ROADSIDE QUALITY AND GHAT COMPLEXITY ANALYSIS

Harshgandha Patki *Pratika Matale* *Namrata Bidgar* *SnehaKatkade*

Marathwada Mitra Mandal's College of Engineering,
Pune, India

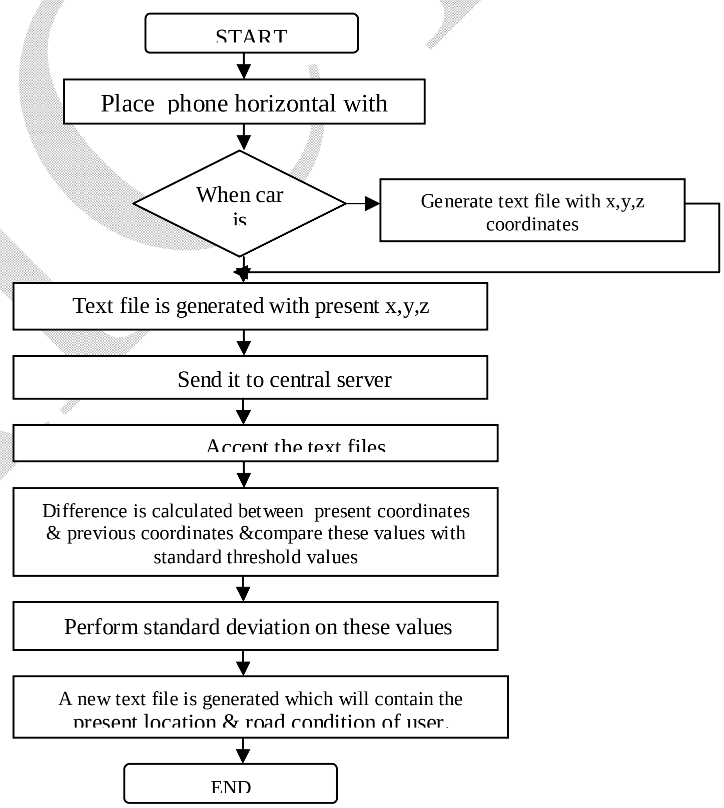
Abstract— ***Improving the condition of road has become a necessity now days. Android Smartphone's are user-friendly way to solve the problem. Latest smart phone consist of useful sensors like accelerometer, Magnetometer and GPS (Global Positioning System).Any user can make use of these sensors to find bad road condition which are encountered every day while driving.The sensors in the Smartphone while user is travelling will inform him or her about the road condition and ghat complexity.GPS is used for finding the current location of user.From admin module data will be stored on central server and from that road quality find out using magnetometer in admin Smartphone. User will fetch data from central server using Smartphone which will provide him path or road condition.***

Keywords— Sensors, Android Smartphone, GPS

I. INTRODUCTION

Unsafe road conditions are major problem for safe transportation. Many accidents are caused especially during rainy season. It is difficult for government and road authorities to maintain such road conditions. Main reason for this difficulty is that this job requires collection of large amount of data, lack of technology and scarcity of budget, which is required for road monitoring. One approach for road condition detection is to provide data reports to central authorities. This can have the highest accuracy, assuming that the people are fair in their approach, it also has the most human interaction and incomprehensive. The department which is responsible for the road condition , it is not possible for them to keep track of each and every road which is damaged, hence for this purpose, a new system must be developed to handle the road condition. Collecting photos of road damage and uploading them to a central server can be one of the simplest methods. But, this method will require strong participation and interaction to analyze the large amount of images collected which will be a complicated and time consuming process. To overcome these drawbacks mentioned above, Smartphone's are the best solution for these problems. Since Smartphone's are widely being used as well as they has additional features such as low cost, GPS System, user-friendly, accelerometer and magnetometer sensors. In India scientist make use of different sensors such as accelerometer, magnetometer and GPS to supervise road condition. Smartphone with accelerometers to track location of potholes.GPS is used to find the current location of user. Magnetometer is used as an orientation sensor to find distance. Two general classes of sensors namely microphone and accelerometer are used for pothole detection in automated embedded sensing systems. Main focus in this paper is on accelerometer data processing for pothole detection[1][2].

II. PROPOSED SYSTEM



III. RELATED WORK

This section comprises of different pothole detection algorithms implemented on accelerometer based systems. The most common method for detecting road conditions is making use of sensors to recognize the obstacles on the road. As the popularity of Smartphone users is increasing due to additional features, methods using Smartphone sensors are used widely. Existing detection methods for road condition [3][4][5]:

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TABLE I: Summarization of Existing Methods

Name of Method	Different sensors used	Smartphone	Comparison
Cartel	Camera, Wi-fi	Not used	
Pothole Patrol	Accelerometer, GPS	Not used	<0.2% false positive
RCM-TAGPS	Accelerometer, GPS	Not used	
Nericell	Accelerometer, GPS, Microphone	Used	11.1% false positive and 22% false negatives
Wolve-Rine	Accelerometer, GPS, Magnetometer	Used	10% false negatives (for bump detection) and 21.6% false negative rate and 2.7% false positive rate(for braking detection)
Pothole detection using Android Smartphone with Accelerometer and Magnetometer.	Accelerometer, GPS, Magnetometer	Used	90% true positive

3.1 Cartel: This system includes installations of sensors on vehicles to collect data and process that data and send it to portal based upon the continuous queries. Those continuous queries are processed by the continuous query processor on remote nodes. It uses GPS for current location of vehicles. It does not offer a way to collect information gathered among various users. It replies to the queries upon the data stored in the relational database. Machine learning implementation is not used in this method [6][7].

3.2 Pothole Patrol: This system uses accelerometer and GPS to monitor road surface. Machine learning algorithm is used in this method. Signals collected using accelerometer are passed through a series of filters. It uses a threshold value to identify potholes and computes a detector score. It uses GPS to detect potholes. Accuracy of this system is less than 0.2%.

3.3 RCM-TAGPS: This system uses sensors like 3-axis accelerometer and GPS.This system performs data cleaning to deal with challenges like GPS error,transmission error.The International Roughness Index is calculated by using the Power Spectral Density(PSD).This system consists of the evaluation of road based on its roughness. Machine learning implementation is not used in this method.

***3.4. Nericell*:** This system is used for detection of potholes ,braking, bumps and honks. It includes sensors like microphone,GPS,GSM Radio and accelerometer. Machine learning implementation is not used in this method.It uses strongest signal (SS)-based localization algorithm. It also uses Euler angles in which the sensor is rotated along the axis of the vehicle.

3.5. Wolverine: It uses accelerometer for collection of data. This method is used for detection of bumps and for monitoring of traffic. It makes use of two steps for reorientation of phone using accelerometer and magnetometer. It also uses GPS for the locating the direction of motion of vehicle .It is used for detection of bumps and braking.

Current method used for road condition is Real time Pothole detection using android smart phone. It makes use of sensors like accelerometer, magnetometer and GPS(Global Positioning System).

IV. TECHNICAL REQUIREMENTS

- System should collect raw data for processing and it should able to detect real time systems like time pothole detection.
- Portability:System should be able to run on multiple hardware or operating systems.
- System should be able to detect potholes while the vehicle is moving. This system is not applicable for two-wheel vehicles are only applicable for four-wheel vehicles.
- Accuracy:System should implement and perform execution correctly.
- Availability:The system should be such that the user can access it at any time.

V. METHODOLOGY

5.1 Admin Android App

This module helps in finding bumps on the road using accelerometer and orientation sensors. The admin is responsible to collect the data of required path using his Smartphone. A standard value is considered as sensitivity as sensitivity differs from Smartphone to Smartphone. This helps in considering proper values for the co-ordinates.

Connection is established between central server and Android Admin App. This data is send as a text file on the central server by the admin app .Every millisecond the text file is updated. Admin Android App helps in calculating the number of turns in ghat using magnetometer sensor.

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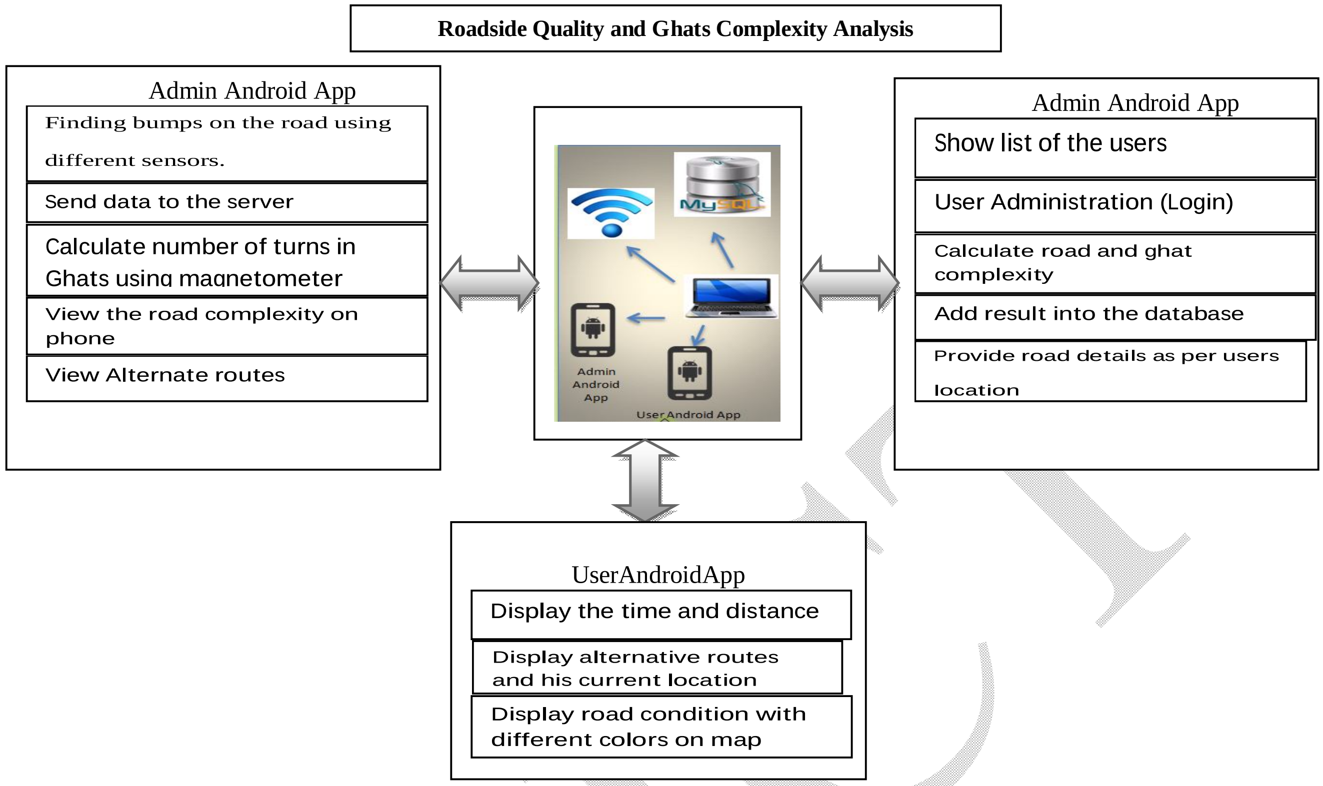

Fig 2 : System Architecture

5.2 Central server

It is a web based application. It acts as a interface between admin and the user. Central server accepts the text files send by the admin app. It evaluates the data from the text file. Text file consists of co-ordinate values per mille-seconds. Standard deviation is performed on the text file and appropriate values are considered. Graphs are generated of X, Y and Z co-ordinates.

Date-wise log of text files is maintained at the server end. Central Server also has list of users. This module is responsible for calculating road and ghat complexity and adds the result into database. Other main function of central server is to provide data to the user as per user's requirements.

5.3 User module

This module gets road details as per his location from the central server. In User android App of the User, Time and Distance from source to destination is displayed.

Road conditions are displayed in different colors on the map. Alternate routes are displayed on the app.

VI. ALGORITHM

6.1 Road Bump Detection Logic

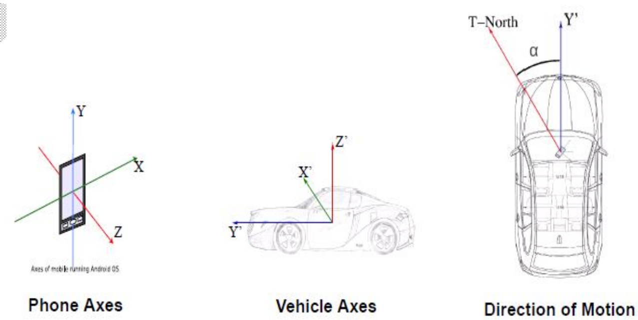

Fig 3 : Representation of co-ordinate Axes.

Step1:- Y-axis (running direction) and Z-axis (vertical direction).
Step2:- Wheelbase time.
Simultaneity index is calculated as follows:-

$$SDyz(i) = SDy(i) * SDz(i) \quad (1)$$

Here, each variable is defined as follows:-
i= recording order number.
X(i), Y(i), Z(i)= acceleration data for each axis.
SDy(i), SDz(i)= 50[ms] standard deviation.
SDyz(i) = simultaneity index.

Corresponding Author: Miss. Harshgandha Patki, MMM College of Engineering, Pune, India.

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Bump index is calculated as follows:-

$Byz(i) = SDyz(i) * SDyz(i + Nw)$ (2)

Where,

Nw= Cycle number of wheelbase time.

Byz(i) = Bump Index.

Cycle number is calculated as follows:-

$Nw = (Lw/V) * H$ (3)

Where,

Nw is related with vehicle speed.

V[m/s]= Vehicle speed.

Lw[m]= Wheelbase

H[Hz]= Recording cycle.

Algorithm 1(Used in admin module):

Step1:- phone will be placed horizontally in the car with GPS(Global Positioning System) ON.

Step2:- Generate a text file with x,y,z coordinates when the car is not moving.

Step3:- when the car starts moving per millisecond a text file will be generated with present x, y, z coordinates.

Step4:- Simultaneously these values will be sent to the central server.

Algorithm 2(used by central server):

Step1:- Accept the text files from admin module.

Step2:- Calculate the difference between present coordinates and the previous coordinates.

Step3:-Compare values generated in step2 with the standard threshold values performing standard deviation on them.

Step4:- A new text file will be generated in which values obtained from step2, its present location and road condition will be stored.

Step5:- Repeat from step1 until car comes to a halt.

Step6:- End.

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

where

σ = the standard deviation

x = each value in the population

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

N = the number of values

VII. EXPERIMENTAL RESULT

- Data is collected from admin Smartphone with the help of accelerometer.
- Threshold value is set for bump sensitivity (Z) and turn sensitivity(X,Y).
- Smartphone is moved and accordingly, left right turns and bumps is recorded text file is generated on the phone and it is send to the server.
- Text file consist of 100 readings and its mean and standard deviation is performed.
- Graph consist of X, Y, Z coordinates according to date time logs at the server side.

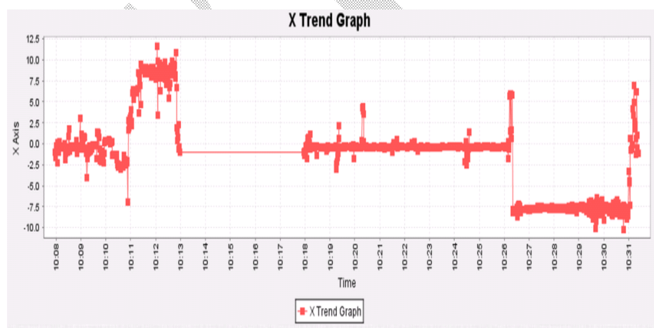

Fig 4 : Standard Deviation for X-Axis.

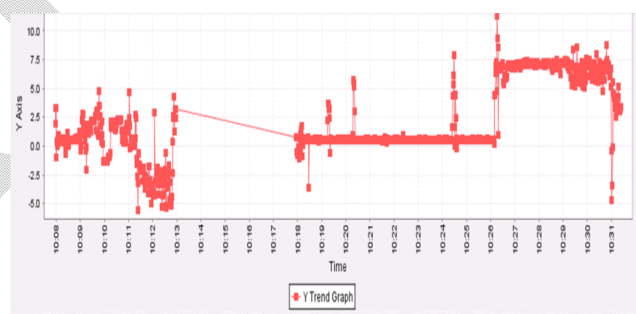

Fig 5. Standard deviation for Y-Axis.

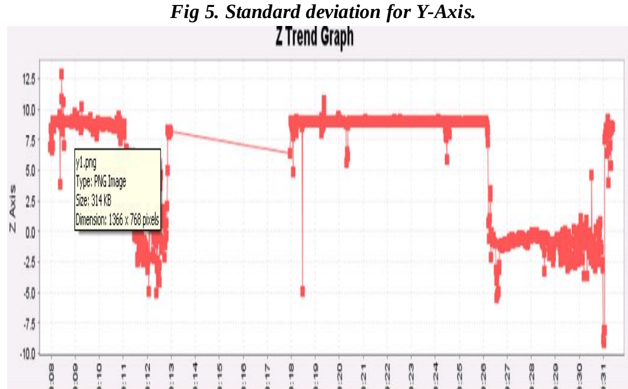

Fig 6 : Standard Deviation For Z-Axis.

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VIII. CONCLUSION AND FUTURE WORK

In this paper, data from accelerometer sensor present in Smartphone is fetched and experimental analysis is performed setting various thresholds and used for distinguishing and classifying various driving events and road anomalies. This whole system can be implemented in very low cost and requires less storage space as well as limited hardware and software resources. Still there are many problems that have to Be solved in future for its practical applications. They include: Detailed analysis on the features and smartphones settings, approximate values of coordinates will be considered and including combinations of various algorithms**.**

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[6] Email:douanphanh-viengnam@ed.tmu.ac.jp

[7] Email:oneyama@ed.tmu.ac.jp