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Pothole Detection through IoT

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***Abstract*— One of the major problems in developing countries is maintenance of roads. Unpredicted hurdles and potholes on road may cause more accidents and also causes damage to the vehicle. Because of bad road conditions, fuel consumption of the vehicle increases, which in turn reduces the efficiency of the vehicle. All these above mentioned reasons insist that it is important to get information of such bad road conditions, collect this information and distribute it to a concerned Government body. This paper describes details of pothole detection through IoT. This system is divided into subsystems. First is sensing subsystem which senses the potholes using ultrasonic sensor, at the same time location also tracked with the help of networking with JavaScript programming. Then communication subsystem which transfers the exact location and value of the detected pothole to cloud. Then collected data with location is sent to a Government body through app.**

Index Terms— **IoT, Networking with JavaScript, ultrasonic sensor, Raspberry pi, Android App**

I. Introduction

Roads are the dominant means of transportation in India today. They carry almost 90 percent of country's passenger traffic and 65 percent of its cargo. Well maintained roads contribute a major portion to the country's economy.
However, most of the roads in India are narrow and overcrowded with poor surface quality and road maintenance needs are not satisfactorily met. Identification of pavement distress such as potholes not only helps drivers to avoid accidents or vehicle damages but also helps authorities to maintain roads. According to the Road Accident Report (2014) published by the road transport and highways ministry, while 4,726 lives were lost in crashes due to humps, 6,672 people died in accidents caused due to potholes and speed breakers. Fig. 1 shows condition of roads with killer potholes. To address the above mentioned problems, an effective solution is needed that collects the information about the potholes and also helps drivers.

Fig.1: Condition of roads with potholes.

II. Software And Hardware requirement:

The proposed system offers a cost effective solution for detecting potholes on roads and notifying government officials about their presence. The system design model has the processing unit as the Raspberry IoT board. The **Raspberry Pi** is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It has an ARMv7 processor, it can run the full range of ARM GNU/Linux distribution, including snappy Ubuntu core. It also has 4 USB ports, 40 GPIO pins, Full HDMI port, Ethernet port and micro SD card port for loading on operating system and storing data Quad core instead of single core processor. For the operating system and multi threaded applications this provides a massive speed boost. Fig. 2 shows the IoT board configuration.

Fig. 2: Raspberry pi 2 model B

The sensor used in the design model is the ultrasonic sensor. The HC-SR04 is an active ultrasonic sensor and contains a transmitter and a receiver. It is used to measure distance at which, objects are placed in front of it. The ultrasonic sensor transmits high frequency sound waves and waits for the reflected wave to hit the receiver. The distance is calculated based on the time taken by the ultrasonic pulse to travel a particular distance. The working principle of this device is shown in figure 2. There are different types of ultrasonic sensors with different transmission ranges and angles of detection. The HC-SR04 sensor work at frequency of 40 KHz and can measure distances of the objects in the range 2 to 400 cm with a 15° angle of detection. From Fig. 3, it shows the working principle of ultrasonic sensor.

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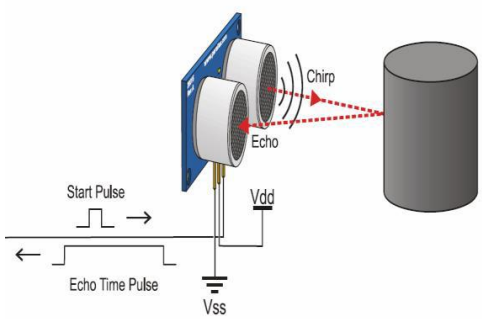

Fig. 3: Ultrasonic sensor (HC-SR04)

The location of the pothole is required to transmit the exact location where the pothole exists. In order to include this design feature in the model Google Maps are used. The Google Maps API allow for the embedding of Google Maps onto web pages of outside developers, using a simple JavaScript interface or a Flash interface. It is designed to work on both mobile devices as well as traditional desktop browser applications. Using Google Map API we are storing the exact location of pothole in terms of latitude and longitude.

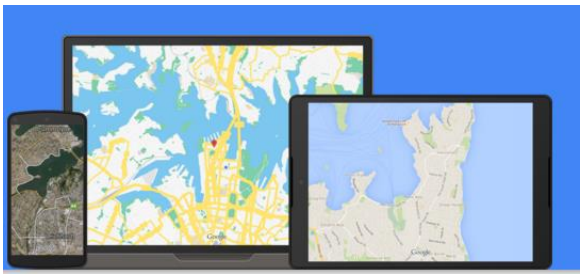

Fig.4: Google Map API

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. Thing Speak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates. It offers the capabilities of real-time data collection, visualizing the collected data in the form of charts, ability to create plugging and apps for collaborating with web services, social network and other APIs. The primary element of Thing Speak activity is the channel, which contains data fields, location fields, and a status field. After you create a **ThingSpeak** channel, we can write data to the channel, process and view the data

Android is a comprehensive software stack of mobile devices that includes an operating system, middleware and key application. In which allows users to drag-and-drop visual objects to create an application that can run on Android devices. By using open source MIT app inventor we have built an app. Notifications (pothole and exact location) are received on this app through cloud. Android app is developed using the App studio. A sample screen shot of the app. designed is shown in Fig. 5.

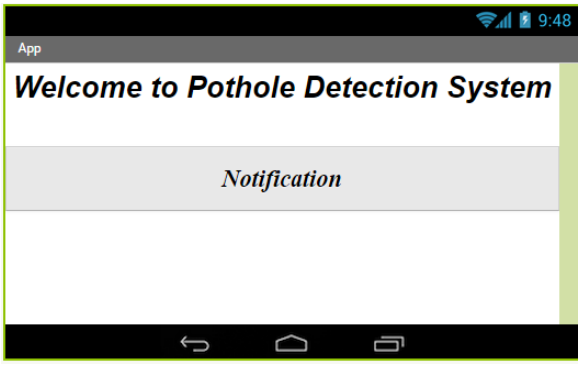

Fig. 5: GUI for the pothole detection system.

III .Working of the System:

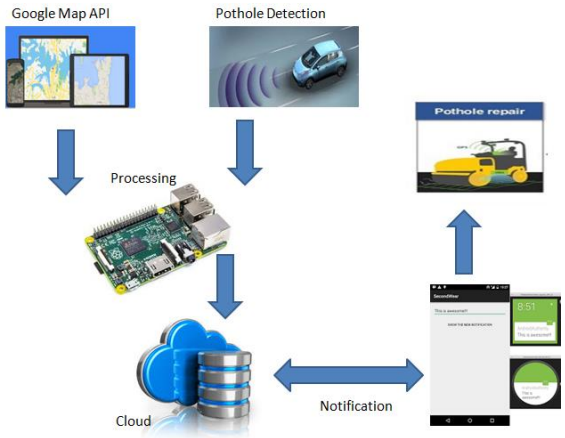

Fig. 6: System model of pothole detection

The app. developed is used by the Government officials. The benefit of this Smart system design is without any intervention of the inspecting officials, the officer in-charge will get the direct information. The maintenance of the roads can be efficiently monitored using this design approach. To improve the system the whole procedure of pothole detection, pothole closure, pothole maintenance can be automated using this design approach.

The vehicle shown in the Fig. 6 indicates a unique design feature. This vehicle is in the custody of the Government officials. The vehicle is mounted with the ultrasonic detector unit and the wi-fi transmission unit using IoT concept. There is no manual intervention form the driver of the vehicle. The task of the vehicle driver is to drive across the city taking the route identified by the government official.

In one day the vehicle can cover 20 kms in the morning and another 20 kms in the afternoon slot during the inspection schedule or chart as prepared by the official. The official will receive the pothole information and take action accordingly with the civil engineering section of the city fixing a deadline for the pothole correction. An action plan is

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prepared by the official and accordingly says after a span of 15-20 days the pothole inspection will move around the same area to inspect if there are any potholes. The government official will get a feedback alert if the pothole still exists in spite of the correction action. In this model technically if the same latitude and longitude is obtained from the Google map this indicates that the pothole is not closed. The maintenance schedule of the official will become a reminder to the concerned authorities to schedule repair works in time.
The automated feature adopted in the design model for pothole detection and maintenance assists in the better governance of the officials.

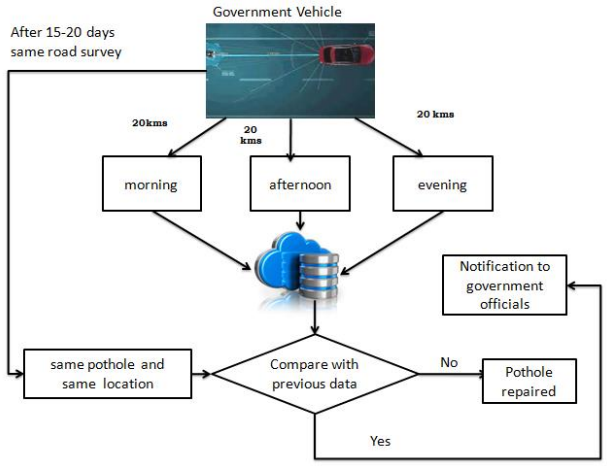

Fig.7:Remainder functioning model

The architecture of the proposed system mechanism is shown in Fig. 6 and its block level representation is described in Fig. 8. It consists of sub system like hardware module, communication module and mobile application module. Hardware module is used to gather information about potholes and their geographical locations and this information is sent to the cloud. Communication module receives information from the hardware module, processes and stores in the database (cloud). Mobile application module uses information stored in the database (cloud) and provides timely notification to the concerned government body.

A. ***Hardware module:***
This module consists of following components, namely, Raspberry pi 2 B models, ultrasonic sensor (HC-SR04). Ultrasonic sensors are connected to GPIO pins of Raspberry pi, which is attached under the clearance of the automotive. The distance between clearance and the ground, on a smooth road surface, is the threshold value. Whenever a vehicle encounters the pothole distance will be greater than the threshold value, it is a pothole so that value is received by raspberry pi.

When the pothole is detected, at that time through networking with JavaScript programming the location of the pothole in terms of longitude and latitude is collected. Then the collected value is sent to cloud

B. Communication module:

This module acts as trans-receiver. It is an intermediary layer between the hardware module and the mobile application module. It stores the detected value sent by the raspberry pi. It sends the notification (potholes value, latitude and longitude) to android app.

C. Mobile application module:

This module is implemented as an android application that is given to the concerned government authority. It displays the newly received data about the presence of potholes and the location from the cloud.

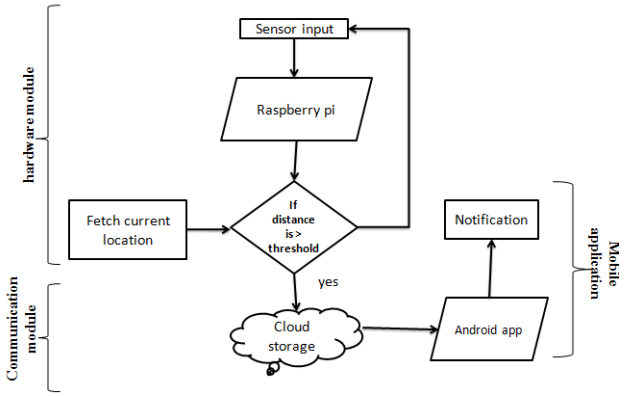

Fig.8: Operational details of pothole detection

IV .Experimental Result:
The functioning model of the estimated system is shown in Fig. 9. It was tested in a real environment.

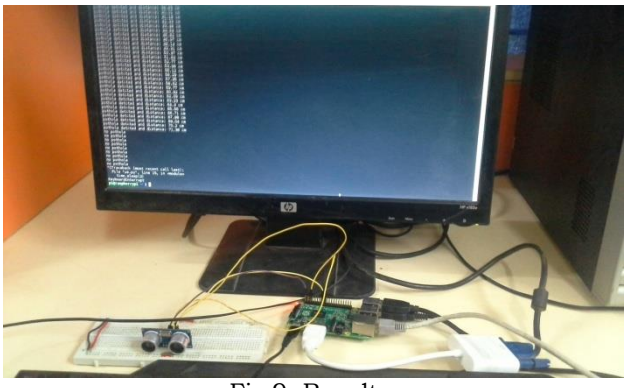

Fig.9: Results

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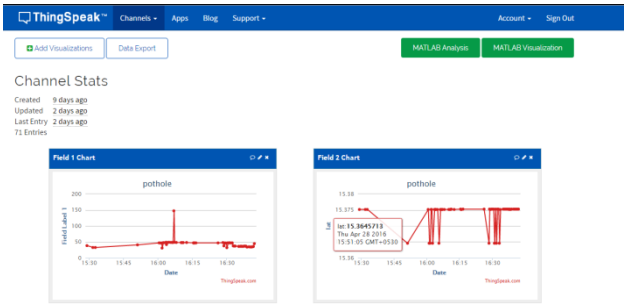

Fig.10: ThingSpeak cloud storage

TABLE.1: Data about pothole and location stored in cloud.

Sl_no	Pothole	Latitude	Longitude
1	Pothole detected	15.37	75.1149
2	pothole detected	14.0988	75.0901
3	pothole detected	15.3704	75.1221
4	pothole detected	15.9089	76.0988

CONCLUSIONS:

We have implemented a pothole detection system which would continuously detect the potholes on the road and detect the hardware's location and send the data to the server side. In this paper we have describes the working, the hardware requirements, the software requirements that it will use to run the system. The data obtained from here is being given to the concerned road management authority for the further procedures. Therefore, drivers' safety may be improved with the establishment of real-time pothole detection system for sharing the pothole information. If such system is implemented it could result in various helps to the public as well as the governmental body for the development of the country.

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