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An IoT Based Smart Garbage Monitoring and Disposal Support System

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***ABSTRACT* - Today globally people designed different systems based on Internet of Things (IoT) principles and made human with smart living. In this article, an important application is proposed for our daily usage and is named as Smart Garbage Monitoring and Disposal Support System (SGMDSS). Since the advent of mobile communication and the spread of the Internet anywhere and anytime, there is a lot of scopes to control the devices from remote places. Solid garbage is one of the prior concerns today globally because improper execution of garbage removal from the villages, towns, and cities affects the people living there and it is the ultimate cause for new diseases. So, proper garbage management by using technology is a major concern of the hour. In the traditional existing system, the monitoring and disposal of garbage are done by humans and it is cumbersome, therefore supporting the traditional system with the flavor of IoT, then monitoring of garbage bins will be easy. This helps the people who are involved in the traditional garbage collection system and it will be the best feasible solution. The SGMDSS is a very innovative information management control system that helps the metros, cities, and villages hygiene and clean with a better garbage disposal. This system uses an advanced approach in which waste monitoring and disposal support are automated. SGMDSS monitors the garbage bins located at different locations and notifies about the level of garbage accumulated in the garbage bins through an android mobile application to the cleaning personnel for disposal and provides the shortest path to the garbage bin location that is almost filled. This information is also sent to the webpage and the entire data is stored and accessed through the cloud. Also, an alert message is sent to the worker.**

Keywords: Internet of Things (IoT), Smart Garbage Monitoring and Disposal Support System (SGMDSS), Mobile Communication.

I. INTRODUCTION

Garbage collectors are present in all the places namely organizations, offices, schools, hospitals, streets, etc [1]. The basic problem involved in the traditional approach in the garbage collection process is checking dust bins without knowing its baseline information that is garbage levels. This approach reduces fuel utilization efficiency and time efficiency for municipal corporation workers [2-4]. Enhancing intelligence in the garbage collection process will optimize the collection process and operational effectiveness [5-7].

In this system, IoT-edged nodes are installed in the garbage bins or garbage collectors, these nodes capture the data that is the level of garbage accumulated in the bin and transmit the data to the cloud. Here, a cloud platform is used to store and visualize the data that is captured by the nodes. All the cleaning workers will be equipped with the android application which retrieves all the data from the cloud. Whenever the garbage is almost full an alert message is sent in the form of SMS to the workers and also the shortest path to collect the garbage is provided by the application. At present, many researchers designed similar systems but this system is designed by incorporating the cloud. Because of this, the collected data of different located bins will be available to all the authorized people of this system through the mobile application. The unique feature of this system is the mobile application will display the shortest path to reach the garbage bin geographical locations which are filled above the threshold levels are available to the respective personnel. Therefore, the real-time monitoring of garbage-filled levels is possible through this IoT application. This will help to minimize the overfilling dustbin issues. The scope of the system is omnipresent. This application can be installed wherever or whenever garbage collection and disposal is requiring at places like homes, apartments, railway stations, organizations, streets, buildings, schools, etc.

A. Existing system:

The present system involves the process where the cleaning workers go to each garbage bin and check for the filled bins to empty them which leads to unnecessary fuel consumption and unnecessary man-power wastage Also sometimes it so happens that the garbage bins are overfilled and not cleared by the workers.

B. Proposed system:

In this proposed system, IoT edge nodes are installed in the garbage bins or garbage collectors, these nodes capture the data that is the level of garbage accumulated in the bin and then transmit the data to the cloud. In this system "ThingSpeak" IoT cloud platform is used to store and visualize the data that is captured by the nodes[11]. All the cleaning workers will be equipped with the android application which retrieves all the data from the cloud. Whenever the garbage is almost filled in any bin the immediately an alert is sent to the workers and also

the shortest path to collect the garbage is provided by the application.

II. DETAILED ARCHITECTURE OF PROPOSED SYSTEM

This section describes the details of each block and working of the proposed Smart Garbage Monitoring and Disposal Support System (SGMDSS). The role of the hardware components used and their integration with the cloud as well as android application platforms to control the functionality of the entire proposed system is presented below. The smart dustbin is inbuilt with the ultrasonic sensor connected to the microcontroller. The microcontroller is further connected to both the Wi-FI module and GSM module. The processed information from the microcontroller is transferred to the ThingSpeak cloud platform where data is presented visually. The same information is available in the android application through a smart mobile phone. The complete process is presented in the block diagram depicted in figure:1 below.

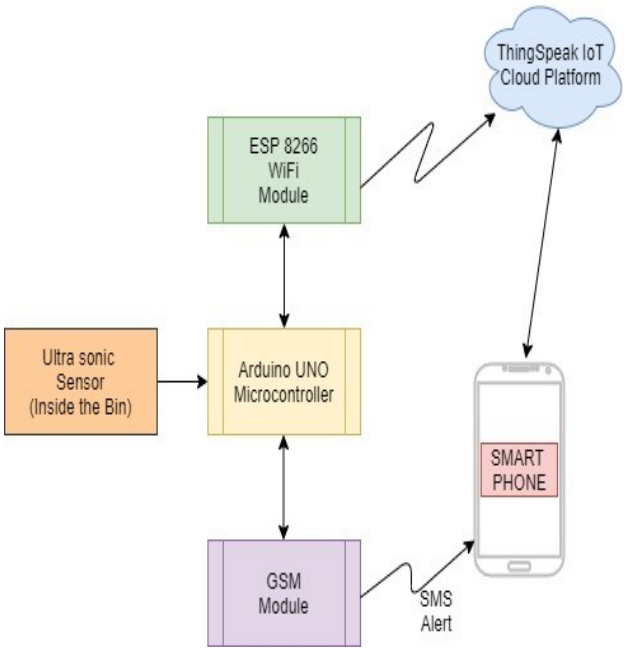


Figure 1: Block diagram of the entire process in SGMDSS

A. Microcontroller block:

The microcontroller used in this work is Arduino UNO, the Arduino boards can read inputs from hardware things (sensors), and accordingly they will initiate the functionality and publish the data through online. The Arduino Uno is an ATmega328 embedded microcontroller chip fabricated on a board that is used for many IoT applications. It consists of digital GPIO (general input/output) pins out of which 6 pins are exclusively used for PWM outputs and six pins are used for analog inputs, it is having an inbuilt resonator (running at 16 MHz) with a USB connection, a power port, an In-Circuit System Programming (ICSP) header, and a reset button.

B. ESP 8266 WiFi Module:

The ESP8266 is a cost-effective(low) Wi-Fi-enabled chip with a full TCP/IP stack and an inbuilt microcontroller unit (MCU) facility [3]. This module could be utilized for both access points like creating a hotspot and a Wi-Fi station. Therefore, this module can easily fetch and upload the data to a cloud platform like ThingSpeak and so making IoT connectivity secure.

C. GSM Module:

Global System for Mobile Communication (GSM) is widely used for many IoT applications in which mobile communication feature needs. In the proposed system, it is used for SMS alert functionality.

D. Ultrasonic Sensor:

The ultrasonic sensor is used in many of the embedded applications for measuring the distance with the help of sound waves [3]. The sensor head emits a sound wave and receives the same wave reflected from the target. This sensor measures the distance between the source and target by measuring the time taken by the wave travelling between the source point and the target point.

E. ThingSpeak:

ThingSpeak[12] is an open IoT Cloud platform mainly used in IoT applications design. It is having the capability of real-time data processing and displays the details in a visual format. It is compatible with all web services and Application Programming Interface (APIs).

III. PROCESS AND METHODOLOGY

The process involved in this application is the measurement of the garbage level in a bin of 30cm height using an ultrasonic sensor. The ultrasonic sensor is installed on the dustbin cap and the sensor is facing towards the bin inside the bottom surface. Therefore, from the top lid position the accumulated level of garbage inside the dustbin is measuring continuously with the help of a microcontroller and the data processed will send to the ThingSpeak cloud via ESP 8266. The levels in the bin are considered as “Filled”,

“Half Filled” and “Empty”. Based on the size of the dustbin the levels are divided into three levels of distances. The “Filled” levels determine the level measured from 1cm-10cm, “Half Filled” means the level from 11cm to 20cm, and the “Empty” means the level from 21cm to 30cm. This logic is implemented in the code and the same is verified practically. When garbage fills the bin for each of the above-mentioned levels, an alert message appears on the webpage, and the level value is displayed in the Android application alongside the bin number. When the bin level reaches the maximum or the

"Filled" level, the person in charge of disposing of garbage in that bin will receive an alert message along with the shortest path to the bin. Due to this, both time and fuel consumption of the garbage collecting vehicles will be reduced. A webpage and a mobile application are developed for the respective city development authorities as well as the personnel working in that department. They can monitor the status of dustbins and their respective locations on that website and also all these details can be retrieved via the ThingSpeak cloud platform. An android mobile application is developed to get the status of individual dust-gathering personnel and it will show the shortest path to reach those respective dustbins.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The circuit schematic of the proposed design and the experimental setup of the bin are shown in figures 4 and 5. The experiment is performed with the designed unit under different test conditions mentioned in table 1. The systempassed all the test cases and the results of the same are presented in table 2. Corresponding to the manually measured value (with bar scale), the ultrasonic measured values are matched with a difference of decimal values in the majority of cases. The dustbin level measured by ultrasonic is exactly reflected in the ThingSpeak database. In Thingspeak the field chart displays the graphical variation of bin levels, and the filled levels are classified with colour indication and are displayed as RED for "Filled", BLUE for "Half Filled" and GREEN for "Empty". At all times, the status of the bin is transferred to the user mobile via the GSM module. All these details of different experimental values are depicted in table2. The screenshots of the system i.e both webpage and android application for different test conditions are presented in figures 6 and 7.

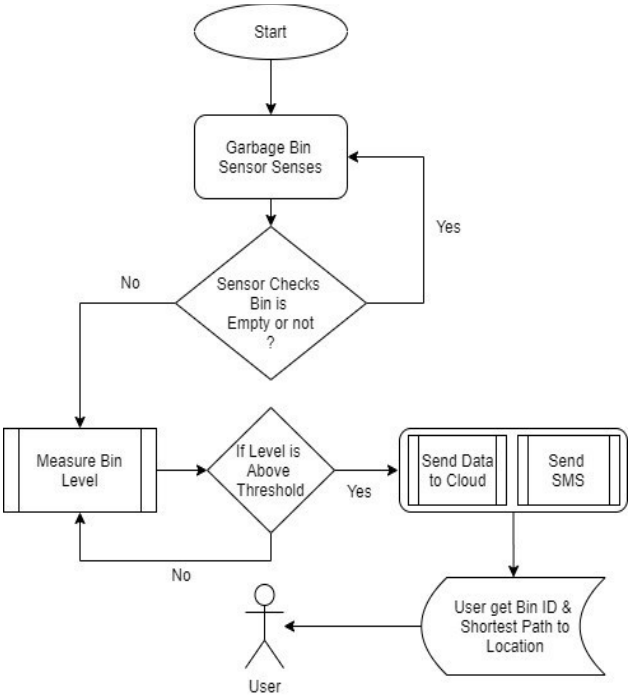


Figure 2: The Flowchart and Methodology

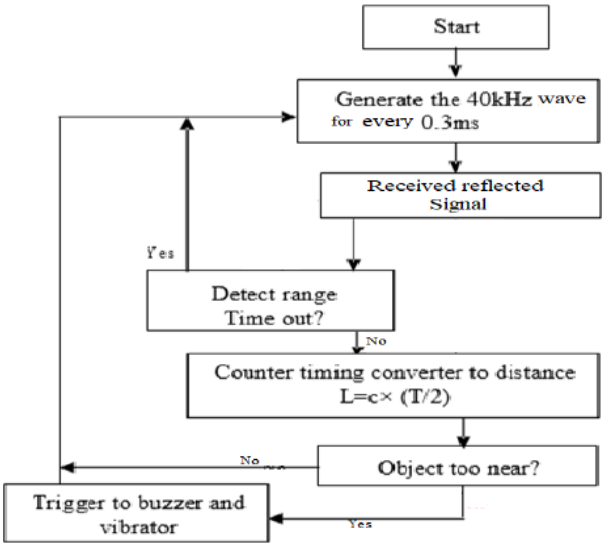


Figure 3: The Principle involved in the system

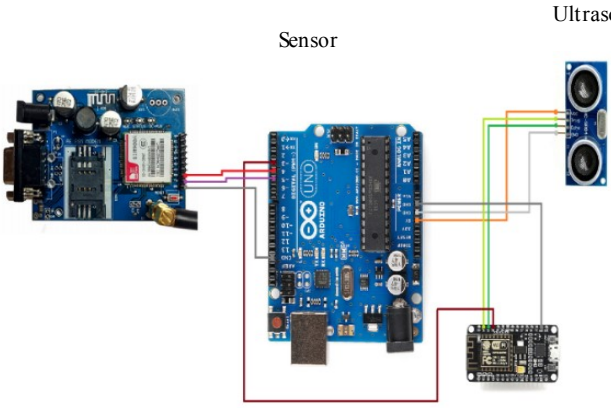


Figure 4: The System circuit schematic

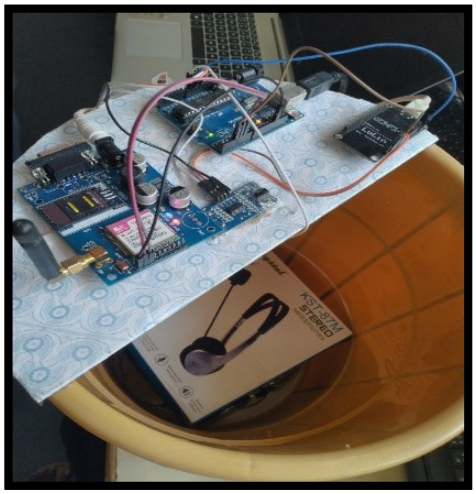


Figure 5: The hardware setup with bin

TABLE 1: DIFFERENT TEST CASES PASSED BY SMART GARBAGE BIN OF SGMDSS SYSTEM.

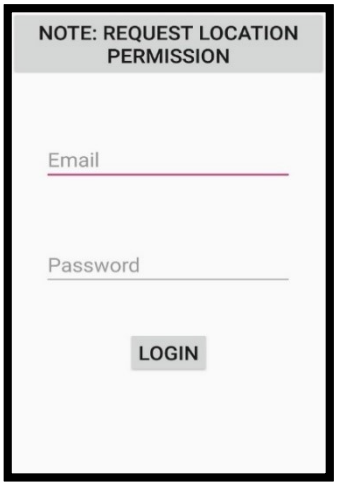
Test Case #	Test Case Description	Test Data	Expected Result	Actual Result	Pass/ Fail
1.	Dust Bin filled completely	1-10 cm	Filled	Filled	PASS
2.	Dust Bin Half filled	11-20 cm	Half filled	Half filled	PASS
3.	Dust Bin empty	21-30 cm	Empty	Empty	PASS
4.	ThingSpeak Data collected	Percentage of Dust in the Dust Bin	Data in cm	Data in cm	PASS
5.	ThingSpeak Indicator	Indicates in Red colour	RED	RED	PASS
6.	GSM sends message if Dust Bin filled	Message with location	Message sent	Message sent	PASS

TABLE 2: EXPERIMENTAL READINGS FOR DIFFERENT CONDITIONS OF TESTED IN THE BIN OF SGMDSS.

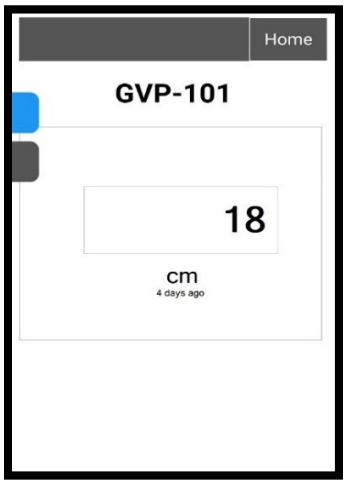
SNo	Dustbin actual level measured manually by scale in cm	Dustbin level given by Ultrasonic In cm	Level reflected in ThingSpeak	Colour Indication in ThingSpeak	Level sent to Mobile	Status
1.	18.5	18	18	Blue	18	Half Filled
2.	12.4	12	12	Blue	12	Half Filled
3.	4.2	4	4	Red	4	Filled
4.	8	8	8	Red	8	Filled
5.	22	21	21	Green	21	Empty
6.	28	29	29	Green	29	Empty
7	3	3	3	Red	3	Filled
8	26	27	27	Green	27	Empty

Figure 6: The ThingSpeak report

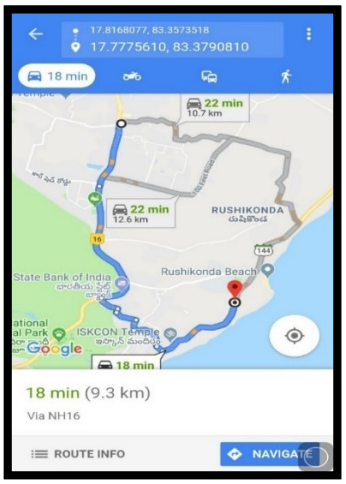
Home Page in Android Application



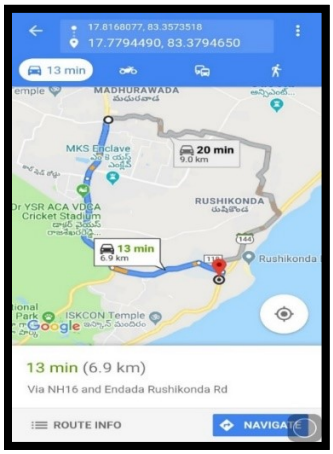
Login Page in Android Application



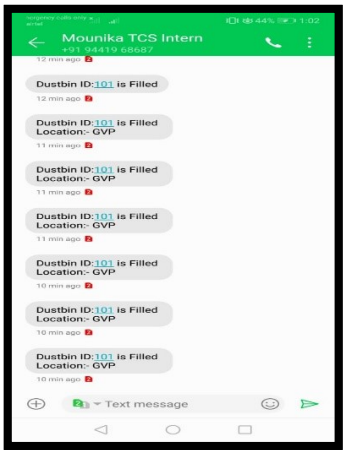
Bin Id and Garbage Level



Normal Route to Bin



Shortest Route to Bin



Message Alert to Worker

Figure 7: The Complete android applications for garbage level in bin and location and SMS alert

V. CONCLUSIONS AND FUTURE SCOPE

The proposed system is designed with integrating different modules like ESP8266 Wi-Fi modem, Ultrasonic Sensor, Arduino board, and a GSM module, which is a cost-efficient and economic smart garbage collection system. The major advantage of this system is, it is implemented with the help of the cloud ThingSpeak database which is an open-source for collecting waste levels at each location and serves back to the mobile application for garbage collection without any delay. By implementing this system, the problem can be minimized for excess accumulation of garbage from the dustbins in streets, residential houses, organizations, etc. which are loaded manually or by using loaders in traditional garbage vans. The improved feature of any other similar systems already existing is, this proposed system can monitor the garbage level automatically with the help of sensors and transfer that information to the cleaning workers through an android application and also provides the shortest route to reach the location of the garbage bin. The process and methodology used in this SGMDSS are more than enough to ensure the practical application and is a seamless system for garbage collection processing, monitoring, and disposal management for a better clean and green environment. The future scope and enhancement of this system are possible with LoRa technology to cover a wide area with further very low cost.

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