DISCERNMENT POTHOLE WITH AUTONOMOUS METROPOLITAN VEHICLE

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Abstract – *Here we propose design of 'Pothole detection System' which assists the driver in avoiding pot-holes on the roads, by giving him prior warnings. The road irregularities and roughness due to bad maintenance are significant cause for road accidents in India. Road users often feel uncomfortable when they drive on rough roads, especially due to potholes. This paper presents a pothole detection system using the concepts of IoT. A mobile application "ROAD MODE " is developed that shows details of upcoming potholes so that driver can plan his safety and avoid bad roads*

Key Words: *pothole detection*

1. INTRODUCTION

Everyone carry on their day to day work by travelling from one place to another using road networks. It may take longer time if the roads are irregular ,further damaged roads lead to accidents . Potholes are one of the major irregularities which is the cause for many accidents in developing countries like India. 11389 accidents were caused in the year 2014 due to potholes and humps alone. Having this social concern in mind, we have proposed a system, that contains an accelerometer that detects a pothole by notifying changes in its co-ordinates. These coordinates helps to identify severity of the potholes. GPS is used to record the location of the potholes. This data is communicated to the server , where the required information about potholes are mined . As the user approaches the location of the pothole , he is warned about appropriate pothole through a mapping application called "*ROAD MODE*". Thus the system acts as a safety mechanism which allows the user overcome the road accidents.

1.2 EXSISTING SYSTEM

The existing work related to road condition perception can be categorized into two types in general as follows: Dedicated-Sensors Based. Ground Penetrating Radar used in work uses radar and operates in a wide radio frequency band from 0.05 to 6.0 GHz to detect tiny defects on roads. Furthermore, GPR can detect the potential potholes hidden under the ground. The defect of this system is that GPR is unrealistic to be widely deployed on ordinary vehicles. In work the authors use an on-board vision system to capture the view of the road when driving, and use the image recognition technique to find out potholes. In their work, pothole larger than 2 feet in diameter can be detected. Using image recognition technique is mature and easy to deploy but has the problem of line-of-sight limitation. In addition, the performance of the scheme is also constrained by poor light conditions such as under bad weather or at night. Vibration-Sensor Based. The Nericell project utilizes acceleration information to detect car braking, stop-and-go traffic and bumping (caused by potholes or other uneven road surface). The detection algorithms are threshold-based. In work the authors examine the vibration characteristics such as the maximum acceleration values and the variations when hitting potholes and propose thresholds to detect the potholes. The pothole patrol is based on a machine learning approach using x- and z-axis acceleration information obtained from a 3D accelerometer and the velocity of a vehicle as inputs to identify potholes and other severe road surface anomalies. In, the authors investigate the variation of vertical vibrations of vehicles using neural network (NN). The approach proposed in utilizes supervised and unsupervised machine learning methods to detect road anomaly. In the authors extract features such as the mean, root mean square, standard deviation and variance of vibrations, and use Support Vector Machine (SVM) to detect potholes. In general, both types of existing schemes conduct a qualitative analysis, which mainly focuses on the detection of an on-road obstacle and its type. However, they cannot tell the specific details of such an obstacle such as the size and the shape of a pothole. As not all potholes are harmful and should be informed to drivers, establishing the profiles of a pothole is of great importance. In P3, though we also utilize the 3D acceleration information to perceive on-road potholes, our major effort is to further infer the specific profiles such as the depth and the length of potholes.

1.2PROBLEM STATEMENT

In countries like India, the probability of encountering irregularities on the road is more since the road conditions are prone to changes .The purpose of this project is to detect and monitor road conditions and bring awareness of the irregularities on the road.

1.3ARCHITECTURAL DESIGN

As explained before the System consists of three subsystems : Sensing, Communication, Localization. These three subsystems work independent of each other, but have one center point they revolve around; that is data. Sensing system generates the data; Communication collects, co-ordinates and distributes the data; lastly Localization uses the data and generates information for the driver. The overall design can be given as follows

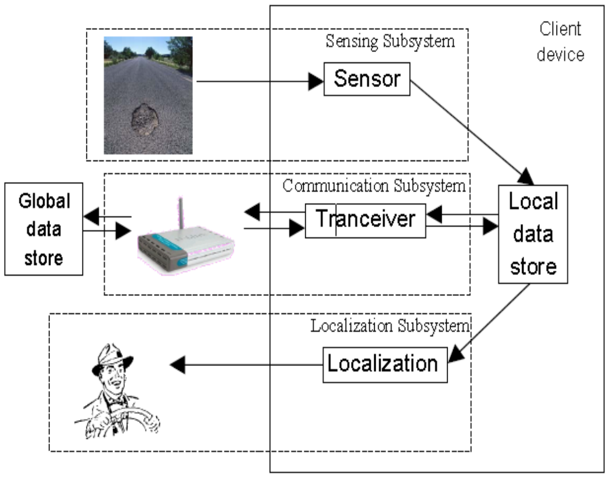

Fig 1 architectural design

1.4 OBJECTIVES

An effective scheme to solve the pothole profile perception problem should meet the following requirements: Low deployment cost: Considering the huge number of road in a metropolis, schemes relying on additional dedicated sensors or new infrastructure would introduce great deployment cost, which is infeasible. Therefore, a low cost pothole perception system without additional expensive dedicated hardware is preferred. Good perception accuracy: The profile including the depth and the length of a pothole can be used to evaluate the potential damages to moving vehicles and therefore is significant to driving safety. An effective scheme should not only be able to judge the types of surface anomalies but have the capability to infer the accurate profile of a pothole.

 Robust to dynamic conditions: A practical scheme should be able to work under complicated and dynamic conditions such as different weather, vehicle types, traversing speeds and light conditions.

2. WORKING MODULE

When any vehicle travels over the damaged pothole vibrations are produced. These vibrations can be sensed by the accelerometer to detect the severity of the pothole. We use adxl335 accelerometer which can easily detect the rate of change of momentum in x, y and z direction. The intensity of vibration is recorded along with the current location which is then sent to common server.

The GPS monitors the coordinates of the potholes and map the index of pothole on a digital map on the user's application. The GPS used in our system is UBLOX Neo 6M. The accelerometer and GPS module are mounted on a Esp8266 nodemcu board The readings of accelerometer , GPS , are sent to the server using wifi module.

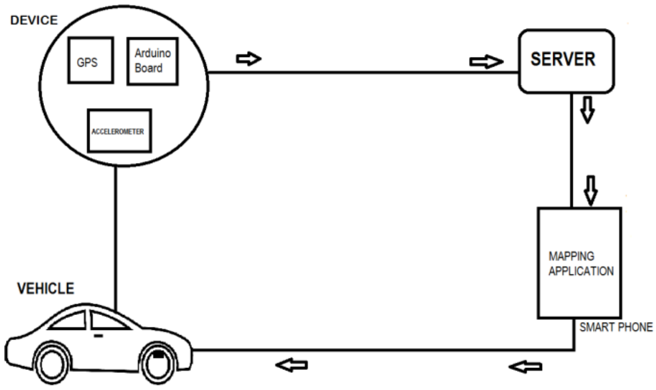

Fig 2 working model

2.2 PRACTICAL ISSUES

Influence of Vehicle Speed and Phone Sampling Rate. When a vehicle hits a pothole at a very high speed, it is possible that the intensity of the shock exceeds the of the suspension system, which may makes the smartphone jump off the surface of the instrument panel or causes the magnitude of the vertical acceleration goes beyond the measuring range of the smartphone. Furthermore, when the vehicle moves at a high speed (for example, at 80 km/h), due to the limited sampling rate of the smartphone (e.g., around 200 Hz), the number of available samples about the pothole becomes quite limited. As a result, the estimated profile of the pothole might be inaccurate. To migrate the influence of high vehicle speeds and low phone sampling rates to the estimation accuracy, P3 can select those individual perceptions obtained with low vehicle speeds for aggregation. In an urban driving environment, we believe that at any time at any where there exist the speed-limited samples which are suitable for our scheme and computation. In specific, with a crowdsourcing application involving plenty vehicles, it is possible that we can obtain pothole profiles perceived by those low-speed vehicles. In addition, as the hardware of modern smartphones improves and more advanced accelerometers with faster sampling rates are embedded in smartphones, the highest vehicle speed of our approach can be increased. Effective Sensory Data and Probing Wheel Selection. In P3, one essential condition is for both of the front and the rear wheels to cross over the same pothole, as required in estimating the instant speed of the vehicle. However, it is possible that both of the wheels or one of them may miss the pothole. In order to deal with this case, P3 only conducts pothole profile perception with effective sensory data and leave other trace unused. With the large number of participants, all potholes will be eventually recovered. With effective sensory data, the pothole can be estimated based on the vibration information collected by either the front wheel or the rear one. In P3, we select the rear wheel as the probing wheel. The main reason is that it is easier to extract the underdamping vibration of the rear wheel as that of the front wheel often overlaps with the forcing vibration of the rear wheel when the vehicle speed is relatively high. Recall that P3 utilizes underdamping vibrations to actively learn the inherent attributes of the vehicle and further estimates the pothole. Using rear wheels as probing wheels can lead to better estimation accuracy. Smartphone Placement and Reorientation. In P3, the smartphone is required to put at the center of the instrument panel of the vehicle. This allows the smartphone to correct estimation errors caused by the displacement of the smartphone and the probing wheel according to the linear model mentioned in above section. However, it is possible to loosen this requirement as long as the smartphone can recognize its relative location within the vehicle. As far as the estimation accuracy is concerned, the best position to put the smartphone is on the package tray of the vehicle right. Depth prediction accuracy affected by both speed smartphone sampling rate.The main consideration of putting the phone on the instrument panel is for the ease of use for the driver. In addition, P3 cannot derive meaningful pothole pro- files unless the coordinate system of the smartphone is aligned with that of the vehicle. Since the pose of the phone could be arbitrary, we need to align the two coordinate systems. We adopt the solution proposed where a rotation matrix is used to do the coordinate system transformation. The True and the Perceived Depth of Potholes. In the case where the length and depth of a pothole is less than the diameter and larger than the radius of the probing wheel, respectively, P3 cannot perceive the real depth of the pothole) but a perceived depth of the pothole. Although the actual depth of potholes is desired, knowing the perceived depth can also provide invaluable assessment about the damage of the road surface. Obtaining the Wheelbase Information. In P3, additional attributes of vehicles such as the wheelbase information and the distance relationship between the instrument panel and the rear wheels are required but cannot be actively learnt by the smartphone. One possible solution to this issue is to let drivers manually provide such information as inputs to P3. One better solution which migrates the labor work of driver is to let drivers select the brand and the type of their vehicles. Then the corresponding attributes can be obtained by looking up a pre-built table. The Road Slope. There are doubts about the impact of road slope to the detection accuracy. We tackled the case in previous work . It shows that the road slope factor can be well filtered in the sensing framework thus the road slope can cause no impact on the detection and profiling phase. As long as we get the vibrations vertical to the road surface (no matter it is level or on a slope) the P3 can work. The key point is how to obtain vibrations vertical to the road surface even when the road is on a slope. To this end, we can adapt the technique proposed in our previous work [6], which reorients the coordinate system of the attached smartphone so that the coordinate system of the smartphone can align with that of the vehicle.

3. OUTCOME

3.1 APPROACH

To evaluate the performance of P3, besides of the Galaxy Nexus 3 smartphone and the Volkswagen Passat B5, we also involve a new smartphone of the Google Nexus 4 (made by LG, Android 4.2, 1.5 GHz quad-core, 2 GB RAM, maximum sampling rate of accelerometer: 200 Hz), a Volkswagen Lavida and two SUVs (a Honda CR-V and a Volkswagen Tiguan) in our experiments. Moreover, we consider different vehicle speeds, different phone placement and different sides of wheels We identify 23 different potholes in the downtown areaof a metropolis and obtain a trace of over 2,760 segments of vibration data collected with different configuration of vehicle type, vehicle speed, phone placement and side of wheels from June 4th to July 2nd for analysis. For the ground truth purpose, we plot the distribution of the real 23 potholes of the downtown road . Demonstration of effective depth. Field study with the implementation of the prototype system that the length and depth of these potholes are among quite large ranges. The depth ranges from 2 to 10 cm while the length between 30 to 120 cm.

3.2 EFFECT ON PLACEMENT OF PHONE AND SIDE WHEELS

As it is possible that vibrations of the wheel on the other side of the probing wheel (called the side wheel) may affect the pothole perception, we examine the eight potholes out of 23 potholes which have uneven road surface nearby. When crossing over these three potholes, it is possible to cause violent side wheel vibrations in addition to the major vibrations caused by the probing wheel at the same time. In this experiment, we examine the impact of phone placement and the side wheel. reason is that the side wheel vibrations are usually asynchronous with the vibrations of the probing wheel. Those asynchronous vibrations would interfere with each other and therefore affects the estimation accuracy and plots the length estimation error rate for all cases. It is interesting to see that the side wheel vibrations has little influence on the length estimation. As explained in above experiment, the inaccuracy of length estimation mainly lies in the estimation errors of the instant speed and the forcing vibration duration caused by a pothole, which are both independent of the effect of side wheel vibrations. We also try the left-side four cases, i.e., C-L, C-L+SW, L-L and L-L+SW, and get similar results, which are omitted from this paper due to the page limitation.

3.3OVERALL APPROACH

As we have learned from above experiments, to examine the best performance of P3, we select those vibration data from the trace when both smartphones are placed at the center of the instrument panel and both vehicles move at the speed less than 30 km/h. We estimate the profile of all 23 potholes based on the selected data and plot the cumulative distribution functions (CDFs) of the depth and length estimation error rate respectively. From these plots, it can be seen that the Tiguan with a better suspension system and the G4 smartphone with a higher sampling rate of 200 Hz. Depth and length error with different placements. CDF of depth and length estimation errors can always achieve lower estimation errors. For example, with the Tiguan and the G4 smartphone, 90 percent of the depth have an error rate less than 10 percent. With the Lavida with a G4 smartphone 90 percent of the length can have an error rate less than 20 percent. Furthermore, we aggregate of all the pothole perception data by using the linear error correction models described. The overall aggregated depth and length estimation error rates over all potholes decrease from 15 and 19 percent to 13 and 16 percent, respectively. It shows that the pothole perceptions with normal vehicles and smartphones can also provide useful information for P3 to improve global pothole estimation. In the future, we plan to enlarge the pothole profiling platform to the metropolitan scale in crowdsourcing way, to enable the solution of precise metropolitan-scale pothole sensing and profiling.

4. ADVANTAGES

The system provides a two way interface to update and access the data regarding any possible irregularity on the road. This will be an important tool to avoid accidents in the place where the risk of accident or injury is substantial.

Irregularities are more dangerous in low visibility conditions, such as night time, or foggy conditions, rain or snow. It also provides a novel method to have a reliable database about the road conditions and accident prone areas and can be further used to upgrade infrastructure.

The project can be extended to enhance the suspension systems of low cost vehicles and increase the comfort of the driver. The major innovation of this work is in countries like India, where the probability of irregularities on the road is more and condition of the roads are prone to changes.

This proposition looks forward to various advantages as:

1) Reducing the time invested by personnel in monitoring damaged roads.

2) Significantly reduce the number of accidents and deaths occurring per year due to damaged roads. .

3) Can be implemented in any vehicle without causing any change in the mechanism of the vehicle.

4) It can function effectively and efficiently in any weather condition.

5) To conclude we can infer that this system provides an easy, safe and cost efficient solution for problems faced by officials appointed for monitoring the damaged roads.

5. CONCLUSION

In this project we propose a demo for Smartphone based road conditioning monitoring and alert system. It is an application that can be of substantial value to city authorities and drivers, especially where the roads are unsafe for commutation.

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