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RIPD: Route Information and Pothole Detection

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Abstract: Potholes on road surfaces have become an increasing concern in developing countries. With the increase in population the number of vehicles on road has also increased and so is the number of potholes. Therefore we have proposed a system that will help the authorities with checking and maintaining the road conditions. We have used an Android OS based smartphone which has various sensors like GPS, GPRS, Accelerometer and various other sensors that will help in future applications. This paper will describe how the potholes will be detected by using the mobile sensing system, selected algorithms that will help in processing the data and sending the processed data along with the location coordinates of the potholes to the servers where they will be mapped using the Google Maps API.

I. INTRODUCTION

Potholes can be described as an indentation on the road surface that is caused mainly due to its continuous use by many different types of vehicles ranging from light-weight vehicles like bikes to heavy-weight vehicles like industrial trucks. Various other factors like improper road construction or natural conditions like rain and snow also leads to potholes on road surfaces. Potholes have become an increasing concern in developing countries due its growing population thereby the increase in vehicles. There is also lack of road monitoring and maintenance systems which leads to worsening of road conditions. Due to the bad road condition the passengers have to face unnecessary body fatigue.

One way of detecting road damage is by using public to report to concerned authorities. They can send information about the extent of the damage and the location of it. But this process also has many problems. This process is highly accurate only when the information provided by the people is genuine. To estimate the damage probabilities, statistical analysis can be done based on its usage intensity. But in order to perform the statistical analysis various vibration and vehicle counting sensors are to be integrated into the pavements. This process leads to the use of expensive equipments which may not be always feasible. Another way of detecting road damage is by collecting photos of the damage by the participants and then sending it to the concerned authorities or to a central server. It is the simplest method but it requires active participation from the users.

This paper proposes a system for automatic detection of potholes. In this system we are using an Android OS based smartphone which consists of many different sensors like GPS (Global Positioning System), GPRS (General Packet Radio Service), Accelerometer and many more. This system will be integrated in public transport so that it is directly handled by the authorities without the need of any participation by the users and giving them incentives for the information. These sensors we will be able to identify potholes with more accuracy and less human errors. Using the accelerometer and Z-axis algorithms potholes will be detected and this information will be sent to the concerned authorities using GPRS. GPS will be used to locate the position of the potholes. The information stored in the server will be processed using aggregation algorithms and the potholes will be listed based on their priority. The identified potholes will also be mapped by using Google Maps API.

II. RELATED WORKS

1. Pothole Detection System

The University of Colombo developed a system called BusNet[3] for pothole detection. They use various sensors such as accelerometer and GPS and technologies such as Crossbow MICAz. The data is collected and transmitted to collection nodes at the required stations which then later process this data. The algorithm uses sensing acceleration for detection of potholes. 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.

Microsoft Research India developed the systems Nericell[2] and TrafficSense[4] 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 < 25 km/hr) and z-peak(for speed of 25 km/hr) algorithms helped in detecting potholes based on threshold value while virtual reorientation helped in adjusting the arbitrary alignment of the smartphone during the motion of the vehicle.

There are various systems that uses machine learning algorithm and methods for pothole detection. National Taiwan University [5] and researchers from University of Jyvaskyla[6] are using such systems. Supervised and unsupervised machine learning methods are being used by National Taiwan University for pothole detection. It uses support vector machine, feature extraction and filtering segmentation 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 Taylor, Chebyshey, Hamming and Normalization feature extraction like mean, root-mean square(RMS), variance, peak-to-peak ratio, standard deviation, power spectrum, density and wavelength packet decomposition is used in the next step. Other features such as genetic algorithm, backward and forward selection, support vector machine is also used. Advantages of this system is its good performance and some of the described methods are useful in real time data processing but the disadvantage of the system is that full implementation of this system is not possible with limited hardware and software resources. In RIPD we are going to make use of algorithms and hardware/software which will help in detecting the locating of the pothole and this information will be sent to the concerned authorities.

III.TECHNICAL REQUIREMENTS

The following technical requirements for RIPD are:

- An Android OS based smartphone as a system with minimum version of android API 8. Portability of application to other platform is considered as an additional feature.
- Different vehicle are likely to yield different sensor data when encountering a pothole thus, system should be able to calibrate or self-calibrate.
- Google Maps API, which are used to display the acquired data onto maps.
- Connection with the server in the integrated smartphones, to send the required data in real time.

IV. MODULE DESCRIPTION

Our system makes use of Android OS based smartphones. The built-in accelerometer in the phone will be used to collect the x, y and z axis accelerations. GPS (Global Positioning System) will be used to collect and send the location coordinates of the potholes. At the server side the information received will be processed using aggregation algorithms and then the list of potholes will be prepared based on their priorities. This will help the authorities to take the necessary decisions. In order to implement our system we have divided it into two modules as follows:

1. Integrated Smartphones
2. Database and Web Server

1. Integrated Smartphones

The public transport will be integrated with Android OS based smartphones. They will be used to detect any variance in the road conditions and will send the information to the web server where they will be stored in log files. In order to detect the potholes phone's accelerometer will be used along with z-axis algorithm. During continuous collection of data, if any difference is found in the readings by the algorithm then it would be sent to the server. Whenever a pothole is detected GPS will send the location coordinates of the pothole along with its timestamp. To identify the potholes we are using combination of two types of Z-axis algorithms namely – Z-Thresh and Z-Diff algorithm [1].

Z-Thresh Algorithm

Z-Thresh is the simplest event detection algorithm. It is also used in the Nericell project [2]. To detect potholes the Z-Thresh algorithm considers the minimum value of the z-axis accelerometer as threshold. Here the damping factor will be the same as we are using public transport. The algorithm calculates the value of the received data with that of threshold value. If the amplitude of the value exceeds the threshold then pothole is identified. Fig 1 shows the Z-thresh algorithm where the events exceed the given threshold value.

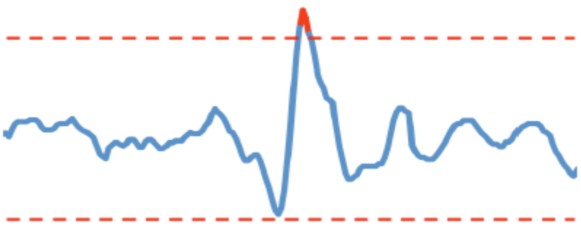

Fig 1: Z-Thresh Algorithm

Z-Diff Algorithm

Z-Diff Algorithm is a bit more advanced as compared to Z-Thresh algorithm. In this algorithm the difference between the consecutive measurements which lie above the threshold value is calculated. Rapid changes in the vertical acceleration data is identified by the algorithm. This helps in increasing the accuracy of our system. Fig 2 shows the Z-Diff algorithm where difference in the consecutive measurements lie above the threshold value.

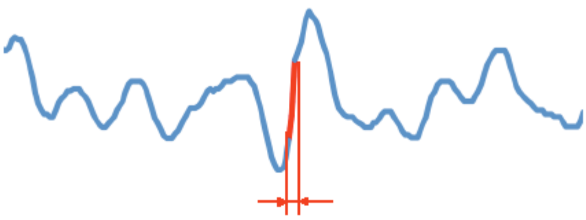

Fig 2: Z-Diff Algorithm

2. Web Server and Database

The data recorded by the smartphone will be sent to the web server. Here we are using Apache Tomcat as the web server. Apache Tomcat provides a HTTP web server environment for the java code to execute. The data received by the server will be further processed using aggregation algorithm and then a list of potholes will be made based on their priorities and the one's which require immediate attention. This information will be saved in the SQL database. The authorities will be able to retrieve the list from the database. In order to obtain additional information about the location of the potholes, they will be mapped onto the Google Maps using the Google Maps API.

V.IMPLEMENTATION

The acceleration data is collected using Samsung Galaxy S Advance smartphone with Kitkat version of Android. The readings are taken in Pune, Maharashtra. The readings are

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taken in several drives in the course of 3 weeks. The preliminary data for pothole was collected using the 3-axis accelerometer sensor present in the Android device. The sensor vendor is Kionix KXTJ2 and the resolution of the sensor is 0.009580079m/sec^2 with Max Range: 19.62 and Min Delay of 5000 microseconds. The data collected from the accelerometer is in the m/s^2 format. We have considered the threshold value as -4.50 which we is an aggregated value taken from different readings with different speed. Tables 1 and 2 shows the partial readings where the potholes were detected with a speed of 20 km/hr and 10 km/hr respectively. It does not contain all the readings which were collected. It consists of 4 columns namely x-axis, y-axis, z-axis and time_from_previous_sample in (ms). The x, y and z axis is used to show the pothole readings in all 3 axes. The time_from_previous_sample is the time difference between the samples recorded.

Table 1: Accelerometer readings for speed of 20 km/hr. The highlighted row shows the readings where the pothole was detected.

X-axis	Y-axis	Z-axis	Time_from_previous_sample (ms)
0.089	-0.096	0.168	40
-0.323	0.32	0.166	40
0.177	0.847	-0.826	39
0.754	0.573	-4.709	40
1.161	-3.388	-2.378	39
-0.35	1.992	1.744	40

Table 2: Accelerometer readings for speed of 10 km/hr. The highlighted row shows the readings where the pothole was detected.

X-axis	Y-axis	Z-axis	Time_from_previous_sample (ms)
-0.084	0.327	1.397	40
-0.075	-0.041	2.145	39
0.062	0.012	-0.496	39
0.499	0.721	-5.142	40
0.794	-0.152	-4.875	39
0.1	-1.736	-0.323	39

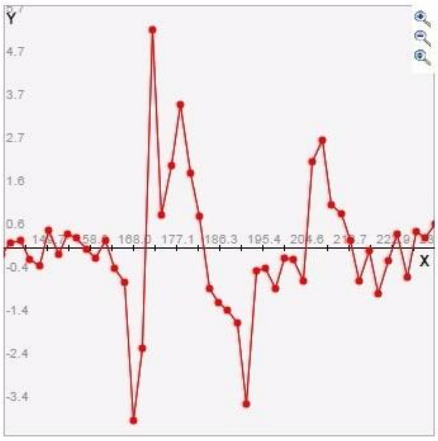

Fig 3(a): Graph illustrating the accelerometer readings for the speed 20 km/hr.

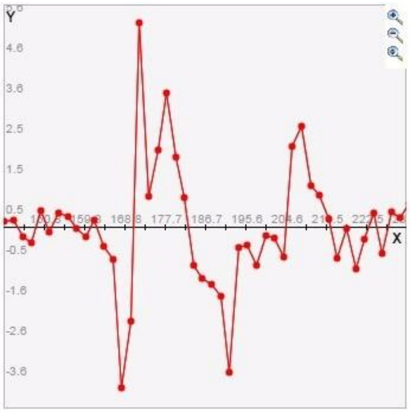

Fig 3(b)

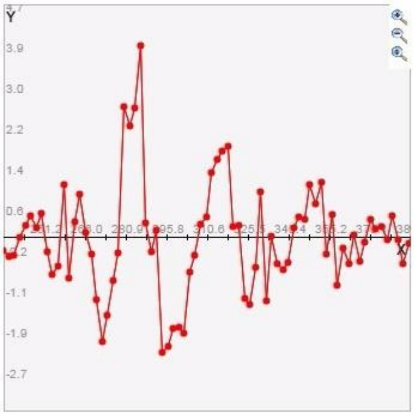

Fig 3(c)

Fig 3(b), 3(c): Graphs illustrating the accelerometer readings for the speed 10 km/hr.

For implementation purpose we are going to consider the following 3 sections:

1. Pothole Detection Application
2. Server and Database
3. Geotagging

1. Pothole Detection Application

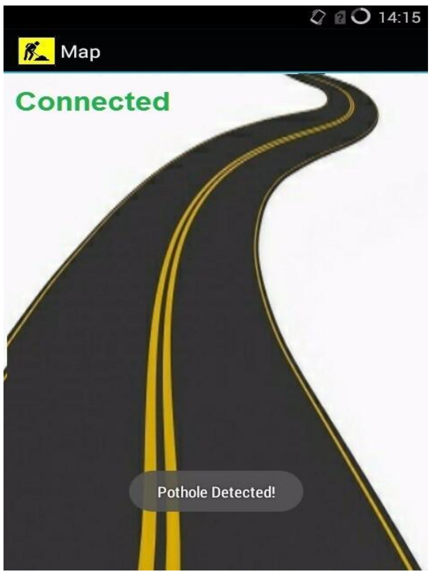

Fig 4: Screenshot of the application when the pothole was detected.

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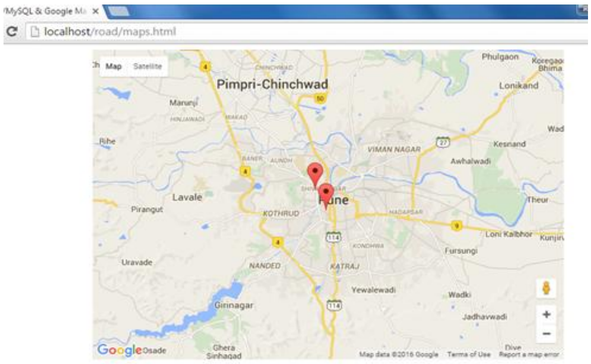
The pothole detection application is an Android application which will be installed in the Android smartphone. The application is integrated with the IP address of the server with which it should communicate. When a pothole is detected the location information of the pothole along with the timestamp is sent to the server. Fig 4 shows the screenshot of the application.

2. Server and Database
Here the data collected by the application will be sent to the web server. We are using Apache Tomcat Server for our system. In the server the data will be processed and then stored in the database. The administrator will be able to access these data from the database.

3. Geotagging
Our system helps the admin to geotag the position of the potholes on the Google map as shown in Fig 6. It can detect the number of real potholes present in the city. It shows the position of potholes along with the count of the number of times it has been detected. Once the data is verified the municipal authorities can take the required actions to repair the road.



Location of potholes

Fig 6: Google Map showing the position of potholes

VI. ADVANTAGES OF THE PROPOSED SYSTEM

1. The manual work required to be done by the authorities to detect a pothole is reduced. Using this system they will be able to detect the potholes effortlessly and within short duration of time.
2. No inclusion of users or public as this system will be handled completely by the government.
3. Admin can locate the potholes on Google Map.
4. List of critical potholes based on count.
5. Due to fast processing and communication the roads will be repaired immediately.
6. Increased life span of vehicles.
7. Comfort to passenger.
8. No need of self calibration as the smartphone will be calibrated according to the public transport bus.

VII.FUTURE SCOPE

1. Driver behavior analysis.
2. Traffic analysis based on braking.
3. Honking patterns.

VIII.CONCLUSION

This paper describes how the system will work by using the accelerometer and GPS to detect the potholes. It will help in pothole identification in an easier and efficient way thereby saving time and resources. With its help Municipal will be able to monitor the road conditions and repair the roads immediately.

REFERENCES

[1] Artis Mednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs, Leo Selavo "Real Time Pothole Detection using AndroidSmartphones with Accelerometers"

[2] P. Mohan, V. N. Padmanabhan, and R. Ramjee, "Nericell: using mobilesmartphones for rich monitoring of road and traffic conditions," inProceedings of the 6th ACM conference on Embedded network sensorsystems, ser. SenSys '08. New York, NY, USA: ACM, 2008, pp. 357–358. [Online]. Available: http://doi.acm.org/10.1145/1460412.1460450

[3] K. De Zoysa, C . Keppitiyagama, G. P. Seneviratne, and W.W.A.T. Shihan, "A public transport system based sensor network for road surface condition monitoring," in proceedings of the 2007 workshop on Network system for developing regions, ser.NSDR'07.New York, NY, USA: ACM, 2007, PP.9:1-9:6. [Online].Available: http://doi.acm.org/10.1145/1326571.1326585

[4] ------,"Trafficsense: Rich monitoring of road and traffic conditions using mobile smartphones,"Microsoft Research, Tech.Rep.MSR-TR-2008-59,April 2008.[Online]. Available: http://research.microsoft.com/pubs/70573/tr-2008-59.pdf

[5] Y-c Tai, C.-w. Chan, and J.Y.-j. Hsu, "Automatic road anomaly selection using smart mobile device, "in Processing of the 2010 Conference on Technologies and Applications of Artificial Intelligence (TAAI2010), November 2010.[Online]. Available: http://w.csie.org/yctai/papers/taai2010 paper.pdf

[6] H.Hautakangas and J.Nieminen, "Data mining for pothole detection." Presented at the Pro gradu seminar, University of Jyvaskyla, February 2011.[Online]. Available: user.jyu.fi/tks/opetus/kevat11/data mining for pothole detection.ppt.