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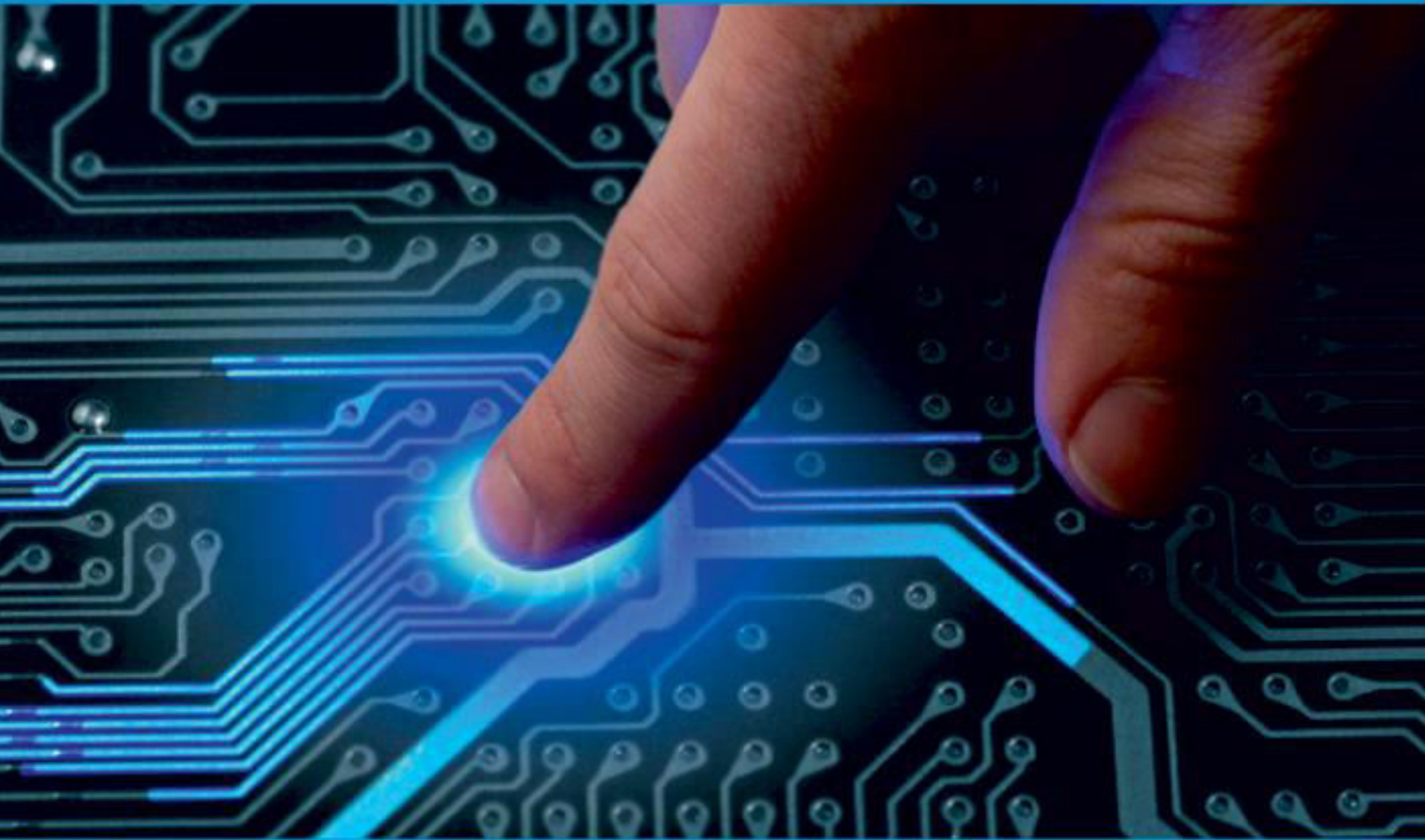

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Idle Pothole Detection using Mobile Sensors

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ABSTRACT: According to the Ministry of Road Transport and Highways (MoRTH), Government of India, close to 5000 road accidents occur due to potholes. Bizarrely, January 15 is National Pothole Day in the US, which houses an estimated 55 million potholes. According to a study by AAA, between 2013 and 2018, 16 million drivers across the US suffered pothole damage to their vehicles, summing to $3 billion every year, costing the average driver $300 in vehicle damage. Through our research and experiments, we have created an application that will detect road irregularities through the idle smartphone, and create a parameter which is displayed to the end user on a Google Maps interface.

KEYWORDS: pothole, mobile sensor, accelerometer, gyrometer

I. Introduction

A pothole is a kind of pavement distress which could be a bowl-shaped depression within the surface of roads, usually asphalt pavement, which is caused because of the sudden change in atmospheric condition. Potholes can generate damages like pneumatic tyre and wheel damage, impact and damage on the lower a part of a vehicle, sudden braking and handwheel operation, and vehicle collision and major accidents.Since these anomalies exist in numerous, random and stochastic shapes this has clothed to be the limitation in today's world.

The potholes became a serious reason for traffic and various road accidents. The india records over 3000 fatal accidents per annum because of these road anomalies Detection of those potholes is extremely important so as to facilitate road maintenance, provide an improved experience in automatic driving, reduce the danger of accidents (collisions, falls etc.) for the vehicles and reduce the probabilities of wear and tear and tear of tires.

Our application attempts to solve the problem of road anomalies faced by many people during their journey. The application is proposed to collect road quality data by using in-built sensors and by using that data we are detecting the road anomalies and then performing various computations.

II. Related work

From [1] paper a suitable system, wherein sensors would be fitted to the government bus network and data collected from it. It faced severe bottlenecks pertaining to the amount of data collected, as rollout was limited to only buses. From [2] we concluded that it is better to use a machine learning approach in which first a set of training data is manually collected by carefully and repeatedly re-driving a set of roads and noting the location of various different classes of road anomalies (potholes, railroad crossings, etc.).The [3] paper describes a mobile sensing system for road irregularity detection using Android OS based smartphones. Selected data processing algorithms are discussed and their evaluation presented with a true positive rate as high as 90% using real world data Authors used an optimization function which considers nature of the packet, size of the packet and distance between the nodes, number of hops and transmission time are also considered for optimization. The [4] paper describes a system and an associated algorithm to monitor the pothole conditions on the road which highlights a machine-learning approach to identify the potholes from accelerometer data and promises real-time detection of the potholes. This [5] thesis helps in formulating an approach, in which a database is maintained for each road, which is made available to the public with the help of a global database or through a portal. Potholes and speed breakers are detected along with their severity using android's built-in accelerometer. From [6] we come to a conclusion that SVM(support vector Machine) is one of the best classifier which is mostly used to train on road anomalies features which will then be used to detect potholes.The Cloud detector then uses the calculated features and the output from the classifier to detect and localize the potholes with lane-level accuracy. From [7] we have concluded a suitable system which uses sensors in every tire of a vehicle which will then capture the vibrations and then contrast them with existing video and manual systems. We also consider other parameters as well like paths being traversed and so on. From paper [8] we concluded that a trained SVM model can be a best choice in order to assess roads using this sensor data. The size of the dataset will directly determine the accuracy

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of the outputs to the trained model. In [9] we come to the conclusion that the virtual road network inspector (VRNI), which is a novel road damage detection method based on support vector machine models, can be used to monitor road conditions. from [10] we have formulated a system which will use the mobility of the particular vehicle on which the developed system will be fitted, and side by side gather data from the vibrations and the GPS sensors,And then using the machine learning approach, they were able to identify and classify the potholes and other road anomalies from the accelerometer data.

III. PROPOSED ALGORITHM

IV. *Design Considerations:*

- The system is designed to use a generic smart-phone with accelerometer sensors as the hardware/software platform.
- The system is designed to run on different smartphone models with different parameters. During the system implementation process, the set of minimal smartphone parameters have been determined and described.
- The system running on a smart-phone has been able to perform its native communication tasks at an adequate quality level while utilizing bare minimum system power.

V. *Description of the Proposed Algorithm:*

Aim of the proposed algorithm is to be able to determine the presence of a pothole accurately during the course of travel. The proposed algorithm consists of three main steps.

Step 1: Polling the accelerometer:

The first step in the algorithm is to detect the presence of accelerometer in the host device and establish a subscription to sensor data. This algorithm makes use of sampling to reduce the polling overhead to the device by only polling 10 times every second.

Step 2: Filtering and determining presence of pothole:

Once the stream of sensor data is setup, we are now ready to analyze the sensor and determine whether at that moment of time whether a pothole was experienced or not. The algorithm is based on using X and Z axis acceleration and the vehicle velocity data as input. The algorithm consists of five consecutive filters: speed, high-pass, z-peak, xz-ratio and speed vs. z ratio. Each filter is used as a rejecter of one or more event types not related to potholes such as door slams or railway crossings. In the event that a cluster of potholes is experienced, the algorithm is mature enough to generate an instance with cumulative intensity thereby reducing processing load on the backend. Each time a pothole is detected, it is associated with current geo-coordinates and stored in a list while associating it with currently being traversed polyline.

Step 3: Collecting the gathered data and packing for upload:

Once the user reaches his destination all the pothole data which had been earlier connected during the transit is now packed in a format suitable for the backend to consume and process. The collected data is then sorted by the algorithm based on timestamps and further scanned for presence of improper values.

VI. ALGORITHM

Step 1: Start Navigation and establish subscription to Accelerometer sensor data.
Step 2: If sensors are present go to step 3, else go to step 8
Step 3: Till Navigation is not over, repeat from step 4 to step 6
Step 4: Invoke high pass filter with current sensor values
Step 5: If pothole detected, store the pothole in a list
Step 6: Go to step 4
Step 7: On end of Navigation, send the list of formatted nodes to server
Step 8: End

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VII. RESULTS

As there was no (recent) survey data available to evaluate our application against, a manual evaluation was carried out. This was done by actively monitoring road quality while out on a drive (in a standard, 5 year old compact hatchback) and comparing against the detected data. External tools were used to carry out testing, such as a manually developed application to keep track of test parameters.

True Hits	False Hits	Missed Hits	Net Accuracy
96%	1 per 67 true hits	4%	96%

Table - Test Results

VII. CONCLUSION AND FUTURE WORK

The goal of our project, repeated for the reader's convenience, is to build an efficient and effective application to collect road quality data with mobile based sensors (so as to moot the requirement of additional hardware). The Pothole Detection System is an attempt to provide its users with better knowledge about the routes of their transportation. Despite hardware differences in terms of GPS accuracy, accelerometer sampling rate and noise, we postulate that accurate pothole detection is possible. We believe that our experience will help to improve efficiency and reduce time and effort for further experiments using the Android platform for vehicular sensing researchers. With further work in this field, it is possible for this project to play a proactive part in improving road conditions in developing countries.

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