ORIGINAL RESEARCH PAPER

Volume - 10 | Issue - 04 | April - 2021 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

INTELLIGENT SMARTPHONE SENSORS FOR DETECTION OF POTHOLES ON A ROAD SURFACE

Computer Science

Ambili M P*

Department of Computer Science College of Engineering Vadakara Kozhikode, India. *Corresponding Author

ABSTRACT

Monitoring of road surface is essential for travellers as well as for the municipal corporations for choosing the best possible road .This will provide the comfort and security to the vehicle travelers. This also helps drivers to avoid accidents. Currently road condition monitoring approach is slow as well as costly. In this paper, to sense potholes which uses accelerometer and gyroscope, both built in the modern day smart phones,.By using accelerometer pothole induced vibrations can be measured on the axis reading, making them distinguishable. Our proposed method is a series of processing methods were applied to the collected data, and features from different frequency domains were extracted, along with various machine-learning classifiers. The results indicated that features from the time and frequency domains outperformed other features for identifying potholes. Among the classifiers tested, the Random Forest method exhibited the best classification performance for potholes.

KEYWORDS

Pothole, Accelerometer And Gyroscope,sensors,classifier,random Forest Method

1. INTRODUCTION

Road surface monitoring is essential for municipal corporations for quick maintenance and detection of potholes, detecting the other abnormalities of the road such as speed breaker rail road crossing etc and making them accessible to the travelers will provide a better driving experience. If such information of all roads is put on a central server which could be accessed by anyone freely, the drivers can choose the best possible road from source to destination.

The pothole detection model is trained that uses the data acquired from the smartphone sensors, namely the accelerometer and the gyroscope, to classify the real instances of potholes. The accelerometer measures vibrations or inclination in the three directions, X, Y, and Z axes, and can help characterize the pothole on the basis of the magnitude of change in its reading. The gyroscope adds an additional dimension to the information supplied by the accelerometer by tracking rotation or twist. This vibrations based approach gives low response time, processing time and maintenance cost of the device.

Fig.1 Example of pothole

2. LITERATURE SURVEY

Several pothole detection methods have been put forward, a few of which make use of the data obtained from the inbuilt smartphone accelerometer to discern potholes.

An analysis of various papers on pothole detection methods by considering the type of equipment and methods employed has been done and the research gaps are identified. After analysing Table 1, it has been observed that while accuracy is high, the recall score is low and potholes are relatively misclassified as compared to non-potholes.

Table1.Analysis of literature review

Authors	Year	Equipment & Methods	Research Gaps Identified
Mednis et al [3]	2011	4 Android OS based smart-phones	Best results are reliant on frequency and timing
Kulkarni et al [4]	2014	Threshold values on x-axis and z-axis have been taken for the neutral network	Other performance metrics not mentioned
Wang et al [5]	2015	Combining the Z-THRESH and G-ZERO approaches	Limitation of the study is the small sample size
Bhatt et al [6]	2017	SVM classifier, improved using a threshold	Recall of 0.42
Song et al [7]	2018	Data pre-processing done for a restrained Inception V3 and Transfer Learning	Considered only five real instances, collected 20 times for each instance, suggesting overfitting

3. PROPOSED WORK

The proposed work focuses on building an efficient pothole detection system, that is a classifier with increased accuracy, while also ensuring that the process is not too complex and time-consuming.

The architecture has four major stages: data collection , pre-processing of data, building the model, and evaluating the classifier. The raw data was collected from the smartphone's in-built sensors: accelerometer and gyroscope.After the data was cleaned and transformed to improve its quality, it was fed to the proposed model, that is the machine learning classifier . Finally, model was evaluated on a number of evaluation metrics to make out its performance.

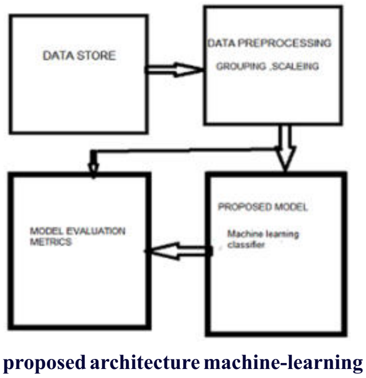

Figure2:- the proposed architecture machine-learning classifiers.

3.1 Data Collection

The dataset is primarily the vibration based sensor readings collected from a smartphone's in-built sensors, that is, the accelerometer and gyroscope as the phone was mounted on the wind shield of the vehicle to detect said vibrations.

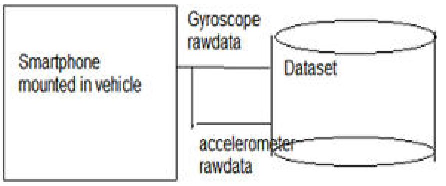

Figure 3:- Raw Data Collection

The data is the result of five trips over a selected road with sufficient instances of potholes to make inferences. The minimum, maximum,mean and standard deviation values of the x,y and z directions of the accelerometer as well as the gyroscope the inputs .

3.2 Pre-processing

3.2.1 Grouping - Each instance of the dataset was originally taken every fifth of a second, which resulted in turbulent fluctuations. The instances were grouped by intervals of two seconds each, in order to make better sense of the data points.

3.2.2 Scaling - Standardization (or z-score normalization) scales the values by the mean while taking into account standard deviation, consequently reducing the effect of the outliers in the features. x =(x − mean(x))/std(x) . This aggregation provides a finer signal for pothole classification.

3.3 Proposed Model

The proposed model is one of the most widely used machine-learning algorithms and exploits swarm intelligence by aggregating individual predictions based on various decision trees to decide the final constructing multiple independently trained decision trees [8]..Generally, Bootstrap Aggregation (Bagging) is used in the ensemble procedure to reduce the variance of the decision trees, which enhances the stability of the prediction results [9]. In this study, we utilized the RF classifier [10] of the Sklearn library with n_estimators = 100 (100 decision trees in the forest).

4 CONCLUSIONS

The objective of this study was to develop a method for using smartphones with embedded accelerometers to identify potholes in road surfaces, which would significantly reduce the time and resources required for pothole detection. The feasibility of this idea was confirmed, as machine-learning models with features extracted from acceleration signals along three axes achieved significant precision and recall for pothole classification.

REFERENCES

[1] A. Sherrif, “How Difficult Is It to Keep Our Roads Pothole Free” (2018)
[2] V. Singh, “The pothole problem in India” (2018)
[3] A. Mednis, G. Strazdins, R. Zviedris, G. Kanonirs, L. Selavo, "Real time pothole detection using Android smartphones with accelerometers", Int. Conf. DCOSS, 1-6 (2011)
[4] A. Kulkarni, N. Mhalgi, S. Gurnani, N. Giri, "Pothole Detection System using Machine Learning on Android", Int. Jou. Em. Tech. Adv. Eng. 14, 7 (2014)
[5] H. Wang, C. Chen, D. Cheng, C. Lin, C. Lo, "A Real-Time Pothole Detection Approach for IntelligentTransportation System", Math. Prob. in Eng. 2015, 1-7 (2015)
[6] U. Bhatt, S. Mani, E. Xi, J.Z. Kolter, "Intelligent Pothole Detection and Road Condition Assessment", ArXiv abs/1710.02595 (2017)
[7] H. Song, K. Baek, Y. Byun, "Pothole Detection using Machine Learning", Adv. Sci. Tech. Let. 150, 151-155 (2018)
[8] Ho, T.K. Random decision forests. In Proceedings of the 3rd International Conference on Document Analysis and Recognition, Montreal, QC, Canada, 14–16 August 1995; pp. 278–282. [CrossRef]
[9] Scikit-Learn. Ensemble Methods. Available online: https://scikit-learn.org/stable/modules/ensemble.html# forest (accessed on 4 Feb 2021).
[10] Scikit-Learn Sklearn.ensemble.Random Forest Classifier. Available online: https://scikit-learn.org/ stable/ modules/ generated/ sklearn. ensemble. Random Forest Classifier.html (accessed on 4 Feb 2021).