A COMPARATIVE STUDY ON POTHOLE DETECTION TECHNIQUES FOR VEHICLE IN AN INTELLIGENT TRANSPORTATION SYSTEM

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ABSTRACT

In modern days, the economical growth and flying technologies has led to serious affect on the quality of traditional transport system. Intelligent transportation system (ITS), desire to boost the transport system, and it becomes more and more popular. Moreover, improving the safeness of traffic is an important task of ITS. The road cracks can be identified in the form of paved path defects, road bumps and potholes. In these types of road defects major damage to vehicles and lost human lives is because of road bumps and pothole. Thus, in detection of these road defects potholes and road bumps takes the major role. This paper gives the study of various pothole detection techniques. Potholes cause tire blast and damage the wheel. The impact of pothole is more on lower vehicles, such as collision of vehicles and causes serious accidents. Thus, accurate and quick detection of potholes has become one of the important task for ITS and road management system (RMS). More research has been made for determining a technology for automatic detection and recognition of potholes. This paper gives the study of existing path hole detection mechanisms and results. The pothole on the road causes serious harm to drivers' safety. Therefore, drivers' safety may be improved with the improvement of real-time pothole detection system for sharing the pothole information Section 1 gives the introduction, Section 2 gives related work, results in Section 3, Conclusion in Section 4 and Section 5 gives references.

Index Terms— VANETs, ITS, OBU, DSRC, Road Bumps, Pothole

I. INTRODUCTION

With the fast growing of highways, a person travelling on road has become too humiliating. In spite, with the increasing no. of vehicles leads heavy load to traffic system. Therefore, Intelligent Transportation System (ITS) is a technology used in Vehicular Adhoc Networks (VANETs) considered for reducing road congestion and relinquish guarantee of vehicle safety and human life [3]. VANET is a system of network in which vehicles and road side units are the communicating devices, connect each other by sharing the information like safety warnings and traffic information with the support of On Board Unit (OBU). VANET uses sensor technology, for short range mobile communication and information processing [4]. Vehicles on highways are more significant for traffic accidents due to the high speed. The main objective of VANET is providing safety assurance and comfort for passengers.

Some of the roads in rural places are with more path holes, and causes serious problem to vehicles and drivers, as of this-potholes are important in indicating the structural defects of the road, and accurate detection of these potholes becomes an important task for ITS. However, detection and evaluation of these path holes manually is time consuming and expensive task. Wherefore, several efforts are used for designing a technology to detect and notice the potholes automatically, and also for sharing that information to the driver for avoiding the accidents, improves the traffic safety and driver safety. The path holes are of different types (figure1).

Figure 1: Types of Potholes

All the Existing pothole detection methods are classified into different types:

- Vibration-based methods,
- Two-Dimensional (2d) image based approach method
- Three-dimensional (3d) reconstruction based methods
- Vision-based methods
- Image recognition method and
- Mobile sensing method.

The importance of accelerometers in Vibration-based method is to detect potholes. It is used in real time processing and it needs a small storage medium for storing the pothole information. The shortcomings of vibration-based method is it produce the incorrect outcome, for instance, instead of potholes the hings and joints were detected because of no connection between the potholes and the wheels.

A 2D image based method with various features is proposed to improve the existing pothole detection method for accurate detection of a pothole. The performance comparison is made on both proposed and existing methods of pothole detection on different parameters such as status of the route, interpretation (recording), and visibility of the road. The suggested method for pothole detection is not only for determining the maintenance of RMS, and also for their repair, by providing alert information to drivers and to government.

The economical comparison of Vision-based method and 3D laser scanner method is strenuous in accurate detection of a pothole as the garble gesticulation produced by disturbance in recording images and visuals.

An Image recognition [13] method uses laser image approach to gather route status and ANN in analyzing the route information in order to identify potholes [6]. Though, this way of detection needs a much computational power to identify the laser image for mobile devices.

In Mobile Sensing Method, On-Board Unit (OBU) uses a sensor G and GPS technology for collecting pot-

hole location information and accelerometer data. This information is analyzed by data processing center to verify the exceededness of the vector's accelerometer data and the threshold limit of detection [8]. However, this method takes batch accelerometer data from start location and is not suitable for providing pothole information at real time.

A 3D laser scanner method [2] uses the 3D measurement for identifying the pothole. The cost of the equipment used for laser scanning method is high, and it focuses on the accuracy of 3D measurements at high computational effort.

A 2D image based method approach [8][13] is a method used for detecting pothole and it is limited to a one frame, so it cannot give the assessment of the pothole in all cases.

In VANET each vehicle is provided with Wi-Fi/ Wi - Max device and behaves as a node. Every vehicle contains unique ID and IP address for communicating with other vehicles. Any vehicle can identify other vehicles identity to a roadway WAP (Wireless Application Protocol) and information is provided by the vehicles directly to the WAPs. The collective information is stored by the WAPs at a dynamic server database.

II. RELATED WORK

A. Image based pothole detection system for ITS Service and Road Management System.

It uses a two-dimensional (2D) image based method for detecting pothole by developing a system for finding pothole for ITS service and RMS. The pothole detection system using 2 dimensional methods is described as follows:

The Pothole Detection System: This PDS uses newly developed optical devices seated on the vehicle to collect the road images and finds a pothole based on recorded information. Figure 3 shows a pothole detection system; which includes optical devices and a PD algorithm.

The optical device on a vehicle record potholes details [2] (like place located, and status of a pothole) and sent to PDA. A pothole detection algorithm sends the pothole information to road management center. The optical devices were mounted on vehicle and perform several functionalities such as collecting and storing the pothole information, through wireless communication, gather the pothole details by GPS. This obtained pothole information is forwarded to a pothole center, pothole center to pothole alert service and from this to RMS. From Fig:2, the pothole data is forwarded from a pothole center to RSEs (Roadside Equipment) and from RSE to (OBU) Onboard Unit /navigations through Dedicated Short-Range Communication (DSR C) [10] and WAVE. At last, pothole alert details (like severity and place) is shown on OBU or on navigation. Before coming near to it, the driver has an opportunity to know the location of it before he reaches it and can avoid the risk. This detection and warn facility becomes an innovative idea for further research.

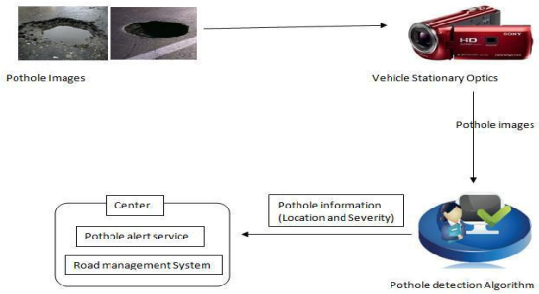

Figure 2: Pothole Detection System

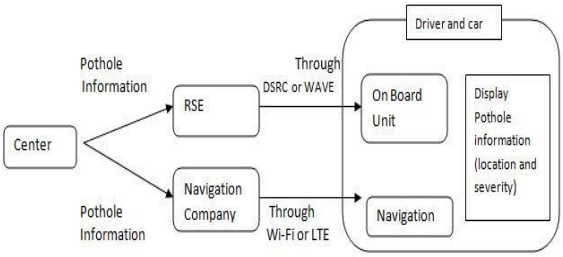

Figure 3: Pothole Alert System

B. A Real -Time pothole Detection Approach for Intelligent Transportation System

This analysis helps the users and the government to detect and share the pothole details through mobile sensing technology. This needs a mobile with GPS and *G*-sensors to gather the pothole location information along with accelerometer data. The accelerometer data is regulated by Euler's angle calculation and is deployed in the pothole detection algorithm to collect the pothole information. Also uses, the spatial interpolation method to avoid location errors from GPS data. Afterwards these details are made public to enhance safe journies

Problem Definition: The shortcomings in previous pothole detection methods are: (1) Specific angle is not fixed to a mobile device; (2) high false positives may be given by taking a single threshold for finding a pothole; (3) unable to detect correct place of the pothole.

Thus, this paper gives a real-time pothole detection method with mobile sensing technique to fetch and normalize the accelerometer data collected from mobile device to establish free angle. In addition, the proposed pothole detection algorithm takes many values and integrates many approaches for accurate location finding of pothole. Finally, the space interpolation method is used in order find pothole exact place to eliminate shortcomings.

Accelerometer Data Normalization: This Method uses Euler angle formulas to normalize accelerometer data in 3-directions (p, q and r). The Euler angle determines the vector set in 3-D Euclidean space parameters (three parameters) and represents three order elementary rotations. From Fig:4 the vector set of accelerometer data is defined as {p',q',r'}.The p'q'r' whirls p'-axis by angle alpha(α). The q'-axis is at an angle with respect to the q-axis, and the r'-axis is at angle

with respect to the r-axis. According to Euler angle formulas, the vector set [p, q, r] can be calculated by taking the values of vector set {p', q', r'} and angle.

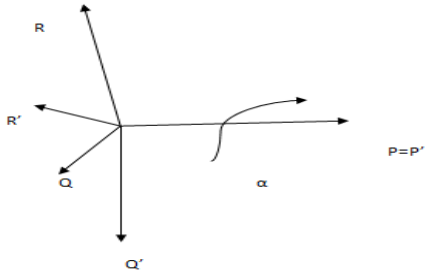

Figure 4: A case study of Euler's angle

C. *Pothole detection system using Machine Learing on Android*

This study uses Accelerometer Sensor of Android smart phone for detecting potholes and *GPS* for identifying the location of potholes on Google Maps. A simple machine-learning approach is used to for identify the potholes from accelerometer data in real time. The pothole detection algorithm uses some assumed some threshold values on first axis (p-axis) and third axis (r-axis). The process of proposed pothole detection system is taking the sensor readings and judging the accuracy of the system in using a neural network.

REQUIREMENTS AND SCOPE

The requirements and scope of the proposed pothole detection system is:

1. Applications utilizing the machine learning implementation should have permissions matching those of the sensors used.
2. Evaluating the raw sensor data in real time.
3. Reporting the collected to the appropriate authorities.
4. Native communication tasks of the device should not be hampered.
5. Data collected by components should be made accessible to all other applications, and components.
6. The algorithm designed should avoid resource-intensive techniques to determine result.

POTHOLE DETECTION SYSTEM

The plug-in of pothole sensor installed in an Android Smart Phone records the changes in the acceleration in order to detect potholes. The device's built-in accelerometer is used for collecting the p-axis, q-axis and r axis accelerations. The GPS (Global Positioning System) chip is used to collect location co-ordinates. The proposed system contain total of 3 modules such as Display module, Logic module and State module. GPS is included in the Display module, with appropriate options to carry out the task. Some generic plug-in should be used implemented along with other context aware applications to detect the pothole location accurately.

This algorithm accepts the training set and displays the pothole scenario in the particular area, when the user starts their journey; they have to launch the pothole detection Android application in their smart phone. The application has the plug-in for running the algorithm, to detect the potholes on the roads while user is driving. It monitors for changes in the acceleration and adds the current time, geographic co-ordinates and pothole statistics to the event log [1].

When the user completes their journey he/she taps the button _Stop and they are presented with the event log. This log should be maintained in the database.

This application gives the condition of the roads along with their locations. The distributable event log can be used to alert the local authorities following which, they can fix the bad road and resolve the complaint. This can eventually result in a safer and a more enjoyable driving experience.

- A high pass filter removes low-frequency components from acceleration signal in x-axis and z- axis.
- *Use a high-pass filter*

final float á = (float)0.8;
gravity[0] = á * gravity[0] + (1 – á)* event.val [0];
gravity[1] = á * gravity[1] + (1 – á)* event.val [1];
gravity[2] = á * gravity[2] + (1 – á)event.val [2];

- Peak acceleration in the z-axis is a prime characteristic of significant road anomalies. This filter rejects all windows with a peak z-acceleration less than a threshold _tz'.
- *High-pass effect: Removing of low-frequency component*

aclVal[0] = event.val [0] – gravity[0];
aclVal[1] = event.val [1] – gravity[1];
aclVal[2] = event.val [2] – gravity[2];

- A true pothole event with large z-peak acceleration should produce a significant peak in the x-axis.

z-peak

Assume threshold on z-axis. (tz)
Reject the reading if AclZ< tz

x-z comparison

Assume threshold on x-axis (tx)

Reject the reading if AclZ< tx*AclZ

- At high speeds, even small road anomalies can create high peak acceleration readings. This high pass filter reject windows where the z acceleration is less than a factor _ts' times the speed of travel.

Speed factor

Assume speed factor _ts'.
Reject the reading if AclZ & lt; ts*speed.

If above conditions are satisfied then it is a pothole. Else, it is not a pothole.

III. RESULT

The pothole identification method was executed with the help of Microsoft Visual C++ 6.0. The images were processed in a laptop for various threshold values and were tested for detection of different types of potholes. The pothole is detected by considering the image of that pothole which is shown in figure 5. Accelerometer technique is used not only for detecting the pothole and also for identifying the height and depth of the pothole,

using X-axis, Y-axis, and Z-axis (Three Dimensional method)the result is shown in figure 6.

Figure 5: Detection of Potholes

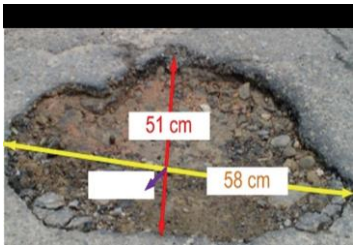

Figure 6: Potholes with height and depth

The detected information is passed to the users mobile for that user has to install an Android app in to their mobile phone and the home page of that mobile app is shown in Figure 7.

Figure 7: Screenshot of the App Home screen

IV. CONCLUSION

The detection and identification of pothole can be performed by using any of the above specified method but these potholes may not be found accurately because the shadow and shape effects a lot. So, to detect pothole effectively it must use the image of the pothole collected from multiple sensors instead of single sensor.

The road defects can be identified in the form of paved path cracks, rutting, road bumps and potholes. In these types of road defects major damage to vehicles and lost human lives is because of road bumps and pothole. Thus, in detection of these road defects potholes and road bumps takes the major role, which is more pervasive and effective communication among the drivers could contribute importantly in reducing road accidents.

This paper gives the mini review of various road defect techniques for identifying pothole based on differrent technologies like mobile sensing techniques [5], Vibration-based methods, Two-dimensional(2d) image based approach method, 3D (Three Dimensional) reconstruction based methods, Vision-based methods, Image recognition method and Mobile sensing method along with their results, pros and corns. Each technology aims to alert the drivers by passing the pothole alert information prior to reach the pothole. Pothole detection and alert service becomes an innovative idea for further research.

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