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Eco Smart Bin: Solar Powered Trash Can System Using Iot Technology With Real Time Waste Segregation

Hanan Habeeb Abdullah[1], Asiya Shaik[2], Mohammed Rahmat Ali[3]

[1,2,3]B.E Students , Department Of CSE , ISL Engineering College(O.U) , India

[3]Assistant Professor, Department of CSE, ISL Engineering College(O.U) , India

ABSTRACT

Garbage disposal is one of the main problems faced in India regardless of the growth of the states and the area of development. It is a major problem in the under developed places It is found that most cases the trashes are spread across the road side because it is not collected on time. This trash leads to spread of disease and cause illness. There is a possibility of having some deadly disease. So, the proposed systems find the solution for the garbage disposal by designing a smart dust bin by managing the garbage. In this modern society certain quick actions are taken to improve the level of cleanliness in the country. People are getting more active in doing all the things possible to clean their surroundings.

Keywords: *- Arduino UNO, Ultrasonic sensor HC-SR04, Wi-Fi module ESP 8266, Arduino IDE, Thing speak apps, servo motor.*

Introduction

The abundant increase in population led to the improper waste disposal. Managing the garbage consumes more time and requires a lot of man power. This method can generate liquid leachate and other fungus which pollute the surface and underground water also accelerates harmful diseases which leads to the degradation of aesthetic value of environment. The wastes is segregated into basic main streams such as metallic, dry and wet these waste has a large potential of recycled and reused. even through there are multiple industrial waste segregators present, it is always better to segregate the waste at source itself. The advantage of doing this type of segregation is, there is no need of rag pickers to segregate the waste. In addition to it the segregated waste can be directly sent to the recycling plant, instead of sending the waste to segregation plant and then to recycling plant. Currently there is no such system for the automatic segregation of waste into dry, wet and other wastes the main purpose of this project is compact, low cost and userfriendly waste segregation system for urban cities to streamline the waste management process.

As the smart city concept spreads around the world, there are many roles to play. A smart city requires people to have a smart life, and cleanliness is a basic requirement for a smart lifestyle. Therefore, there is a need to develop smart waste management strategies with the help of technology worldwide to make cities cleaner, greener, healthier, and smarter.

Literature Survey

IoT-enabled smart trash cans are used for waste and landfill. It can be used for waste management. This may be the lack of general and public grade IOT-based smart waste disposal devices. This is a technologically complex field at a time when all your data is stored in the cloud with access to high-speed data in real time, and its data relies on the trash of IoT management racks. Associate Applied to sensible towns. Devices that connect to a network to exchange information and communicate with other devices with an assigned UID to reduce human-to-human or human-to- laptop interactions Research and Competitive Garbage Overview. Garbage that comes from cities, public places, communities, universities, homes, etc. may contain unwanted materials. This project is called a "smart city" and supports the "Internet of Things" (IOT). Therefore, cleanliness is essential for a good life attitude and cleanliness starts from garbage.

TITLE 1: Smart Dustbin-Wet and Dry(Metal) Waste Segregator with Alert System(2018), Mr.M.R.Mohamed Shahidh Meeran, Mr.S.Rajeshwaran, Mrs.Susan Shiny(Assistant Professor)

This paper is an innovative way to revolutionize the waste management system using sensors. Segregation is achieved using respective automated sensors. Presently there's no such system for segregation of dry and wet wastes at domestic level or social unit level. This paper proposes an automated sensor based waste management and segregation system.

TITLE 2: Smart Waste Segregation and Monitoring System using IoT(2019), V. Sowndharya, P.Savitha , S.Hebziba Jeba Rani.

The amount of waste has been increasing due to the increase in human population and urbanization. In cities, the overflowed bin creates an unhygienic environment. Thus degrades the environment, to overcome this situation “Automatic Waste Segregator” is developed to reduce to work for the ragpickers the wastes are segregated by the human beings which leads to health problems to the workers. The proposed system separates the waste into three categories namely wet, dry and metallic waste. This developed system is not only cost efficient also makes the waste management productive one. Each of the wastes are detected by the respective sensors and gets segregated inside the

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bins which is assigned to them the details of amount of waste disposal is updated in the server regularly

TITLE 3: Smart Waste Management System using IoT(2021), Bindushree V, Manasa M, Sanjana Rao, Vidyashree T, Gowra PS.
An The aim of the project is to implement an efficient method to manage the waste in big cities as well as small ones. The issue of disorganized garbage collection is the biggest hurdle in our everyday life to reduce it, an IoT system is developed that will keep track of each bin depending upon the level filled. This is through an electronic system which segregates wet and dry waste. A setup consists of several sensors which includes IR sensor for detecting the presence of any waste and soil moisture sensor to detect whether the waste is dry or wet. Here, whenever the IR sensor detects any waste, the motor will turn towards either dry bin or wet bin depending on the soil moisture sensor's value. Ultrasonic sensors are placed at the top of each bin and is used for calculating duration by sending a signal. The signal is thus used to calculate the amount of space available in the bin, thereby helps to clear the bin as and when the bin is near to full.

TITLE 4: Smart Garbage Segregation System Using IoT(2022), Darshil Shah , Rushi Patel, Nilesh Dubey, Divyesh Patel.
In last 5 years Indian Prime Minister has put a lot effort on 'Smart City' and 'SwacchBharat Mission' as per his vision India should be considered as a clean nation in world by 2nd October 2022 which is 150th birth anniversary of Father of Nation. A lot of work has done for public awareness to clean their surroundings and put the garbage into dustbins. We have also seen a problem that wet and dry garbage is thrown in same dustbin which is little bit harder to separate afterwards. So, we have tried to over come this problem by using a well-known concept in Computer Science called IOT. In this System we will use a microcontroller based on Arduino platform which will control all the sensors. In this system we are using Ultrasonic Sensor, Humidity Moisture Sensor, GSM module, Servo Motor. The Humidity Sensor will measure the respective humidity in the garbage if it is greater than specific value than the Arduino board will be programmed in such a way that it will trigger the motor which is fitted in wet portion of dustbin, it will open the door of wet portion otherwise the dry portion of dustbin will be opened.

TITLE 5: A Garbage Disposal Management System to Support Swachh Bharath Mission
AUTHOR: - Denicke Solomon H, Abishek R, Ramachandra T, et al
YEAR: - April 2022

Abstract: Currently, people prefer to live in a clean environment to be healthy. Both organic and inorganic waste from homes is disposed of in community bins managed by local councils or municipalities or companies. Wastewater generated by stray dogs pulling their food out and people throwing garbage out of moving vehicles causes serious problems for neighbors. While the Indians are aware of the Swachh Bharath Mission, there are many challenges. The work presented in this paper is to facilitate waste management using Arduino, connected network, two ultrasonic sensors, servo motors, GSM/GPRS module, 4 X 4 matrix keypad, piezo buzzer and LEDs. The waste management system is ideal for busy public areas such as universities, shopping malls, train stations and airports. While it's designed to cost more than regular trash, it lasts longer and is easier to dispose of.
Keywords: Arduino, Ultrasonic Sensors, GSM, GPRS, LED, Buzzer, Garbage Disposal Management System, Swachh Bharath Mission.
Proposed System Architecture: The functional block diagram shows the waste disposal device with main components and structures such as ultrasonic sensor, servo motor, GSM/GPRS module, 4x4 matrix keypad, parallel switching network and Arduino Mega 2560 microcontroller.
Conclusion: - Smart storage boxes are popular because they are easy to manage and user-friendly. The standard prohibits the public from throwing garbage on the trash can. It is also used to reduce waste. Going one step further and sending materials to local storage instead of the website will save a lot of time and also keep existing cleaners safe on the job. Investing in designs is inexpensive because they last longer without changing. Therefore, the waste management strategy will assist in the realization of the Swachh Bharath Mission concept.

TITLE 6: A Smart Automated Garbage Management System to Replace Human Labour
AUTHOR: - Souvik Mondal, Sayantani Das, Shirsendu Banerjee, Koushik Pal
YEAR: - April 2022
Abstract: About 100,000 tons of municipal solid waste are thrown away every day in India. These wastes are mostly fruits and vegetables, animal skins, wastepaper, plastic cloth bags, batteries, metal scraps and many other materials. An intelligent waste management system is required to manage and dispose of this large amount of waste. This waste management process also includes the separation of biodegradable and non-biodegradable wastes, which is carried out manually by them at the landfill. It is very unhygienic and can give them deadly diseases. Power to be housed in a removable enclosure and able to work remotely over Wi -Fi connection. As a result, workers working in municipal waste do not have to enter directly with waste and poison. Thus,

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they can do their job by having knowledge about health and cleanliness.

Keywords: - Garbage management, robotic arm, integrated system, garbage sorting.

OBJECTIVE: -

The main purpose of this project is to create an intelligent waste management system that uses a movable chassis and a robot arm placed on a two-shelf bin, sensors and some electronic equipment. Urban waste is known to employ large numbers of workers to sort and manage waste. This process of identifying waste is done by workers with their own hands, which puts them in direct contact with waste and poison. It is very dangerous and bad for their health and can be caused by some bacteria, viruses or methane, carbon dioxide etc. They will be affected by many deadly diseases caused by certain pollutants such as the robot arm of Model will first pick up the garbage, then sensors will recognize the material, determine whether it is biodegradable or non-biodegradable waste, and place it in the appropriate place. In other words, the system works in a way that makes human hands. Thus, the system ensures that workers are not directly exposed to harmful and toxic whips in addition to pollution. This will help them help the community learn about health.

Conclusion

In conclusion, we can say that in this work plan we are trying to create an electric generator for intelligent waste management and describe some controls by connecting them to robots. In this concept, we present a brief description of the layout components and circuit connections. This is the perfect solution for handling large volumes of waste. The logic behind the different waste is very simple because it is just our sensor design compared to other models applying machine learning or spectroscopy, so it's easy to design and use. The main aim of the program is to follow people's efforts to distinguish between biodegradable and non-biodegradable waste. Therefore, by using this combination, those working in the landfill will be able to maintain hygiene and not be affected by pollution or diseases.

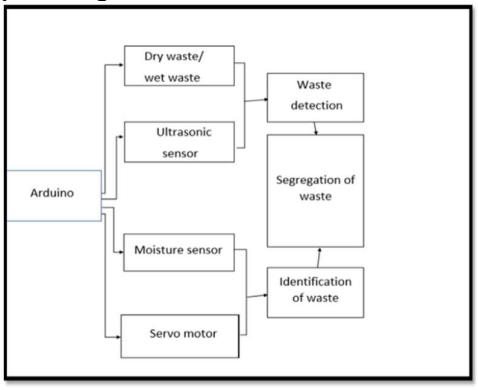
METHODOLOGY

Existing Method

In the Existing system, an ultrasonic sensor is placed on the top of the garbage bin to detect the hand of the person who comes to throw the trash. Another ultrasonic sensor is placed inside the garbage bin to detect garbage level. Two servo motors are attached with the lid and are connected with the Arduino microcontroller. The Arduino microcontroller calculates the distance of trash level in the garbage bin with respect to the threshold distance. When the garbage bin is full, the processor activates the GSM/GPRS module to send an alert message to the local garbage collector. The uniqueness of the garbage disposal system is achieved by placing the parallel switching network on the top of the lid. The purpose of this project is to make a trash can that can be opened and closed by itself when needed. In this mechanism, Arduino is used to control the servo motor and ultrasonic sensor. The ultrasonic sensor works when a person walks in front of the sensor, it can detect person

Proposed Method

The core of our proposed Smart waste bin scheme basically consists of an ultrasonic sensor that functions as the distance calculator. The ultrasonic sensor will be attached to waste bin which is placed in public areas. The ultrasonic sensor continuously measure the distance in front of the bin and if the distance fall below a particular value the presence of humans can be identified. At this time the H Bridge can be activated and lid can be opened, a buzzer can be activated for indicating the operation. This system is entirely working in renewable solar energy. Since the solar energy is highly fluctuating voltage regulator circuit is used for making a constant supply of voltage to charge the battery. LM317 voltage regulator is used for in the circuit for the above purpose. The aforementioned functionality has been achieved by interfacing the ultrasonic sensor modules with the ATMEGA328 microcontroller on board the Arduino Uno board. The Arduino integrated development environment is an opensource project which simplified the coding g The main goal of this study is to automate the efficient sorting of different types of waste. This information can significantly improve decision-making for those managing litter bins and cleaning services to ensure effective disposal. The ultrasonic sensor is tasked with object identification, and moisture sensors play a crucial role in detecting wet and metal waste. Upon identification, the waste is deposited into the bin, where the sensor categorizes its type. The bin is designed with two partitions, each dedicated to collecting a specific type of waste. Following this, the motor engages in rotation to separate the collected wastes, facilitating subsequent processing.



Block diagram of the proposed system

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IMPLEMENTATION

Power Supply:

- Solar panel charges the battery.
- Battery powers all components.

Waste Detection:

- IR sensor detects hand near lid → activates motor to open the lid.

Waste Type Identification:

Waste falls onto moisture sensor:

- Wet Waste: High moisture → servo directs it to wet bin
- Dry Waste: Low moisture → servo directs it to dry bin

Waste Level Monitoring:

- Ultrasonic sensor checks the height of waste inside each bin.
- If bin is full, sends signal to controller.

Notifications:

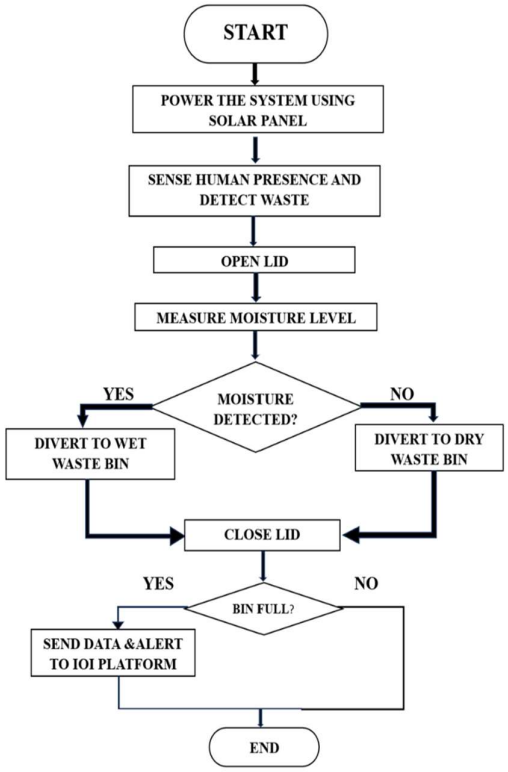
- GSM/Wi-Fi sends alert to municipal server or mobile app.
- LCD displays "Bin Full" or "Segregating".

Circuit Diagram Overview

- Solar Panel → Charge Controller → Battery → Arduino

Arduino connected to:

- IR Sensor (for lid)
- Moisture Sensor (for waste type)
- Servo Motor (for directing waste)
- Ultrasonic Sensor (for level check)
- LCD Display (for messages)
- GSM or Wi-Fi Module (for notifications)



SOFTWARE TESTING

Unit testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program input produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration.

Functional Testing :

Verifies the system performs all required tasks correctly.

Subtype	Description	Example
Unit Testing	Test individual components (e.g., sensors, servos)	Test moisture sensor output with various materials
Integration Testing	Test combined modules working together	Waste detection → segregation → cloud upload
System Testing	End-to-end test of complete system	Insert waste and validate dashboard update, lid operation, and segregation

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Hardware Testing : Ensures that physical components are working properly.

Subtype	Description	Example
Sensor Accuracy Testing	Check sensor readings vs actual values	Moisture level reading validation
Servo Motor Testing	Ensure servos move to correct positions	Bin diverter and lid servo range
Power Testing	Assess performance under solar/battery	Power availability in cloudy/night conditions

IoT Communication Testing: Validates cloud interaction and data transmission.

Subtype	Description	Example
Connectivity Testing	Ensure stable WiFi/IoT connection	WiFi reconnection after drop
Cloud Data Sync Testing	Check data appears on cloud dashboard	Adafruit IO feed update on waste input
Offline Handling	Test system behavior without network	Retry logic or offline storage simulation

Performance Testing: Tests system behavior under various loads and stress.

Subtype	Description	Example
Load Testing	Continuous waste inputs	System logs all inputs without missing data
Stress Testing	Power off/on rapidly, network toggling	Check system robustness under unstable conditions
Battery Runtime Testing	Measure backup power duration	Hours of operation without sunlight

Usability Testing: Checks how intuitive and user-friendly the system is.

Description	Example
Users must understand where to dispose of waste and the system should respond quickly and clearly	Observe non-technical users interact with the system

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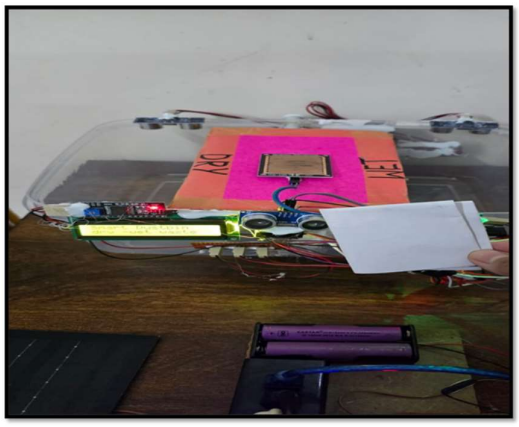
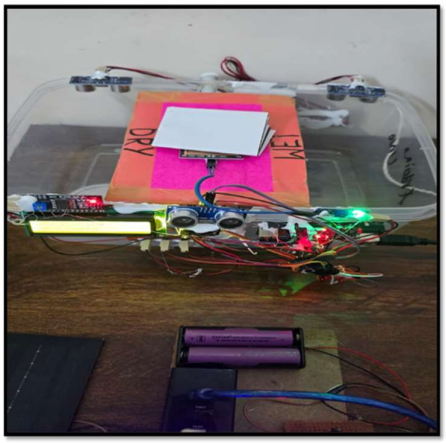
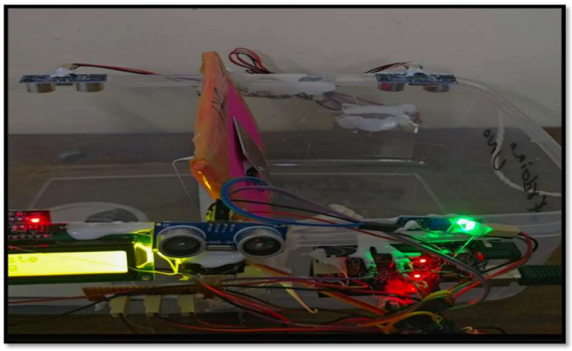
Results



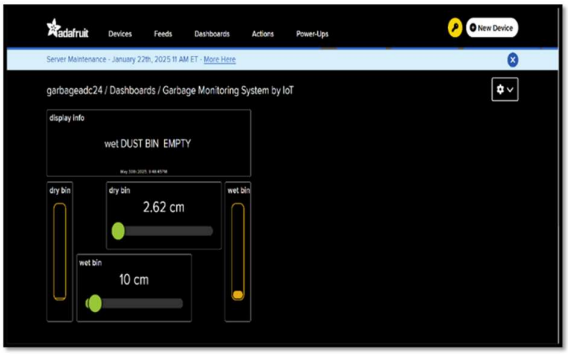
Sensing the distance and human motion.



Sensing if the waste is dry or wet.



Detecting and dumping the waste in dry section.



dashboard that shows wet bin is empty and dry is full

CONCLUSION

The segregation of dry and wet waste at the source improves recycling efficiency and reduces the burden on landfills and waste processing facilities. This approach encourages responsible waste disposal habits and supports environmental conservation efforts. Overall, this project demonstrates the potential of integrating renewable energy with smart waste management systems to promote cleaner, greener, and more sustainable urban environments.

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FUTURE ENHANCEMENT

Our project still has a lot of space for improvement and possibilities in the future like any other project.

• The whole system can be implemented by using machine learning for advanced system management.
• We can improve the accuracy of the data by using more high-end sensors, i.e., a better version of the sensors compared to that we have used in this system for each measurement parameter.

1. **Integration of Gas Sensors & AI:** Future systems can use gas sensors (like MQ-135) with AI to detect and classify foul odors (e.g., ammonia, methane), enabling smarter waste monitoring and management.
2. **Real-Time Alerts & Predictive Maintenance:** Odor data can trigger real-time alerts and help predict when bins need to be emptied or sanitized, improving hygiene and optimizing collection schedules.
3. **Smart Response Mechanisms:** Automatic deodorization systems and ventilation can be activated based on odor levels, reducing health risks and enhancing public cleanliness.

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