MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-443 (project 535/592) | December 2021

A Streamlined Bridge Inspection Framework Utilizing Unmanned Aerial Vehicles (UAVs)

the ISSUE

Bridge inspections are often cumbersome, expensive, and time-consuming. There is a need to improve bridge inspection techniques to save time and reduce costs. Advancements in unmanned aerial vehicles (UAVs) allow for better data collection and more control at a more affordable cost. Currently, UAVs are used to assist inspectors in viewing bridges or other structures from different vantage points with the inspectors still taking measurements and making decisions with traditional, more subjective, techniques. To take full advantage of the UAV's capabilities, perform quantitative inspections automatically, and create a more streamlined workflow, there is a need for more robust data processing of the information attained by the UAV.

the RESEARCH

Researchers developed a streamlined decision-making support framework that uniquely integrates UAV-based field inspection, automates data processing, and establishes an element-wise as-built bridge information model (AB-BrIM). In this framework, a UAV platform with optical sensors first collects the data through flight missions around a structure. Next, the collected images are fed through a proposed automated damage detection algorithm to quantitatively identify cracks (i.e., type, size, amount, and location). Next, a 3-D point cloud is created using photogrammetry based on a structure-from-motion algorithm. Moreover, to provide component-wise information, the 3-D point cloud is then segmented into its structural elements (e.g., beam, girders, deck, etc.) using human-in-the-loop machine learning techniques. The identified damage information is automatically linked to each element by mapping the images from the UAV to the 3-D point cloud using the camera poses. Finally, an AB-BrIM is automatically established based on the segmented 3-D point cloud to facilitate 3-D visualization of the obtained element-wise and quantitative damage information.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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Project Title

[535] Development of unmanned aerial vehicle (UAV) bridge inspection procedures
[592] Development of an Autonomous Transportation Infrastructure Inspection System Based on Unmanned Aerial Vehicles (UAVs)

Sponsors | Partners

CSU Drone Center (in-kind)
Larimer County (in-kind)
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the FINDINGS

The researchers found that the data analytics tool can identify and track damage over time automatically from images collected by the UAV. The mapping of damage information to structural elements allows them to document damage information for bridge components, which is consistent with current bridge inspection practices in the United States. The resulting AB-BrIM with 3-D visualization of quantitative damage information offers a transparent condition evaluation tool and has the advantage of storing any relevant inspection data, including past reports, images collected by the UAV, and repair logs. Moreover, the AB-BrIM incorporates component-wise damage information to facilitate adaptation from research to practice and can greatly ease the planning of repair and maintenance decisions.

the IMPACT

Current UAV-based bridge inspections lack the data analytics techniques of tracking changes in damage and identifying the location of specific damage. Researchers found that new image computation and machine learning algorithms developed through this project are effective for quantifying, tracking, and identifying the damage location. These data analytics tools will allow more quantitative condition assessment, which is superior to the existing practice. The tools are expected to help the inspection industry and state DOTs reduce the cost of bridge inspections while increasing the frequency and usefulness of inspections for efficient bridge maintenance.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1052

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.

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