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IOT Based Smart Garbage Management System (A Swachh Bharat Initiative)

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ABSTRACT*:*

We live in the age of Smart Cities, where everything is planned and organized. Urban migration has increased dramatically in recent years. As a result, rubbish wastage has increased everywhere. One of our key environmental problem is solid waste management, which has an influence on our society's health and ecology. Garbage disposal in public locations pollutes the environment. It has the ability to spread a variety of dangerous diseases to those who live nearby. Checking, collecting, and removing rubbish waste is one of the major problems faced by today's society, as its absence of upkeep will have bad ecological consequences. The old method of manually monitoring garbage in garbage containers is ineffective since it requires a lot of human effort. In this paper, a 24×7 monitoring system is designed for monitoring dumpsters. For selective clearing here we designed smart and organized system. The ultrasonic sensor is used for measuring the level of garbage in the dustbin. DC motor powered platform is used for separating dry and wet waste. Moisture sensor and IR sensor are used for separating dry and wet waste. Any of the containers is full then an alert message is sent from the dustbin. In turn, employees can clear the corresponding garbage inside containers.

Technical Keywords: IOT, Arduino microcontroller, Ultrasonic Sensor, Wi-Fi, Solid waste management.

1. INTRODUCTION

Most human society agrees that cleanliness is next to Godliness, and the scenario beyond this proverb is that keeping the environment clean is a very significant means of remaining healthy, and it is said to lay greater focus on cleanliness. However, it is not as simple as reciting the proverb to effectively or correctly manage waste in streets. Solid management is currently a serious challenge in growing country metropolises.

Population increase and rising per capita income, have resulted in the development of massive amounts of solid garbage, posing major challenges to environmental quality and human health. These carelessly dumped rubbish will eventually become a breeding ground for hazardous microorganisms, insects, and mosquitoes. The current technique has drawbacks such as being time consuming and inefficient. Even a foul odor contributes to an unhealthy environment. So, the proposed model discusses how to make use of recent technological breakthroughs to keep our environment clean and tidy.

Solid waste management is big challenge in the city. The garbage collecting authority in traditional manner doesn't know about the level of garbage in dustbin, if the dust bins get full by garbage, then it gets overflowed as well as spelled out from the dustbin leading to unhygienic condition in cities. Sometimes due to unclean garbage bins harmful diseases are easily spreadable. Use of traditional system result in waste of time and money spending on system. Hence idea is to designed and develop IOT based garbage monitoring and management system

2. LITERATURE SURVEY

This paper includes, A Smart Dustbin recommended based on Internet of Things in which the smart dustbin was built on a platform which was based on Arduino Uno board which was connected with a GSM modem and an ultrasonic sensor. The sensor was placed on the lid of the dustbin. A maximum level was set as 10cm. If the garbage inside dustbin full up to maximum level, the sensor activates the GSM modem which notifies the associated authority till the garbage in the bin is emptied. At the end a conclusion was made that various issues like cost, maintenance and durability were solved when these smart bins were designed. It also contributed towards a dirt free and clean environment in the process of building a smart city [1].

The researchers suggest the method for garbage management. System based on microcontroller which had IR wireless systems with central system which attached with dustbin that showed the status of garbage in the dustbin [2].

The notifications were seen on a mobile by using Wi-Fi. They only used weight-based sensors to reduce cost. And to send and receive the data on the sender side they only used a Wi-Fi module. The sensor could only measure the weight of waste present in the dustbin but not the level of waste. The author states a method for organizing the collection of the garbage in the commercial and residential areas of the cities [3].

In this system, the ultrasonic sensor used to detect level of garbage in the bin which will send the data to the control room using the GSM module. A GUI was also developed to check the information GUI that was related to the garbage for different locations, GUI was based on MATLAB so it was different. Slave unit was in the bin whereas the master unit was there in the control room, these two units were present in system. After checking the level of garbage by sensor it will send to the slave unit. Further data send to master unit that notifies the authorities to clean the bin. Decision Support System which would be used for garbage collection in the cities proposed by this paper [4].

Ineffective waste collection in the inaccessible areas of the city this system used to handle. In those parts of the cities which were facing the most problems in that area cameras were placed. Find the companies that were involved in collecting the waste was the first part and owned trucks and who could also organize some drivers for collecting the garbage from various parts of the city in the truck and pass on the city dumps or the recycling organizations these are the two parts of system. Various bins with an embedded device which was low in price were placed around city and helped in tracking the garbage level in the bins [5].

This paper proposed, two different sections. One is transmitter and another is receiver section. A different ID was given to each bin so that it could be easier to find out that which bin is full and ready to be emptied. Microcontroller is available in transmitter section and sensors which used to check the level of the garbage and with the help of the RF Transmitter data is passed onto system, then RF Receiver receives the data and sends it to the authorities associated so that the bin can be emptied as soon as possible [6].

In this paper, proposed a model for cyber security systems using artificial system to have secured transactions [7]

3. PROPOSED SOLUTION

Most human society agrees that cleanliness is next to Godliness, and the scenario beyond this proverb is that keeping the environment clean is a very significant means of remaining healthy, and it is said to lay greater focus on cleanliness. However, it is not as simple as reciting the proverb to effectively or correctly manage waste in streets.

1) To reduce the time required for garbage collection.

2) Optimize waste collection routes using real time garbage level data.

3) To minimize human efforts.

4) Allow trash collectors to plan their daily/weekly garbage pickup schedule.

5) To automate the garbage monitoring process

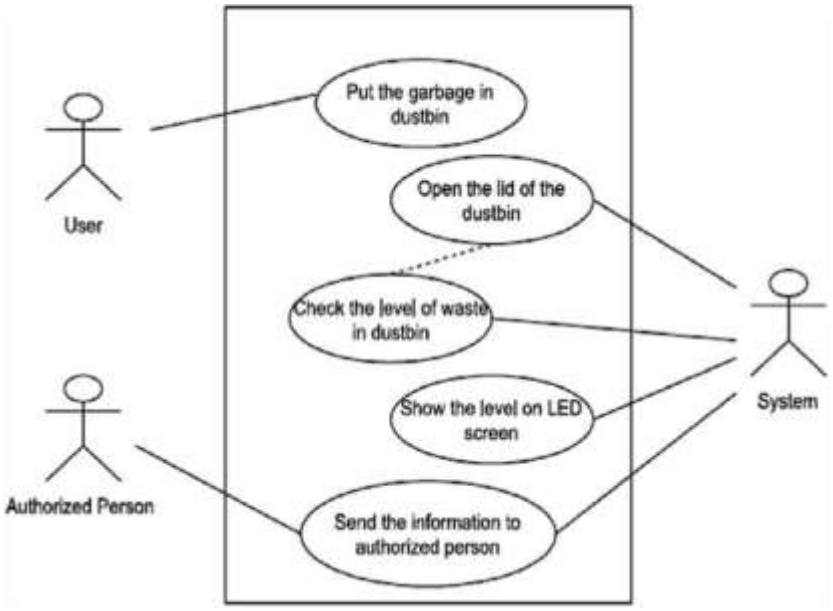


Figure 1. UML Diagram of proposed system

Here we proposed, a 24×7 monitoring system is designed for monitoring dustbins. In this system, a smart and organized system is designed for selective clearing. The ultrasonic sensor is used for calculating the level of waste in the dumpster. DC motor powered platform is used for separating wet and dry waste. IR sensor and moisture sensor are used for segregating wet and dry waste. If the containers are full then a notification is sent from the dumpster. Then employees can clear the respective dumpster. All these sensors are attached to an Arduino Uno board. For controlling all mechanical setup based on current conditions it can be used.

Distances can measure by using ultrasonic waves with help of ultrasonic sensor. The sensor sends an ultrasonic wave and receives the reflected wave back from the target. Moisture Sensor measures the volumetric water content DC motor which is connected to the digital pins of Arduino.

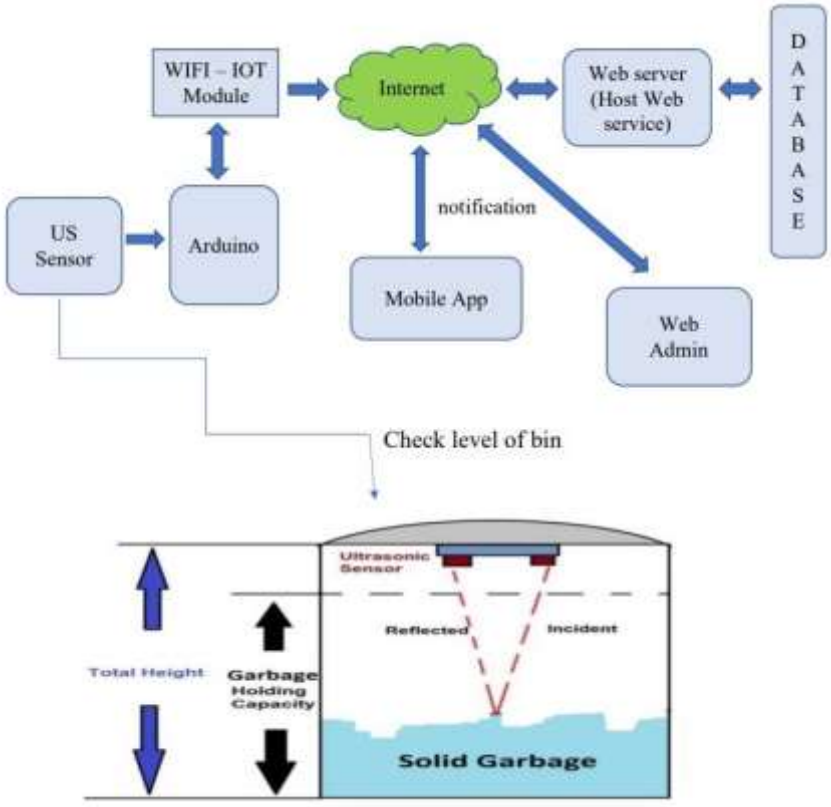
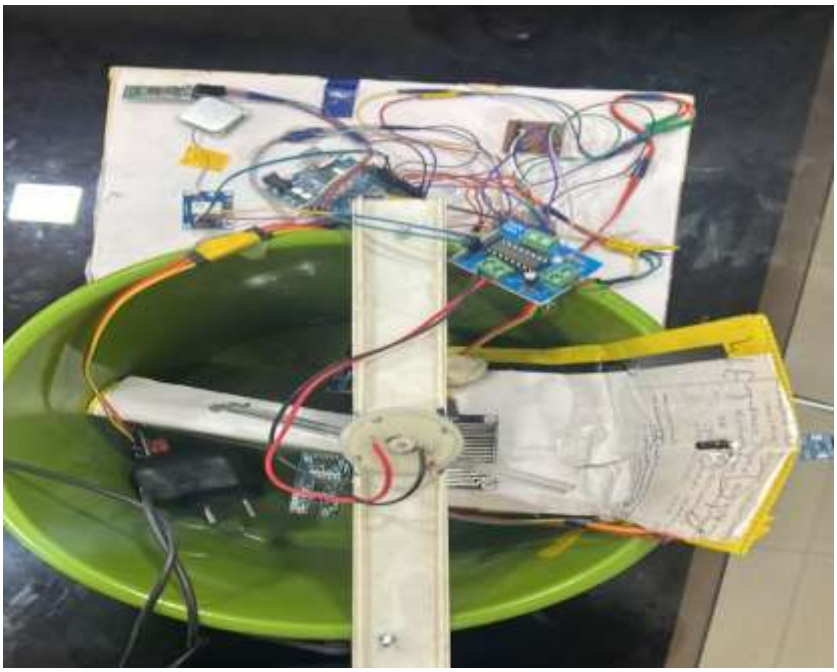


Figure 2. Architecture Diagram

Architectural diagram of smart garbage management system. US sensors sense the level of garbage then the message is passed to the database via Arduino through internet by which the web admin will get the notification on the mobile app.

When the system is turned ON the Ultrasonic Sensors will get the current garbage level of the bin. The Ultrasonic sensors do this work by emitting a sound wave that is above the human hearing range. The sensor's transducer functions as a microphone, receiving and emitting ultrasonic sound. To deliver a pulse and receive the echo, ultrasonic sensors use a single transducer. The sensor measures the time between delivering and receiving an ultrasonic pulse to determine the distance to a target. The Sensors operation is straight forward. It sends a 40kHz ultrasonic pulse that travels through the air and if it encounters an obstruction or item bounces back to the sensor. The distance can be estimated by multiplying the travel time by the sound speed. The moisture sensor will detect whether the garbage is wet or dry. The sensor determines the volumetric content of water within the specified material and estimate the volumetric water content indirectly, using other rules like dielectric constant, electrical resistance, otherwise neutron interaction, and moisture content replacement. These values will then be sent to the ESP8266 Wi-Fi module via serial communication. On receiving those values, the Wi-Fi module will post those values to the web server via the internet. The Website will then get the values from the web server and present a graphical view of the garbage bins along with moisture level of the garbage.

The process involved in this application is the measurement of the garbage level in a bin of 30cm (about 11.81 in) height using an ultrasonic sensor. The ultrasonic sensor is placed on the dustbin cap and the sensor is facing towards the bin inside the bottom surface. Therefore, from the top lid position the accumulated level of garbage inside the dustbin is measuring continuously with the help of a microcontroller and the data processed will be sent to the user. "Filled", "Half Filled" and "Empty" are the levels of dustbin. Depend on the size of the dustbin the levels are divided into three levels of distances. From 1cm-10cm level determine as "Filled", "Half Filled" means the level from 11cm to 20cm, and the "Empty" means the level from 21cm to 30cm. This logic is written in the code and the same is verified practically. When garbage fills the bin for each of the threshold levels, an alert message appears on the webpage, and the level value is displayed in the Android application alongside the bin number. Because of this, both time and fuel consumption of the garbage collecting vehicles will be reduced. Authorities can monitor the status of dustbins and their respective locations on that website. An android mobile application is developed to get the status of individual dust gathering personnel and it will show the shortest path to reach those respective dustbins.



4. Algorithm

Here's a proposed solution for an IoT-based Smart garbage management system using Arduino:

Start: The system initialization begins.

Initialize Sensors: Connect and initialize sensors such as ultrasonic- sensor, Moisture-sensor, and IR sensor.

Measure Garbage Level: Use the ultrasonic sensor to measure the distance between the sensor and the garbage level inside the dumpster. This data helps determine whether the dumpster is filled, half-filled, or empty.

Determine Waste Type: Utilize the moisture sensor to detect the moisture level in the garbage and determine whether it is wet or dry waste.

Send Data to Arduino: Transmit the garbage level and waste type data from the sensors to the Arduino Uno board.

Connect to the Internet: Establish an internet connection for the Arduino board to communicate with other devices and systems.

Update Database: Send the garbage level and waste type data to a centralized database for storage and further processing.

Real-time Monitoring: Use a mobile Bluetooth terminal app that can access the database and display real-time information about the garbage levels and waste types in each dumpster.

Generate Alerts: Implement a notification system that sends alerts to designated personnel when the garbage level reaches a certain threshold (e.g., "Filled" level). The Alerts can be sent via SMS on the mobile.

Start

Initialize the system and sensors

Connect to the internet and establish a connection with the centralized database

Loop:

a. Measure the garbage level using the ultrasonic sensor

b. Determine the waste type using the moisture sensor

c. Send the garbage level and waste type data to the Arduino board

d. Update the database with the latest data

e. Check if the garbage level reaches the threshold for generating an alert

f. If the threshold is met:

Generate an alert message indicating the dumpster number and the level of garbage (e.g., "Bin 1 is filled")

Send the alert message to the designated personnel via SMS or any other notification method

g. Repeat the loop

End

This algorithm continuously monitors the garbage levels and waste types using the sensors connected to Arduino. It updates the database with the latest data and checks if the garbage level reaches the threshold for generating an alert. If the threshold is met, an alert message is generated and sent to the designated personnel via SMS or any other chosen notification method.

5. Flowchart

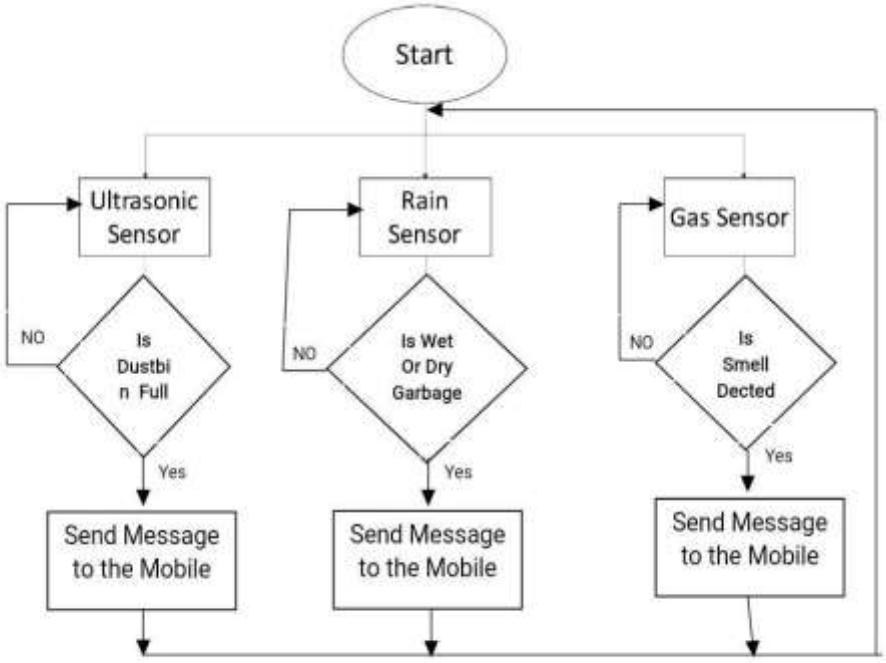


Figure 3. Flowchart

6. SYSTEM SPECIFICATIONS

A. Hardware Requirements: -

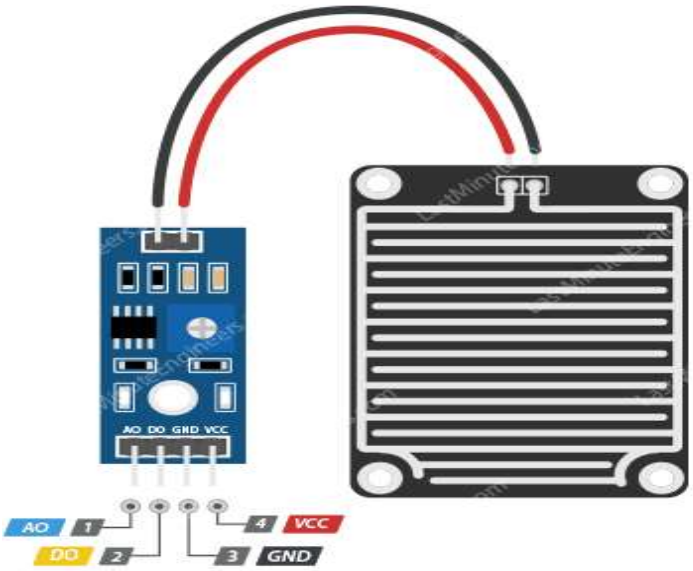
1. Arduino UNO: It is an open-source microcontroller board build on the ATmega328P. It was designed and manufactured by the Arduino LLC in Italy. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, and a power jack. The board is equipped with a number of sensors such as a temperature sensor, light sensor, and humidity sensor, among others, which can be added as per the requirements of a project. With its simple and accessible user interface, Arduino UNO is widely used for various DIY electronics projects, robotics, and Internet of Things applications.

2. Ultrasonic Sensor: Ultrasonic Sensor Ultrasonic sensor also called HC-SR04 uses sonar waves to detect distance to an object like bats do. An Ultrasonic sensor is can measure the distance to an item by using sound waves. It has four pins: TRIG, ECHO, GND, and VCC. When the sound waves transferred in environment then waves are fetched by ECHO after striking an object. Its process is not affected by sunlight or black material. The sensor module combined of an ultrasonic transmitter and receiver.

3. GPS Module: GPS Module Global Positioning System is a device which is capable of receiving information from GPS satellites and calculating the device's territory position. Using software, the device may display the position on a Google maps, and it may offer directions. The GPS system information can be retrieved by the GPS device in all kind of weather condition and anywhere on the planet. GPS devices may be able to direct: the roads or paths available, traffic and alternative routes, roads that might be taken to get to the destination, if some roads are busy then the alternative route can be given to the user.

4.Rain drop Sensor Module

A rain drop sensor module is a device that is used to detect the presence of rain. It typically consists of a sensor that can detect the electrical conductivity of water, and a circuit that can interpret the sensor's readings and output a signal indicating the presence of rain. These modules are commonly used in weather stations, irrigation systems, and other applications where the detection of rain is important. Some rain drop sensor modules may also include additional features such as temperature and humidity sensors.



B. Software Requirements:

1. Arduino IDE: It includes a code editor which provides simple one clicks mechanisms to compile and upload programs to an Arduino board. The Arduino IDE work with the languages C and C++ using special rules of code structuring. It attaches to the Arduino and Genuino hardware to connect programs and communicate with them.

2. SQLite: SQLite is a database which is used to store the data mostly gathered from the android application. The SQLite engine does not have any standalone processes like client-server database management systems with which the application program communicates. Rather than, SQLite library becomes an integral part of the application program as it is linked in. This can be called dynamically. The data stored in the SQLite can be viewed using DB browser for SQLite application.

7. CONCLUSION AND FUTURE SCOPE

This research demonstrated a smart waste management monitoring system based on IoT technologies. After reviewing multiple research works, the proposed system has been implemented in a way that can be concluded as follows: Technology can also play a major role in proper waste management. This system works by sensing the garbage level in the bins and by sending the data to the website. The truck drivers can then check if the bins are full or not and optimize employee collection routes. This system was solely concerned with solid waste.

In the near future, other types of sensors might be combined with the ultrasonic sensor to achieve more exact results and take the system to the next level. And the system is combined with autonomous vehicles that can move throughout the dumping ground. Such vehicles can replace the need for multiple stationary monitoring stations.

8. REFERENCES

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