waste management practices have exacerbated the problem, as cleaners often lack visibility into the fill levels of dustbins, leading to inefficiencies in waste collection. To address this inefficiency and enhance waste management effectiveness, we have introduced the Smart Dustbin concept, leveraging Arduino microcontrollers and ultrasonic sensors to accurately detect dustbin fill levels.

As waste accumulation continues to escalate, public bins are reaching capacity, leading to overflowing trash and cluttered streets within the community. Addressing waste management intelligently is imperative. SThe proliferation of waste poses substantial health and environmental challenges, with far-reaching consequences. Waste serves as a breeding ground for harmful bacteria, insects, and flies, which pose serious health risks, including food poisoning, typhoid, gastroenteritis, and salmonella. Insects such as flies are notorious carriers of diseases like malaria and dengue, while rodents and stray animals thrive in waste, spreading additional illnesses in surroundings. Taking into consideration of all these problems we have come up with a waste management system which will provide an effective solution to waste related problems.

## II. LITERATURE SURVEY

Table 1: References and Key Findings

| Reference | Key Findings |
|---|---|
| Namratha A M, Dr. Manjula G (2021) | This paper enhances the cleanliness of the smart cities by the practical application of "Automatic waste management and segregation system using IOT".This proposed system is an effective waste segregation system that has no human intervention or interference to separate dry and wet waste. |
| Pushpa Singh, Murari Kumar Singh (2020) | They're proposed frameworkhave developed a concept to segregate and manage household wastage using IoT and machine learning. They have taken three parameters for monitoring and analysis of a dustbin. They have used ultrasonic sensor and MQ4 sensor to monitor the dustbin Status. |
| Rishabh Kumar Singhvi, Ritesh Kumar Saraswat (2019) | This Smart system provides the filling status of dustbin using message and it will save time, fuel and money of Municipal Corporation. |
| Megha S. Chaudhari, Vaishali Raut (2019) | - Improper disposal and improper maintenance of domestic waste create issues in public health and environment pollution thus this paper attempts to provide practical solution towards managing the waste collaborating it with the use of IOT |

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## III. PROPOSED SYSTEM

The proposed Intelligent Waste Management System aims to revolutionize traditional waste management practices by leveraging IoT sensors to monitor waste bins in real-time, provide accurate fill level data, and enable efficient segregation of waste into dry and wet categories. This system utilizes IoT technology integrated with Arduino Uno microcontrollers, moisture sensors, GSM and GPS modules to achieve these objectives.

The primary idea behind this project is to address the inefficiencies and challenges faced in conventional waste management systems. Traditional methods often rely on scheduled waste collection routines, leading to either overflowing bins or inefficient use of resources due to premature collections.

Additionally, lack of segregation at the source results in lower recycling rates and increased environmental pollution and public health diseases. By employing IoT sensors to continuously monitor the fill levels of waste bins and segregate waste based on moisture content, the proposed system aims to optimize waste collection routes, minimize overflow incidents, and improve recycling efforts. Furthermore, real-time monitoring of the condition of waste bins enables timely maintenance and repairs, ensuring their functionality and longevity.

➢ *The Implementation of the Proposed Intelligent Waste Management System Offers Several Significant Benefits:*

- **Efficient Resource Allocation:** By providing accurate and up-to-date data on fill levels, the system enables waste management authorities to optimize collection routes and schedules, leading to reduced fuel consumption and operational costs.
- **Environmental Sustainability:** Segregating waste into dry and wet categories facilitates efficient recycling and composting processes, thereby reducing landfill usage and minimizing environmental pollution.
- **Improved Public Health:** Timely maintenance and repairs of waste bins prevent issues such as overflowing or damaged bins, which can attract pests and pose health hazards to the public.

## IV. METHODOLOGY

- **Sensor Calibration and Testing:** Every particular sensors which are touch, moisture, ultrasonic, GSM, and GPS are calibrated and tested individually to ensure accurate readings and proper individual functionality.
- **Integration with Arduino Uno:** Once calibrated, the sensors are integrated with the Arduino Uno microcontroller using jump wires. The Arduino Uno firmware is programmed to receive data from the sensors, process it, and control the servo motor and GSM module based on predefined algorithms and thresholds.
- **Hardware Assembly:** The sensors, Arduino Uno, servo motor, GSM module, and GPS module are assembled onto a suitable platform, such as a prototype board or Bread board. Proper wiring and connections are established to ensure reliable communication and operation of all components. Mounting the touch sensor in a strategic location within the waste bin to detect when waste is placed on it.
- **Software Development:** The firmware for the Arduino Uno is developed to incorporate logic for waste segregation, fill level monitoring, and communication with the GSM module. Implement algorithms to process data from the moisture sensor to categorize waste into dry and wet categories. Configure the touch sensor to trigger the system when waste is placed on it, initiating the segregation process. Program the ultrasonic sensor to measure the fill level of waste bins and trigger alerts when thresholds are reached. Integrate the GSM module to send alert SMS to designated authorities when overflow or maintenance issues are detected. Additionally, software for receiving and processing SMS alerts sent by the GSM module is developed on the authority's end.
- **System Testing and Optimization:** The assembled system undergoes field testing in real-world conditions to evaluate its performance and reliability. Any issues or discrepancies encountered during testing are addressed through software adjustments or hardware modifications. Optimization techniques may be employed to enhance the system's efficiency and accuracy based on field test results.
- **Field Deployment and Evaluation:** Deploy the system in real-world waste management settings to assess its effectiveness and practicality. Monitor system performance over an extended period, collecting data on waste fill levels, segregation accuracy, maintenance alerts, and GPS tracking. Gather feedback from waste management authorities and endusers to identify areas for improvement and optimization.

By following this methodology, the Intelligent Waste Management System can be effectively implemented, providing accurate waste monitoring, segregation, and maintenance capabilities to improve overall waste management processes.

## V. SYSTEM DESIGNS

➢ *Arduino Uno*


Fig 1: Arduino Uno

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The Arduino serves as a processing unit for the embedded intelligent waste management system. This will be used for controlling and coordinating the operation of all sensors and actuators. The Arduino collects data from various sensors and then processes it to make decisions regarding waste segregation and bin maintenance.

➢ *Touch Sensor*

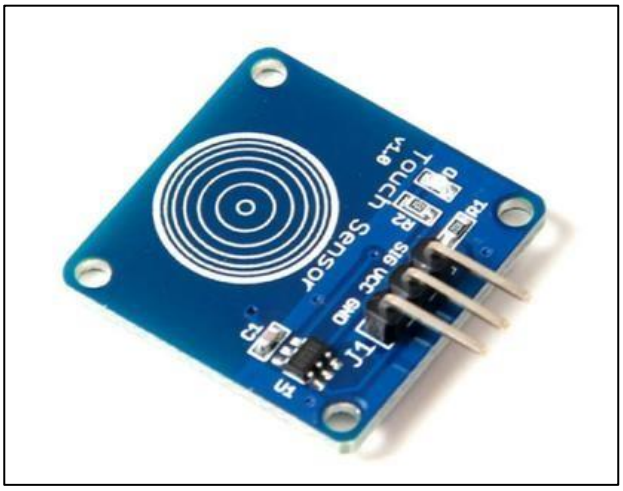


Fig 2: Touch Sensor

The touch sensor detects when waste is placed in the bins. It serves as a trigger mechanism to initiate the waste segregation process upon waste deposition.

➢ *Ultrasonic Sensor for Fill Level Monitoring*

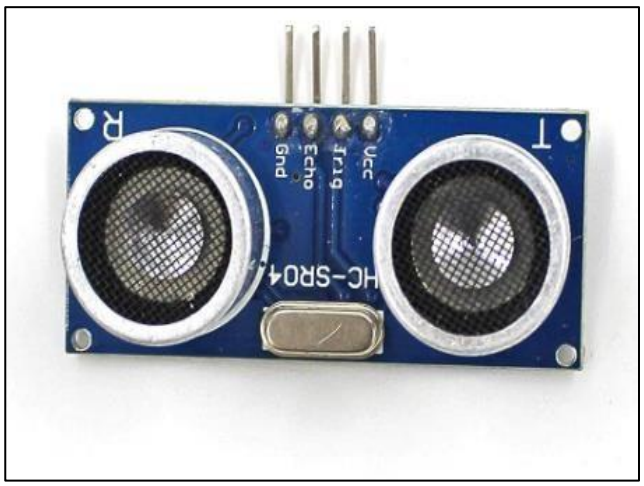


Fig 3: Ultrasonic Sensor for Fill Level Monitoring

An Ultrasonic Sensor is used to determine the fill level of garbage in the dustbin. It determine current status of the dustbin. It provides real-time date on the fill level by detecting the distance from the top of the bin to the waste surface. This data is crucial for scheduling timely waste collection and preventing overflowing bins.

➢ *Moisture Sensor for Waste Segregation*

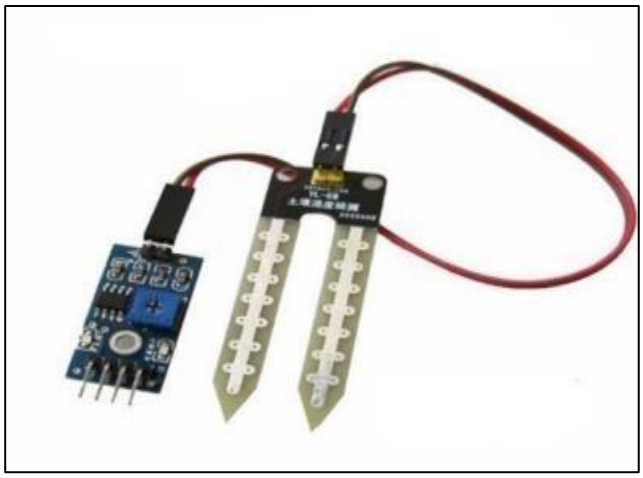

Fig 4: Moisture Sensor for Waste Segregation-

Moisture sensor is employed to assess the moisture content of the waste. It is used to check the water content from the waste placed on it and helps the waste to fall in right bin which categorizes them into dry waste and wet waste. This categorization facilitates efficient recycling and composting processes.

➢ *Servo Motor for Waste Separation*

The servo motor is employed to mechanically separate dry waste from wet waste. It rotates in the certain direction along the specified waste category. The servo motor receives instructions from the Arduino uno and rotates in the respective direction ensuring proper segregation process.

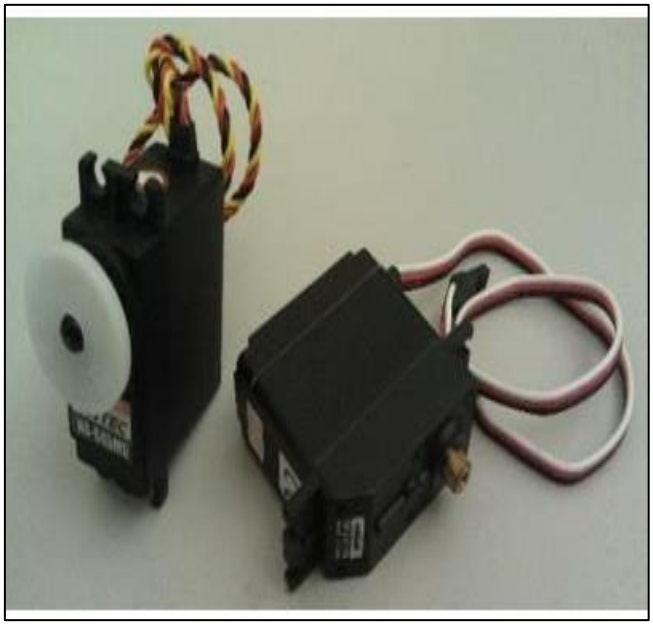

Fig 5: Servo Motor for Waste Separation

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➢ *GSM Module for Alerting Authorities*

Fig 6: GSM Module for Alerting Authorities

The GSM module is integrated to enable communication with waste management authorities. When the fill level of a bin reaches a predetermined threshold, the Arduino Uno triggers the GSM module to send an alert SMS to the designated authority. This ensures prompt action to empty bins before they overflow, maintaining cleanliness and preventing environmental pollution.

➢ *GPS Module for Location Tracking*

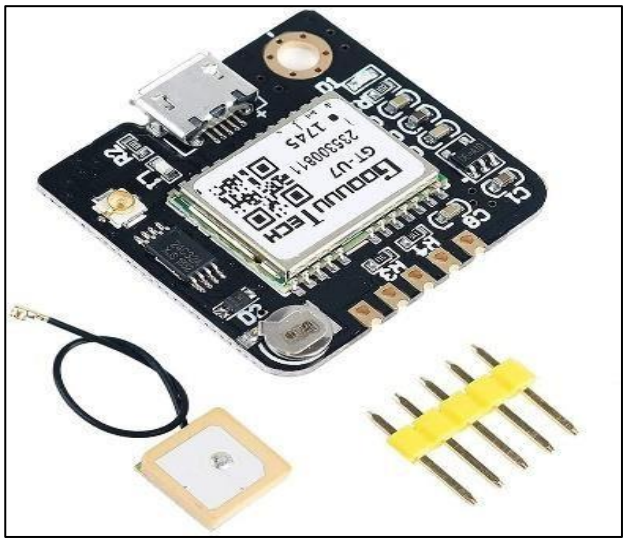

Fig 7: GPS Module for Location Tracking

The GPS module is incorporated to provide accurate location data of the waste bins. It enables waste management authorities to precisely locate each bin, facilitating efficient collection routes and logistics planning. Additionally, the GPS data aids in monitoring the distribution of bins across different areas, ensuring equitable access to waste disposal facilities.

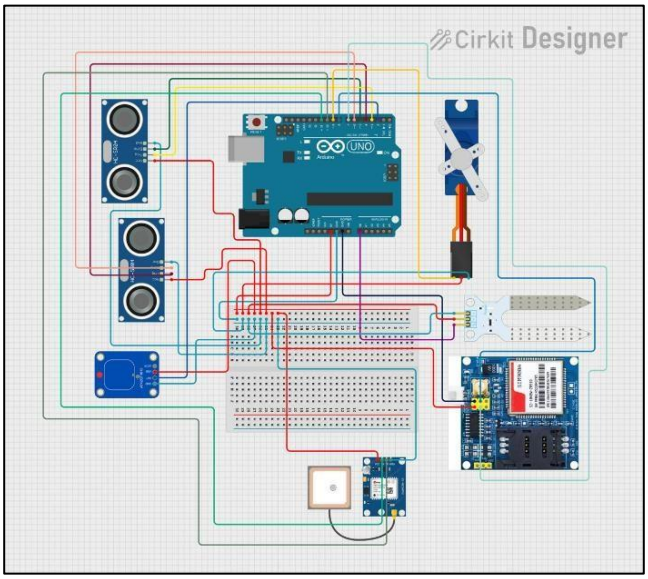


Fig 8: System Design

In the System design of this project the Arduino Uno is the central control unit of the system which is responsible for data collection, processing, and control of actuators. It serves as the brain of the system, coordinating the operation of all sensors and actuators. The Moisture Sensor measures the moisture content of the waste placed in the bins. Based on the moisture level detected, the waste is categorized into dry and wet waste. This enables efficient segregation for recycling and composting processes. Touch Sensor is placed within the waste bin, the touch sensor detects when waste is deposited. It acts as a trigger mechanism to initiate the waste segregation process upon waste deposition. The servo motor is responsible for mechanically separating dry and wet waste into their respective bins. Upon receiving instructions from the Arduino Uno, the servo motor rotates to direct the waste into the appropriate bins, ensuring proper segregation. The Ultrasonic sensor measures the fill level of waste bins by detecting the distance from the top of the bin to the waste surface. It provides real-time data on fill levels, enabling waste management authorities to schedule timely collections and prevent overflow incidents. Integrated for communication with waste management authorities, the GSM module sends alert SMS to designated authorities when the fill level of a bin reaches a predefined threshold or maintenance is required. This facilitates prompt action and maintenance based on the alert message received. The GPS module allocates the location of the waste bins, providing accurate positioning of the waste bin. It enables waste management authorities to precisely locate each bin, optimize collection routes, and ensure equitable access to waste disposal facilities.

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## VI. RESULT

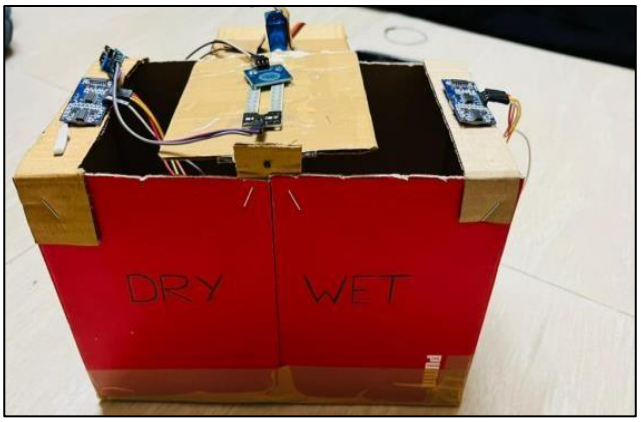

Fig 9: Front View

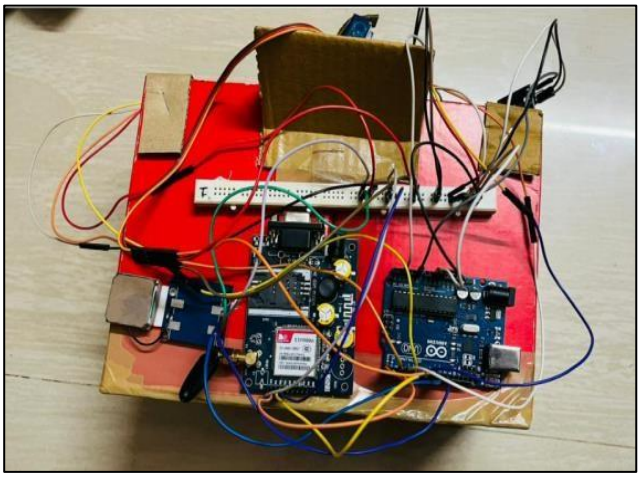
Fig 10: Side view

Fig 11: Dry Waste Detection

Fig 12: Wet Waste Detection

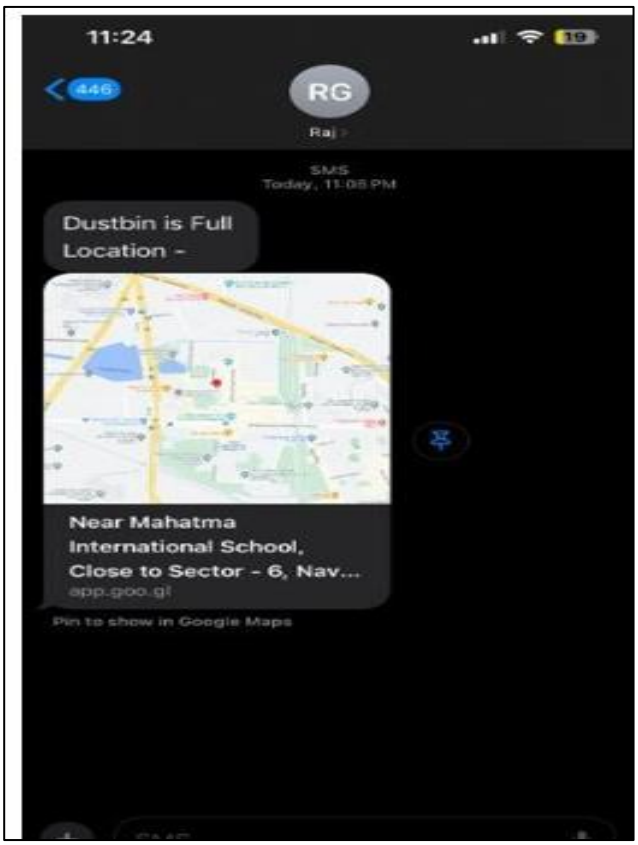

Fig 13: SMS Received

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## VII. CONCLUSION

It represents a significant step towards creating a more efficient and environmentally conscious waste disposal system. By employing a combination of sensors, microcontrollers, and communication modules, we have successfully developed a system that automates waste segregation and notifies the authorities when the bins are full. Through rigorous testing and calibration, we have demonstrated the system's capability to accurately differentiate between dry and wet waste. The integration of a servo motor for automated bin lids ensures a seamless and user-friendly experience for waste disposal. One of the key highlights of this project is the implementation of a GSM module, which enables real-time communication with the server. This functionality greatly enhances the efficiency of waste management operations, allowing for timely responses to fill level notifications. In conclusion, the "Intelligent

Waste Management using IoT" project not only showcases the power of IoT technology in addressing critical environmental challenges but also lays the foundation for more sustainable waste management practices.

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