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(Deemed to be University)

Submitted in partial fulfillment of the requirements for the award
of Bachelor of Technology Degree in Information Technology

By
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of who carried out the project entitled **"Developing bin sensor using IoT waste management system"** under our supervision from Jan 2021 to April 2022

Internal Guide

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Submitted for Viva voce Examination held on

Internal Examiner External Examiner

DECLARATION

I hereby declare that the Project Report entitled **“Developing bin sensor using IoT waste management system”** done by me under the guidance of Dr. L. Mary Gladence at Sathyabama Institute of Science and Technology (Deemed to be University), Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Information Technology.

DATE:

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Developing bin sensor using IoT for waste management system

1. Abstract -

India is now the fastest developing economy and home of 1380 million people. Rapid industrialization, population explosion, and economic growth in India led to the migration of people from villages to cities generating thousands of metric tons of Municipal solid waste daily in terms of kg/capita/day. Garbage strewn can cause many things one of her dues is the amount of garbage that accumulate in the area. It is usually not enough to accommodate the waste dumped by other people. It is also discovered that the garbage is being collected at irregular intervals of time due to lack of updated data regarding the amount of bin full or empty. Thus, we created a new method for waste collection and monitoring. The garbage bins will be monitored by the “bin sensors” which later informs regarding the amount of garbage collected in the garbage bins through our waste monitoring system. In this study, conducted the design and manufacture of prototype of bin sensor using ESP32, ultrasonic sensor and GPS.

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2. Introduction -

Internet of things (IoT) is the latest communication model, where objects and tools of daily life will be equipped with technology to communicate, and the appropriate protocol that will enable them to communicate with each other and the user, which become an integral part of the internet [1]. In the recent paper of Harmon said [2], that IoT can describe the architecture of the integrated system between sensors, software, networks, and the appropriate interfaces that will provide real-time awareness, process, and knowledge to gather intelligence to be able to make good decisions. IoT will encourage the development of applications that has great potential in a wide range of data generated by those objects to simplify the use of the old and new services to citizen, companies and public administration, with allows easy access and interaction with a wide range of devices. The application of IoT can be classified into various types based on network availability, size, coverage, and repeatability [3].

- Smart Home / Smart Building
- Healthcare
- Smart Business
- Utilities
- Mobile
- Environmental monitoring

With most existing waste management systems, a city collection service will travel a predefined route regularly and empty trash and recycling receptacles, whether they are full or not. The fixed nature of this system creates the possibility of half-full bins being emptied, unnecessary fuel being spent, and excess use of city resources. The current manual collection methods are highly resource-intensive. With the help of IoT, they can be transitioned into data-driven collection processes.

To collect the waste on time and keep the city clean we will install bin sensor over the garbage bins to distinguish the level of garbage and compare it with the depth of garbage bins. ESP32 has inbuilt Wi-fi support by which bin sensor will be able to send the fill level data of garbage bins to our waste monitoring system. Bin sensor is equipped with GPS so we can create a shorter route and most appropriate schedule for waste collection using the data collected by our bin sensor. It will increase efficiency and reduce your fuel and energy cost, fewer waste trucks will be used and the waste container will always be emptied at the proper time. It will be a cost-effective way to improve the environment and well-being of people. It can reduce the container overflows.

3. Waste monitoring -

Due to the overflowed garbage bins, the environment has become unclean. This can result in the spread of diseases and other harmful organisms. A smart garbage management system should be developed to prevent this issue. This method can be easily implemented through the use of Internet of Things.

With this kind of technology- smart garbage monitoring prototype, will give a lot of advantages Like Bashir, A. has written, such as [4]:

1. Intelligent planning. with the waste volume monitoring technology, sanitary agency can schedule the departure for transporting waste [5].
2. Business efficiency increases. When sanitary agency can schedule their work, the use of resources can be used appropriately [6].
3. Increase the quality of life (reducing pollution due to the waste was strewn). With the reduction of pollution, the environment would be more comfortable than ever.

That point shows that the new method of managing waste in an efficient way may reduce the inappropriate use of human resource, time and cost [4][6]. And also by comparing to the conventional static scheduling of transporting waste, this system scheduling are said to allow cost reduction, by reducing the number of trucks, and manual labor cost [6].

3.1. Hardware components -

ESP32 -

The predecessor of ESP32, the ESP8266 has a builtin processor. However due to multitasking involved in updating the WiFi stack, most of the applications use a separate micro-controller for data processing, interfacing sensors and digital Input Output. With the ESP32 you may not want to use an additional micro-controller. ESP32 has Xtensa® Dual-Core 32-bit LX6 microprocessors, which runs up to 600 DMIPS. The ESP32 will run on breakout boards and modules from 160Mhz upto 240MHz . That is very good speed for anything that requires a microcontroller with connectivity options [7].

HC-SR04 ultrasonic sensor -

Just like the authors of [8][9] did, in this paper the author using an ultrasonic sensor. The workings of this sensor is automatically send a signal ultrasonic periodically and will detect whether there will be a signal ultrasonic that will be reflected back to the ultrasonic sensor, if the sensor receives the reflection, the author could mentioned the time signal sent by the sensor until the sensor detects the reflected signal is called duration / time. After the authors obtain data

duration / time, the author could find the distance between waste and ultrasonic sensor using this formula:

$$s = t \times v$$

which,

t = duration / time (second)

v = velocity (m/s)

s = distance (m)

in this case the author need to use the speed of sound which is 344 m/s, because sensor ultrasonic using ultrasonic sound when release a signal. After that the author need to divide by 2 because the sound had travel 2 times, one from sensor to garbage/waste, and one more from garbage/waste to sensor. And the formula becomes like this:

$$s = (t \times 344 \text{ m/s}) / 2$$

Ublox Neo 6M GPS

To the location of the trash bin, we are using the NEO-6M GPS module. • It can track up to 22 satellites on 50 channels and achieves the industry's highest level of sensitivity i.e. -161 dB tracking while consuming only 45mA supply current. GPS receivers actually work by figuring out how far they are from several satellites. They are pre-programmed to know where the GPS satellites are at any given time. The satellites transmit information about their position and the current time in the form of radio signals towards the Earth. These signals identify the satellites and tell the receiver where they are located. The receiver then calculates how far away each satellite is by figuring out how long it took for the signals to arrive.

3.2. Software Components -

Arduino IDE

Ngrok

3.3. Circuit Design :-

GPS (Neo 6M)	ESP32
Vcc	VIN
Rx	D2
Tx	D4
GND	GND

Ultrasonic sensor (HC-SR04)	ESP32
Vcc	VIN
Trig	D19
Echo	D18
GND	GND

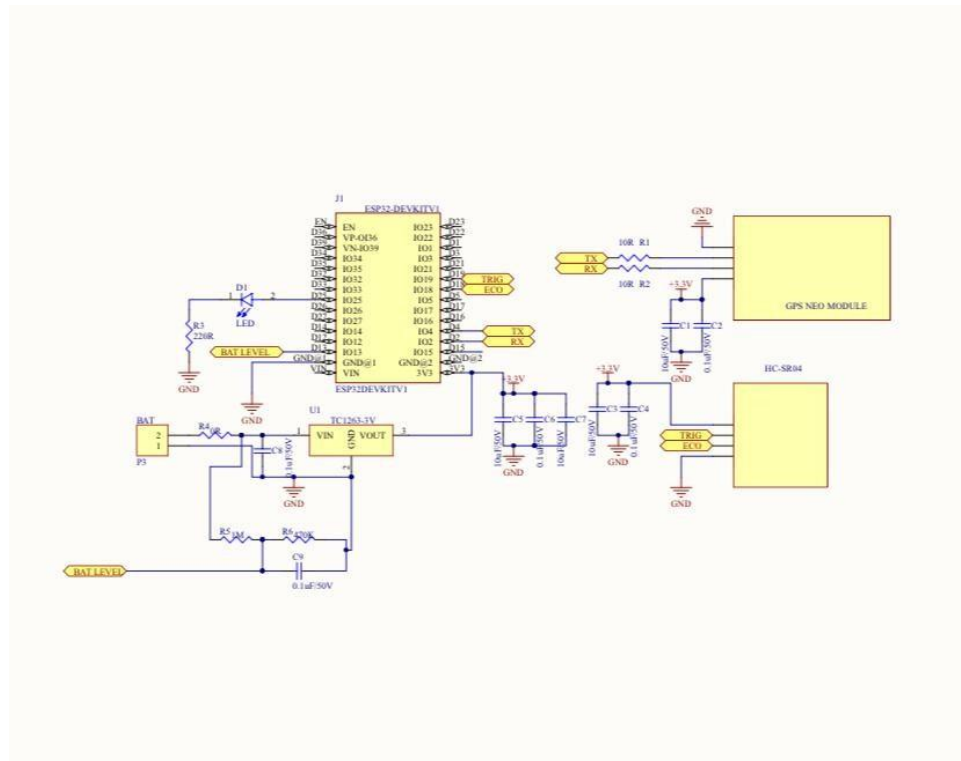


Fig. 1. Schematic view of sensor

4. Flow Diagram -

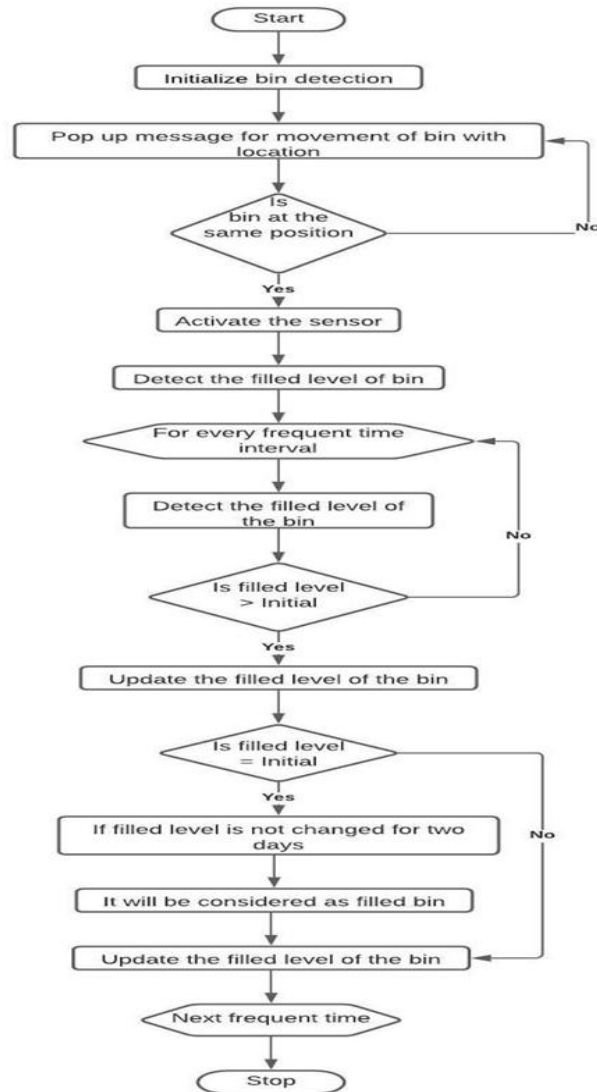


Fig. 2. Flow diagram of the sensor

Figure 2 shows the work flow diagram of nodes. Firstly, it will initialize the detection of bin if the location of bin is changed then it sends a pop-up message. If the position of bin will be same the sensor will be activated and it will start measuring the fill level of bin. Every one hour the sensor will update the fill level. If filled level of bin does not change for two days it will be considered as filled.

5. Methodology -

By using the prototype, the author constructs a new process for new waste disposal method, there are 5 step for the new method [10][11].

Step 1 : Using the ultrasonic sensor to obtain data duration of the round trip of signal ultrasonic to the trash and back to the sensor again. This phase will be carried out periodically, so the available data will continue to generate real-time data.

Step 2 : after that, the data of duration receive by the PCB, then the PCB will do the calculation process to obtain the distance between the sensor and waste/garbage.

Step 3 : Distance data will be received by us to be managed and processed so it can be seen and read by users with ease.

Step 4 : Then we will process the distance data to be measured, if the distance data exceed or equals to the predetermined value of the limit, it will proceed to the next step, but if it turns out not reach out to the predetermined value, then it will go back to the first step.

Step 5 : We will generate notification alert if waste bin already reached the point of full and the garbage/waste need to be disposed.

5.1. Data Resources -

conducted trials using waste volume monitoring prototype that the we created. The data consist of time, distance, and the sent of notification alerts. 3 sessions will be conducted trials which have different condition, ie:

1. At the time when waste bin is empty
2. At the time when waste bin will be filled with trash periodically until half full.

3. At the time when waste bin will be filled with trash periodically until reach the limit value that have been set.

Where, the first session will take 30 data based on roscoe said that in the experimental study recommended 30 samples or more. As for the trial of the 2nd and 3rd only done 10 times due simply to see whether the function of waste volume monitoring are work properly.

5.2. Evaluation -

When conducting this evaluation the author has a target whether the waste volume monitoring technology would function properly. Therefore in this study we conducted three trials, in which trial has a different assessment requirements.

In the first trial whether the monitoring waste volume prototype can give the exact distance data as expected, by calculating the accuracy of the results using this formula:

$$\text{Accuracy} = b/a * 100\%$$

Where,

- b is number of correct data
- a is amount of data from the trial

The second trial is whether this prototype can give actual distance data in real time. And for the 3rd trial the author wanted to know whether the function of notification alert will be sent successfully in accordance with a predetermined distance.

6. Test case generation and analysis -

S.No.	Scenario of test	Test step	Test data	Expected results	Actual Result	Pass /Fail
1	Test compatibility of ESP32 with software	1.Connect ESP32 to laptop 2.Execute the code to ESP32	Connecting ESP32 to laptop	Code should be executed	Code is executed successfully	Pass
2	Check ultrasonic sensor with the obstacle	If there is any obstacle, there should be indication	Put an obstacle in front of ultrasonic sensor	Ultrasonic sensor indicates that there is an obstacle	Ultrasonic sensor indicates that there is an obstacle	Pass
3	Check ultrasonic sensor without any obstacle	If there is no obstacle, there should be no indication	Having no obstacle in front of the ultrasonic sensor	Ultrasonic sensor indicates that there is no obstacle	Ultrasonic sensor indicates that there is no obstacle	Pass
4	Compile arduinoESP32 code	Compile and run all the divisions of ESP32 code	ESP32 code	Compilation and execution successfully	Compilation and execution successfully	Pass
5	Check GPS module	GPS should give the exact location of bins	GPS coordinates of the bin	GPS should give the exact coordinates	GPS gave the exact coordinates	Pass
6	Test the breadboard	Connect the wires with the components	Connect wires with the basic output	It should give correct results	Breadboard is working fine	Pass

7. Result -

In this study we use a container that has a length of 30 cm, width 27 cm, and 50 cm high . In the first trial the author get a result like in the table below:

S.No.	Time	Distance
1	9:00	50
2	9:05	50
3	9:10	50
4	9:15	50
5	9:20	49.6
6	9:25	50
7	9:30	50
8	9:35	50
9	9:40	50
10	9:45	50
11	9:50	50
12	9:55	50
13	10:00	50
14	10:05	49.4
15	10:10	50
16	10:15	50
17	10:20	50
18	10:25	50
19	10:30	50
20	10:35	50
21	10:40	49.5
22	10:45	50
23	10:50	50
24	10:55	50
25	11:00	50
26	11:05	49.6
27	11:10	50
28	11:15	50
29	11:20	50
30	11:25	49.7

From the table above can be seen that, this prototype get the numbers 50 cm for 25 times from 30 result data, With the height of the container used is 50 cm. With the calculation of accuracy that have been discussed in the evaluation, this prototype have 83.33% of accuracy.

In the 2nd trial the author get result like the table below:

S.No.	Time	Distance
1	11:30	50
2	11:35	47.3
3	11:40	42.7
4	11:45	39.9
5	11:50	36.7
6	12:00	35.4
7	12:05	30.2
8	12:10	29.1
9	12:15	25.6
10	12:20	20.5

From the table above can be seen that distance from sensor and trash are going smaller from 50 cm to 20.5 cm. prove that the prototype can provide data in real time without error.

Last trial result are :

S.No	Time	Distance	Notification
1	12:30	20.5	-
2	12:35	18.8	-
3	12:40	16.3	-
4	12:45	15.8	-
5	12:50	13.7	-
6	12:55	11.4	-
7	1:00	10.1	-
8	1:05	8.9	☐
9	1:10	7.7	☐
10	1:15	3.6	☐

8. Conclusion

Based on the research that has been done, the prototype of monitoring the waste volume can function well up to receives notifications alert when a container filled up. So with this prototype we can use a new method of waste disposal. Although the prototype of monitoring the waste volume had given a good results, there remains some suggestions for development. As it takes its expert systems in order to make a better system and prevent errors that might occur later. It also calls for additional technologies such as GPS to detect trash anywhere and ultrasonic sensor for more actual data of distance calculation.

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