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Automatic Detection of Humps and Potholes on Roads and Notification to Aid Drivers

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Abstract: One of the major problems in developing countries is well maintenance of roads. Well maintained roads contribute a major portion to the country's economy. Identification of pavement distress such as potholes and humps not only helps drivers to avoid accidents or vehicle damages, but also helps authorities to maintain roads. This paper discusses previous pothole detection methods that have been developed and proposes a cost-effective solution to identify the potholes and humps on roads and provide timely alerts to drivers to avoid accidents or vehicle damages. 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, This serves as a valuable source of information to the government authorities and vehicle drivers. An android application is used to alert drivers so that precautionary measures can be taken to evade accidents. Alerts are given in the form of a flash messages with an audio beep.

Keywords: Android application, potholes and Humps, Ultrasonic Sensor, GPS Receiver

I. Introduction

India is considered one of the fastest developing countries as of today. India's road network is gigantic, giving it a thought about the condition of the roads. Roads indirectly contribute to the economic growth of the country and it is extremely essential that the roads are well built and strong. India is home to several bad roads be it the metropolitans, the cities or the villages. Since India is a developing nation there is a constant demand for good quality infrastructure, transportation and services. But since India is a huge country with quite a sizable population this problem still has not been addressed in totality.

Over the past few years, there has been a large increase in vehicle population. This increase in vehicle population has led to increasing road accidents and also traffic congestion. According to Global Road Safety Report, 2015 released by the World Health Organization (WHO), India accounts for more than 200,000 deaths because of road accidents. These accidents can be due to over speeding, drunk and driving, jumping traffic signals and also due to humps, speed-breakers and potholes. Hence it is important to collect information regarding these poor road conditions and distribute the same to other vehicles that in turn help reduce accidents caused due to potholes and humps [1].

Roads are normally placed with speed breakers that are used to control the speed of the vehicle. But these speed breakers have been a cause of accidents because a definite dimension is not followed throughout. Likewise, potholes are formed due to oil spills, heavy rains and also due to movement of heavy vehicles. These bad road conditions cause accidents, affect the quality of driving and also consumes more fuel.

Hence, in this paper we have proposed a system that would notify the drivers regarding any hurdles such as potholes and humps and this information can be used by the Government to correct these roads effectively.

II. Related Work

Youquanet 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.

Moazzam*et al.* [4] have developed a model in which a low cost Kinect sensor is used. Kinect gives the direct depth measurements, thereby reducing computing costs. Meshes are generated for better visualization of potholes. Area of pothole is analyzed with respect to depth. The approximate volume of pothole is calculated using trapezoidal rule on are a depth curves through pavement image analysis. In addition pothole's area, length, and width are estimated. The paper also proposes methodology to characterize pothole.

Rode *et al.* [5] have designed a system in which novel Wi-Fi based architecture for pothole detection and warning system which assists the driver in avoiding pothole on the roads by prior warning. The system consists of access points placed on the road sides for broadcasting data, which can be received by Wi-Fi enable vehicles as they enter the area covered by the influence of the access points. The application can be integrated in the vehicle so as to alarm the driver in the form of a visual signal, audio signal or even trigger the breaking system.

R. Sundar, *et al.* [6] 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.* [7] 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 million 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.* [8]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.* [9] 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.* [10] have developed a system in which the various road conditions are detected using smart phone 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.

III. Architecture of the Proposed System

This proposed system of detection and notification of potholes and humps to the drivers is a cost effective solution.

ARM7 Processor LPC 2148: ARM is a 32-bit processor that uses RISC architecture and is generally faster than other controllers. Since RISC architecture is used it consumes less power, has reduced heat and is also low cost. ARM is the main component in the proposed system as it is responsible for various tasks such as processing the information received by the sensors, sending this information to the server and also receiving alerts.

Fig 1 Block diagram of the proposed system

Ultrasonic Sensor HC-SR04: Ultrasonic sensors are based on measuring the properties of sound waves with frequency above the human audible range. The HC-SR04 module includes ultrasonic transmitter, receiver and control circuit. It is used to measure distance between two objects and this distance is calculated based on the time taken by the ultrasonic pulse to travel a particular distance. The module automatically sends a 40kHz square wave and automatically detect the received pulse signal. The distance is calculated based on the time taken by the transmitted signal to return.

GPS Receiver: GPS receiver is a constellation of 27 earth orbiting satellites. It is a satellite navigation system and is used to capture the geographical location. The receiver can figure out how far the signal has travelled by timing how long it took the signal to arrive. It is maintained by US government and is freely available to anyone with GPS receiver.

LCD Display JDH162A: Liquid Crystal Display screen is an electronic display module. A 16x2 means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix This is used to display notifications regarding the humps and potholes on roads and alert the driver.

IV. Methodology

The architecture of proposed system consists of 3 parts: sensing unit, server unit and user unit as shown in figure 1.

Sensing unit: This module consists of ARM processor (LPC2148), GPS receiver, ultrasonic sensor (HC-SR04) and Wi-Fi modem. The distance between the car body and the road is measured using an ultrasonic sensor. A threshold value is set such that 1.the value depends on ground clearance of the vehicle. The measured distance is compared with the 2.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 Wi-Fi modem.

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 Wi-Fi modem and the same is displayed on the LCD display in the user vehicle. A LED light is used in two-wheelers to provide the alerts. The alert is displayed 100 meters before the pothole or hump appears.

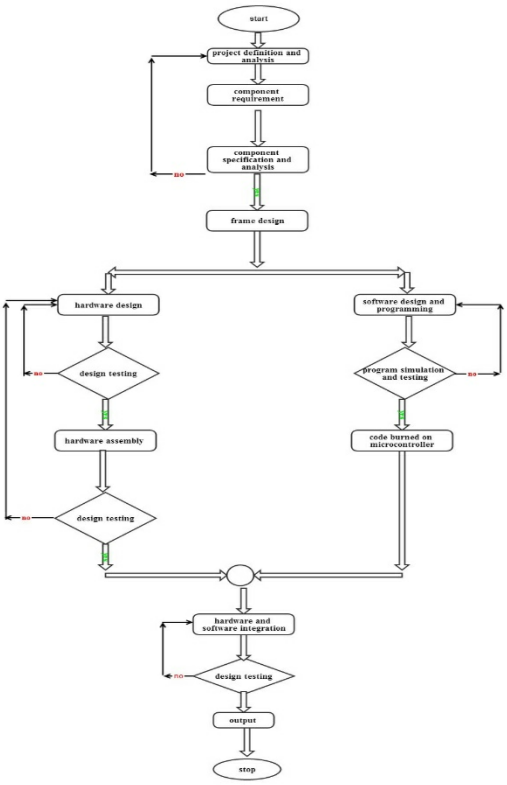

Fig 2 Flow of the system

V. Results

The working of our proposed system was tested in simulated environment in which the demo model is created which consist of artificial humps as well as pothole and shown in figure 3.

The test was divided into two parts:

Detection of humps and potholes and this information was recorded and later was stored in the database.

Based on the detection of humps and potholes, the alerts were sent from the stored information in the database.

For demo purpose, ARM7 (microcontroller) is fixed on a car and the threshold value of the car is measured. The ARM7 module worked the same way as expected to detect the humps and potholes and this information was sent to user notifying about the humps and potholes.

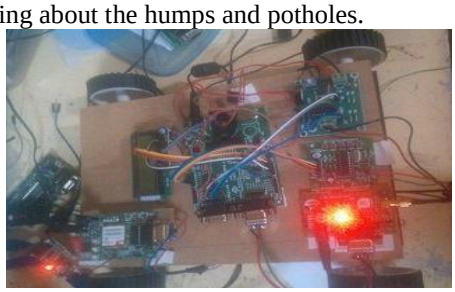

Fig 3: Working model of the proposed system

Future Scope

Since we know the exact location of the potholes and humps we can implement this system in google maps, which is useful to users during navigation.

Conclusion

The proposed system basically serves two purposes; it automatically detects the potholes and humps and sends the information regarding this to the vehicle drivers, so that they can avoid accidents. This is a cost efficient solution for detection of humps and potholes, this system helps us to avoid dreadful potholes and humps and hence to avoid any tragic accidents due to bad road conditions. The information can also be used by the Government authorities for the maintenance of the roads.

The proposed system can be further improved to display alerts such as 'Bad road ahead' in order to help the driver be more alert while driving/riding on such roads.

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