AZIGBEE GARBAGE BIN MONITORING SYSTEM WITH IoT

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Abstract– One of the critical responsibilities in ensuring a clean and pollution-free society is maintaining garbage disposal. Damage to the environment and human health results from improper garbage maintenance and disposal. However, it can be seen that garbage bins in several places including cities are left to overflow on streets. With the development of IoT, this scenario can be improved by providing screening of the status of trash bins. A Bin Level Monitoring Unit (BLMU) consists of the end sensor with the bin. The filled status of the garbage bin is detected and sent to a Wireless Access Point Unit (WAPU). The ZIGBEE devices are used to communicate each local device to a master IoT device which is placed in each area. Thishelps connect multiple devices to connect to a network and access the IoT module. The bin is accessed by the public and municipality by their RFID tags. There is an automatic locking system in case of the bin is full or is detected with poisonous gas.The bin can then be opened only by the municipality with their tag.

Keywords: IoT, BLMU, WAPU, ZIGBEE, RFID.

I. INTRODUCTION

Municipal waste is a major source of pollution that is affecting the health of people, particularly in urbanareas. However, waste generation is unavoidable in society. Real-time monitoring of trash cans in urban areas can be made possible by technological advancements in sensor design, communication protocols, and remote monitoring techniques[1]. The Internet of Things (IoT) consists of various types of components that are connected over the web. Thesecomponents can be sensors, processors, andcommunication devices that collect the data required andsend them to the cloud for analysis by utilizing a gateway. IoT is majorly applied to smart automation systems like home automation systems[2][17]. A smart garbage monitoring system can be established through IoT that shares the status of the garbage bins with the municipality. This will help them to dispose of garbage in a much more efficient and simple way. The current advancements in

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technology make it possible to track the locations of those bins that are full. The amount of garbage filled will help the municipality to map a route for garbage trucks, which is much more efficient than the current periodic system. The waste disposed of can be of many types like chemical, medical, or industrial which may in certain cases emit harmful gases[3][12-14]. To prevent people from coming in contact with these gases, a gas sensor is used to detect and lock the bin. The municipality will also be notified and can come to collect the garbage with the necessary precautions.

II. LITERATURE SURVEY

IoT-Enabled Smart Waste Bin Management System and Efficient Route Selection was proposed. Internet of things (IoT) is an emerging technology that offers promising solutions to modernize the traditional systems. It accords promising result in crystallizing smart cities, smart homes, smart industries, and smart environment. This article presents the smart waste management architecture for smart cities and efficient routing technique considering least delay for the architecture [1][13]. In wireless sensor networks, end-to-end delay is one of the important Quality of Services (QoS) parameter to overcome delay in data communication [10]. In this article, we consider end-to-end delay minimization in smart waste management application. The term "end- to-end delay" is defined as the total time taken by a single packet to reach the destination node. The proposed scheme considers the interference level, the length of the routing path, and the number of hops along the path. The simulation results show that the proposed scheme outperforms current schemes

Smart garbage management system for a sustainable urban life: Proper waste management is one of the major problems for densely populated urban areas. It is getting difficult day by day to lead a healthy, sustainable living in urban areas because of environmental contamination. Due to the lack of proper waste management approach, problems like an overflow of waste occurs that badly harm our environment. Polluted surroundings result in the spread of various kinds of diseases in an epidemic form. For developed and developing countries, waste management is a challenge to long-term development [5][15]. Proper management of waste is getting tougher because of increasing population, urbanization, and industrialization. In this modern era of technology, we need to apply technology-based solutions to handle large amounts of waste for overpopulated urban areas [7-8]. We have reviewed several recent research articles related to the smart waste management system, and almost all of them have some major limitations as well as progress [2][18]. To ensure environmental hygiene and sustainable urban life, we have presented a smart IoT based integrated system consists of an identification system, an automated lid system, a display system, and a communication system. Arduino Uno is used as a microcontroller to synchronize all of the four systems. Sensors are used for identification and measuring the garbage level. The system provides the facility of continuous monitoring of the status of waste inside the garbage bin and shows the percentage filled up on liquid crystal display (LCD). The communication system uses a global system for mobile communications (GSM) module that will inform the corresponding authority to collect the waste when the garbage bin is filled up.

Improper disposal of solid waste that impacts human health and pollutes the environment, arising a need for successful and necessary collection of waste materials [6]. However, most trash bins placed in cities can be seen overflowing due to traditional or inefficient waste management approaches. Therefore, a real-time remote monitoring system is needed to alert the level of garbage in bins to the relevant authority for immediate waste clearance. This paper presents the development and validation of a self-powered, simply connect, IoT

solution to monitor the unfilled level of trash bins from acentral monitoring station. The end sensor nodes of the developed IoT system are called Bin Level Monitoring Unit (BLMU) which are installed in every trash bin where the unfilled level needs to be monitored [3][9]. Every BLMU measures the unfilled level of the trash bins and transmits it to a wireless access point unit (WAPU). Each WAPU receives the unfilled level data from several BLMUs and uploads it to the central server for storage and analysis. The waste collection authority can view and analyse the unfilled level of each bin using a smart graphical user interface . The following important experiments were carried out to validate the developed system: (1) the developed bin level monitoring system was tested by filling a trash bin with solid waste at various levels, and the corresponding unfilled level of the trash bin was monitored using the smart graphical user interface. (2) The life expectancy of the BLMU was evaluated as approximately 434 days. (3) The maximum transmission distance between a BLMU and a WAPU is119 m. (4) The cost of a developed trash bin is 107 USD.Based on the results achieved, the developed trash bins can be suitable for smart cities.

Domestic waste managementis considered as a critical practice that must be followed from the time waste is generated until the time it is disposed of. The integration of smart bins in the waste management process increases the demands on the wastecollection strategy. This study looks at how the internet of things (IoT) can be used to improve waste collection systems. It contrasts a standard periodic review technique with an IoT-enabled strategy in which we assume garbage bins are equipped with smart sensors that provide continuous monitoring of the bin's status [4][11]. Asimulation model is developed that is based on two modules: the waste generation and the waste management. The Al Rayyan, Qatar region's partial data is simulated using various parameter values and scenarios. The simulation is validated by taking economic, environmental, and citizen satisfaction performance measures into account. The results of the experiments revealed that each collection method performed well in a specific situation. In comparison to the periodic review waste collection method, the truck travels fewer miles while meeting economic, environmental, and public satisfaction goals in the IoT- oriented method [14].

Municipal solid waste management remains a major problem in urban areas, leading to serious health and environmental issues. Consequently, trash bins are placed in many places to handle the municipal solid waste, but these binscan overflow, spreading around the area, polluting the environment, and causing inconvenience to the public. Therefore, there is a need for a real-time remote monitoring system [18] that alerts the level of garbage in the trash bins to the municipality or a waste management company. To manage the municipal solid waste efficiently, this article presents the development and validation of a self-powered, LoRaWAN Internet-of- Things (IoT)-enabled trash bin level monitoring system. The end nodes of the proposed IoT system are called trash bin level measurement unit (TBLMU) and areinstalled in each trash bin where the status needs to be monitored [5]. The TBLMU measures the unfilled level andgeographical location of a trash bin, processes the data, and transmits it to a LoRaWAN gateway at a frequency of 915 MHz. A LoRaWAN gateway serves as a concentrator for the TBLMUs and relays data between aTBLMU and an IoT trash bin level monitoring server. The users can view and analyse the status of every bin and its geolocation by using a smart graphical user interface. The accuracy of the developed system, wireless range between a TBLMU and a LoRaWAN gateway, average current consumption and lifeexpectancy of the TBLMU, battery charging time, and the cost were studied and are reported here.

TABLE 1 COMPARISON OF EXISTING MODELS WITH THE PROPOSED MODEL

S NO	PARAMETER	A Proposed IoT-Enabled Smart Waste Bin Management System and Efficient Route Selection	Smart garbage management system for a sustainable urban life	An IoT-based bin level monitoring system for solid waste management	Domestic Waste Management with IoT-enabled Applications	A LoRaWAN IoT-Enabled Trash Bin Level Monitoring System
1	Location tracking	YES	NO	NO	YES	YES
2	Bin locking	NO	YES	NO	NO	NO
3	SMS Alert	YES	YES	YES	YES	YES
4	Harmful Gas detection	NO	NO	NO	NO	NO

III. EXISTING SYSTEM

Each bin is thought of as a node with sensors fixed to measure the amount of garbage inside. The Bin level is monitored with an ultrasonic sensor. These end nodes of the IoT system are called trash bin level measurement units (TBLMU) and are installed in each trash bin where the status needs to be monitored. A trashcan's unfilled level and geographic location are measuredby the TBLMU, which also analyses and transmits the information.

IV. PROPOSED SYSTEM

The suggested system allows for real-time monitoring of the garbage bins' condition and presents that information to the relevant authorities. Garbage monitoring can be made better with IoT. Bin levels are determined using ultrasonic sensors installed within the bins. The trash can is locked and may only be accessed by the municipality if it is full. Due to the ambiguity of the waste disposed of, the emission of poisonous gas is possible. A gas sensor may also detect the presence of any dangerous gas. To prevent the public from inhaling those harmful gases the bin is locked automatically. The municipality is alerted of this and they can dispose of thewaste. The location of those bins that are full and with poisonous gas is shared with the municipality with GPS.The municipality is informed of all these data via a GSMmodule

ADVANTAGES OF THE PROPOSED SYSTEM

- A remedy is given to the situation where the binbecomes full. The bin is locked automatically once its full and can only be opened by reading the RFID tag from the municipality.

- There is a gas sensor to detect poisonous gas and once detected the bin is again locked.
- Automatic locking system

V. SYSTEM REQUIREMENTS HARDWARE REQUIREMENTS

- POWER SUPPLY
- ARDUINO UNO
- LCD
- ULTRASONIC SENSOR
- RFID READER
- RFID TAG
- LCD
- ZIGBEE PAIR
- ESP8266
- MQ4 GAS SENSOR
- SERVO MOTOR

SOFTWARE REQUIREMENTS

- ARDUINO IDE
- EMBEDDED C LANGUAGE

VI. ARCHITECTURE DIAGRAM

VII.

RECEIVER

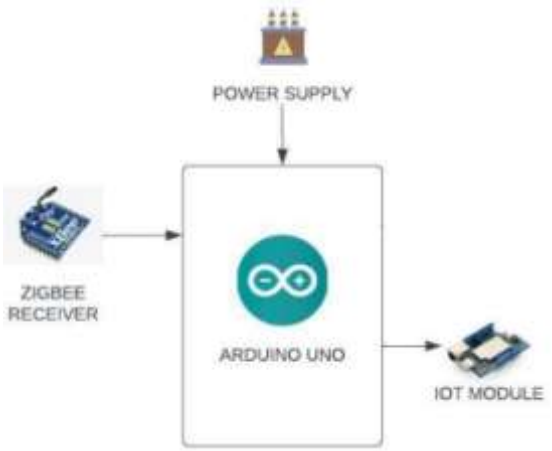


Fig 1 Receiver

TRANSMITTER

Fig 2 Transmitter

MODULE DESIGNLIST OF MODULES

1. Bin-level checking
2. Poisonous gas detection
3. Location tracking
4. Status sharing and display

BIN LEVEL CHECKING

The ultrasonic sensor is used to check the level of the bin. Using the transceivers in the sensor the distance of the bin from the top is calculated which helpsdetermine the level. The position of the sensor to be fixed is important. Fixing it on the top will produce the most accurate filled-up level of garbage.

If the level detected shows that the bin is full then the bin is automatically locked. The public can no longer open the bin using their RFID tag. The municipality can now come and collect the garbage. The IoT module will update the condition of the bin as full on the webpage.

Considering the height of the bin to be around 15 to 20 cm, if garbage has been filled at around 5 cm i.e., the distance between the lid and the garbage is around 15 cm, then it is considered to be medium level or low level. The distance between the lid and the garbage when reduced to 5 cm or below is considered asthe bin is full.

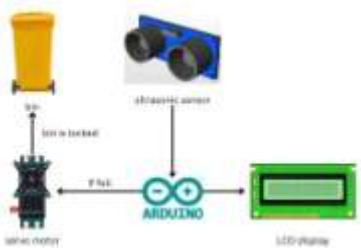


Fig 3 Bin Level CheckingPOISONOUS GAS DETECTION

The garbage that is filled can be of unknown nature sometimes. There can be chemicals and other forms of discard that can produce harmful gases. This can be the case, especially in industries and hospitals. The gases can be methane, ammonium, etc which can cause harm to humans and the environment. There will also be the presence of bad odor.

Once the emission of poisonous gas is detected the bin gets locked automatically. The bin again cannot be opened by the public. Thus, people coming into contact with harmful gases can be prevented. It can be opened only by the municipality using its RFID tag.

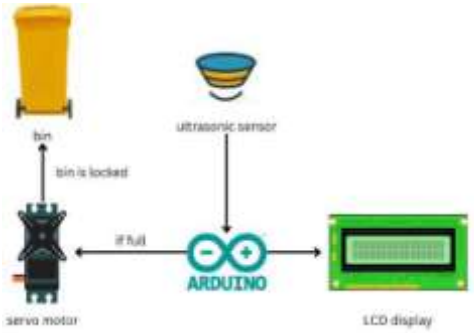


Fig 4 Poisonous Gas detectionLOCATION TRACKING

The bin contains a GPS tracker to identify the location of the bin that is full. The status of the bin is sentalong with the location of that bin. The location information will be helpful while deciding on a route forgarbage collection by municipality.

Traveling to places where the bin is yet to be full will be a waste of fuel and time. Therefore, having the status and location of the bins will help develop an efficient route for garbage trucks.

Fig 5 Location TrackingSTATUS SHARING AND DISPLAY

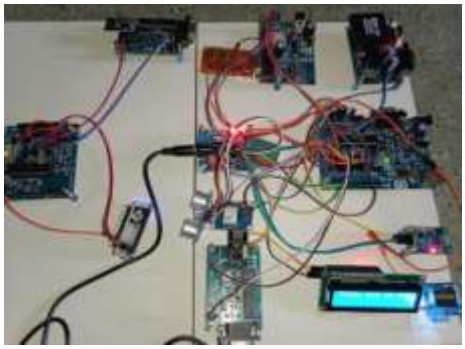
The GSM module is used to share the alert message with the municipality. Once the bin is full, an SMS alert is sent to the municipality. The status of the bin together with its location is sent to the municipality. The municipality arranges routes for the garbage trucks using

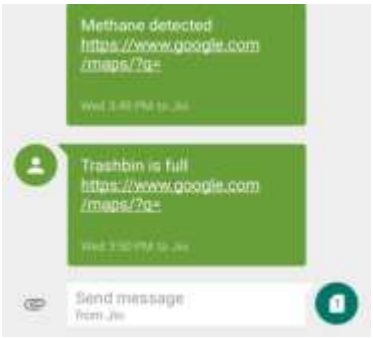
Fig 6 Status sharing and display

this data.

The status of the bin is constantly shown on the LCD. All the alert messages are displayed on this LCD as well. Three LEDs are used to differentiate the level of garbage filled in the bin. All those alert messages are displayed on the LCD.

VIII. RESULT AND OUTPUT





CONCLUSION

Smart Bins contribute to improved operational efficiency, and a safer, cleaner, and more hygienic environment, all while lowering management expenses, resource consumption, and roadside emissions. Busy places like campuses, amusement parks, airports, and train stations are perfect places to deploy the Smart Bin. Smart bins can provide betterment to the current situation of garbage disposal. Monitoring garbage bins will help the environment stay clean. Municipalities must take care in managing the garbage through these bins. Energy waste can be avoided by saving fuel from the garbage trucks where they travel to place with unfilled bins. Once proper data on the bins are obtained, an efficient route can be built through various algorithms and techniques. Real-time monitoring of trash cans in urban areas is made possible by technological advancements in sensor design, communication protocols, and remote monitoring techniques. Providing a clean and hygienic environment to the future generation can be made possible if this is implemented full-fledged throughout the country

FUTURE ENHANCEMENT

The current age is full of automation. Artificial Intelligence is flourishing in all fields these days. This smart monitoring system can be automated completely by using a robot that collects the garbage as well.
Diseases spread through the waste through bacteria and other disease-inducing microorganism formation. Detection of this bacterial presence can be incorporated into this system to take precautions while handling the waste.
This system can be enhanced to be utilized on a larger scale. Bigger bins can be set up with this system using multiple sensors. Though it is important to design them in a way that those sensors do not cause interference with each other.

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