Embedded based Potholes and Humps Mapping using Android Application

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Abstract— Potholes and humps have been known to be a major nuisance in roadside transportation, especially in India. Due to the significant weather fluctuations we experience, these potholes evidently are more severe. Identification of these potholes and humps not only helps drivers to avoid accidents or vehicle damages, but also helps authorities to maintain roads. This paper discusses the mapping of Potholes and humps which assists the driver in avoiding potholes on the roads, by giving him prior warnings. If the driver is approaching a pothole or hump or driver may be warned in advanced regarding what road has how many potholes. Ultrasonic sensors are used to identify the potholes and humps and also to measure their depth and height, respectively. The proposed system captures the geographical location coordinates of the potholes and humps using a global positioning system receiver. The sensed-data includes pothole depth, height of hump, and geographic location, which is stored in the database.

Key words: Android Application, GPS, ARM 7, Ultrasonic Sensors, Bluetooth HC 05

I. INTRODUCTION

Road maintenance is the major issue in the society. Due to load carrying vehicles and rain creates potholes and humps on roads. According to the population and roads India is the second largest in the economy. Most of the transportation is done using Roads as the way of transport. Potholes and badly designed speed breakers don't just irritate drivers and damage vehicles. They actually kill.

The government recorded deaths caused by potholes, speed breakers and humps on roads. In 2014, about 11,400 people died in such cases with Uttar Pradesh topping the list. Another 4,100 people were killed in crashes on stretches under repair or under construction. 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.

To address the above mentioned problems, a cost effective solution is needed that collects the information about the severity of potholes and humps and also helps drivers to drive safely. With the proposed system an attempt has been made to endorse drivers to ward off the accidents caused due to potholes and raised humps.

The remaining section of the paper are as follows: Section II emphasizes on the related work that has been done and is going on in the field of detection of potholes and humps.

Section III discusses the various components used in the proposed system. Section IV describes the architecture and implementation of the proposed system. Experimental results of the proposed work are presented in Section V. Section VI talks about Conclusion.

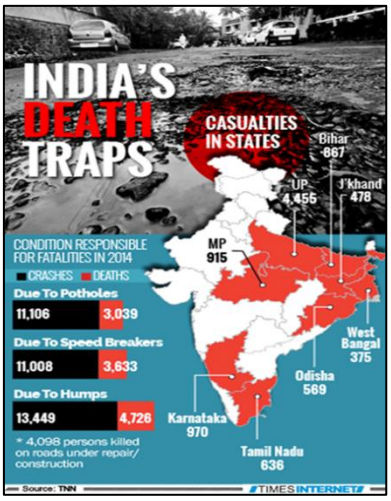

Fig. 1: Conditions responsible for fatalities in 2014

II. RELATED WORK

The Kinetic sensor features a RGB camera plus an IR camera, which cameras capture RGB images and depth images. Pavement distress recognition is certainly an intriguing subject of research and researchers are actually concentrating on pothole recognition techniques. This gives an account in regards to the existing solutions for finding potholes and humps on roads.

Moazzam et al [1] have recommended an affordable model for analyzing 3d pavement distress images. It utilizes an affordable Kinetic sensor, which supplies the direct depth dimensions, therefore reducing computing costs. These images are evaluated using MATLAB atmosphere, by getting rid of metrological and characteristic features, to search for the depth of potholes.

Youquan et al. [2] have developed a model which employs optical imaging principle of 3-dimensional projection transformation to obtain pictorial information of pothole's cross-section in pothole detection. Multiple digital image processing technologies, including: binarization, image processing, thinning, three dimensional reconstruction, error analysis and compensation are conducted in the series of image analysis and processing.

Lin and Liu [3] have proposed a method for pothole detection based on SVM, where SVM stands for Support Vector Machine. Texture measure based on the Histogram is extracted as the features of the image region, and the non-linear support vector machine is built up to identify whether a target region is a pothole. Based on this, an algorithm for recognizing the potholes of the pavement is proposed. The experimental result shows that the algorithm can achieve a high recognition rate.

R. Sundar, et al. [4] have developed an intelligent traffic control system to pass emergency vehicles smoothly. Each individual vehicle is equipped with special radio frequency identification (RFID) tag which makes it impossible to remove or destroy. If RFID-tab read belongs to the stolen vehicle, then a message is sent using GSM SIM300 to the police control room. In addition, when an ambulance is approaching the junction, it will communicate to the traffic controller in the junction to turn on the green light.

Samyak Kathane, et al. [5] have proposed a model which is Real time pothole detection and vehicle accident detection and reporting system and Antitheft. In this system the wireless access point collects the information about potholes, it distributes this information to BMC using wireless broadcast. This system is used for the accident detection too. Antitheft in car can help to save millions of dollars. Sensor boards that we used for collecting the environmental data also has an accelerometer that can measure both the vertical and the horizontal acceleration. For example, when a bus goes over the pothole there would be significant change in vertical component of the acceleration and for humps there would be a horizontal component.

Taehyeong Kim, et al. [6] proposed a paper in which classification of potholes are given. Potholes are classified according to the location, shape, length and depth. Many researchers have studied the methods to detect potholes and improve survey efficiency and pavement quality through prior investigation and immediate action. With these detecting methods, there is need for developing a classification guideline for supporting decision-making system of pothole repair. The purpose of this study is to develop a guideline of pothole classification for supporting a decision-making system of pothole repair.

Ajit Danti, et al. [7] have developed a model based on Image Processing approach. In this paper Haugh Transformation is given for lane detection. Clustering based algorithm is used for detection of potholes. In this experimental results are tested with real time image database.

Gunjan Chugh, et al. [8] have developed a system in which the various road conditions are detected using smartphone sensor. This system includes a set of sensors installed in vehicles. The most common approach for detecting road condition is using sensors. GPS receiver is used to collect the data. This solution provides the method for detecting road anomalies like potholes.

Venkatesh et al. [9] have proposed an intelligent system that has made use of laser line striper and a camera to detect and avoid potholes. This system maintains a centralized database of the location of potholes. It also sends warning messages to the nearby vehicles about the occurrence of potholes using Dedicated Short Range Communication protocol.

Hegde et al. [10], have proposed an intelligent transport system to detect potholes. It makes use of ultrasonic sensors to detect the presence of potholes. This system also sends warning messages to all the vehicles in the range of 100 meters using Zigbee module. However, the system provides warnings after detecting the potholes which does not effectively help drivers to avoid potential accidents.

More et al. [11], proposed a system where sensors are mounted on public vehicles. These sensors record vertical and horizontal accelerations experienced by vehicles on their route. The installed GPS device logs its corresponding coordinates to locate potholes and the collected data is processed to locate potholes along the path traversed earlier by the vehicle. A Fire Bird V robot is used for experimenting with constant speed. The moving robot is mounted with a servo motor which rotates 0-180 degrees along with IR Sharp sensors. IR Sharp sensors check for variance in constant speed. If variance is detected, it is an indication of a pothole; robot stops and camera moves to take pictures of the pothole while GPS device locates its coordinates. Although this is a cost effective solution, it is restricted to collecting information about potholes.

Yu and Salari [12], implemented a system that uses laser imaging for detecting potholes. Pavement distress such as pothole is detected when the laser source deformation is observed in the captured images. Different techniques such as Multi window median filtering and tile partitioning are applied to detect the presence of potholes. These potholes are further classified based on their shapes and severity. Although this is an accurate and efficient method for detecting potholes, the cameras capture shaky images due to uneven road surface, which reduces the efficiency of pothole detection.

Chen et al. proposed a system for detecting potholes using GPS sensor and three-axis accelerometer. The outputs are taken from the GPS sensor and three-axis accelerometer and fed into data cleaning algorithm. In the second part of the implementation the inputs to the algorithm are processed for power spectra density (PSD) to calculate the roughness of potholes. After analyzing, roughness is classified into different levels.

Rode et al. have proposed a system in which, Wi-Fi equipped vehicles collect information about the road surface and pass it to the Wi-Fi access point. The access point then broadcasts this information to other vehicles in the vicinity in the form of warnings. However, the system turns out to be an expensive one as all vehicles should be installed with Wi-Fi stations and more number of access points have to be set up.

III. COMPONENTS USED IN THE PROPOSED SYSTEM

The proposed system offers a cost effective solution for detecting potholes and humps on roads and notifying drivers about their presence. Components used in the proposed work are as follows:

A. ARM 7 Microcontroller

The ARM7TDMI-S provides high-performance and very low power consumption. It is a general purpose 32-bit microprocessor. RISC principle is used in ARM architecture and the instruction set and related decode mechanism are much simple. This simplicity results in a high instruction throughput and powerful real-time interrupt response from a small and cost-effective processor core.

B. Ultrasonic Sensors HC-SR04

Ultrasonic sensor are basically used to measure the distances between the object place in front of it and the sensor. The ultrasonic sensor works on Doppler Effect. It consists of ultrasonic transmitter and a receiver. The transmitter transmits the signal in single direction. This transmitted signal is then reflected back by the obstacle and received by the receiver. The signal transmitted and received back in

some duration of time. Which will be used to calculate the distance between the ultrasonic sensor and the obstacle.

C. GPS Receiver

A GPS tracking unit is a device that uses the Global Positioning System to determine the location of a vehicle, person, or other asset to which it is attached. This position will be recorded at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a data base (Central Location), or internet connected computer, using a cellular (GPRS or SMS), radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop in real time or when analyzing the track later, using GPS tracking software.

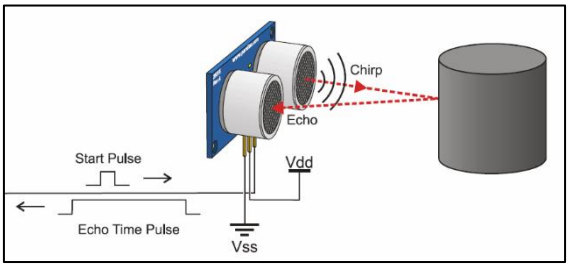

Fig. 2: Working principle of ultrasonic sensor

D. HC 05 Bluetooth Module

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm.

IV. ARCHITECTURE & IMPLEMENTATION

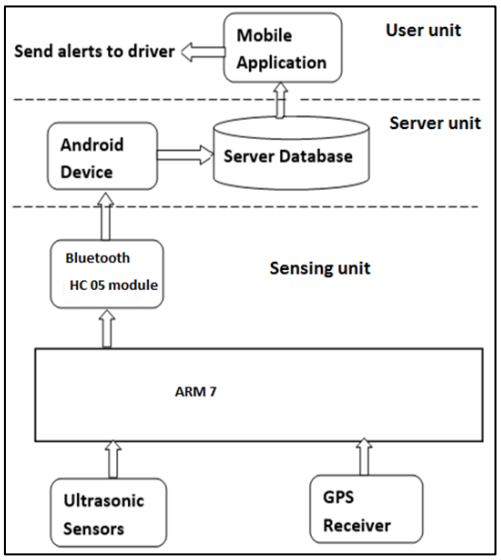

Fig. 3: Architecture of the proposed system

The architecture of proposed system consists of 3 parts: sensing unit, server unit and user unit as shown in figure 3.

A. Sensing unit: This module consists of ARM processor

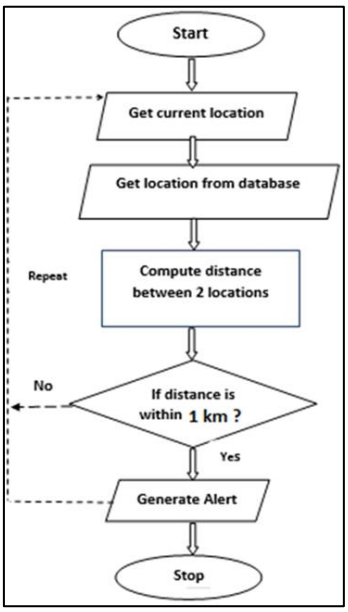

Fig. 4. Work flow of mobile application

(LPC2138), GPS receiver, ultrasonic sensor (HC-SR04) and HC 05 Bluetooth module. The distance between the car body and the road is measured using an ultrasonic sensor. A threshold value is set such that the value depends on ground clearance of the vehicle. The measured distance is compared with the threshold value to detect pothole or hump. If the measured distance is greater when compared with the threshold value, then it is classified to be a pothole, and if the measured distance is less, then it is classified to be a hump. The location co-ordinates retrieved by the GPS receiver, along with this data the information regarding the detected pothole or hump at a particular location co-ordinate is transmitted to the server using a GSM modem. Along with this data the information regarding the detected pothole or hump at a particular location co-ordinate is transmitted to the server using a GSM modem.

B. User Unit

The user unit is responsible for providing alerts regarding the potholes or humps on roads at a particular given location. The GPS receiver is constantly receiving information regarding its location co-ordinates, using this information the database is checked for any data around the given location co-ordinates. Any data found, it is received by the ARM processor from the database through the Bluetooth module and the same is displayed on the map in the user vehicle. The alert is displayed within the range of 1 Km from the current position of vehicle.

C. Server Unit

The server unit is nothing but the database. It is an intermediate layer between sensing and user units. Its function is to store the information received by the sensing unit and provide the same to the user unit when requested. This unit can also be updated regularly for accurate information regarding the potholes and humps.

V. EXPERIMENTAL RESULT

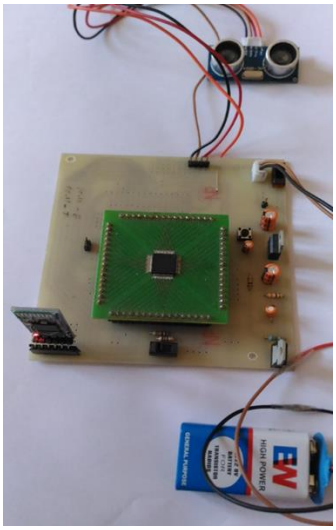

Fig. 5: Working model of a system

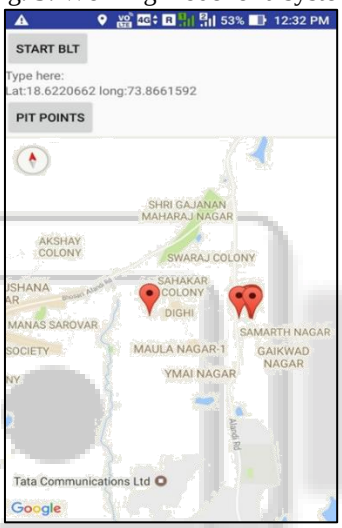

Fig. 6: Potholes and humps with road maps

The working model of the proposed system is shown in figure 5. It was tested in a simulated environment with artificial and humps was recorded and stored in the server database. In second phase, alerts were generated based on pothole and hump information stored in database. During the tests it was found that the Microcontroller module worked as expected to identify potholes and humps. Information about potholes and humps was successfully sent to the TCP/IP server. The snapshot of the map is shown in figure 6 where the potholes and humps can be seen with their latitude and longitude values.

VI. CONCLUSION

The project serves two important purposes. Firstly automatic detection of potholes and humps and secondly continuous alert to the vehicle driver in his mobile application using map which can be helpful for avoiding the accident occurrence. It will save many lives and ailing patients who suffer from tragic accidents .Well maintained roads contribute a major portion of the country's economy. The solution also works in rainy season when potholes are filled with muddy water as alerts are generated using the information stored in the database.

The proposed system considers the presence of potholes and humps. However, it does not consider the fact that potholes or humps get repaired by concerned authorities periodically. This system can be further improved to consider the above fact and update server database accordingly.

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