IoT enabled E-waste management system for smart city

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***Abstract*: Waste management is one of the major problem in case of both developed or developing country. The main issue in the waste management is that the waste bins at different public locations gets overflowed well in advance before the next cleaning process takes place. It leads to various hazards such as bad odor & ugliness to that place which results in the spread of various diseases. To avoid all such hazardous effects and maintain cleanliness and health this system proposes e-waste management system. The main purpose of the work is to develop a smart intelligent e-waste system for a proper waste management by signaling an alert message to the municipal web server for instant cleaning of waste bin.**

This e-waste management process is done by the ultrasonic sensor which is interfaced with microcontroller. It checks the level of waste filled in the waste bin and sends this information to the municipal web server. An Android application is developed and linked to a web server to receive the alerts from the municipal web server. This system performs the remote monitoring & controlling of the cleaning process and reduces the manual process of monitoring and verification.

***Keywords*: Internet of things, Smart waste management, Shortest Path Spanning-Tree algorithm, Database management, Visualization, Optimization**

I. INTRODUCTION

Waste may consists of the unwanted material left over from City, Public area, Society, College, home etc. This work is related to the "Smart City" and it is based on "Internet of Things" (IOT). In today's scenario, waste collection and its management is very critical issue. In India 2 October 2014, Indian Prime Minister Mr. Narendra Modi announced Clean India Mission launched by Government of India. Inspiring by these mission we proposed e-waste management system. The work proposed in this paper illustrates how the e-waste management solution empowers cleaning public areas like Railway stations, Global store, Colleges, Hotels etc. This project IOT based E-waste Management system is a very innovative system which will help to keep the cities clean. This system monitors the waste bins and informs about the level of waste collected in the waste bins via a web page. For this the system uses ultrasonic sensors placed over the bins to detect the waste level and compare it with the waste bins depth. The system makes use of Arduino family microcontroller and ESP8266 Wi –Fi module.

II. PROPOSED WORK

This paper represents E-waste Management System as an IoT based service for the smart cities. This waste management mechanism consists of Ultrasonic sensor which measures the level of waste present in waste bins at regular intervals. This measured data is stored on the server i.e. cleaning authority. This measured values of the waste level are compared with the threshold values in order to determine the overflow. Whenever an overflow occurs, an alert message is sent to the cleaners via Android app.

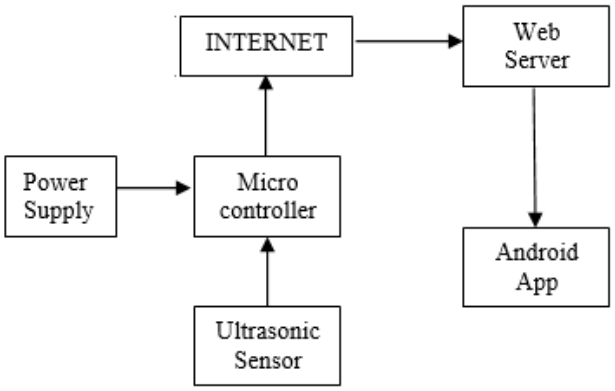

Fig1. Block Diagram of Waste Management System

III. IMPLEMENTATION

The proposed system continuously measures the level of waste in the waste bins using ultrasonic sensor. This ultrasonic sensor is interfaced with a microcontroller in order to measure the waste at regular intervals. The information is sent to the web server using Wi-Fi modules. In case of overflows, an alert message is sent to end users via android app.

A. Hardware Requirements:

i. Ultrasonic Ranging module HC-SR04

ii. ESP8266 Node MCU Wi-Fi module

i. Ultrasonic Ranging Module HC-SR04:

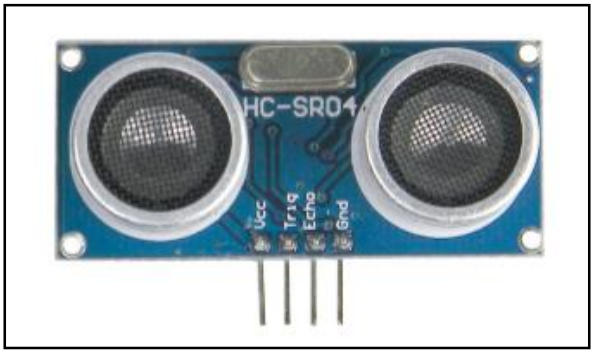

Fig2. Ultrasonic Ranging Module HC-SR04

The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone). The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object.

Working Principle:

The transmitter emits 8 bursts of a directional 40 KHz ultrasonic wave when triggered and starts a timer. Ultrasonic pulses travel outward until they encounter an object. The object causes the wave to be reflected back towards the unit. The ultrasonic receiver would detect the reflected wave and stop the stop timer. The velocity of the ultrasonic burst is 340m/sec. in air. Based on the number of counts by the timer, the distance can be calculated between the object and transmitter as:

$$D = C\ X\ T$$

This formula is known as the time/rate/distance (TRD) measurement formula, where D is the measured distance, and C is the propagation velocity (Rate) in air (speed of sound) and T represents time.

In this application T is divided by 2 as T is double the time value from transmitter to object back to receiver. Therefore, distance is calculated as,

$$\boldsymbol{D = \frac{C \times T}{2}}$$

Distance in cm = echo pulse width in uS/58
Distance in inch = echo pulse width in uS/148

ii. ESP8266 Node MCU Wi-Fi Module:

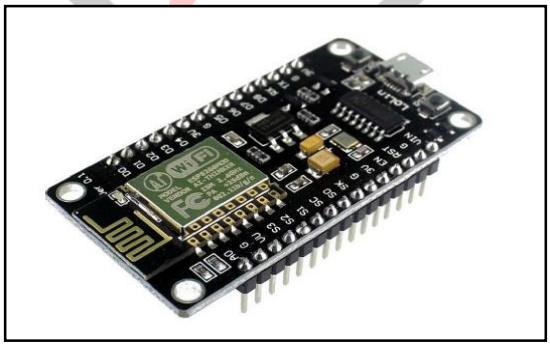

Fig3. ESP8266 Node MCU Wi-Fi Module

The ESP8266 is the name of a micro controller designed by Espressif Systems. The ESP8266 itself is a self-contained Wi-Fi networking solution offering as a bridge from existing micro controller to Wi-Fi and is also capable of running self-contained applications. This module comes with a built in USB connector and a rich assortment of pin-outs. With a micro USB cable, you can connect Node MCU to your laptop and flash it without any trouble. It is also immediately breadboard friendly.

B. Circuit Connections

The ultrasonic sensor has four pins namely: VCC, Trig, Echo, and GND. The VCC (+5V) is connected to the voltage regulator's input on the ESP8266 board. The Trig input pin is connected to the D1 (GPIO5) pin of the Wi-Fi module. The Echo output pin generates the 5V output signal which needs to be given to the microcontroller. Since, ESP8266 Wi-Fi module works at 3.3V, so the output of the ultrasonic sensor needs to be lowered down from 5V to 3.3V. Thus, the Echo output signal is given as input to the Voltage divider (consists of serial combination of 1k and 2.2k resistors). The output of voltage divider is now given as input to the D2 (GPIO4) pin of the Wi-Fi module. The GND pin of ultrasonic sensor is connected to the GND of the ESP8266 module.

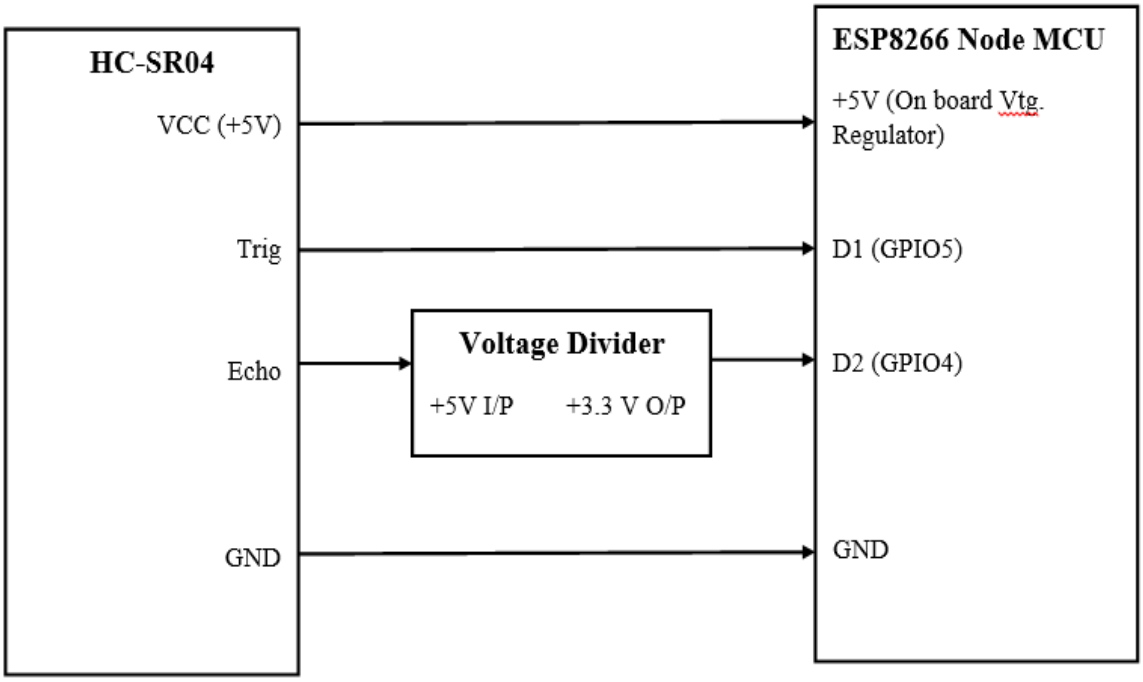

Fig4. Circuit Connections

C. Ultrasonic Distance Measurement:

For ultrasonic distance measurement, Trig input pin has to make HIGH for min. 10uS in order to start the measurement from the microcontroller. In order to measure the distance in cm, following formula is used:

$$\text{Distance in cm} = \frac{Echo\ pulse\ width\ in\ uS\ (Duration)}{58}$$

Condition	Status	Result
Distance >16cm	0	Waste bin is empty
8cm < Distance < 16cm	1	Waste bin is partially filled
Distance < 8cm	2	Waste bin is full

Table1: Conditions for ultrasonic distance measurement

For the programming, the total height of the waste bin is considered to be 25cm. When the distance measured is greater than 16cm, then status 0 is sent which indicates that the "Waste bin is Empty." When the measured distance lies in between 8-16 cm, then it updates status 1 which indicates that the "Waste bin is partially filled". Thus, when the measured distance is less than 8 cm, then it updates status 2 indicating "Waste bin is full".

IV. RESULTS

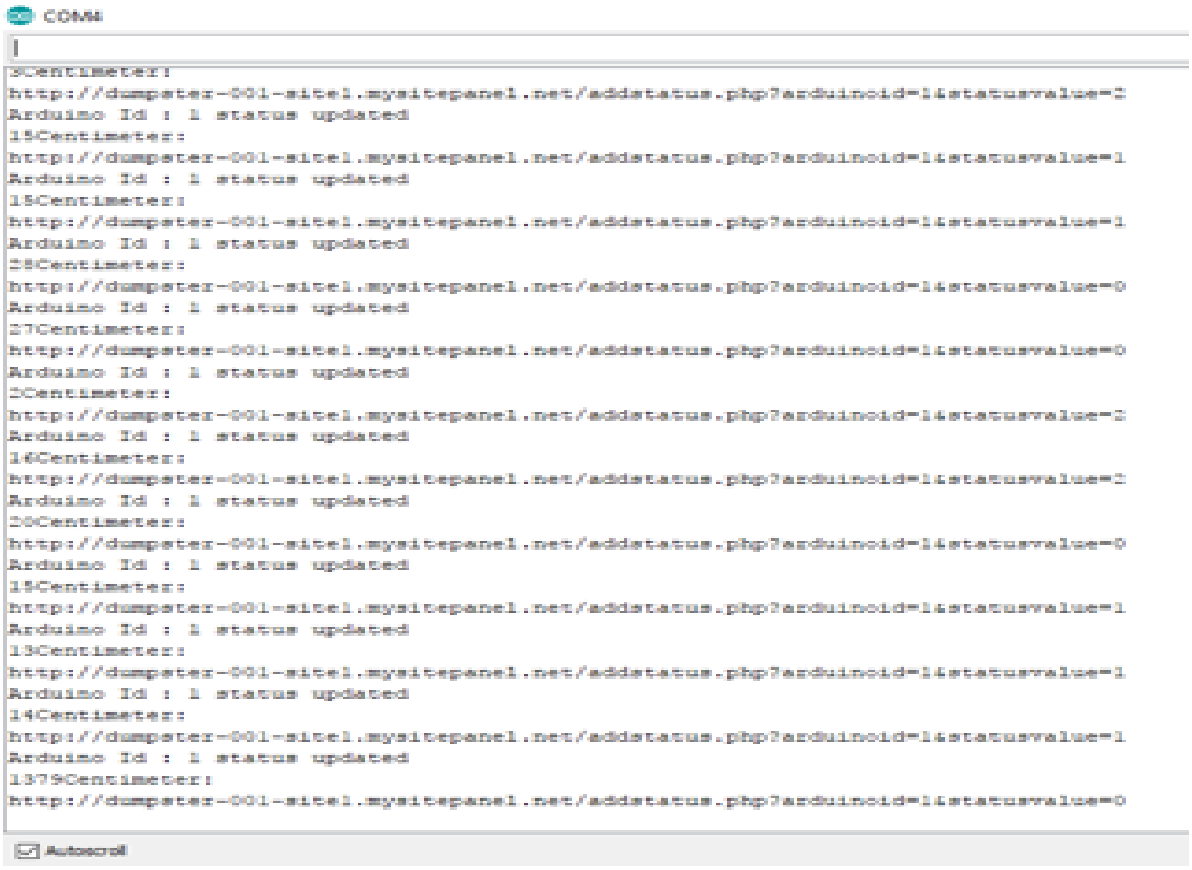

Fig5. Updated waste bin status on serial monitor of Arduino IDE

V. CONCLUSION

This work represents a waste management solution based on providing intelligence to waste bins, using an IoT prototype with sensors. It can read, collect, and transmit huge volume of data over the Internet. This work measures the level of waste present in the waste bins with the help of ultrasonic sensor. The measured values are compared with the threshold values and according to that status is updated. Later this data is sent (through Internet) to a server for storage and processing. This data helps to give alerts for the workers in case of overflows. By implementing this project we will avoid over flowing of garbage from the container in residential area which is previously either loaded manually or with the help of loaders in traditional trucks. In future, we would like to enhance the system for different kind of wastes, namely solid and liquid wastes.

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