Real Time Detection and Reporting Of Road Potholes

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Abstract— One of the major problems in developing countries is maintenance of roads. Poor road conditions cause discomfort to the passenger, damage to vehicles, and increase the chances of road accidents. Therefore, it is desirable to have a mechanism to report potholes on a large scale occurring in the routes on which people wish to take in real time. Also understanding conditions of road surface is very important for road maintenance and management. To ensure road surface quality it should be monitored continuously and repaired as necessary. This paper proposes a cost-effective solution to identify the potholes on roads and provide timely alerts to drivers to avoid accidents or vehicle damages. A connected technology is developed which will allow a vehicle to gather data about the location and severity of potholes. It will allow vehicles to receive warnings allowing the driver to slow down, smooth the ride, with the aim of reducing the potential for punctures, wheel and vehicle damage.

Index Terms— Automatic sensing, Potholes, Road maintenance, Raspberry Pi, GPS

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1 INTRODUCTION

India has the second largest population in the world with one of the fastest growing economy. As the population rises, the need for well-maintained roads is also increasing as road transport is one of the most primary means of transport in the country. However, most of the roads in the country are narrow, congested and of very poor quality. Dangerous road surface conditions are major distraction for safe and comfortable transportation. Driving a vehicle in India is potentially life taking.

Pothole is a depression in the road surface caused by wear or subsidence. Potholes are formed because of substantial downpours and poor drainage framework in urban areas. Research for the Department for Transport has shown that the public's main concern on roads is potholes. Potholes stand out above all other defects as the most unacceptable of all conditions. Nearly everyone has this at the top of their scale. Potholed roads are a common sight across rural and urban India especially during and after monsoons. Every year crores and crores of rupees are spent by the highway agencies in extensive pothole patch repairs. Because of adverse media coverage these agencies do patch repairs of main streets in urban areas and main highways in rural areas after the monsoon season is over. By lanes in towns and cities and some secondary roads in rural areas usually remain neglected for years. This ritual is repeated year after year even though several lakhs of people are involved in accidents due to potholes causing serious injuries and in many cases fatalities. Both drivers and road maintainers are interested in fixing the potholes as soon as possible. However, they must be identified first.

According to the survey report "Road Accidents in India, 2011", by the ministry of road transport and highways, a total of 1,42,485 people had lost their lives due to fatal road accidents. Of these, nearly 1.5 per cent or nearly 2,200 fatalities were due to poor condition of roads. According to most recent figures by a few state governments, potholes across the nation has claimed 3,597 lives in 2017, an over half ascent in the toll than a year ago. Around 30 deaths happen day by day on streets because of potholes.

The simplest method to detect potholes is collecting photos of road damage and hazards taken by the participants and uploading them to a central server. However, it requires strong participation from the users. An automated approach to detect potholes with little or no human interaction is more promising. This would ensure more comprehensive survey data with fewer errors caused by human factors than generated by mere enthusiasm of the participants. Some pothole detection methods have been proposed previously and they can be classified into two groups: Image recognition method and mobile sensing method. Image recognition methods include image processing techniques to collect and analyse the road information to detect potholes. In mobile sensing methods, accelerometers and gyro sensors are incorporated and the data processing centre analyses these data to check whether the data exceed the thresholds for pothole detection.
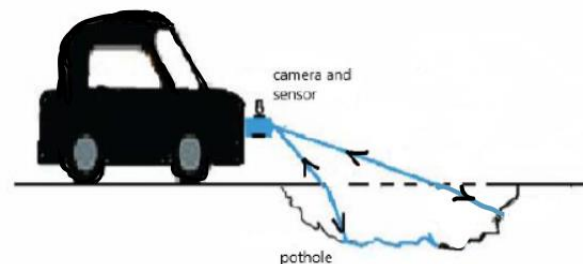

Fig. 1. Proposed System

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2 METHODOLOGY

The system proposed is a simple and cost-effective solution to detect potholes on a large scale and provide prior intimation to the driver. The aim of the proposed system is to detect potholes before the vehicle crosses the pothole so that damage to the vehicle and the potential risk of accidents can be reduced. The components used in the proposed work are as follows:

Sharp GP2Y0A710K0F IR Sensor: GP2Y0A710K0F is a distance measuring sensor unit, composed of an integrated combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. The sensor output is an analog voltage corresponding to the detection distance. The measuring distance ranges from 100 cm to 550 cm.

Arduino UNO: Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller.

Raspberry Pi 3 & Camera Module: The Raspberry Pi 3 Model B is a tiny credit card size computer that can be used for many applications. Additionally, it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs. The Raspberry Pi Camera Module is a custom designed add-on for Raspberry Pi. It attaches to Raspberry Pi by way of one of the small sockets on the board upper surface. This interface uses the dedicated CSI interface, designed especially for interfacing to cameras.

NEO-6M GPS module: The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability.

Fig. 2.Architecture of the proposed system

Buzzer: A Peizo buzzer is a device that is used togenerate beep sound, generally a warning or alert in embedded system. Through analog write the beep of the buzzer can be controlled. The architecture of the proposed system is shown in figure 3. It consists of 3 parts; sensing module, Control module and the action module.

Sensing Module: The sensing module consists of Sharp IR distance sensor which has a long range of 100-550cm. The sensor is mounted on top of the vehicle facing the road at an angle. The IR sensor output is an analog voltage which corresponds to the distance measured. Hence, it requires an initial calibration to determine the correspondence between the output voltage and distance measured. Furthermore, the distance between the IR sensor position and the ground is identified and set as threshold.

Control Module: Arduino UNO receives the analog voltage signal from the Sharp IR sensor. With the help of in-built Analog-to-Digital Converter (ADC) present in the Arduino UNO, the analog output is converted to its equivalent digital value based on the equation of calibration. This data is serially transmitted to the Raspberry Pi 3 Module using the TX and RX ports. The distance between the sensor and ground is continuously calculated. Pothole detection takes place whenever the measured distance exceeds the distance threshold and the difference between the measured value and the threshold is computed to be the depth of the pothole.

Action Module: This module comprises of Buzzer, Camera and the GPS unit. Buzzer is used to alert the driver immediately about the approaching pothole. This indicates the driver to reduce the speed of the vehicle, which reduces the chance of accidents and vehicle damage. The camera module is triggered to capture an image of the pothole. Simultaneously, the neo-6m GPS module records the approximate longitude and latitude of the location of the pothole. All the information regarding the detected pothole i.e. depth, image and location is forwarded to the road maintenance authorities.
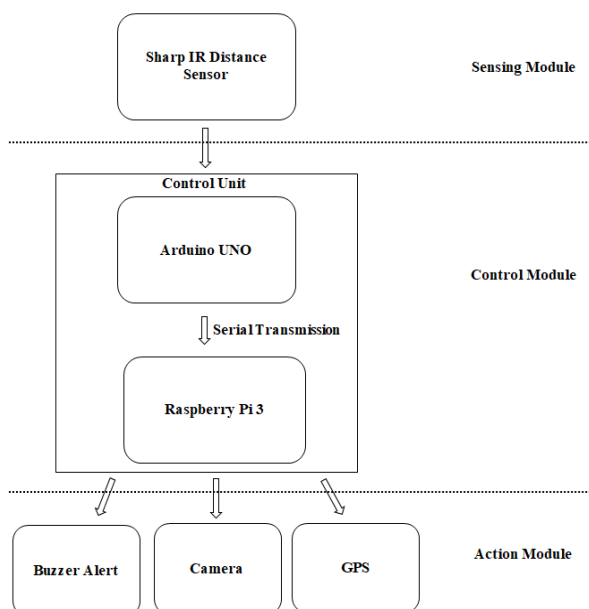
3 RESULTS & DISCUSSION

A field survey was carried out to note down the number and depth of the potholes in a route manually. The model was deployed onto the vehicle and tested in real time.

The results of the test are shown below:

POTHOLE	NUMBER
Potholes Detected	6
Potholes Not Detected	4
Total Number Of Potholes	10
Efficiency Of The System	60%

Table 1: Efficiency of the proposed system

POTHOLE DEPTH	LATITUDE	LONGITUDE	IMAGE
4 cm	12.9401° N	77.5812° E	
6 cm	12.5653° N	77.3397° E	
6.2 cm	12.5872° N	77.3491° E	
3.1 cm	12.5238° N	77.6353° E	
2 cm	12.5606° N	77.3945° E	
2.3 cm	12.5843° N	77.9721° E	

Table 2: Recorded results

In the first phase, alerts were generated based on pothole information to help the driver avoid the pothole or slowdown in order to reduce the damage caused to the vehicle. In second phase, information about was recorded and sent to the concerned authorities. While testing in the simulated environment, the control module was fixed on a car and the threshold value was configured to 120cm. During the tests it was found that the microcontroller module worked well to identify potholes. Table 2 shows a set of potholes identified by the system. Information about potholes was successfully sent to the road maintenance authorities.

Use of serial transmission between Arduino and Raspberry Pi produces a slight amount of delay due to which some potholes could not be detected at the right time. In order to solve this issue a long-range Ultrasonic sensor could be used but the sacrifice of the cost of the system.

4   CONCLUSION

A pothole detection system was developed using Raspberry pi control module and SHARP GP2Y0A710K0F IR sensor. Pothole was detected each time when the distance from the vehicle to the road exceeded the threshold distance previously set. Followed by the detection, the Raspberry pi camera module immediately captured an image of the pothole and the location was recorded. An alarm is used to alert drivers so that precautionary measures can be taken to evade accidents. The sensed-data including pothole depth, picture, and geographic location of the pothole served as a valuable source of information to the government authorities and vehicle drivers. An important aspect of the proposed system is the maintenance of roads which will rapidly make our city a smart city and these developed roads will lead to the safety of human life & this system can be used to benefit the people by using some high-level technologies and ideas for the increased development of the roads and prevention from accidents.

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