Bridge Deck Inspection Using Small Unmanned Aircraft Systems Based Airborne Imaging

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19STUNM04

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Funds Requested to UTC:
$50,000

Funding Source(s):
Tran-SET
University of New Mexico
New Mexico Department of Transportation

Total Project Cost:
$100,000

Developing a complete data acquisition and analysis system to accurately and rapidly detect bridge deck surface and subsurface distresses at a low cost using Small Unmanned Aircraft Systems (sUAS)

Traditional bridge deck inspection is primarily conducted on the ground by having inspectors either visually inspect the surface condition or interpret the acoustic feedback from hammer sounding or chain dragging method to determine the subsurface condition. These traditional methods are expensive, time-consuming, labor-intensive, unsafe, can exhibit a high degree of variability, and require specialized staff on a regular basis. In recent years, many remote sensing technologies have shown promise in bridge deck inspection. This project will focus on using small unmanned aircraft systems (sUAS) based airborne imaging techniques and image analysis techniques to develop a complete data acquisition and analysis system to accurately and rapidly detect bridge deck surface and subsurface distresses at a low cost. This project will also develop a guidebook for the implementation of the proposed bridge deck inspection system to assist transportation agencies with workforce development and professional training.

Problem Statement

Bridges are one very important type of transportation infrastructure. Similar to other types of transportation infrastructure, bridges deteriorate over time. Subsequently, transportation infrastructure management agencies dedicate a considerable amount of time and money to monitor and inspect bridges as part of their infrastructure asset management programs. These collected bridge condition data are used by these agencies to make maintenance and repair decisions. As one crucial component of bridge inspection, bridge deck inspection ensures the serviceability and safety of everything above, on, and underneath bridge decks. Traditionally, bridge deck inspection is primarily conducted on the ground by having inspectors either visually inspect the deck surface condition or interpret the acoustic feedback from hammer sounding or chain dragging method to determine the subsurface condition. These traditional methods have many limitations, including but not limited to expensive, labor-intensive, and timeconsuming.

To date, several remote sensing technologies such as small unmanned aircraft systems (sUAS), hyperspatial resolution natural color and near-infrared aerial imagery, structure-from-motion (SfM), object-based image analysis (OBIA), and thermal infrared aerial imagery have shown promise in inspecting bridge deck conditions. In recent years, sUAS have emerged as an important platform for collecting of various types of hyper-spatial resolution aerial imagery to provide a synoptic view of the ground objects. As an advanced photogrammetric method, SfM is used for creating the three-dimensional coordinates of objects by analyzing overlapping aerial images captured from varied perspective. When coupled with hyper-spatial resolution aerial data and OBIA, SfM holds the potential to permit the estimation of horizontal and vertical measurement at sub-inch scales, and ultimately, the detection and assessment of bridge deck surface distresses (i.e., cracks and spalling) at finder scales. Bridge deck subsurface delamination interfere the heat transfer through the concrete and influence the amount of radiant energy emitted from the concrete surface. Therefore, thermal infrared imaging techniques can be used to detect and assess bridge deck subsurface distresses (i.e., delamination).

Objectives

The proposed project includes two objectives: (1) develop a sUAS based bridge deck condition data acquisition and analysis system which can be used to accurately and rapidly detect bridge deck surface distresses (i.e., cracks) and subsurface distresses (i.e., delamination) at a low cost; (2) a guidebook for the implementation of the sUAS based bridge deck inspection system to assist transportation agencies with workforce development and professional training.

Intended Implementation of Research

Education, Workforce Development, and Outreach Activities: The developed technologies are highly implementable as this proposed project will develop a set of ArcGIS software tools that can be used immediately by state DOTs to detect and map bridge deck surface and subsurface defects. The research team will promote project-related technologies through three outreach workshops to train transportation professionals in the State of New Mexico to effectively use the developed tools. Partnered with NMDOT District 2 and Bridge Management Bureau, these workshops will be provided on a bi-monthly basis for three times during the implementation phase. The project team will create a videotaped workshop that will be web-accessible to the audience with no cost through the New Mexico Resource Geographic Information System Program and Clearinghouse (NM RGIS Clearinghouse, available at rgis.unm.edu). This online videotaped workshop will enable remote and broader access for transportation professionals in other states across the United States.

This proposed project will provide funding to UNM undergraduate students who will join the transportation industry in the future. Student participation in the sUAS based aerial data collection and the development of bridge deck condition inspection and mapping tools as well as workshops will expose them to geospatial technologies, which are already becoming the norm in many government and industry decision-making processes.

Through technology implementation, the project team will also identify best practices for the implementation of an operational sUAS based bridge deck condition assessment program. Based on these identified best practices, the project team will develop a guidebook for the implementation of the sUAS based bridge deck condition data acquisition and analysis system to assist transportation agencies with workforce development and professional training. PI Su Zhang and Co-PI Shirley Baros and Susan Bogus Halter are experienced with technology implementation and they will lead this task.

A series of bi-monthly workshops will be provided to transportation engineers within the State of New Mexico. A free videotaped workshop will also be provided online for audience from other states across the United States. Workshops will be developed and provided by EDAC and the Department of Civil, Construction, and Environmental Engineering at UNM. PI Su Zhang and Co-PI Shirley Baros and Susan Bogus Halter and Remote Sensing Specialist Paul Neville will lead the workshop development and presentation with the participation of the undergraduate students.

Anticipated Impacts/Benefits of Implementation

The purpose of this Tran-SET proposal is to perform a proof-of-concept study that investigates the following research questions: “Can bridge deck surface and subsurface distresses be detected and assessed from sUAS collected aerial data?” and “How should the detected distress information be used to inform decisions on bridge deck maintenance?” We anticipate that this grant will provide a preliminary response to these questions, which will allow us to justify an expanded and more detailed proposal that focuses on developing a completely autonomous bridge deck condition data acquisition and analysis system to improve inspection accuracy and reduce inspection time and cost.

Web links

- TranSET’s website (https://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/View/1644247)

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 website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Mr. Christopher Melson (Tran-SET Program Manager) directly at transet@lsu.edu.