2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE) 978-1-7281-4142-8/20/$31.00 ©2020 IEEE 10.1109/ic-ETITE47903.2020.347

Development and Analysis of Pothole detection and Alert based on NodeMCU

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Abstract---Traffic congestion and accidents are mainly due to pathetic condition of road. The most common form of distress on such roads are potholes, which can compromise safety, and result in vehicle damage. Repairing the roads on regular bases will ensure the drivers safety and helps reduction in vehicle damage. There are many methods existing for pothole detection which use sophisticated equipment and algorithms. Due to the huge data computation such processes are slow and power consuming. In this paper, we propose an efficient depth-based pothole detection technique without any high computation and processing. In the proposed method we use the depth calculated by ultrasonic sensor as a base for detecting the pothole and there after its location is sent to mail. The results indicate that this method can be used in identification of potholes and maintaining the roads in proper condition.

Keywords—Node MCU, GPS module, Ultrasonic sensor, IFTTT Webhooks.

I. INTRODUCTION

The safety of a vehicle is the first priority while constructing and maintaining a road. This safety is not assured when the condition of road is deprived. Most of the roads in India are congested with poor quality and maintenance needs are not done as per the requirement. Increase in number of vehicles has led to problems such as traffic congestion and increase in the number of roads accidents. Potholes, formed due to heavy rains and movement of heavy vehicles is also a reason for accidents and loss of human lives. Maintenance authorities need to regularly check the quality of the roads in order for maintenance [1]. Detection of such potholes helps the authorities to maintain the condition of roads and also keep in track with its condition. The survey for such maintaining analysis is done annually and time spent, cost for such actions is huge [2]. This project helps to directly detect a pothole and inform the maintenance authorities its location through mail. This method is not an annual procedure rather a continuous process, whenever pothole is detected the location is directly sent [3]. This project is cost efficient as the components used are of general basis and can be installed in any type of system or vehicle for it working. The potholes are detected by using ultrasonic sensor and the location (latitude and longitude values) are given with the interfacing of GPS module and node MCU. The location is shared with the help of IFTTT Webhooks which is linked to the maintenance authority's Gmail Id.

Fig 1: Condition of roads with potholes.

II. COMPONENTS USED IN THE PROPOSED SYSTEM

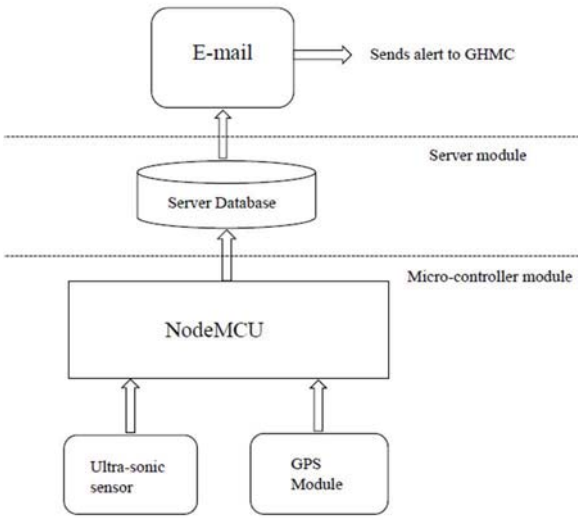

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Fig 2: Block Diagram

A. Node MCU

Node MCU consists of esp8266 wi-fi source module which is used for IOT purpose. The scripting langue used in esp8266 is LUA. NODEMCU was created in short after the release of esp8266. It consists of firmware which runs mainly on the esp8266 wi-fi module. It is mainly used in the

projects of arduino and raspberry pi. It consists of memory OF 128K Bytes and storage of 4Mbytes. The operating system present in node MCU is XTOS. Which the main function of node MCU is used for security operating functions.

Fig 3: Node MCU

B. Ultrasonic Sensor

Ultrasonic sensor is a device used to calculate distance by measuring time lapse between the sender and receiver. The sender uses the waves which are inaudible to human in range of above 20khz. These waves are known as ultrasonic waves or ultrasonic pulses. The sender transmits the ultrasonic pulses(40khz) which gets reflected by the obstacle or receiver, by the time the sensor calculates the time taken to get back the reflected pulse. Then distance is measured by multiplying the time with the speed of pulse. It is also known as proximity sensor which are used for anti-collision detection like presence, distance, level, position. ultrasonic sensors using single transducer for transmitting sound wave and receiving the echo pulse. These are reliable and can be used in any lighting environment.

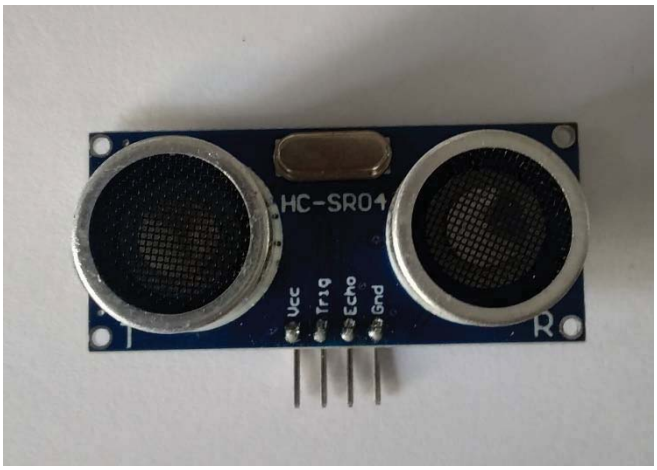

Fig 4: Ultrasonic sensor

$$\text{Distance}=\left[\frac{\text{Time x Speed of Sound in Air } \left(\frac{340\ \text{m}}{\text{s}}\right)}{2}\right] \quad (1)$$

C. GPS Module

The GPS module is used to calculation the position of the object. The GPS receiver is the satellite based system which uses the satellite and the ground receiver in order to calculate the position of the object [4]. When the GPS module is on, it receives the signal for the satellite and calculates the time to receive the signal from the satellites then the GPS receiver calculates the distance between the receiver and satellite. In order to calculate the distance, the satellite transmits some pseudocode and it is received by the GPS receiver. Then the receiver compares the signal and their difference is the travelling time. Similarly, the GPS receiver continue this procedure with nearby satellites and calculates the distance by using *trilateration* method. The GPS receiver gives the value in NMEA (National Marine Electronics Association) format. It transmits the signal to the Arduino with the baud rate of 9600.

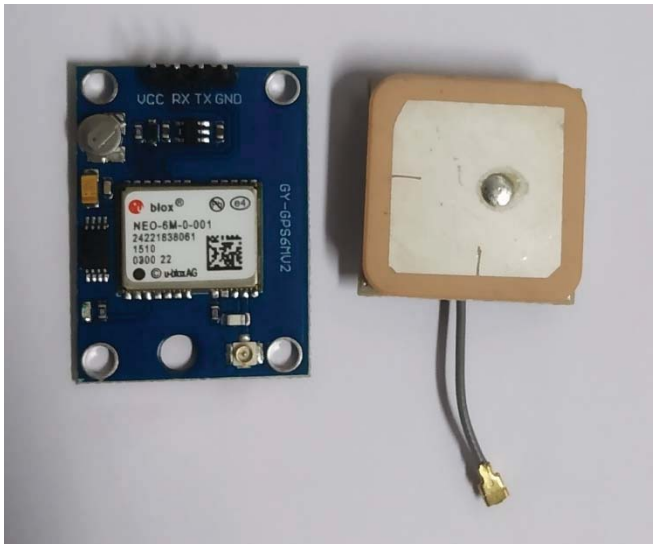

Fig 5: GPS Module

D. Server Database

The server database usually stores the data that is sent using the micro controller. In this system we are using the e-mail as an alert generating source which is the destination of the data sent from the micro-controller. So, the database for this system will be the database of the G-mail provided by Google.

III. Methodology

In this paper, we describe the software system design, program techniques, and system approaches used in the development of programming the microprocessor in the pothole detection system. The software program is responsible for accepting data and commands, executing different commands, and supporting data Input/output ports. This paper discusses the software in terms of routines and subroutines. The software mainly consists of two parts, one is control part, and the other is triggering part. It is intended to give a general idea of program flow and implementation

A. Arduino IDE

In this system Arduino software from Arduino developer is used to develop program for many Arduino based devices. Arduino IDE supports vast number of boards which need to be downloaded and imported to the IDE. Node MCU is one such board that need to be imported and the program can be written in extensive languages like C, C++, Java, etc. It

provides the workspace and extensible plug-in's so as to code in an uncomplicated manner.

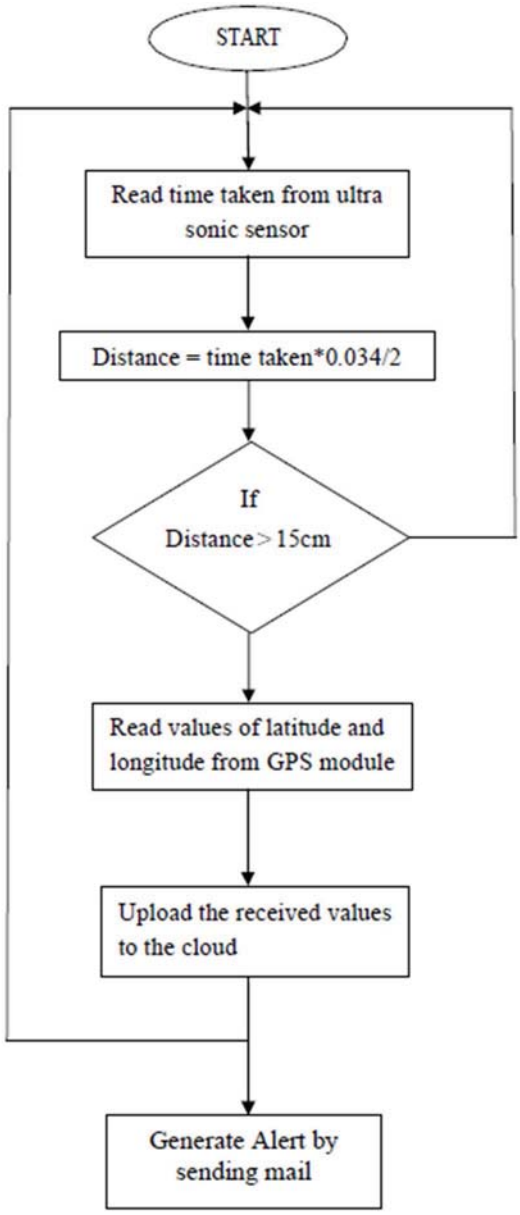

Fig 5: Flow Chart

B. NodeMCU

Initially Node MCU [3] should be connected to a Wi-Fi network so that it can have access to internet and can be able to connect to the http client, in this system our http client is the webhooks server through which we need send the location information.

C. Calculating Depth

As shown in the flow chart we get the time taken for the ultrasonic wave to hit the obstacle and reflect back to the sensor, this information is sent to Node MCU and using the equation distance is calculated.

Distance = time taken * (speed of ultrasonic wave /2)

gives us the distance from sensor to the obstacle. We are intended to calculate the depth, in order to calculate the depth of pothole we will reduce the calculated distance by the ground clearance level of the system or vehicle [5]. The depth is given by

Depth = Present distance – Ground clearance

D. Pothole Detection

From the above calculations we are able to get the depth of the pothole. If the **Depth** is zero then there will be no pothole existed at that particular place. If the **Depth** is greater than zero then the GPS module sends the location the micro-controller. The GPS Module plays a key role to get the location co-ordinates. The receiver pin in initiated with the help of Arduino IDE and the GPS Module has a default transmitter pin as discussed. After getting the co-ordinates they must be processed in the required format as specified in the libraries present in the IDE.

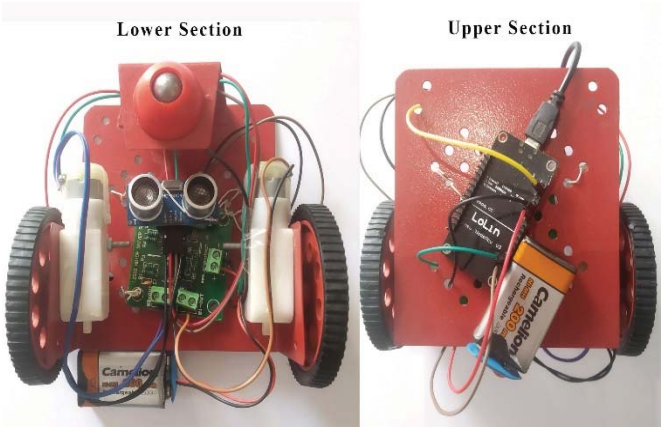

Fig 6: Laboratory system developed for pothole detection

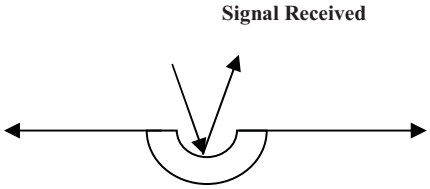

Fig 7: Principle for detection of pothole

E. Sharing the location

In order to achieve sharing the location the major role is played by the server, to connect the device to the sever we need to avail a service which acts as an intermediary layer between the microcontroller and the server [6]. In this system IFTTT is acting as an intermediary platform which is connecting the micro controller and the server platform. The IFTTT platform provides a unique API key for each and every event occurring which speaks the security aspect of the system. In this platform the micro-controller and the G-

mail must be integrated to as receive an E-mail. This event should be triggered using the micro-controller using the values of latitude, longitude and the depth of the pothole. The IFTTT also consist of many other services and in that we are going to use webhooks. The IFTTT using those values sends an E-mail consisting the required information.

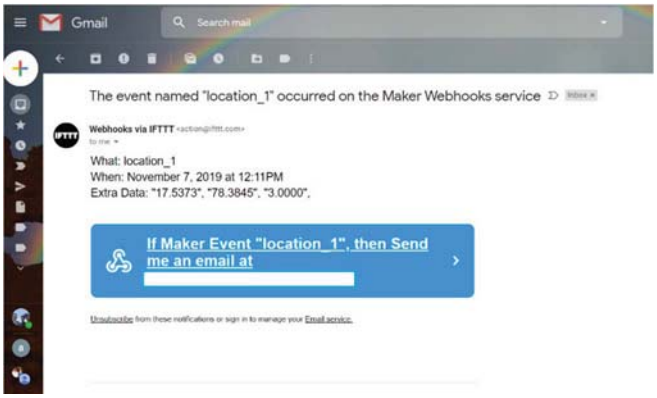

Fig 8: Location sent to mail

III. EXPERIMENTATION

The working model proposed in this paper as shown in the Fig 6 is tested using the system with artificial potholes and after getting the fruitful results it is fixed to the bike. The experiment is carried in a simulated environment where the microcontroller module is fixed to the system and the threshold value was configured to 3 cm. During the test it was found that the microcontroller module worked as expected to identify potholes. The values which we got are tabulated in Table-1.

These tabulated values are sent to the cloud (as specified the cloud is Gmail database). The snapshot of the values is shown in the Fig 8.

Table-1

S No	Height/Depth (cm)	Latitude	Longitude
1.	5.3	17.3978	78.5027
2.	3.6	17.5377	78.3841
3.	4.2	17.4705	78.5632
4.	4.8	17.4701	78.5631

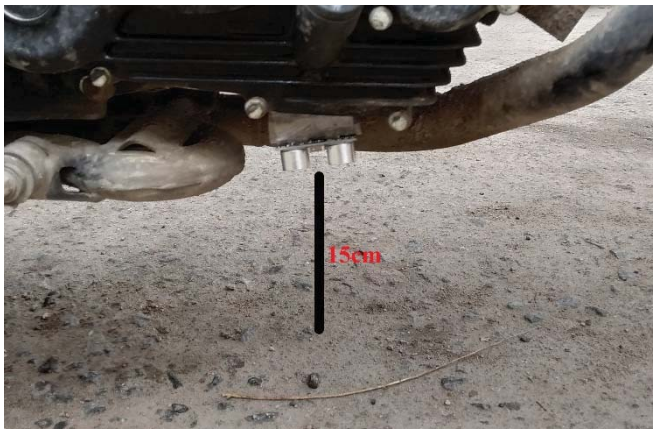

Fig 9: Real life application of system attached to a bike for detection of pothole (absence of pothole)

Fig 10: Real life application of system attached to a bike for detection of pothole (in the presence of pothole)

IV CONCLUSION

In this paper we proposed an effective automatic detection of potholes using depth based analysis. The paper uses the depth calculated using ultrasonic sensor and an algorithm in the detection procedure. The depth calculated is compared with the ground clearance of that system so as to identify the pothole position and depth by which we can depict the danger accompanied with it. The location is shared using GPS module and IFTTT server to the mails of the maintenance authorities who can take the necessary actions. This system can help the maintenance authorities with a regular and cost effective approach towards the identification of pathetic road conditions.

This model can be extended to a greater extent by using vehicle to vehicle interaction within a specific zone where everyone can be informed about the pothole and adjust their speeds accordingly for their safety.

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