A smartphone app offers a user-friendly and cost-effective method for collecting pavement roughness data.

RESEARCH SOLUTIONS

Using smartphones to efficiently assess road conditions

Maintaining local and county roads is a top priority for transportation agencies. However, evaluating the condition of a road to determine when it needs maintenance can be a slow and costly process. The primary indicator of road condition is pavement roughness, which has a direct effect on ride quality, driver safety, fuel consumption, and carbon emissions. Traditional methods of measuring pavement roughness are expensive and time-intensive. A smartphone app could effectively collect pavement roughness data while providing significant cost savings to the local agencies using the tool.

THE NEED

Determining when a road surface needs maintenance is often dependent on knowing the roughness of the pavement, which is a primary indicator of road condition and ride quality. But the traditional techniques used to measure pavement roughness can be costly and time-consuming for local agencies. Given these limitations, roughness data from county and local roads is commonly only collected once every few years.

A smartphone-based system could offer a cost-effective solution to vehicle data collection. Smartphones contain the necessary sensors, such as multi-axis accelerometers and GPS, required to help collect pavement roughness data. This project aimed to develop a user-friendly smartphone app that harnesses information from smartphone sensors to provide accurate and dependable pavement roughness data annually and at low cost to local agencies in Iowa.

RESEARCH APPROACH

Initial steps to develop an open-source smartphone-based app

> **"The project was successful in developing a mobile application that can generate reliable pavement roughness data while saving local agencies time and money."**
>
> **— BRIAN MOORE,**
> Executive Director, Iowa County Engineers Association Service Bureau

collect pavement roughness data annually at a significantly lower cost. This technology will allow for more regular measurements of pavement quality and, subsequently, more timely road repairs where needed while freeing up funds for other local agency priorities.

included a literature review and an investigation of current third-party mobile apps that measure pavement roughness. An examination of pavement roughness calculation models helped to improve upon these methods for use in the prototype. Information gathered from these steps was then used to develop and test a prototype of the smartphone app to determine its effectiveness. These steps included:

- Developing a prototype smartphone app that was supported by a Python-based algorithm to more efficiently process the data collected.

- Calibrating the app for speed, vehicle type, and device placement.

- Evaluating the app at speeds ranging from 30 mph to 70 mph to allow users to calibrate it for improved accuracy.

- Testing the app in diverse conditions and comparing the results to those obtained by standard methods of measuring pavement roughness (i.e., Class 1 high-speed profilometer).

WHAT IOWA DID

Prototype testing occurred at 24 diverse roadway sites. Researchers tested the tool using one iPhone and three Android devices. A comparison of the results from these devices to the results obtained by the more costly and time-consuming methods of measuring pavement roughness demonstrated the reliability of the smartphone app.

Overall, the project successfully:

- Developed an open-sourced smartphone app compatible with iOS and Android platforms that can reliably collect pavement roughness data.

- Designed a cloud server to interface with smartphones for data collection.

- Developed an improved algorithm to convert data collected from smartphones into a pavement roughness measurement.

- Segmented road measurements into sections as short as 0.1 mile for more targeted and efficient analysis.

Additionally, the project developed a prototype application for detecting areas of distress on road surfaces using a smartphone's camera. While this prototype needs further development, it holds great promise for comprehensive road infrastructure evaluation and maintenance for local agencies at a significantly lower cost.

PUTTING IT TO WORK

By using the smartphone app developed in this project, local pavement engineers will be able to

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