



Research Problem Statement

RESEARCH PROGRAMS USE ONLY	
RESEARCH IDEA NO:	25-004
DATE OF RECEIPT:	Apr 25, 2024
TOTAL MDT COST WITH IDC:	

Title: Highway Speed Micro & Macro-Texture Data Collection & Processing for Pavement Safety

Yes No **Are you an MDT Employee?**

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Yes No A research idea must have an MDT employee as its' champion. Have you contacted an MDT employee regarding your research idea?

MDT Contact: D.J. Berg

1. Problem Statement: What issue or situation are you trying to solve?

Macro and micro-texture data can be used to evaluation roadway friction at the road network level. Both micro and macro-texture data of pavements are crucial for adequate assessment of pavement surface friction, which is a primary indicator of pavement safety sufficiency during inclement weather. The current practice of data collection of pavement macro-texture at network level is based decades-old principle of Mean Profile Depth (MPD) and is well established nationally. However, while micro-texture has been identified as a critical function of available friction, it has not been fully developed because the collection of micro-texture data at highway speed is currently not available due to lack of standards and limitation of sensor technology to achieve sub-0.5-mm data accuracy. The new Safety Sensor at the Western Transportation Institute (WTI) at 0.1-mm 3D resolution is a potential solution to applying a highway speed data collection technology for implementation at MDT for both micro and macro-texture in one pass data collection.

2. Research Proposed: What work will be completed and accomplished to address the problem?

The proposed research includes (1) the network level data collection for MDT using the new WTI data vehicle equipped with the Safety Sensor at 0.1-mm 3D resolution; (2) development of technical solutions in data processing and computation using various tribology principles to better represent safety properties of pavement surface than the traditional methods, such as MPD; (3) development of PMS based safety index for network level survey that would pinpoint potential pavement sections with safety concerns; (4) development of evaluation method on pavement section with chip seal treatments for texture & friction properties; (5) development of safety evaluation procedures on bridge approaches and bridge decks based on data collected with the 0.1-mm Safety Sensor.

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3. Background: What led you to this topic? Provide sufficient background in non-technical language (no jargon) to help reviewers understand your thoughts behind the issue or statement (problem).

The latest 3D imaging Safety Sensor can collect pavement surface image in 3D at planar resolution of 0.1 mm and vertical resolution of 0.04 mm covering both macro- and micro-texture properties of a pavement surface. However the longitudinal resolution will suffer when the Safety Sensor operates high speed due to limitation of electronics. The Artificial Intelligence (AI) based PT-SRAGN and extended PT-SRAGN methods have demonstrated great potential to achieve 0.1 mm data collection at high speed on the software side. These latest Super-Resolution (SR) techniques are commonly used to enhance poor-quality or coarse 2D images. The experimental results demonstrate that this AI-based solution can effectively acquire 3D texture data at a resolution of 0.1 mm in both dimensions at high speed. Leveraging the newly emerged diffusion models is promising to obtain an even better intelligent and automated framework for image reconstruction with enhanced quality so as to achieve superb 0.1 mm 3D data collection at highway speed.

4. Expected benefits to MDT: What benefits do you anticipate this project would offer? How would results be used within MDT (District and Divisions)?

The proposed solution would provide MDT a tool-set to collect pavement surface safety data and its related analysis in a rapid and cost-effective manner. The data will have direct benefit for decisions concerning roadway and bridge surface treatment options.

Yes No **Has the problem statement been vetted through initial review by the Research Section, which includes a literature review completed by the MDT Librarian?**

5. Research Objectives: Identify the outcome of the research. Basic listing of deliverables or sets of deliverables. *This should be a basic list of what is "likely" to be required as a part of this research. This does not have to be detailed but will help any reviewers and proposal responders understand your thoughts behind the problem. We don't want to tell them how do to the research but we want to state what the objectives are.*

The research will deliver macro and micro texture measurement data for use by the department in making pavement preservation, bridge preservation, and safety improvement decisions. The outcome will include a metric for use in the Pavement Management System. The primary objective will to be determine the efficacy of the technology and a foundation for which a business case could be made to collect network level texture data.

6. Deliverables and Products: What tools and outcomes would help MDT implement the results or findings of the research? How would you expect results to be used by MDT. Include work units within the Agency that would need to implement (use) the results. Examples of products are: specifications, manuals, processes, tools, training courses, additional resources needed, models, or updated designs.

The research will have applicability to Pavement Analysis, Bridge, and Traffic & Safety. The anticipated findings of this research will be that texture measurement data could be applied to MDT decision systems to improve proactive approaches to project selection for bridge, safety, and pavement preservation projects. Deliverable will include data, data analytics, data products, and reports documenting the research.

7. IT Component: Most research projects produce and/or use data. If you think this idea would use or create data, the project has an IT component.

Yes No **Does this idea have an IT Component?**

If Yes describe - Examples: purchase of software; data storage; data retrieval; database development; acquisition of existing applications.

The researchers will be collecting road surface imagery and will be responsible for processing the data. The

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data deliverable can be stored in on network share drives. Should MDT choose to implement the research for network level data collection, MDT would likely host the data in the Pavement Management System. It is unknown at this time how much storage that would require.

8. Cost Estimate - include assumptions and timeline to support the estimate.

It is estimated that this project will require a two-year effort at \$150,000 per year. The project total is anticipated to be \$300,000.

9. Sponsor. Your division administrator will become the sponsor of this idea. Please state what Division you are in and who is the Division Administrator.

Engineering/Dustin Rouse

10. Additional Information: What else would you like to share to elevate the importance of your problem statement? Include any additional information you think is relevant to the proposal. Key information could include units and personnel that were consulted during the development of the research idea, or any additional business units that would be beneficial to implementation.

Traffic & Safety has expressed interest in this research and is willing to provide staff for the technical committee. Bridge is supportive, however cannot allocate staff to the committee.

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