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Study of Estimation of Road Roughness Condition and Ghat Complexity Analysis Using Smartphone Sensors

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Abstract - *Nowadays we all are using Google maps and its application for navigation during travelling, but these applications couldn't able to tell you about any road's condition or its complexity. In this paper we analyse road quality and ghat complexity analysis using android phone proposes to utilize the GPS system of phone and different sensors like accelerometer, magnetometer, etc. of android phone, so we could analyse the road and user can upload this information of that road on central server so every application user can use this information during traveling.*

KEYWORDS: Road Bump logic detection, Ghat Complexity, Magnetometer, Vehicle axis

1. INTRODUCTION

Collection of data through smartphone devices is very easy and also it takes the low cost. In addition, a wide range of population is using the smartphone devices. In the previous study, we explored the used of smartphones, fixed to vehicles with a predetermined orientation, to estimate road roughness where promising results have been observed. In other words, the smartphone is placed loosely at locations that a driver would be more likely to put their smartphones inside a car while driving.

Maintaining and monitoring the road infrastructure is a challenging task for almost all governments and road authorities. One of the reasons is that the task requires the collection of the substantial amount of road network condition data, which is very important for maintenance planning and monitoring, over time, in addition to the significant efforts that have to be directed to the actual maintenance of the road network. In developing countries, the attention that should be addressed on data collection is usually ignored or neglected mainly due to the lack of technology and budget. So, in such type countries infrastructure of road condition data is left outdated and its make difficult to do planning and programming for maintenance purpose.

Finding the roughness of road is consistently recognized as a most important asset of measuring road condition through the world. To measure IRI, there are many approaches, however, the majority of them, on one hand, requires sophisticated profilers and tools, which are expensive to acquire and operate as well as often require skilful operators. On the other hand, visual inspection is also a popular practice in many developing countries. While this is relatively a much cheaper option to implement, it is usually very labor intensive and time-consuming. The Location Based Distance Calculation algorithm used can be helpful to the user at the time if there are multiple routes and for destination and he can choose one of the finest and shortest routes.

2. RELATED WORK

In [1] the paper is describing that using Android OS based smart-phone that detecting the road condition by using the mobile sensor. Selected data processing algorithms are discussed and their evaluation presented with a true positive rate as high as 90% using real-world data. The optimal parameters for the algorithms are determined as well as recommendations for their application. This paper describes accelerometer data based pothole detection algorithms for deployment on devices with limited hardware/software resources and their evaluation on real-world data acquired using different Android OS based smart-phones. The evaluation tests resulted in optimal setup for each selected algorithm and the performance analysis in the context of the different road take appropriate action accordingly. Road roughness condition, measured by the International Roughness irregularity classes show true positive rates as high as 90%. In [2] almost every today's smartphone is integrated with many useful sensors. For making smartphones user interface and applications more convenient and appealing smartphone sensors are designed. These sensors, moreover, are potentially useful for many other applications in different fields. Using smartphone sensors to estimate road roughness condition may be also possible since many similar sensors are already in use in many sophisticated road roughness profilers. This study shows that the data we are going to use is collected by the sensors of smartphone under the realistic settings of smartphone and also gives the realistic location of moving a vehicle to evaluate the relationship with an actual roughness of the road. Conducted experiment collect the data from acceleration and GPS sensors of smartphone and simultaneously analysis of road is carried out. It has been revealed that the data from smartphone accelerometers has a linear relationship with road roughness condition, whereas the strength of the relationship varies at different frequency ranges. By a result of this paper is confirm that the sensors of the smartphone have great potential to estimate the current status of road condition. The frequency domain to calculate magnitudes of the signal in different frequency ranges. The relationship between the magnitudes and road roughness is investigated. The results of the paper confirm that road roughness condition is linked to a linear function of the magnitude of acceleration and average speed. It has also been revealed that vibration signal of the corresponding road pavement condition (roughness) occurs at the frequency range of 40-50Hz. In other words, data from the smartphone acceleration sensors at the frequency range of 40-50Hz is best in expressing the road roughness condition. In [3] the goal of the research is to smartphones. We believe smartphones would help road authorities in overcoming some difficulties relating to the road surface (roughness) and traffic condition data Collection and updating. In [4] the enhancement of passengers' comfort and their safety are part of the constant concerns for car manufacturers. Semiactive damping control systems have emerged to adapt the suspension features, where the road profile is one of the most important factors determining the automotive vehicle performance. Because direct measurements of the road profile represent expensive solutions and are susceptible to contamination, this paper proposes a novel road profile estimator that offers the essential information (road roughness and its frequency) for the adjustment of the vehicle dynamics using conventional sensors, such as accelerometers or displacement/velocity sensors easy to mount, cheap, and useful to estimate all suspension variables. Based on the Qparameterization approach, an adaptive observer estimates the dynamic road signal; afterward, a Fourier analysis is used to compute the road roughness condition online and to perform an International Organization for Standardization (ISO) 8608 classification. Experimental results on the rear-left corner of a 1:5 scale vehicle, equipped with electro-rheological (ER) dampers, have been used to validate the proposed road profile estimation method. Different ISO road classes evaluate the performance of the proposed algorithm, whose results show that any road can be identified successfully at least 70% of the time with a false alarm rate lower explore a low cost and easier way for continuous road condition monitoring by obtaining road surface (roughness) and traffic conditions data Using Android than 5%; the general accuracy of the road classifier is 95%. The second test with variable vehicle velocity shows the importance of the online frequency estimation to adapt the road estimation algorithm to any driving velocity; in this test, the road is correctly estimated in 868 of 1042 m (an error of 16.7%). Finally, the ER damper is tested with different damping coefficients.

3. PROPOSED SYSTEM

The system is used to find roughness of road and ghat complexity using the mobile sensor. The system also utilizes the GPS system of the phone and different sensors like accelerometer and magnetometer. Using that sensor we can analyze the road and upload the information on a central server so that every mobile user can access that information while traveling. Architecture is shown in fig-1.

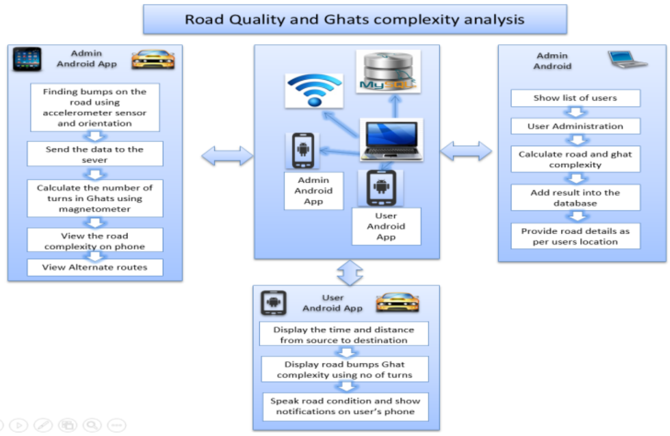

Fig -1: Architecture Diagram Road Roughness Condition and Ghat Complexity Analysis [5]

1. Admin android App

1. Finding bumps on the road using accelerometer sensor
2. Sends data to the server
3. Calculate number of turns in the ghat using magnetometer.
4. View alternative route for user if the road was

2. User Android App

1. Display time and distance from the source to destination
2. Display road condition on the road map with different colors
3. Display alternative route to user if road condition is bad.

3. Standalone HTTP Server

This application consists of server sockets that are designed for following tasks

- Fetch text file from the admin android app
- Perform Analysis on text file according to the road bump logic. Shown in fig.2

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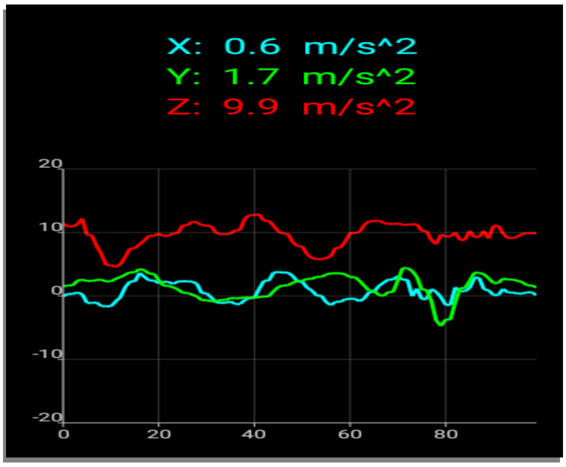

Fig-2: Logic of Road Bump Detection

- Add results in to database user to notify on which location have bumps and find complexity of the ghat.
- Provide road details to users as per the user's location.

4. PROPOSED METHOD

Bump Detection

The lowest layer of the system is on the application running on the Smartphone. The application collects data from the accelerometer, magnetometer and GPS and then processes this to detect braking and bump events. It then attaches a time and running on the Smartphone. The application collects data from the accelerometer, magnetometer and GPS and then processes this to detect braking and bump events. It then attaches a time and Location tag to this event data, and sends it across to the web server for further processing. Bump is detected using sensor data gathered from admin phone, details of location of bump is stored on the server side for other users.

Algorithm Used:

A. Road Bump Detection Logic

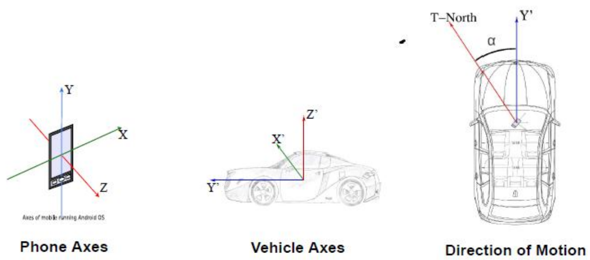

Fig-3: Logic of Road Bump Detection[5]

The road bump detection logic is shown in fig-3 and designed as follows.

Condition 1: Y-axis is used as running direction of vehicle. Z-axis is used as vertical direction. 50[ms] is large Standard Deviation.

Condition 2: The above sections are appeared with wheelbase time.

Here, each variable is defined as follows. A recording order number is defined 'i'. An acceleration data are defined X(i), Y(i), Z(i) for each axis. For Y-axis or running direction and Z-axis or vertical direction 50[ms] standard deviation is defined SDy(i), SDz(i). For the condition 1, simultaneity index is defined SDyz(i), and it is calculated by equation 1.

SDyz(i) = SDy(i) * SDz(i) -------------------- (equation 1)

Cycle number of wheelbase time is defined Nw. For the condition 2, Bump Index is defined

Byz(i), and it is calculated by equation 2.

Byz(i) = SDyz(i) * SDyz(i + Nw) -------------(equation 2)

Nw is related with vehicle speed. Speed of vehicle is defined V [m/s]. Wheelbase is defined Lw[m].Recording cycle is defined H[Hz]. Nw is calculated by equation 3.

Nw = (Lw/V) * H ---------------------------- (equation 3)

Standard Deviation:

$$\sigma = \sqrt{\frac{\sum(x-\overline{x})^2}{N}}$$

$where$

$\sigma = the\ standard\ deviation$

$x = each\ value\ in\ the\ population$

$\overline{x} = the\ mean\ of\ the\ values$

$N = the\ number\ of\ values\ (the\ population)$

B. FINDING GHATS COMPLEXITY

The web service needs to send over the inferred events to the Smartphone running the application. The Smartphone sends over its location, and the web service responds with events of interests in the vicinity of this location. These events are displayed on a map on the phone, so that the user of the application can choose to take alternate routes based on this.

Algorithm Used:

Location Based Distance Calculation

This uses the 'haversine' formula to calculate the circle distance between two points that is, the shortest distance over the earth's surface – giving an 'as-the-crow-flies' distance between the points.

a=sin²(Δφ/2)+cos(φ1).cos(φ2).sin²(Δλ/)
Harversine
c = 2.atan2(a, √(1−a))
formula: d = R.c
Where,

R is radius of earth (mean radius = 6,371km), φ is latitude, λ is longitude,

Note that angles need to be in radians to pass to trig functions!

Evaluation of Road at Server Side

The rest web service on the server receives the event traces of several Smartphone's along with the time and location tags. This information can be helpful to user at the time if there are multiple routes for destination and users can choose one of the best and shortest route.

Make data available to other users

The web service needs to send over the inferred events to the Smartphone running the application. The Smartphone sends over its location, and the web service responds with events of interests in the vicinity of this location. These events are displayed on a map on phone, so that the user of the application can choose to take alternate routes or shortest routes based on this.

5. CONCLUSION

By using Road Quality and Ghats complexity analysis system user would analyze the road and can upload this information of that road on central server so every application user can use this information during travelling.it also provide information that can be helpful to user at the time if there are multiple routes and for destination and he can choose one of the finest and shortest route.

FUTURE SCOPE

Reducing the error rate of the existing system for correct road estimation i.e. less than 16.7%. Starting and ending of ghats is automatically detected in future.

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