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Advance Pothole Notification technique for Vehicle Road Safety using Android Applications

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ABSTRACT

In this study the advance Vehicle-Road communicating system architecture for pothole emphasized road condition detection is defined. The proposed system provides smart phone based accurate notifications about the pothole locations over the road on which vehicle is traveling. The Accelerometer sensor and navigation system interfaced microcontroller based embedded device mounted inside the vehicle works as a pothole inspector which updates the database on instant basis for every single experienced pothole. This updated database supports smart phone application to display pothole locations over Google map in reference to user's geographical location. This system not only helps user to get prior information about badly damaged road areas but also provides an accurate and periodically updated road surveys to government for statistical analysis of road health.

Index Terms: Vehicle monitoring, pothole detection, Microcontroller, Accelerometer Sensor, GPS, GPRS, Smart phone application

1. INTRODUCTION

According to ministry of road safety and road maintenance of India, the road safety can be termed as "Road safety is a multi-sector and multi-dimensional subject. It includes orderly development and management of roads, provision of safer vehicles, and a comprehensive response to accidents. It relies on modern traffic management systems and practices, improved safety standards in design, construction, operation and maintenance of roads, and production and maintenance of safer vehicles." So if road safety comes in to reference then we should think of the root causes that disturbs Road safety. Such causes mainly rotate around three issues 1) Driver's negligence 2) Faulty Vehicle 3) The road on which the vehicle moves. Mainly first two issues are closely related to third issue. If the road condition is bad a single person can't change road condition instantly but at least if it is facilitated with the service that will alert him about the potholes over the road then Driver will be most aware while driving the vehicle and hence most prominent road mishap will get avoided. To avoid Deadly Road Accidents the care needed to be taken while driving. One should be more attentive for potholes over the road, oil content on the road, lane which is to be followed while driving, adjacent vehicle's behavior etc. Most of the mishap happens on the road are mainly due to lack of attentiveness of driver against potholes on the road.

Indian Roads consist of 53 national highways which carries about 40 % of the total road traffic. Underlying fact is that around 25% of villages in India are still having poor road links. Currently India's annual expenditure on the road sector is around Rs 20,000 to 30,000 crore. Out of 2 million kilometers of roads in India 960,000 kilometers are surfaced roads and 1 million kilometers of roads in India are the poorly constructed one. Indian Road Accident statistics suggests 1,374 road accidents take place every day resulting in 400 deaths. (57 accidents per every average hour and resulting in the deaths of 17). As per the statistical reviews, road accidents in 2015 were recorded as 5, 01,423 whereas Road accidents in 2014 were recorded as 4, 89,400 Increment in Accidents yearly: 2.5% Number of deaths in 2015 due to Road Accidents: 1, 46,133 Number of deaths in 2014 due to Road Accidents: 1, 39,671Yearly Increment in deaths due to road accidents: 4.6%

Today's Road transport system needs safety assurance while traveling so that road mishaps on larger scales can be restricted which are mainly occurring due to bad road conditions. This can be achieved if the driver have prior information about bad road condition and pothole location on that road from which driver is driving the vehicle. By having this information driver will be most alert while driving the vehicle and this will helpful for safe journey. In today's world this information could be displayed via growing smart phone technology so that on map, while driving driver will get idea about upcoming bad patches over road which is the key idea of the proposed system.

This paper elaborates the proposed system in five sections. Section II consists all about previous work done. Section III explains System hardware and working principle of the proposed system. Section IV provides detail of the system working flow where as Section V emphasizes on Experimental results while Section VI tells us about future expansion of the proposed system followed by the conclusion in Section VII.

2. RELATED WORKS

A. Vehicle Behavior Analysis for Uneven Road Surface Detection:

In this study, vehicle behavior is modeled using two dimensional spatio-temporal trajectories for uneven road surface detection. The research claims that capturing the sudden change in vehicle's vertical motion pattern can suggest an anomaly, like a speed bump or a pothole on road [7].

B. Obstacle detection based on the hybrid road plane:

This paper presents a new obstacle detection method that is achieved on the depth image. It focuses attention on the obstacle detection in the case of pitch angle variation (weak calibration conditions) due to uneven-road surface[8].

C. Internet-Based Interactive Embedded Data acquisition System:

In this paper, the principles of a low operational- cost but flexible Internet-based data-acquisition system is presented. The main core of the system is an embedded hardware. The embedded device communicates through General Packet Radio Service (GPRS), which makes it accessible from anywhere in the world through a web server built into the embedded device. In addition, GPRS provides a bidirectional real-time data transfer allowing interaction [11].

D. Design of Intelligent Mobile Vehicle checking system based on ARM7:

ARM based module proposed is interfaced with modules such as video capture, GPS positioning and wireless transmission, the system software uses the embedded software developing platform based on ADS integrated development environment[18].

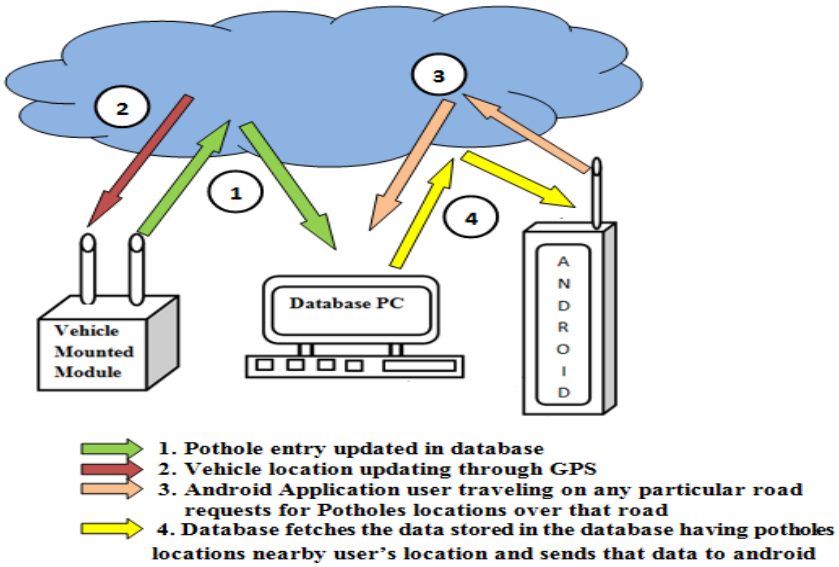

Fig 1.Proposed System Architecture

3. PROPOSE SYSTEM

The system architecture proposed here is focused for vehicle road safety by continuously updating the driver about upcoming potholes or bad patch areas over the road and that too with the help of today's growing smart phone technology. The in all System architectures is as shown in Fig 1. The system which is developed is linked with the microcontroller based module installed inside the vehicle. The module which is configured is as shown in Fig 2. The Microcontroller here we used is LPC 2141/42/44/46/48 to configure Vehicle mounted system. The features of these 16bit/32bit micro controllers are like multiple UART, SPI, SSP to I2C-bus, on-chip SRAM of 8Kb up to 40Kb make this device suitable for communication gateways and protocol convertors, single 10- bit ADC, dual 10- bit ADC,10-bit DAC,PWM channels and 45 fast GPIO lines, edge and level sensitive external interrupt pins. The thumb modes

commands, high speed flash memory ranging from 32kB to 512Kb make this controller series suitable for industrial field. This microcontroller is interfaced with GPS receiver S1315RL.It provides information such as location co-ordinates, vehicle velocity, time instant etc. anywhere on the earth. It is small in size and consumes low power. It tracks up to 12 satellites at a time. It can meet all the sensitivity requirements of car navigation as well as other location-based applications. Every Module is defined with ID i.e. Vehicle Identity.

Further for more clarification every road is previously assigned with the unique RID termed Unique Road Identity. The module installed inside the vehicle is interfaced with three axis accelerometer Sensor MMA 7361. When the vehicle faces sudden change in the acceleration the accelerometer g-value (centre of gravity) on three coordinate varies. On the basis of these variations, the potholes over the road and their location can be tracked. These Road disturbance Locations, concern Road Identity (RID) and the vehicle details like VID against which we are gathering this information are transferred to database via GPRS transceiver GPRS SIM900 The module can maintain the connectivity with remote server with the help of TCP/IP. For transferring the data from vehicle based module to database we specifically need GSM/GPRS module, a SIM card and a cellular antenna so as to make efficient data transfer. Here in system design we use Dual Band GSM/GPRS engine –SIM 900A.It works on the frequencies 900/1800 MHz. The database keeps itself update with the help of above mentioned information received from individual vehicle for particular RID. This information gathered in the database is collectively useful for android application users in order to get bad road locations before they pass over the road so that drivers will be aware about danger zones of the road. Also this continuous database updating will be useful government to perform regular road wise surveys so as to confirm road conditions.

A. Accelerometer Sensor Working:

When vehicle is traveling on the road, the coordinates of g-value vary and these variations will be helpful for system to decide the pothole locations and patch counts on specific RID.The location where driver experiences the sudden downward jerk due to pothole creates considerable Y axial g-value deviation for accelerometer sensor. How the Road bad patch indication get checked on the basis of g value coordinates deviations is explained diagrammatically in Fig 3.The Fig 3 explains how vehicle experiences downward jerk due to the depth of the potholes.

In practical when we observed the actual behavior of accelerometer the sensitivity of it is so high that centre of gravity shoots up for minute sensations on the path also.So in order to nullify this issue we assign a threshold for axial deviation over which if accelerometer sensor reading reaches then only system consider that sensation as Jerk and uploads that entry in database against that particular Road ID with pot hole location.

As per the road travel analysis almost all suddenly arising and abnormally generated bad patches on road are in the down word direction in reference to road plane. The Speed breakers are visible to the driver due to their speed breaker indicatory colors and due to road side indications so driver gradually reduces speed to safety limit in order to cross it safely without strong jerk. But the road patches does not have any indications and are unknown to driver and when wheel suddenly goes to that patch it created down word jerk to the vehicle. Some of the examples of such road patches are shown below in figure 3 for reference. On the basis of analysis of figures 3 we confirmed the vertical rotation around Y axis and most prominently downward rotation will provide clear idea about Jerk and hence we defined a threshold to Y-axis for defining jerk criteria.

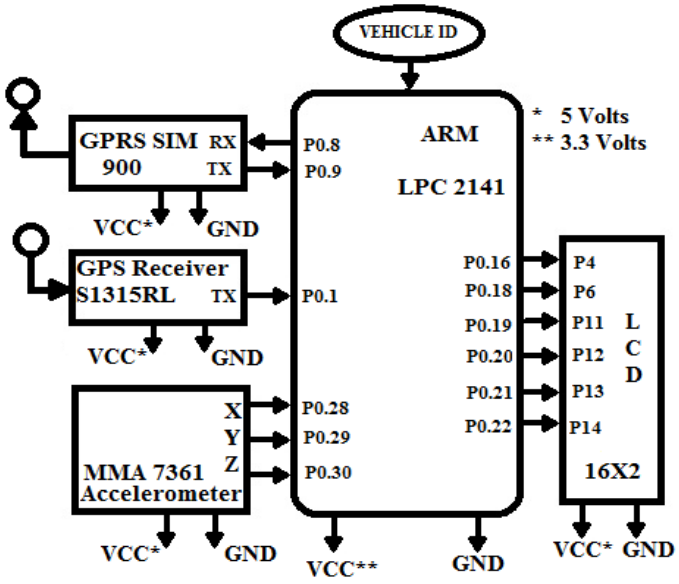

Fig 2: Vehicle Mounted Module assembly

The remaining two axes X and Z also configured with a threshold since downward jerk due to potholes also reflects in g-value deviation on X and Z axes but its comparatively less as compare to Y axis deviation. The ARM Controller is programmed in above explained manner so as to perform accurate decision making in order to confirm the jerk due to potholes.

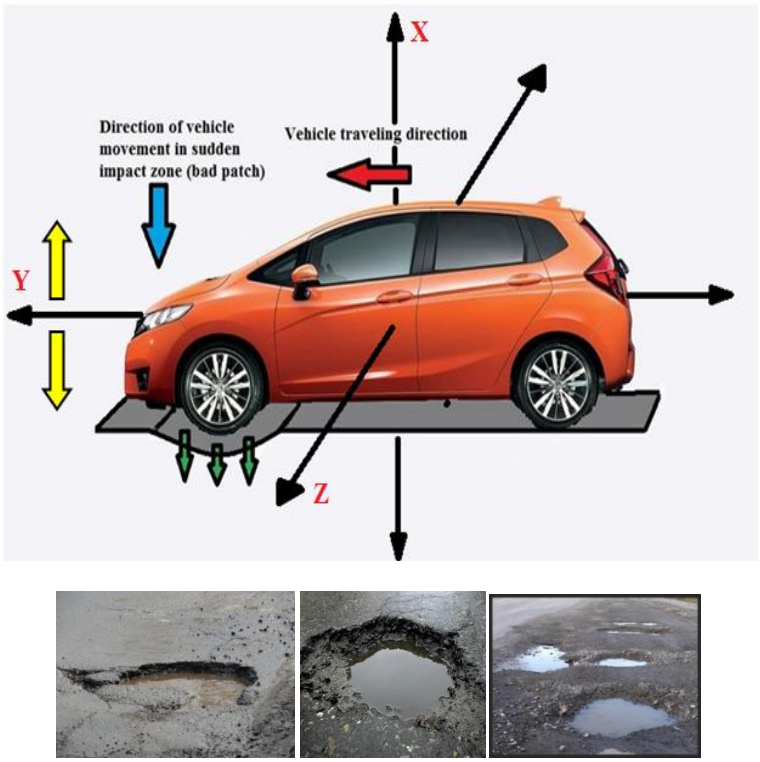

Fig 3: Downward Jerk sensed by Accelerometer which occurred due to above shown potholes over the road

B. HTTP communication:

For the designed hardware in order to facilitate the communication the vehicle mounted hardware, database and end user equipment that is Smartphone based application should be synchronized. This alignment of work is done with the help of HTTP secure communication in between these communicating devices. The entire communication between these devices takes place in three different but synchronized flows. These three flows are nothing but (1) Vehicle mounted Device to Database communication (2) Database to Smartphone and Database to Vehicle communication (3) Smartphone to Database communication. The HTTP communication between vehicle based module and android application is takes place via database server. When android user sends a request using command HTTPPOST ( ).execute ( ) the database sends relevant data in reference to location of the smart phone user. Smart phone application downloads this data using RxHTTP=Download ( ) command and it gets displayed over Google map when user hits the button get a Jerk Log so as to initiate command on Click (View src).

C. Database:

The prior intention of database table is to finalize the jerk location, instantaneous vehicle location tracking for specific VID on the particular road for particular RID. Web hosting services is to be used for web server construction. Web page will compose of PHP and it will directly be connected to database table. Commands like “mysquli_ connect” will be used to establish a connection to a MySQL database. The database table consists of Vehicle ID (VID), Road ID (RID) and Jerk location, so as to highlight this location on the Google Maps.

D. Android Application Frame work

The user having android application API will access the Google map API which will log on to Google Maps servers, displays map and responds to user according to the command which he has entered. The main and improved features of developed application is to display the location of the vehicle whose driver is carrying the developed smart phone application and wants to bad road areas over which he or she is driving the vehicle. In such case Android application takes initiative to fetch required data and displays it in front of driver so as to guide it to avoid bad areas of road and to take required care on risky zone while driving on that road.

4. WORKING FLOW

The system flow chart given in Fig. 4 explains how system analyzes the issue when decision making needs to be done for road disturbance evaluation followed by vehicle tracking. The use of Accelerometer sensor is modified so as to bifurcate the jerks due to potholes of the road. The ARM controller based vehicle mounted module is programmed with thresholds namely Xth, Yth, Zth which are the thresholds for coordinate variations in order to confirm the jerk sensation due to pot hole. GPS receiver continuously updates the location of the vehicle mounted module on geographical plane. When the vehicle sense the jerk, the 3 axis g value coordinate variation of accelerometer sensor takes place. The controller verifies the all coordinate deviation with predefined threshold values .The decided threshold values are programmatically synced with the plane on which the accelerometer is placed.

This provision helps to nullify the error that may vary the deviation values. The sensed deviation is compared with the threshold values and if only Y- axial deviation is dominant over defined threshold in reference to other coordinates deviations then the controller confirms that the deviation is due to the sensed jerk because of Pothole on the road. The controller transfers this location assigned with jerk indication to the database via GPRS transceiver along with Road ID. The entire data is get filtered in the database and then it gets fetched by user which is using the designed android application. This data is synced with user's location so that it will intimate the user about incoming bad road areas over the road on which the vehicle is traveling. In this way, on Android application the user will get exact locations of the road where the bad patches are located. The flow diagram given in Fig 4 is just providing one cycle which Vehicle mounted device performs during decision making.

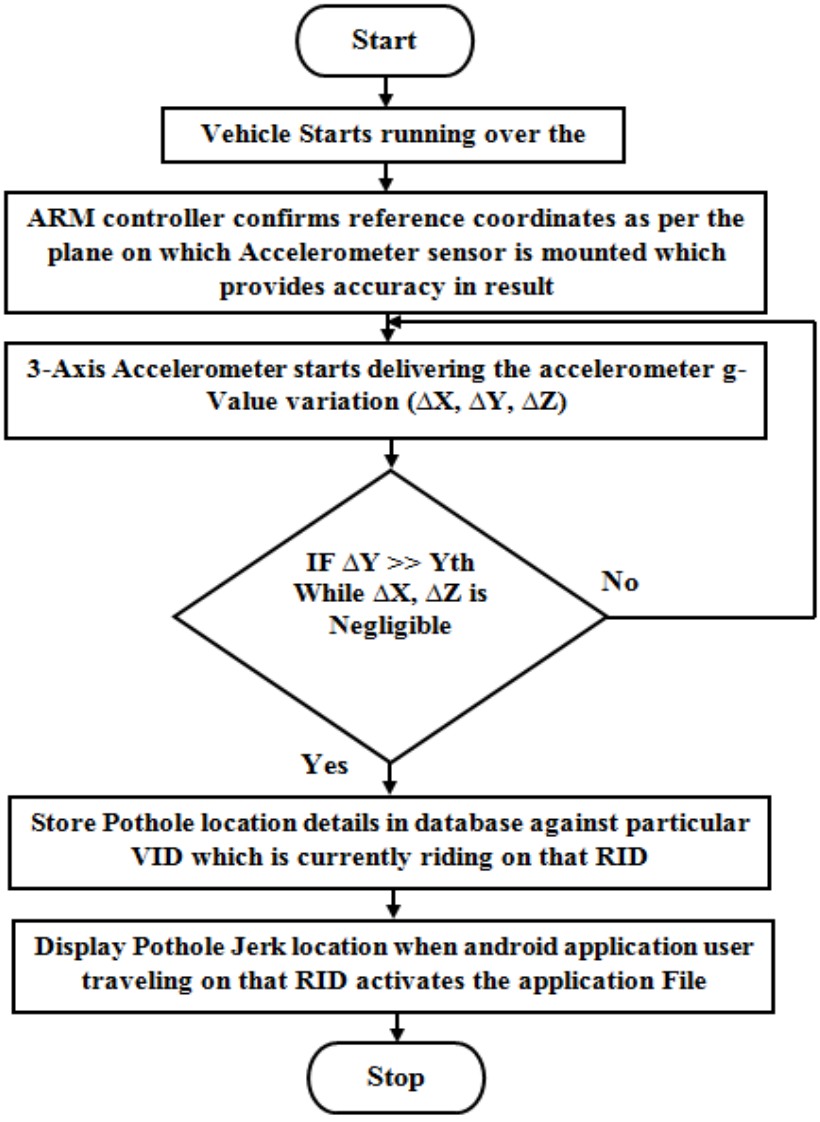

Fig 4: System flow chart

This flow chart explains one event analysis. This process keeps on continuing till the entire journey gets over and assures the user the desire road safety from dangerous potholes along with vehicle tracking.

5. EXPERIMENTAL RESULTS

This system is implemented as per the proposed concept. In the lab we tested the Vehicle installed device with the help of vehicle Robot. We move the vehicle robot over the experiential area where Pothole Jerk can be sensed (Fig 5). When the vehicle passes over this area as discussed in previous sections the downward Jerk provides Y axial Deviations for Accelerometer sensor which are noted by Vehicle installed device. Since this deviation crosses over the coordinate defined threshold hence this Jerk location along with the Road identity is shared with the database on instant basis. Hence in Fig 6 we can see that database records the entry of pothole for the location where we perform the vehicle Pothole Jerk sensation test in Lab. Now when a smart phone carrying driver or user passes over the same location then after using the newly developed application that driver must get intimation about the nearest potholes over the road from which he or she is driving the vehicle. Similarly smart phone application showed result as expected and this result is as shown in Fig 7 where nearby Smart phone location the Jerk location spot is clearly displaying. That Spot indicator in Application is suggesting the pothole at that location.

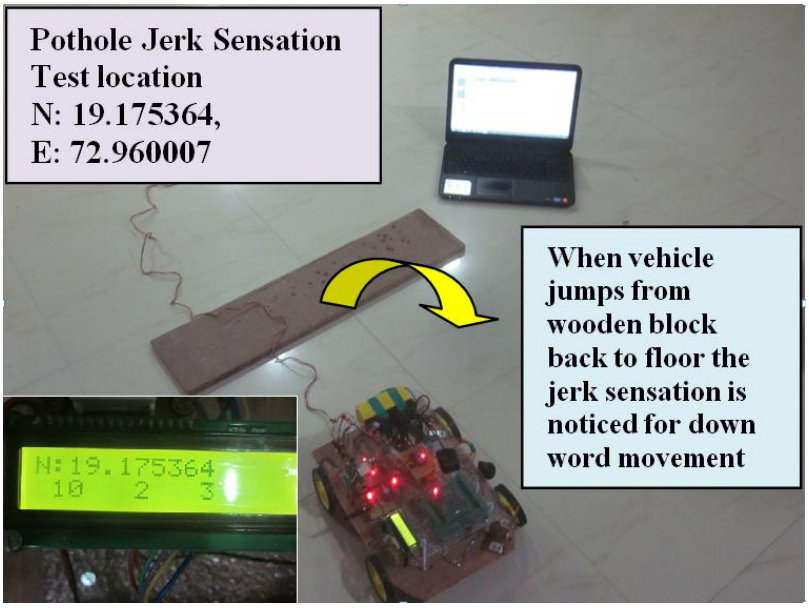

Fig 5: Vehicle robot Pothole sensation test

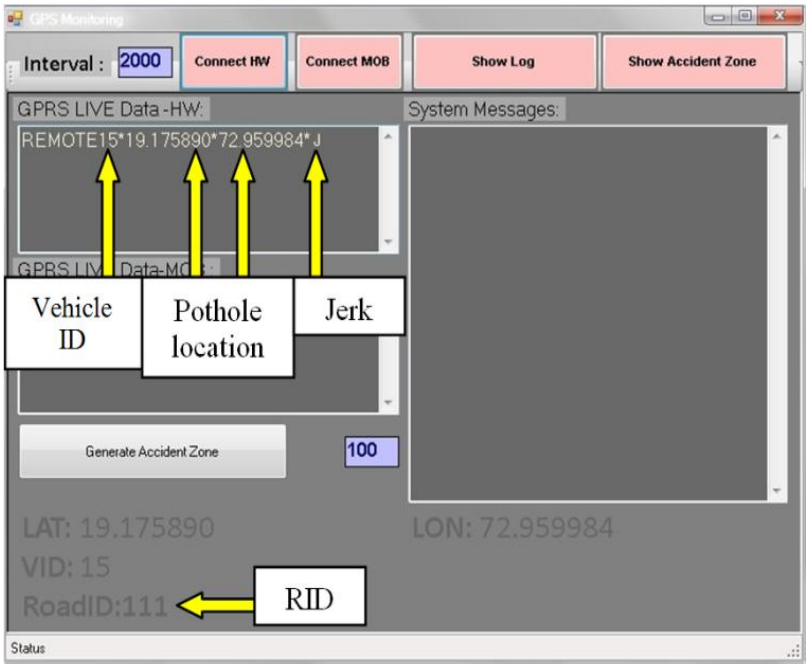

Fig 6: Database entry for Vehicle Jerk Sensation test

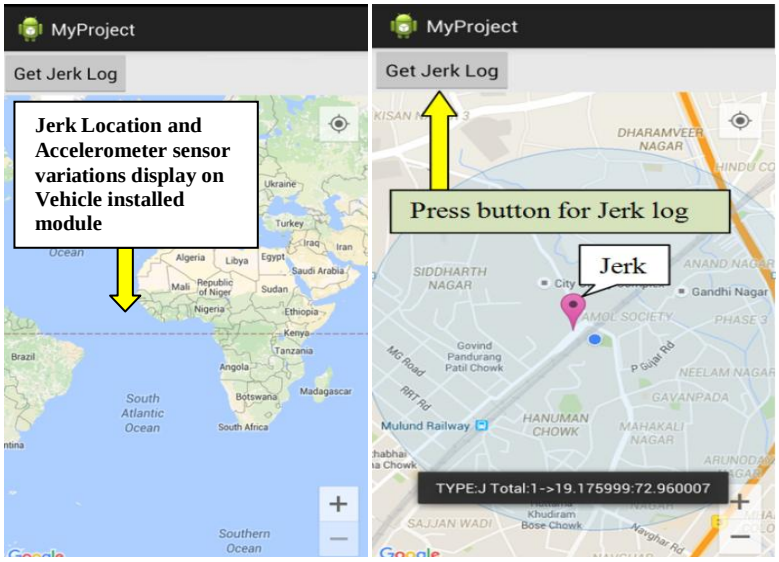

Fig 7: Smartphone output showing Pothole location nearby user's location when user travels over the same area

We can see in the smart phone application, that the location 19.175999, 72.960007 where we tested the pothole jerk sensation test with the help of vehicle Robot (VID 15) at road of RID 111is reflecting. In database also this entry has been saved for future purpose. In this way the continuous updating of database for pothole entries is takes place and accordingly the same update is reflecting over the smart phone application for guiding the end user who is driving the vehicle on that road.

FUTURE SCOPE

The System architecture as discussed earlier is many more useful in real time. It is not only an extension of Google maps which usually shows traffic intensity and driving directions but it makes user or driver more safe by intimating him about risky areas of the road on which user is driving the vehicle. The system architecture in further extension will be more useful in versatile manner for Government and for end users. The vehicle mounted device is mounted inside all vehicles by default at the time of manufacture. This device is not costly and hence can be produce on gross level. So every single vehicle is equipped with this vehicle mounted module. When such equipped vehicle travels over a road in any area of the India every single vehicle will update its Jerk sensations due to potholes on the basis of readings read by the 3 axis accelerometer sensor. The regional database can be formed for receiving these updates provided by each vehicle against specific road. The regional database knows the location where old pothole jerks observed where new pothole jerks observed, the combined backups of all databases in regular interval can be stored at State wise server and followed by all data will get gathered at national database. In this way in regular interval of time the national database of Road health monitoring gets updated.

CONCLUSION

This system helps user to become more alert while driving since bad road areas like potholes are with uncertainty they can be anywhere and suddenly comes in front of vehicle. So the implemented system is most cost effective and represented in a user-friendly manner so that the road mishaps which are mainly occurs due to bad road conditions are can be avoided. The system not only guides the driver about the bad road areas prior to the journey but also makes every vehicle as a pothole inspector because of which the database keeps on continuous updating which leads to a accurate entries in database about pot hole location on every single road which is in combine useful to Government of India so as to do the periodic Survey of the roads.

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