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Waste Management System Using IoT Environment

Mrs. Mamatha G, Likhitha N, Meghana M, Nomika R, Pragathi S
S J C Institute of Technology, Chickballapur

Abstract: To reduce its negative effects on the environment and public health, it is crucial to make sure that the waste that has been collected is appropriately managed and processed. Recycling, composting, and incineration are a few examples of waste management techniques that can be used to accomplish this. Recycling involves turning garbage into new products, which helps to cut down on the amount of waste that is disposed of in landfills or incinerators. Composting is the process of turning organic waste into a fertilizer rich in nutrients that may be utilized to enhance the quality of the soil. Burning waste products at high temperatures produces energy in the form of heat or electricity during incineration.It is crucial to remember that waste management is not just a government concern; it also necessitates participation and accountability from private citizens and companies. This can be accomplished by implementing sustainable waste management techniques, such as cutting back on trash production, recycling products, and adopting appropriate disposal methods.

In conclusion, the rise in solid and hazardous waste brought on by industrialization, urbanization, and economic expansion poses a significant challenge to waste management. Waste may be effectively separated with the use of cutting-edge systems like the Waste Segregator, which can then be managed through a variety of waste management techniques like recycling, composting, and burning. To maintain a cleaner and healthier environment for future generations, sustainable waste management calls for active participation from everyone.

Keywords: Waste Classification, Internet of Things**.**.

I. INTRODUCTION

The modern world has several difficulties, one of which is smart waste management. If an appropriate disposal system is not managed, it becomes a significant matter of worry. A country can advance through managing garbage well and recycling effectively. In this project, a machine that can automatically classify waste into different categories is created in order to facilitate and improve waste management. Using a microprocessor and operational amplifier to build an electromechanical system, it is feasible to separate metal, paper, plastics, and glass. The use of a proper recycling system will allow society to benefit from the garbage problem instead of being cursed by it. Recycling will be done more effectively thanks to the sorting process. This waste sorter will transform the current waste management system into a SMART system. This SMART technology will contribute to a healthier, more livable planet by lowering global warming and improving air quality. People have disposed of unwanted items using a variety of methods since the dawn of human civilization. It was occasionally burned, thrown into the ocean, buried in the ground, or fed to animals. Modern society's top priority is continually finding ways to get rid of waste.

As was the case in 1350, improper waste management might result in serious hazards. Over 25 million people from all over Europe succumb to the "black plague" in just five years after it first appeared. By 2025, the rate of trash production in Bangladesh is expected to increase and reach 47,064 tones per day. In 2025, the Waste Generation Rate (kg/cap/day) is anticipated to reach 0.6. Ineffective waste management practices may cause environmental contamination, which in turn encourages the growth of insects, mice, and other scavenger animals and the spread of a number of diseases. If the waste is not collected in a timely manner, the customary technique includes burning it. The burning of garbage significantly pollutes the air. Social health problems are also made worse by the uncontrolled release of methane caused by anaerobic decomposition of trash. The overall sustainability of the system must also be

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taken into account. While separating garbage is a crucial first step towards successful waste management, it's also crucial to make sure the waste is processed correctly and disposed of sustainably.

II. LITERATURE SURVEY

"Smart Waste Management and Classification Systems Using Cutting Edge Approach" by Sehrish Munawar Cheema, Abdul Hannan and Ivan Miguel Pires (2022). waste grid segmentation mechanism, which maps the pile at the waste yard into grid-like segments. A camera captures the waste yard image and sends it to an edge node to create a waste grid.

"IoT Based Smart Waste Management System Using Wireless Sensor Network" by P. Gope, S. Biswas, and P. K. Sarkar (2019). An implementation of an IoT-based solid waste management system that uses a wireless sensor network to monitor the waste levels in bins. The system uses machine learning algorithms to predict the level of waste and optimize the waste collection routes. The authors also propose a mobile application that allows citizens to report any issues related to waste management, such as overflowing bins or littering.

"Internet of Things based Smart Waste Management System" by A. Kumar, R. Kumar, and A. Garg (2020). A waste management system that uses IoT devices to monitor the landfill sites and provide real-time data on waste decomposition. The system uses sensors to measure the temperature, humidity, and gas emissions in the landfill site and sends alerts to the waste management department if any issues are detected. The authors also propose the use of blockchain technology to ensure the transparency and accountability of the waste management process.

"Smart Waste Management System Using IoT" by S. S. Hiremath and S. K. Patil (2021).

A smart waste management system that uses IoT devices and cloud computing to optimize waste collection routes and reduce transportation costs. The system uses sensors to detect the level of waste in the bins and sends notifications to the waste management department when the bins are full. The authors also propose the use of a mobile application that allows citizens to track the status of waste collection and disposal in their area.

"IoT-Based Smart Waste Management: A Review of the Literature and Future Directions" by A. Al-Timemy, R. H. Khan, S. S. Al-Fahad, and H. Almohammed (2021). Article provides an overview of the current state of research on IoT-based smart waste management systems. The authors discuss the various components of the system, including sensors, RFID tags, and data analytics, and provide insights into the challenges and future directions of research in this field. The article also highlights the potential of IoT technology in improving the efficiency and
sustainability of waste management processes

III. PROBLEM STATEMENT

The waste management system has been created to include a variety of cutting-edge techniques for effectively processing, managing, and segregating waste. One such development is the usage of "self-aware" smart bins that use Wi-Fi to transmit their fill levels to a central server. This makes it possible to plan a garbage collection schedule based on the shortest distance between bins that are nearly full, maximizing the utilization of trucks and fuel usage.

On a platform where the person stands, there is a weighing equipment available to guarantee correct measurement of the trash. The individual weighs their trash, and PMC provides a polythene bag with markings on it so that the volume can be calculated. After determining the waste's density, the system separates it into dry and wet solid waste, which are then each placed separately in their corresponding dustbin sections. The dustbin's lid is opened by the Arduino-interfaced DC motor.

Users have created a platform with piezoelectric sensors that produce electricity when weight is applied in order to meet the energy needs of the system. The energy produced by the system can be used to power its parts or stored in a battery for later use.

IV. DEVICE ARCHITECTURE

The microcontroller is the central processing unit for the smart trash bins. It will be responsible for controlling the sensors, processing the data received from the sensors. The power supply is a critical component of the embedded system, as it provides electrical power to the microcontroller and other electronic components.

The power supply for the smart trash bins needs to be reliable and efficient to ensure the continuous functioning of the system. Therefore, proper measures need to be taken to ensure that the power supply is designed to meet the power requirements of the system. The power supply must be able to handle the peak loads during system operation and also provide sufficient energy storage to handle periods of low energy availability.

V. SIGNIFICANCE & RELEVANCE OF WORK

Existing System: Many different areas of solid waste management, such as garbage collection, transportation, processing, and disposal, have been thoroughly researched over the years.

Only a small number of research, nevertheless, have concentrated on the real-time monitoring of trash cans. Bin monitoring systems have been created in certain current research, but they have some drawbacks, including high cost, constrained scalability, and incompatibility with various garbage bin types. To ensure prompt and effective waste collection, several researchers have proposed dynamic routing algorithms that can address problems like truck overload and damage and can offer alternate routes. These algorithms optimize waste collection routes and schedules using real-time information from trash cans.

Disadvantages

- Inadequate mechanism for real-time monitoring and tracking of trucks and trash cans being collected.
- Lack of ability to react promptly to urgent events such truck accidents, breakdowns, and extended idle times.
- Inefficient and unauthorized use of vehicles resulting in production loss.

Proposed System

The suggested system incorporates trash segregation that is automatic from the start of disposal. Sensors under the lid and in other places around the bin are constantly checking the bin's condition. Based on its density, the system automatically separates the garbage into WET and DRY solid waste categories. The system separates the garbage into compartments designated for WET or DRY solid waste based on the moisture sensor readings. The metal is recognized using a proximity sensor. The garbage is permitted to be put into the appropriate compartment using a DC motor connected to the microcontroller.

Advantages

- The suggested system features bin status monitoring, allowing it to recognize when a bin is nearly full and requires emptying.
- The device can avoid the overflow of waste, which can result in littering and other issues, by keeping an eye on the condition of the bin.
- The system also features automatic trash segregation, which enables sorting and separation of garbage without the need for manual assistance.
- Waste that is automatically separated can be managed more effectively and with less work from human operators.

VI. METHODOLOGY

The Waste Management System project is made up of a single microcontroller, IR transmitter and receiver, LDR, proximity sensor, moisture sensor, DC motor, and LCD. It is designed utilizing a structured modular design philosophy. The microcontroller, which serves as the project's central controlling element, is programmed with a program that enables it to respond to inputs from sensors by taking appropriate action. The trash is placed in the specified metals bin using a conveyor belt once the metal sensor identifies that it is made of metal and the IR recognizes that it is being placed on the system tray. Depending on whether the material is wet or dry, the moisture sensor determines where the proper collection container should be placed. The starter/stopper and conveyor belt are powered by a DC motor, which also moves the waste collecting.

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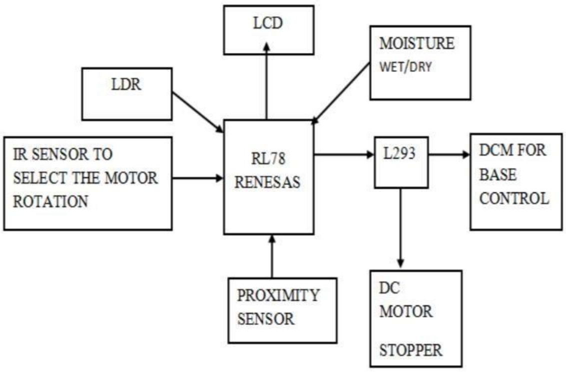

Figure 1: Block Diagram of Waste Management System

OBJECTIVES

- The suggested system uses a range of sensors and modules to accomplish the following objectives:
- Utilize an IR proximity sensor to find rubbish being pushed into the system.
- Utilize a metal detection technology to distinguish metallic waste.
- Utilize a moisture detecting module to distinguish between wet and dry garbage.
- Position the proper container for the type of garbage by rotating a circular base.
- Gather the trash in the designated bins so it may be processed further.
- Sorting the garbage into the appropriate bins.

VII. SYSTEM REQUIREMENTS SPECIFICATION

Functional Requirements:

Renesas Flash Programmer, a graphical user interface for programming.

A 32-bit microcontroller featuring Arm Cortex processing cores for quicker performance and more memory capacity is the Renesas microcontroller.

Liquid Crystal Display, or LCD, is a flat panel display that is used for display purposes.

Moisture sensor: This device calculates or measures the water content of trash.

IR Sensors: These electronic gadgets are used to find nearby items since they can detect infrared light.

DC motors are employed in spinning, conveying, turntables, and other devices where a constant or low-speed torque and adjustable speed are necessary.

To determine whether trash has been placed in the trash bin, LDRs are employed.

CubeSutie+ Compiler: This tool is used to combine all the software development tools into one platform.

Non-Functional Requirements:

Smart trash cans come with connectivity and sensor technology.

To determine the type and quantity of waste, various sensors are mounted to the bin at various points. These sensors are used by the system to automatically identify the garbage.

The waste is disposed of in the appropriate bin based on the type that was discovered.

To position the appropriate waste bin under the flap for disposal, a DC motor rotates the waste bins.

VIII. SYSTEM DESIGN

Technical Background: Mixed garbage is sorted in the industrial setting utilizing a variety of techniques. To start, larger things are sorted manually to remove them. The garbage is then separated based on size using spinning drums with holes that are perforated a specific size. Electromagnets or eddy current-based separators are utilized for metallic objects. In contrast to X-rays, which are used to separate materials based on density, near-infrared scanners are used to

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distinguish between various types of plastics based on their capacity to reflect light. These techniques can't be applied at the household level and are expensive. The solution put forward in this study to address this problem involves automating the waste segregation procedure and lowering the cost such that it can be applied at the home level.

Proposed Solution: Waste is forced through a flap by the proposed mechanism to function. The mechanism is activated when an IR proximity sensor detects the presence of garbage. Once the garbage is discovered, the metal detection system is tasked with locating any metallic waste. Following that, the moisture-sensing module makes a distinction between wet and dry waste. The rotation of a circular base holding containers for dry, moist, and metallic trash is based on the identification of the waste type. The garbage is subsequently dumped into the proper container using the conveyor belt. By doing this, the waste is guaranteed to be separated and may be collected separately for additional processing.

System Architecture: The suggested solution incorporates intelligent trash cans with sensors that can identify various sorts of waste and split them into different containers. The sensors are spread throughout the container in various places.These workstations determine the shortest route to gather the most waste in that area while accounting for bins that are over 80% full. They also forecast when the remaining bins will be roughly filled and when the rubbish will be roughly collected.

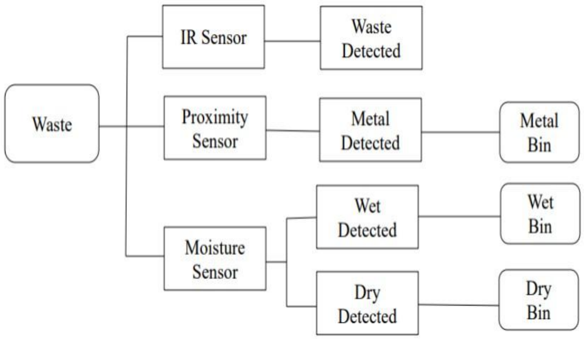

Figure 2: System Architecture of Automatic Waste Segregator.

At the end of the day, the workstations backup all the data to a central server, which stores it all in a database and produces reports.

IX. IMPLEMENTATION

The implementation is divided into four modules.

Entry System and Initialization: The segregation begins with this module. An IR proximity sensor detects garbage being deposited into the garbage Segregator model and sends an interrupt to the microcontroller, causing it to exit low power mode. In order to prevent changes in the environment from impairing the sensing process, the controller then initializes all of the sensor modules.

Metal Detection System: A capacitive or photoelectric sensor, for instance, might work with a plastic target, whereas an inductive proximity sensor needs a metal target. The term "nominal range" refers to the greatest distance that this sensor can detect. Some sensors have the ability to alter the nominal range or feature a graduated detecting distance reporting mechanism.

The proximity count value changes as a result of the inductive interaction between the coil and the item. The metal detection system can identify any conducting material regardless of its magnetic characteristics since it is not impacted by magnetic fields. This suggests that there is a metallic object nearby. If the waste is not metallic, it is sent down the second slope and towards the apex. Otherwise, the actuators are turned on and the sensing module is turned off.

Moisture sensing module: This moisture sensor is straightforward to use and can be used to measure soil moisture. When soil moisture is deficient, the module produces a low amount of output. We can determine if the waste is dry or wet using the sensor. The moisture content of the soil is determined using a moisture sensor. Low level (0V) will be the digital output when the soil moisture value detected by the sensor is above the threshold value, and high level (5V) will be the digital output when it is below the threshold value. The current soil moisture measurement is immediately read from the digital pin to determine whether it is above the threshold or not.

The moisture sensor's fork-shaped probe, which has two exposed conductors, functions as a variable resistor (much like a potentiometer) whose resistance changes in response to the amount of water in the soil. The soil will have better conductivity and less resistance the more water it contains. Less water in the soil will cause it to have poor conductivity, which will increase resistance. The module is made available at an Analogue Output (AO) pin and generates an output voltage in accordance with the resistance of the probe.

The relative dielectric constant is the characteristic that is employed for waste segregation. Due to the moisture, oil, and fat content included in kitchen garbage, wet waste has a greater relative dielectric constant than dry waste. The type of rubbish is assumed to be wet waste if the change in the capacitive count exceeds the threshold; otherwise, it is assumed to be dry waste. Since each plate's capacitance value varies, so does the change that each plate detects in the same object. For each pair of capacitors, a different threshold level is specified. The actuators are turned on after determining whether the waste is wet or dry.

Segregation Module: A pair of DC geared motors are used to separate the waste since they are affordable and appropriate for this purpose. The trash cans are set up on a spherical platform that is attached to the DC geared motor's axle. The circular base of the motor rotates along with its axle. According to the lookup table, the DC geared motor will revolve either clockwise or anticlockwise if the waste container appropriate for the type of rubbish is not positioned beneath the flap.

Table: Table for the rotation of the base control motor

Type of Waste	Before disposal of Waste	After disposal of waste
Metal	Default	Default
Wet	Clockwise	Anti-Clockwise
Dry	Anti-Clockwise	Clockwise

When the necessary container lines up with the flap, the IR sensor module, which is positioned underneath the circular base, generates an interrupt. In order to prevent overshooting of the container brought on by the base's momentum, the microcontroller utilizes this interrupt to stop the DC motor. The DC motor rotates at slower speeds thanks to pulse width modulation (PWM), which is produced by the microcontroller's timer. A second DC geared motor is employed with the conveyor belt after the needed container is in position.

The motor then waits two seconds to make sure the trash falls to the ground before rotating anticlockwise to return to its starting position. The motor is once more rotated using PWM. The segregation process is now finished, and the type of garbage that was found is kept to help with the following iteration's rotation direction determination. Until the next waste material enters the system, the microcontroller is placed in low power mode.

X. FUTURE SCOPE

Technology is developing at a quick pace, which is resulting in the creation of smaller, more streamlined, and more portable equipment. The technology for adaptable solar electricity is one such advance. We can develop a more enduring and eco-friendly source of energy by adding flexible solar panels made of lightweight materials like plastic into the design of these gadgets. The gadget can be equipped with these solar panels, which can help supply a dependable source of electricity, increasing the device's autonomy and minimizing the need for other power sources.

The usage of flexible solar power also offers the additional benefit of improving the device's energy efficiency and lowering its carbon impact. The creation of flexible solar power will undoubtedly play a significant part in determining the direction of technology as we continue to look for innovative ways to incorporate sustainable technologies into our daily lives.

XI. CONCLUSION

The use of an IoT ecosystem in waste management has the potential to completely change how we handle and get rid of waste. We can gather real-time data on waste generation and disposal, keep an eye on landfills and waste treatment facilities, and plan waste collection routes to cut down on transportation costs and lessen the environmental impact.

We can develop a more effective and sustainable waste management system that benefits the community and the environment by utilizing the power of IoT devices like sensors, RFID tags, and smart trash cans. Additionally, the application of IoT technology can help to increase worker safety, lower the danger of exposure to hazardous waste, and improve general public health.

It is essential to adopt new technologies and creative ways to address these problems as we continue to struggle with the challenges of rising trash output and constrained landfill space.

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