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IOT based Road Pothole and Hump Identification using Ultrasound Waves

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***Abstract**: The major problems still exsist in Indian transporta-tion system is the maintenance of roads. Well maintained roads contribute to the major portion of the countrys economical devel-opement.The Identification or detection of pavement anomalies such as potholes and humps can not only help the drivers to avoid meeting with accidents or vehicle damages, but also helps the municipal authorities for the correct maintainance of the roads. This work is an atempt to produce and implement an IOT based cost effective module to detect/identify the potholes and humps along the roads.Ultrasonic distance sensors are used for the identification of the potholes and humps and also to measure their depth and height, respectively. The measured informations are stored in Thingspeak.com an IOT open server for future analysis.*
***Index Terms**: Ultrasonic sensor, Pothole and Hump detec-tion,ESP 8266, IOT, Arduino*

I. Introduction

Fig. 1. Condition of roads with potholes.

Most of the road accidents in India can be classified by two main reasons first is the dangerous road conditions and second is the careless driving. These cause the major distractions for comfortable and safe transportation. maintaining our roadways in proper condition is a high risk involved problem.Well created roads get degraded over relatively short periods of time because of the unexpected traffic load, harsh weather, and natural wear and tear. Most of the time such degradation of the roads makes severe damages to the vehicles ,health of the drivers, and even for the pedestrians. Sometimes it cause even death. Unexpected poptholes and humps are the major road distresses that cause these kind of issues. Bothdrivers and road maintenance authorities are interested in fixing them as soon as the exsist. However, these conditions have to be identified first. Therefore , an intelligent pothole-Hump detection system is the need of the day.

In the proposed work use a cost-effective ultrasonic sensor for analysing the road surface conditions. In such monitoring system, a device with sensor is mountedat the bottom potion of the test vehicle. The ultrasonic distance sensor continuously measure the distance between it and the road surfaced by sending and receiving ultrasonic sound signals. by analysing the received signals , the system can detect road surface anomalies such as humps or potholes. The inclusion of Internet of Things(IOT) increases the applications of this model, since by the use of IOT the measured pothole and hump information can be analyzed by the autherized person from anywhere in this world and he can have the data in a downloadable format which can be used for further analysis.

II. Problem Statement/Relevance

Because of the large increase in the road accidents in the recent years due to unexpected potholes and humps in the roads, need of an efficient system that can detect such potholes and humps are very essential nowadays which can save hundreds of human life and it can also reduce the manual human efforts to identify these road irregularities.

III. System Design

A. Block Diagram

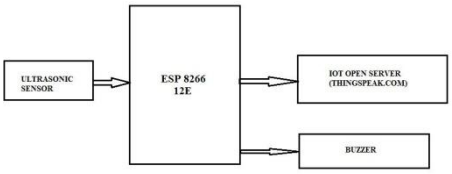

Fig. 2. Block Diagram of the System.

B. ESP 8266-12E

The ESP8266 WiFi Module is a self capable System on chip(SOC) with an integrated TCP/IP protocol stack which could give all types of microcontroller access to the WiFi network associated with it. The ESP8266 is very much ca-pable of either hosting an application or offloading all Wi-Fi networking functions from a different application processor. Each ESP8266 module has a pre-programmed AT command set firmware, so that you can easly connect them to other processor devices so that i provide as much wifi strength that a normal wifi shield provides. The ESP8266 module is a very cost effective SOC with small size, a huge, and ever growing, support systems.

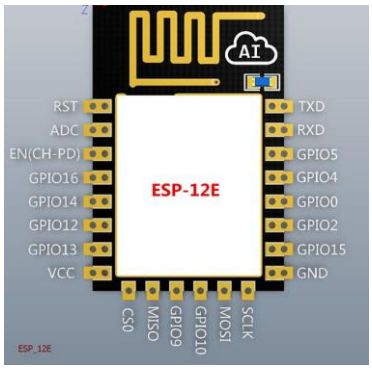

Fig. 3. ESP-8266-12E

ESP8266 comes with a powerful on-board processing and storage capability which allows the processor to use it as a microcontroller similar as an Arduino that can be integrated with the sensors and other application specific devices through its GPIO pins with less development up-front and reduced loading during runtime. Its high degree of on-chip integration leads for less external circuitry, which includes the front-end module, is designed to occupy reduced PCB area. The ESP826 module supports APSD for VoIP applications and Bluetooth co-existance interfaces, it also contains a self-calibrated RF allowing to work under all operating conditions, and not least requires no external RF parts.

C. Ultrasonic Sensor

The HC-SR04 is an active ultrasonic sensor that contains an ultrasound transmitter and a receiver.It is also known as Ping Sensor. It is used to measure distance from it at which, the objects are placed. The sensor continouously transmits ultrasonic sound waves and waits for the reflected wave to return and incident on the receiver side. The distance is then obtained based on the time taken by the ultrasonic wave to travel from the object back to the sensor.The working principle of the sensor is shown in figure 5. There are variety of ultrasonic sensors availablein the market with different transmission ranges and angles of detection. The

Fig. 4. ultrasonic sensor

HC-SR04 ultrasonic sensor is one among them with operating frequency of 40 KHz and it can measure distances of the objects upto to 400 cm with an angle of detection of 15.

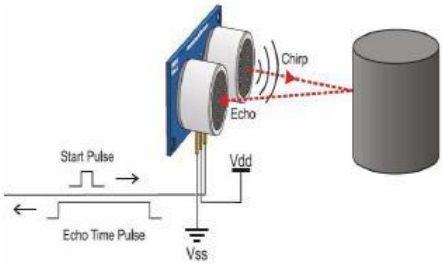

Fig. 5. working principle of ultrasonic sensor

D. Thingspeak Website

The Internet of Things one of the dominant upcoming technology that gives access to a wide range of web services and embedded devices.ThingSpeak website is a complete open data server platform and API for the Internet of Things technology which enables somebody to collect, store, analyze, visualize, and act on data from various sensors or actuators, such as Arduino, Raspberry Pi, BeagleBone Black, and other similar embedded hardwares. For an example, with ThingS-peak platform one can generate location-tracking applications, sensor-logging applications, and a social network of things with status updates, such that one can have their home thermostat control itself based on his/her current location.

IV. Circuit And Hardware Interconnections

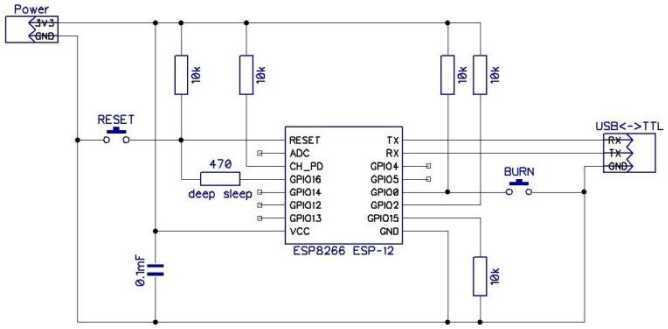

Fig. 6. connections to ESP module

Three things has to be given most care while doing the ESP module connections.

1) Make the GPIO 0 pin to ground while uploading a new firmwire.
2) Alwas press Reset button before uploading.
3) Make sure that the ESP is powered with 3.3V only. We use three General Purpose pins of the ESP module.
1) GPIO 5 : As output pin to Sensor's Trigger pin.
2) GPIO4 : AS input pin to Sensor's Echo pin.
3) GPIO 12 : As output pin to Buzzer's positive cable.

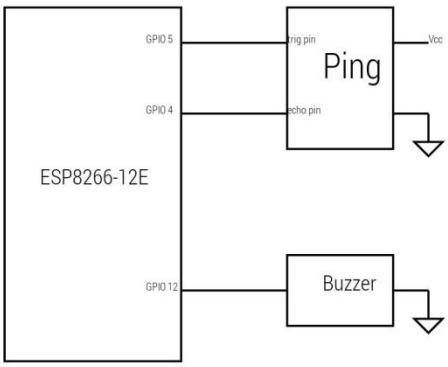

Fig. 7. Interconnection of ESP module with ultrasonic sensor and Buzzer

V. Working Of The Model

The working of the proposed Project model is simple. The ultra sonic sensor also known as Ping sensor continously transmits Sound waves in the form of pulsea and it will strike on the potholes and Humps and reflects back. The reflected Pulses are captured by the receiver of the Ping. The ESP processor alalyzes the duration of the received sound pulse and it will be converted to equivalent distance in centimeters by using the following formula.

distance=pulseduration 58:2

Now the controller sets a threshold and if the distance is less than the threshold it decides that the reflection is from a Hump whereas if the calculated distance is morethan the threshold then controller fixes that the reflection is from a Pothole.

These Pothole Depth and Hump Height informations are sent to The open IOT servor Called ' Thingspeak.com' via ESP wifi system which is also inbuilt in this ESP module. The 'Thingspeak.com' website updates in every 15seconds so that The information regarding the Potholes and Humps can be extraced from the open servor in every 15 seconds.

Whenever a Pothole or Hump is detected by the Ultrasonic sensor the Buzzer Associate with the module makes the indication.

VI. Implementation Results

The hardware module is programmed using the Arduino 1.6.5 IDE. The open-source Arduino Software (IDE) makes the process easy to write code and upload the written code to ESP board. It can operate on various system platforms such as Windows, Mac OS X, and Linux.

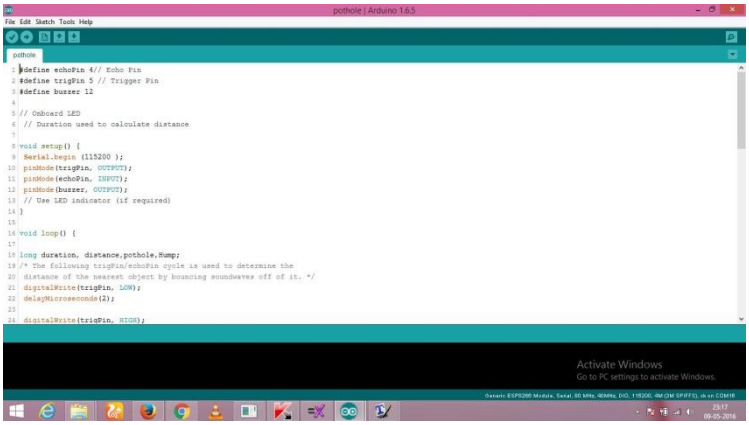

Fig. 8. Arduino 1.6.5 IDE

The measured Pothole Depth and Hump Height informa-tions have displayed on the serial Monitor of the Arduino IDE.

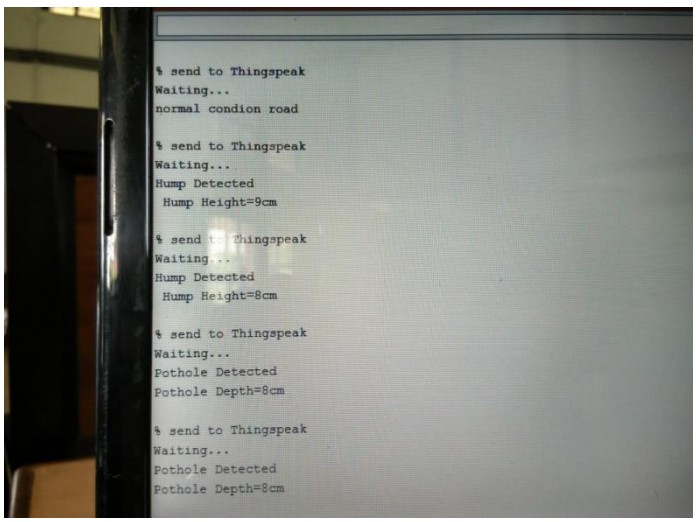

Fig. 9. Pothole and Hump information displayed on Serial Monitor.

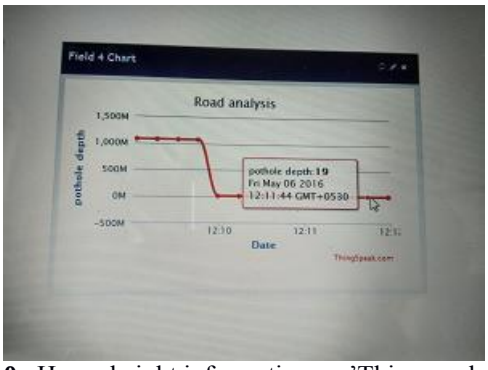

Fig. 10. Hump height information on 'Thingspeak.com'

The Pothole and Hump Information such as their depth and height along with the time of occurance is transferred and also plotted in the Thingspeak Website in seperate Channels for the further analysis.This data can be accessed by a person who has the server access from anywhere in this world.

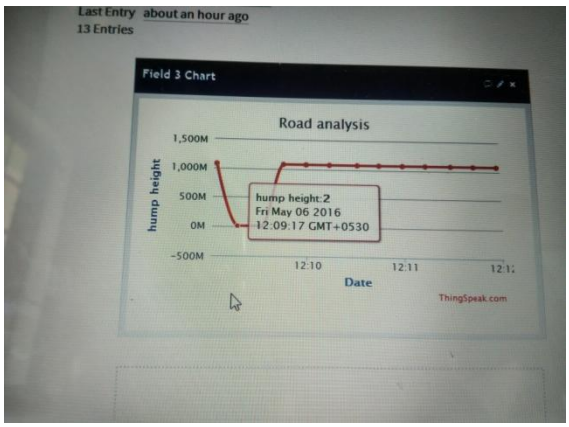

Fig. 11. Hump height information on 'Thingspeak.com'

The implemented prototype includes Thingspeak open sever, ESP-8266 module, an ultrasonic sensor and a Buzzer which is illustrated in figure 12

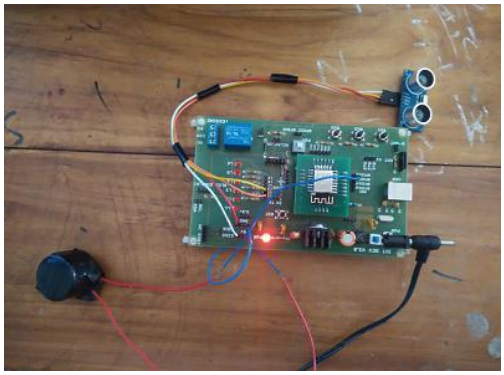

Fig. 12. The prototype of the proposed system

VII. Conclusion

The proposed system/model have used ultrasonic sensor for distance calculation which is fixed on a test vehicle for moni-toring road surface condition.The implemented a prototype of the proposed system model uses IOT based ESP 8266 Micro Controller and an ultrasonic distance measuring sensor. In the prototype, Through experimental evaluations,it has been found that the prototype can detect a pothole or Hump in a damaged road upto 3m Height or Depth. These datas can be seen by a person from anywhere in this world through IOT supported open server called 'Thingspeak.com'.These datas can be used to analyze the situation or condition of a particular road without manual human efforts and further maintanance actions can be carried out more fastly and effectively

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