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RIPD: Route Information and Pothole Detection

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Abstract: The most common problems faced by a daily commuter are – waiting for public transport vehicle to arrive and experiencing unnecessary body fatigue due to poor road conditions such as potholes. In this paper, we have discussed a system which will overcome these problems. In this system, we have used Android OS based smartphones as they not only contain sensors like Accelerometer, GPS (Global Positioning System), GPRS (General Packet Radio Service) but also contain a wide range of other sensors which can be used for future applications. These smartphones will be integrated in public transport vehicles, with unique vehicle IDs, which will be continuously monitoring the road conditions while transmitting the real-time location co-ordinates of the vehicle that will be displayed on maps using Google Maps API.

Keywords: RIPD, GPS (Global Positioning System), GPRS (General Packet Radio Service), Google Maps API.

I. INTRODUCTION

In our day-to-day life, every passenger has to face a number of unnecessary problems like waiting for the public transport, exertion due to bad road conditions. As the passenger has to wait, a lot of time is wasted which could be utilized for other activities. Moreover, poor road conditions make it dangerous for the driver as well as for the passengers as it could lead to fatal accidents, physical problems such as back-pain, joint-pain, etc. and also damage the vehicle.

This paper proposes an all-in-one system which incorporates pothole detection as well as real-time monitoring of vehicles. For monitoring the road conditions, we are detecting the most primary cause that is Potholes.

For monitoring the potholes, we have to detect potholes so that the concerned authorities can repair in time. One of the approaches for detecting potholes is doing it manually by using human reports to the central authorities. While the accuracy is higher, this approach is not feasible because integrity may not be maintained, human errors etc. So we have decided to automate the process using smartphones which rules out the factor of human intervention thus reducing errors. With the help of accelerometers and various advanced Z-axis algorithms [1] we can detect potholes and send their location coordinates using GPS. This information is stored at the server where various aggregation algorithms are performed and the list of most prior potholes is displayed.

The need for vehicle tracking system first arose in the shipping industry where they need to track the location of the ships [2]. Later, this system also found its application in large industries for fleet management to manage companies' fleet transport. In the proposed system, RIPD –Route Information and Pothole Detection, we are developing two mobile applications out of which one will continuously send the real-time location co-ordinates to a server where this information will be stored into a database along with its unique vehicle ID. Another is a crowd sourcing application which will require a unique vehicle ID after entry of which, will display the location of vehicle onto the map using Google Maps API.

II. RELATED WORK

There are similar works related to vehicle tracking system and road monitoring system for pothole detection. In this section some system uses LED panels GSM/GPS technology for vehicle tracking system while, in pothole detection accelerometers are used for collecting pothole based data. There are many fields in which vehicle tracking system is used such as tracking of automobile's position, anti-theft tracking and intelligent transport system.

a. Vehicle Tracking System

Bus tracking system was proposed by Lau [4] in UCSI University, Malaysia. This system allowed the students to obtain information regarding the bus for a fixed route and also helped them know the current status and timings of the particular bus. A Smartphone application and LED panel was used for this system. The real-time bus tracking system helped the college students to spend more time studying or relaxing rather than spending time in a bus stop waiting for a bus which may be delayed. This system therefore helped in making the students life more comfortable and also helped managing their time effectively.

Ramadan, Al-Khedher, and Al-Kheder [5] proposed the anti-theft and vehicle tracking system. They used the GPS/GSM technology for tracking the position of the vehicle when stolen. In order to determine the position more accurately, they used the Kalman filter [6] which reduces the positional errors. The status and location of the vehicle can be tracked with a laptop which is embedded with Google Earth. This system therefore helped in protecting the vehicles from intruders.

b. Pothole Detection System

The University of Colombo developed a system called BusNet [7] for pothole detection. They use technologies

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such as Crossbow MICAz and various other sensors such as accelerometer and GPS. The disadvantage of this system is that it is not applicable for processing of data in real time and has only limited storage for data. The data is collected and transmitted to collection nodes at the required stations which then later process these data. The algorithm uses sensing acceleration for detection of potholes.

Microsoft Research India developed the systems- Nericell [3] and Traffic Sense [8] which uses Windows OS smartphones to detect potholes. The hardware/software platform consisted of various sensors such as accelerometers, microphones and GPS. They used z-sus, z-peak and virtual reorientation algorithms for their system. Z-sus(for speed <25km/hr) and z-peak(for speed of 25km/hr) algorithms helped in detecting potholes based on threshold values while virtual reorientation algorithm helped in adjusting the arbitrary alignment of the smartphone during the motion of the vehicle.

There are various systems which uses machine learning methods for pothole detection. National Taiwan University [9] and researchers from University of Jyvaskyla [10] are using such systems. National Taiwan University makes use of supervised and unsupervised machine learning methods for pothole detection. It uses filtering, segmentation, feature extraction and support vector machine for detecting road abnormalities. The University of Jyvaskyla uses offline data mining for pothole detection where the accelerometer data is pre-processed using band-pass filters, a sliding window with different methods such as Hamming, Taylor, Chebyshev and Normalization Feature extraction like mean, root mean square(RMS), peak-to-peak ratio, variance, power spectrum, standard deviation, density and wavelength packet decomposition is used in the next step. Various other features such as backward and forward selection, genetic algorithm, and support vector machine is also used. Advantages of this system is that it shows good performance and some of the described methods are useful in real time data processing but the disadvantage is that it is not possible for full implementation of the system with limited hardware and software resources.

In RIPD we are going to make use of algorithms which will help us in two different fields:

1) Real-time bus tracking system where information and current status of the buses will be provided to the end users.
2) These buses will also contain hardware/software which will help in detecting the location of potholes and this information will be sent to the concerned authorities.

III. TECHNICAL REQUIREMENTS

The following technical requirements for RIPD are:

- The system should be an Android OS based smartphone with minimum version of android API 8. Portability of application to other platforms is considered as an additional feature.
- System should be able to calibrate or self-calibrate, as different vehicles are likely to yield different sensor data when encountering a pothole.
- Google Maps API, which are used to display the acquired data onto maps.
- Connection with the server in the integrated smartphone, to send the required data in real-time.
- PHP at the server side to get the location data and MySQL database to store, retrieve and process the data stored in the database.

IV. OUR APPROACH

Our system, RIPD, consists of three major modules, namely –

a. Integrated Smartphone
b. Web Server and Database
c. Traveller Application

These modules along with their sub-modules are described below –

a. Integrated Smartphone

Android OS based smartphones will be integrated in public transport vehicles. These smartphones will check the anomalies faced while travelling and simultaneously track the location co-ordinates onto log files. It will be connected to a web server where it will transfer data. It will perform the following tasks –

- Detecting potholes.
- Real-time vehicle tracking.

For detecting potholes, the integrated smartphone will use Accelerometer, GPS and various Z-axis algorithms. Once all these sensors are activated, the accelerometer will continuously record the Z-axis readings and use the algorithms to detect potholes. Whenever a pothole is detected the location co-ordinates are recorded using GPS sensor and sent to the server along with the timestamp. In our system we are using a combination of two Z-axis algorithms – Z-THRESH and Z-DIFF [1].

Z-Thresh algorithm

The Z-THRESH algorithm is based is similar to Z-peak algorithm used in Nericell [3]. The Z-thresh algorithm basically rotates around comparing the accelerometer values with a predefined threshold value. For that, we have to first select the threshold value which may vary from vehicle to vehicle according to their Damping Ratio. The reading of the accelerometer will be checked against the threshold line and whenever the amplitude of the Z-axis readings crosses this line, a pothole is detected. The demo visualization is shown in Fig 1.

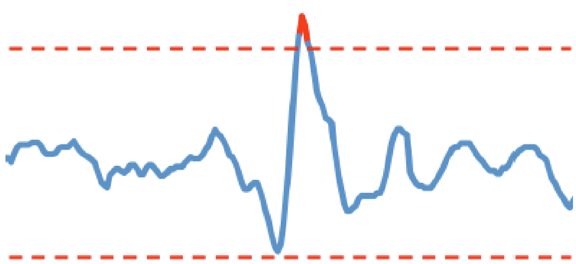

Fig.1. Pothole Detection Algorithm Z-THRESH

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Z-Diff algorithm
The Z-Diff algorithm is slightly more sophisticated algorithm. This algorithm is used to enhance the accuracy of the RIPD system. In Z-Diff algorithm, we are finding the deviation among the consecutive Z-axis which is compared against the threshold value. Z-diff is also used for detecting fast changes in Z-axis data. The demo visualization is shown in Fig 2.

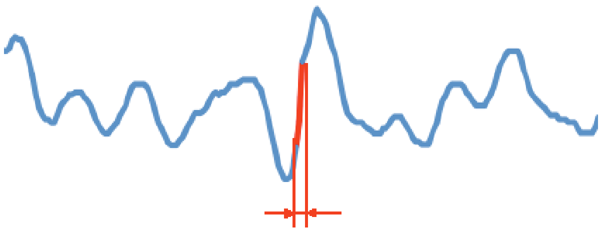

Fig. 2.Pothole Detection Algorithm Z-DIFF

For real-time vehicle tracking, RIPD will use the GPS component of the Integrated Smartphone to track the location the vehicle. This tracking of the location is carried out within a certain time interval, which will be based on the speed of the vehicle. The time interval is inversely proportional to the speed of the vehicle.

b. Web Server and Database
The data recorded by the integrated smartphone will then be sent to a web server. This data is then saved in the MySQL database which is present at the web server. The web server will be emphasizing on two things. First, the information about the location of the potholes will be aggregated and processed based on certain parameters to get a list of potholes that need urgent attention. Second, the information about the real-time location of the vehicle is processed and represented on the map using Google API's simultaneously it will transfer this information to the travelers mobile application.

c. Traveller Application
The Traveller Application is based on the concept of ITS-Intelligent Transport System. The primary requirement of the Traveller Application is internet connectivity in the user devices. The user will request for the real-time location of the vehicle to the web server. The web server will then respond to the request with the information of the location which will represent this information onto a map.

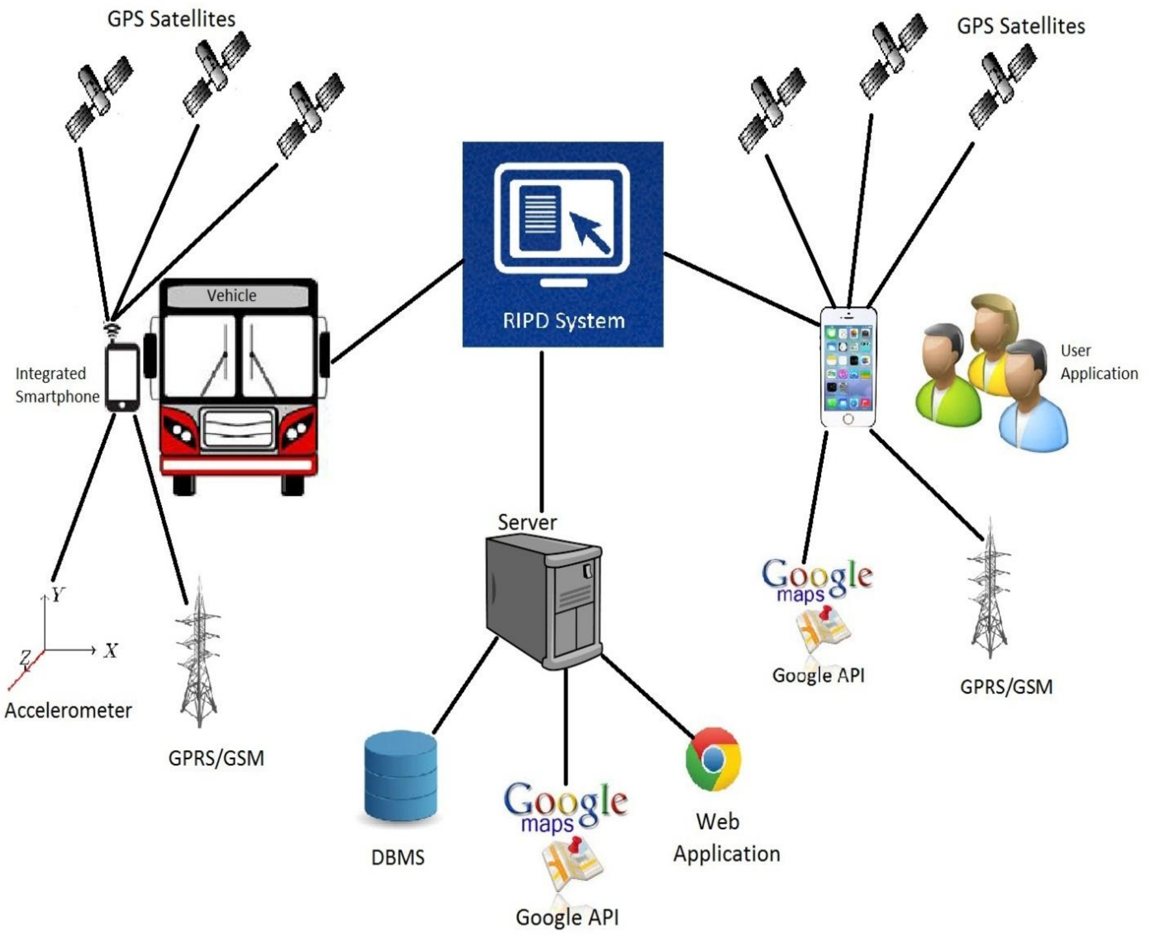

Fig3. RIPD System

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V. CONCLUSION

This paper describes the RIPD system which will use -

1) Android smartphone along with its GPS/GSM modules to track the location of the vehicle and send it to the server.
2) Accelerometer and GPS algorithms to detect the potholes on roads.

The implementation will be low-cost as we are using this system on Android OS phones which are nowadays easily available and at a lower cost. The future work includes experiments with combinations of the proposed algorithms and development of these functionalities.

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