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Smart Garbage Monitoring System Leveraging Raspberry Pi Technology

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Abstract

Healthy lifestyle and good environment start from a clean place. In this highly populated metropolitan city, the crisis for cleanliness needs to be discussed. Managing of garbage has various steps included in it, starting from the waste collection, segregation to waste management it requires a lot of work to be done behind. Recycling process needs to be effective. This project can be implemented using Internet of Things (IoT) under the concepts of smart cities. This makes the work easy as it consumes less time and gives out productive outputs. On overall basis acute garbage monitoring system provides a great impact in smart cities. This is the best method for waste management compared to manually monitoring the waste wherein it requires lot of time and human work. Also, the cost can be controlled using good equipment. The waste management process is dispensable. This can also be implemented by using machine learning. This paper gives justification for smart management of wastage by providing few steps in detail like sending notification to garbage collectors whenever the bins are full via smart devices and through built-in sensors. The entire process is monitored using Raspberry Pi. This avoids scattering of garbage and keeps the place clean.

Keywords

Metropolitan, Recycling, Acute, Machine learning, Sensors, Raspberry pi, Garbage

Introduction

In recent times as the population is high, there is more production of trash and disposal of this trash has become difficult. Due to this increase in wastage many people are suffering. People living near the dumping areas are suffering from the harmful effects of substandard hygiene. Garbage management is one of the major problems faced by the entire world. Trash needs to be disposed properly so that ecosystem and the habitat would not get affected. Garbage collectors need to monitor and collect the garbage in time. If the waste management is not done properly, it affects the natural resources by polluting them. Sometimes, this disposal is open to the fresh water and due to the contamination, it affects not only the marine system but also the human lifestyle. Though the garbage bins are available, we can see litter dropped everywhere. Even though there are campaigns like clean India, there are still places where trash bins are being over filled and people try to empty their trash in the same bins which causes the wastage to overflow and spill on the road and passes by the air. One of the optimal ways to reduce this is to recycle the waste produce. Now-a-days, the process of recycling plays an important role in making the city clean since the waste produce is high and resources are getting scarce. Recycling is a reasonable practice. The process of wastage decomposition and recondition follows 4 main steps i.e., reduce, recycle, reuse, and recover [1, 2].

- Reduce: This concept deals with the curtailment of the amount of wastage produced, people should buy only whatever required that too in fewer quantities.
- Reuse: This concept deals with reutilization of other products rather than throwing them away.
- Recycle: This concept deals with the product that undergoes a mechanical process in order to change itself to get a new form. A cutting-edge waste management system employs smart technology, Raspberry Pi, and nanotechnology to revolutionize garbage monitoring. Integrated with Raspberry Pi, sensors utilizing nanotechnology are strategically deployed within waste bins to capture real-time data on garbage levels, composition, and environmental conditions. This innovative fusion of Raspberry Pi and nanotechnology not only enhances the efficiency of waste collection by providing timely insights but also contributes to sustainable practices by minimizing unnecessary pickups and reducing environmental impact.
- Recover: This concept deals with the process of converting wastage into useful resources through various means like biological, thermal, etc. Using this process, resources like fuel, electricity, compost, heat can be produced.

Literature Review

Since waste management has become a serious issue, it needs to be solved efficiently in order to protect the environment and natural resources. To attain this issue various authors stated different measures. Modification of waste management can be done efficiently by adopting various innovations and by using latest equipment. To solve the problem the existing research conducted various surveys. Sohag and Podder [3] conducted the research and designed an IoT related model. This model observes the status of the waste bin and sends notification to the garbage collectors whenever the garbage level is full. This entire process is done based on Arduino Uno and ultrasonic sensor; the major drawback of this system is that it works only small-scale garbage bins. To implement this project in metropolitan cities authors have designed the garbage systems using various IoT devices and android applications through which user can access the system to know the status of the garbage bins. They also designed system that differentiates non-biodegradable and biodegradable waste by using ultrasonic sensor. These sensors are mainly used to measure the intensity of garbage. It also includes MQ4 sensor to record the level of the odor. This information will be sent to the authorities via NodeMCU web server. Mithinti et al. [4] gave a selection algorithm this depends upon the time and date, percentage level of garbage. On this basis the path for the shortest algorithm is calculated and the bin to be disposed will be selected. They use great equipment like Zigbee, Wemos D1 mini, Arduino, AVR microcontroller wifi-enabled microcontrollers, VANET, Raspberry Pi, NodeMCU. It also consists of various sensors like IR sensor, gas and smoke detection sensor, ultrasonic sensor, rain sensor, flame sensor, methane, and carbon monoxide detection sensor. Garbage collectors are notified through buzzer. GSM/GPS are used for directing the routes and different languages like Embedded C, Python and HTML are included for the implementation.

Existing Methods

In the implementation system, municipal workers collect the trash based on the scheduled structures. Garbage bins kept in public places are overflowing as there is increase of wastage on daily basis, because of this the garbage bins are left unchecked, and they produce rotten smell that may cause the air pollution and may also spread diseases which may affect the human lifestyle. Therefore, people must ensure that cleaning and disposal is done on regular basis. Also, garbage collectors need to ensure the routes without any difficulties and should dispose the garbage on time to avoid littering and spreading of unhealthy germs everywhere. The wastage management using an IoT system can be accomplished by a providing a software-based service (service-as-a-service). This is one of the best ways that involves in garbage collection. This provides a better connection among the stake holders those who are involved in this project. It sends the information regarding the level of garbage produced to the garbage collectors. As per the collected reports these dustmen vehicle reaches the area and collects the trash for the disposal. This makes the wastage collection unfeasible. At the end people living in the society should not lack an accessible way to have the collected information about how the wastage disposal service is functioning. For this project that includes tracking the trash bags and processing of notification to the garbage collectors can be managed using the IoT theme. Hence it helps both people and the garbage collectors to make the city clean [5-9].

Proposed System

In the proposed system, that is smart wastage disposal system based on IoT along with the GPS link, it also consists of real time monitoring which alerts whenever the garbage needs to be collected. Here the components included are Raspberry Pi module B, GPS antenna and GSM module. It also has the technique of bin compression so that whenever the bins are overloaded it signals using buzzer and send notification via IoT devices. The data presented in the proposed system is done using ultrasonic sensors where the data is sent to the NodeMCU and is updated into the fire base database via Wi-Fi-connectivity which is provided by ESP8266 SoC. The data is updated to the user interface and the authorities through android application. This application is made using IoT Gecko that sends the SMS alerts to the garbage collectors. GSM modules can also be used for this purpose. productive garbage management require the cooperation of municipalities, garbage management companies, dustmen and the people living in the society. In the proposed solution, various IoT things are used to sense the information, it also requires cloud-based infrastructure which collects and performs analysis of the data. To ensure this process is performed perfectly there is requirement for the ubiquitous network of communicating devices. Data exchange can be done through the infrastructure between the devices and parties involved. Infrastructure managing needs data exchange and interactions based on IoT infrastructure and smart devices.

Hardware Description

Raspberry pi

Raspberry Pi is a series of small single-board computers used to explore computing (Figure 1). It is a microprocessor which enables us to connect it with various other electronic components like monitor, keyboard, mouse in order for it to interact with the outside world. It is known for being compact and cost efficient. Raspberry Pi is a prime hardware component used while implementing IoT projects. It acts as the brain of the system and features a quicker 64-bit 1.4 GHz quad core chip along with 1 GB of RAM with a 300 Mbit/s Ethernet and a dual-band 802.11 b/g/n/AC wireless LAN. Apart from this it is also equipped with Bluetooth 4.2 with enables us to establish a network of up to 7 devices within 30 feet radius.

The most popular language for programming the Raspberry Pi is Python which is a high-level general-purpose programming language. Other programming language used is scratch which can be used to write code by arranging blocks.

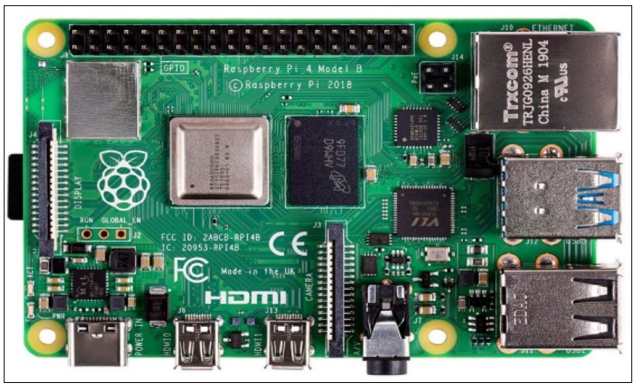


Figure 1: Raspberry Pi.

Hence it can be used as a mini processor containing the code vital for the IoT implementation.

Ultrasonic sensor

Ultrasonic sensor is used for measurement of distance, and this is done using ultrasonic waves (Figure 2). This sensor emits a wave and measures the distance between the object and the sensor by measuring the time between emission and reception. It works on the principle of SONAR. It helps in determining the level of the garbage.

RFID - Reader

RFID stands for Radio Frequency Identification. RFID tag is used along with the RFID reader in order to gather information, which is used as a pathway for every object (Figure 3). Radio wave acts as interpreter in between the tag and the reader. This technology works in the same way as barcodes. The RFID tag must be placed within the range of the RFID reader for the RFID tag to be able to transfer the information to the RFID reader.

RFID - Tag

RFID tags are a part of a smart tracking system which

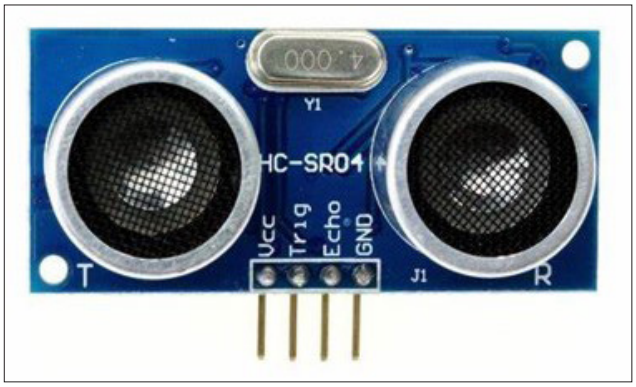


Figure 2: Ultrasonic sensor.

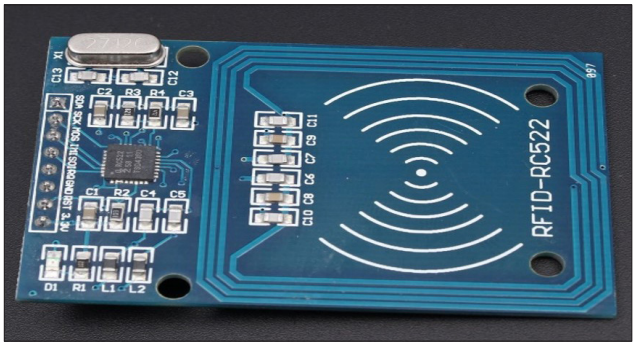


Figure 3: RFID - Reader.



Figure 4: RFID - Tag.

uses barcodes to identify objects (Figure 4). It uses radio wave technology to transfer information to the RFID reader which then transfers it to the RFID computer program.

GPRS module

GPRS module also known as GSM module is a chip or a circuit which is used to set up communication between the mobile or a computer and the GPRS system. It is used to track a device and provides directions to its locations (Figure 5).

Buzzer

A buzzer is an electrochemical device used for audio signaling (Figure 6). This device works to convert audio signal to sound. Buzzer IC is the best and the most effiecient way to communicate between the user and the product.It is powered by DC voltage and can produce a variety of sounds ranging from an alarm to a siren.

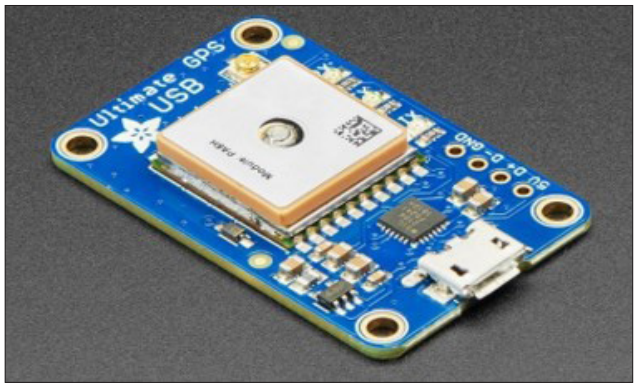


Figure 5: GPRS module.



Figure 6: Buzzer.

LCD

An LCD (Liquid crystal display) is a digital flat planel display technology (Figure 7). It is widely used in the production of electronic gadget screens. LCD consists of a backlight that acts as a light source to a number of individual pixels that are arranged in a rectangular grid. Each pixel has Red, Green and Blue sub-pixel that can be turned off or turned on. When all of the sub-pixels of a pixel are turned off the pixel appears to be black in color.

Software Description

Raspberry pi compiler

Thonny Python is a new integrated development environment which containing Raspbian of latest version with PIXEL operating system. This software enables us to write the optimal codes easily. Thonny uses Python version 3.6 as the default programming language.



Figure 7: LCD.

MC programming language: Python

MC is a small package offered by python version 3.6. This package helps us generate phrases using Markov chains.

IoT Gecko

IoT Gecko is one of the largest platforms that is used to develop and operate IoT based systems with ease. IoT Gecko can be used to control and monitor the physical world using its interface (Figure 8).

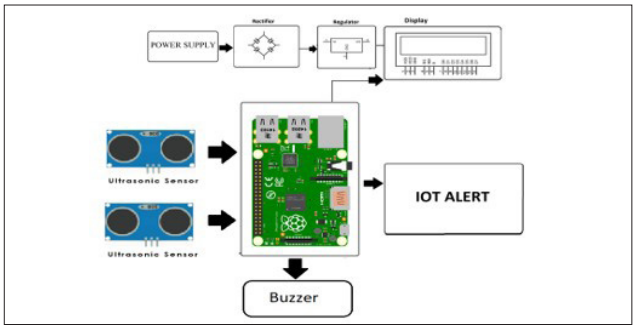


Figure 8: Block diagram.

Smart Garbage Monitoring System

Smart garbage monitoring system mainly consists of 7 sub-systems.

Power supply

The first sub-system is power supply. The power supply contains a rectifier, passive components and a voltage regulator. This sub-system is responsible for converting an AC voltage to a DC voltage and helps maintain a DC level voltage to all DC powered devices.

Input blocks

The next two blocks consist of ultrasonic sensors. These sensors used the Doppler effect principle. These sensors monitor the garbage level in the bins, and then transmits the data to the Raspberry Pi controller.

Main processing unit

The fourth block contains the Raspberry Pi which can be interfaced with input, output, and slave devices. The Raspberry Pi board has built-in USB ports, Bluetooth, Wi-Fi, interface, HDMI and GPIOs. Python is a high-level general-purpose programming language used in Raspberry Pi. Raspberry Pi also requires an OS for system-level operations. Raspbian is a widely used OS which is a variant of Linux OS. Raspberry Pi is the main controller which gathers data from the input devices and transmits it to the output devices.

Output

The fifth and sixth blocks contain an LCD screen and the buzzer. When the trash can is full the buzzer is activated to notify the person. The level of garbage present in the trash can is displayed on the LCD screen.

The seventh block has a remote server-based GUI. The

Raspberry Pi controller transfers the sensor data to the remote server using IoT protocols. GUI is used to present the data in a visual form using graphs. These graphs are in turn used to monitor the garbage levels over a period of time.

Working

This smart garbage monitoring system uses Raspberry Pi microcontroller along with two ultrasonic sensors which are placed at different locations to monitor two levels of the trash can. The ultrasonic sensor has a transmitter and also a receiver. The level of garbage in the trash can is determined using the time-lapse value. This helps obtain the distance between the surface of the garbage and the sensor. The garbage level of the trash can be measured by the ultrasonic sensors is sent to the Raspberry Pi single-board computer continuously. Raspberry Pi controller then processes this data and transmits it to the remote server as well as the output devices like an LCD if used. The output device then displays the message which here is the level of garbage and the remote server stores and visualises this data. This when implemented with the RFID module can be used to intimate the garbage collector to collect the trash. The trash can will be equipped with an RFID tag. The garbage collection truck is also equipped with an RFID reader which starts a communication line with the RFID tag when in proximity. The RFID tag then transfers the information regarding the garbage levels of the trash can and also sends a notification asking them to collect the garbage when the trash can is completely filled. If the truck is not in proximity the information is sent to a control station using RFID and GPS devices. The control station then compiles this information and intimates the truck driver to drive to the location using a GPS mapping service. This enables the garbage collector to reach the location through an efficient route and collect the garbage hassle free (Figure 9).

Advantages

It provides the most efficient way for garbage collection. It helps in saving fuel by providing the truck with an optimal route to the trash can and also reducing the number of trips to collect trash. It also helps with time management as the truck doesn't have to go to the same spot twice if the trash can is not completely filled. It can also play an important role in reducing the traffic, hence resulting in reduced congestion on roads. Hence it results in easy commuting for other passengers on the road. It also has reasonably priced components making it low cost and budget friendly thereby helping mass production easier. This system also helps prevent the spread of diseases as it makes sure that the trash can doesn't spill out the excess garbage. The garbage collector collects the garbage from the trash can as soon as it is filled, this ensures that the garbage doesn't spill out.

Applications

Smart technology for garbage monitoring can be implemented to turn cities into 'SMART CITIES'. Introducing technology into garbage management will help us perform the task in an ideal manner. This also can be implemented under the 'SWACCH BHARAT ABHIYAN' which helps clean the nation and maintain its hygiene. It can be used not only domestically (Automated garbage disposal reminder) but also industrially (Notify the garbage truck to collect the trash). This system can be used to monitor numerous bins at the same time from centralized grounds.

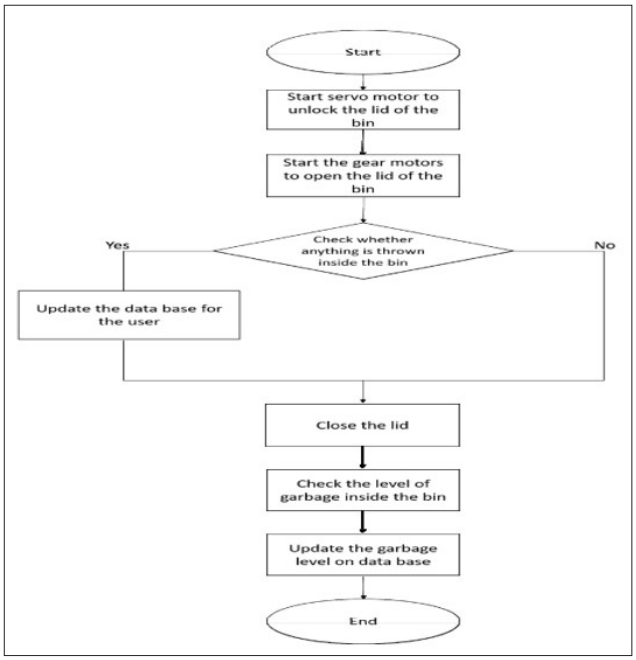


Figure 9: Flowchart.

Conclusion

In conclusion, smart garbage monitoring technology helps deal with a major problem that our nation is facing today which is garbage management. This system helps monitor the garbage level in a garbage bin and then sends a notification to the garbage collector to come collect it. This not only helps reduce the usage of fuel as the number of trips is reduced but will also help reduce the traffic in major cities. The components are affordable, making it cost efficient and reasonably priced. This enables smaller industries and households to use this system. By using this system, we can also save time due to reduced trips to the same area. Hence it is a very efficient way to manage and monitor the garbage disposal functions we carry out in our day-to-day life.

Acknowledgements

None.

Conflict of Interest

None.

References

1. IoT Garbage Monitoring Using Raspberry Pi. [https://nevonprojects.com/iot-garbage-monitoring-using-raspberry-pi/] [Accessed December 08, 2023]

2. IoT Garbage Monitoring Using Raspberry Pi. [https://www.projectsof8051.com/iot-garbage-monitoring-using-raspberry-pi/] [Accessed December 08, 2023]
3. Sohag MU, Podder AK. 2020. Smart garbage management system for a sustainable urban life: an IoT based application. *Internet Things* 11: 100255. https://doi.org/10.1016/j.iot.2020.100255
4. Mithinti S, Kumar A, Bokadia S, Agarwal S, Malhotra I, et al. 2019. IoT based smart bin for smart city application. In International Conference on Intelligent Computing and Control Systems, Madurai, Tamil Nadu, India.
5. Kanade P, Alva P, Prasad JP, Kanade S. 2021. Smart garbage monitoring system using Internet of Things (IoT). In 5th International Conference on Computing Methodologies and Communication, Erode, Tamil Nadu, India.
6. Tripathi A, Pandey C, Narwal A, Negi D. 2018. Cloud based smart dustbin system for metro station. In 3rd International Conference on Internet of Things: Smart Innovation and Usages, Bhimtal, Uttarakhand, India.
7. Pelonero L, Fornaia A, Tramontana E. 2020. From smart city to smart citizen: rewarding waste recycle by designing a data-centric IoT based garbage collection service. In IEEE International Conference on Smart Computing, Bologna, Italy.
8. Srilatha M, Abhinav C, Balaram M, Sanjana A. 2021. Smart monitoring and collection of garbage system using internet of things. In Third International Conference on Intelligent Communication Technologies and Virtual Mobile Networks, Tirunelveli, Tamil Nadu, India.
9. Medehal A, Annaluru A, Bandyopadhyay S, Chandar TS. 2020. Automated smart garbage monitoring system with optimal route generation for collection. In IEEE International Smart Cities Conference, Piscataway, NJ, USA.