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Detection of Pothole in Real-Time using Android based Application

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Abstract - *Road networks are the means of transporting, sharing and movement of goods and services from place to place in society. Road networks are also channels of communication in some parts of the world. Consequently, access to good road networks enhances the quality of life and work of people living in society. But the poor nature of design and development of road networks coupled with natural disasters such as heavy rainfall has brought about many unwanted potholes and scratches on the roads which are very dangerous to commuters and other road users as well as vehicles that utilize the roads. In addition, the lack of a proper road maintenance system has resulted in an ever-increasing number of potholes which endanger efficient transportation and road safety. Meanwhile road maintenance works has largely depended on manual detection and reporting.*

The project conducts a study into the use of the internet of things to detect and report potholes on roads. The paper assembles an open hardware equipment and sensor to experiment the detection and reporting of potholes using GPS Tracker devices. The project presented the architectural design and system to detect, report and manage potholes and other road obstacles using GPS Tracker. The project also presented some prospects and challenges in the implementation of the internet of things GPS.

The main components of the project are the Accelerometer, GPS and the Android smartphone. This project would be given to government road contractors to rectify the potholes and avoid accidents and help in traffic analysis. Also, our aim is to make safety systems affordable to every vehicle in the country.

Key Words: Accelerometer, GPS, SVM Algorithm, XAMPP Server.

1. INTRODUCTION

Roads are the dominant means of transportation in India today. Over the last two decades, there has been a tremendous increase in the vehicle population. This proliferation of vehicles has led to several problems. Potholes are formed due to heavy rains and movement of vehicles. To address the above-mentioned problems, a cost-effective solution is needed that collects the information about the severity of potholes and also helps the drivers to drive safely. With the proposed system an attempt has been made to endorse drivers to ward off the accidents caused due to potholes. Accidents are pretty common on the roads as the cars move very close to each other, which can be prevented by assisting the driver by informing him that another vehicle is very close to him. In case of Emergency help and accident cases, sending the real time location to registered numbers can save lives.

Potholes and speed ramps are among the most common obstacles on most road networks. These road obstacles and disruptions in the surface condition of roads are among the causative factors of road accidents, carnages and fatalities. This project examines the prospects and challenges of the Internet of things GPS Tracker in detecting, reporting and management of potholes and other obstacles on our road networks.

2. RELATED WORK

Road infrastructure repair has accrued many knowledge over the last few days. Poor road conditions often cause problems and harm to automobiles and passengers that cannot be ignored. Some of the big factors that are causing harm are potholes, speed-breakers, rough patches, etc. The existence of such abnormalities also affects the consistency of the ride and protection of the passengers. The paper explains the low-cost method that uses a smartphone and an OBD-II module to find and locate road potholes [9].

2.1 Architectural Design

Modules: -

- Preprocessing
- Feature Extraction
- Classification

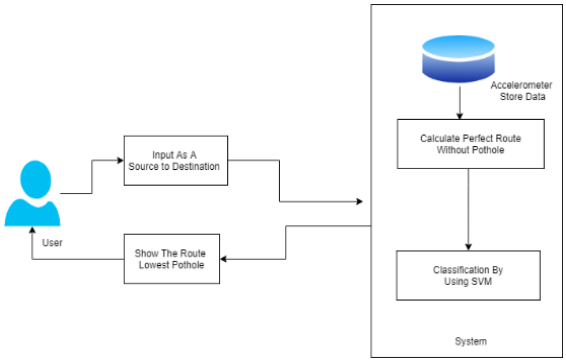

Fig -1: System Architecture

2.2 Data Model and Description

In Data Flow Diagram, we show that flow of data in our system in DFD0 we show that base DFD in which rectangle present input as well as output and circle show our system, In DFD1 we show actual input and actual output of system input of our system is text or image and output is rumor detected likewise in DFD 2 we present operation of user as well as admin.

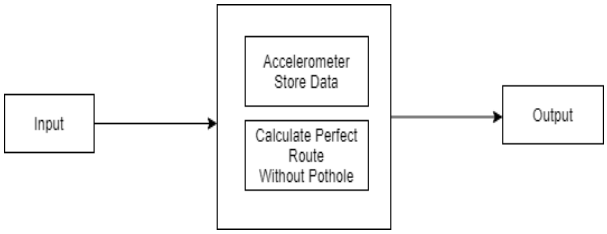

Fig -2: Data Flow Diagram (DFD 1)

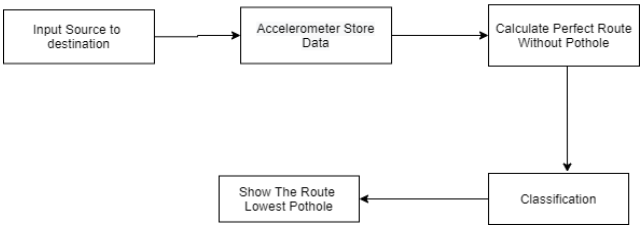

Fig -3: Data Flow Diagram (DFD 2)

3. LITERATURE SURVEY

This literature survey review has helped us to understand and motivated us to develop android based application for pothole detection for various real world.

3.1 Analysis of Pothole Detection Technique

Potholes are not just structural distortions on road surface, but they are also a major cause of causalities. The proposal describes one such road maintenance system which uses Basic Ultrasonic Sensors, Raspberry Pi and A Mobile Phone with Internet Capabilities which are connected to an Internet-of-Things platform over the Internet. In addition to providing a generic Internet-of-Things based platform, the proposed solution brings objective real time data about the state of the roads in a particular region which can be sent to the local authorities to take further actions upon. An immediate detection and repair can result in road safety and saves many lives.

3.2 Stero Vision Based Technique

Yaqi Li Christos Papachristou [4] proposed a stereo based system that helps to detect the potholes. Following is the workflow for the same:

- The system contains two USB cameras taking photo simultaneously of the road.
- After collecting all the required data. We use parameters obtained from camera calibration with checkerboard to calculate the disparity map.
- By making the use of 2-dimensional image points that can be projected to 3-dimensional world points using the disparity map.
- With all the 3-dimensional points, we use the bisquare weighted robust least-squares approximation for road surface fitting.
- All points below the road surface model can be detected as pothole region. The size and depth of each pothole can be obtained as well.

So, these steps help us in the robust detection of the road conditions.

3.3 Deep Learning Approach for pothole detection

Author introduces us to a system which uses deep learning algorithms and is integrated with smartphones to detect potholes in real-time. The UI of the system is a smartphone application which maps all potholes on a route that the user is traveling. The deep learning approach which we are using is object detection algorithm known as Single Shot Multi-box Detector. In this algorithm Single Shot Multi-box Detector (SSD) looks for potholes using a mobile camera in the background. As soon as some unregistered pothole is been detected by SSD, immediately the coordinates of potholes are updated in real time in our database. Along with this accelerometer and gyroscope readings are continuously taken and assessed by a Deep Feed Forward Neural Network model to detect unregistered potholes. This dual mechanism not only cross-validates detection but also provides stable result.

3.4 Detection of Potholes Using CNN

Convolutional Neural Networks (CNNs) have the ability to learn the art of extracting relevant features from an Image. We have created a dataset of 1500 images datasets of pothole. The dataset is annotated and trained using YOLO (You Only Look Once). The new dataset is trained on YOLOv3, YOLOv2, YOLOv3-tiny, and the results are compared. The results are evaluated based on the mAP, precision and recall. The model is tested on different pothole images and it detects with a reasonable accuracy.

3.5 Deep Trigger Based Pothole Detection and OBD - II

The author describes a low-cost method that employs a smartphone and an OBD-II module to detect and locate potholes on roads. It utilizes vision data, sensor data and OBD data to create and validate triggers caused by potholes. The image-triggered and data-triggered methods proposed recognize potholes on roads and create a trigger through image/video processing and data processing respectively.

The results obtained from each method is cross validated by the other method that help in evaluating ride quality based on road conditions.

3.6 Cooperative Sensing And Analysis Of Pothole

There are many different approaches for road quality controls. Among them, the one making use of smartphones has recently become very popular. Nevertheless, building a system that saves energy for smartphones and adapts to real conditions remains a big challenge. In this article author Van Khang Nguyen†‡ and ´Eric Renault§ [5], we introduce a lightweight architecture to sense and analyze potholes based on data collected with smartphones. In this model, we improve some algorithms for real-time road-anomaly detection using smartphones. The efficiency of these new algorithms has been verified by experiments with both cars and scooters. Index Terms—road anomaly, pothole, Grubbs's test, sensors network.

4. TECHNOLOGIES USED

Our smart phones have a sensor for checking the acceleration. And to detect potholes we can use this sensor through its changing acceleration value. For this system the user have to have an android smart phone. Accelerometer is in-build in every android mobile phones and it finds the x, y and z axis values of the device.

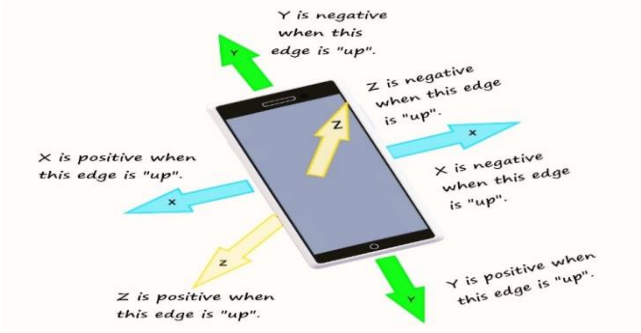

Fig -4: Functioning of Accelerometer sensor

GPS chip in the phone will locate the detected pothole. The android application will collect the data of sensors. Figure 4.2 shows the real time variation in the sensors of any android application from SensorLab application.

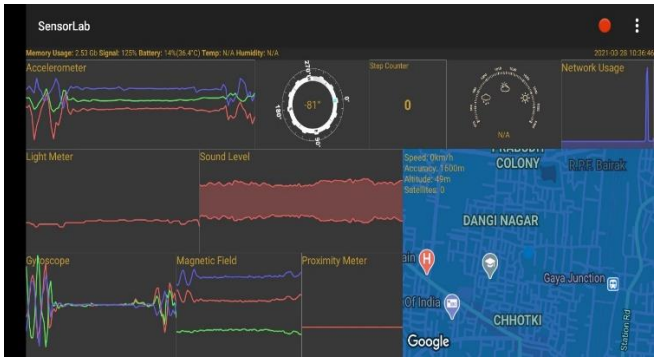

Fig -5: Real-Time variation in sensor

The data of acceleration values and GPS can be stored in a database from the application. While analyzing the data it is observed the data cannot be predicting potholes right so it needs various pre-processing techniques. If phone is kept not at any proper angle then it can effect the accuracy of the system also if there is just acceleration problem of the vehicle and not a pothole it can predict wrong information. For various false conditions the data needs to be pre-processed. The pre-processing steps can include labelling, filtering, sampling, reorientation for more accuracy. We can use classification methods of machine learning for predicting potholes. Machine-learning utilizes data or experience to automatically optimize the performance of computer programs. Classification being the most essential work in Machine learning. It involves using the model constructed with a training dataset to make predictions regarding the categories of items in the testing set. The object of this study was to use the vehicle vibration data collected by the smartphone to find potholes via machine-learning; a substantial classification task. We will do a comparative study on SVM and CNN for better performance. The condition of roads and their location is sent to the required municipal authorities to take care of that area.

4.1 Algorithm Comparisions [SVM vs CNN]

SVM learns decision boundary which maximizes the distance against the closest observations that belong to opposite classes. This, in turn, should produce better performances against the edge cases that we're going to encounter in the future.

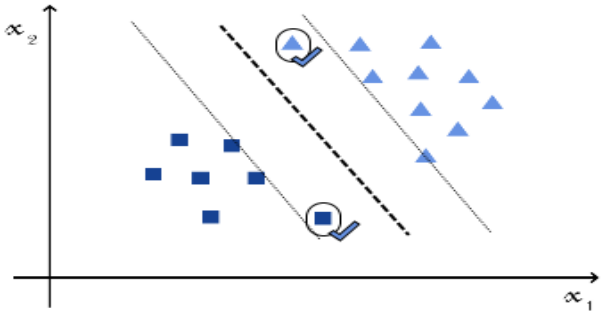

Fig -5: Visualization of SVM Algorithm

A neural network would certainly learn some decision function and perform well under training, testing, and validation. The function learned, however, isn't necessarily distant from the observed samples. On the contrary, it may be very close to them, and thus incorrectly classify many future observations against real-world data.

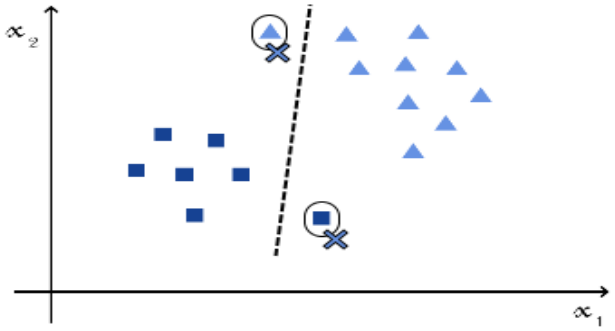

Fig -6: Visualization of CNN Algorithm

An CNN is a parametric classifier that uses hyper-parameters tuning during the training phase. An SVM is a non-parametric classifier that finds a linear vector (if a linear kernel is used) to separate classes.

In comparison to SVMs, CNNs are more prone to becoming trapped in local minima, meaning that they sometime miss the global picture.

While most machine learning algorithms can overfit if they don't have enough training samples, CNNs can also overfit if training goes on for too long - a problem that SVMs do not have.

As stated previously, SVMs are typically used for classification problems. In some of these problems they perform really well, in some cases better than CNN, due to the fact that for constructing the decision boundary, SVMs only rely on the Support Vectors, which are the training samples that lay exactly on the hyperplanes used to define the margin.

In addition, in the case of not linearly separable data, SVMs have the powerful "kernel trick", which allows to map the data to a very high dimension space in which the data can be separable by a hyperplane, almost at cost 0.

And hence for classifying the potholes SVM can do better as it tests the border situation well.

4.2 Proposed Algorithm for Detection of Potholes

The acceleration values of all the coordinates is detected through accelerometer and other sensor like gyroscope. We can implement the system through following algorithm.

1) The low-frequency elements are removed by filtering via high pass filter from acceleration of x and z axis. This will remove values less than threshold.

2) Road potholes can be identified by peak value of x-axis acceleration produced by large value of z-axis acceleration.

3) Even small road problems can be detected as potholes at high speed with high acceleration reading and therefore the filter should rejects where z peak value is less than a factor multiplied by speed of travel.

4) Classification algorithm is then applied on the cleaned data.

5. CONCLUSION

This study was done for development of a system for detecting potholes using smartphones. There is lot of other research about finding potholes but it can be more expensive and not feasible to implement but with the help of android application we can use it at very less cost and much reliable. In this study we have analyzed and surveyed the steps for designing a system and collected the data of various sensor which can be helpful for this. Classification method is also being analyzed and the best for this system will be support vector machine algorithm. Hence, we conclude with a design of an android application for detecting of road anomalies.

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