A Deep Learning Tool for the Assessment of Pavement Smoothness and Aggregate Segregation during Construction

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21COLSU14

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Lead Institution:

Louisiana State University

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Tran-SET

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Total Project Cost:

$ 60,000

Developing a deep-learning tool for the assessment of pavement smoothness and aggregate segregation

Research studies indicate that Non-Destructive Testing (NDT) methods have the potential for use in the Quality Assurance (QA) of pavement construction since they allow for (a) fast evaluation of the product uniformity in real time as construction progresses; (b) identifying potential defects during construction to allow for timely corrective actions; (c) more frequent inspecting, testing, and replicating without the damaging effects of coring and other destructive testing; and (d) reducing the testing and inspections costs, while improving construction quality. For example, results of NCHRP 10-65 showed that GeoGauge is the device recommended for estimating the modulus of unbound layers, while the portable seismic pavement analyzer (PSPA) was recommended for estimating the modulus of Hot Mix Asphalt (HMA) layers. However, despite their high potential and usefulness, the transition of NDT methods from research to QA programs has been limited, and the destructive and time-consuming process of coring and laboratory testing continues to be the most widely used QA methods in the US. The present study will develop a machine learning-based classifier for the prediction of pavement smoothness and aggregate segregation based on digital image analysis and deep learning models. The proposed classifier will be developed such that it can be used by site engineers to predict pavement smoothness and aggregate segregation in real-time using camera-captured pavement images during the construction phase.

Problem Statement

In spite of the successful transition of pavement condition evaluation to automated inspection, construction monitoring and quality assurance practices are still based on costly, discrete, and destructive methods. In addition, most state QA programs are based on pavement construction procedures that encompass in-situ coring for layer thickness determination, density measurements, laboratory tests to measure volumetrics, and smoothness measurements in case of the availability of a profiler. In general, these methods are destructive and timeconsuming. Furthermore, QA programs are based on empirical specifications that are principally designed to make sure that all the critical raw ingredients are used in the installed paving mat. Findings by the research team in NCHRP 9-48 demonstrated that focusing on specifications' compliance has little relation and no relevance on in-service pavement performance. There have been numerous examples showing irrelevancy between QC/QA compliance and field pavement performance. Ultimately, this approach leads to poor construction quality, rough surfaces, segregated asphalt mixes, and premature pavement failure.

Objectives

The main objective of this study is to develop a machine learning-based classifier for the prediction of pavement smoothness and aggregate segregation based on digital image analysis and deep learning models. The proposed classifier will be developed such that it can be used by site engineers to predict pavement smoothness and aggregate segregation in real-time using camera-captured pavement images during the construction phase. The developed classifier and application may be used by the site engineer during construction activities to assess the smoothness of the paving mat and to detect the presence of segregation. This tool will be practical and straightforward and may be used by state agencies in case of the inaccessibility of laser-based surface tester or profilometer.

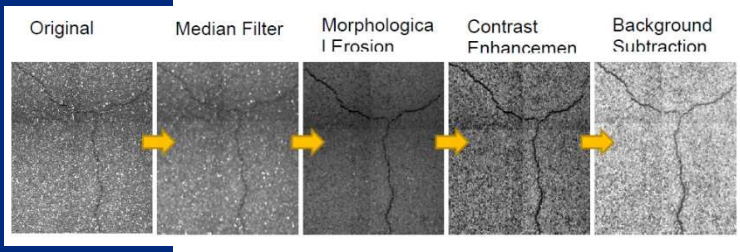

Figure 1. Illustration of processed input images for cement-treated reflective cracking

Intended Implementation of Research

Workforce Development, Education, and Outreach: This research project will provide partial funding to a graduate student at Louisiana State University. The student will be extensively trained on machine learning methods, pavement construction practices, QA specifications, and asphalt mixes production. Results of this work will also be disseminated at national conferences and journal publications. In addition, this project will present the general knowledge related to this study such as AI and pavement construction to K-12 students in Louisiana. The research team will also prepare educational materials on the use of machine learning methods in transportation applications, which can be incorporated in transportation courses at LSU and shared with other universities in Region 6. In addition, the research findings will be published online to disseminate the results to researchers all over the world.

Anticipated Impacts/Benefits of Implementation

The project is expected to deliver the following deliverables:

- A fully-operational tool will be delivered. This tool can be used by site engineers to predict surface smoothness and to detect aggregate segregation during construction activities.
- The research team will submit two technical papers in peer-reviewed journals and will present the results of the study in related conference including the Tran-SET annual conference.
- The final report will be submitted at the end of the technical phase with details of the analysis and the AI models developed in this study. The final report will be prepared to provide a comprehensive description of the literature, approach, methodology, findings, conclusions, and recommendations.
- The implementation report will be delivered at the end of the implementation phase using the required Tran-SET format. The implementation report will include a complete description of the developed products from the education, T2, and workforce development activities that were conducted during the implementation phase of this project.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.