Application of GIS for Road Condition Monitoring With Comparative Analysis of Different Implemented Techniques

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Abstract : *In real world scenario, there are many miscillineous issues are there regarding road conditions like maintaining the road conditions for long time, but this couldn't happen because either laziness of road transport department they make the road but don't think of future perspective or peoples, yes, this is the situation occur because of human errors, like peoples see there are any bad road surface condition but they don't want to involve in such situations. Human errors and errors from transport authority are two main ingredients for bad road conditions. Considering all these aspects we make a scenario where human (user) can record the road surface condition their own and submit data to transport authority and authority take action accordingly on respective road surface. For all scenario we maked cross platform ionic 3 application as front end and firebase as backend a real time database for data storage. From the front end as we collected road surface pothole data .The collected results in application provided with timestamp, we are considering transport authority will take initiative and take action accordingly.*

IndexTerms **- ionic 3, road monitoring, pothole detection, firebase, realtime database, Google maps API.**

I. INTRODUCTION

Bad road condition are harmful for society which is causing damage to all the passengers who are travelling to their destinations. every citizen from country always against with bad roads around there areas , but human always has to be aware about these things to remember all the time , some automated actions has to be taken against all their activities for road conditions. As we talked in details, the department of road transport are not aware of those things were happening in their areas of current road conditions and these roads can repairs happens steadily [1].

The source behind poor road conditions occurs the in-formation gap between the someone who is travelling from one place to another, all the public living around and the road transport department who are responsible for all the situations. Considering all the aspects of the road monitoring we marked the pothole detection system where we bridge the gap from human with transport authorities about road condition detection system [1]. When considering the transportation, traffic situations and roads conditions are important part of day-to-day life. so constantly we has to take care of all these vehicular things , if the roads in the city not worked properly then the growth and investment of any business will depend on the condition of the road , more business and will invest their business in your city if your cities road conditions work proper.

To surveillance all the traffic and road condition, the ITS [2] developed. Surveillance take the deployment of the dedicated sensors on vehicles like for tracking the units we can use GPS. But to use the traffic cameras, doppler radar these are typically restricted to busiest extend of the road [2, 12]. Aurangabad city considering as an application of developing country tends to be varied as because of the many economics and social reasons. The road bumpy and potholes are place mostly consider heart of the issues for city. As we know the different type of countries such as 2-tyre vehicles such as moped , motorbikes and 3 - wheelers such as rickshaws , 4- tyre vehicles and buses [3].

The main motivation of this paper is to make system bet-ter from the collected pothole data, applying different ma-chine learning algorithms like support vector machine, k-means algorithm and verifying the accuracy, Precision of the collected data. Surveillance of all the road conditions are challenging tasks but in same condition to hold the new things for city development also important, to make all things happen we have to collect all the required information such as for coordinates geolocation strategy, consist of latitude and longitude values, when the monitoring started, when it is ended, all interval coordinates of potholes. With once all the required coordinates collection done, we stored on real time databases firebase. Which is real time database for all the applications like web, mobile (android, iOS) applications [11].

Accelerometer measurement of x, y, z coordinate with gyroscope for rate of rotation, here we are taking the acceleration data with gyroscope with real time acceleration data changes with respect to change of angle using gyroscope. By using combination of these accelerometer and gyroscope sensors. We accomplish the following task.

Detection of potholes by providing the classification of all the collected data , see all the results on google maps by storing the date wise all pothole data , this will results a great help for road transport department for visual analysis from google maps.

II. RELATED WORK

This section considers the points of how we could make the old system improve like in terms of cost effective, without if we take prior knowledge of embedded systems for recording accelerometer data which is great in terms of precision, accuracy and terms like placing cameras on vehicles to capture the position when found the bad surface conditions on road. All these terms are good but in terms of cost effective and handle to use, a common citizen can't afford to take effort to do all this things. So that device accelerometer with Gsensors, geolocation with watch position for with potholes constantly. Once all the pothole results were collected, anal-ysis of those data using machine learning algorithms were applied.

Device accelerometer measures the proper device acceleration and G-sensors are used to consider the device object motion detection with respect to its acceleration. Both should use together to make sure, the device accelerometer senses the gravitational force applied [4]. Measurement unit: [+/- g]. The 3- axis Rolling X, Pitch Y, Yaw Z should calculate on which direction exactly the gravitational force in getting received and it will reacting accordingly.

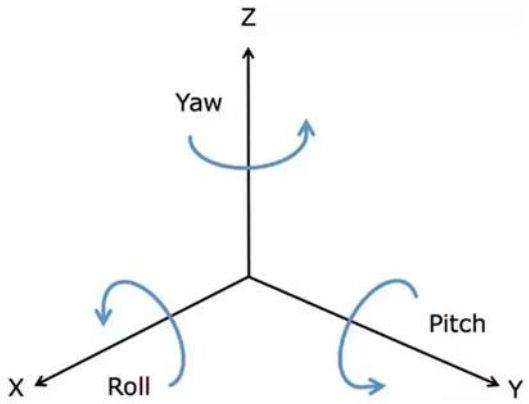

Figure1: Device acceleration Implementation [4].

From the figure 1.Device acceleration concept the roll, pitch, yaw concept where basically used in aircraft , the same strategy when we are on bike / vehicle , we don't have any physical support from the earth surface , but still we can calculate the speed of vehicle/aircraft with respect to the accelerometer and G-sensors as same application we use for road surface quality detection using those 2 sensors for detection and when detected taking the surface coordinates for analysis to improve the quality of road surface around the city of Aurangabad.

III. COMPARATIVE ANALYSIS OF DIFFERENT ROAD MONITORING SYSTEM

The table below demonstrates the different works to be presented by various authors on road monitoring and pothole detection Analysis different types of methods or authors, techniques used in implementation, event phases and drawbacks in the system below:

Table 1: Comparative Analysis of Different Road Monitoring System Systems.

Author and Year of Publication	**Techniques Used**	**Event Phase**	**Limitations**
Carmel. A, Adhithiyan. M, Senthil Kumar. P , May 2018	Decision trees, Image processing, Potholes, Naïve Bayes, K-Means	The encapsulated images of road and preprocess the data have been taken by converting the image into HSV color space, sample patching for image mask and applying contour detection, convex hull calculation and a final extraction of image [5]. Framed the type of damage like cracks, potholes and subsistence depressions.	Detection of potholes in bad conditions such as shadow, uneven lights is not provided using image processing techniques as it is required.
Artis Mednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs,	Sensing mobile, sensing participatory, potholes,	Different algorithms for data processing are discussed and results calculated and there results represented using true positive data as high as 90% for real world data [6].	As different algorithms discussed so different irregularity happened on dataset , so difficult to decide which algorithms to use for any kind of dataset.

Leo Selavo 2017.	accelerometers algorithms	A mobile sensing system for road irregularity detection using Android OS based smartphones.	
Aniket Kulkarni, Nitish Mhalgi, Sagar Gurnani, Dr. Nupur Giri July 2014	Machine Learning,, Android, Neural Networks, Pothole, Sensor, Context	Accelerometer sensor inside android phone uses for detecting the pothole on road and global positioning systems for mapping coordinates on google maps, also uses machine learning algorithms for classification of the database. Machine learning framework used for neural network using 'Encog' for android.	Human errors -- when pressing controls on testing. Network accuracy -- although cell site triangulation will not always accurate. Centralized databases -- data is collected by individual device, should be centralized for proper access to users.
Umang Bhatt, Shouvik Man, Edgar Xi, J. Zico Kolter [1]	SVM models to classify road conditions. Gyroscope and accelerometer sensor inside phone to capture the car's movement.	Real Time road classification and show on smartphone whether current road condition is good or bad. Detect the pothole/non-pothole.	It's a 2 app implementation uses one app for collection of road potholes mounted on car and second one for labelling on position for data collection. Collecting data 5 times/sec, so lots of data collected at the end of trip so, lots of bogus data collected.
Mohd Sohel Deshmukh, Swapnil R.Rajput May- 2016 [8]	Non-Emergency, Urban areas, Geographical Information system (GIS), AngularJS	All in one complaint system for local municipal corporation for aurangabad city, which register the complaint, complaint go to respective department, department body will follow the process to accomplish.	The accuracy of the location when in case someone capture the photo and register at some other location , so complaint on wrong location will registered , so the photo exit data extraction process will missed here for better product usage.
Digambar R. Ghayal , Dr. Karbhari V. Kale July-Aug 2018 [9]	GIS ,Ionic 3 , cross platform, Accelerometer, Geolocations, G-sensor	Developed road monitoring detection algorithm for better road surface pothole data collection for the city of aurangabad. GIS geolocation to capture and watch the location and subscribe when pothole detection using accelerometer and g-sensor data exceed the threshold.	Accuracy of geolocation on device still issue to concentrate on as a device accuracy should not be more than 2 meters for correct pothole detection precision. Results are more in the forms of visual ways unlike different road classification techniques can be more useful to get accurate results.

IV. RESULT ANALYSIS

Result consist of random pothole data collected and using machine learning algorithms filter the pothole data from the accelerometer collected data. From the fig 2. We can see the storage of pothole data for the trip with distance covered, start/end time of the location with let long coordinates. The root node is the start timestamp of the trip, the detail storage of result mapping shown in figure 3 with mapping of the data to the google maps, here the transportation team will see the number of pothole on trip. Ionic google maps API is used to display pothole data from the node pothole (figure 2) to maps. Asynchronous data points generated to handle all the data if the pothole data contains large data, to mark all pothole data on single maps for different trips makes to handle critical, but ionic google maps API, making sure to handle all the sync activity smoothly for better performance...

Markers are used to display the pothole data on location, a timestamp when user fined the pothole. Haversian formula used to calculate the distance from the start and end of the location coordinate distance for better visual inside location mapping.

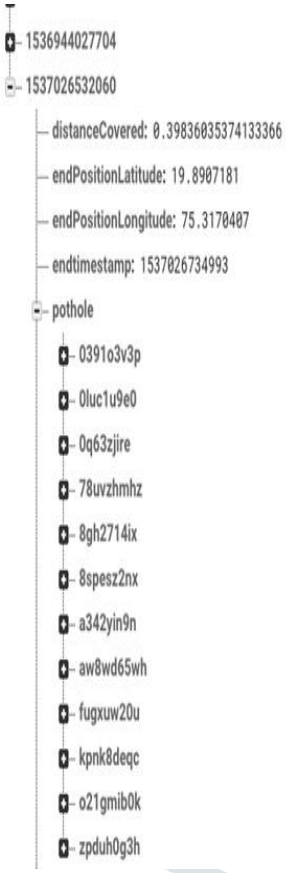

Figure 2: Storage structure of pothole database of a trip

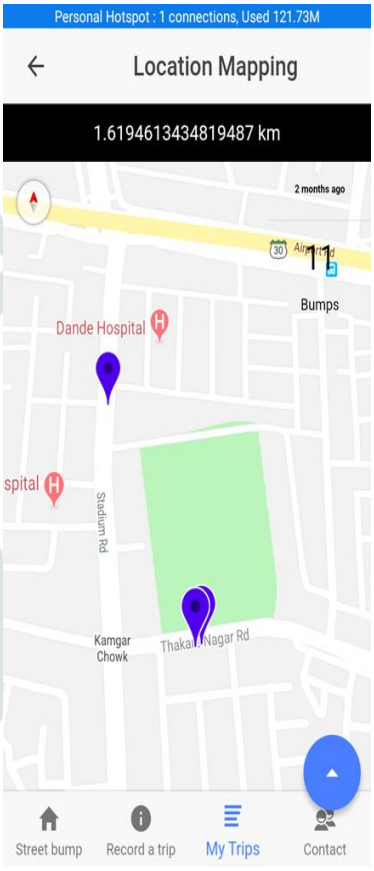

Figure 3: Mapping pothole data to google maps.

It is important to maintain the good database to understand the conditions so pothole detection with acceleration data-base with integration of gyroscope sensor calculated with Rx, Ry, and Rz projection for the vector R on the x, y, and z coordinates [10].

$$R^2 = Rx^2 + Ry^2 + Rz^2$$

The equation above is equivalent to Pythagoras theorem.

Accelerometer reading of all the pothole data is complex to understand from the figure 4 as shown below, to compute the best result of all accelerated data we use the standard deviation of all the Rx, Ry, Rz coordinates and store the re-sult on database so that better to get the best results from the collected database, this will variance the data we collected randomly and after formula Standard deviation.

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

Formula indicate the SD for the accelerometer data from the previous timestamp with current timestamp and square root of all the aggregate terms from the equation I. once we get the Deviation result from the pothole collected database, the resultant graph will change and display the accelerometer data movement clear to user as we implemented in system and get the result.

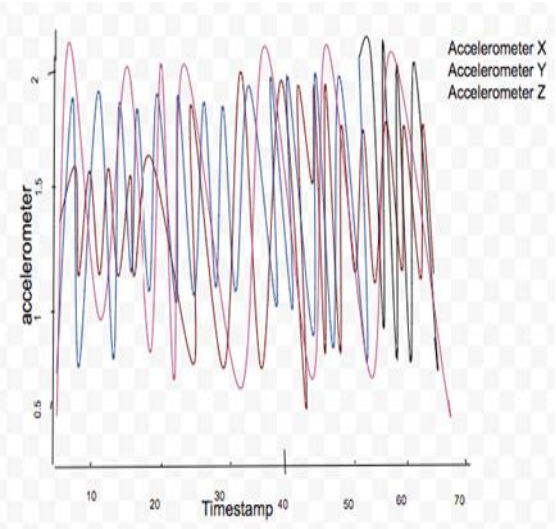

Figure 4: Accelerometer reading of pothole database.

V. CONCLUSION AND FUTURE SCOPE

Current Road monitoring application makes a difference with less resources , which added an advantage for all people who wants to make there city better and put the contribution , out application makes it possible to do, user can take the application , use realtime and store the results for analysis.

Collection of coordinates using accelerometer and gyroscope data makes the less variance because of astonish variables. Recollecting the pothole database from the collected route makes the application better for the resources we used in application for better accuracy. In future, we can make the application better in terms of ac-curacy and technique right now we use and also in terms of location coordinates for more precise coordinates, GPS microcontroller will provide better alternative for this solution.

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