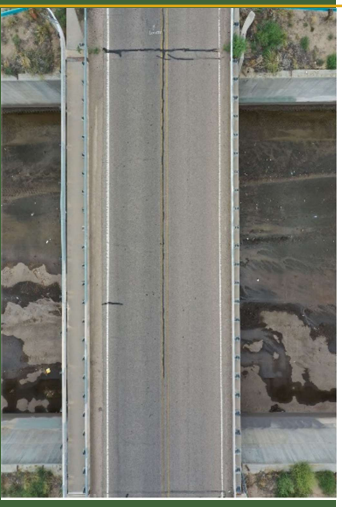
Bridge Deck Inspection Using Small Unmanned Aircraft System Based Airborne Imaging Techniques



Highlight | Dec. 2020

Project No. 19STUNM04

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Inspecting Bridge Deck Wearing Surface and Subsurface Conditions Through the Use of Small Unmanned Aircraft System Based Airborne Imaging Techniques

This research developed a robust and powerful toolset that be used in standard GIS for operational implementation. This toolset can be used to detect, extract, and map bridge deck surface and subsurface distresses with an adequate degree of accuracy while maximizing the ability to assist inspectors with varying expertise. Research results revealed that the toolset is able to effectively detect and evaluate bridge deck surface and subsurface distresses at a high accuracy. This research also developed a guidebook on using the developed tools for professional education and training. The ultimate goal of this research is to train a new generation of transportation engineers that can effectively use the developed S-UAS based data collection and analysis system to accurately and rapidly detect, extract, and map bridge deck surface and surface distresses at a low cost.

Background

Bridges are critical transportation infrastructure assets because they provide passage over physical obstacles to substantially reduce travel time and travel cost. Similar to other types of transportation infrastructure, bridges deteriorate over time. Therefore, bridges should be consistently monitored and routinely inspected to ensure their serviceability, capacity, and safety under current traffic. In the United States, routine and in-depth bridge inspections are conducted by transportation infrastructure management agencies at all levels (e.g., federal, state, local, and tribal) to detect the signs of deterioration, identify the causes, and make decisions on the distribution of limited resources for maintenance, repair, rehabilitation, and construction projects.

Traditional bridge deck condition evaluation methods are expensive, time-consuming, labor-intensive, unsafe, and requiring specialized staff on a regular basis. They can also exhibit a high degree of variability.

Project Summary

The main objective of this research is to develop a new approach to accurately and rapidly detect, extract, and map bridge deck wearing surface and subsurface distresses with S-UAS based airborne imaging techniques and transfer the technologies to transportation infrastructure management agencies at all levels (e.g., federal, state, local, and tribal) for implementation and workforce development.

Specifically, this research project was focused on: (1) developing a S-UAS based bridge deck condition data acquisition and analysis system which can be used to accurately and rapidly detect bridge deck wearing surface distresses (i.e., cracks) and subsurface distresses (i.e., delamination) at a low cost; (2) developing a guidebook for the implementation of the S-UAS based bridge deck inspection system to assist transportation agencies with workforce development and professional training.

Status Update

The main components of the output developed in this project include: (1) an S-UAS based data acquisition system; (2) a desktop-based data processing tool; (3) a data analysis toolset that is compatible with standard geographic information systems (GIS); and (4) an implementation guidebook. The current status of these components is: components (1), (2), (3), and (4) have been completed Input hyper-spatial resolution aerial imagery, thermal-infrared imagery, and ground-truth data have been successfully collected and analyzed to have outputs to assist with engieering reviews.

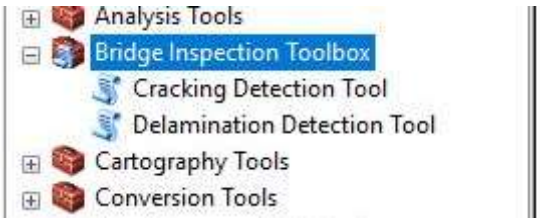

Figure 1. Bridge Inspection Toolbox which has two tools that are compatible with ArcGIS.

The developed toolbox is compatible with standard GIS, and it is designed to analyze the processed hyper-spatial resolution natural color aerial photos and thermal-infrared images to detect bridge deck surface and subsurface distresses. This toolset has been developed in Python programming language and it will be made publicly accessible in GitHub. The project team will collect feedback from users to improve the toolset.

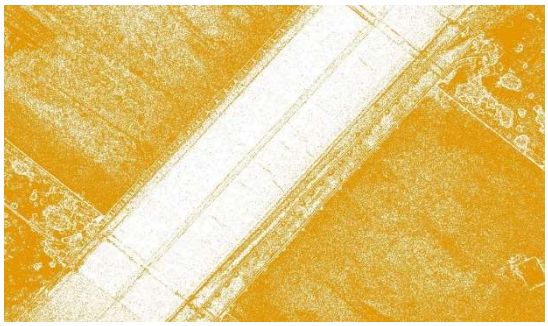

Figure 2. Cracking Highlighting Image

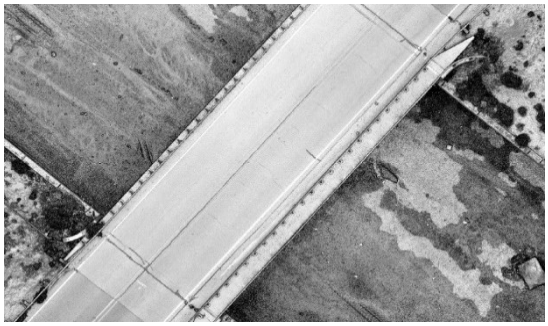

Figure 3. Cracking Accentuating Image

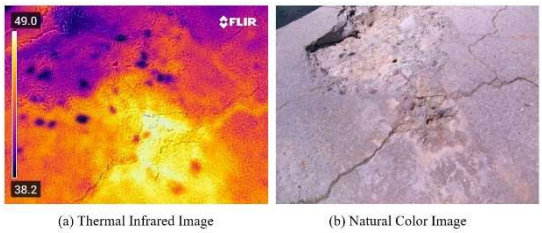

Figure 4. Thermal Infrared Image.

Impacts

This research project will enable bridge engineers to inspect bridge deck surface and subsurface conditions and map the detected distresses in a more accurate, rapid, and cost-effective manner. This proposed project will also enable more accurate bridge deck surface and subsurface distress information collection to assist transportation agencies in improving the durability and extending the life of bridges. In addition, the proposed project will assist transportation agencies with the development of cost-effective solutions for the maintenance, preservation, and rehabilitation of bridge infrastructure assets.

The developed sUAS-based bridge deck condition evaluation system will be transferred to state DOTs and other transportation management agencies for their free use. The expected benefits are a reduction in cost and labor and an increase in accuracy and speed for bridge deck condition evaluation. A guidebook of using the sUAS-based bridge deck evaluation system will be developed for professional education and training to assist state DOTs in deploying the developed system.

Student participation (S-UAS based bridge deck condition evaluation system development) and transportation professional participation (training workshops) has exposed students and workforce alike to geospatial technologies, S-UAS operations, and spatial data management, which are already becoming the norm in many government and industry decision-making processes.

Through the development of the S-UAS based bridge deck condition evaluation system, the project team investigated the morphological and contextual characteristics of bridge deck surface and subsurface distresses. These experiences have improved the understanding of the typical width, length, area, and location of bridge deck distresses, which has an impact on the base of bridge deck distress knowledge.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.