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

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Abstract- Our system works on producing the result sets which shows the road conditions and ghat complexity during traveling. We all use the map but it does not show potholes and bumps in the road. Our system analyzes the data through the sensors of mobile phone such as sensors like accelerometer, orientation sensor, and magnetometer to analyze the ghat complexity and roads quality we use the GPS system of an android phone.

Keywords - *Road Bump logic detection, Ghat Complexity, Magnetometer, Vehicle axis*

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I. INTRODUCTION

Collecting the data from the Android phone is a very easy task and it took the very low cost. Nowadays many people use smartphones so it is very easy to install the system on smartphones and collection of data. People easily can mount their smartphone on the dashboard of a car. Our aim is to find potholes and bumps in the road, so the GPS system plays the major role in our system which detects the position of bumps and potholes in the road.

The developed system is a client-server system. There are two types of clients, one is admin and second is a mobile user. Admin will collect the data then it will be sent to the server where using divide and conquer algorithm data will be clustered and the final standard deviation is considered as a bump and pothole in the road. The smartphone user installs the system on the Android phone when a user wants to travel one place to another place user can use our system to navigate the path and our system will show the good quality road for convenient travel.

Finding the roughness of road is consistently recognized as a most important asset of measuring road condition through the world. Road survey is very costlier and it will take too much time so our system will reduce the cost of the survey and time. It also helps to the government to find out which roads are in bad conditions so that they can reconstruct it as soon as possible.

II. WORKING OF SYSTEM

There are two types of the client first is admin which collect the data from different roads and second smartphone users who request to the server for knowing the which is the best route for traveling and which road has the best quality for traveling. The system will provide the shortest path with minimum bumps and potholes in the road. Our system will save the time reaching from the source to destination.

The admin has the smartphone which is mounted on a dashboard of the car. The accelerometer has x, y, z-axis where the y-axis is used for running direction of a car, the z-axis is used for vertical direction. The vibration of the car says that the road is in good condition or not. The z-axis gets the

reading from that vibration and sends that data to the server. The GPS sensor gets that reading with longitude and latitude for showing where the actual bump and pothole is located. When the ghat starts the Y-axis count the number of turns on the road and also the how complex is that turn is counted by y-axis. On the basis of that complexity, we will decide the how complex is that ghat. All the reading are collected by that smartphone and it will send to the server, where using the divide and conquer algorithm the data will get separated. In the algorithm, we used mean and standard deviation.

III. ARCHITECTURE OF SYSTEM

The system utilizes the GPS system of the phone and also sensors like accelerometer and orientation sensor. This sensor used to collect the data and we can upload it to the central server so that every smartphone user can access it while traveling.

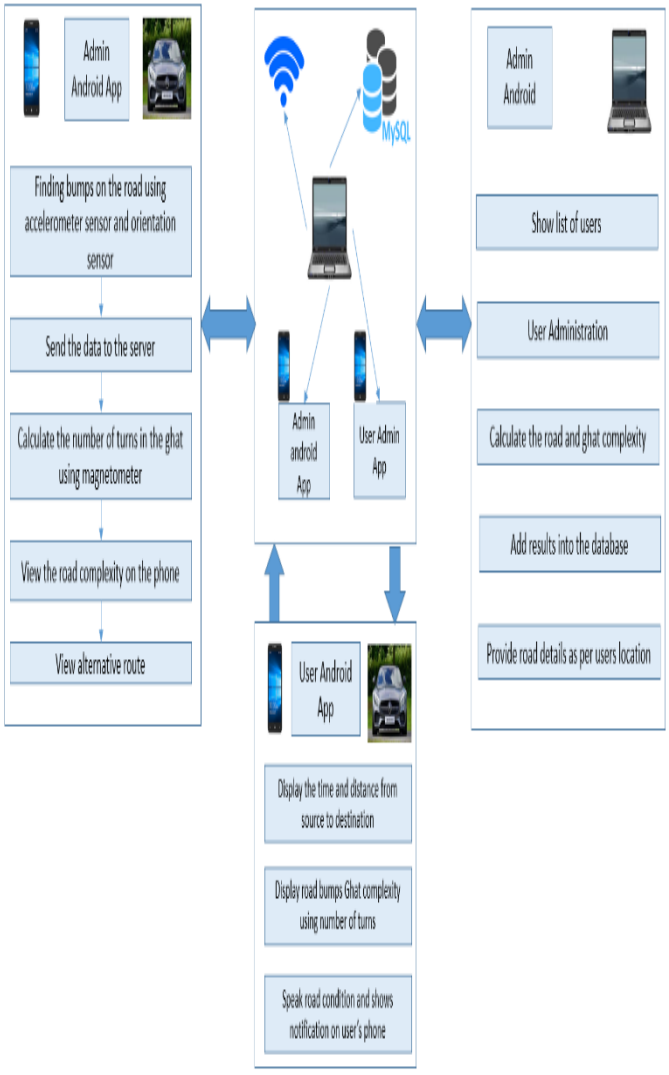

Figure 1. Architecture DiagramRoad Roughness Condition and Ghat Complexity Analysis

1. **Admin android App**
   1. Collect the data from the road using accelerometer sensor for finding bumps.
   2. Created .txt files will upload to the server
   3. The Magnetometer will count the number of turns in the ghat.
   4. If the road is in bad condition, the alternative route will show on the user application.
2. **User Android App**

1. The required time from source to destination will be displayed on user application.
2. Different routes will be shown in different colors.
3. Alternative routes will be displayed on the application.

3. **Standalone HTTP Server**

The proposed system consists of apache tomcat server which is design for the following task.

- Txt file will be fetched from admin android app.
- Perform Analysis of text file according to the road bump logic.

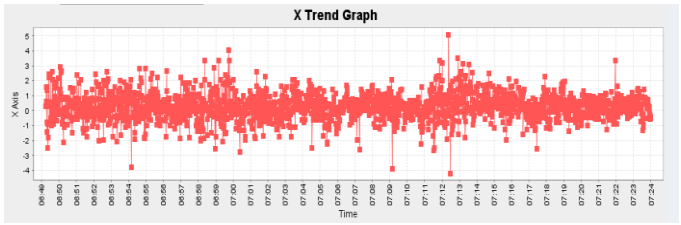

Figure 2. X-axis values of Accelerometer

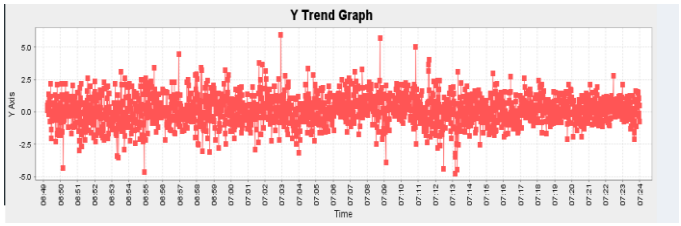

Figure 3. Y-axis values of Accelerometer

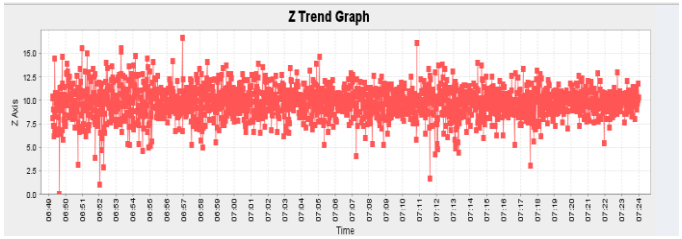

Figure 4. Z-axis values of Accelerometer

- As per the user's location, it will provide the road details.
- Add results to the database user to notify on which location has bumps and find the complexity of the ghat.

IV. PROPOSED METHOD

Algorithm Used:

A. Road Bump Detection Logic

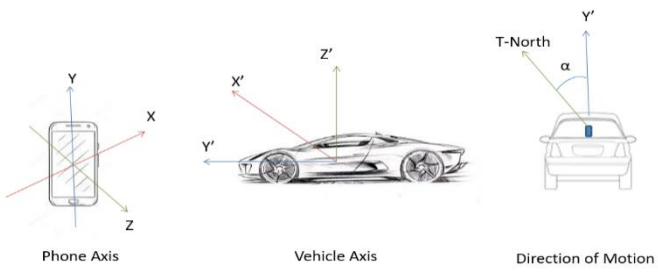

Figure 5. The Logic of Bump Detection

The road bump detection logic is designed as follows.
Condition 1: Y-axis is used as running direction of the vehicle. Z-axis is used as the vertical direction. 50[ms] is large Standard Deviation.
Condition 2: The above sections appeare 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 to vehicle speed. Vehicle speed 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)

EXPERIMENT RESULT:

This logic is applied to data. The 50[ms] standard deviation of Z-axis acceleration or vertical direction SDz(i) is drawn in Fig. Simultaneity index SDyz(i) is drawn in Fig. Bump index Byz(i) is drawn below:

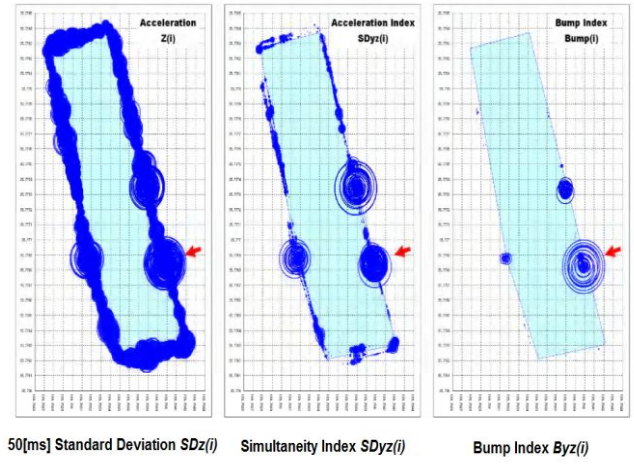

Figure 6. Experimental Results of Accelerometer

V. 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. GHATS COMPLEXITY

By using the magnetometer we find the number of turns and the intensity of the turn. If the number of turns is more and have high turn intensity then that ghat have more complexity.

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.

$a=\sin^2(\Delta\varphi/2)+\cos(\varphi1).\cos(\varphi2).\sin^2(\Delta\lambda/)$
Harversine
$c = 2.\text{atan2}(a, \sqrt{(1-a)})$
formula: $d = R.c$

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

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

Road Evaluation at Server side

The server gets data from a smartphone. By using the divide and conquer algorithm the data will get clustered and by using mean and standard deviation we will find the correct location of the pothole and bump by using longitude and latitude recorded by GPS.

Data available to the other users

If any new user wants to travel from one place to another place. If the route is unknown for the user then any user can share the route of that particular route. So here we can share the different routes to others and make data useful for everyone.

IV. CONCLUSION

Road Roughness Condition and Ghat Complexity Analysis system helpful for finding the routes where have a minimum bump and pothole in the road which google map does not show. It will reduce the road accident if any new user travels in the new place. The data is saved on a remote server so every smartphone users can access it and data will be available for every smartphone user.

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