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Smart Dustbin using GPS Tracking

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Abstract - *One of the major concerns with the environment is solid waste management which impacts the health and surroundings of society. The handling, disposal and management of waste is one of the primary difficulties we face today. The usual way of manually managing the waste bins is a complicated process and requires more human effort, time and cost which can easily be eliminated with the present technologies. Thus we aim to provide an effective and economical waste management system hence providing a clean, healthy and green environment. Within the scope of the project we develop three subsystems: smart waste bin and real-time monitoring system that are interconnected to perform as an efficient waste management system that yields to a green and healthy living environment. We aim to design and develop the project, in the most efficient manner to get the best possible outcomes. Technically, we will be using technologies such as IOT, web development, data analysis, networking involving cloud. We will be deciding various different phases related to the planning, designing, building, testing and getting real life feedback on the project work and hence tend to make a better system that contributes to fulfil the needs of the target audience. Summing up all, we are helping the community for a cleaner environment. We hereby are involving few technologies around us which have never been used this way for a better tomorrow.*

***Key Words*: GPS module, dustbin, IoT, NodeMCU, ultrasonic sensor**

1.INTRODUCTION

Solid waste management and cleanliness are a rising issue in today's time. It is important to find a feasible solution to this problem as it has adverse effects on the health of the living beings and the environment. It is not a location based problem, it is something we see every day and everywhere but don't do anything about it. There are many solutions to this problem and it is important that we implement them for the betterment of the world. This problem will never have an ideal solution but it is important that we try our best to solve this issue. We will be revisiting different technologies and will integrate them all together to make a more smart, feasible and efficient solution.

"Cleanliness is an important issue and should be taken as the foremost responsibility by everyone". In this world of environmental issues, people are getting more aware about the issue at hand. Convectional waste management systems which are currently employed in India have static routes and schedules where garbage from containers are collected on fixed schedules, regardless if they are full or not. This type of situation is often seen at dustbins with no covers and no hygiene control with improper collection methods by the collectors. This severely affects the health and hygiene of the people. Secondly most of the times people end-up disposing garbage on open streets, which affects hygiene of community. Many a times, even if the dustbin is not full, it starts stinking resulting in an extremely rotten smell. This is mainly due to the wet waste present in the dustbin. If the dustbin is not addressed until it is filled, this stinking smell may last for many days and this may severely affect the health of the people who pass by and who live nearby.

2. LITERAUTRE REVIEW

Many problems with respect to cleanliness are taking place in many countries and many different technologies have been introduced for handling solid waste management system. The authors in [1] have used ultrasonic sensors to measure the level of the waste in the dustbin which uses the Arduino Mega microcontroller. The use of PIR sensor is according to the closing and the opening of the lid of the bin. A LCD screen is connected to the bin which informs whether motion is detected or not. Their module is powered by solar energy. The model uses a Wi-Fi module (ESP8266) which sends data to a web server which is developed by the authors using Bootstrap. The data sent is sent with a timestamp by the RTC module which also provides the user with the location of the bin (latitude and longitude) by the use of a GSM module. The drawback of this model is that to see the values of waste on particular days or timings, one needs to open the server or check the database and also requires a separate Wi-Fi module to connect to the internet. The proposed model attempts to provide the values on a mobile app and by using the board NodeMCU, we reduce the need of the Wi-Fi module.

The researchers in [2] used an ultrasonic sensor connected to the NodeMCU which gives the level of the waste in the bin. Their model uses a PIR sensor which detects any motion near it. A buzzer is connected to the model which buzzes as soon as the ultrasonic sensor gives a reading for the level of the waste or if any movement is detected. A moisture sensor is connected to the bin which gives the output of moisture in the waste. All these values are sent to Thingspeak cloud and Virtuino app. The drawback with this model is that there is no cloud security. The model we propose attempts to use a different cloud and a self-developed app which ensures total security in the model.

"SMART GARBAGE MONITORING SYSTEM USING SENSORS WITH RFID OVER INTERNET OF THINGS" developed by [3] use RFID scanners which give us the individual ID's of the dustbins which can direct us to the location of the dustbin. A photoelectric sensor is used to detect if there are any metal items going in the waste and a weight sensor is used to keep track of how much the dustbin can hold before it reaches a threshold. The IR sensor connects to a local base station which can monitor the bin status. The dustbin, if reaches the threshold level, makes a noise and send the status to the station. The disadvantage of this model is that an individual IR sensor is required to create a base station and the noise made by the sensors in the bin will lead to disturbance in the environment. The model we propose attempts to send notifications to the authorities directly without disrupting the peace and quiet of the environment.

The solutions created for management of waste faces its own difficulties. The solution proposed by [4] suggest the use of only a GSM module and an ultrasonic sensor which send the status of the bin directly to the registered number. Though there is a reduction in number of sensors, a disadvantage of this model is the number of contacts and the limited number of messages or calls depending on the SIM plans. The model proposed in this paper makes it easy for authorized and registered members to monitor the status of the bin.

Some researchers [5] and [6] make use of the IR sensor to make the dustbin even smarter by monitoring the waste scattered outside the dustbin. The analysis and monitoring by the system can reduce the human effort in cleaning the areas daily and helps in making the world a cleaner place.

3. REQUIREMENT ANALYSIS

Before you begin to understand the working of the project, we need to know the requirements of the project and the tools used.

3.1 Hardware Requirements

The hardware setup which will be installed on the lid of every dustbin will consist of a NodeMCU, Ultrasonic sensor, GPS Module and connecting wires.

- NodeMCU - NodeMCU is one of the most used open source IoT platform. It is an integration of firmware which runs on the ESP8266 Wi-Fi SystemOnChip (SoC) and hardware which is based on the ESP-12 module which allows you to access many features of the ESP8266. This module has been used in our project as a microcontroller for connection to the Wi-Fi and for powering and retrieving values from other components such as the GPS module and the Ultrasonic Sensor. The model used in this proposal is **NodeMCU 1.0 (ESP-12E).**
- Ultrasonic Sensor - Ultrasonic sensor is used in this project to measure the amount of garbage present in the dustbin at any point of time. This function is performed by the ultrasonic sensor by measuring time between emission and reception of the ultrasonic waves and then calculating the distance using speed-distance-time formula. It provides a digital output to the NodeMCU with a 5V battery input. The model used in this proposal is **HC-SR04**.
- GPS module - GPS (Global Positioning System) is a module which uses satellites and ground stations to measure and find its position or location on the Earth. This module provides us with latitude and longitue values. The model used in this proposal is **Neo 6m**.

Apart from these three hardware modules, jumper wires will be used to connect these components with each other. And a power source such as a battery or solar powered system can be used in later phases of the project for saving energy.

3.2 Software Requirements

Arduino IDE, XAMPP and PHP and Google's Firebase cloud are the three main software components required by the project.

- Arduino IDE - It is used to generate the codes for the project and is used to upload the code on the microcontroller unit for implementation and testing.
- Firebase - The cloud server we have used in our proposal is Firebase cloud which is supported by Google. It is used for saving the database and for visualization and analysis of the data.
- XAMPP Server - XAMPP Severs are used to host webpages and web applications on the local server. One can use PHP MySQL databases to CRUD operations. Hosting of dynamic and static web applications is what XAMPP is best for.

Coding languages required for designing the web page are HTML, CSS and PHP. HTML and CSS are the languages which help in designing of the front end, and PHP is used for storing the data in the local database on the system.

4. PROPOSED WORK

In this section, we will be discussing about the design, architecture and working of the proposed model.

4.1 Design

The architecture used for our model is a level 4 architecture used in Internet of Things. This architecture tells us that the project runs on cloud with the REST WEB services being used with HTTP protocol (Fig -1).

The monitoring nodes are the end nodes which are connected to the sensors and actuators which send values to the cloud via HTTP network. The user is at observer node in the local end. The database values are sent to the observer

node and analytics component by CRUD methodology for easy retrieval and analysis of the data.

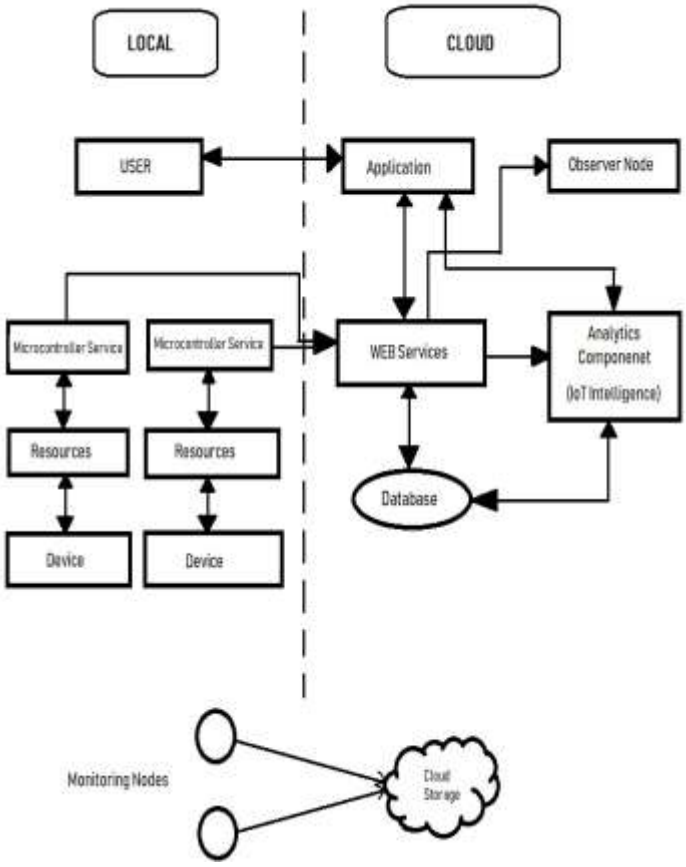

Fig -1: Architecture

4.2 Work Flow

Ultrasonic sensors are used for this system. The sensor will be placed on top of bin and will be connected to the esp8266 module which will be the medium for wireless communication through the cloud. Firebase cloud service will be used and the web application will receive the notification which will help in sending the information to the office that the level of garbage has reached its maximum level. After this the bin should be emptied as soon as possible (Fig -2).

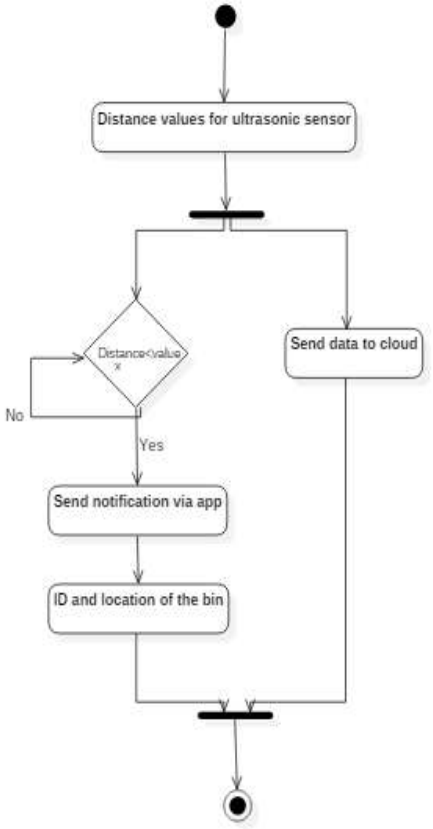

Fig -2: Work Flow

4.3 Implementation

The circuit connections are as given (Fig -3).

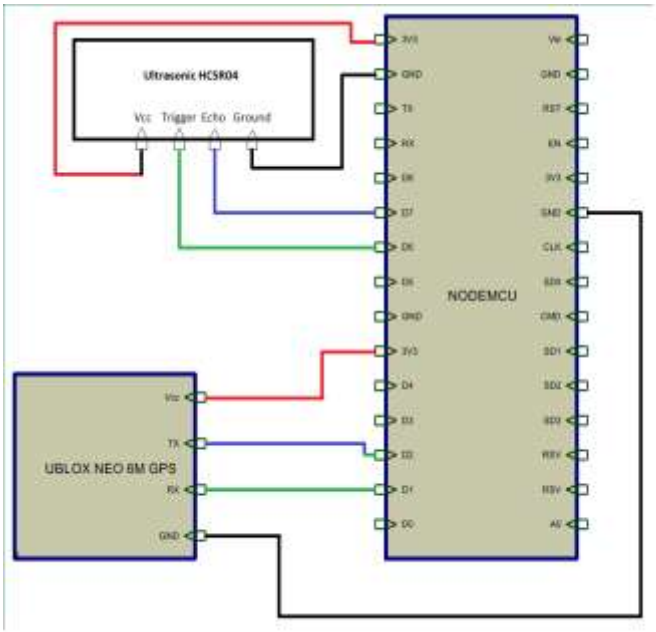

Fig -3: Circuit connection

The NodeMCU module has been used in our project as a microcontroller for connection to the Wi-Fi and for powering and retrieving values from other components such as the GPS module and the Ultrasonic Sensor. The Ultrasonic sensor is used in this project to measure the amount of garbage present in the dustbin at any point of time. This function is performed by the ultrasonic sensor by measuring time between emission and reception of the ultrasonic waves and then calculating the distance using speed-distance-time formula. It provides a digital output to the NodeMCU with a 5V battery input.

The logic used in finding whether the dustbin is full or not depends on the height of the dustbin. In our project we have assumed the height of every dustbin to be the same and accordingly updates are sent to the cloud:

1. Calculate distance of garbage from lid.
2. If the distance is less than 12 cm, then throw alert notification to clean the dustbin.
3. If not, keep checking till it does.
4. Once the notification is sent or values to cloud are uploaded, send updates to the app with the GPS location of every dustbin which will give us almost the exact location of each dustbin.

The GPS (Global Positioning System) module provides us with latitude and longitue values which can be used to find the location of the device using google maps. This will be useful in our project for easy navigation of the dustbins that require immediate cleaning.

Till now we have seen what components are being used in this project. Now we will look at the method of implementation of all the components. The hardware components with all the sufficient and correct connections will be installed under the dustbin cover or lid. The NodeMCU needs to be connected to any Wi-Fi network so that the interaction between the microcontroller and the cloud platform can be established. After successful connection of the NodeMCU and the Wi-Fi, the values retrieved by the NodeMCU from Ultrasonic sensor and GPS module can be sent across the cloud. The ultrasonic sensor will send the current garbage level in the dustbin. And the code for detection of full or partially-full dustbin will be modified in such a way that whenever the threshold level is reached, a notification will be triggered in the web application. In the web application, the initial page will have three option. One will be for the user registration and the other will be for the user login. The third option will be a feedback form which will be helpful in getting views from the audience. The user in this case is the admin of the garbage collection authority or the garbage collectors who will come to collect the garbage. The user after registration will be able to see all the dustbins and the level of garbage in each of them with respect to different locations and areas. The user will get a notification alert whenever a dustbin gets completely filled. The user will be then provided with necessary details such as the location of the dustbins where the cleaning is immediately required and the ID of that particular dustbin for easy and efficient navigation of the dustbins. The location parameters will be detected using the GPS module and the location will be found after calculating the position according to the latitude and longitude values received by the GPS module. This will help in cleaning the dustbins as soon as they get filled and in keeping the environment healthy.

The feedback form will enable the authorities to assess themselves and to make changes according to the feedbacks of the people who throw the garbage in the dustbin. After filling the form, one can open the stored submission details on the cloud and will be displayed on the app which will be used by the garbage collectors and the authorities. Analysis of the data collected over the time can be done so that the predictability and chances of a particular dustbin getting filled at a particular time can be predicted and according to that analysis, the garbage collectors can schedule their garbage collecting strategies. This project will not only help the residents to experience a healthy environment around them but will also help the management to work efficiently.

We have a website which shows the status of the bin. A URL will be provided to the user for accessing the website to view the status of the bin so that he can know every bin is filled to what level. This can help in prioritizing the cleaning of bins according to their filled status. Microcontroller takes the values from ultrasonic sensor and sends it to Firebase. Values from cloud can be retrieved using database which can be later reflected on the website showing status of each bin (Fig -4).

Fig -4: Application Dashboard

Users will be given an option to give feedback about the dustbins and their cleaning through a website. This website is designed using HTML & CSS containing a feedback form to be filled. The data submitted in this form will be sent to database using PHP as back end technology (Fig -5).

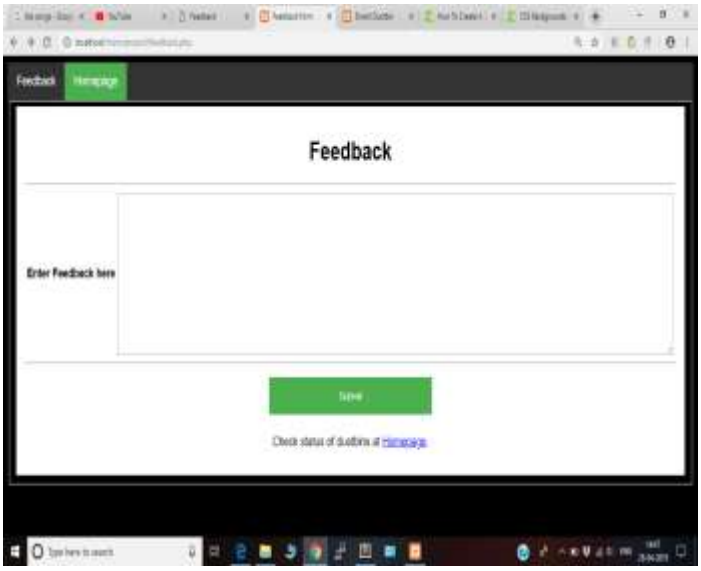

Fig -5: Feedback Form

5. RESULTS AND CONCLUSION

Best practices of this project includes success of reaching every milestone on time and getting benefitted from it. We have used cheap and efficient components to make the project economical. Code compaction has made the project more efficient by defining proper deliverables. The project can be easily used by users (garbage collectors and administration) for disposal and retrieval of waste. It can be deployed anywhere for proper waste disposal and pickup, which will help in making the environment cleaner and greener.

This project involves less human effort while automating the waste disposal by integrating hardware and application. The hardware detects the level of garbage and the application sends the notification of garbage retrieval .This project saves effort of garbage collectors by saving their time and cost of fuel of the vehicle. It provides proper disposal method of garbage, eliminating the dustbin getting completely filled and garbage spilling out. This is an efficient way of disposing the garbage considering the cost and easy to use attributes.

6. FUTUTRE SCOPE

There can be many different modules which can be implemented with this project. The modules which can be included are of various domains ranging from IoT to ML to AI to Big Data Analytics. Some of the improvements to this project can be providing the power source for the board using solar power which is a more eco-friendly solution. Analytics of the peak times of locations of where the dustbin is filled and for how long can be done to save human effort. Automation of opening and closing of lid and automation of switching on and off of the entire system is also a possibility which will, end of the day, save a lot of power.

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BIOGRAPHIES

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