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Smart Trash Can Monitoring System using IoT - Creating Solutions for Smart Cities

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Abstract: *In today's world, the trash cans placed in the cities are jam-packed due to the increase in the waste. A lot of stinking and sewage problems causes bad hygienic conditions and leads to deadly diseases & human illness. To avoid these, we have designed a "Smart Trash Can Monitoring System" where it can overcome this in an innovative and efficient way. This idea can be implemented for Smart Buildings, Cities, Colleges, Hospitals, Public spots and Bus stands. Each trash can contain a smart device for level detection of the trash can which transmits the garbage/trash level with its token ID, accessed by the concerned municipal/regional authorities through the mobile app, so that they can take immediate actions to clean the trash can once it gets filled. The device consists of an Ultra Sonic Sensor, Arduino Uno, GPS and Wi-Fi module.*

Keywords: Smart Trash Can, Efficient, Smart Cities, Level Detection, Arduino Uno, GPS, Ultrasonic Sensor, Wi-Fi Module

1. INTRODUCTION

The devices which are interconnected and controlled via internet is called as Internet of Things (IoT). In this project, the [7] Smart Trash Cans are connected to the internet to provide the real time information. In the recent years, there was a rapid growth in population which leads to more waste disposal. So, a proper waste management system is necessary to avoid spreading many diseases by managing and monitoring the smart trash cans. [1] There are multiple trashcans in the city and are interfaced with a smart device consists of Arduino Uno micro controller-based system with Ultrasonic Sensors, GPS and Wi-Fi modules. [8] The Ultrasonic sensor detects the level of the waste in trashcan and sends the signals to Arduino through Wi-Fi Module (NodeMCU ESP8266) with precise location. The data is sent to the user [2] through a mobile app with the help of internet connectivity. A message or alert is sent as notification that the trash can is almost full so that the concerned municipality authorities can call for an action and empty the trashcan.

Major problems caused in the cities are:

1. Vehicle fuel consumption
2. Overflowing bins which create unclean city
3. Many pests, rodents and animals which makes unhealthy surroundings
4. Manual monitoring
5. Increase in operational costs

Smart solutions to these issues are:

1. Garbage level monitoring
2. Providing optimal routes which help in reducing collections
3. Location based real time solutions through continuous tracking
4. Efficient waste controlling for municipal wellbeing
5. Urbanized & Organized living
6. Instant alerts
7. Automatic collection of data

2. PROPOSED SYSTEM

In this, we are going to make a Smart Trash Can Monitoring System which detects the level of trash can and states whether it is empty or full through the mobile app and we can get to know the status of the 'Smart Trash Can' from anywhere in the world via Internet. It is useful and can be fixed in the trash cans at public places, smart cities and other spots. We are using micro controllers and sensors to reduce the cost and to make it as an efficient device. To monitor the trash cans, the sensors are attached to trash can to detect the level. The system consists of sensor circuitry used for monitoring the smart trash can. The sensors used are Ultrasonic sensor, Arduino Uno, GPS and Node MCU ESp8266 Wi-Fi module.

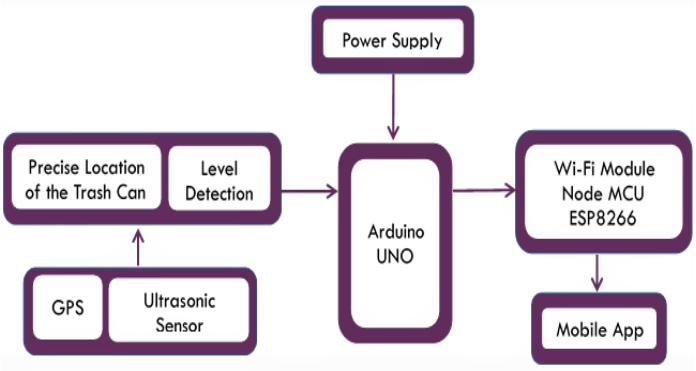

Fig -1: Basic Block Diagram

2.1. Arduino Uno

It's a single-board microcontroller, designed to make the application of interactive objects or environments more accessible. Sense the environment by receiving input from variety of sensors. Can be programmed with the Arduino software IDE. [5] The Atmega328 on the Arduino Uno comes preburned with a bootloader that allows us to upload new code to it, without the use of an external hardware programmer. The microcontroller can also be programmed through the ICSP (In-Circuit Serial Programming) header. It works on Windows, Linux as well as Mac platforms.

2.2. Ultrasonic Sensor

The ultrasonic sensor is used to measure the distance to an obstacle. We measure the time which it takes to signal to come back. An ultrasonic sensor has two mesh holes one part is for sending the sound out and the other one is microphone, which can measure the sound again. One of the advantages of ultrasonic sensing is its outstanding capability to sense deep details without any disturbance. Ultrasound can propagate through any kinds of media including solids, liquids and gases except vacuum. Time taken by pulse is for to and fro travel of ultrasonic signals, while we need only half of this.

Therefore, time is taken as time/2. Distance = Speed * Time/2

2.3. GPS Module

The Global Positioning System (GPS) is a satellite-based navigation system made up of at least 24 satellites. GPS works in any weather conditions, anywhere in the world, 24 hours a day. GPS receivers use this information and trilateration to calculate a user's exact location. GPS satellites transmit at least 2 low-power radio signals. The signals travel by line of sight, meaning they will pass through clouds, glass and plastic but will not go through most solid objects, such as buildings and mountains. However, modern receivers are more sensitive and can usually track through houses.

2.4. NodeMCU ESP8266 Wi-Fi Module

NodeMCU is an eLua based firmware for the [6] ESP8266 Wi-Fi SOC from Espressif. The NodeMCU firmware is a companion project to the popular NodeMCU dev kits, ready-made open source development boards with ESP8266-12E chips. It's a SOC with integrated MQTT protocol stack that can give any microcontroller access to the Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi- Fi networking functions from another application processor.

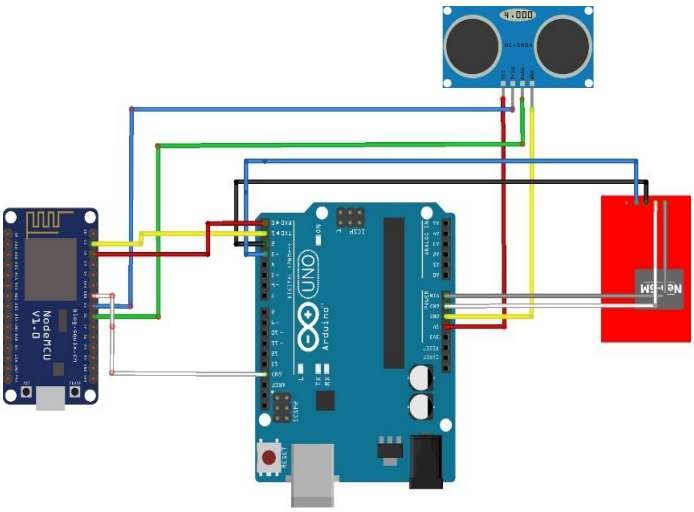

Fig -2: Circuit Diagram

3. Working Principle

The Block diagram shows the arrangement of different components used in the Smart trash can system. [4] Ultrasonic Sensor, Arduino Uno, Power Supply, NodeMCU Wi-Fi module- ESP8266 for connecting to internet. The project module is divided into two parts sensor section and NodeMCU Wi-Fi module ESP8266 section. Sensors are attached to the trash can. Sensors are used to detect the level in the trashcan whether the it is full or empty. The sensor senses the content of the trash can and sends the signals or the data to the Arduino. Wi-Fi Module [3] helps us to send the information of the trash can at the receiver side through internet. In this project the ultrasonic sensor will send the distance to NodeMCU Wi-Fi Module ESP8266 and if the distance is less than threshold values it will send an alert message or notification to the concerned authorities or users.

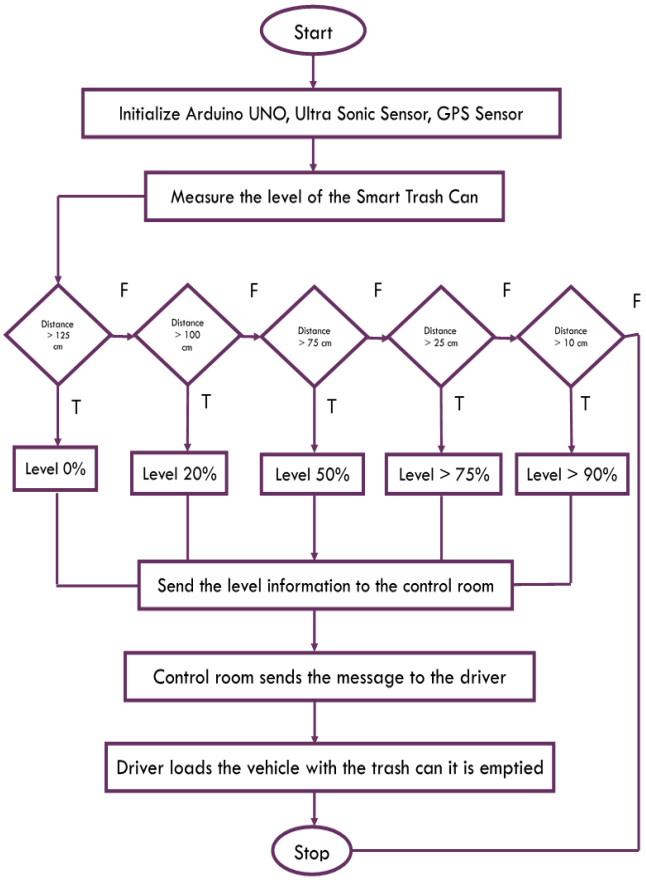

Fig -3: Flow Chart

Algorithm

Step1: Start

Step 2: Initialize Arduino, Ultrasonic Sensor, GPS Sensor

Step 3: Measure the level of the Trash can

Step 4: i.) If distance > 125cm, indicate as Level 0% then go to Step 5 else ii

ii.) If distance > 100cm, indicate as Level 20% then go to Step 5 else iii

iii.) If distance > 75cm, indicate as Level 50% then go to Step 5 else iv

iv.) If distance > 25cm, indicate as Level > 75% then go to Step 5 else v

v.) If distance > 10cm, indicate as Level > 90% then go to Step 5

Step 5: Send the level information to the control room

Step 6: Control room sends the message to the driver

Step 7: Driver loads the vehicle with the trash can it is emptied

Step 8: Stop

4. Output Results

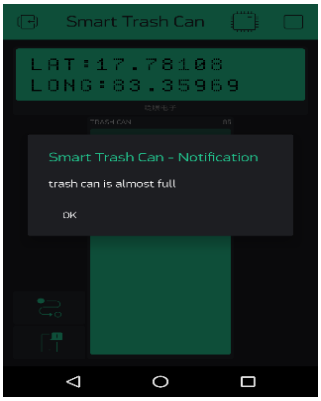

Fig -3: Notification Alert

Fig -4: Trash Can Setup

Fig -5: Location Detection

Fig -6: Prototype Setup

Fig -7: Level & Location Detection

5. ER Diagram

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database. An entity in this context is a component of data. In other words, ER diagrams illustrate the logical structure of databases. At first glance an entity relationship diagram looks very much like a flowchart. It is the specialized symbols, and the meanings of those symbols, that make it unique. In ER Model, we disintegrate data into entities, attributes and setup relationships between entities, all this can be represented visually using the ER diagram. It's interlinked with the Driver, Authority, Vehicle, Trash Can and User.

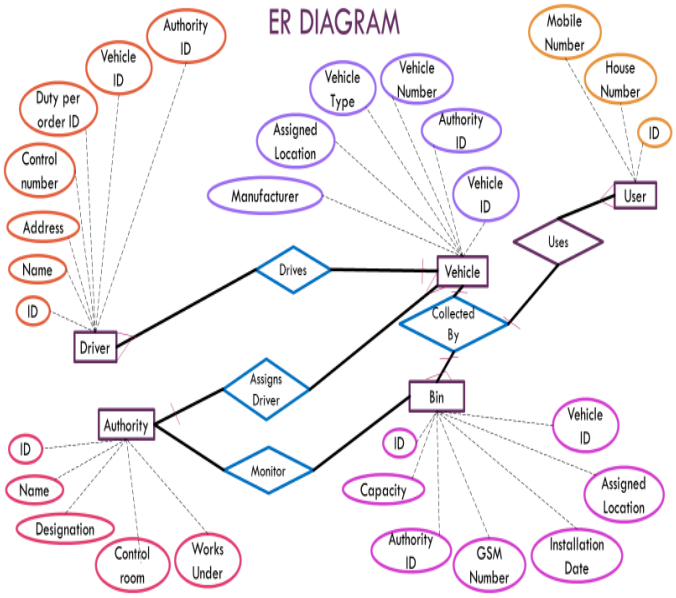

Fig -8: Entity Relationship Diagram

6. Applications

- Providing free Wi-Fi for smart citizens after dumping the trash in the can.
- Compressing the waste inside the bin.
- Providing optimal routes which help in reducing collections
- Location based real time solutions through continuous tracking.
- Smart bins powered by solar energy.
- Providing free money depending on the weight of garbage/ waste.
- To stop beach erosions by Crushing & Converting glass bottles into sand near beaches.
- Efficient waste controlling for municipal wellbeing
- Instant alerts and automatic collection of data.

Conclusion

With the rapid urbanization growth, the scenario around the world has been changed, as more number of people desire to live in the city lights with more opportunities for growth and success. Smart cities came into action to accommodate this growth in an effective way. The key parameter indicators like cleanliness and hygiene are the topic of concern in these smart cities. Also, the growth should go hand in hand with the green environment and research should be further done on such technologies to cope up with the future needs. Our work is small but efficient step towards cleanliness and belief is that this project would encourage people to do efficient work on the associated topics. This project is a new solution and is developed to enhance the waste monitoring management system.

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