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Road Bump and Intensity Detection using Smartphone Sensors

Prof.B.U.Lanjewar[1], Rahul Sagar[2], Rasika Pawar[2], Jyoti Khedkar[2], Kunal Gosavi[2]

Professor, Dept of Computer Engineering GHRIET, Savitribai Phule Pune University Pune, India[1]

BE Final Year Students, Department of Computer Engineering, GHRIET, Savitribai Phule Pune, India[2]

ABSTRACT:-Road roughness is one of the most important and primary indicator of the utility of roads. As roads are key part of the general population in their lives, thus checking the road conditions has expected a lot of consideration. So the clients can maintain a strategic distance from or be careful of the terrible road ahead by utilizing road surface condition data. Road condition can be characterized by the anomaly, which might be as surface roughness, pothole, breaks, and consumption. To measure road surface condition, the cell phones are an extremely helpful device. The cell phones as of now have sensors that can record valuable perusing for surface condition estimation.

KEYWORDS:-Smartphone (android), accelerometer. Magnetometer, algorithms, road condition.

I. INTRODUCTION

Enhancing the state of road has turned into a need now days. With the expanded road systems numerous fatalities on road are expanding, the nature of road is also the purpose of worry in India. A piece of this issue can be handled by utilizing the coordinated cell phones. Most recent advanced mobile phone comprise of helpful sensor which incorporate G-sensors, electronic compass, gyrator, receiver, accelerometer, Magnetometer, GPS (Global Positioning Framework) and cameras are prepared in cell phone (e.g., cell phone and iPad).A few application utilize these sensors in cell phones and combinemobile sensing techniques to solve problems such asinterpersonal organization, human services, environment observing, and movement data.

The paper is describing framework for road anomaly like road bump and pothole detection using Android OS based advanced cells. This framework utilizes Accelerometer and Magnetometer Sensor's of Android cell phone for recognition of potholes and GPS for plotting the area of pothole on Google Maps. This data can be useful to client at the time if there are different path for destination and he can pick one of the finest and most limited path.

II. RELATED WORK

Some pothole detection methods have been proposed .The advantages and shortcomings of these methods are presented in the following subsections.

Mobile Sensing Method. *:*-For BusNet project, the *G*sensor and GPS are equipped in the on-board unit (OBU) in bus to collect accelerometer data and location information. These data can be sent to data processing center via wireless networks, and data processing center can analyze these data to check whether the vectors of accelerometer data exceed the thresholds for pothole detection However, this approach requires that the batch accelerometer data is sent when bus enters the bus station. Therefore, this approach cannot provide real-time pothole detection information. The pothole patrol system which was proposed by a project team from Massachusetts Institute of Technologycombined *G*-sensor and GPS. This system analyzed the x- axis accelerometer data and z-axis accelerometer data and equipped five data filters which include (1) speed, (2) high-pass,(3) z-peak, (4) xz-ratio, and (5) speed versus $z$ratio Although these data filters can detect potholes, only z- peak of data filter can obtain the precise pothole information. However, high misjudgment of z-peak of data filters with the surge of road.

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Nericell project used a smartphone based on Windows Mobile operation system which is equipped with *G*-sensor and GPS to collect and analyze accelerometer data for pothole detection .However, the smartphone in this project should be equipped with the specific angle. Furthermore, this project only considered analyzing *z*-axis accelerometer data with high misjudgment.

Mednis et al. proposed four pothole detection approaches which include (1) *Z*-THRESH approach, (2) *Z*-DIFF approach, (3) STDEV-*Z* approach, and (4)*G*-ZEROapproach to analyze the accelerometer data. The accelerometer data in this study is obtained from Tmote sensors, Texas Instruments controllers, and Analog Devices *G*-sensors However, the results of *Z*-THRESH approach and *G*-ZERO approach would be influenced by peak value to generate more false-positives. The results of *Z*-DIFF approach and STDEV-*Z* approach are dependent on frequency and timing. Therefore, the design and comparisons of these approaches for mobile device require to be investigated.

III. LITERATURE SURVEY

We exhibit the related exploration in a deliberate way which improves our work. The cell phones are utilized to appraise IRI of road unpleasantness in exceptionally constrained studies. In past concentrates, the greater part of the enthusiasm for recognizing street knocks and oddities utilizing versatile sensors.

Cashell, K et al.proposed a system that make the use of a separate accelerometer to fit in a simulation car and use it to assess road roughness condition . The roughness of the road can be estimated from acceleration data obtained from the sensor.

Aauthors, Eriksson, Girod, , Hull, Newton, Madden, Balakrishnan have developed a system to utilize standalone accelerometers to successfully detect road anomalies. This system uses three axis acceleration sensors and GPS devices deployed on embedded computers in cars.

Ramjee et al.made the use of many sensing components to monitor road conditions from mobile phone. The potholes, bumps, braking and honking can be detected by analyzing data from the sensors,. Then the information is used to assess road conditions. This system is called as Nericell arranges the smartphones to perform sensing and report data back to a server for aggregation.

Selavo et al.andStrazdins et al. have uses Android smartphone devices with accelerometers are used to detect potholes location on road. The approaches for detection includes algorithms like Z-THRESH ,Z-DIFF ,STDEV(Z) , G-ZERO to detect events in the acceleration vibration data.

Tai, Y. et al.explores the use of mobile phone with a tri-axial accelerometer to collect acceleration data while riding a motorcycle. Both supervised and unsupervised machine learning methods are used to identify road conditions.

IV. PROPOSED SYSTEM

The proposed framework is utilized for appraisal of road harshness condition (Quality) and ghatdifficulty utilizing cell phone (android telephone). It uses the GPS arrangement of telephone and sensors like accelerometer, magnetometer of android telephone, so we can analyze the road and can transfer this data on server so every client can utilize this data during travelling. The system take the data as x, y, z co-ordinates and axes can be viewed as along with vehicle axes and phone axes.

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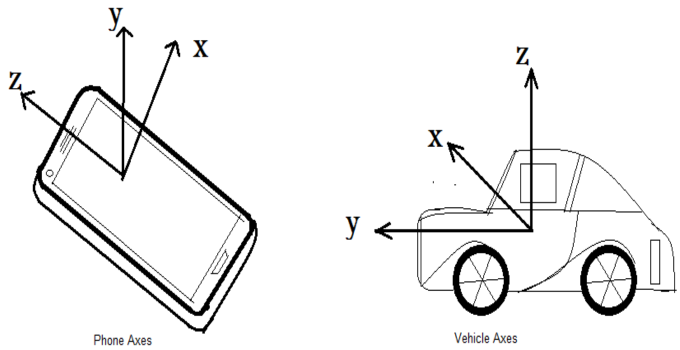

Representation of co-ordinate Axis
X-axis Horizontal Direction
Y-axis Running Direction
Z-axis Vertical Direction

V. SYSTEM ARCHITECTURE

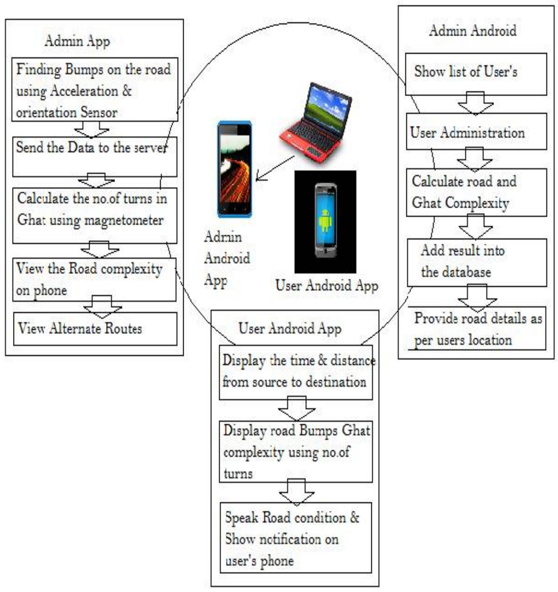

Fig 1.System Architecture

VI. WORKING

A. BUMP DETECTION

The least layer of the framework is on the application running on the Smartphone. The application gathers information from the accelerometer and GPS and afterward forms this to identify braking and bump occasions. It then connects a time stamp and Location tag to this information, and sends it crosswise over to the web server for further preparing. Bump is distinguished utilizing sensor information gatheredfrom administrator telephone,details of location of bump is stored on the server side different clients.

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B. FINDING GHAT'S COMPLEXITY

As we have seen the information which we get from accelerometer and magnetometer, in that we consider y axis for Ghats location, here we compute the edge of "Y" axis with the north direction by which we can get the amount of auto is turned at right or left side. For this we likewise consider the past angle of "Y" axis with north direction. This include the count of turns particular caution, furthermore we can finish up the amount they are intense.

C. EVALUATION OF ROAD AT SERVER SIDE

The REST web administration on the server gets the occasions hints of a few Smartphone's alongside the time and area labels. Utilizing this data, the web administration construes larger amount of assessment, for example, road is smooth or it is with an excessive amount of hindrance, Ghats are excessively complex or they are simple, making it impossible to drive, and so forth.

D. MAKE DATA AVAILABLE TO OTHER USERS

The web benefit needs to send over the gathered occasions to the Smartphones running the application. The Smartphones sends its area, and the network access responds with occasions of interests in the vicinity of this location. These occasions are shown on a map on the android telephone, so that the client of the android application can take alternate routes based on this.

VII. ALGORITHM USED

I. Road Bump Detection Logic

Based on the experiment results, road bump detection logic is designed as fallows.

Condition 1: Both of the Y-axis or running direction and Z-axis vertical direction, 50[ms] Standard deviation large.

Condition 2: This sections are appeared with wheelbase time . Here each variables is defined as follows. recordingorder numbers defined 'i',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)----------(1)

Cycle number of wheelbase times 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 withvehicle speed .Vehicle speed is defined V[m/s].wheelbase is defined Lw[m].Recording cycle is defined H[Hz]. Nw is calculated equation 3.

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

Standard Deviation

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

Where $\sigma = \textit{the standared deviation}$

x=each value in the population

x'=the mean of the values

N=the number of values(the population)

II. 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-files' distance between the points.

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Haversine formula $a=sin^2(\Delta\emptyset/2)+\cos(\emptyset_1).\cos(\emptyset_2).sin^2(\Delta\gamma/2)$
$c=2.\mathrm{atan}2(\sqrt{a},\sqrt{(1-a)})$
d=R.c
where $\emptyset$ is latitude , γ is longitude, R I earth's radius
Note that angels need to be in radians to pass to trig functions.

VIII. EXPERIMENTAL RESULT

I. Information is gathered from administrator Smartphone with the help of accelerometer..
II. Threshold value is set for bump affectability (Z) and turn sensitivity(X,Y).
III. Cell phone is moved and accordingly, left right turns and bump is recorded and txt file created on the telephone and it is send to the server.
IV. Txt file comprise of 100 readings and its mean and standard deviation is performed.
V. Graph consist of X, Y, Z co-ordinates as per date time logs at the server side.

The proposed system results are demonstrated as follows.

Figure:2 Shows Home screen of application.

Figure:3 Shows Sensor screen of application.

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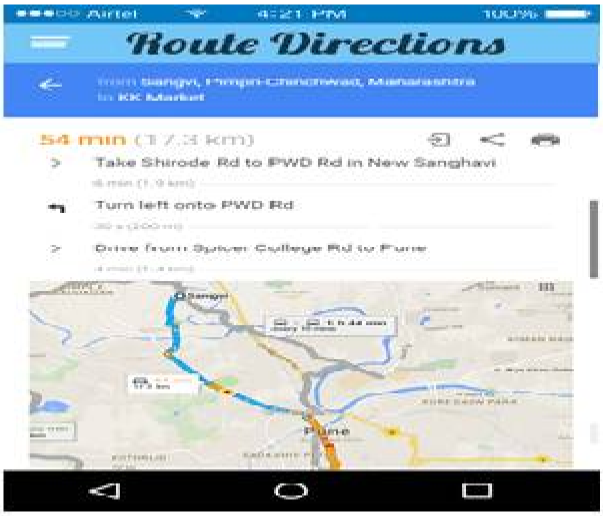

Figure:4 We provide source and destination address to app . Figure:5 Direction from source to destination shown along with location of bump and pothole

Figure:6 Server side UI provided to the admin only.

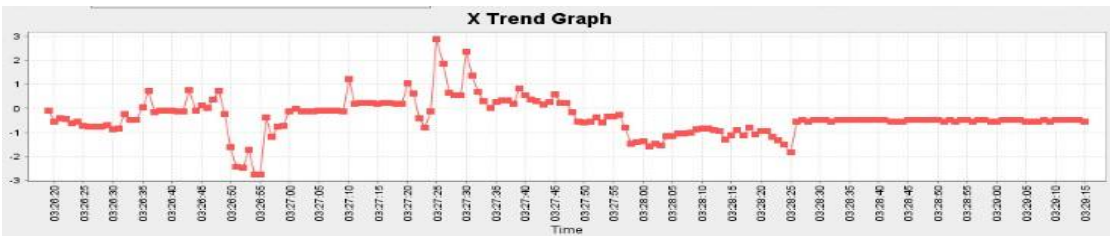

Figure: 7 Standard deviation for X-Axis.

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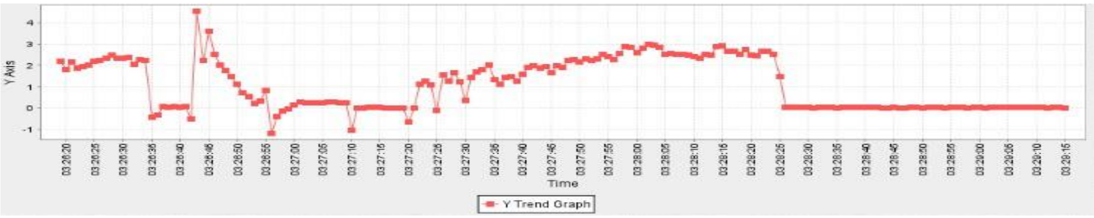

Figure: 8 Standard deviation for Y-Axis.

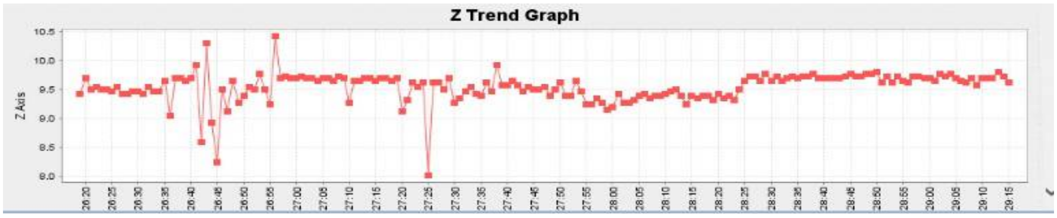

Figure: 9 Standard deviation for Z-Axis.

In Fig 7, Fig 8, Fig 9 server side statistical estimations are shown. After analyzing the generated txt file result is in graphically manner

IX. CONCLUSION

In this paper we have attempted to take care of the issues identified with drivers' complexity, and focus on the road while driving. Information from accelerometer sensor present in Smartphones is fetched and experimental analysisis performed. To make driving more comfortable for the driver, the cell phone is the connection between the comfort for driving. Cell phone's sensors like accelerometer, magnetometer gathers the constant information, which is given to the server and deployed as per the section made in the software. From the investigation, it has been found that acceleration data from smartphone has linear relationship with road roughness condition. However,the significant of relationship relies uponspeed of vehicle, when speed is less than 30kph.Besides the relationship additionally party relies upon vehicle sort and gadget. Based on the condition indexes, similar tendency of the grouping of the whole of might be adequate to estimateroad unpleasantness condition from acceleration information acquire by cell phones, there are still numerous issues that must be managed in our future attempts to make the future works incorporates:

- Detail studies about on the components and the relationship of the increasing speed information and road harshness condition. Sensible Cell phones setting, not settled co-ordinate, will likewise be considered.
- Explore ways to deal with appraisal road surface condition from numerous unknown road/cell phone clients, who agree to participate. A lot of information for a wide range of road areas would enable us to build models to simulate and estimate road unpleasantness condition and soundness of road infrastructure as a whole.

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