International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Review of Estimation of Road Roughness Condition from Smartphones

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Abstract: ***Today's every smartphone is incorporated with many useful sensors. The sensors are originally designed to make the smartphones' user interface and applications more convenient and interesting. These sensors, moreover, are potentially useful for many other applications in different fields. The use of smartphone sensors to estimate road roughness condition may be also possible, since many similar sensors are already in use in many sophisticated road roughness profilers. This study explores the use of data, collected by sensors from smartphones and use it to know the condition of data.***

Keywords: Smartphones sensors, accelerometer, road roughness, roughness condition, condition estimation

1. Introduction

Road Roughness is consistently recognized as one of the most important road condition measures throughout the world. To Maintain and monitor the road infrastructure is a challenging task for almost all governments and road authorities. The reasons behind this is that the task requires the collection of large amount of road network condition data, which is very important for maintenance planning and monitoring, more time, in addition to the significant efforts that have to be directed to actual maintenance of the road network. In rising countries, the attention that should be addressed on data collection is usually ignored or neglected mainly due to the lack of technology and budget. Therefore, in these countries, road infrastructure condition data is often left outdated, making it difficult for proper planning and programming of the maintenance.

Road surface condition information is very useful for road users because with the accessibility of such information, road users can avoid or be cautious of the bad road ahead. In addition, for road authorities, the information is very important as it can be applied in judgment making processes especially for strategic planning such as quality management planning, maintenance planning and programming. Bad road condition can cause; damage to vehicles, may increase fuel consumption, increase road user costs for vehicle maintenance, reduced driving comfort, and sometimes it may pose a significant traffic safety threat to road users. Therefore, road condition information is usually of the benefit of the general public, road users and particularly the government or road authorities.

The use of smartphones to collect the data is a promising alternative because of its low cost and easy to use feature in addition to its potentially wide population coverage as probe devices. In these days, Smartphones usually come with many useful sensors. A 3D or 3-Axis accelerometer is one of the most common sensors that can be found inside a smartphone. Accelerometer sensor gives us the acceleration measurements in m/s2 along each of x, y, z axes. It can be used to distinguish the motion activities. In smartphones, accelerometers are originally used for detecting the direction of the screen as well as in some user interfaces and applications. In[3], this process of road estimation is shown.

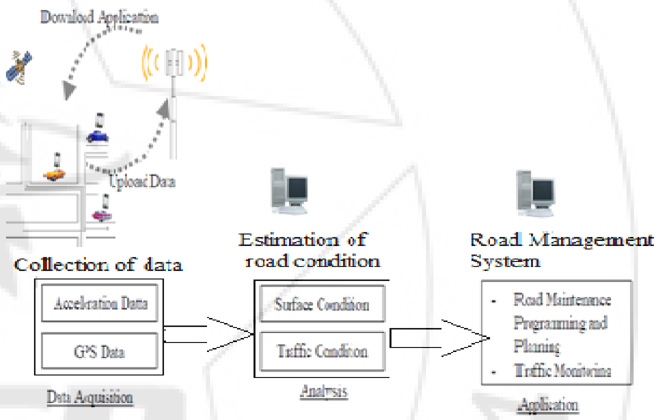

Figure 1: Conceptuali image of continuous road condition monitoring system

2. Review on Estimation of Road Roughness Condition Methods

- Road roughness is a broad term[1] that incorporates everything from potholes and cracks to the random deviations that exist in a profile. To build a roughness index, road irregularities need to be measured first. Existing methods of gauging the roughness are based either on visual inspections or using one of a limited number of instrumented vehicles that can take physical measurements of the road irregularities. In this the collection of data is done from accelerometers fixed in a specific vehicle type and the use of this data to estimate the road condition. The estimate is approximate, accelerometers are being more and more used by car manufacturers to improve suspension performance and the proposed method is relatively inexpensive to implement and provide road managers with constantly updated measurements of roughness. This approach is possible due to the relationship between the power spectral densities of road surface and vehicle accelerations via a transfer function. This shows how road profiles can be correctly classified using axle and body accelerations from a range of simulated vehicle-road dynamic scenarios. Two important methods to classify the roughness of a profile are the International Roughness index (IRI)[9] and the International Standards Organisation (ISO)[10] classification . In this the road condition is classified according to ISO, that uses Fourier analysis to calculate the Power Spectral Density (*PSD*) function of the surface. Then, the *PSD* of a road profile can be estimated from the *PSD* of the axle or body accelerations measured over the road profile. Such an approach requires prior knowledge of the vehicle transform function. This transform function depends only on vehicle parameters and it can be obtained by dividing the *PSD* of accelerations measured over a known profile by the *PSD* of that profile.

- In [2] authors said the importance of the road infrastructure for the society could be compared with importance of blood vessels for humans. To make sure road surface quality it should be monitored continuously and repaired as necessary. The optimal distribution of resources for road repairs is possible providing the availability of complete and objective real time data about the state of the roads. Participatory sensing is a promising approach for such data collection.

This describe a mobile sensing system for road irregularity detection using Android OS based smart-phones. Data processing algorithms and their evaluation presented with true positive rate as high as 90% using real world data.

The first round data is collected from the accelerometer sensors using a modified LynxNet collar device[6] on road with various potholes. This device is based on Tmote Mini sensor node with Texas Instruments micro-controller MSP430F1611 and Analog Devices 3-axis accelerometer ADXL335. MansOS based software used for raw acceleration data acquisition (sampling rate 100Hz) and transmission through USB interface to a laptop computer[7]. RoadMic pothole detection methodology was used to collect reference data. The test tracks were the same as for the RoadMic project[8]. After the acquisition of the first test data set, a search for potential event related features was performed. The emphasis was placed on features that did not require resource-intensive signal processing techniques and therefore were suitable for implementation for detection using devices with limited hardware and software resources. The first and the simplest event detection algorithm ZTHRESH were tested on the acquired data set. Next, a slightly more advanced algorithm was Z-DIFF tested on the acquired data set.

- In[3] , Understanding condition of road surface is very important especially for road maintenance and asset management. There are many approaches to obtain road surface condition data, however almost all of them are either low speed with thorough human intervention techniques (visual inspection) or techniques that require advanced measurement equipment (sophisticated profilers), which usually comes with high costs and requiring skillful operators. Using smartphone to gather data is a promising alternative because of its low cost and easy to use features in addition to its potentially wide population coverage as probe devices. In this, features and relationship of acceleration vibration that may be useful to state or estimate road roughness condition.

We assume that different road surface conditions cause vehicles to vibrate differently, therefore by placing smartphones that come with acceleration sensors, the difference of the vibration is believed to be captured. In the experiment, we place two smartphones on two different vehicles. We then drive each vehicle with normal driving condition along many roads that have different surface conditions. Different approximately fixed driving speeds are also performed on four selected short sections (0.6 to 1km in length). The four short sections consist of different surface conditions such as good, fair, poor, and bad respectively. Sensors on the smartphones record acceleration and GPS data. To simplify our experiment, direction of the smartphones is fixed. Thus, we assume that the acceleration coordinates of the vehicle and smartphones are the same. A video camera is also used to capture the road surface; this video footage is used for data checking and verification in case there is a need.

- In [4] , We think about the problem of monitoring road and traffic conditions in a city. The past work in this area has required the deployment of dedicated sensors on vehicles and/or on the roadside, or the tracking of mobile phones by service providers. Furthermore, past work has largely focused on the developed world, with its relatively simple traffic flow patterns. In fact, traffic flow in cities of the developing regions of the world, tends to be much more complex unsettled to varied road conditions (e.g., potholed roads), chaotic traffic (e.g., a lot of braking and honking), and a heterogeneous mix of vehicles (2-wheelers, 3-wheelers, cars, buses, etc.). We present Nericell, a system that performs rich sensing by piggybacking on smartphones that users carry with them in normal cours to monitor road and traffic conditions in such a setting . In this system, we focus specifically on the sensing component, which uses the accelerometer, microphone, GSM radio, and/or GPS sensors in these phones to detect potholes, bumps, braking, and honking. Nericell system addresses several challenges including virtually reorienting the accelerometer on a phone that is at an arbitrary orientation, and performing honk detection and localization in an energy efficient manner. We also touch upon the idea of triggered sensing, where dissimilar sensors are used in tandem to conserve energy. We calculate the effectiveness of the sensing functions in Nericell based on experiments conducted on the roads.

- In [5], The purpose is to improve traffic safety through collecting and distributing up-to-date road surface condition information using mobile phones. Road surface condition information is seen useful for both travellers and for the road network maintenance. The problem is to detect road surface anomalies that, when left unreported, can cause wear of vehicles, lesser driving comfort and vehicle controllability, or an accident. In this work we developed a pattern recognition system for detecting road condition from accelerometer and GPS readings.

Data was gathered using a mobile phone that was attached to a rack on the windshield of a vehicle. The stand was carefully positioned and secured to maintain roughly the same accelerometer coordinates across data collection drives.

3. Conclusion

We can use the accelerometer of smartphones to collect the data about road and estimate condition of road. The use of smarphones because of its low cost and easy to use feature in addition to its potentially wide population coverage as probe devices. The data about road condition is necessary for proper maintenance and programming of road Road surface condition information is very useful for road users because with the availability of such information, road users can avoid or be cautious of the bad road ahead. In this paper an effort has been taken to give the existing approaches, in estimation of road condition in order to motivate the researches to further come with other new ideas.

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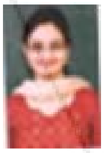

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