Dumpster Monitoring System

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ABSTRACT

Waste generation and collection is a major concern in the present world. The major reason for this may be the unawareness of people or improper behavior of the people. The filled garbage bin always leads to the formation of different diseases for humans and also causes environmental issues. As a solution, this paper proposes an IOT-enabled dumpster monitoring system to maintain the environment safe and tidy. The heart of the design is a Node MCU module. The system uses an ultrasonic sensor to detect the garbage level in the bins and it is compared with the depth of the garbage container. The information on the undesirable level of garbage is intimated to the concerned authorities for further action. All the information regarding garbage monitoring is made available on a web page named a dumpster monitoring system. The main benefit of the system is that it maintains the collection of waste on time and prevents bin overflow.

Keywords: Waste monitoring, Waste management, Automatic lid

1   Introduction

Nowadays waste management is becoming a major task. It includes the pickup of trash, transportation, and landfilling. Waste management is an important process that brings a clean environment, reduced pollutants, water resources, etc. The timely waste removal from the collection site and its scientific disposal is a major challenge that society faces.

In every locality, there will be one or two dustbins placed for waste collection. The waste is collected by the truck drivers, and they set a particular time like one week or one month to collect the waste. In fact, in some cases, the waste will be filled earlier and that makes issues in the environment and also health-related hazards. The IoT-based Dumpster Monitoring System uses NodeMCU, L293D, Gas sensor, Ultrasonic Distance sensor, and Power supply. The system uses an IoT page to show the levels of dustbins. There are two units on the IoT page, the Driver unit and the Admin unit. Once the dustbin is filled or if there is any unwanted odour present in the dustbin, the system automatically locks the dustbin door with the help of a motor driver and sends the data to the IoT page. This is done on the admin page and the time for waste collection and others are shown in the Driver unit. The system also contains three monitors. While pressing the buttons it will be changing from one driver to another.

Thus, this system will help in the proper collection of dumped waste once the dustbin is filled. By this, fuel consumption and carbon emission can be reduced. This system will help the cities and municipalities to manage their waste efficiently and effectively.

2   Existing System

The existing system provides intelligent waste management by providing an automatic trash bin that has an IoT functional unit installed. Using this current status of the bin-container can be intimated to local authorities.

This paper [1] aims to transport and modify IoT with sensors to make a smart trash monitoring system. Having installed this system, any kind of waste collection site can be monitored effectively, and the filled bins waste can be transported to the final treatment station. The system is made using C programming language, PHP programming, Web socket, and the protocol used MQTT and HTTP [2]. Generally, the system is having hardware and software part which includes hardware, software, data visualization, and data

management. The hardware part consists of a can for trash collection which is equipped with multiple sensors and a system for communication. Thus, the monitoring of the garbage level and scheduling of garbage collection is carried out [3]. This increases the effectiveness of pollutant management, and it imparts a positive change in society. The system measures the height of the waste container, and a notification will be sent to the supervisor's smartphone if the trash level is reached the threshold. In the existing system, the trash bins opening and closing mechanisms are automized and also the complaint registering system is not included [4]. Here is an automatic garbage bin that will sort the waste by checking whether it is organic or not. A camera module is used for this along with the IoT [5]. A narrow-band IoT for observing the dumpster bin which is based on edge computing is explained in this paper [6]. Different types of waste like metals and non-metals are sorted and it is tracked with the help of a web that uses the MQTT Protocol [7]. An intelligent dumpster system is introduced here for reducing the Covid-19 spread in Indonesia. Here the laborers will get an alarm once the level of the bin is filled. Table 1 shows the comparison of the existing system and the proposed system.

Table 1: *Comparison of Existing and Proposed Systems*

SL No.	Journals/conference paper	Year of publication	Technology used	Components used
01	Smart Trash Monitoring System Design Using NodeMCU- based IoT	2019	IoT	NodeMCU, Ultrasonic sensor, Arduino
02	Smart Trash Cans for Waste Management Using NodeMCU and Ultrasonic Sensor	2022	IoT	ESP8266, Ultrasonic sensor, Servo
03	An NB-IoT-based smart trash can system for improved health in smart cities	2019	NB-IoT	compression sensor, a location sensor, an Infrared sensor, and an alarm sensor
04	Smart trash with web-integrated volume monitoring and sorting system via MQTT protocol	2022	MQTT Protocol	proximity sensors, capacitive proximity sensors, infrared sensors, an ultrasonic sensor, and a Wi-Fi module.
05	IoT-project smart trash can with Blynk Platform Integration	2021	IoT	Node MCU ESP8266 microcontroller and other sensors
06	Proposed system		IoT	Ultrasonic sensors, gas sensor, NodeMCU, WiFi module, LED, Motor driver

3 Proposed System

In this project, we devised a mechanism to detect waste through an IoT system that automatically initiates the process when the trash inside the bin is found to be full. In this work two additional features, one for complaint registration and the other for automizing the trash bin opening and closing operation. The intelligent trash bin uses nodeMCU to control the system and the connection between the device and WiFi. With the help of Ultrasonic sensors, the level of trash is detected. The system also gives the details of the trash bin level on the web page and according to that the trash bin lid is opened and closed. This system is more useful in the present environment because environmental pollution is more caused due to the generation of waste and also it is the major reason for most diseases. Hence this dumpster monitoring system will be a better solution. As it is using IoT technology, we will be getting real-time data. The future work of this system will provide an automatic messaging system, automatic waste pit detection and dumping the waste in it. Through this, the manual work in waste dumping can be completely replaced.

4   Design

Both software and hardware are essential parts of the design. The output from the hardware is connected using the IoT to the software.

4.1   Hardware Requirements

4.1.1   NodeMCU

A free source IoT operating platform called NodeMCU which runs on ESP-8266 Wireless Fidelity SoC. In this paper, it is used as the main microcontroller because of its WiFi connecting capacity which will be used to send the data from the sensors to the web and the mobile interfaces. Figure 1 shows the hardware connection.

4.1.2   Ultrasonic Distance Sensor

Without any physical interaction, the trash bin level can be determined by ultra-sonic distance measuring sensors. It detects the level of the dumpster which is filled in the waste bin. The sensor uses an ultrasonic burst as an input, and it produces an output. The distance from the bin top to the trash can be measured with the help of the echo which is generated as an output to the burst.

4.1.3   Power Supply

The power supply is used for the conversion of an ac voltage to a dc voltage. For the conversion process, the ac voltage is rectified and through a filtering process, a dc level is obtained. Then the voltage is regulated to a fixed dc voltage level. Typically, the ac voltage, which is used here will be 120V, it is stepped down to a lower level of dc voltage to get the desired output.

4.1.4   Gas Sensor

Gas sensors are usually used to detect gas leakages like LPG or any other toxic gas. Here the gases that is generated from a trash can includes methane, carbon monoxide, carbon dioxide, and some other poisonous gases. These gases lead to generating bad smells from the bin and it will lead to health issues and other environmental issues. Gas sensors will detect these unwanted gases and send the data to the web.

4.1.5   L293D (Motor Driver IC)

The motor driver will drive the motor in either direction. Here it is connected to the dustbin lid which will automatically be closed when the waste bin level is greater than a particular level and opened when the waste bin is empty. The L293D uses motor supply VSS for its operations. So, the main purpose of using the motor driver is to close and open the lid according to the hardware output.

4.1.6   Switches and Button

The switches and buttons will provide the switching between one user to another user. These are the basic components that are present in this system.
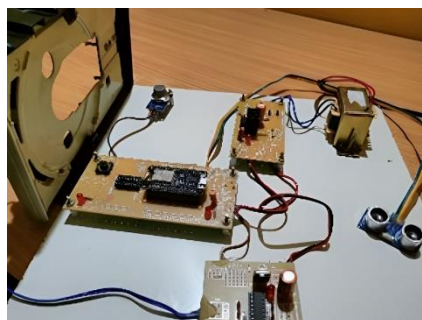
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Figure 1: *Hardware components*

4.2 Software Requirements

The software part consists of two web pages, one for the driver and one for the admin. The front end of the webpage is developed using Java, CSS, and HTML. For the backend of the webpage, a PHP script is used. The webpage is designed to display the level of garbage in the bin and internal conditions like the presence of foul smell etc when the driver logs in. The figure 2 and figure 3 are the webpage layout.

Figure 2: *Webpage of the driver unit which shows the details of the waste bin*

Figure 3: *Webpage of the Admin unit which shows the details of pending cleaning*

We use node MCU for the data collection and sending it to the IoT page. One web page is for the driver unit and the other is for the admin unit. The driver unit will be showing the details regarding the waste level and the foul smell, and the admin unit will be showing the details of the pending waste collection area or waste bin to be collected. In this system, the APACHE HTTP server is used for the interface. It is free software. Here the system uses PHP language. The Cascade style sheet provides the design of the web page. The system uses Arduino IDE for programming the hardware part. Embedded C is used as the programming language. With this, the interface between the software and hardware is done. The Embedded C is used to program the nodeMCU. The WiFi module in the system will be used to provide sufficient data for the system's work. And nodeMCU will track the dustbin.

5 Working Principle

The dumpster monitoring system uses hardware and software components for the work. The principle that is used here is IoT technology. The nodeMCU is connected with the following devices for the proper working of the system.

There is a trash bin, in which an ultrasonic distance sensor is placed for monitoring the waste level. An AC is transmitted from the power supply to the transformer. The incoming 230V is converted to 5V which is needed to feed into this system, with the help of a step-down transformer. After converting to the required DC level, the 5V is given to the motor driver which will be working as an atomized system. The motor driver is connected to the lid of the trash bin. The nodeMCU which is used here as the major controller is connected to the web pages. Two web pages are used in this system. The first webpage consists of the Driver alert unit which will show the details regarding the trash bins which is located in different places. Once the trash bin level is filled or the waste level is increased to a particular level, the sonar will measure the length of the waste level and the measured data will be sent to the IoT page. Any unwanted odour in the trash bin will be detected by the Gas Sensor, and that data will also be sent to the IoT page. Once the waste level is full, the LED will blink and similarly, a red color will appear on the IoT page for the filled trash bin. After sensing the filled bin, the lid of the bin will be closed automatically with the help of a motor driver. The admin unit will show the details regarding the pending cleaning. Figure 4 shows the block diagram of the system.
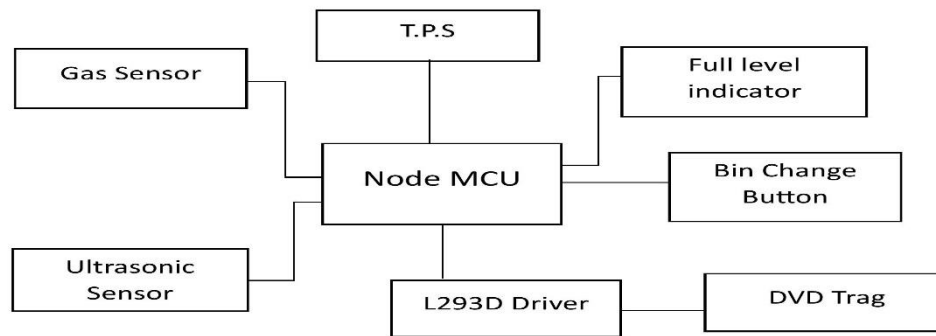

Figure 4: *Block diagram*

6   Results

The result shows that once the trash bin level is increased up to a certain level, the lid of the trash bin is automatically closed, and it gets open when the dustbin is empty. The data from the sensors will be sent to the IOT page and the details will be visible on the website.

<div align="center">

The condition for bin closing and opening.

If distance >=50 filled level is low

If distance < 50 and >=25 filled level is medium

If the distance is <25 level is full, and the trash bin is locked

</div>

The above details show the conditions for the waste level. According to this details, the waste bin will be closed and opened automatically. So the function of this system will be done.

7   Conclusion

The efficient and timely disposal of waste materials is an important concern for all the local administrative bodies. Especially in urban areas improper waste management creates many untoward effects. The proposed project idea can be incorporated into the proper waste management system. In this case, the entire governing of waste management happens through electronic means. The Node MCU along with the controlling unit performs the data analysis and proper communication is initiated with the authorities. The necessary details and status of waste management are also available in the web application. Thus, timely intervention and taste disposal are possible. The entire project can be realized cost-effectively, and the operation of the circuitry is found to be easy for usage and implementation. The proposed system helps to bring forth a clean and disinfected pollution- less environment. This provides appropriate updates and hence frequent manual checks and the littering from the garbage bin can be eliminated.

8 Publisher's Note

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