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Waste Management Framework Using Brainy Litter Basket

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ABSTRACT

Due to the increased number of individuals disposing of their waste, the sanitation of the waste management system has decreased. The persistent act of disposing waste in shared spaces by individuals may result in significant ramifications for the nearby ecological system. The existence of such circumstances in the vicinity has the capability to aggravate an extensive array of severe health conditions. The aforementioned phenomenon will lead to a decrease in the value of the impacted region. Effective waste management practises are necessary to address the issue of waste disposal and maintain cleanliness. The present investigation presents a novel waste management framework that leverages Internet of Things (IoT)-enabled sensor devices to monitor and record the quantity of refuse deposited into receptacles. Upon detection, the system promptly entered an alarm state that was exclusively operable through GSM/GPRS technology. The microcontroller establishes a connection between the GSM/GPRS system and the sensor system in the present system. The smart garbage bin additionally encourages recycling by categorising various types of waste (wet and dry). This guarantees prompt waste collection, lessens litter and unhealthy conditions. This led to the environment becoming more green and to support for Swachh Bharat for cleanliness.

Keywords: Garbage; Microcontroller; GSM/GPRS.

1. Introduction

Managing waste in urban or metropolitan areas is widely regarded as one of the most challenging tasks faced by nations worldwide, according to the majority of individuals [1]. The implementation of a properly structured waste management system is crucial in preserving an environmentally sustainable atmosphere [2]. There are numerous modern mechanisms of expertise. However, the persistence of limited information can be attributed to the difficulty involved in acquiring it [3]. The erroneous belief is anticipated to impede the rapid progress of nationwide growth in heavily populated suburban areas, while simultaneously intensifying the imperative to protect urban ecology [4]. The creation of a prototype for a waste management system presents a formidable undertaking due to insufficient cooperation among federal, state, and local governments and local authorities in relation to waste transportation and treatment. Currently, the waste collection procedure is carried out using traditional methods, which require a significant amount of physical labour and an extended period of time [5].

Since August 2012, cities in the Bengaluru style have been facing a severe waste crisis due to two urban dumpsites that have been opposed by nearby residents due to concerns over their potential negative impact on ecological and health conditions [6]. The municipal operations were suspended due to the identification of substantial quantities of refuse on unoccupied areas across the urban area. In order to prevent further extensive damage caused by the crisis, the Bruhat Bengaluru Mahanagara Palike (BBMP) was compelled to undertake corrective measures [7].

The Bruhat Bengaluru Mahanagara Palike (BBMP) has implemented a waste sorting and distribution system with the aim of diverting residual waste from landfills and mitigating the associated environmental impact. During this period, BBMP initiated several programmes and prioritised them, such as the Information Education and Communication (IEC) campaign and the Wake-Up Clean-Up Campaign. The implementation of an initiative called

Information, Education, and Communication (IEC) has been initiated to promote the practise of waste segregation at the grassroots level [8].

The term "thing" in the context of the Internet of Things (IoT) refers to a tangible entity that possesses sensor capabilities, enabling it to transmit data via IP address and engage in autonomous communication with base stations [9]. This technology enables an object to engage with both its internal and external surfaces, contingent upon a chosen course of action. The Internet of Things has the capability to establish communication with a multitude of online systems. The objects possess the capability to be remotely controlled or monitored through digital means, regardless of geographical location [10]. This approach can prove advantageous for individuals who possess the ability to acquire supplementary information from diverse sources, thereby augmenting their effectiveness and fortifying their safeguarding measures.

2. Existing System

Waste receptacles that are enabled with Internet of Things (IoT) technology have been employed for a significant period of time. Various authors have illustrated systems that utilise sensors integrated into waste containers to determine their level of fullness. Upon completion of the form, an automated notification was sent to the server endpoint of the system using the Arduino SIM module, which utilised the Arduino board [11]. After the server received the message, it was then forwarded to the assigned worker who is accountable for its management. In the event that the person in question is reachable, they would acknowledge the assignment, convey their accessibility, and proceed to the designated location. If the primary worker is unavailable, the responsibility would be assigned to a substitute worker [12]. The researchers devised a waste management system in real-time that employed intelligent waste receptacles with the ability to detect the degree of waste build-up. The system facilitates remote access and comprehensive review of data pertaining to smart trash cans, thereby empowering individuals to make informed decisions based on the available information [13]. The implementation of the suggested approach resulted in advantages such as decreased costs, optimised allocation of resources, and improved utilisation of intelligent waste bins. The aforementioned methodology led to an incidental decrease in vehicular congestion within the urban area. The frequency of waste collection services in urban areas is dependent on the population density, with larger cities commonly receiving two to three visits per day [14]. The system offered instantaneous updates regarding the current status of individual dust bins, thereby allowing the relevant authority to dispatch the garbage collection vehicle exclusively when the dustbin has attained its maximum capacity [15]. The deficient upkeep of the receptacle is evidenced by a malfunctioning cover, resulting in the excessive accumulation of refuse within its confines. One advantage of utilising this disposal technique is the efficient eradication of refuse, and the lack of electronic constituents simplifies the act of clearing the container [16]. In order to streamline the process of identifying bins that have reached their maximum capacity and are in need of emptying, a unique identification number has been designated for each individual bin [17]. The project is composed of two discrete elements, specifically the transmitting segment and the receiving segment. The transmitter module, which consists of sensors and a microprocessor, employs an RF Transmitter to rapidly transmit information to the system, thereby enabling the timely discharge of the bin [18]. The RF Receiver subsequently acquires the data that has been transmitted by the RF Transmitter and conveys it to the intended recipient [19].

A plastic container storage bin will be used in this method for garbage disposal, but this method has more drawbacks than benefits [20]. The various drawbacks include The bin develops a foul odour if maintenance is not done properly [21]. If the trash can is not removed as soon as it is full, many flies, mosquitoes, and other insects will congregate around, which can be a source of various diseases. The environment will be harmed if the trash can's lid is missing and the trash overflows.

3. Proposed System

3.1. IoT Framework

IoT frameworks may support the communication between "things" and enable the creation of more intricate systems, such as distributed computing and distributed applications. Some IoT frameworks at the moment appear to focus on real-time data logging solutions, providing a foundation for working with multiple "things" and allowing them to interact. Specific software-development environments for the hardware used in the Internet of things may become necessary as a result of future improvements. Businesses are creating technological platforms to give the Internet of Things this kind of capability. More intelligent platforms are being created in the future. Easily adapted for Internet of Things (IoT) applications, RESET is a scalable architecture that enables objects to communicate through the Hypertext Transfer Protocol.

3.2. System Description

We have proposed a Smart Garbage system that separates the dry and moist garbage, as well as the metallic waste [4]. The system's primary objective is to create an automated waste sorting system. In addition to this, another benefit is that it notifies the waste management facility via IOT once any rubbish bin is full. Our design for a smart trash can will enable us to dispose of wet and dry waste separately. The user receives an alarm message if the dustbin is 50% to 75% full.

The system will assign users points based on how much rubbish they dump, and those users will receive rewards in accordance with their point totals. The major functions of the web application are to process, view, and maintain user profiles as well as the eco point collection system. Three categories—households, small enterprises, and large businesses—are listed in the user profile. They can examine their details and their points for waste in each category by logging onto their profiles.

Recycle centres can also use this web application to see how much of each type of waste are there and then place a purchase order. Indications are supported by this online application [5]. As a result, this web application informs the administrator whether a dustbin is full or has reached its maximum capacity. The system was created with people's lifestyles in mind because it is intended for the entire population.

Based on that, sensors, RFID, and GSM modules are positioned. A prototype was created based on the framework to illustrate the functionality of the system. The Smart Dustbin is a technological solution that employs electronic components such as an Arduino, a servo motor, an ultrasonic sensor, and a GSM module. The present study involves the integration of the Arduino microcontroller and the GSM module for the purpose of remotely opening the lid of a trash can and transmitting notifications to a mobile device. In contrast to the aforementioned dustbins,

this intelligent variant exhibits superior efficacy and efficiency. This intelligently designed waste receptacle operates in the following manner: The ultrasonic sensor is situated anteriorly on the receptacle and is linked to both the lid and Arduino. Upon placement of human hand and waste in front of the ultrasonic sensor, the lid of the trashcan is activated, allowing for the disposal of waste and subsequent detection by the sensor. A further ultrasonic sensor is situated inside the receptacle, which gauges the vertical extent of the refuse contained therein. The aforementioned metric is employed to transmit a notification to a cellular device through a GSM module, denoting the status of the waste receptacle as either full or not full. The advantages of this methodology are as follows: A receptacle commonly referred to as a dustbin is utilised for the purpose of containing waste materials. The utilisation of diverse electronic constituents renders this receptacle a "Smart Dustbin".

3.3. Block Diagram

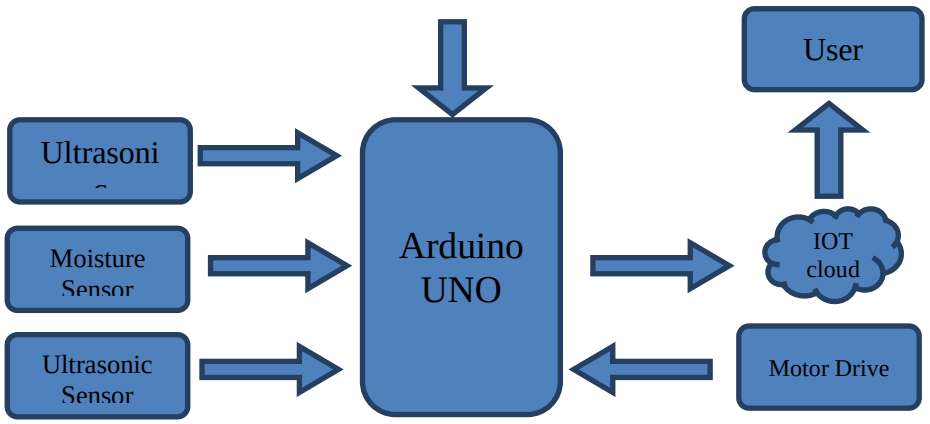

Figure 1. Block Diagram

3.4. Circuit Diagram

By measuring the distance between the top of the trash can and the waste, the sensor can detect the level of waste. A wireless link is used to transmit the acquired data to a distant server. All of the information gathered by the sensors and trucks is stored in MySQL. Use is made of the three moisture sensors. The output is seen on the display.

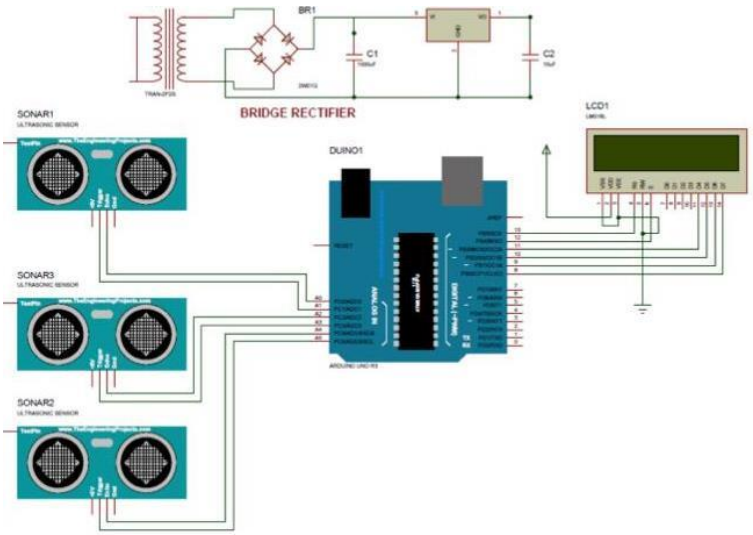

Figure 2. Circuit Diagram

3.5. Arduino Uno

The ATmega328 serves as the foundation for the Arduino Uno, which is a microcontroller board. The device is equipped with a ceramic resonator operating at a frequency of 16 MHz. It features six analogue inputs and fourteen digital input/output pins, six of which are capable of functioning as pulse-width modulation outputs. Additionally, the device is outfitted with a USB port, a power jack, an ICSP header, and a reset button. The package includes all the necessary components to facilitate the functioning of the microcontroller. To commence operations, simply connect a USB cable, an AC-to-DC adapter, or a battery. Each of the three central processing units (CPUs) possesses an identical arrangement of pins.

The applied voltage during operation is 5 volts. The appropriate range of input voltage for this device is between 7 to 12 volts. The range of acceptable input voltage is limited to a minimum of 6 volts and a maximum of 20 volts. The device in question possesses a total of 14 input/output pins that are digital in nature, with 6 of these pins being utilised for the purpose of generating pulse width modulation. The analogue input pins are a type of input pin that can receive and process analogue signals in electronic devices. The direct current input/output current. The present flow of electricity at 3.3 volts. The current measurement for the pin is 40 milliamperes. The current passing through the circuit is 50 milliamperes. The Atmega 328's flash memory has a capacity of 32 KB, with a portion of 0.5 KB being allocated for the bootloader. The SRAM capacity of the ATmega328 is 2 KB, while its EEPROM capacity is 1 KB. The clock's speed is 16 MHz. Section 2.4 discusses the concept of power. The Arduino Uno can be powered by either an external power source or through a USB connection. The selection of the power source is automated. External power can be supplied by either a battery or an AC-to-DC adapter, commonly known as a wall wart, without relying on USB.

The ultrasonic sensor, with a rating of 4.5, is a device that utilises sound waves with frequencies higher than the audible range of human hearing to detect objects and measure distances. The ultrasonic sensor is a technological apparatus that employs ultrasonic sound waves to determine the spatial separation between itself and a target object. The ultrasonic sensor operates by emitting ultrasonic pulses from a transducer and subsequently receiving the reflected waves to ascertain the distance between the sensor and an object. Frequently, ultrasonic sensors are integrated with proximity sensors. They are commonly found in anti-collision safety systems and self-parking automotive technologies. Ultrasonic sensors are utilised in both robotic obstacle detection systems and manufacturing technology. The ultrasonic sensor and moisture sensor are two types of sensors commonly used in various applications. The ultrasonic sensor is a device that uses sound waves to detect objects and measure distances. On the other hand, the moisture sensor is a device that measures the moisture content of a material or substance. Both sensors have their unique features and functions that make them useful in different settings.

A moisture sensor is a device that quantifies the amount of moisture present in a given substance. The quantification of moisture content in soil, air, or other substances is a common practise in various fields such as agriculture, horticulture, and other industrial sectors. Moisture sensors function by measuring the electrical resistance of the material [5]. The electrical conductivity of a material is observed to be higher in its wet state as compared to its dry state. The sensor detects alterations in resistance and subsequently converts them into a displayable digital reading or transmits them to a computer.

The present project employs a motorized mechanism to facilitate the operation of the dustbin lid, enabling it to be opened and closed as required. The term "IoT cloud" refers to an extensive infrastructure that provides support for both IoT devices and applications. The aforementioned encompasses the auxiliary physical components, including servers and storage devices, that are necessary for executing and performing instantaneous tasks.

The power supply is a crucial component in electronic devices that provides electrical energy to the system. A power supply is an electrical device that furnishes electricity to an electrical load, including but not limited to electronic devices such as servers and laptop computers. The fundamental function of a power supply is to convert electrical energy from a given source into the appropriate voltage, current, and frequency required to operate a load. The Arduino Integrated Development Environment (IDE) is a software platform used for programming and developing Arduino microcontroller boards. Arduino is a prototype platform that is open-source and utilises uncomplicated hardware and software. The device comprises a programmable circuit board, commonly referred to as a microcontroller, and pre-existing software known as Arduino IDE (Integrated Development Environment). The latter is utilised for the purpose of creating and transferring computer code to the physical board. Arduino provides a standardised form factor that consolidates the functionalities of the micro-controller into a more convenient enclosure.

Arduino is a prototype platform that is open-source and utilises basic hardware and software. The device is comprised of a circuit board that incorporates a microcontroller, which can be programmed using the Arduino IDE (Integrated Development Environment) software. This software facilitates the creation and uploading of computer code to the physical board. Embedded C was developed by the C Standards Committee as a collection of language extensions for the C programming language, with the aim of addressing the issue of inconsistency among C extensions for different embedded devices. Historically, the C programming language has required nonstandard extensions in order to incorporate advanced functionalities such as fixed-point arithmetic, multiple distinct memory banks, and fundamental input/output operations.

3.6. Embedded Programming

Hardware and software working together are referred to as embedded. Programming embedded systems involves using the system's approved programming interfaces to modify an embedded system inside of a device. A development environment for creating embedded systems that can run Java programmes is Java. In reality, we can refer to Arduino as an application product of embedded systems because it is a very small component of embedded systems. Arduino is a microcontroller board like any other, with a specially created API and software that makes programming it very simple. Arduino is merely a drop of water in the ocean of embedded systems.

4. Result

The brainy litter basket is a creative approach that makes use of the internet of things to improve garbage management. This project consists of a trash can with software and sensor connectivity. This guarantees prompt waste collection while minimizing clutter and unhealthy conditions. This bin's communication capabilities with municipal waste management systems make rubbish collection and disposal more effective. These containers are made to promote environmentally friendly practises including recycling and trash minimization. We may separate

our garbage into moist and dry items with the use of a clever trash can, preventing an unpleasant odour from emanating from the trash can. When the trash can is halfway to fully filled, an alert message is sent to the user. To collect the trash, notifications can be sent in real time. Therefore, waste will be picked up periodically.

Figure 3. Hardware Prototype

5. Conclusion

The project can also be implemented with ease thanks to IOT based Dustbins, which make it easier for people to manage waste, reduce the work of calling or waiting for the specific person to make the area clean, and create a healthier environment to live in. The present research endeavours to propose a pragmatic approach to waste management by integrating it with the Internet of Things (IoT) technology. Specifically, the study suggests offering complimentary internet services for a predetermined duration upon depositing waste into the receptacle. Inadequate management and upkeep of household refuse give rise to concerns regarding public health and environmental contamination. The suggested strategy will undoubtedly assist in resolving any significant waste-related problems and maintaining a clean environment.

5.1. Future Scope

This concept was created with the intention of maintaining a clean, green atmosphere. It can be improved in a variety of ways. Following are its future scope:

(i) The system can be installed with a time stamp that displays a real-time clock to the person who needs to know when the smart dustbin is filled and when the rubbish is collected;

(ii) Android apps with dustbin locators can be created so that users can track the nearest bin and its status if the system is used to monitor trash containers in bigger areas;

(iii) With the help of a small grinder and a wet waste container, it is possible to break down organic waste quickly;

(iv) Using a camera sensor to process images of the state of the road's cleanliness and to fine people for improper waste disposal.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional, or personal interests.

Consent for publication

The authors declare that they consented to the publication of this research work.

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