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Waste Management System using IoT

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Abstract: ***There is a growing problem with waste accumulation and disposal in urban areas regardless of whether they are in developed or developing country, due to the way of managing waste containers. It has becoming more challenging and difficult to manage huge volume of waste generated. The main problem with waste management is that the trash cans in public areas overflow well before the next cleaning process starts. Due to the negligence of most people, the overflowing garbage wastes created an unsanitary environment, an unpleasant odour and serve as a breeding ground for microorganisms that cause illness. An Internet of Things (IoT)-based smart waste system is proposed, to empty the bins at the appropriate moment, to prevent all such hazardous scenarios and maintain public cleanliness and health. This system is designed in such a way that it is self-powered by photovoltaic panel which is embedded on the top of the waste bin lid. An ultrasonic sensor has been used to measure the level of garbage dumped, and DHT11 and proximity sensors enables the segregation process. This project describes real-time sensor-based container level monitoring, and track the real-time status of how garbage collection is being carried out.***
Keywords: Arduino, Internet of Things, RFID

I. INTRODUCTION

The consumption of packaged goods, textiles, paper, food, plastics, metals, and glass is on the rise, which is one of the main reasons why industries and families are producing alarming amounts of garbage every day. Bins overflowing with trash cause significant environmental harm, potentially affecting communities and adversely impacting public health. Although lightweight, affordable, and easily installed bins are already in use throughout many cities, these disposals are not intelligent enough to be sustainable. Consequently, controlling this waste becomes essential to living a normal life[1]. The smart dustbin is a clever solution that eliminates the issue of waste disposal; this bin is able to identify what kind of material has been thrown inside it and separates it accordingly into biodegradable or non-biodegradable materials. Segregation of waste is a significant problem that results from the lack of scientific and organized storage of trash resulting from the segregation issue. Without proper management, this type of waste can become dispersed throughout communities without any sense or order. Segregation of waste is a significant problem that results from the lack of scientific and organized storage of trash resulting from the segregation issue [5]. The sensors in these devices help facility managers or waste collectors know when a bin is starting to overflow so that they can empty it before it becomes an issue. The data collected from the smart bins is used to create a more user-friendly interface for the garbage truck application. This system makes it easier for trucks to find and collect bin contents, which in turn reduces traffic congestion and travel time. All cities spend a significant amount of money each year on waste assembly, regardless of their size, geographic location, or level of economic stability. The majority of residents in the region are used to estimate the location of the bins in the streets and the number of collection vehicles needed to empty them, however the prediction can occasionally be inconsistent [6]. In both residential and business settings, those who dump wastes typically do not make any efforts to provide suitable dustbins for segregated waste. Thus the waste management system that will help in managing the overflowing garbage generated in residential, commercial and industrial settings. As the population grows, solid waste levels have also increased in urban and rural areas, making waste management an increasingly global concern. Garbage collected from residential homes or by mass-assortment events can be disposed of improperly due to mistreatment of collection vehicles. In cases like restaurants, malls and other commercial establishments where trash is typically collected from vehicles on-site, our proposed system could assist with proper disposal. Smart bins can help cities move towards a more sustainable future, as they make efficient use of waste collection and recycling. They are perfect for areas with high volumes of human traffic, such as parks, academic institutions, malls, hospitals etc.

Physical objects that are outfitted with sensors, computing power, software, and other technologies and can exchange data with other systems and devices over the Internet or other communications networks are referred to as "Internet of things" (IoT). The Internet of Things ecosystem consists of web-enabled smart devices that collect, send, and act on data from their environment using embedded systems like processors, sensors, and communication equipment. IoT devices communicate the sensor data they gather by connecting to an IoT gateway or other edge device, which either analyses data locally or sends it to the cloud for analysis.

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These devices communicate with one another and behave in response to the information they share.

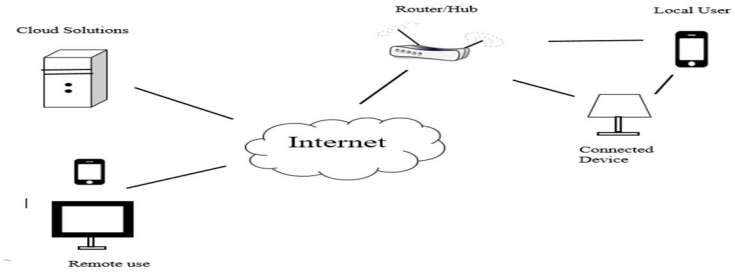


Fig.1.1 Working procedure of IoT

The remainder of the text is structured as follows: A quick overview of the dustbin monitoring systems in use is provided in Section 2. The system model and block diagram for the smart trash can are introduced in Section 3; the hardware implementation is covered in Section 4, and the conclusion is given in Section 5.

II. RELATED WORK

G Kumaravel et al.[4] (2022) discussed a smart, IoT-based system to empty the trash cans on schedule. The photovoltaic panel integrated on the top of the trash can lid powers this device on its own because to the way it is built. An energy sensor module and an ultrasonic sensor are both used to measure the voltage and power of the battery unit, respectively. Later, with the aid of GSM, this data is sent to the IoT server.

TejashreeKadus et al.[1] (2020) discussed a solution that uses a Smart Trash Bin in conjunction with a mobile application. The main objective of this application is to enhance the idea of a smart city while using fewer resources and efforts. Once these smart bins are widely adopted, waste can be managed, taking the place of the current standard bins efficiently because it prevents rubbish from being piled up on the side of the road.

Chinmai Shetty et al.[6] (2020) proposed a trash management system employing a sensor which assists in determining the quantity of trash in the trash can and real-time information obtained from the numerous trash cans dispersed in various locations. The information would be updated on the website whenever the trash is collected.

MamtaPandey et al.[5] (2020) discussed a smart system for managing trash bin that is based on microcontrollers and has ultrasonic sensors on the trash cans. In the suggested technique, a smart trash can made of an Arduino Uno, an ultrasonic sensor, a servo motor and a battery has been created. Dust bin covers will raise when someone approaches within a certain distance and then wait for the user to load and close the bin.

R. Zade et al.[3] (2018) discussed a system that monitors the trash cans, notifies users via a web page on the amount of trash being gathered in the cans, and buzzers and LEDs alert users. The system's HC-SR04 ultrasonic sensors are placed over the trash cans to detect the level of waste. The depth of the garbage cans is then compared to it.

S. Vinoth Kumar et al.[2] (2017) planned a IoT-based waste management system keeps track of how much garbage is in the trash cans utilising detecting equipment. In this arrangement, the GSM/GPRS system and the detector system are connected via a microcontroller. A golem application is created for the specified information that is elaborated to the different levels of waste in various locations in order to monitor and integrate.

III. METHODOLOGY

The model that is proposed in this work collects, analyses and processes data in the database. This information displays the status of garbage being disposed on an authorized application. If a dustbin is found to be full, then the authority will send out alerts informing whoever is responsible for collecting garbage from that area. The sanitation trucks will collect all of the garbage from the filled dustbin and dispose it properly. The authority monitors this process and display any warnings or notifications related to waste disposal when required. The sensor in the smart dustbin is utilized to gather input data. The dustbin has ultrasonic sensors inside to determine whether or not it is full. The DHT11 sensor is a basic, extremely affordable digital temperature and humidity sensor. It also includes a thermistor sensor to measure the ambient air and a proximity sensor that detects objects by coming into direct physical contact with them and converting information about their movement or presence into an electrical signal that separates the garbage that is thrown in the trash can into wet, dry, and metallic waste.

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The automatic opening of the dustbin lid is accomplished by the infrared sensor. The RFID technology was also utilized by the smart trash can. The trash can has an RFID reader attached, and the person who has to dispose of the trash can open the trash can by displaying the provided RFID tags. Users that frequently dispose of their trash in the trash can earn reward points. A gas sensor is also affixed to the trash can to detect harmful gases created by the decomposition of rubbish that has been present for a long period. A rechargeable battery that powers the system is continuously charged by a solar panel during the day. The dustbin has a GPS module that is used to transmit the dustbin's GPS location to the local government.

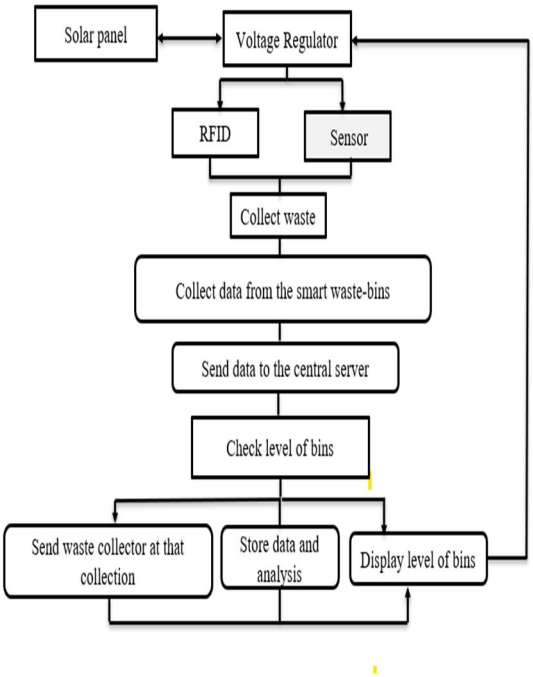


Fig. 3.1 Flow diagram of system model

IV. SYSTEM IMPLEMENTATION

The system has the following four modules:

A. Identify the user using RFID

An RFID tag is made comprised of a tiny radio transponder, a radio receiver, and a radio transmitter. When activated by an electromagnetic pulse from a nearby RFID reader device, the tag transfers digital data, frequently an inventory identification number, back to the reader. Data is transmitted from RFID tags to the RFID reader using an integrated circuit and an antenna. The reader then converts the radio waves into a different kind of data that is more useful. In order to be saved in a database and later assessed, the data collected from the tags is then communicated to a host computer system via a communications interface.

B. Segregation of wastes

Using a DHT 11 sensor and a proximity sensor, the thrown garbage is separated based on wet, dry, and metallic sensors. A proximity sensor is used to find the metallic garbage. The magnetic field is used by proximity sensors to identify the presence of metallic items. The inductive property between the sensor and the metal object is changed when a metal object enters the field, allowing for the detection of the object's presence. The DHT11 humidity sensor is mounted on the interior wall of the trash can to measure the relative humidity there. It aids the user in determining whether or not the rubbish being thrown is moist.

C. Detection of odor in dustbin

When the garbage bin begins to fill up and doesn't receive regular disposal, it emits an unpleasant odor. This is done through the installation of a gas sensor which detects toxic gases that are produced as a result of decomposing waste in the bin. If hazardous chemicals are detected, appropriate measures will be taken accordingly.

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D. Track location of Dustbin

The GPS module, which comprises of a receiving antenna, uses information gathered from GPS satellites to determine the location of the smart bin. The microcontroller unit receives real-time location tracking data from the GPS module in the form of latitude and longitude values. The microcontroller then uses a Wi-Fi transceiver to connect to a website, where the waste management unit may access information such as the bin's fill level and GPS locations. The GPS module will be used to determine the position parameters, and the position will be set up after being calculated based on the latitude and longitude data entered by the GPS module. This will help keep the area clean and ensure that the dust bins are cleaned as soon as they are full.

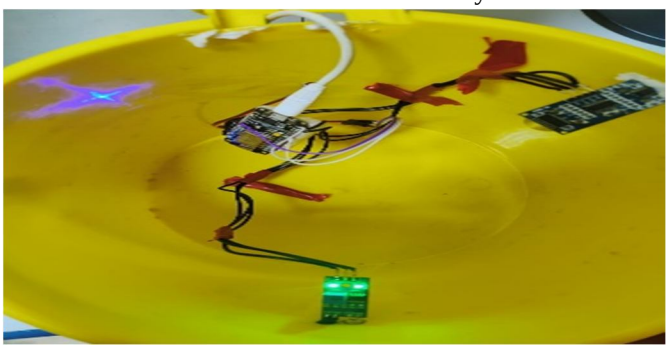


Fig. 4.1 Model of Smart bin

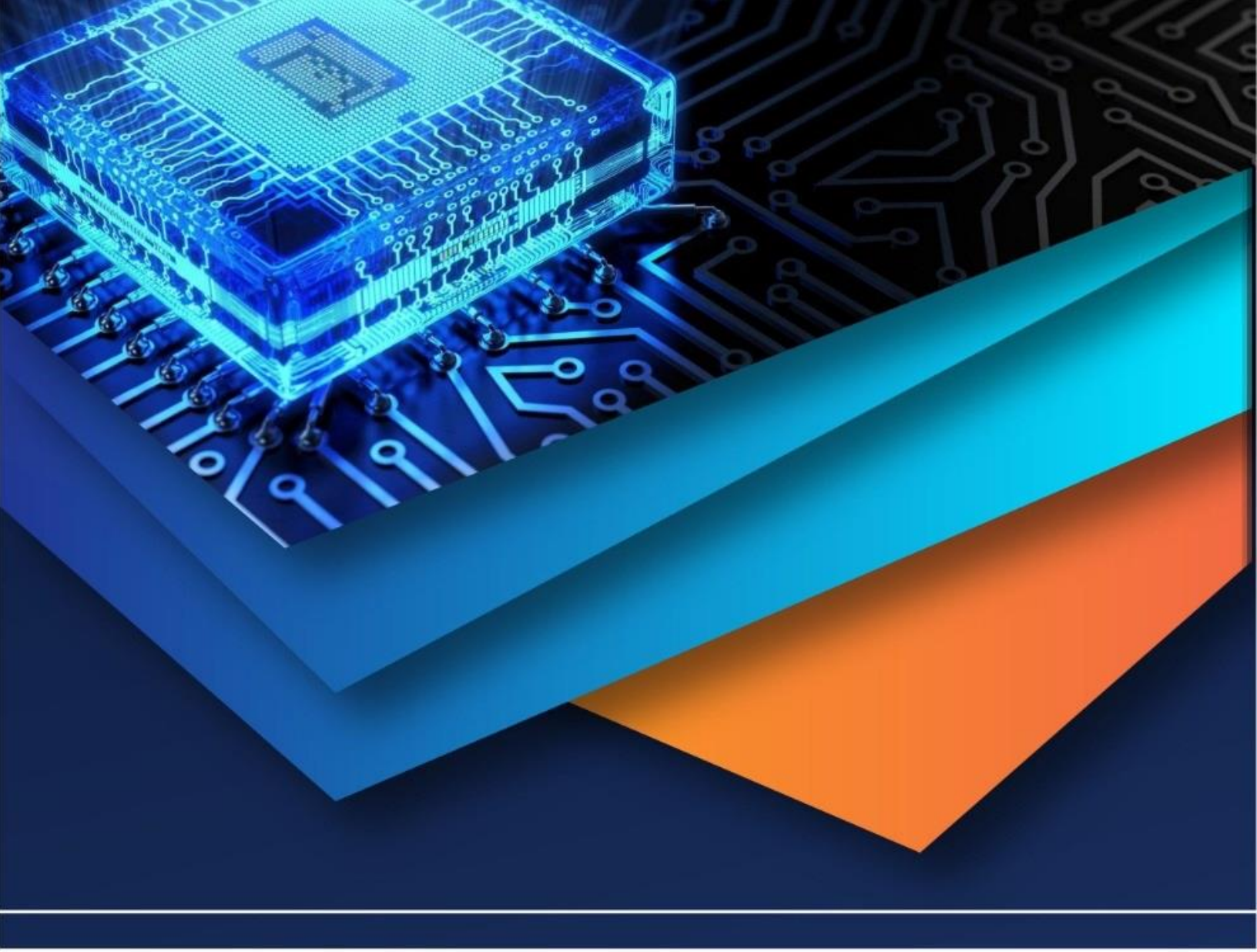
V. CONCLUSION

A garbage management system is used to monitor the level of smart trash cans and determine whether they are full or not. When the trash can is full in this method, the appropriate person is notified. The affordability of this system makes it possible to create the idea of the smart city. The location tracking of the smart bin for optimal route detection can be done in future works. The resources can be optimized by using smart trash cans effectively. This technique lessens traffic in the smart city to help clean up the environment. This can be expanded by making the system global, which will allow for greater system optimization and the application of Artificial Intelligence to identify users who dump large amounts of plastic garbage.

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