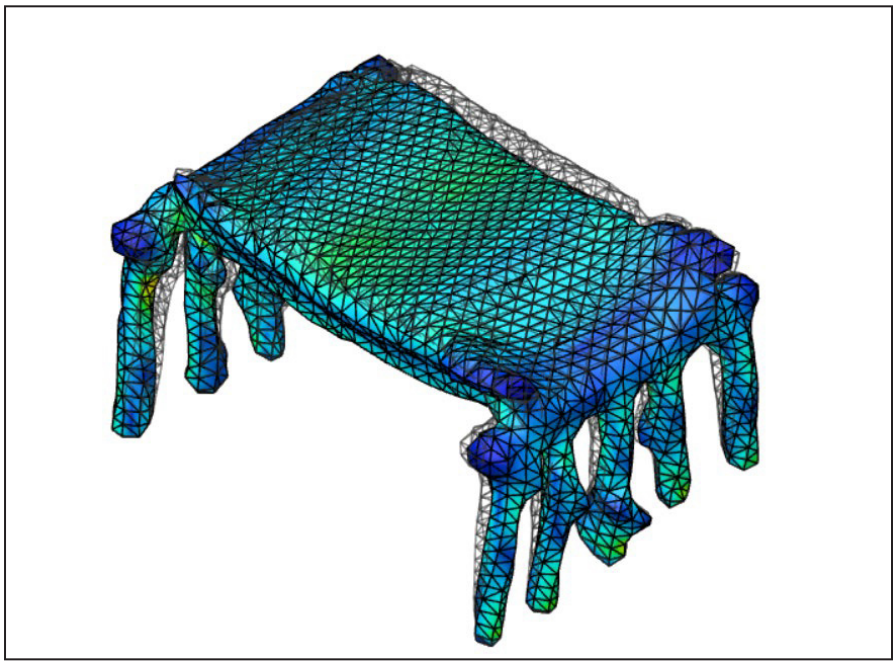
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-569 (project 571) | October 2024

Monitoring Transportation Structure Integrity Loss and Risk with Structure-From-Motion



the **ISSUE**

With heavy use of aging U.S. infrastructure and limited resources for regular inspections, there is an urgent need to potentially accelerate the inspection process or, at a minimum, develop inspection tools that provide workers with more efficient resources.

the **RESEARCH**

The focus of this work is to continue the development of analysis methodologies that begin with two-dimensional imaging, transition these images into point clouds, then convert these to solid elements that can be input into finite element software to evaluate the structural traits and integrity of the resulting structure.

In this study, researchers made several attempts to unite several of these photogrammetry and analysis tools to simulate some of the more prevalent areas of damage. To reduce the scope of the work to something reasonable, the focus was on two areas: 1) the level of cracking and surface damage that can be captured from imaging methods, and 2) the modeling of one type of natural hazard – particle flow – that can cause considerable damage. This is especially timely in areas following post-fire runoff zones that can experience significant erosion or damage to bridges, culverts, and retaining walls because of the dynamic loads of larger particles on the supporting structure.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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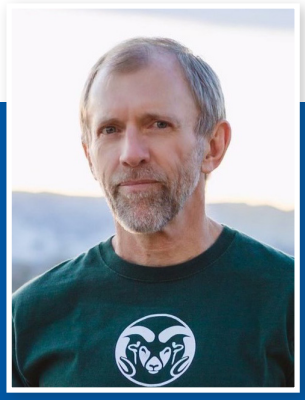

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Project Title

Monitoring Transportation Structure Integrity Loss and Risk with Structure-From-Motion

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the FINDINGS

Key findings included: Cracks in buildings and roadways can be identified well below the distance of 1 cm and frequently far below this level.

The researchers developed and applied a methodology for performing a complete structural analysis, moving from digital images, acquired from either hand-held cameras or uncrewed aircraft systems, through several image processing schemes into a finite element analysis of representative structures.

We developed a discrete-element model to represent the interacting particles that simulate particle flow during flood or rockfall events. This new approach provided excellent agreement with existing numerical models and can be used to further extend our methodology for very difficult-to-capture particle movement.

the IMPACT

This methodology allows engineers and inspectors to quantify and track levels of damage and degradation over long time periods and compare original designs and geometries with current conditions. As these methods improve in accuracy, there will be a trend to automate and combine the current approach of using several different tools for the imaging, processing, and analysis into a single entity.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1230

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.