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IoT-Based Intelligent Waste Management System: A Look Ahead for India

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ABSTRACT-

To construct smart cities, an intelligent machine that monitors the garbage, offers real-time information is required. Currently, Municipal Corporations in India do not receive real-time information about dustbins. In this regard, we are implementing an Internet of Things (IoT) system that will communicate with the company's on dustbin overflow and toxin levels. A website is also being built to monitor the data relating to dustbins. A message is transmitted to the mobile phone via the GSM module, and information on the dustbin's status is updated on the website. Citizens can also use this website to raise concerns about dustbins or garbage management. In the recommended solution, an Arduino microcontroller is utilized in order to connect the sensors to the GSM/GPRS module. Gas sensors determine the toxicity level, whereas ultrasonic sensors determine the trashcan level.

Keywords: gas sensor, ultrasonic sensor, Arduino,microcontroller, IoT, toxicity level, GSM/GPRS.

INTRODUCTION:

India is home to one-sixth of the world's population, making it one of the most populated nations in the world. Due to the enormous population, garbage is produced in vast quantities by both industry and homes. Trash may sometimes disintegrate and release foul-smelling gases that are bad for the environment. [1] [2].

Garbage production in smart cities is high. Mumbai generates a substantial quantity of waste, as do 46 other cities. Every day, 11,000 tons of waste are produced by it [3]. Dustbins are positioned across the city to handle this garbage however they usually overflow and are ignored. Information on trashcan spills is not sent in real time to the municipal corporation. [2] [4].

- Although we use dustbins to dispose of rubbish,certain issues persist. For example:
- Not all garbage is properly disposed of.Nothing is monitored about it.
- . There was no documentation of dangerousgases being present in the trash.
- Bins overflow and are not routinely cleaned.

While we are unable to halt the production of trash, we are able to appropriately manage and regulate it. It's crucial to manage solid waste using the appropriate database.

Indian streets are lined with dustbins. Trash is deposited into these dustbins by individuals, and they are cleaned by the municipal corporation (MC). Trash cans do, however, sometimes overflow and aren't always cleaned promptly. A clever method must be employed to determine the dustbin's present status in real time. [5].

Different sorts of technology are all around us. As a result, we need to make use of it to get real-time surveillance of every trash can in a certain area. Notify the MC, who is incharge of cleaning it, when the trashcan is full. Every dustbin's data is archived for further use.

LITERATURE REVIEW

Slightly less than half of the many studies conducted on intelligent waste management systems have shownefficacy in addressing these issues.

P Haribabu et al.'s trashcan was installed via IoT. [2]. An Arduino board and a GSM modem were used, and the trashcan has an ultrasonic sensor (HC-SR04). There were also many Light Emitting Diodes (LEDs) and a siren to signal the amount of dust in the bin. Jeetendra Joshiet al.'s "Cloud computing based smart garbage monitoring system" idea measures the level of dustbins using an ultrasonic sensor. Additionally, they provide an app that plots the fastest path to the garbage can. Their strategy is built on the front-end stack methodology. [5]. S. Vinoth Kumar et al.'s "Smart garbage monitoring and clearance system using Internet of Things (IoT)" was a great idea, but it was unprepared for the dangerous gas that the

dustbin emitted. [6]. Krishna Nidre et al. conducted more study on a "IoT-based solid waste management system for smart city". They recommended using two sensing devices to monitor the trashcan in real time: weight sensing and garbage filled level detection.

Weight sensing is not the most accurate way to determine if the trash is full or not, but they were notifying users if it was. [7]. A study on "Dissipation of Waste using Dynamic Perception and Alarming System: A Smart City Application" was also carried out by Imteaj A et al., who also developed an android application. With the help of this software, users may find nearby trash cans on OpenStreetMap by entering a route (OSM) [8]. The "Smart City Initiative: Traffic and Waste Management," proposed by Ankitha S. et al., uses smart dustbins with unique ID numbers. A notification is sent to the server, which links all garbage collection trucks, when the dustbin is full. [9]. The study by Trushali S. Vasagade et al. makes use of IoT to measure several factors by positioning several sensors in various places. To find rubbish that has been tossed outdoors, they are using a sensor outside the container. [10]. An "autonomous smart waste collection system" including Bluetooth, Zigbee, Wi-Fi, and an additional module was presented by Shujatullah Khan et al. Infrared (IR) sensors power their smart trash can. A Global System for Mobile Communication (GSM) modem is used to send data to the relevant authorities when trash reaches the threshold level. [11]. Therefore, taking into account all of this research, we can say that intelligent waste management is an essential problem that cannot be solved.

The Internet of Things (IoT) and the GSM/GPRS protocol are used in this work to link the transmitter and receiver [7]. Our proposed "IoT-based smart waste management system: India prospective" offers a real-time dustbin status. It determines the proportion of garbage filled and the toxicity level. Information is sent to the website for later review. It maintains the accuracy of the database's time and date as well as the toxicity level and filling percentage of the trash can. When the trash is full or the toxicity is high, it notifies the person in question. Figure 1 explains our system as a whole. An ultrasonic sensor and a gas sensor are connected to the Arduino, and using the GSM module, they provide data to the municipal corporation. The recommended system may also be understood by referring to the flow chartin Figure 2..

The dustbin's fill level is detected with an ultrasonic sensor. [4].

1. 1. The dustbin's toxicity is evaluated by the gas sensor. The dustbin becomes more poisonous when it contains trash because it releases harmful gases.
2. A notification is sent to the MC via the GSM module if the level is less than 10 cmor the toxicity of the gases is high.
3. From trash cans is periodically transmittedto the website and kept there. The date andtime of the data are retained..
4. The MC will send a truck driver to empty a full trashcan if it finds one. The timely clearance of the dustbins is ensured by using this procedure.

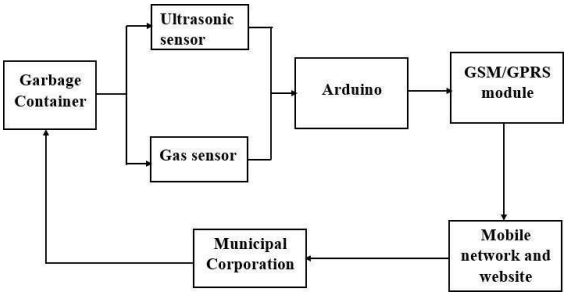

Fig.1: Block diagram of proposedsystem

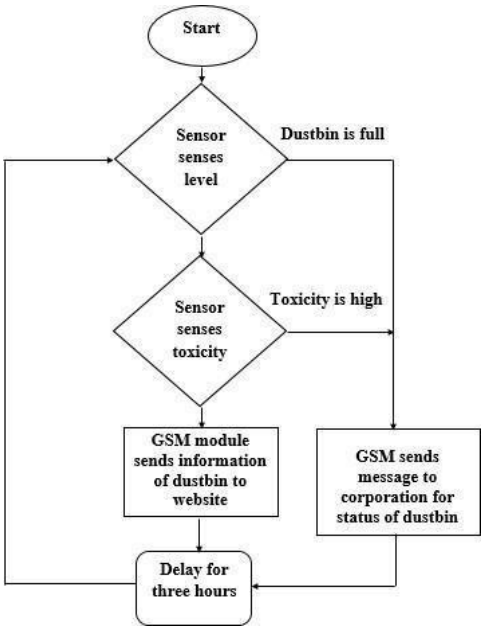

Fig.2: Flow chart of the system

The whole system is described in the sections that follow.

For Controlling System

In the proposed system, an Arduino board serves as the controller. It communicates with the sensors and GPRS module. What it is is a programmable control unit. We can program Arduino and use it to control any sort of device by using the Arduino IDE software. The required power supply is 5 volts. Both sensors use power. from the board of Arduino. There are fourteen digital input and output pins on it. Pulse width modulation (PWM) outputs make up six of them. There are six analog pins in addition. Whereas the ultrasonic sensor is linked to a digital pin, the gas sensor is

connected to an analog pin. The PWM pin is linked to the GSM. Arduino is shown in Figure3.

Fig.3: Arduino UNO R3

Table.1: Specifications of Arduino

Parameter	Specifications
Operating Voltage	5 Volt DC
Input Voltage	7-12 V
Clock Speed	16 MHz
DC current per I/O pin	40mA

For determining the dustbin's level

We utilize an ultrasonic sensor to detect the distance between the blockage and the gadget in order to determine the level. We consider impediments to be worthless. Transmitter and receiver are its two constituent pieces. Periodically, the transmitter blasts out high-frequency sounds. At the speed of sound, these waves propagate through the atmosphere [1][2][10]. The obstacle reflects the waves back, and the amount of time is calculated.. Figure 4 shows an ultrasonicsensor.

To calculate the distance between a sensor and an impediment, apply the formula below.

(2*Distance= Speed*Time)

The table displays the exact specifications of the ultrasonic sensor.2..

Table.2: Details of the Ultrasonic Sensor

Parameter	Specifications
Operating Voltage	5 Volt DC
Operating Current	15 mA
Frequency of Operation	40 Hz
Range	2cm-400cm

To quantify toxicity

A natural methane gas sensor (MQ4) is used in our system to identify the existence of hazardous gases released from the garbage. The sensitivity of this sensor to methane gas is high. The main source of these gases is biodegradable waste, which includes rotting fruits and vegetables, dead animals, and eggs [13]. The methane gas sensor is shown in Figure 5, and the MQ4 gas sensor's specifications are displayed in Table 3.

Fig.4: Ultrasonic Sensor HC-SR04

Fig.5: Natural Methane Gas Sensor MQ4

Table.3: Specifications of MQ4 Gas Sensor

Parameter	Specifications
Operating Voltage	5 Volt DC
Heater Voltage	4.8V - 5.2V
Heater Resistance	28 ohm - 34 ohm
Load Resistance	20K ohm

For communication

We make use of the Global System for Mobile Communication (GSM) technology to link the system to the mobile network. The GSM is an open digital technology that uses binary data transmission. The speed at which data is sent from

GSM operates at 9.6 Kbps. It can send messages and make phone calls. It operates in India with frequencies ranging from 900 MHz to 1800 MHz. When the dustbin overflows, our system sends a single message via GSM. GSM also provides information on their website.The table shows the particular values of SIM900A.4. The SIM900A is shown in Figure 6..

Table.4: Specifications of SIM900A

Parameter	Specifications
Operating Voltage	5V - 12V
Operating Current	2 Ampere

Frequency of operation	900/1800 MHz
Operation Temperature	-40^0 C to $+85^0$C

Fig.6: SIM900A GSM/GPRS Module

To transmit data over the internet

The Internet of Things (IoT) is a network of actual items, including cars, appliances, and household appliances, that are integrated with electronics, software, sensors, and actuators to enable communication, data collection, and exchange. [5].].

Dustbin reports and real-time data are shown on our proposed project website using HTML code. The GSM/GPRS module is used to transport all data [14–15]. Real-time data is saved by the website into a database that may be retrieved whenever necessary. It will also be put to use later on. We created a single website that keeps track of the date and time the trash becomes filled. Additionally, there is a complaint box for the locals to use. Dustbins will be routinely cleaned by this method. The administrator (admin) may check the dustbin's status online in the event that a complaint is received. One user may log in as an administrator on this website by using the admin login page. He may get the information for every trash can. There is one on this site.

The latest news is shown in other blocks. The webpage has the most recent news.

RESULT AND DISCUSSION

The GSM module and the Arduino have all of their connections made. It works well and sends SMS when the toxicity is high or it is full. It updates the webpage with data once every three hours.

We replicated our idea on a single board after initially putting it into practice on Proteus. The Arduino IDE is used to code. A computer with an AMD A4-3330MX APU CPU clocked at 2.20 GHz and 2 GB of RAM is used to execute the program. We get the intended outcome when all necessary factors are satisfied.

The device receives an SMS saying, "Your dustbin is full located at MLVTEC, Raj Nagar, RKGIT Gate No-1 or toxicity is high," when an ultrasonic sensor detects a distance of less than 10 cm or a gas sensor detects a high level of toxicity, as shown in fig. 7.

Fig.7: Screenshot of message sent

- The website was created to monitor dustbins. Itincludes the following features:
- Desk for complaints
- Newsfeed
- Admin Login
- Ultrasonic and gas sensor data were used to providedustbin details, including time and date.
- The administrator may add news.
- Admin can see the complaints with name andmobile number.

Figure 8 displays the home page of the website.
Information on the dustbins is available on the admin-viewable webpage. As shown in figure 9, this website shows the toxicity level and percentage of the trashcan filled along with the date and hour.
Figure 10 illustrates how an admin may see a citizen's complaint along with its name, phone number, date, and time on the admin dashboard page.

Fig.8: the website's home page

Fig.9: Specifics of the trash can

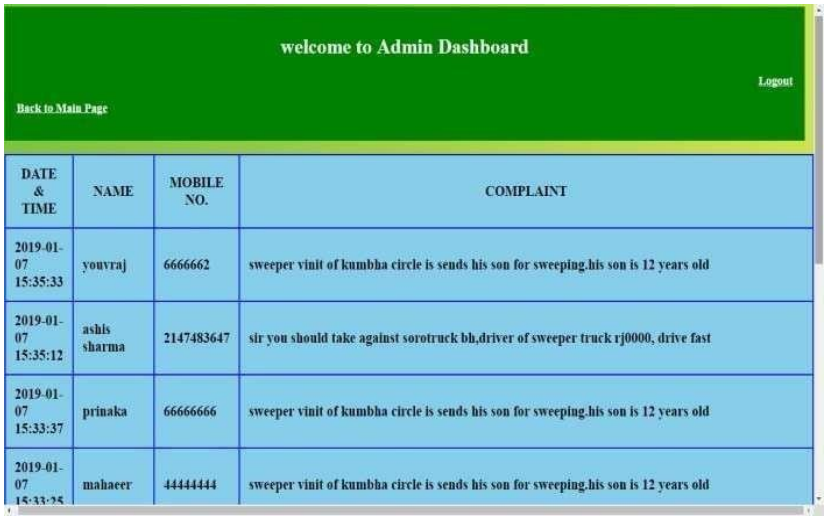

Fig.10: Dashboard

1. Dustbins may also be equipped with LED signboards and bio-enabled gas sensors. A few elements that apply to multifunctional smart trash cans include:
2. Smart Dustbins along different sensors.
3. Street Signage
4. For public information there will be LED display
5. Wi-Fi modules are usable in train stations, resulting in low power consumption.
6. CCTV Camera
7. Dustbin Tracking System
8. Sensors and equipment of the future will generate their own energy using solar or piezoelectric panels.
9. Rather of purchasing a new trash can, this device may be added to already-existing dustbins. The figure 12 shows the current dustbin. The table compares a number of efforts..5.

Table.5: Comparison of Projects

S. No.	Name of the existence Project	Author name	Level Sensor	Toxicity Sensor	Web/ App support
1.	Implementing of Smart Waste management System Using IoT	P Haribabu et al. [2]	Present	Absent	Present
2.	Smart Garbage Monitoring and Clearance System	S. Vinoth Kumar et al. [4]	Present	Absent	Present
3.	IoT Based Solid Waste Management System for Smart City	Krishna Nirde et at. [5]	Present	Absent	Present
4.	Dissipation of Waste Using Dynamic Perception and alarming System	Imteaj A et al. [6]	Absent	Absent	Present
6.	Autonomous Smart Waste Collection System	Shujatullah Khan et al. [9]	Present	Absent	Present
7.	**(Our Proposed System)**	-----	**Present**	**Present**	**Present**

Figure 11 depicts the model we have suggested.

Fig.11: Smart Dustbin

There are several places where this project may be carried out, such as parks, train stations, bus stops, historical sites, and so on. Since all bus stops and train stations will have Wi-Fi in the future, smart dustbins will contain features like Wi-Fi Hotspots instead of GSM modules.

We have built one trash can, but many more may be installed with unique IDs, allowing their monitoring from any location on the planet to be a breeze. The recipient of the message should be the one responsible for emptying the garbage can based on the unique ID..

Fig.12: Existing Dustbin

CONCLUSION

In addition to solving the long-standing problem of ineffective trash management, the application of this cutting-edge method transforms municipal corporations' interactions with the public and their ability to monitor community cleanliness. Through the utilization of intelligent technology and real- time data tracking, the system provides a full resolution to the issues encountered earlier.

This method's capacity to deliver precise and current information on the state of dustbin filling is one of its main benefits. Authorities may also effectively organize and schedule cleaning activities, guaranteeing that waste is collected and disposed of in a timely manner, by getting automated information about the status of dustbins.

Furthermore, the creation of a centralized internet database improves waste management initiatives even more. This database acts as a central store for all pertinent data, such as dustbin locations, fill levels, and maintenance records. In addition to helping decision-makers make well-informed choices, such extensive data also helps authorities spot patterns and trends in the production and disposal of trash, which opens up new avenues for resource allocation and strategic planning.

FUTURE SCOPE

India has a promising future for IoT-based smart garbage management systems, since they provide several benefits to both citizens and local government representatives. First off, a significant increase in the amount of waste produced in cities is anticipated as India's urbanization rate continues to rise. By streamlining waste collection routes, enabling data-driven decision-making by municipal authorities, and offering real-time monitoring of dustbins, IoT-based solutions provide a scalable approach to effectively manage this expanding waste stream. This lowers operating expenses and their negative effects on the environment in addition to increasing the efficacy of waste management procedures.

Second, the use of intelligent waste management systems can support India's attempts to develop resilient and sustainable urban areas. Cities may reduce the quantity of waste dumped in landfills, encourage recycling and composting programs, and better track waste generation patterns by utilizing IoT technology. This is in accordance with the government's Swachh Bharat Mission, which aims to improve sanitation and cleanliness across the country.

In addition, IoT-based solutions can improve public health outcomes by decreasing instances of illegal dumping, littering, and the spread of pests that spread disease, such rats and mosquitoes. Through timely dustbin emptying and appropriate trash disposal, smart waste management systems can help reduce health hazards related to uncollected waste and unhygienic conditions.

Moreover, the integration of technologies into trash disposal programs presents prospects for ingenuity and entrepreneurial ventures in India's rapidly expanding technology industry. In the course of creating jobs and promoting economic growth, startups and technology companies can create new services and solutions specifically designed to address the particular difficulties associated with garbage management in Indian cities.

All things considered, IoT-based smart waste management systems have a bright future in India. They have the power to transform urban sanitation procedures, enhance public health results, and promote sustainability and innovation in Indian cities. India can create cities that are healthier, cleaner, and more habitable for coming generations if it embraces these technologies and makes investments in their ongoing development and application.

REFERENCES :

1. Haribabu P, Kassa SR, Nagaraju J, Karthik R, Shirisha N, Anila M, “Implementation of a smart waste management system using IoT” in International Conference on IntelligentSustainable System (ICISS) (pp. 1155-1156), IEEE.
2. Jain A, Bagherwal R, "Design and implementation of a smart solid waste monitoring and collection system based on Internet of Things” in 8th International Conference on Computing, Communication and NetworkingTechnologies (ICCCNT), 2017 Jul 3 (pp. 1- 5), IEEE.
3. The Hindustan times available at: https://www.google.com/amp/S/m.hindustantimes.com/M um bai-news/105-rise-in-waste-getnerated-in-mumbai- from-1999- to-2016-study/story- QEI4qWehSae9ZYtImNdBaM_amp.html (Accessed on 10 Jan 2019).to-2016-study/story- QEI4qWehSae9ZYtImNdBaM_amp.html (Accessed on 10 Jan 2019).
4. Ravale U, Khade A, Patel N, Chaure S. “Smart Trash: An Efficient Way for Monitoring Solid Waste Management”in2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC) 2017 Sep8 (pp. 1135-1137). IEEE.
5. Joshi J, Reddy J, Reddy P, Agarwal A, Agarwal R, Bagga A, Bhargava, “Cloud computing based smart garbage monitoring system” in 3rd International Conference on Electronic Design (ICED), 2016 Aug 11 (pp. 70-75), IEEE.
6. Kumar SV, Kumaran TS, Kumar AK, Mathapati M, “Smart garbage monitoring and clearance system using internet of things” in IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), 2017 Aug 2 (pp. 184- 189), IEEE.
7. Nirde K, Mulay PS, Chaskar UM, “IoT based solid waste management system for smart city” in International Conference on Intelligent Computing and Control Systems (ICICCS), 2017 Jun 15 (pp. 666-669), IEEE.
8. Imteaj A, Chowdhury M, Mahamud MA, “Dissipation of waste using dynamic perception and alarming system: A smart city application” in International Conference on Electrical Engineering and Information Communication Technology (ICEEICT), 2015 May 21 (pp.1-5), IEEE.
9. Ankitha S, Nayana KB, Shravya SR, Jain L, “Smart city initiative: Traffic and waste management” in 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), 2017 May 19 (pp. 1227-1231), IEEE.
10. Vasagade TS, Tamboli SS, Shinde AD, “Dynamic solid waste collection and management system based on sensors, elevator and GSM”, in Inventive Communication andComputational Technologies (ICICCT), 2017 Mar 10, (pp. 263- 267), IEEE.
11. Khan S, Venkat S, Jayavel K. in IEEE International Conference on Power, Control, Signals and Instrumentation Engineering (ICPCSI) on “Autonomous smart waste collection system using internet of things” 2017 Sep 21 (pp. 1181-1186). IEEE.
12. Kolhatkar C, Joshi B, Choudhari P, Bhuva D. “Smart E- dustbin”in2018 International Conference on Smart City and Emerging Technology (ICSCET) 2018 Jan 5 (pp. 1-3). IEEE.
13. Rohit GS, Chandra MB, Saha S, Das D. “Smart Dual Dustbin Model for Waste Management in Smart Cities”in2018 3rd International Conference for Convergence in Technology (I2CT) 2018 Apr 6 (pp. 1-5). IEEE.
14. Tejashree Kadus, Pawankumar Nirmal, and Kartikee Kulkarni, “Smart Waste Management System using IOT,” International Journal of Engineering Research and, vol. V9, no. 04, May 2020.
15. Haldorai and A. Ramu, “Security and channel noise management in cognitive radio networks,” Computers & Electrical Engineering, vol. 87, p. 106784, Oct. 2020. doi:10.1016/j.compeleceng.2020.106784
16. Zeinab, Kamal Aldein Mohammed, and Sayed Ali Ahmed Elmustafa. "Internet of Things applications, challenges and related future technologies." World Scientific News 2, no. 67 (2017): 126-148.
17. Haldorai and A. Ramu, “Canonical Correlation Analysis Based Hyper Basis Feedforward Neural Network Classification for Urban Sustainability,” Neural Processing Letters, Aug. 2020. doi:10.1007/s11063-020-10327-3
18. Parashar and A. Parashar, “IoT-Based Cloud-Enabled Smart Electricity Management System,” Smart Innovation, Systems and Technologies, pp. 755-766, Oct. 2019.
19. Hayati AP, Emalya N, Munawar E, Schwarzböck T, Lederer J, Fellner J. “Analysis the potential gas production of old municipal solid waste landfill as an alternative energy source: Preliminary results.” inIOP Conference Series: Materials Science and Engineering 2018 Mar (Vol. 334, No. 1, p. 012031). IOP Publishing.
20. Murugaanandam S, Ganapathy V, Balaji R. “Efficient IOT Based Smart Bin for Clean Environment”in2018 International Conference on Communication and Signal Processing (ICCSP) 2018 Apr 3 (pp. 0715-0720). IEEE