EXPLORATORY ADVANCED RESEARCH

USING ARTIFICIAL INTELLIGENCE TO EVALUATE PAVEMENT CONDITION AND SAFETY

July 2024

FACT SHEET

Pavement engineering practices depend heavily on pavement information manually collected in the field. An Exploratory Advanced Research (EAR) Program-sponsored project wants to enhance automation of pavement information collection for use in pavement condition safety and evaluation at highway speed. Through this project, titled Artificial Intelligence Approaches to Multi-Object Evaluations of Pavement for Condition and Safety, Oklahoma State University (OSU) researchers are developing novel approaches to pavement engineering while increasing safety.

A pickup truck is equipped with multiple pavement data collection instruments. Clockwise from left to right: Pave3D 8k condition survey system, Ames® Profiler, and a grip tester.

The research team is developing new artificial intelligence (AI) approaches, using deep-learning (DL) methods, to better monitor pavement conditions for safety. This project is mapping pavement surface conditions using lasers and then feeding those images into a database to train an AI software program. The commercially available OSU-engineered data collection system—validated at the Federal level and by many States—is analyzing the three dimensional (3D) image data from the pavement surface.

High-resolution, 3D image datasets can train AI algorithms for evaluating cracking and other forms of distresses on roadways.

This project aims to demonstrate the feasibility of applying linear-based high-performance 3D laser imaging technology that can provide submillimeter-resolution images for pavement surface condition and safety evaluation at highway speed.

The research team is using four pavement condition and texture data collection instruments. These instruments include a laser safety scanner, a laser texture scanner, a condition survey system, and an ultra-high-resolution area scanner. The team is also using graphics processing units and a field-programmable gate array to train the AI algorithms.

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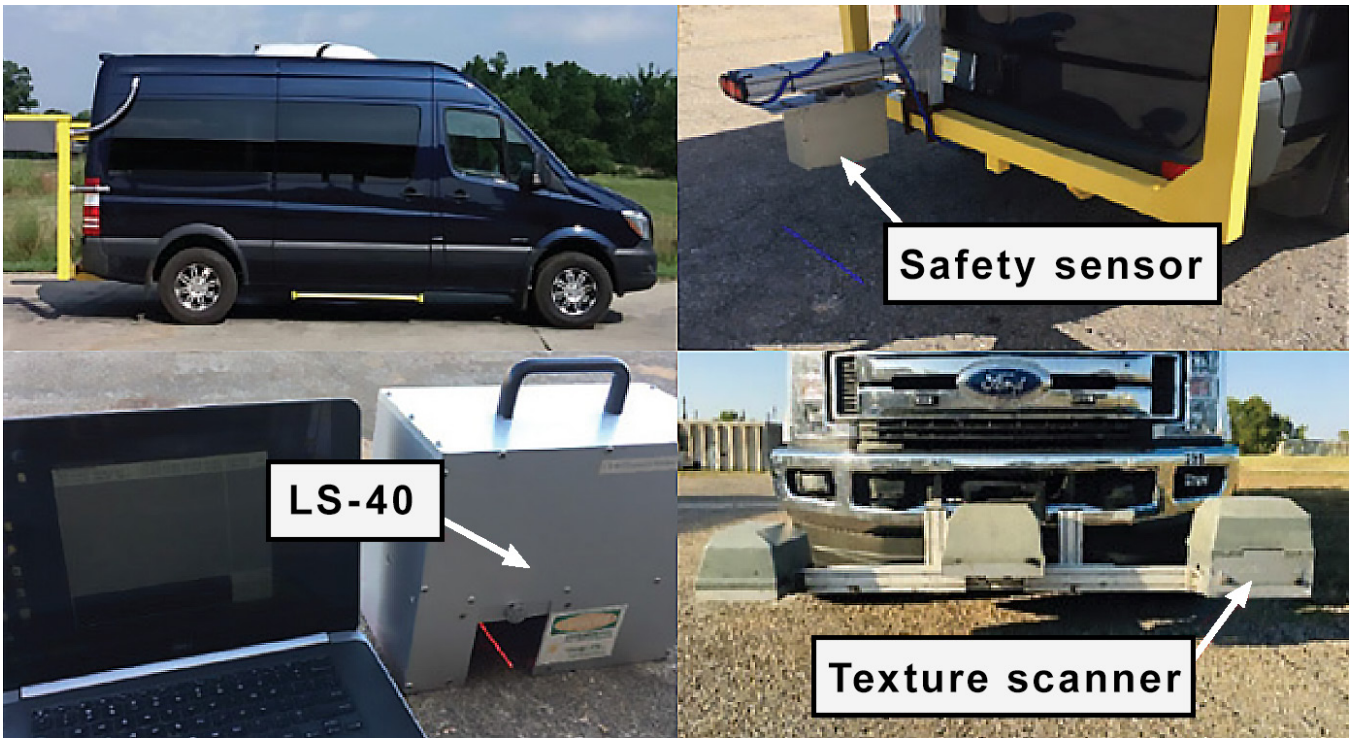

Pavement condition and texture collection instruments. Clockwise from left to right: Pave3D 8K condition survey system, 0.1-mm 3D laser safety sensor, a high-speed laser texture scanner, and a LS-40 ultra-high-resolution area scanner.

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The researchers are completing a comprehensive roadway surface condition survey that considers a wide range of multiple distresses or objects. The AI-enhanced technology used by the research team automates the roadway surface condition evaluation process and could conceivably replace existing macrotexture and contact-based friction tester equipment used by pavement engineers today.

The new technology in use by the research team has the capacity to provide the Federal Highway Administration (FHWA) and State departments of transportation with a higher level of repeatability, consistency, and accuracy in evaluating pavement surfaces. The technology provides a noncontact, continuous, and low-cost solution for future pavement condition and safety evaluation.

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This study is going to verify data consistency and quality for the submillimeter-resolution 3D images by comparing them with manually annotated, cloud-based collections of images. The data will include pavement surface conditions with multiclass objects of both macro and microtexture that come from previously selected pavement sections.

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BACKGROUND

Pavement engineering practices depend heavily on pavement information collected in the field in four general areas:

- Structural soundness through deflection measurement.
- Functional data through measuring longitudinal roughness.
- Surface condition or distress survey.
- Surface safety through measuring friction and texture.

This study focuses on two of the four data elements: surface condition and safety.

PROJECT OVERVIEW

The research team is compiling data from the 0.1-mm-resolution 3D imaging system and friction testing devices. The research team is using manually annotated multiple distress images to form a cloud-based image storage system for pavement surface condition survey and texture evaluation for research and education. The team is also archiving this information in a relational database available via a user-friendly Web interface searchable by keyword, data, technique, and material system.

For future research and education, the researchers are archiving and documenting the DL techniques they are testing and using to perform their research. These techniques include the source code of various training techniques from the training stage and the why and how of selecting training techniques used for the final DL network.

The research team is developing a software interface to display 3D virtual pavement surfaces and submillimeter-resolution 3D texture images and calculating the proposed texture parameters, estimating friction numbers, and evaluating safety via the developed DL models. As part of this effort, the research team's goal is to explore the relationship between pavement condition survey, texture, and friction for better maintaining and designing surface conditions and texture. FHWA will also receive a fully tested computer software program with a user-friendly interface from the research team.

What Is the EAR Program?

The EAR Program supports longer term, higher risk research with the potential for transformative improvements to the U.S. transportation system. The EAR Program seeks to leverage promising expertise and advances in science and engineering to create breakthrough solutions to highway transportation issues.

CONTACT

For more information about this EAR Program project, please contact Amir Golalipour, FHWA Office of Infrastructure Research and Development, at 202-493-3089 (email: amir.golalipour@dot.gov).

LEARN MORE

To learn more about the EAR Program, visit https://highways.dot.gov/research/exploratory-advanced-research. The website features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events.

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