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# Smart Dustbin Management Using IoT

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***Abstract:*** ***Managing waste is one of the many prominent issues surrounding metropolitan cities and countries at large. One of the problems with the garbage cleaning process is the cycle of replacing filled cans with new ones. Due to overcrowding of places like public parks, gardens, and general gathering of people for special occasions in the calendar, the responsibility of going to the garbage can and discarding the waste is somewhat lost in the hustling nature of the city. To address this issue, we have come up with a possible solution-The Smart Dustbin with proximity sensors which will detect any trash thrown outside the perimeter of the can and alert the surrounding people with auditory or sensory cues. This feature will help citizens discard trash responsibly and take ownership of improper disposal of trash in the surrounding area. The Smart Dustbin will also be improved in terms of implementation cost and complexity in building it. To implement Smart Dustbin, we use the NodeMCU board that helps us connect to Wi-Fi and notify the administrators to empty the bin through cloud services. The ultrasonic sensor is used to estimate the filling ratio of the bin and proximity sensors give an alert if any waste is thrown around the bin.***
***Keywords: cloud, database, waste management, Internet of Things, nearest unfilled dustbin,.***

## I. INTRODUCTION

Internet of Things has become very famous in the 21st century because of its extensive use in all areas of our daily life such as smart home, smart irrigation, baby monitoring, smart cities, embedded systems and exchange of information. In this highly connected world, due to the huge data bandwidth available to normal people and no restrictions on the type of data to be sent and received or the size of the data or format led to transmitting and receiving vast sizes of data. This led to the "Internet" of "Things", where a myriad of devices is connected together to operate in an integrated manner. IoT has been dormant for a long while due to the lack of awareness about embedded systems and cloud technologies. It's now a major part of many people's lives due to the extensive manufacturing of IoT sensors and devices. IoT works in a combined manner with other technologies such as cloud computing, machine learning, big data analytics and conversational artificial intelligence. It is also more practical because of the features such as low-cost sensors, affordable connections, high speed data transfer etc.

## II. LITERATURE REVIEW

The field of IoT has enabled various researchers to work in different aspects and add functionalities to improve the issues with traditional systems. The traditional waste collection system seen today is neither optimized nor efficient i.e., regular overflowing of bins, poor management of waste materials, unhygienic garbage conditions etc. Such issues of waste management in the cities were improved by IoT to a certain extent. The basic functionality of notifying the authorities when the dustbin is filled is implemented using an Ultrasonic sensor and Blynk Application, also an LED screen was used to display a message when the bin is full [1]. The inclusion of deep learning and machine learning algorithms in managing effective waste collection were implemented and the Tensor Flow python library was imported for detecting the type of waste being dumped [2]. The bin is divided into different compartments for accumulating different types of waste when the IR sensor detects an object outside the bin and opens the lid using servo motor [3]. Machine learning and graph theory techniques are used to detect the shortest path while collecting the waste [4][5]. An alert is sent to authorities when the bin is filled 75%[6]. To monitor daily garbage an IoT based system developed using WeMos and Ultrasonic sensors[7].

The drawbacks in the existing system are as follows-

The issue of waste being accumulated around the dustbin is not addressed in the existing systems.

In some of the papers, an alert is sent only when the bin is full, but no prior notifications are given when the bin is going to be filled in some time.

The usage of the LED screen is limited to only displaying that the bin is filled.

The lid of the bin opens only an object is detected, but this can be proved to be time-taking.

In some of the systems, lid is always open, which can lead to overflowing of the bin and other problems in case of rain.

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## III. PROBLEM DEFINITION

Managing waste is one of the prominent issues surrounding metropolitan cities and countries at large. One of the problems with the garbage cleaning process is the cycle of replacing filled cans with new ones. Due to overcrowding of places like public parks, gardens, and general gathering of people for special occasions in the calendar, the responsibility of going to the garbage can and discarding the waste is somewhat lost in the hustling nature of the city. To address this issue, we have come up with a possible solution for implementing Smart Dustbin using IOT.

## IV. MOTIVATION

Noting from the previous section, the traditional systems are prone to issues like overflow of waste from the bins, improper waste disposal and lack of alert systems on monitoring waste collection. To address them, we have decided to make a monitoring system which is heavily based on IoT domain. Using IoT brings in the automation factor which in turn brings efficient data collection and hence better monitoring.

IoT uses a network of sensors to communicate with each other and manage the system altogether. The term IoT is mainly used for devices that wouldn't usually be generally expected to have an internet connection, and that can communicate with the network independently of human action.

Smart Dustbin Management is an IOT based project mainly focusing on the waste management in closed communities such as universities, gated communities, parks, malls and resorts.

## V. EVALUATION ENVIRONMENT

The proposed system includes dustbins all over the area which unique identification numbers, the dustbins are each equipped with an ultrasonic sensor, IR sensor, LED screen, Rain sensor, NodeMCU and beep generator.

The real-time filling ratio of the dustbin, calculated using ultrasonic sensor is sent to the authorities via the Wi-Fi module. A notification is sent when the dustbin is filled partially and a final warning is issued when the bin is completely filled. If the bin is filled completely, the status is displayed on the screen along with the information regarding the nearest unfilled dustbin. The IR sensor prevents waste from being accumulated around the bin. Rain sensor is used to detect any rain in the chosen location where the bin is placed. It gives an insight to the waste management people in terms of collecting the waste.

### *A. Experimental Setup*

#### *1) Arduino Board*

It acts as a microcontroller which is the heart of an IoT project, that is responsible for triggering all the other sensors. It has an inbuilt memory to store the code and has various GPIO pins to connect different sensors.

#### *2) Ultrasonic Sensor*

It measures distance from the lid of the bin to the waste inside it using the SONAR principle, where a radio wave is sent by the transmitter and the reflected wave when an obstacle is found is received by the receiver.

#### *3) IR Sensor*

It measures the waste around the bin by transmitting a light wave and sensing if it is reflected back due to any obstacle, in this the waste thrown outside the bin.

#### *4) ESP 8266 WiFi Module*

It is used to send and receive data to and from the cloud respectively.

#### *5) Led Screen*

It displays the data with respect to the bin, i.e., the status of the bin, filling ratio, direction of the nearest unfilled dustbin, and the status regarding the waste thrown outside the bin.

#### *6) Rain Sensor*

It is used to detect any rain in the chosen location where the bin is placed. It gives an insight to the waste management people in terms of collecting the waste.

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*7) Beep Generator*

Beeps are generated when waste is thrown outside the bin and also when the bin is completely filled.

*B. Discussion*

*1) System Overview*

The system architecture of smart dustbin, as shown in Fig 1, consists of a NodeMCU controller which is responsible for operating all the sensors connected to it. The software control of this model is through ThingSpeak application which will get real time updates on the data fed through the sensors.

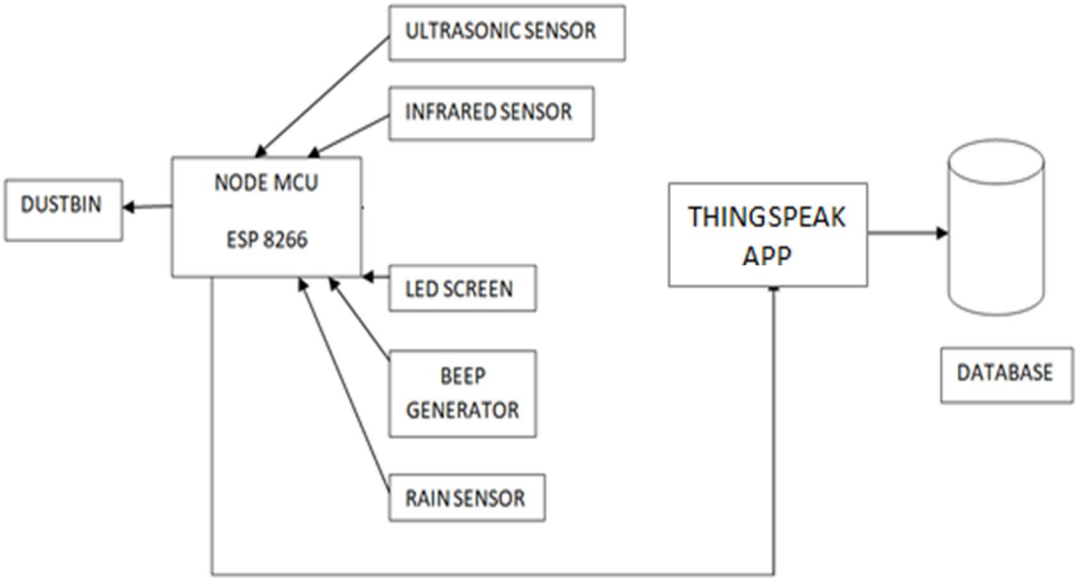



Fig 1. System Architecture

*2) Methodology*

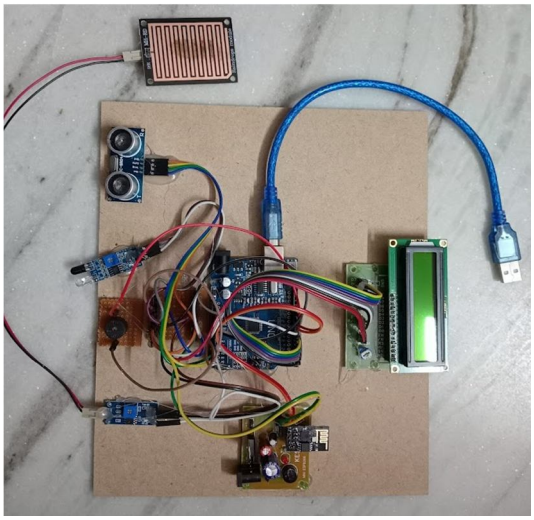


Fig 2. Working Model

The above shown in Fig 2 is mounted on top of a dustbin and every bin is assigned with a unique bin id.

Here in the present scenario, the dustbins in a closed environment, are placed as shown if Fig 3. They are marked as coordinates on a plane of four quadrants.

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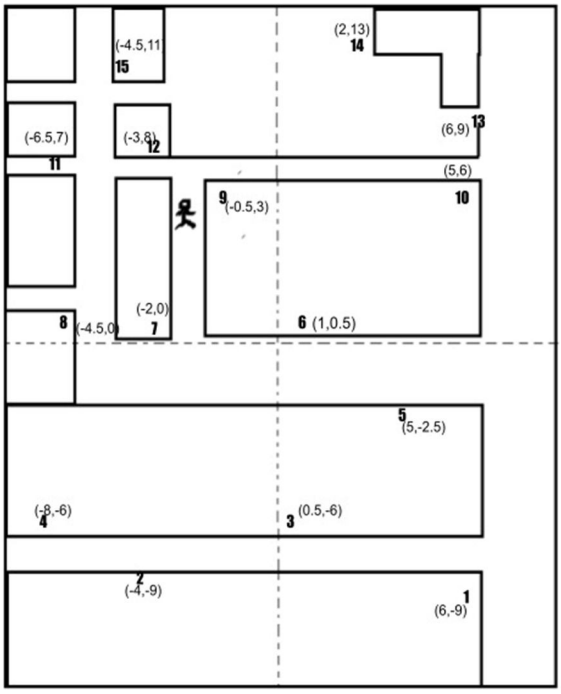



Fig 3. Bin positions in a college

The data about all these 15 bins is stored in a relational database which is shown in the following Fig 4.

```
MariaDB [smartbiniot]> select * from smartbin;
+----+-------+-------+------+------------+
| id | loc_x | loc_y | size | fill_ratio |
+----+-------+-------+------+------------+
|  1 |     6 |    -9 |  100 |         30 |
| 10 |     5 |     6 |  100 |        100 |
| 11 |  -6.5 |     7 |  100 |         30 |
| 12 |    -3 |     8 |  100 |        100 |
| 13 |     6 |     9 |  100 |         90 |
| 14 |     2 |    13 |  100 |         40 |
| 15 |  -4.5 |    11 |  100 |         60 |
|  2 |    -4 |    -9 |  100 |        100 |
|  3 |   0.5 |    -6 |  100 |         70 |
|  4 |    -8 |    -6 |  100 |         50 |
|  5 |     5 |  -2.5 |  100 |         80 |
|  6 |     1 |   0.5 |  100 |         20 |
|  7 |    -2 |     0 |  100 |         20 |
|  8 |  -4.5 |     0 |  100 |         90 |
|  9 |  -0.5 |     5 |  100 |        100 |
+----+-------+-------+------+------------+
15 rows in set (0.000 sec)
```

Fig 4. Database of bin info

Arduino board calls a PHP page which in turn connects to the database and performs the request by getting the data from the database, calculates the nearest unfilled dustbin direction by using the two-dimensional Euclidean distance formula and at last sends the reply to Arduino microcontroller which is then displayed on the LED screen.

All the data sent to the cloud can be viewed on a mobile on the ThingView Application available on Google Play Store and App Store just by adding the API created on the ThingSpeak cloud. This way the garbage collectors are notified of the real time filling ratio of all the bins in the locality.

Fig 5 is the picture of the dustbin under experiment with id as ‘9’, whose size is around 16 centimeters due to the system being a prototype. The actual working model consists dustbins of size exactly 100 cm.

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## VI. RESULTS

Fig 6 and Fig 7 are the resultant levels in the app as executed by the bin with id 9 and the bin is shown below.

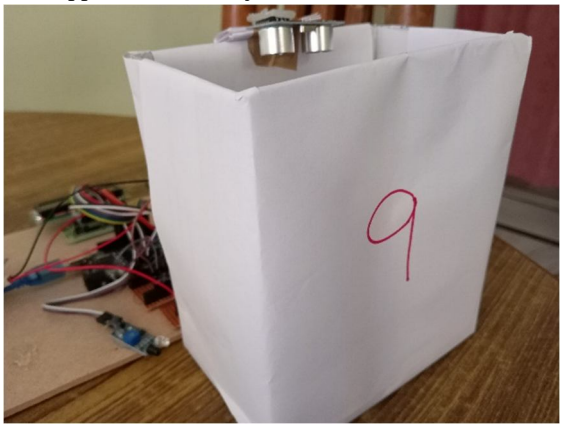



Fig 5. Arrangement of bin with id=9.




Fig 6. Bin levels displayed on the App




Fig 6. Bin and Rain levels

Fig 8 shows the updated level of the bin for every 30 seconds.
The outputs of the LED screen are shown in the next figures where the first one, i.e., Fig 9 is the result of bin being filled completely and the next one, i.e., Fig 10 is the result throwing waste in the surroundings of the dustbin.




Fig 8. Level of bin with id=9




Fig 9. LED when bin with id=9 is filled

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Fig 10. LED when waste is thrown outside

## VII. CONCLUSION

As the proposed system is the low cost and small-scale implementation, there is a huge scope of commercializing the project and reaping good profits which facilitates utmost hygiene and systematic waste management in the closed communities. The functionality of closing and opening of the lid under external conditions like rain and overflow detection can be implemented with necessary additional components. Therefore, the Smart Dustbin Management system has an enormous future scope that can be implemented for other highly populated regions with a good strategy.

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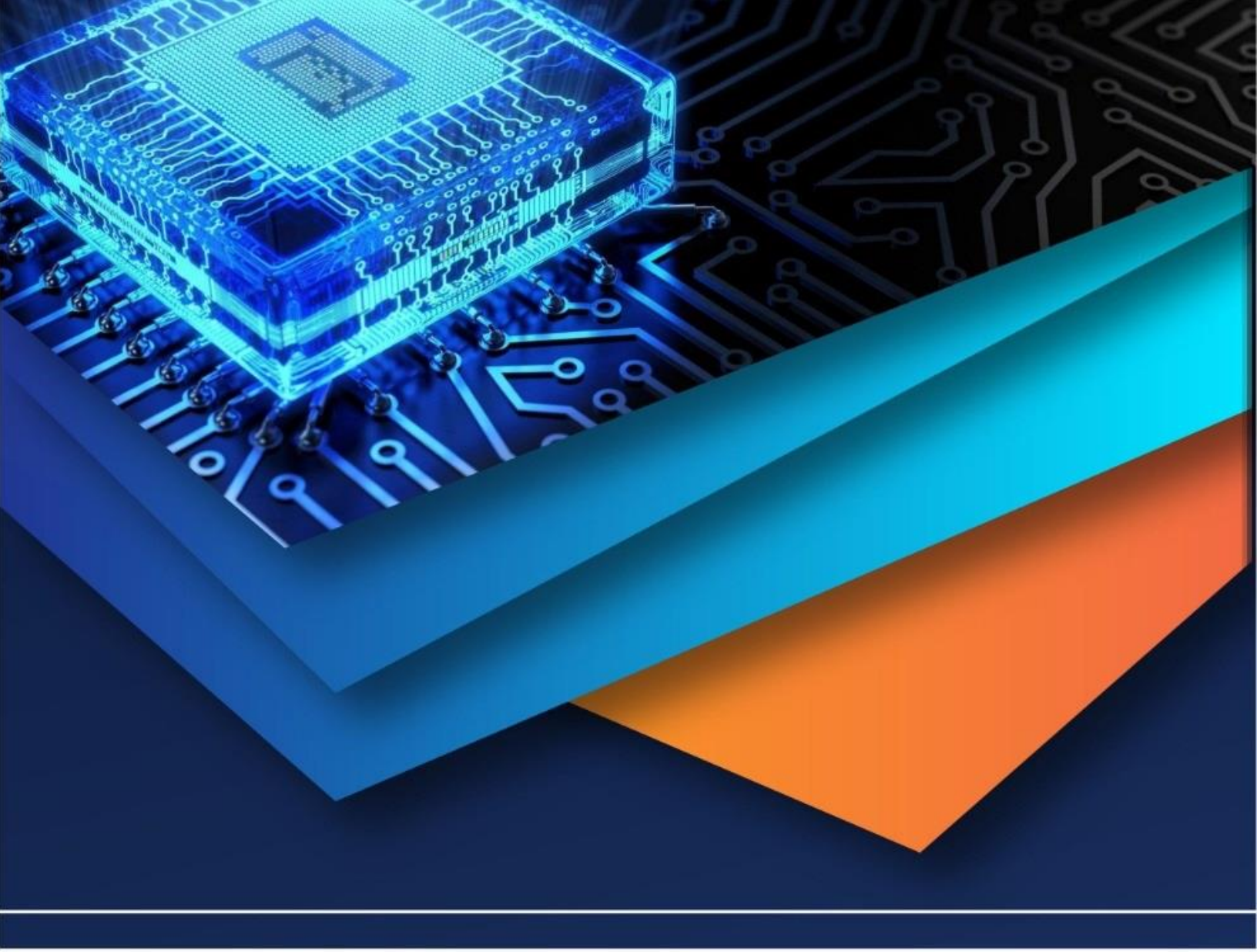
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