Testing & Evaluation of Road Bounce PRO-Mobile Phone App Based Technology for Road Measurement

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ABSTRACT

Road roughness plays a crucial role in assessing the overall condition of a road. It impacts various factors such as vehicle operating costs, speed, comfort, safety, fuel efficiency, and wear and tear. Every road user seeks a smooth and pleasant driving experience. The measurement of road roughness is a key task that influences maintenance decisions. According to the Indian Road Congress (IRC) standards, roughness measurements should be conducted every 6 months on highways to determine the necessary functional overlay requirements based on the roughness index. Roughness measurements using profile meters namely Rod & Level, Dipstick, Merlin etc. all are time consuming. The Road Roughness Measurement System (RTRRMS) is a system installed on vehicles to assess how the vehicle reacts to the pavement profile. In India, the Central Road Research Institute (CRRI) has developed a 5th Wheel Bump Indicator that is mounted on cars to measure roughness. The RTRRMS 5th Wheel Bump Indicator utilizes binary true/false information and range-based analog data generated by digital accelerometers commonly found in smartphones. This measurement system is facilitated through an application called "ROAD BOUNCE”. This paper aims to showcase the results obtained from the testing and assessment of an App-based roughness measurement technology in terms of its precision and user-friendliness. The evaluation was conducted across various vehicles and mobile phones, considering different factors such as speed, tire pressure, gradients, and more.

Keywords:- Road Bounce, RTRRMS, Roughness Measurement, Cell Phone based Roughness.

INTRODUCTION

Pavement roughness pertains to the unevenness of the road surface, which can result in vehicle vibrations. Initially, a freshly constructed pavement possesses a certain level of roughness to ensure adequate friction. However, over time, as the pavement undergoes wear and tear from traffic and environmental elements, the roughness gradually intensifies. Pavement roughness serves as a widely adopted metric in numerous countries to assess vehicle operating costs. This is due to the fact that rough roads can result in vehicle deterioration, ultimately leading to higher fuel consumption. Therefore, it is imperative to acknowledge the significance of pavement roughness in order to ensure seamless and secure journeys on highways. To accurately measure road roughness, various highway agencies have devised advanced equipment. This article explores the topic of ROAD BOUNCE, a technology that measures roughness using a mobile app. It examines the accuracy and usability of this technology across various vehicles, mobile phones, speeds, tyre pressures, gradients, and more. The findings of this study offer valuable insights into the predictive capabilities of Road Bounce in determining pavement roughness.

ROUGHNESS MEASUREMENT APPLICATION

With the rapid evolution of technology, smartphones are now equipped with top-notch sensors and impressive computing capabilities. These sensors, integrated into a smartphone, can work in conjunction with the powerful processing capacity of the device to collect response-type data from a vehicle and analyze it to produce a roughness index of the pavement surface. By utilizing the mobile app, the phone detects vibrations while placed in a survey vehicle. These vibrations are typically measured as g-values (changes in acceleration in a vertical plane) using the built-in accelerometers of the phone. These accelerations are then converted into precise vertical movements with millimeter-level accuracy to determine the vehicle's ride quality index. The ride quality index varies depending on the type of vehicle, phone model, and speed. Subsequently, this data is correlated with preconfigured calibration settings to generate accurate roughness values. 1. The application enables the calculation of the roughness index at both higher resolution (100m or 1km) and lower resolution (20m). It has the capability to operate offline, eliminating the need for an internet connection or a sim card in the phone, which is advantageous for conducting surveys in remote locations with limited connectivity.

METHODOLOGY

CALIBRATION

The application offers the choice of selecting pre-configured calibrations that are saved on the phone by the application developer. Users also have the option to input calibration data manually from a reference instrument. These calibrations are tailored to the speed and type of vehicle being used, allowing the application to be compatible with various phones and survey conditions.

TESTING AND VALIDATION

To initiate the survey procedure, the operator initially chooses the suitable calibration from the application based on the survey vehicle in use. Once the calibration is selected, the operator places the phone on the car's dashboard and commences the recording process by clicking on the designated button. When the vehicle comes to a halt, the recording process is ceased by clicking on the appropriate stop button within the application. Immediately after the survey concludes, the application displays the captured roughness index data in a tabular format on the screen. The data can be exported in various formats, including CSV, XML, KML or PDF, and includes geotagging information. Exporting the report is made effortless through commonly used data sharing methods like messaging applications or email.

TEST RESULTS

REPEATABILITY TEST

During the testing process, it is crucial to maintain the consistency of the test results by using the same vehicle, mobile phones, and track, while ensuring a constant vehicle speed. It should be emphasized that achieving exact agreement in repeated measurements with an instrument may not always be possible due to random effects that differ from one measurement to another. However, in this particular scenario, it was observed that two sets of results were consistent when testing on the same road with the exact vehicle and mobile device.

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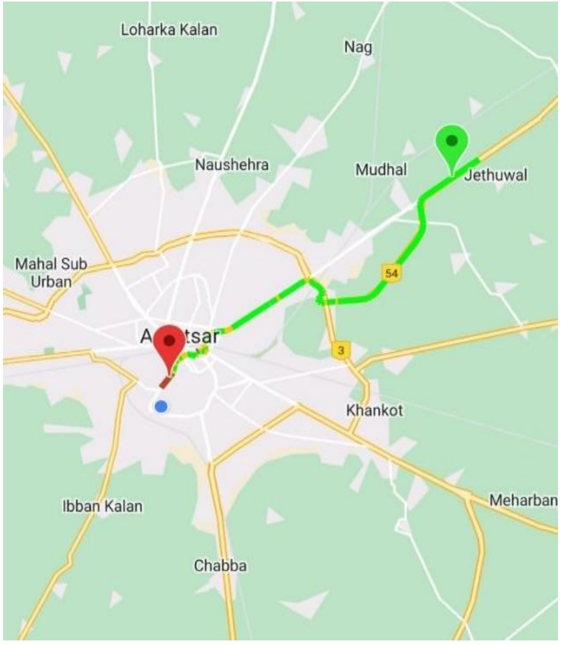

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Date: 2024-03-12 16:35:40

Sample Riding quality report

#	Meters	Speed (mph)	GPS Accuracy	Lat.,Long. (From,To)	RI
1	0 - 100	16	56%	(31.6900054, 74.9732141), (31.6906317, 74.9743498)	1.79
2	100 - 200	9	100%	(31.6237457, 74.8680809), (31.6210915, 74.8656589)	1293.36
3	200 - 300	27	100%	(31.6906317, 74.9743498), (31.6911268, 74.9751755)	1.61
4	300 - 400	11	100%	(31.6210915, 74.8656589), (31.6203875, 74.8650477)	1905.79
5	400 - 500	30	100%	(31.6911268, 74.9751755), (31.69169, 74.9761539)	1.57

NOTE: Please buy subscription to get full report.

Category Reference For Riding Quality

Good	Average	Poor
< 2.00	2.00 - 2.60	> 2.60

PAVEMENT CONDITION THROUGH VISUAL INSPECTION

The test track underwent inspection at every 100-meter interval, where the road condition was carefully observed. The anticipated "roughness class" for each 100-meter section of the road was duly recorded. The projected roughness was then classified into segments of Good, Bad, or Average.

TESTING PROCESS

Throughout the testing phase, the recommended speed for the instrument ranged from 29 to 31 kmph, whereas the mobile app vehicle suggested maintaining a speed range of 30 to 60 kmph.

DATA COLLECTION

The data was generated electronically in various formats, with the roughness index being automatically computed at 1 km intervals and on a mobile phone application at 100-meter intervals.

RESULTS

The mobile application outcomes were classified based on Good, Bad, or Average statuses.

CONCLUSION

This paper presents a discussion on the development and testing of a mobile application designed to measure the unevenness and toughness of pavement. The conclusions drawn from the test results are as follows.

- Digital accelerometer-based systems demonstrate a noticeably lower repeatability error ratio when compared to the conventional tools utilized by different road authorities.
- It has also been noted that outcomes obtained from digital accelerometer-based systems, such as road bounce, align with meticulous visual observations.
- The digital data captured is automatically stored on cloud servers, removing the need for manual input and enhancing the security of the information.
- The liberal speed limits closely aligning with actual driving speeds have significantly reduced

the operational time required for road surveys by 90%.

- The accessibility of road survey equipment has significantly improved in comparison to conventional tools and technologies.
- Significant time is saved on sensor calibration as it can now be conducted on site rather than at a separate testing facility.
- Utilizing advanced technology, conducting surveys to identify potholes across an entire state or country has become feasible, eliminating the need for substantial capital investment in road-testing equipment.
- Digital technology enables systems to collect detailed data on all irregularities, rather than just measuring bumps, leading to a comprehensive dataset.

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