CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6663: Evaluation of Pavement Rutting and Distress Measurements

Background

The Texas Department of Transportation's (TxDOT) 3-D automated system (Figure 1) performs high-speed measurement of pavement surface rutting, cracking, and other distresses. Designed to obtain more accurate and consistent assessments of pavement surface conditions, the system can potentially eliminate the need for network-level, manual, subjective visual assessments. This project's primary objective was to compare the TxDOT system's accuracy and precision to state-of-the-art commercially available automated or semi-automated systems. This study will help inform decisions about data collection methods used for TxDOT's Pavement Management Information System (PMIS).

Figure 1: TxDOT 3D automated system

What the Researchers Did

This research project comprised three phases. The first two phases provided a project-level assessment of the accuracy and precision of TxDOT and vendor systems operating at highway speeds. Phase I evaluated automated transverse profile and rut depth measurements. Phase II evaluated automated and semi-automated measurements of surface distresses, texture, and cross slope. Phase III extended the evaluation to an analysis of semi-automated measurements collected for network-level processes and applications in the Bryan and Houston Districts.

The Phase I rutting experiment included 26 flexible pavement test sections, each 550-ft long, with both asphalt concrete and surface treatments. TxDOT and four vendors—Dynatest, Fugro, Pathway Services, and Applus—collected measurements. The research team assessed each system's accuracy and repeatability by performing two evaluations. The first evaluation assessed each hardware system's accuracy in collecting accurate full-lane-width transverse profiles. The second evaluation assessed the hardware and data processing algorithms' ability to evaluate these profiles and provide accurate rut depth values.

The Phase II visual distress, cross slope, and texture experiment included 20 test sections with both flexible and rigid pavements, each 550-ft long. TxDOT and three vendors—Dynatest, Fugro, and WayLink-OSU—collected measurements. The project compared automated distress, texture, and cross slope measurements with manual measurements collected by experienced manual distress raters. Each vendor's crack maps were compared to manual crack measurements and static digital images.

For Phase III, Fugro Roadware and Pathway Services collected semi-automated pavement condition and distress data on the entire highway network of the Bryan and Houston Districts. The research team compared the automated measurements to the data collected for TxDOT's PMIS. This phase also included

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an analysis of the automated system production rates.

What They Found

From the Phase I evaluation of rutting measurements:

- All five systems were capable of capturing surface profiles with the necessary accuracy.
- All systems tended to underestimate the manual rut measurement; however, three of the five systems provided reasonably accurate results for practical purposes.
- All the systems showed a high dispersion of measurement errors. Calibrating system algorithms for Texas conditions could decrease errors.

From the Phase II evaluation of surface distress measurements:

- One vendor slightly outperformed the other two based on fully automated cracking measurements; however, all systems showed poor overall accuracy and precision before manual post-processing.
- The accuracy of cracking measurements improved significantly after manual post-processing; however, reported false positives still exceeded 30% for certain vendors and specific crack types.
- Several types of distresses, such as patching, punchouts, spalling, and joint damage, were reported only after manual post-processing of the crack maps.

From the Phase III evaluation of semi-automated measurements:

- The average production rate for all four vans was 103 miles per day, varying from 63 to 253. Vendors typically quote production rates of 200 miles per day, which is achievable.
- The automated systems captured more distress than manual ratings, resulting in lower distress and condition scores; however, the amount of difference varied between vendors for specific distresses, condition score, and distress score when compared to the PMIS baseline data.
- Vendor score values above the PMIS Score value in one category could compensate for lower values in a different category, resulting in agreement with the PMIS score for the category results totals.
- Both vendors' results aligned closely with TxDOT PMIS Ride Scores.

What This Means

- The data collection hardware systems evaluated in this study performed satisfactorily.
- Fully automated surface distress measurement algorithms are not ready for implementation in Texas, based on the research team's evaluations.
- Semi-automated distress measurement methods that incorporate algorithms and filters for calculating distresses and manual post-processing methods to correct distress ratings detect more distresses than PMIS manual ratings.
- The research team recommends staged implementation of full-lane-width laser transverse profile measurements and rut depth measurement algorithms to obtain more accurate rut depth measurements than the TxDOT five-point rutbar. Staged implementation would include calibration of the rut depth algorithms for Texas conditions.
- Also recommended is staged implementation of semi-automated distress measurements to improve safety and provide more accurate and complete measurements of visual distress, including calibration of visual distress algorithms and post-processing methods for Texas conditions.
- TxDOT implementation of calibration procedures for automated visual distress data collection vehicles and a driver certification program can reduce variability in automated measurements. Vehicle calibration methods should address the testing fleet's level of repeatability and reproducibility.

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