Identifying Congestion and Disruptions Based on Device Sensors

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Abstract - *In the modern world most of the countries uses large scale infrastructure for the maintenance and development of the road. In developed countries, sensor networks together with surveillance cameras help to identify elements disturbing cars' mobility. On such countries, the lack of an effective and efficient road infrastructure system makes the task of road's maintenance and traffic control very much difficult. In this paper, we propose an efficient method to identify and evaluate the road condition based on accelerometer patterns along with urban computing strategies can be used to collect data about the various congestions and disruptions present on a particular path. This valuable information can be used to monitor traffic related issues. The implementation of such an economic navigation system could help most of the companies and authorities to save freight and money and even reduce car accidents. The various modern features available on smartphones nowadays like accelerometer and GPS can be efficiently used to detect most of the road imperfections present on a particular route. In the proposed system each citizen's car act as a road watcher for detecting various congestions and disruptions by means of the mobile phone's acceleration sensing capabilities. Here we conduct a series of steps to identify the accelerometer values that are associated with congestions and disruptions.*

Key Words: IoT, Crowd sourcing

1. INTRODUCTION

In recent times, traffic related issues has been a major concern in most of the developed countries because of how much they influence on the time as well as productivity of a nation. Thus the need for an effective and efficient road monitoring system has become more important. In the past, stationary road-side sensors like inductive loop, visual camera and RFID reader are used to identify various congestions and disruptions present on the road surface. However these infrastructure has not been economical due to the high installation, maintenance cost and also the limited coverage and representativeness. With advanced technologies available on most of the mobile phones these days, it will be better to replace traditional expensive infrastructure with much more economic smart devices like mobile phones. The advantages of using mobile phones as traffic probes are as follows:

- It considerably reduces the cost in implementation and maintenance of the infrastructure used compare to traditional infrastructure where expensive devices like inductive loop, visual camera and RFID reader are used.
- It overcomes the coverage limitation and representativeness limitation while using traditional system like road-side sensors. Since the high penetration rate of mobile phones makes the sensed data cover most geographical area.

With the use of smartphone devices we either rely on power-hungry sensors like GPS or have control over the mobility context of the mobile phone probes (i.e., when and where they are traveling by vehicle). However, it is infeasible to use mobile phones as dedicated traffic probes. This is because that they are commonly used as private devices and could be carried to anywhere in our day to day living environment. After all our propose system is basically an android application for identifying the various congestion and as well as disruptions available on the road surface using a citizen's mobile phones as an alternative or complement to previous systems that where available like road-side sensors or floating vehicles.

In the proposed system, users run an android application on their mobile phones when they start their journey. Here we present a framework to collect crowd-based information to monitor road health conditions and road hazards. The proposed system make use of the valuable data collected through the sensor technologies available in driver smart devices to offer more advanced, accurately method for monitoring the road surface anomalies and conditions.

2. RSD DETECTION

In recent years, there has been an increase in the use of mobile sensors available with computational units that are capable of gathering large amount of quality data that can be used for detecting various surface anomalies which is shown by fig 1.1. Literature study reveals that with use of the advanced technologies available in smartphone sensors like GPS, accelerometer then we can build an effective system for monitoring and maintenance of road surfaces.

Hence we compare the results of measurements obtained from GPS sensors and accelerometers for crowdsourcing as well as for validating the status of the currently identified disruption. In case of disruption identification, we compare the obtained value through accelerometer with a particular threshold value. If it is greater than threshold, we identify it as disruption. Then we upload the longitude and latitude value to the server database.

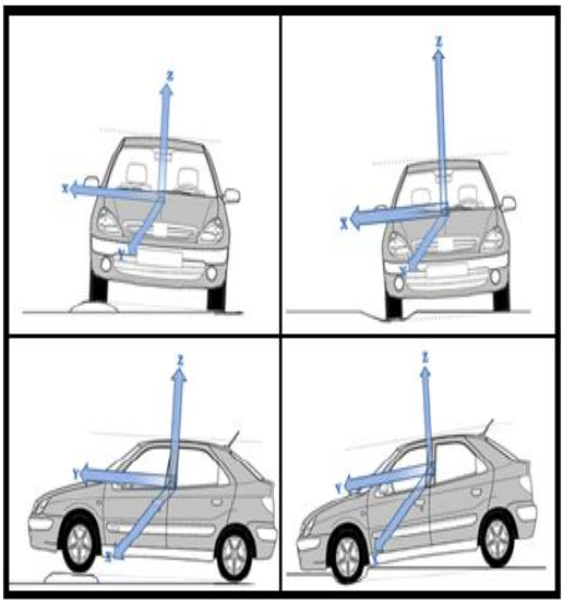


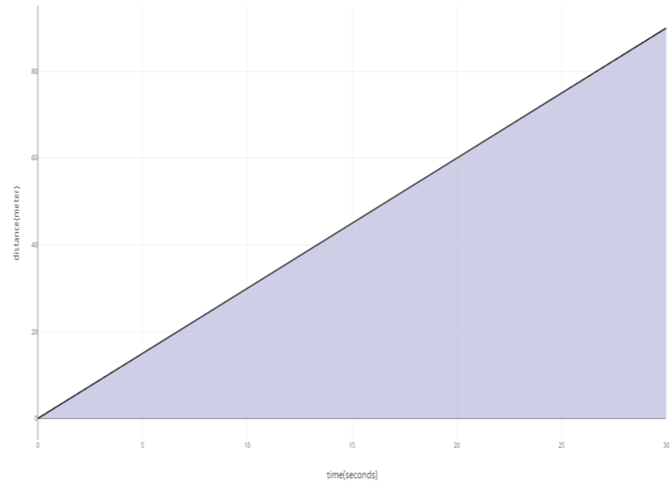
Fig - 1.1: Vehicle motion with road anomalies.

The aim is to investigate and to compare the results achieved by different sensor that are placed in a car. Moreover, there may be some difference with suspension type which can have influence on accelerometer measurements. The modern car suspension is a sophisticated mechanical system capable to absorb various road impacts in order to protect the passengers from shocks. The vibration transmission is described by introducing suspension models.

Crowdsensing approaches for road surface conditions monitoring can benefit in validating the obtained data value from a particular user by comparing it with other ones for that exact same location. Deteriorated roads will induce vehicle damage, traffic congestion and driver discomfort which influence traffic management may even cause car accidents. After collecting the relevant information, we use google maps to give hint to the user about the various surface disruptions and congestions through that particular route. The system relies heavily on mobile phone sensors like accelerometer and cellular signal on gathering the required data. As compared to other traditional built-in sensors, cellular signal have many advantages, such as energy-efficient, unobtrusive, and impervious to environmental noises. Then by using this application, user can send incident notification to the server. But here we apply a crowd sourcing technique to check whether the data is fake or not and based on this result the data will be stored or pass to the server database for mapping purpose.

Along with many benefits, smart phones are increasing the value of the wireless technology, including the mobile phones, wireless tablets and the notebook computers. Here we simultaneously take the GPS reading .For the detection of congestion on a particular path, we consider a circle and check whether the new location value is within that particular area. If the new values are within that particular region it is recognized as congestion. In case of disruptions, along with location value from GPS, we also consider the value of accelerometer. If the value of accelerometer is above a particular threshold it will be recognized as congestion. Then the location values of accelerometer are uploaded to the database. In case of congestion we just overwrite the value with same car id. In case of disruptions we keep inserting the location values. Database will be cleared after each weekend.

speed = *abs*(x+y+z - last_x - last_y - last_z) / diffTime *10000 (1)



Here x, y and z are the accelerometer values along different directions calculated through a smartphone. The term diffTime is the difference between current time and the time where the last update has taken place. Here we calculate the speed value. Then using equation 1 we can estimate the value of speed and is then compared with a particular threshold known as shake threshold which is set to 1400. If the value is greater, we identify it as disruption.

3. CONGESTION DETECTION

To overcome the traffic congestion that occur in high frequency these days, we propose an efficient and effective android application for road congestion and as well as disruptions detection using citizen's mobile phones, as an alternative to traditional systems that are based on road-side sensors. In the proposed system, users run an application on their mobile phones. The application works in two phases: First, it continuously monitors the motions of the mobile phone user, and detects the vehicular movement periods (i.e., the periods when the user is traveling by vehicle).

Second, once a vehicular movement period is detected, it continuously estimates the road segments traveled by the user and the congestion degree of these road segments within the period. Here we present a framework to collect crowd-based information to monitor road health conditions and road hazards. The proposed system utilizes the sensor technologies available in driver smart devices to offer more advanced, accurately localized road surface anomaly monitoring.

$dist=2*asin(sqrt(pow(sin($latDelta/2),2)+cos($latFrom)*cos($latTo)*pow(sin($lonDelta/2),2)))*earthradius
(2)

We instantly estimate the values of latitude and longitude between 10 second time intervals. In the equation, latTo represent the lattitude value at the given time, latFrom represent latitude value before 10 seconds, latDelta is difference between current latitude value and that of 10 seconds earlier. LonDelta is the difference between current longitude value and that of 10 seconds earlier. Equation 2 shows the calculation of the distance value and then we check whether the distance value is lesser than 30 meter, if yes it is identified as congestion.

4. RESULT AND EVALUATION

The road disruptions appears in different forms such as transverse cracks, longitudinal cracks, crocodile cracks, and road dents. Also, this distress might cause the removal of pavement, introducing various levels of potholes. In addition, road-related infrastructure services such as manholes, speed bumps, drain pits, road and bridge joints, deceleration strips, and railroad crossings may also damage vehicles when they are improperly maintained.

The graph shows the congestion frequency according to various time intervals. The x coordinates represent time in seconds and y coordinate represent distance in meter. According to our application, to detect congestion we check the location value at 10 seconds time interval. If the new locations is still found to be in a 30 meter circle, we identify it as congestion. In the above case if the value at 10 seconds is within 30 meters it is said to be congestion. The shaded portion represent congestion.

Here we present a framework to collect crowd-based information to monitor road health condition and road hazards. Proposed system is a fine combination of Android mobile technology and embedded system. An application should be installed on android mobile handset to get voice notifications about road disruptions. User can send details about traffic signals, accidents and some other disruptions. The proposed system utilizes the sensor technologies available in driver smart devices to offer more advanced, accurately localized road surface anomaly monitoring. While developments have been independently made in these areas of Intelligent Transportation Systems (ITS), there is very limited work towards a framework that integrates the above to provide a real-time, personalized, driver service application. We introduce an application to identify surface disruptions based on accelerometer patterns and also use a crowd sourcing technique for store or pass incident details to the server.

We extend a prior study to improve the algorithm based on using accelerometer, GPS and magnetometer sensor readings for traffic and road conditions detection. The aim is to investigate and to compare the results achieved by different sensor types and location in the car. Moreover, various car models differ with suspension type which can have influence on accelerometer readouts. . In our work, we simultaneously take the GPS reading for the detection of congestion on a particular path, we consider a circle and check whether the new location value is within that particular area. If the new values are within that particular region it is recognized as congestion.

The rapid development of the Internet of Things is prompting further growth in crowdsensing applications to provide smart and robust solutions for challenges arising in smart cities. An important aspect of road information services as a smart city application is the monitoring of road surface conditions. In case of disruptions, along with location value from GPS, we also consider the value of accelerometer. If the value of accelerometer is above a particular threshold it will be recognized as congestion. Then the location values of accelerometer are uploaded to the database. In case of congestion we just overwrite the value with same car id. In case of disruptions we keep inserting the location values. Database will be cleared after each weekend. These locations values are then used to mark the various congestions and disruptions on google map.

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