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Research Article

Warning System to Identify Pothole and Speed Breakers on Roads Using JSON Data

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Abstract

In India potholes are the most important problem which can be multiplied with the aid of each rainy season. Identification of road distress such as potholes and speed humps help to keep away from vehicle damages and accidents. Additionally, it helps to concerned authorities for maintaining public roads. The proposed system is designed as a cost-effective solution for detection of potholes and speed humps on roads. The advanced technique is an interconnection of the detection system, firebase real time database, and map application. This proposed model is used to find the potholes and speed humps on roads along with its geographical location. By the usage of these database drivers are alerted with android application in order to make precautionary measures. In this proposed model we build a mobile- based dynamic reporting system with JavaScript Object Notation (JSON) data. This stored data is synchronizing in real time to every connected client..

Keywords Pothole, Speed Hump, Cloud database, JSON data, Android Map Application.

1. Introduction

India has the second largest road network among rest of the world. So, India has gigantic network of road connectivity because roads are the important way of public transportation from one place to the another. As claimed by survey of National Highways Authority of India (NHAI) roadways carry almost 65% of freightage and 90% of passengers are travel on road. As stated by the survey of Ministry of Road Transport and Highways (MoRTH) due to potholes over 25000 injured and 9300 deaths are occurred during the year 2015-17. In India, 3,000 peoples for each year are killed by accidents due to potholes. Speed breakers are used in urban and residential areas on minor roads. Potholes are usually formed by rainy season and also presence of heavy traffic on roads. The majority of the roads in India has poor maintenance. This poor road condition can contribute to vehicle damage and accidents. However, in India travel by roads is dangerous task. Many accidents are occurred by drunk and drive, head-on collision, pothole, speed hump, and rollover, etc. To control all these accidents is not possible, but we can control some of the accidents such as pothole and speed hump.

In the existing work, a low-cost model such as Kinect sensor is used to for analysing 3D pavement distress images [1]. MATLAB is used to analyse the captured images, by extracting characteristic and metrological potholes depth. RGB and IR camera are present in this Kinect sensor which is used to capture RGB and depth images respectively. 3D cross-section of pavement pothole detection is designed in [2]. Here two CCD cameras with LED light is used to capture the pavement images. After this image acquisition step various image processing techniques are performed. Pothole detection model with various machine learning model is designed in [3]. This model discriminate potholes from other defects such as pavement cracks. In this research random forest give best results than the other models. The GPS sensor and 3-axis accelerometer are used for pothole

detection model in [4]. To ensure road safety, its mandatory to regularly inspect and repair pothole on roads [5, 6]. This manual pothole detection is, however, tedious and time-consuming [7, 8]. Therefore, automatic pothole detection system was developed in order to locate potholes on road effectively. By using the smart-phones accelerometer [9] the roughness level and potholes in the roads were monitored. Here roads are detected by using Gaussian model-based mining algorithm.

This research introduces an automatic warning system to identify pothole and speed hump on roads using JSON data. The details of the materials and methods are presented in section 2. The details of the experimental results and discussion are presented in section 3. Finally, conclusions of the proposed pothole and speed hump detection system are presented in section 4.

2 Materials and Methods

The proposed road surface warning system helps drivers to alert about pothole and speed humps on roads. This proposed system must include the following two steps 1. Identification of pothole and speed humps location information on roads 2. This information is saved as JSON data in the server. Finally, this saved data are shared to the client who are travelling to that area with an android map application. The block diagram of the proposed road surface warning system is shown in Fig. 1. This system will offer an effective usage of road safety to aid drivers avoid from potholes and speed humps accident. In the detection system, we use different components such as:

Arduino Uno R3. It is an open source microcontroller board based on the ATmega328P. At the heart of the Arduino is the microcontroller. It has 6 analog input/output pins, 14 digital input/output pins, power jack pin, a USB connection pin, and a reset pin. It carries everything related to support the microcontroller.

Ultrasonic sensor HC-SR04. This component is mainly used to determine the distance of the target object. The transmitters emit 40 kHz ultrasonic sound pulses. When this ultrasound bounces off any nearby objects, it reflects as echo which is sensed by the receiver. That measure the time difference between the transmitted and received signal. In this proposed work ultrasonic sensor HC-SR04 is used to detect the pothole and speed humps by measuring the depth and height from the vehicle to the road surface respectively. It is measured by sending a sound from vehicle to road and sound is reflected towards the sensor, then we calculate the distance by the reflected sound. After measuring the distance, it is differentiated as pothole or speed hump depending upon the threshold value.

Wi-Fi ESP 8266. This device is used for send the GPS data to the cloud database. It making Internet of Things as easy as possible because it can easily fetch the internet.

GPS NEO 6M. This satellite navigation module is used to find the geographical location of pothole and speed breakers on roads.

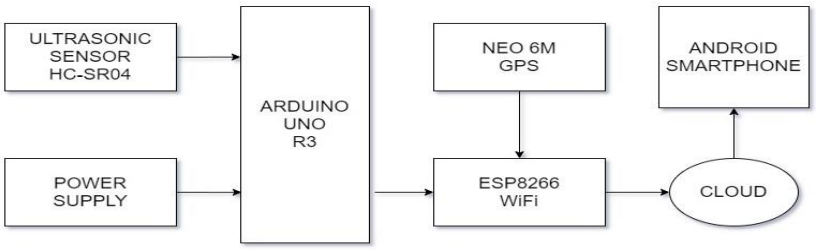

Fig. 1. Proposed system architecture.

2.1 Proposed System Implementation

In this proposed method two main systems are implemented which are automated detection system and mapping application.

Automated Detection System. In this module, the automated detection system contains Arduino UNO R3, Ultrasonic sensor HC-SR04, Wi-Fi ESP 8266, and GPS NEO 6M. This integrated module is fixed under the vehicles bottom side. Ultrasonic sensor includes two transmitters, receivers for measuring the depth and height of the pothole and speed humps. The transmitter transmits high-frequency ultrasonic waves of frequency greater than 40 KHz and waits for the reflected wave to hit the receiver. The distance is measured based on the time taken for the waves reflected by an obstacle. To calculates the depth depending upon the echo signal to travel back after reflecting from the desired target. It continuously measures the distance from the car to the road to find the threshold value for either pothole or speed breaker. If the measured depth is lesser than the threshold

value then it is considered as a speed hump or the measured depth is greater than the threshold value then it is considered as a pothole. The working algorithm of the proposed warning system is shown in Fig. 2.

Arduino and ESP 8266 are interconnected by jumper wires to make serial communication between them. The GPS NEO 6M is connected to ESP8266. If a pothole or speed hump location are identified then ESP8266 sends GPS data to the cloud database. If the received data is 1 then it is a pothole or the data is 2 then it is a speed hump or the data is 0 then nothing is detected.

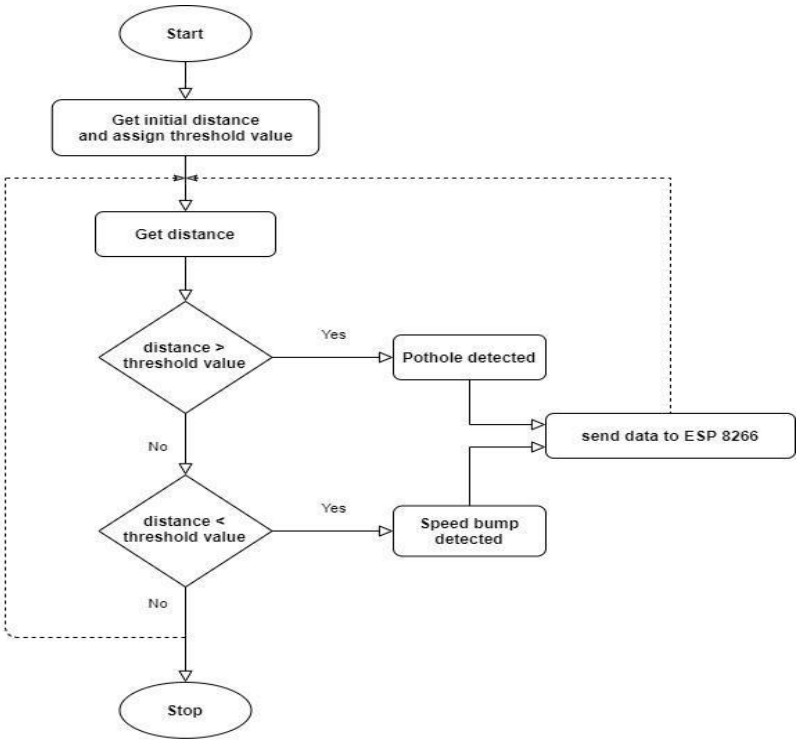

Fig. 2. Pothole and speed hump detection.

Map application. The android map application uses the Google map API. For this application, the current location of the user is tracked by GPS. The map application connected to the Firebase database. By getting the information about the pothole and speed hump. It will show the marker at the specific places. If any pothole or speed hump is identified by the user then he reduces the speed of his vehicle and tries to avoid road accidents.

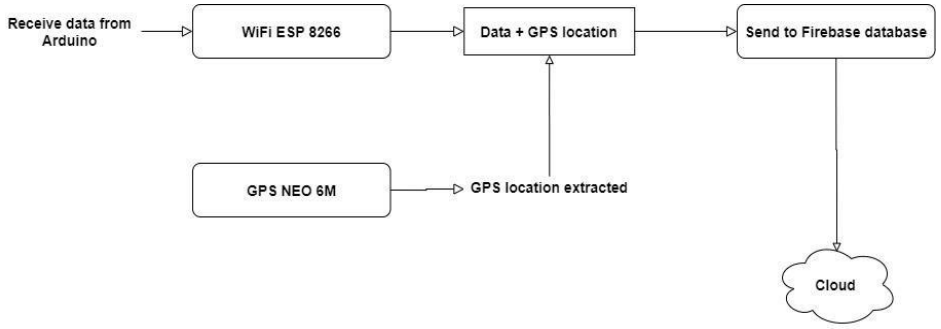

Fig. 3. Sending data to cloud database.

3 Results and Discussion

Fig. 4 shows the setup of the proposed hardware system. This hardware setup is fixed under the vehicle for testing purpose. In this testing environment threshold value is fixed to 10 cm, which is the road surface clearance for that vehicle. For acquire the test results this vehicle was moved on the urban roads. The ultrasonic sensor exactly identifies the distance between the vehicle to that road surface and compared it with the threshold value. The output from the sensor is display by the serial monitor in the Arduino IDE. If the detected distance value is greater than the threshold value it displays "Pothole" or lesser than the threshold value it displays

"Speed hump". Fig. 5 shows the snapshot of notification in serial monitor. In the real time testing environment condition, some results are shown in Table 1.

Cloud database acts as an intermediary layer between the detection system and the map application. In this cloud database, the data are received from the ESP 8266 Wi-Fi microchip. This received data is stored as JSON format in the database because it acts as a lightweight format for storing and transporting data. This stored data is synchronized in real time to every connected client. Real time database instance is shared by all of our clients and automatically updates is shown in Fig. 3. It shows the procedure for sending data to cloud database.

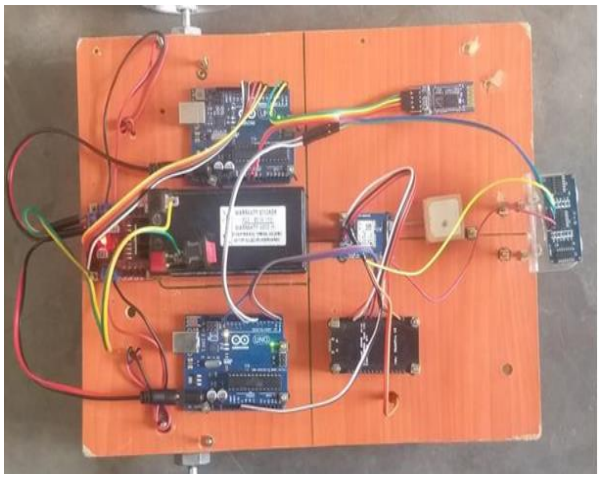

Fig. 4. Hardware implementation set up.

The main component of this system is the Map application. Based on the dataset from the Firebase database, it shows the multiple markers to display the pothole and speed hump. The real time directions and a satellite view. This application will show the live location of the user and also display the nearby markers of the pothole and speed hump. The orange color marker shows where the pothole is located and the yellow color marker shows where the speed hump is located. The blue color marker with a circular that displays the current location of the user. This application is used widely for drivers. It can used by anyone with simplistic design. It is free to use and available at anywhere anytime from Google map API. Fig. 6 and 7 shows the output of the map application interface. It shows the pothole and speed hump located nearby to the user. Therefore, this application is used to reduce some of the accidents and prevent the driver by alerting the information about pothole and speed hump.

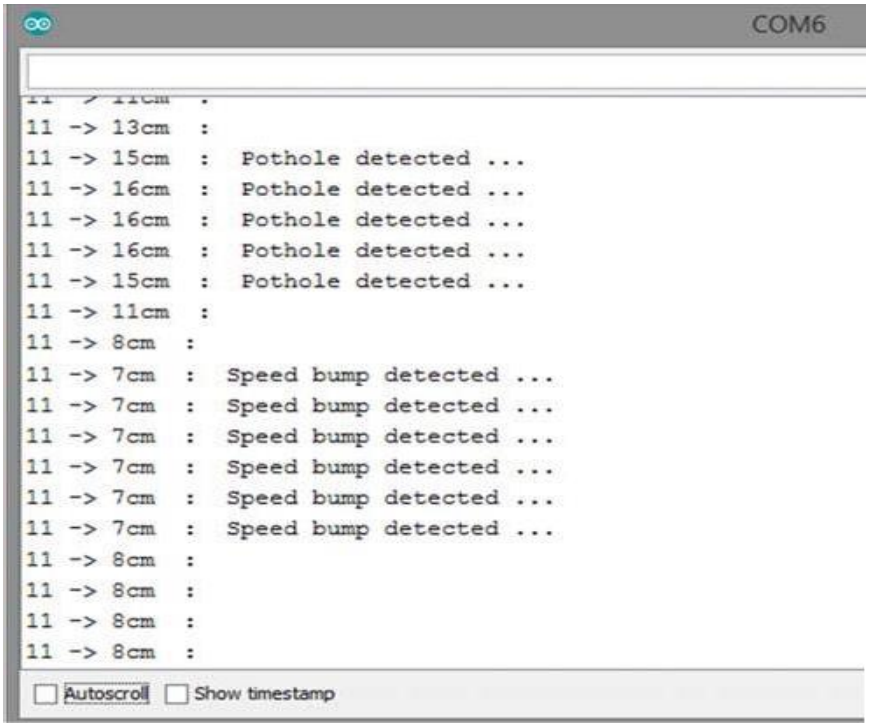

Fig. 5. Notification in serial monitor.

Table 1. Collected information of pothole and speed humps on roads.

S. No	Obstacle Type	Height/Depth in cms	Latitude information	Longitude information
1	P	16.4	11.83037	76.45487
2	S	8.1	11.83051	76.45472
3	S	6.4	11.83028	76.45458
4	P	15.2	11.82026	76.45581
5	S	5.6	11.83063	76.45370

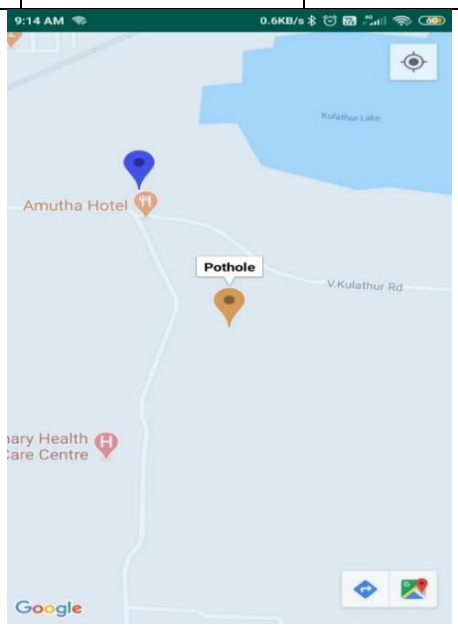

Fig. 6. pothole location information is shared in map application.

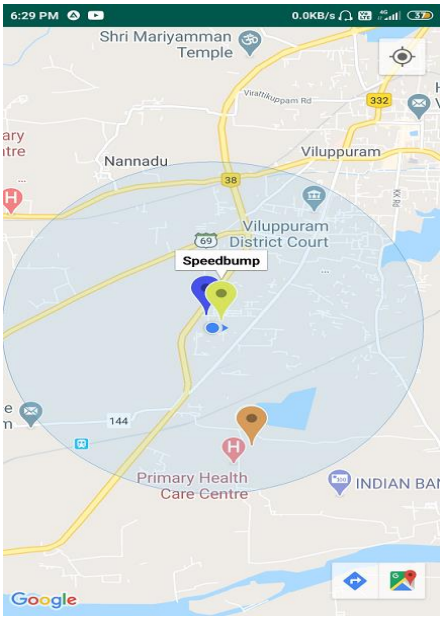

Fig. 7. Speed hump location information is shared in map application.

4 Conclusions

Automatic potholes and speed humps detection is one of the vital tasks which help the drivers to avoid road accidents and also helps concern authorities to maintain the road. Moreover, the conventional system of manually detecting and evaluating methods are expensive and time-consuming. This cost-effective proposed model is used to find the pothole and speed humps location information on roads. This information is saved as JSON data in the server. Finally, this saved data are shared to the client who are travelling to that area with an android map application. Any user can able to access these features by using these Map applications. In the future, we will add more features such as adding autonomous speed limit feature in the car to overcome the road accidents

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