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Designing an Eco-System for Waste Management for Smart Cities

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A B S T R A C T

A smart waste management system using sensors is a system that utilizes sensor technology to monitor and manage waste in a more efficient and sustainable manner. The system includes various types of sensors that can detect different waste types, levels, and locations, and transmit data to a central management platform. This data is then analyzed and used to optimize waste collection routes, reduce the amount of waste sent to landfills, and improve recycling rates. The system can also provide real-time alerts for issues such as bin overflows or fire hazards, allowing for quick response times. Overall, the implementation of a smart waste management system using sensors can greatly improve waste management efficiency, reduce costs, and promote a cleaner and healthier environment. This study introduces a technique to efficiently manage waste in large cities without the need for 24/7 manual maintenance. By creating an embedded IoT system that would track each bin individually for the amount of waste dropped, the issue of disorganized and non-systematic waste collection is thus solved. Wet and dry garbage is here separated using an automatic method. Here, sensors can be utilized to sort moist and dry trash into different containers instead of using a mechanical arrangement. An IR sensor can be used to identify the presence of any waste, wet or dry, and in the following step, a moister sensor can be used to detect wet waste.

Keywords: Segregation, Dry waste, Wet waste, Sensors, Arduino UNO, Waste Management.

1. Introduction

A network that connects various entities or objects is known as the "Internet of Things" (IoT). Because of this, it is also known as The Internet of Objects. The various home equipment is linked together by a basic IoT application. A microcontroller, sensors, and other parts that enable the various services needed by an application often make up the network. The city's environment can be made smarter using this technology.

Waste management is a crucial responsibility in the majority of metropolitan areas to make the city cleaner and safer. It has been known and believed for generations that "CLEANLINESS IS EQUAL TO GODLINESS." We frequently see images of trash cans filled to the brim with trash spilling out. Due to the large number of insects and mosquitoes that breed. According to estimates, India produces roughly 0.1 million tonnes of municipal solid trash each day. The primary cause of obstructed drainage, methane level lighting up, and soil and water contamination is the disposal of all forms of rubbish into landfills.

On the other hand, it has an impact on local residents and indirectly affects climate change. Wastemanagement is the process of controlling waste at every stage, from creation through disposal. The several phases involve a procedure for trash collection, transport, treatment, and disposal, as well as monitoring. Waste can be either liquid or solid. Different types of waste are managed and disposed of in different ways. Without adequate management, the waste containers may overflow and emit an unpleasant odour. Waste management that is effective can cut back on labour and fuel expenditures.

The amount of rubbish produced is rising daily. The possible effects of the waste produced depend on a number of variables, including industrial development, environmental conditions, and capacity. In developing economies, things are becoming worse. The exhaustion of garbage collection services and poor management of dump sites are some of the causes. The first phase in the waste monitoring system that helps to protect the environment is trash segregation.

Additionally, the atmosphere's air quality is enhanced by this. Waste segregation is the process of dividing waste into dry and wet components. Most wastes that are produced are inevitable, and the components in them have an effect on both the general health of people and the environment.

Garbage management must be done correctly by separating wet and dry garbage. The dry trash can be recycled as a result, and the moist waste can be composted. Stale food, fruits, and other products are categorized as wet wastes while items like aluminium foil, glass, and paper are termed dry wastes.

The primary problem with waste management is that the trash cans fill up long before the cleaning is done. So that the right action may be done, a system that can inform the concerned parties of the dustbin's state is needed. The information must be sent to the person in charge of collecting the trash from the dustbin if the bin is not full but its weight has exceeded the limit.

The development of technology can be used to manage trash properly. One such approach to proper trash management is smart waste management.

2. Related Work

Chithkala H S et al. [1] The proposed system uses ultrasonic sensors to detect the level of waste in the dustbin and sends the data to a central server using IoT technology. The data is then analysed to determine when the dustbin needs to be emptied. The system can also send alerts to waste management authorities when a dustbin is nearing its maximum capacity, allowing them to take action before the bin overflows. The authors believe that this system can help to improve the efficiency of waste management and reduce the environmental impact of waste disposal. By preventing dustbins from overloading, the system can reduce the need for frequent waste collection trips, which can save time, resources, and reduce carbon emissions.

Mahesh B.L et al. [2] The proposed system consists of smart bins equipped with sensors to detect the level of garbage, and a central server that receives data from the smart bins and analyses it to determine the optimal waste collection schedule. The system can also send alerts to waste management authorities when a bin is nearing its maximum capacity. Overall, the literature survey conducted by the authors highlights the need for more efficient and environmentally friendly solutions for garbage management, and their proposed smart garbage management system is a promising solution that can address the limitations of existing systems.

Das et al. [3] The study focuses on the use of Artificial Intelligence (AI) in smart waste management systems. The authors explain how AI can be used to analyse waste generation patterns and optimize waste collection schedules accordingly. They provide examples of AI-based waste management systems being developed in various countries, such as the Waste Wise system in the United States and the SmartBin system in Ireland. They highlight the potential of blockchain technology to track waste movements and ensure compliance with regulations, and the potential of robotics to automate waste collection and processing tasks.

Tejashree Kadus, Pawankumar Nirmal, and Kartikee Kulkarni et al. [4] The authors explain how IoT technology can be used to monitor waste levels in real-time and optimize waste collection schedules. The authors also discuss the potential of other emerging technologies, such as Artificial Intelligence (AI) and Big Data, in smart waste management. They highlight the potential of AI to analyse waste generation patterns and optimize waste collection schedules accordingly, and the potential of Big Data to provide insights into waste generation and disposal patterns.

Kumar Kranthi, E. Ramaraj et al. [5] The authors explain how the system uses IoT sensors and Arduino microcontrollers to monitor waste levels in real-time and optimize waste collection schedules. They discuss the various components used in the system, such as ultrasonic sensors, Wi-Fi modules, and a web server for data monitoring and analysis. The authors also discuss the potential benefits of the system, such as reducing the number of collection trips required, optimizing waste collection schedules based on real-time data, and reducing the amount of waste sent to landfill.

Varun Thirapati and Harish Kumar et al. [6] The proposed system consists of sensors installed in waste bins that monitor the fill level of the bins and transmit data to a cloud-based server. The data is then processed and analysed to generate alerts for waste collection when the bins reach a certain fill level. The authors also suggest the use of GPS technology to track the location of waste collection vehicles and optimize their routes. The article provides a detailed description of the system architecture and the technologies used, including the use of Arduino boards, ultrasonic sensors, and cloud computing platforms. The authors also discuss the challenges and limitations of the system, such as the cost of implementing the technology and the need for a stable internet connection.

Ruhin Mary Saji, Drishya Gopakumar et al. [7] The authors start by discussing the challenges associated with traditional methods of garbage management, such as manual monitoring and collection. They argue that these methods are inefficient and can lead to environmental and health concerns. The authors propose the use of IoT technology to automate garbage management and improve the overall efficiency of waste collection and disposal. They review various studies that have proposed different systems and technologies for garbage management, such as sensors for monitoring fill levels of garbage bins, GPS for tracking garbage collection vehicles, and cloud computing for data analysis and management.

Lilyan Anthony et al. [8] The authors discuss several existing systems for garbage monitoring, including RFID-based systems, GPS-based systems, and camera-based systems. They note that these systems have limitations, such as high cost, limited coverage, and low accuracy. They propose a new system that uses ultrasonic sensors to monitor garbage levels in bins and transmit data to a central server. They explain how the ultrasonic sensors work, how the data is transmitted, and how the central server processes the data. They also discuss the benefits of their system, including improved efficiency, reduced costs, and better environmental outcomes.

Dr. K.G. Srinivasa and M. Batty et al. [9]The authors then review the literature on garbage collection systems for smart cities. They discuss the different types of systems that have been proposed, including sensor-based systems, RFID-based systems, and camera-based systems. They evaluate the strengths and weaknesses of each type of system and identify the key challenges in implementing them. The authors conclude that IoT-based solutions have the potential to revolutionize waste management in smart cities. They note that sensor-based systems and camera-based systems are the most commonly proposed solutions for garbage collection, while ultrasonic sensors are the most commonly proposed sensors for garbage monitoring. They suggest that future research should focus on optimizing these systems and integrating them with other smart city technologies.

P. R. Naregalkar and Krishna kishor Thanvi et al. [10] The authors provide a detailed description of their proposed system, including the hardware and software components. They explain how the ultrasonic sensors work, how the data is transmitted, and how the central server processes the data. They also discuss the benefits of their system, including improved efficiency, reduced costs, and better environmental outcomes. The authors provide a

detailed description of their proposed system, including the hardware and software components. They explain how the ultrasonic sensors work, how the data is transmitted, and how the central server processes the data. They also discuss the benefits of their system, including improved efficiency, reduced costs, and better environmental outcomes.

KC Meghana and KR Natraj et al. [11] The authors have highlighted the importance of using machine learning algorithms to analyze the data collected by the sensors and make predictions about the waste generation patterns in different areas of the city. Finally, the authors have suggested future research directions in this area, including the use of blockchain technology for secure and transparent waste management systems and the integration of renewable energy sources to power the IoT sensors and devices.

Nisha Bhagchandani, Ms. Rupa et al. [12] The study has emphasized the importance of using machine learning algorithms to analyze the data collected by the sensors and make predictions about the waste generation patterns in different areas of the city. The study has compared the proposed system with other existing garbage management systems and has concluded that the IoT-based system is more efficient and cost-effective. The authors have suggested future research directions in this area, including the use of blockchain technology for secure and transparent waste management systems and the integration of renewable energy sources to power the IoT sensors and devices.

Table 1:Comparative analysis

SI.NO	Author(s)	Techniques	Performance measures
1	ChithkalaH S, Deeksha S, KavyashreeOlekar, S Sujitha, Akshay M J	GSM modem	Waste minimization
2	Akhila Joseph, Anjali, Suhaila B.M, Mahesh B. L	GSM module	Waste minimization
3	Tejashree Kadus, Pawankumar Nirmal, Kartikee Kulkarni	Wi-Fi module	Recycle and reuse
4	K. Kranthi Kumar, Dr. E. Ramaraj, Dr. P. Geetha	Inductive proximity sensor, IR and moist sensor	Waste minimization
5	Varun Thirapati and Harish Kumar	GSM (Global System for Mobile Communication)	Waste minimization
6	Ruhin Mary Saji and Drishya Gopakumar	Wifi-module	Recycle and reuse
7	Lilyan Anthony and Pradnya Chavan	Sensor, Communication and Monitoring modules	Recycle and reuse
8	Kanchan Mahajan and Prerana Gadhave	ZigBee, GSM and ARM7	Waste minimization
9	Dr.K.G.Srinivasa and M.Batty	IR sensor, microcontroller and Wi-Fi module	Recycle and reuse
10	P.R.Naregalkar and Krishna kishorThanvi	RFI, IGPS, GPRS, GIS and web camera	Recycle and reuse
11	K C Meghana and K R Natraj	GSM module	Waste minimization
12	Ms. Nisha Bhagchandani and Ms. Rupa	An IOT based embedded device	Waste minimization

3. System description

Figure1represents an integration of Smart Waste Management System mainly it consists of Ultrasonic Sensor, IR Sensor, Moisture Sensor, DC Gear Motor and Arduino UNO

- Ultrasonic sensor measure distances by using ultrasonic waves. The sensor emits an ultrasonic wave and receives the reflected wave back from the target.
- IR Sensor emits in order to sense some aspects of the surroundings.
- Moisture Sensor measures the volumetric water content in the soil. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing hydrology and agriculture
- DC motor which is connected to the digital pins of Arduino

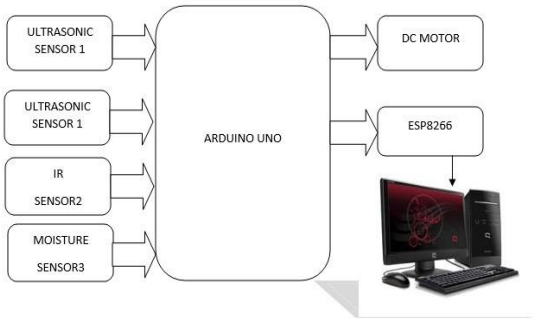

Figure 1: Architecture of proposed system

4. Methodology

Steps:

4.1 Segregation

The first step of waste management is to segregation. Here Segregation also includes several steps like:

4.1.1Use separate bins

Have separate bins for dry and wet waste. This can be done at the source, such as households, offices, or commercial establishments. Label the bins clearly so that people can understand which bin is for dry waste and which is for wet waste.

4.1.2Know what goes where

It is important to know what items belong in each bin. Wet waste includes food waste, vegetable and fruit peels, tea bags, and eggshells, while dry waste includes plastic, paper, glass, and metal.

4.1.3Don't mix

Make sure that the dry and wet waste is not mixed together. Mixing them can make it difficult to separate them later and can also lead to odour and hygiene issues.

4.2Collection

Once the waste is segregated than it needs to collected. This can be done by local authorities or by private waste management companies. The suggested smart waste management system has a 24-hour monitoring system that was designed to watch after dumpsters. The IR sensor, moisture sensor, and interface are all attached to the Arduino UNO pins to separate the garbage into dry and wet waste. For selective clearance, a clever and well-organized mechanism is created here. The level of waste in the dumpster is determined using the ultrasonic sensor. Platform with DC motor power is used to separate wet and dry garbage. Wet and dry garbage are separated using an IR sensor and moisture sensor. If one of the containers is full, the dumpster will send out a warning message. Person can then empty the associated dumpster. An Arduino Uno board is linked to each sensor. Person can then empty the associated dumpster. An Arduino Uno board is linked to each sensor. Person can then empty the associated dumpster. An Arduino Uno board is linked to each sensor.

5. Results

The outcome of the proposed work is

- Segregation of wet and dry waste using sensors
- Our project makes it possible to measure the amount of waste in the containers if one of the containers is full then alert message will be sent to the corresponding person.

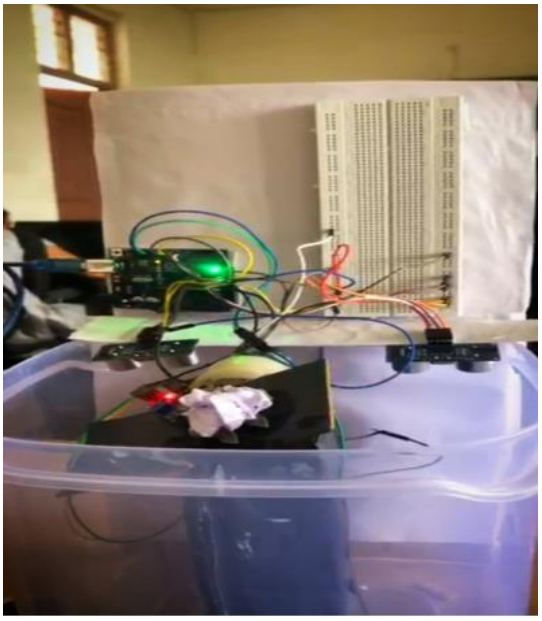

Figure 2: Wet waste dumped

Figure 3: Dry waste dumped

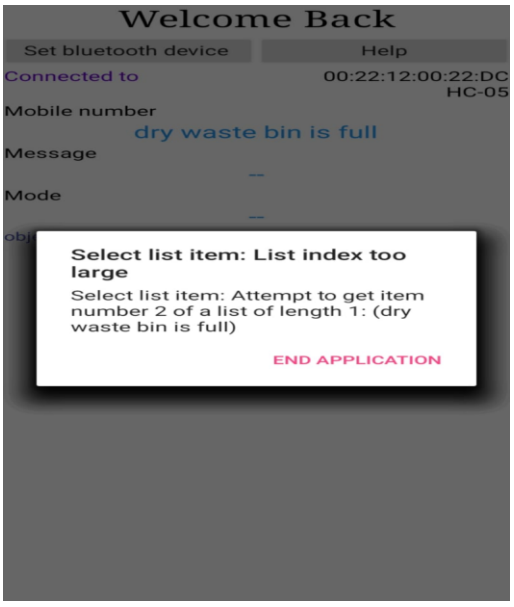

Figure 4: Alert Message

6. Conclusion

The population increasing day by day and generates million tons of wastes per year. City administrations, municipalities and waste management organizations in different countries faces the challenge to provide efficient and effective system to collect, dispose-off properly, and recycle the waste, keeping health standards and environment friendliness. The smart waste management system collects the wastes in proper time, disposes and recycles in the proper way. The system helps in better waste management and making the cities clean and efficient. The waste management systems provide better health environment by proper waste management.

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