Design and Implementation of Pothole Detector using Multisensor System

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Abstract: In this fast-moving world that we live in, safe commute is not only everyone's priority but also to provide a hassle-free shuttle between places is the government's duty. In this paper, we propose a system which detects potholes on the road. As we all know prevention is better than cure, we design and implement a system which not only recognizes potholes but also stores this data on a cloud platform which can act as a database for further reference and enable us to analyze the data. The proposed system contains two important functions, first is to detect the pothole which is done through a multi-sensor subsystem consisting of accelerometer and gyroscope and secondly warn the driver and store this information on a cloud base which can be accessed by other users which will help them apprehend the potholes on their way. Once the location of the potholes is known, Government authorities can be informed about the same. These instructions give you basic guidelines for preparing camera-ready papers for McGraw-Hill conference proceedings/Journal Publications.

Keywords: Accelerometer, Arduino-Uno, Gyroscope, ThingSpeak channel and Serial monitor.

Introduction

Over the last two deacdes, India has grown tremendously, as more and more people graduate by the minute and more and more of us gain employment by the hour ,we are all bound to commute and spend most of our time travelling.Parallaly , reports and survey are of the opinion that [1]. "Last year,10,727 people were killed in crashes caused by potholes ,speed breakers and roads under repair or being constructed.Though fatalities under these catagories had come down marginally from 2014,the number of people killed due to potholes rose to 3,416 from 3,049 in the previous years."Evidently the key reason to road accidents happens to be faulty roads and unanticipated occurance of potholes.The safety of the motorists should be priortized and a smooth commute should be ensured for everyone.Thinking along such lines we came up with the idea of integrating a hardware system which detects the potholes using an accelerometer and a gyroscope along with a software which can measure these results on a real time basis and store the necessary data on a cloud base.

Figure1. Potholes present on the roads

Rajeshwari et. al [9] have developed a system which uses ultrasonic sensors to identify the potholes and humps and also to measure their depth and height, respectively, which is then stored on a database. Although this is a cost-effective system, unevenness and terrain mapping of the roads will affect the results and will fail to produce accurate values. The ultrasonic sensors cannot be calibrated on a real-time basis.

Ionut Schiopu et, all [10] have proposed a system where they video track the path by using a camera mounted on the car and analyze the image acquired. The image is processed and various features are obtained. Through this approach, it is unclear how the false positives are eliminated also the delay caused due to processing of image is ambiguous. Aliaksei Mikhailiuk [11]. and colleague have proposed a system which is vision based to detect potholes on a real-time basis by using TMS320C6678 DSP and complex processing algorithms which may be accurate but is definitely not cost effective. Our vision of a good system would be one, which is cost effective and low power consuming as it can be implemented on low end vehicles as well. Artis Mednis and team [12] have developed a system which detects potholes based on an accelerometer which is present in mobile phones on an Android OS. The calibration of the phone and the vehicle will definitely be unequal which will lead to multiple false negatives when compared with results of an ideal case scenario.
The current systems employed to detect potholes mainly consist of a [12] vision based system which use real time image processing algorithms and happens to be an expensive piece of technology. The proposed system design (prototype) could be implemented in real time by the automobile industries in their vehicles. The system will be linked to the cloud base which will be regularly updated. As it is cost effective and consumes less power, it is easier to implement on low-end vehicles.

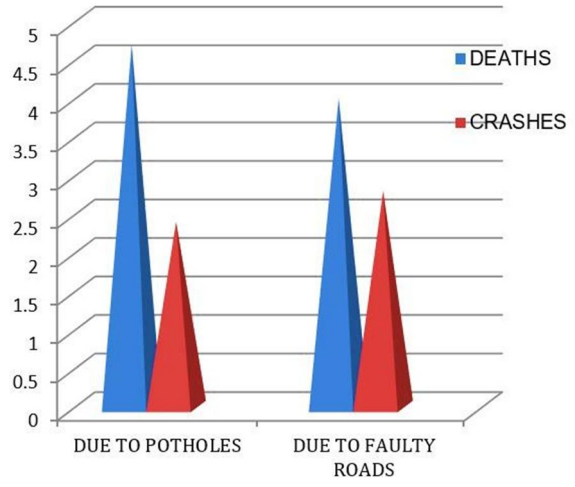

Figure2. A graphical represntation of deaths caused due to potholes and faulty roads

We are trying to design and implement a cost-effective system based on vibration sensed off the uneven-ness of the road. The proposed system design (prototype) could be implemented in real time by the automobile industries. The various components used to design the prototype hav been discussed in the next section. The results and various evaluation parameters have been discussed in the subsequent sections. On a larger scale this design could be integrated with the [2] global positioning system tracking available in our country as well as the real-time satellite feed available in Google maps [3]. This way the travellers would be well aware of the potholes on their path.
The remaining sections of the paper are as follows: Section II emphasizes on the hardware and software used to build the project. Section III gives a detailed explanation of how the prototype is made by integrating various sensors and forming a network between the hardware and the software. Experimental results and snapshots of the trial are included for better understanding. Further, the feasibility of the project is discussed and is followed by a brief conclusion and a reference list.

Hardware and software

Hardware

ARDUINO UNO: We have chosen this microcontroller over the various other options available in the market due to its ease of interfacing with various sensors and efficient programming through the Arduino IDE.
ADXL345: This particular sensor happens to be a combination of accelerometer and a gyroscope. Accelerometer is used to measure “proper acceleration” by gauging the acceleration along the three axes (X, Y, Z), which accurately sense orientation. The gyroscope is used to maintain a uniform orientation based on the principles of angular momentum.
ARDUINO WIFI SHEILD: This helps to connect the microcontroller to the internet wirelessly. By using simple commands, we were able to connect the hardware to a web based server which is used to analyze the real-time data.

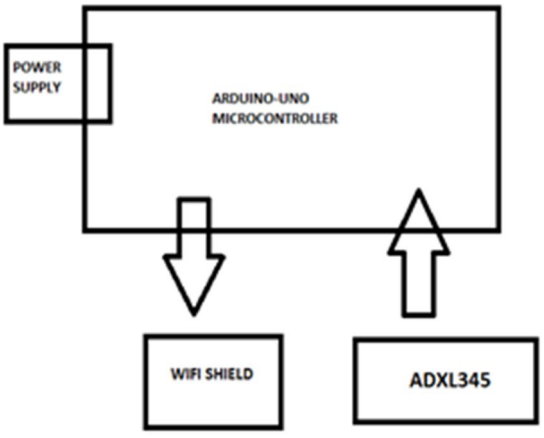

Figure3. Schematic of the system

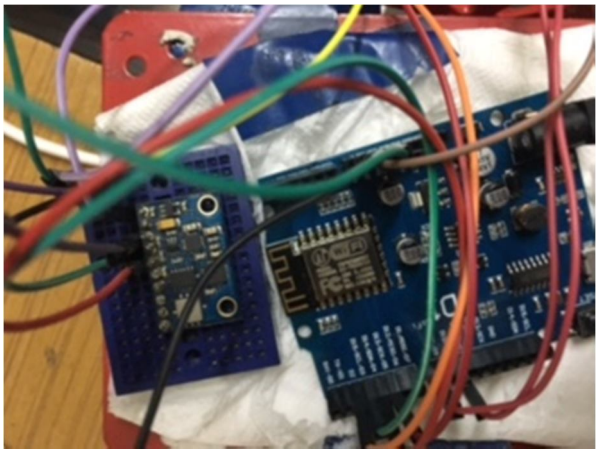

Figure4. Working model of the proposed system

Software

ARDUINO IDE: This is the standard software used to interface the Arduino hardware with software.

THINGSPEAK: This is used to analyze the data acquired by the sensors on a real-time basis. The data is plotted in a graphical manner against time.

Design and implementation

To test the practicality of our design we made a robot. The robot mainly consisted of a bare metal body, wheels and chassis which were controlled through a motor driver .On the robot we mounted our microcontroller and the peripheral sensors. Through the WiFi shield we were able to successfully connect the system to an internet network wirelessly.

Figure5. Flowchart of the designed system

Our prototype is made up of an Arduino and sensor system which detects the unevenness of the road by using an accelerometer and a gyroscope for accurate detection .The sensor keeps receiving the data and it is displayed on a serial monitor. This data is sent to an online database known as thingspeak. Here, we have created a channel for the project which records these values in a graphical manner.

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È¤lÌÉäbfSKý$<ð Å üAccelerometer Test

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Sensor:       ADXL345
Driver Ver:   1
Unique ID:    12345
Max Value:    -156.91 m/s^2
Min Value:    156.91 m/s^2
Resolution:   0.04 m/s^2
------------------------------------

Data Rate:    100  Hz
Range:         +/- 16  g

X: -0.27  Y: -0.12  Z: 8.94  m/s^2
X: -0.27  Y: 0.08  Z: 8.51  m/s^2
X: -0.24  Y: 0.94  Z: 8.67  m/s^2
X: -0.75  Y: 0.16  Z: 8.71  m/s^2
X: -0.55  Y: 0.35  Z: 8.83  m/s^2
X: -0.08  Y: -0.08  Z: 8.75  m/s^2
X: -0.31  Y: -0.16  Z: 9.38  m/s^2
Reading: 9.38 send to Thingspeak
```

Figure6. Real time data acquired while testing the prototype

The real time data is further analyzed on this channel. Data mining [13], which is a popular technique can be implemented to use the data base both efficiently and effectively.

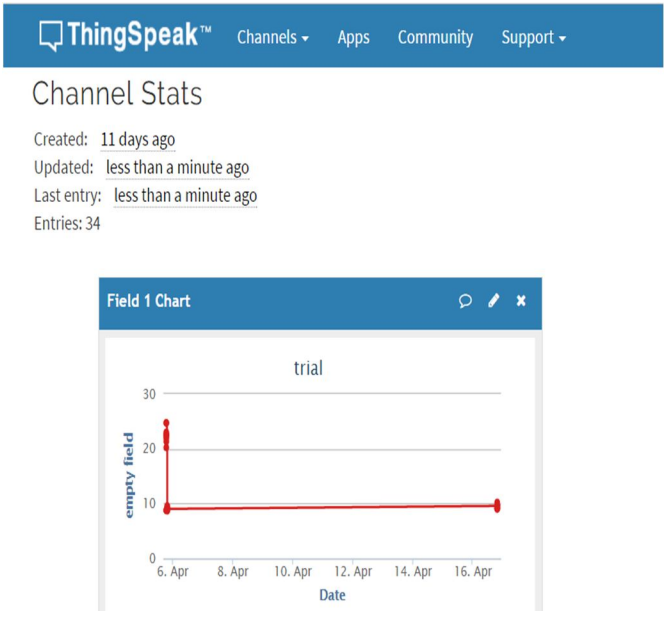

Figure7. Data being sent to a web server where it can be analyzed further

The proposed system design (prototype) could be implemented in real time by the automobile industries in their vehicles. The system will be linked to the cloud base which will be regularly updated. As it is cost effective and consumes lesser power, it is easier to implement on low-end vehicles as well. As we have been noticing, the amount of deaths or accident cases due to

these potholes is increasing by the day. People are usually distracted while driving on the roads and some sort of an alert system is needed to grab their attention in order to prevent them from facing the consequences of these potholes.
Further we would expand our system by linking the database to a GPS system. This would tell the commuters and drivers of the potholes in their path well in advance. This could also assist the government authorities to locate the faulty roads and help them reconstruct the roads efficiently. The cost factor would also have a positive aspect as no such complicated or delicate equipment are being used to implement this system.
Moreover, this sensor can be mounted easily on the automobile with no complications involved. The accelerometer and gyroscope based concept leads to a more flexible and less-complicated system when compared to the already existing image processing, ultrasonic based techniques to detect potholes.

Conclusion

Our system is efficiently designed to fulfill two main criteria; First one being detecting potholes on the road and second is to form a software interface with the system which can store the data on a cloud source which is accessible to all. This will help others travelling on the road.
The cost-effective system that we have proposed will prevent accidents to a great extent. Our proposed solution makes use of a better and more efficient technology to detect potholes and warn the driver about them so that he is aware a prior. Compared the already existing technology, this system would be time efficient and would consumer lesser power. As there would be database comprising of the location of the potholes, it will notify the government authorities and in turn necessary action can be taken.
As we can extend the project by integrating it with GPS systems and real time satellite feed, it will help the commuters have a prior idea of the potholes on the path and make them conscious of their route enabling a safe travel.

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