Inertial Sensors Based Road Condition Monitoring & Alternate Route Suggestion

Anjali Vijay Dagade, Shobha S. Nikam

Abstract*: Nowadays maintenance of road is major problem in developing countries. Major portion of country's economy is put up for well maintenance of roads. Here the detection of pothole and bumps is done which will be useful to government authorities to maintain the road condition. Also it helps the drivers to get aware about potholes and bumps & suggest the alternate route which are without potholes and bumps using the ultrasonic sensor and GPS sensor in the smart phone. The data collected using sensor is sent to the cloud storage and heat map is generated. This would be very useful to the government bodies for maintenance purpose as well as for driver safety point of view. For displaying the road condition the android application and web application is developed and according to the data the alternate route would be suggested to driver.

***Keywords*: GPS Sensor, Pothole, Ultrasonic Sensor, Heat map**

I. INTRODUCTION

The quality of the road is mostly judged from the conditions of road. The classification of road are done as safe or dangerous according to road condition, as road conditions are judged using the potholes and bumps. The main reason for damage of vehicle and aging faster are surface conditions of roads. These unfavourable road conditions of the road lead harm to the driver, vehicle, surrounding people and property. Accordingly this proposed system is upgrading the road condition and avoid the road accidents. Government spends millions of money for maintenance of road. With this proposed system the government would not require special officers and road inspection person as the system would spot the pothole and it will be uploaded on the map. So the government can directly get access to potholes on the road and maintain the road at that particular pothole location. This is done using advanced and smart technology and its implementation using the mobile and web user interface, so the road condition can be easily maintained. This proposed system will beneficial in the present as well as in future. As nowadays everyone has smart phone and the reporting of potholes and bumps can be done easily by everyone which will be helpful for the people while travelling. The process of getting the output is as data collection, storage analysis, processing and transmission in an efficient way.

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Driving the vehicle on the road having bad condition is very dangerous to the driver. Due to rains, oil spills quality of the road decreases Such hurdles may cause road accidents. To overcome such problem, proposed this system Pothole Detection and Notification System. In this system sensor is used to sense the pothole, road quality.GPS system finds the position of pothole and rough road, and store the Latitude and longitude in database. Based on Latitude and Longitude User can see the location of detected pothole and rough road area on map, and also suggest alternate path for this. All the data is saved in the database. This collected information of bad condition roads is helpful for recovery of the road. Android phones gives best use of GPS sensor , internet connectivity, etc. i.e. its inbuilt features. Day to day life problems of user can be solved by using various android applications. Traffic congestion, Road accidents, Pothole detection are the major problems in urban areas as well as rural area. So in order to provide solution for pothole problem, we developed an android application which detects pothole automatically as well as sends notification to user. User can see location of detected pot hole on map on web as well as he can find alternate best route suggestion on Android app .

II. LITERATURE REVIEW

According to the review, there are various methodologies for pothole detection. The system which is proposed in this paper is beneficial to identify the pothole and bumps. Also the system captures the location of pothole and bumps with the help of mobile phone sensor and the collected data will be sent to cloud storage for further processing. The display of the road condition is done using android and web user interface, as well as alternate route would be suggested.

In 2017, Amr S. El-Wakeel, Jin Li, Muhammed T. Rahman, Aboelmagd Noureldin and Hossam S. Hassanein proposed system using acceleration sensors and GPS of Tablet and VTI. Here recognition of the condition of roads were done. They also proposed multilevel decision tree classifier to differentiate between various anomalies[1].

In 2017, Andrew Fox, B.V.K. Vijaya Kumar, Jinzhu Chen and Fan Bai designed a system using a accelerometer data using vehicle sensors. Here the road angle data is calculated for the multilane pothole data and single lane results are compared [2].

In 2016, Guangtao Xue, Hongzi Zhu, Zhenxian Hu, Wen Zhuo, Chao Yang, Yanmin Zhu, Jiadi Yu,

Yuan Luo proposed a system for detecting a pothole in dark using the 3D accelerometer and Smartphone. The average error occurrence in this system is 14% in detecting the pothole [3].

In 2018, Huaijun Wang, Na Huo, Junhuai Li, Kan Wang and Zhixiao Wang proposed a detection of pothole using Mahalanobis-Taguchi System. Here its plots the potholes on the map so the next upcoming vehicle can get pothole information. [4]

In 2017, Sultan Basudan, Xiaodong Lin, Karthik Sankaranarayanan designed a system using Fog computing which will inform the Road surface condition in the bad weather. In this the data is uploaded to the cloud and then the information regarding the road condition is share between the vehicle drivers. [5]

In 2017, Azza Allouch, Anis Koubˆaa, Tarek Abbes, and Adel Ammar proposed a system using Gyroscope and tri-axial accelerometer which plots the potholes using GPS system. Here the accuracy of system in locating the potholes is 98.6% [6].

III. METHODOLOGY

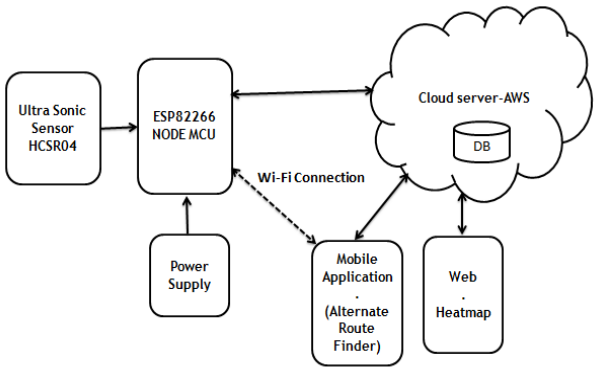

Fig. 1: Block diagram of proposed system

A. Hardware design description

The components used in the proposed system are: Ultrasonic sensor HC-SR04, ESP82266 Node MCU, power bank for power supply purpose and driver's Android phone. The hardware is mounted on the 2- wheeler vehicle in such a way that it measures the height of the pothole, manhole or speed bump; basically it detects these anomalies with help of mentioned components. Ultrasonic sensor is connected to the module which has ESP82266 micro controller of whose self-contained Wi-Fi is connected with the driver's Android phone's Hotspot. Through this connectivity the readings taken by sensor are stored in database of server to which the server responds JavaScript Object Notation (JSON).

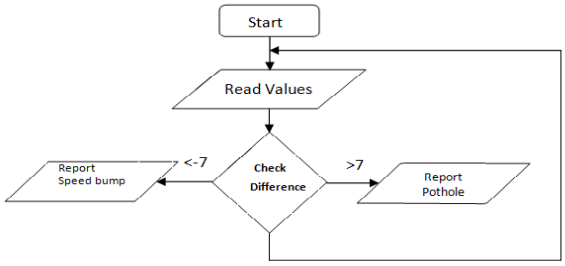

Fig. 2: Flowchart for hardware design

B. Software Design Description

Software requirements include Operating system Windows or Ubuntu, etc through which user can access the system. Java, Java Script, etc software packages can be used for development of system. The software interface to the project is Android application. Also the communication interface between the Android application and Services Internet which is provided by the Global Standards for Mobile Communication (GSM) of which fourth Generation (4G) cellular network is used.

Machine learning is also included, i.e. reading of dataset is done which is given to the classifier for training from which x, y and z are read probabilities are calculated and data gets sorted, if it gets classified then it is reported to the server if not then whole process repeats.

Also the Android application which is developed cautions the driver before hand; as the condition is set for speed, if it goes above O Km/hr location is reported to the server, from database it is checked whether pothole is present or not, if it is present it flash the message on screen of the phone and also audio message is evoked which alerts the driver almost from 100 meters prior.

IV. RESULTS

For machine learning purpose this 'Pothole' named application has been generated as seen in figure 3, where we manually marked the potholes, the application consists of screen having 'start service' and 'stop service' select buttons, also it shows service status either 'stopped' or 'running'.

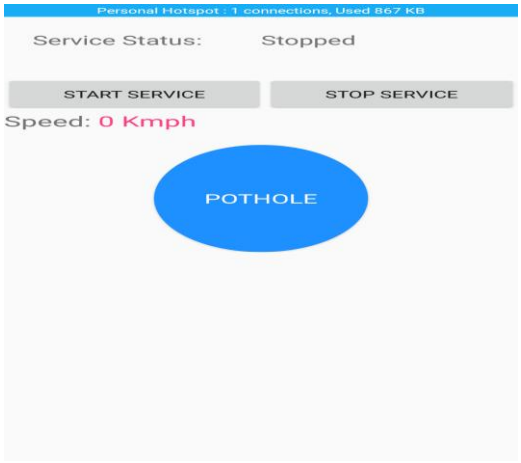

Fig. 3: Android application- Pothole

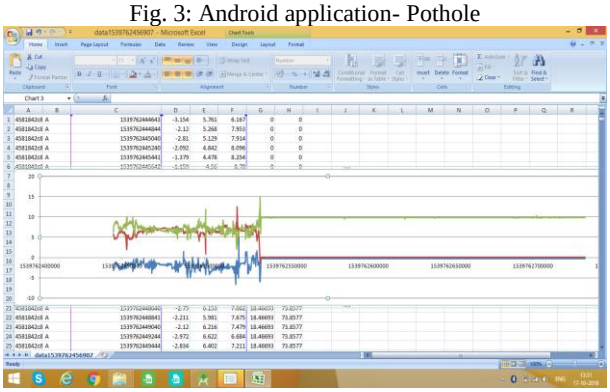

Fig. 4: CSV file showing Vibrations

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With the help of Gyroscope and GPS the motion of the smart phone has been detected and comma- separated values (CSV) file has been generated which includes 'Android ID', 'accelerometer data', 'x, y, z coordinates' , 'latitude' and 'longitude' ; Vibrations are noted from this data obtained from CSV file as shown in figure 4. In such way from another smart phone same data has been noted and sensitivity average is been calculated and one standard for different types of potholes has been set.

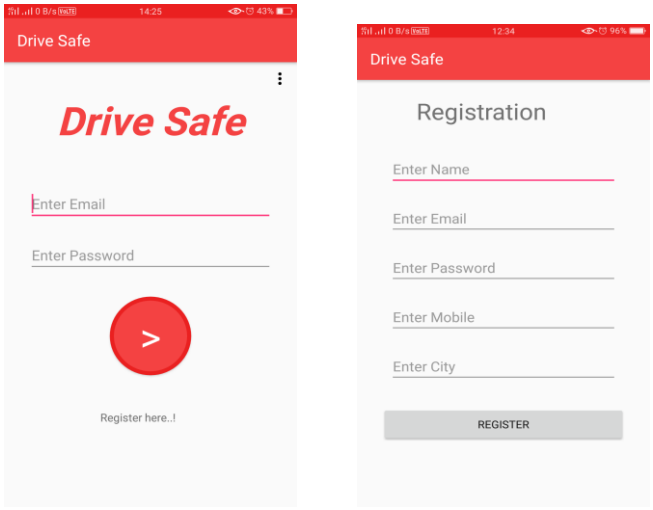

Fig. 5: Android application - Drive Safe

In figure 5, 'Drive Safe' named another android application is been developed which is the main application the driver would be using while driving the vehicle. This application includes the registration of the user whose details are saved to the database, these includes Name, Mail ID, Password, Mobile no. and city. After registration user needs to login.

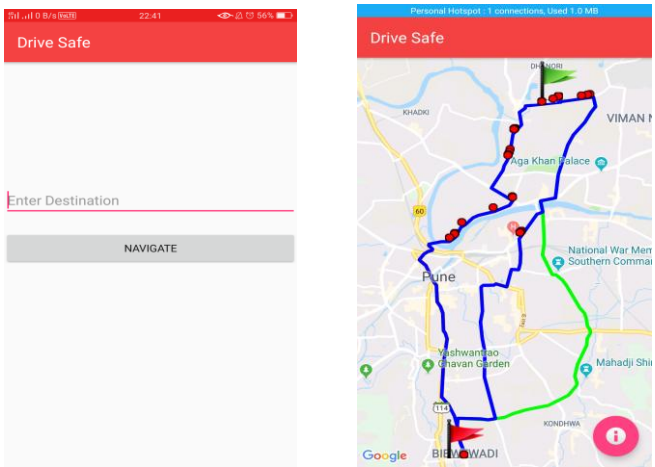

Fig. 6: Drive Safe application - Navigation window and result

After login the application asks for the destination to be navigated, after entering the navigation user may get the results as shown in figure aside. In figure 6. Source and destination can be seen as well as detected potholes can be seen and with proper examination best alternate route is been suggested to the user.

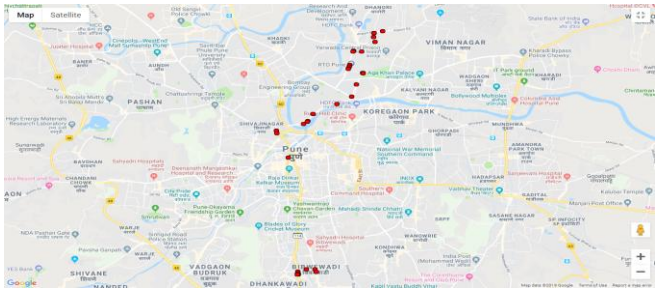

Fig. 7: Heat Map generated on web

As seen in figure 7, web application is also been generated to show the heat map of the detected potholes.

V. CONCLUSION

Proposed system is able to detect the potholes, speed bumps, deceleration strips i.e. the surface of road. The potholes, speed bumps surface of road are detected using inertial sensor and ultrasonic sensor. The GPS is used to locate the area. All the gathered data is stored in the database. Using this database heat map is generated and the best alternate route is suggested to the user on the android application. This gathered information can be transferred to the government bodies which will help them to look after wear and tear of the roads, hence the system will help to minimize the unavoidable circumstances on road as well as it would be of great support to a developing city indeed country.

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