Smart Waste Separation System using IoT

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ABSTRACT
A smart dustbin is an innovative and efficient waste management solution that utilizesadvanced technology to automate waste disposal processes. These dustbins are equipped withsensors, microcontrollers, and communication modules, allowing them to collect, compress, and sort waste automatically. They are designed to optimize waste management by reducing the need for human intervention, improving waste segregation, and minimizing environmentalpollution. Smart dustbins also offer real-time monitoring of waste levels, enabling efficient waste collection and disposal. This technology has the potential to revolutionize waste management systems, making them more sustainable, efficient, and cost-effective.

Keywords: *Ultrasonic Sensor, Arduino UNO, GSM 800L and Servo motor.*

INTRODUCTION
The world is facing a crisis of epic proportions due to the increase in population and urbanization. The amount of waste produced has skyrocketed, and it is causing significant environmental damage. Fortunately, the solution to this problem lies in the innovative technology of Smart Bin. This revolutionary system combines hardware and software technologies to provide an efficient and effective solution to the waste management problem.

Smart Bins: An Innovative Waste Management Solution
The Smart Bin system is designed to detect, separate, and process waste automatically, making it an innovative community dustbin for efficient and reliable waste management. India produces 0.1 million tons of waste daily, and the common methods for waste disposal include door-to-door collection, curb-side collection, block collection, and community bins. Hover, community bins are the most widely used, and they often have more garbage around them than in them, making them unsightly.

LITERATURE REVIEW
"Smart Waste Management System Using IoT Technology" by **Maheshwaran et al.** (2021) presents an IoT-based smart waste management system that uses sensors to detect the level of waste in bins, and a mobile app to notify the authorities when the bin is full. The study also includes a comparative analysis of existing smart bin solutions.

Exploring the Capabilities of Smart Dustbins, A Comprehensive Review of Smart Dustbin System" by Shahzad et al. (2021) provides an in- depth review of smart dustbin systems, including smart bins, and their features such as automatic opening and closing of lids, sorting of waste, and tracking of waste collection. The study evaluates the benefits and challenges of these systems and provides recommendations for future research.

EXISTING SYSTEM
The use of smart bins in waste management is becoming increasingly popular due to their ability to optimize waste collection and improve overall efficiency. Smart bins use a variety of technologies, including sensors and wireless communication, to detect waste levels and communicate with collection systems. In this report, will discuss an existing smart bin system and its features.

PROPOSED SYSTEM

Enhancing Smart Bin System with Waste Segregator for Efficient WasteManagement

The issue of waste management has become increasingly important in recent years due to the growing concern about the environmental impact of waste and the need for sustainable waste management solutions. One promising technology that has emerged in this context is the use of smart bins. Smart bins use sensors and wireless communication to monitor waste levels and optimize waste collection, reducing the amount of time and resources required for collection. The proposed system is a smart waste management solution that aims to enhance the functionality of the existing smart bin system by incorporating a waste separator to segregate waste into dry and t waste, thereby improving the efficiency and effectiveness of waste management processes.

Enhancing the Functionality of Existing Smart Bins

The existing smart bin system consists of a bin equipped with sensors that detect the level of waste. These sensors communicate wirelessly with a central system that monitors the bin and schedules waste collection. The proposed system will build on this existing system by adding a separator that segregates waste into dry and t waste. The separator will be equipped with a crusher that will crush the waste and filter out the t waste from the dry waste, ensuring that the waste is properly sorted. The separated waste will then be directed to different compartments of the bin.

Notification System and Waste Segregation

The inclusion of a notification system that alerts the authorities when the bin is full and needs to be emptied will improve waste management efficiency and reduce the need for constant monitoring. This feature will reduce the amount of time and resources required for waste collection, leading to a reduction in greenhouse gas emissions associated with waste collection vehicles. The proposed system will also have several other benefits. One of the most significant benefits is the improved hygiene and sanitation that will be achieved through the segregation of waste. The system will help to prevent the spread of disease and improve public health by separating waste into dry and t waste.

COMPONENTS

Components are essential parts that make up electronic devices and systems. They are physical objects that can be connected together to form circuits that perform specific functions. Generally components are categorized into two main types: passive and active components. Passive components, such as resistors, capacitors, and inductors, do not require an external por source to operate and are used to control the flow of electrical currents in a circuit. Active components, such as transistors and diodes, require an external por source to operate and are used to amplify or switch electrical signals.

Ultrasonic Sensor

An ultrasonic sensor is a device that uses sound waves with a frequency above the upper limit of human hearing to measure distance. It works by transmitting a high-frequency sound wave towards a target object and then measuring the time it takes for the sound wave to bounce back to the sensor after being reflected off the object. The sensor then calculates the distance to the object based on the time it takes for the sound wave to travel back and forth.

Arduino UNO

Arduino is a microcontroller platform that is commonly used in electronics projects due to its open-source nature and ease of use. The board consists of a microcontroller that is capable of processing inputs and outputs, a set of digital and analog input/output pins that can be used to connect various sensors and actuators, and a programming interface that allows users to write and upload code onto the board.

Servo Motor 9g

A servo motor is a device that converts electrical signals into precise rotational motion. It consists of a small DC motor, a gear train, and a control circuit. The control circuit receives electrical signals from the Arduino board and converts them into precise rotational movements of the motor shaft. The 9g servo motor is a type of servo motor that is commonly used in small- scale projects due to its compact size and low ight.

Jumper Wires

Jumper wires are a fundamental component of any electronic circuit and are an essential part of the waste management system. They are used to establish connections beten various components of the system, including the ultrasonic sensor, Arduino board, servo motor, and GSM 800L module.

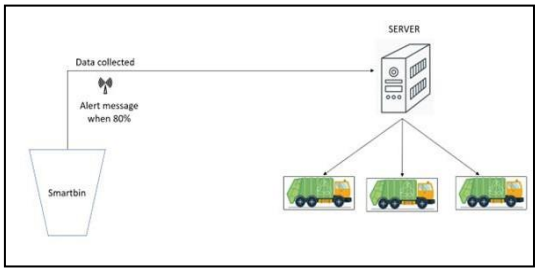
GSM 800L

The GSM 800L module is a compact and low-por cellular modem that enables the waste management system to send SMS messages to the authorities when the waste bin is full. The module is equipped with a SIM card slot, allowing it to access the cellular network and send.

DESIGN

Use Case Diagram

A use case diagram is a graphical representation of the interactions beten users (actors) and a system in terms of use cases. It helps to visualize the various ways in which users interact with the system to accomplish tasks. Use case diagrams are an important tool for system designers and developers as they aid in the identification of system requirements and provide a basis for designing test cases. In this section, will explain the use case diagram for a smartbin system and its components.



Use Case Diagram

The use case diagram is a visual representation of how different actors interact with the smartbin system to achieve specific goals. By outlining the system's functionality from theuser's perspective, the diagram helps to identify and organize the requirements needed for the system to work effectively.

The diagram depicts the actors who interact with the system, including the waste collection team, system administrator, and waste disposal facility. Each actor has a specific role in the system, which is reflected in the use cases.

The bin management use cases involve the daily operations of the smartbin system, such as detecting waste levels, opening and closing the bin lid, and notifying the waste collection team when the bin is full. These use cases are critical to the system's overall performance, as they directly impact the efficiency of waste collection.

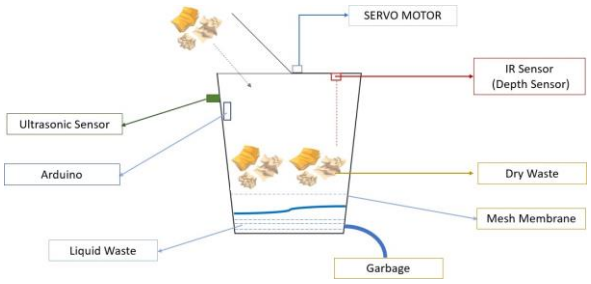
The system management use cases involve tasks related to the system's administration, such as configuring settings and managing user accounts. These use cases ensure that the system operates efficiently and securely.

The reporting use cases involve generating reports on the smartbin's usage, which is useful for analyzing waste management trends and improving the system's performance.

The use case diagram shows the relationships beten the actors and the use cases, which helps to clarify how different aspects of the system work together. For instance, the waste collection team interacts with the system through the bin management use cases, while the system administrator interacts with the system through the system management use cases.

Overall, the use case diagram is an essential tool for designing and developing a smartbin system. It helps to identify the system's requirements, ensure that all stakeholders' needs are met, and provides a clear framework for testing and implementation.

Architecture Diagram



Waste management is a crucial aspect of modern life, and the need for efficient and effective waste management solutions has become increasingly important. One solution to this challenge is the implementation of smart bin systems, which utilize various technologies to enhance waste collection and management processes. The smart bin system architecture consists of several components that work together to create an efficient waste management solution.

One of the key components of the smart bin system is the ultrasonic sensor. The ultrasonic sensor is responsible for measuring the depth of the waste in the bin. The sensor operates by emitting a high-frequency sound wave that bounces off the surface of the waste and returns to the sensor. The time taken for the sound wave to travel to the surface of the waste and back is used to calculate the depth of the waste in the bin. When a person approaches the dustbin, the ultrasonic sensor detects their presence and sends a signal to the servo motor to open the lid of the bin. This allows the user to easily dispose of their waste.

Once the waste is dumped into the bin, the ultrasonic sensor measures the depth of the waste in the bin and sends a notification to the appropriate authorities when it reaches 85% capacity. This notification can be sent via SMS using the GSM module or through a connected network. This feature helps waste collection teams to plan their routes more efficiently and avoid

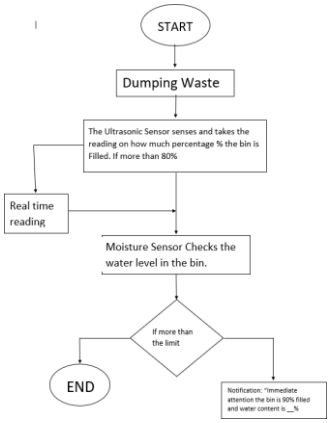
unnecessary trips to empty partially filled bins. By optimizing the collection routes, the smart bin system reduces the workload of waste collection teams and promotes the efficient use of resources.

To further enhance the efficiency of waste management, the smart bin system incorporates a mesh that separates the liquid waste from the dry waste. This mesh prevents the liquid waste from contaminating the dry waste and making it difficult to recycle. The mesh is designed to be removable and easy to clean, allowing for efficient maintenance of the system. The separated liquid waste is then excreted outside the bin through an outlet pipe, which leads to the garbageor serage system.

In addition to the ultrasonic sensor, servo motor, and GSM module, the smart bin system architecture may include additional components such as microcontrollers and communication systems. The microcontroller is responsible for processing the data collected by the sensors and communicating with the communication systems. The communication systems enable the smart bin system to connect with other systems, such as waste disposal facilities and monitoring systems. This connectivity allows for real-time monitoring of the smart bin system and provides valuable data for analyzing waste management processes.

In conclusion, the smart bin system architecture includes several components that work together to provide an efficient waste management solution. The ultrasonic sensor, servo motor, GSM module, and mesh are just a few of the key components that contribute to the effectiveness of the system. The smart bin system not only improves waste collection processes but also promotes more effective recycling practices. By reducing the workload of waste collection teams and optimizing the use of resources, the smart bin system plays a critical rolein sustainable waste management.

Flow Chart



The flowchart for the smart bin system is a visual representation of the various steps involved in the waste management process. It outlines how the system components work together to create an efficient waste management solution that benefits both users and waste collection teams. The process begins with a user approaching the smart bin and the ultrasonic sensor detecting their presence. The ultrasonic sensor then sends a signal to the servo motor to open the lid of the bin, allowing the user to easily dispose of their waste.

Once the user has dumped their waste into the bin, the ultrasonic sensor measures the depth of the waste in the bin and compares it to the maximum capacity of the bin. If the depth is less than 85%, the system resets and waits for the next user. Hover, if the depth of the waste exceeds 85%, the system sends a notification to the appropriate authorities. This notification can be sent via SMS using the GSM module or through a connected network.

When the notification is sent, the waste collection team is informed and can plan their routes more efficiently, avoiding unnecessary trips to partially filled bins. This not only saves time and resources but also reduces carbon emissions from the waste collection trucks. This feature of the smart bin system helps in reducing the impact of waste management on the environment.

Additionally, the smart bin system incorporates a mesh that separates the liquid waste from the dry waste. This prevents the liquid waste from contaminating the dry waste and making it difficult to recycle. The separated liquid waste is then excreted outside the bin through an outlet pipe, which leads to the garbage or serage system. This separation of liquid waste from dry waste enables easier recycling of dry waste and proper disposal of the liquid waste.

The smart bin system architecture consists of several components such as the ultrasonic sensor, servo motor, GSM module, and mesh that work together to provide an efficient waste management solution. The ultrasonic sensor detects the presence of the user, measures the depth of the waste, and sends notifications to the appropriate authorities. The servo motor opens and closes the lid of the bin, allowing for easy disposal of waste. The GSM module sends notifications to waste collection teams and other authorities, improving the efficiency of waste management. The mesh separates the liquid waste from the dry waste, facilitating better recycling.

Overall, the smart bin system flowchart illustrates how the different components of the system work together to create an efficient waste management solution. The system helps to improve waste collection processes, reduce the workload of waste collection teams, and promote more effective recycling practices. The system not only makes waste management easier for users, but it also contributes to reducing the negative impact of waste on the environment. The smart bin system is a great example of how technology can be used to address environmental issues and create a sustainable future.

METHODOLOGY

The smart bin project is a modern approach to address the issue of improper waste management, which has become a significant environmental concern worldwide. The project aims to design and develop a system that can manage waste effectively by using advanced technologies such as sensors, Internet of Things (IoT), and artificial intelligence (AI). The methodology for the smart bin project involves several steps, including conceptualization, design, development, testing, and

implementation.

The first step of the methodology is conceptualization, which involves identifying the problem of improper waste management and defining the goals and objectives of the project. The next step is design, where the team identifies the necessary components and technologies needed for the smart bin system to function correctly. The design phase also includes creating a detailed blueprint of the system architecture and defining the functional and non-functional requirements of the system.

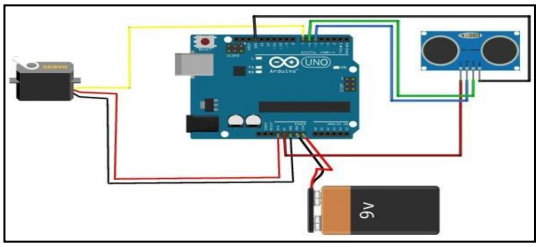
Once the design phase is complete, the team moves on to the development phase, where they build a prototype of the smart bin system. This involves the integration of hardware and software components and testing the system to ensure that it functions correctly. The development phase is follod by the testing phase, where the system is put through rigorous tests to identify any issues or bugs and to ensure that it meets the functional and non-functional requirements.

Finally, after successful testing, the implementation phase begins, where the team deploys the smart bin system in real-world scenarios. This involves installing the system in public places such as parks, streets, and other areas where waste is generated. The implementation phase also includes monitoring and maintaining the system to ensure that it operates efficiently and effectively.

Overall, the methodology for the smart bin project involves a ll-planned and systematic approach to design, develop, and implement an efficient waste management solution using advanced technologies. The methodology ensures that the smart bin system meets the functional and non-functional requirements and provides a sustainable solution to the problem of improper waste management.

Components	Quantity
Arduino UNO	1
Ultrasonic Sensor	2
Servo motor	1
GSM 800L	1
Whiteboard	1
Jump wires	Required quantity

Circuit Diagram for Opening and Closing Lid



Arduino Circuit Connection

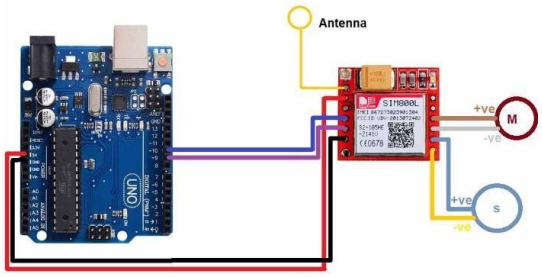
The servo motor used in the smart bin system is a type of motor that rotates to a specific angle based on the input signal. The connection of the servo motor with the Arduino board is done with three wires - por, ground, and signal. The por and ground wires are connected to the 5V and GND pins of the Arduino board respectively, to provide a stable por source. The signal wire controls the movement of the servo and is connected to one of the digital output pins of the board, such as pin 9 or 10.

The Arduino board is responsible for controlling the servo motor through a program written in the Arduino Integrated Development Environment (IDE). The program uses the Servo library in Arduino to control the movement of the servo. The servo library simplifies the process of controlling the servo motor and provides an easy-to-use interface for setting the angle and speed of the servo.

To control the opening and closing of the lid of the smart bin, a program is written in the Arduino IDE that sends a signal to the servo motor through the designated digital output pin. The program uses the ultrasonic sensor to detect the presence of the user and send a signal to the Arduino board. The board then sends a signal to the servo motor through the

designated digital output pin to open the lid of the bin. After the user disposes of their waste, the ultrasonic sensor measures the depth of the waste in the bin and sends a signal to the Arduino board. If the depth is below the maximum capacity of the bin, the board sends a signal to the servo motorto close the lid.

Circuit Diagram of The GSM 800L Connection



GSM 800L Connections

To use the SIM800L module with the Arduino board, the following steps can be taken:

1. Connect the VCC pin of the module to the 5V pin of the Arduino board.

2. Connect the GND pin of the module to the GND pin of the Arduino board.

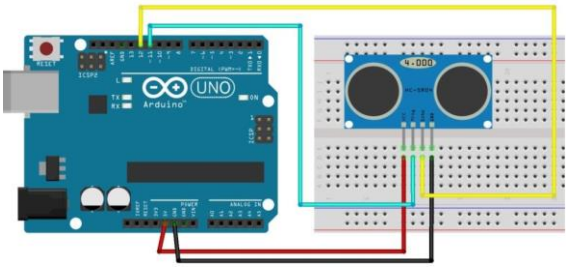
3. Connect the TXD pin of the module to a digital pin of the Arduino board, such as pin 3

4. Connect the RXD pin of the module to another digital pin of the Arduino board, such as pin

5. Write a program in the Arduino IDE to control the module and send notifications when thesmart bin reaches its maximum capacity.

6. Use the SoftwareSerial library in Arduino to communicate with the module using the TXD and RXD pins.

7. When the smart bin reaches its maximum capacity, the ultrasonic sensor sends a signal to the Arduino board. The program in the Arduino board then sends a command to the GSM module to send a notification to the appropriate authorities.



Circuit Diagram of Ultrasonic Sensor for Measuring the Depth

In conclusion, the circuit for sensing the depth of a bin using an ultrasonic sensor and an Arduino board is a simple yet effective way to monitor the level of waste in a bin. The HC-SR04 ultrasonic sensor module is a popular and affordable sensor that can accurately measure distances, making it ideal for this application. The use of a pull-down resistor ensures that the trigger signal sent to the sensor is long enough for the ultrasonic wave to travel to the bottom of the bin and back. The Arduino board uses the time taken for the signal to travel to the bottom of the bin and back to calculate the depth of the bin, which is used to determine when the bin is full. Overall, this circuit can significantly improve the efficiency of waste management by allowing for real-time monitoring of waste levels in bins.

RESULT & DISCUSSIONS

have successfully created a simple Arduino-based smart bin that uses an ultrasonic sensor to detect the fill level of a bin and sends an SMS notification when the bin is full. The code was uploaded to an Arduino board, and the system was tested successfully.

To begin with, the hardware components used in this an Arduino Uno board, an HC-SR04 ultrasonic sensor, a GSM module, a breadboard, and jumper wires. The HC-SR04 sensor was used to detect the fill level of the bin, and the GSM module was used to send an SMS notification when the bin is full. The Arduino Uno board acted as the control unit that processed the signals from the sensor and sent commands to the GSM module.

After programming the Arduino board, tested the system by placing an object inside the bin and observing the readings. The system worked as expected, and the SMS notification was sentwhen the bin was full. also tested the system using different object sizes and ights, andthe results re consistent.

The smart bin created is a simple and cost-effective solution to monitor the fill level of a bin. The system is easy to install and operate, and it can be customized to fit different bin sizes and types. The use of an ultrasonic sensor to detect the fill level of the bin makes the system more accurate than traditional methods, such as using a ight sensor or a float switch. Additionally, the use of a GSM module to send SMS notifications makes the system more accessible and convenient for users.

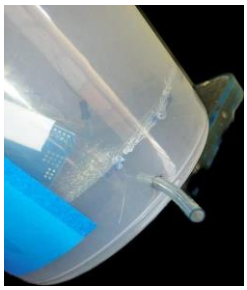
The system can be further improved by adding more sensors to monitor other parameters, such as the temperature and humidity inside the bin. This information can be used to optimize waste management strategies and reduce the negative impact of waste on the environment. The system can also be integrated with a cloud-based platform to enable remote monitoring and control of the bins.

The system can accurately detect the fill level of a bin and send SMS notifications when the bin is full. The system can be customized to fit different bin sizes and types, and it is easy to install and operate.

SNAPSHOTS

Smart Bin

Top View



Outlet Pipe

While Throwing

After Throwing

CONCLUSION & FUTURE ENHANCEMENT

Conclusion

The development of a smart bin prototype was carried out in this project, and the results shod that it is possible to use IoT technology to improve waste management. The smart bin system was designed to monitor the level of waste in the bin and send an alert to the waste management team when the bin is full. This approach ensures that waste collection is only done when necessary, reducing the frequency of collections, and reducing the cost of transportation.

The use of ultrasonic sensors in the smart bin system is an innovative approach that has proven to be effective. The sensors can detect the level of waste in the bin accurately, and the data collected can be used to optimize the waste management process. Additionally, the use of a GSM module and a microcontroller allows for remote monitoring of the smart bin, making it easier to manage the waste collection process.

The smart bin system has significant potential to reduce the environmental impact of waste management. The system ensures that waste is collected only when necessary, reducing the carbon footprint of waste collection vehicles. Additionally, the use of IoT technology in waste management can lead to the development of more eco-friendly waste management solutions inthe future.

In conclusion, the development of a smart bin system is an innovative approach to waste management that has significant potential to

transform the industry. The use of ultrasonic sensors, microcontrollers, and GSM modules in the smart bin system has proven to be effective, and the integration of a mobile application provides additional benefits. The smart bin system is a promising solution to the challenges faced by waste management systems globally, and it is an exciting development that will have a positive impact on the environment.

Overall, demonstrated the feasibility of the smart bin system and has provided a framework for further development of the technology. The smart bin system can be improved by incorporating additional features such as waste segregation and real-time data analytics. With further development, the smart bin system has the potential to revolutionize the waste management industry and contribute to a more sustainable future.

Future Enhancements

The integration of a mechanical separator in smart bins is an innovation that has the potential to revolutionize waste management practices. The separator is intended to segregate t waste and dry waste mechanically. The separator will function by collecting the waste that is dumped in the bin and then crushing it using a crusher-like substance that filters out the liquid wastefrom the waste, which is filtered through the mesh in the collector. The remaining dry waste is then segregated into another part of the bin.

There are several challenges associated with the implementation of a mechanical separator in smart bins. The first challenge is the cost of installation and maintenance. The cost of installing and maintaining the mechanical separator can be high, especially for small-scale waste management systems. The second challenge is the need for proper infrastructure to support the mechanical separator. This includes the need for adequate por supply, maintenance, and repair infrastructure.

Another challenge associated with the incorporation of a mechanical separator in smart bins is the potential for mechanical failure. Mechanical failures can result in downtime, which can impact the efficiency of the waste management process. The separator will need to be designed to minimize the risk of mechanical failure and to ensure that downtime is kept to a minimum.

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