An IoT Based Smart Garbage Monitoring System using Lora Technology

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Abstract— The overflow of garbage in public areas generate unhealthy condition, and it generates numerous diseases to the population. To avoid it, the trash bins & garbage management should be modernized using the Internet of Things (IoT). During this paper, we proposed an 'IoT based smart garbage monitoring system using Lora' to unravel this problem. Using an Ultrasonic sensor, Arduino pro mini, & RFM95 Lora module we monitored the level of garbage by making use of Lora technology.

Keywords: IoT, Lora Technology, Smart Garbage Monitoring System

I. INTRODUCTION

With the rise of population density, urbanization is assuming extreme proportions & presents an incredible urban problem associated with waste generation. The increase of garbage generation has been considered a serious challenge to large urban cities worldwide & represents a critical issue for countries with an accelerated increase in cities.

We see repeatedly in our city trash cans or garbage cans placed in public places are always overloaded. This leads to the unhealthiest environment for people also to leave the place dirty. Because of the trash containers being overfull & refuse spills out. This prompts the number of maladies as a huge number of creepy crawlies & flies to breed thereon & leads to bad odour within the surrounding.

To address the restrictions of conventional garbage storage & collection system we can replace the trash bins with smart bins & connecting them to a cloud server. The concerned person can utilize this information for the gathering of garbage from different parts of the town. It can help to scale back the gathering time with reduced costs, also as citizenship promotion.

A. Aims and Objectives

- To enhance the practicality of IoT based solid waste collection & management system for a sustainable city.
- To make an economical IoT enabled Smart bin.
- To reduce the time, & cost of waste collection.
- To reduce fuel consumption by sending optimized routes to garbage collection vehicle.
- To reduce the environmental pollution & hazard by avoiding the trash bin overload & spill over.

II. MATERIALS

A. Ultrasonic Sensor

Fig. 1: Ultrasonic Sensor

Ultrasonic Sensor provides extremely short to long-range detection & ranging. It provides accurate & constant non-contact distance measurements from about 2 cm to 400 cm with very high accuracy. It is often easily interfaced with a microcontroller.

B. Arduino Pro Mini

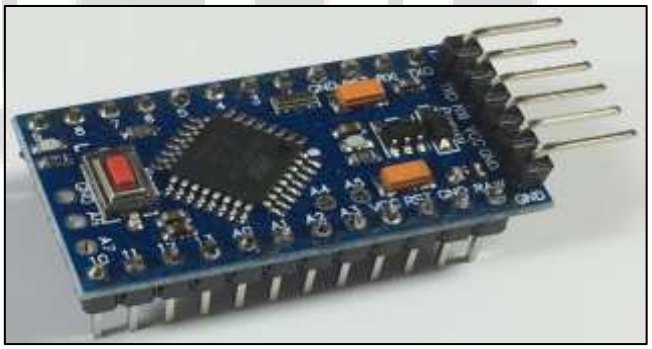

Fig. 2: Arduino Pro Mini

This board was formed for installations where space is premium & projects are made as permanent setups. It is tiny & available in 3.3 V & 5 V versions, powered by ATmega328. The Arduino Pro Mini is a microcontroller board supported the ATmega328. It's 14 digital input/output pins, 6 analog inputs, an on-board resonator, a push button, & holes for mounting pin headers. The board comes without remounted headers, allowing the use of different types of connectors or direct soldering of wires. There are two types of the Arduino Pro Mini. One runs at 3.3V & 8 MHz, the second at 5V & 16 MHz.

C. RFM95 LoRa Module

Fig. 3: RFM95 LoRa Module

The RFM95 transceiver module features the LoRa (Long Range) modem that provides ultra-long range spread spectrum communication, & a high interference resistance whilst minimizing power requirement. LoRa also provides significant benefits in both blocking & selectivity over conventional modulation techniques, solving the normal design compromise between range, interference immunity, & power requirement.

III. Methodology

The proposed system highlighted during this paper, "IoT based garbage monitoring system using LoRa Technology," aims at using an equivalent concept of the IoT & connecting a built device using an open-source computer & software to send data from a standard trash container to the upkeep facility office. The target of the proposed system is to make a tool that will shoot ultrasonic waves to understand the level of the trash in a container.

Data collected from the sensors are going to be sent through the LoRa that will display collected data on Computer. The platform is going to be found out to alert maintenance workers that trash must be collected so that they will plan an efficient route, emptying the fullest trash bins first. The location coordinates of those trash bins will be predefined within the code, rather than applying a GPS antenna to gain the location.

A. LoRa node using Arduino Pro Mini and RFM95 LoRa Transceiver Module

There are a variety of sensors that may be utilized in the system with an ultrasonic sensor which aren't important like temperature sensor, pressure sensor, humidity sensor, etc. which increases the cost, size & power consumption of the system. Therefore, we made a smart bin which will be fitted with only an Ultrasonic sensor to detect the extent of garbage collected.

As shown in Fig. 6, the ultrasonic sensor is connected to an Arduino pro mini that collects the sensor data & sends it to a LoRa gateway using RFM95 LoRa transmitter node. We have used the Arduino pro mini as a microcontroller because it's really low power consumption, very small in size, & low cost.

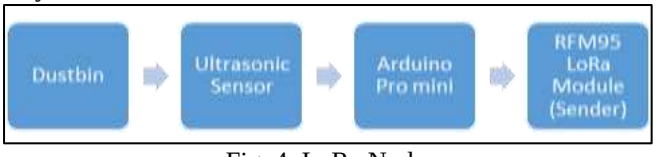

Fig. 4: LoRa Node

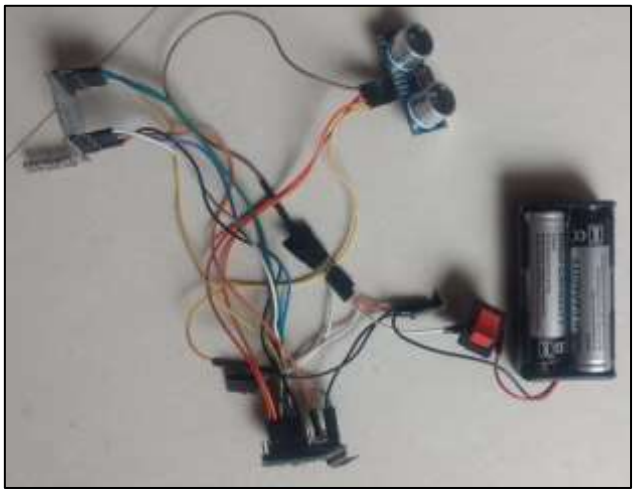

Fig. 5: Hardware setup

B. LoRa Receiver Using Arduino Pro Mini and RFM95 Lora Transceiver Module.

To receive the sensor data from smart bin a receiver is made with an RFM95 LoRa module and Arduino pro mini. The receiver connected to PC through the USB cable where the trash level can be seen. The design of the system is cost-effective & versatile.

Fig. 6: LoRa Receiver

IV. Results and Discussions

The prototype was first tested indoors in a trash container. Below is the final prototype device.

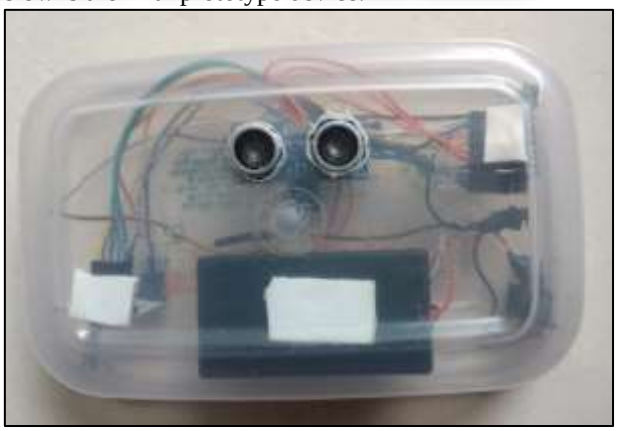

Fig. 7: Prototype Device

The prototype worked as intended. The trash level was successfully reported to the PC as shown in Fig. 8.

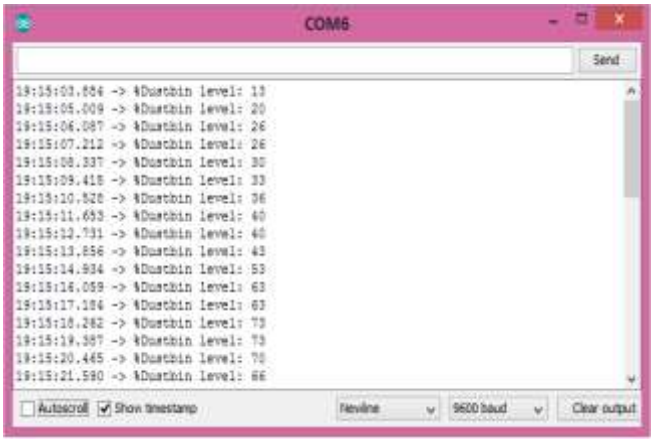

Fig. 8: The trash level reporting to the PC

When all the components (Ultrasonic Sensor, Arduino pro mini, & RFM95 LoRa module) are active, the system consumes an approximate total of 75mA. A charged 6000mAh battery last for 80hrs. The battery was prolonged by making some adjustments within the code to send the microcontroller board in Deep-sleep mode. A Deep-sleep mode is when the board disables all the modules on the board except the processor needed to work the system. During the Deep-sleep mode, required processors can awaken to perform the required task & return to Deep-sleep mode.

The Arduino pro mini offers an excellent deep-sleep mode. Consistent with the manufacturer datasheet, the board will consume as low as 0.054 mA when within the idle period. The consumption of the microcontroller drastically decreased from 40mA to 0.054 mA, which may be a significant improvement.

Sr. No.	Components	Normal Mode (mA)	Deep Sleep Mode (mA)
1.	Arduino pro mini (3.3 V)	40	0.054
2.	HC-SR 04 Sensor	15	5.000
3.	RFM95 LoRa module	20	0.500
	Total	75	5.554
	System running time: (with a 3000 mAh battery)	40 hours	540 hours

Table 1: System power consumption

Table 1 shows a breakdown of the facility consumption of various components within the system. When the system was running with all the components, it drew ~ 75 mA, which took up to 40 hours to discharge a charged battery. During a real-life scenario, the system is going to be set to run at an interval of 3 hr., enabling the battery to run longer before recharging.

In terms of cost, most components used for this project were at an inexpensive price. Table 2 shows the entire cost of the system without labour hours. The total cost of components of the device is Rs. 1,208/-. The cost of the device can be further decreased when mass-produced.

Sr. No	Component	Rate (Rs.)	Qty.	Cost (Rs.)
1	Ultrasonic Sensor	130	1	130
2	Arduino Pro Mini	260	1	260
3	RFM95	320	1	320
4	LiPo Battery (3000 mAh)	200	2	400
5	Jumper wires	16	3	48
6	Outer body	50	1	50
	Total Cost			1208

Table 2: Components prices list

The results provided during this research shows that a smart garbage monitoring system can be successfully managed & that normal trash cans can be turned into a smart bin with minimum cost.

V. CONCLUSIONS

This research manages to present an economical and user-friendly IoT based smart garbage monitoring system using LoRa. The system is often reproduced and is used for small-scale areas. Despite the successful completion of this project, there's still room for improvement. The most goal of the system is to contribute to the universal community & improve the standard of life within the world.

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