PAVEMENT ROUGHNESS MONITORING USING ANDROID-BASED SMARTPHONE APPLICATION IN LOW-SPEED ROADS

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ABSTRACT - Pavement roughness is the imperfections in a pavement surface that affect the ride quality, safety, and some other factors in a vehicle. The International Roughness Index (IRI), a criterion to assess ride quality and pavement unevenness, can be used to express roughness. There are several ways to obtain data regarding the condition of the road surface, but almost all of them run at low speeds with significant reliance on human involvement or call for advanced measurement tools, which typically have high costs and demand expert operators. A major percentage of the road network is not covered by the annual collection of pavement condition data by several transportation organizations. The data collection was done in the Roadroid application by selecting video mode in Roadroid application. Finally, IRI values obtained by RDA were compared with IRI values generated by the Roadroid application. Based on the relationship between the RoadRoid and actual IRI values of Sri Lanka's Road Development Authority (RDA), statistical analysis shows a linear regression model with $R^2 = 0.766$. The experiment's results support the smartphone app as a practical substitute for evaluating pavement roughness on low-speed roads, offering efficient data delivery and technical benefits.

Keywords: Pavement roughness; Android-based application; Pavement condition

1. INTRODUCTION

Pavement roughness is a widely recognized criterion for assessing the condition of the pavement, particularly for network-level condition assessments that represent riding quality. The Federal Highway Administration (FHWA) considers pavement roughness as the most crucial factor affecting the riding experience. Road quality significantly depends on the condition of the pavement [1]. The condition of the pavement is crucial to the safe movement of vehicles. The road surface condition or pavement condition needs to be carefully monitored and maintained as needed to maintain quality. The measurement and characterization of pavement roughness is a top priority for highway authorities around the world. [2] Funding allocations for road reconstruction in Sri Lanka have grown to be a significant problem for the government. Therefore, the RDA only has pavement roughness data for type A and type B of some roadways. The International Roughness Index (IRI) is the roughness index which is mostly obtained from measured longitudinal road profiles. A quarter-car vehicle math model can be used to generate IRI. [3]. There are various applications available on the Google Play Store for collecting roughness data. RoadLab, Roadroid, Androsensor, and RoadBounce are some of them. Ekpenyong [5] observed that the RoadLab Pro smartphone application failed to gather IRI data on sections of road with total/partial pavement deterioration; this may be a failure that smartphone applications reliant on accelerometers as primary roughness sensors may not detect [5]. In this study, the Roadroid application was selected to measure the road roughness in low-speed roads in Sri Lanka, this application directly generates eIRI (estimated IRI) and the cIRI (calculated IRI), for each 100 m of road length. The main objective of this study is to use Android-based smartphone applications to measure road roughness on low-speed roads. This has been previously used to check to get the pavement roughness in expressways [4]. However, this has not been tested for the street of Sri Lanka.

2. MATERIALS AND METHODS

The Roadroid application was installed on the smartphone shown in Figure 1. Samsung S21FE smartphone was used to collect data. A car holder was used to attach the Smartphone to the

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windshield in landscape mode and standing vertically from the road as shown in Figure 2. The testing vehicle was KJCR42V Toyota. In the Galle district, three road sections shown in Figure 3 were chosen to collect data between 10:00 p.m. and 1:00 a.m. According to the existing regulation under Motor Traffic Act, the speed limit in Sri Lankan urban areas is 40 km/hr for motorcycles and heavy vehicles, and other vehicles 50km/hr. Therefore, data collection was done with the vehicular speeds of 30km/h, 40km/h, and 50 km/h at the outside lane of flexible road segments. In data collection, after the smartphone was attached to the front window, the Roadroid was opened. Then the message appeared on the smartphone screen and clicked ‘ok’. Then fitting adjustments were done (X, Y, Z as close to 0 as possible). After that, the location and date appeared on the screen. Data collection was done by selecting video mode with the defined route. It could be observed that this application directly generates estimated IRI (eIRI) and calculated IRI (cIRI) for each 100m of road length. Finally, cIRI value was compared with the IRI values available at RDA which were collected using a laser profiler. Then average cIRI values were obtained from the Roadroid profile for each road. After uploading the obtained data to Roadroid account, an aggregate file was downloaded from the Roadroid account. The survey summary of B594 Galle Port Access Pinnaduwa is shown in Figure 4.

Figure 1. Samsung Galaxy S21 FE Smart-phone

Figure 2. Car Holder

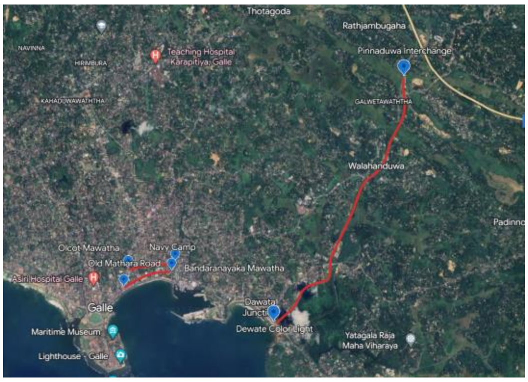

Figure 3. Selected Roads on Map

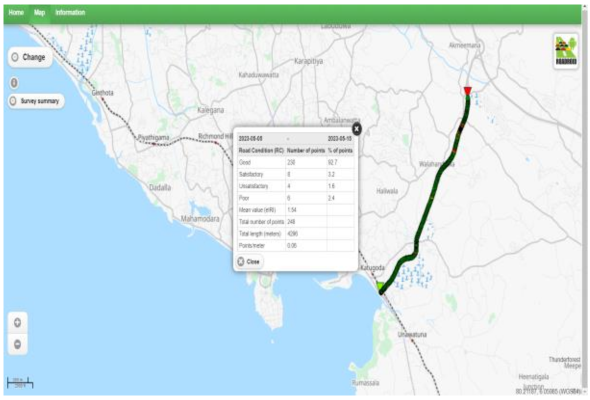

Figure 4. Survey summary of Galle Port Access Pinnaduwa

RESULTS AND DISCUSSION

In Figure 5, IRI values in 100 m intervals are illustrated as line graphs of B594 Galle Port Access to the Pinnaduwa road. Similarly, line graphs were developed for all other road sections selected in this study. Table 1 shows the average cIRI values and road lengths of each road section. The study has logged 70.32 kilometers in total. This study has shown a connection between the IRI values gathered by the Roadroid application and the IRI values obtained by the Sri Lankan Road Development Authority's Laser Profiler. Statistical analysis shows a linear regression model with $R^2 = 0.766$ as shown in Figure 6.

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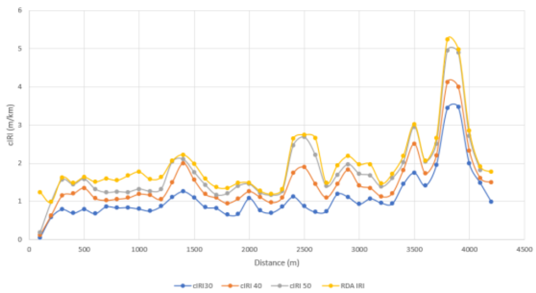

Figure 5. IRI vs Distance curve of B594

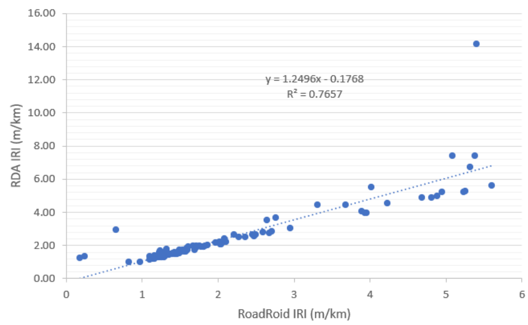

Figure 6: Relationship between RDA and RoadRoid IRI values

Table 1. Road Sections and Avg. cIRI values

Road	Road Name	Road Length(km)	Avg. cIRI
AB01	Galle - Marine Drive (to be named as Old Matara Road)	0.806	2.5
B594	Galle Port Access	4.3	2.55
AB03	Thalapitiya road, Galle	0.76	2.05

4. CONCLUSIONS

This study was done on the outside lane of different three distinct flexible road segments in the Galle district, Sri Lanka to check the relationship between captured data from a smartphone by the Roadroid application against referenced data obtained from Laser Profiler. Future research might concentrate on other types of pavements as this study was based on flexible pavements.

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