

IoT Based Smart Waste Monitoring System

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ABSTRACT—The issue of waste management has been a terrible problem. So, the waste needs to be managed. The collection of waste costs a considerable amount of money, time and huge amount of energy. The waste spills over the roadside leads to the spread of diseases. This also causes bad odor. This paper proposes an idea to monitor and manage the waste by using various sensors and ESP32 IoT Module. The IR detector detects the object and the servo motor is used for automatic opening and closing of dustbin. The ultrasonic sensor detects the level of waste in the dustbin and alerts the authorized person when the level reaches 90% and full. The notification will be sent when there is an existence of fire and when it causes foul odour. The collection of garbage routes is done through GPS. The data will be sent to the IoT based cloud server platform to perform analysis of the waste produced. This monitoring and managing of garbage waste reduce the human work so that they need not waste the time by monitoring the bins regularly.

KEYWORDS—ESP32, Ultrasonic sensor HC-SR04, flame sensor, MQ135 Air Quality Gas Sensor, smart waste management

I. INTRODUCTION

The current population of India is 133.92 crores (2017) and this is nearly 18% of the world population, the country produces about 62 million tons of waste every year, this is a mixed waste which can be recyclable and non-recyclable. By 2030, the various parts of the universe will get developed also as more populated as a result of which the waste amount also will increase [1]. As reported by a research, the population growth is directly proportional to the waste generation [2]. The most important part of a healthy life is clean environment [3].

Solid Waste Management dispute is the major contest to the administration [4]. Phenomena such as urbanization, industrialization and economic growth have resulted in increased waste generation [5]. The main problems affecting solid waste

management are unscientific treatment, improper collection of waste, and ethical problems. This successively results in hazards like environmental degradation, water pollution, soil pollution, and air pollution. Human health is affected primarily by air pollutants discharged within the atmosphere and by the doable contamination of fresh sources and agricultural soils.

An efficient waste collection is important to stop the waste from affecting human health and polluting environment. Large quantities of uncollected waste are one among the thing which will affect society health and ecological system if it is not properly managed. The country will face a problem when there is no appropriate management for this waste collection. There are many areas where peoples are highly affected by the environmental pollution. This leads to very harmful and poisonous effects on the human health. One of the major causes of the pollution is the very poor management of the waste materials [6]. There are some negative effects while considering the garbage bins always being full. One of the most effects is the surrounding area beginning to smell and be very unpleasant. When the garbage bins are full people put their waste on sides of the garbage bins. When this is done for some time, first it starts to smell bad. So, others who come later tend not to go close and throw their trash in the direction of the garbage bins. Another negative effect is the diseases that spread. It's not just the garbage that spread them, but the animals also can be a source [7].

An IoT based cost-effective system which monitor the waste in the dustbin enables garbage bin monitoring, dynamic scheduling and routing of garbage collector trucks in a smart city [8]. The Internet of Things (IoT) can be interpreted as an object around us that can communicate together and the other way through network internet. Internet of Things has a concept that aims to enlarge the benefits of being connected in an internet connection continuously [9].

In this paper, we are going to propose an idea to monitor the level of the garbage using

ultrasonic sensor by alerting the authorized person through notification when the bin gets 90% filled. The IR sensor is used for automatic opening and closing of garbage with the help of servo motor when the object is detected. It also sends notification when there is an existence of fire and causes foul odour. The data is stored in the cloud and the analytics data is used to manage the shortest collection routes effectively.

The paper is distributed as follows. Section II discusses the proposed system and the system development. Section III discusses the experimental result of the system. Finally, Section IV discusses the conclusion and future work of the system.

II. PROPOSED SYSTEM

This section briefly explains about the proposed methodology. This project proposed a methodology where an infrared sensor is used for the detection of object and an ultrasonic sensor detects the level of the waste in the dustbin. When the dustbin reaches the level of 90% and full, the notification is being sent to the authorized person. By updating the status, they can collect the garbage once it gets filled. It also notifies when there is an existence of fire. When the garbage is not filled and it is being stored for more than 3-4 days, this may cause a foul odour. So, if it causes foul odour the notification is sent to the person to clear the garbage. The data is being sent to the cloud. The GPS is used for the location of the bin. All the data is being displayed via mobile application.

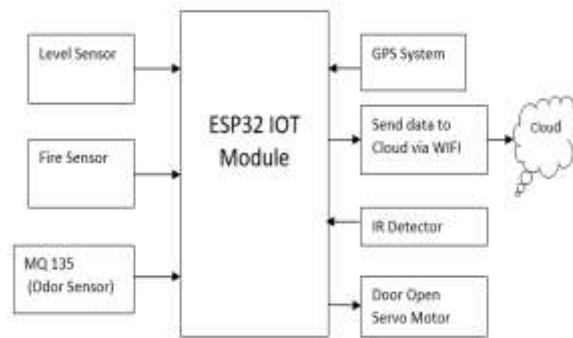


Fig. 1 Block diagram of Smart Garbage Monitoring System

A. System Development

In this system, an object is detected by IR detector and the dustbin gets automatically opened by using servo motor. The level of the waste is detected by ultrasonic sensor HC-SR04 and when it exceeds the threshold level the notification is being sent to the

authorized person. When there is an existence of fire a notification is sent. A gas sensor is used to detect the presence of foul odour. The collected data is sent to the cloud via Wi-Fi which is displayed via mobile application as shown in Figure 1.

B. Flowchart

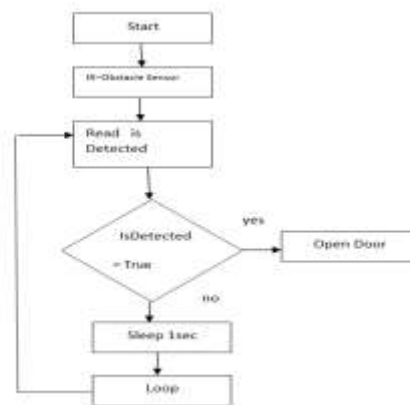


Fig. 2 a Flow chart of garbage door open

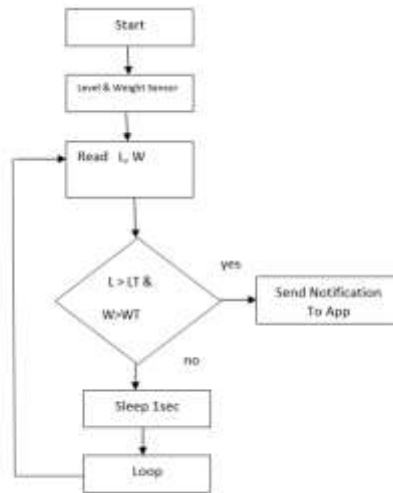


Fig. 2 b Flow chart of App notification

The flowchart of our proposed system is described in Figure 2 a, b. This shows the complete information about the proposed system.

C. ESP32 IoT Module

ESP32 is a series of low-cost, low-power system on a chip micro controller integrated with both Wi-Fi and dual-mode bluetooth. The ESP32

series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes built-in antenna switches, power amplifier, filters, and power-management modules as shown in Figure 3. To program ESP32 module, a user-friendly interface Arduino IDE Software is used [10,11].



Fig. 3 ESP32 IoT Module

D. Ultrasonic sensor

An ultrasonic sensor is a device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. To calculate the distance between the sensor and the object, the sensor

calculates the time it takes between the emission of the sound by the transmitter to its contact with the receiver by using the formula $D = \frac{1}{2} T \times C$, where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second.

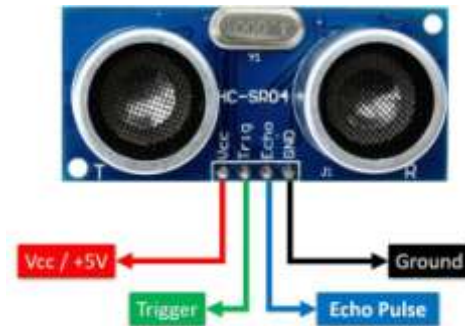


Fig. 4 Ultrasonic Sensor

E. ThingSpeak Cloud

Thing Speak is an IoT analytics platform service which allows to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data to ThingSpeak.

III. RESULTS AND DISCUSSION

At the top of the dustbin an ultrasonic sensor is located to detect the level of the waste present in the dustbin. When the level in the dustbin exceeds the threshold level, the notification is being sent to the authorized person. A few more sensors like MQ 135 gas sensor and flame detector are used. These components are easily available and less expensive.



Fig. 5 Garbage Level Display in LCD

In this Figure 5, the ultrasonic sensor is set at the top of the dustbin and it is connected to the ESP32 IoT Module. When there is no waste inside the dustbin, it displays “Smart bin is empty”. When the level of the waste exceeds the threshold level, it

displays that the Smart bin is full. A notification is also sent to the authorized person when it exceeds the threshold level.

A mobile application is created to display the details in the app to the user. A notification is sent to the user via mobile app.



Fig. 6 Graph analysis

In this Figure 6, the level of the waste, fire and odour is displayed in graphical representation. The data is stored in the cloud and it is displayed via mobile application. This helps to maintain clean and healthy environment.

IV. CONCLUSION

In this paper, we propose “IoT Based Smart Garbage Monitoring System” to keep the city clean and safe. This system implements different kinds of sensors, ESP32 module with inbuilt WIFI and Bluetooth connection, Ultrasonic sensor HC-SR04 to detect the level of garbage which is filled. NEO-6M GPS Module is used to track the location, MQ135 Air Quality Gas Sensor is used to detect foul odour, IR Flame sensor is used to detect the existence of fire, load cell is used to find the weight of the garbage, IR detector and servo motor is used to open the lid automatic and LED light is used to indicate whether the garbage is full or not. Notification is sent to the authorized person when it reaches above the threshold value and also for the existence of fire and foul odour notification is sent to the authorized person. A mobile application was successfully developed and tested to display the data. By implementing this system, we can make our environment clean and hygienic. The future work can be carried out in finding the segregation of waste based on image processing.

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