# Rapid Exploitation of Commercial Remotely Sensed Imagery for Disaster Response and Recovery
# University of Vermont

## Executive Summary

Natural disasters can severely impact our nation's transportation network. Commercial remote sensing data are increasingly being used in disaster response and recovery, but obtaining actionable information from imagery is still hampered by slow and cumbersome workflows. This project designed, developed and deployed an automated system capable of identifying damaged portions of a road network from commercial satellite imagery. To estimate the amount of fill required to repair these damaged roads a workflow was developed that used 3D models generated from Unmanned Aircraft Systems (UAS).

## Findings & Outputs

Automated approaches can accurately assess road damage from satellite imagery and offer substantial time savings compared to manual assessment. Nevertheless, such techniques are sensitive to the local landscape, type of damage, and image properties. UAS provide a readily deployable solution for assessing damage and estimating the amount of fill needed to repair affected roadways that is faster than more traditional approaches, and has the advantage of being able to operate over inaccessible areas. We found volumetric estimates from 3D to UAS to be within 5% of the actual volume.

## Products & Outcomes

The Automated Damage Detection (ADDS) developed as part of this project allows a user to harness the power of automated feature extraction while providing the flexibility to adjust to differing sensors and conditions through an intuitive user interface. ADDS provides a means by which to screen large amounts of satellite imagery and rapidly identify portions of a road that have been damaged.

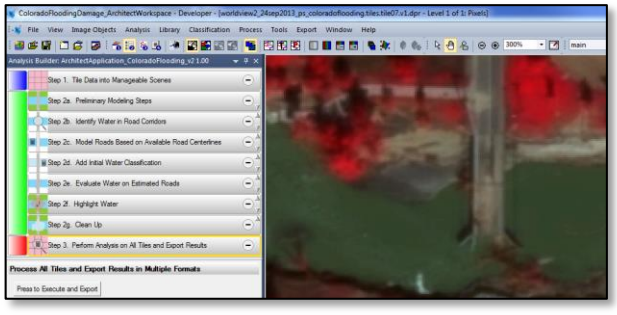


*Figure 1. The interface for the Automated Damage Detection System.*

The workflows developed for UAS operations and volume calculations allow transportation analysts to quickly and accurately estimate the amount of fill needed to repair damaged roadways.

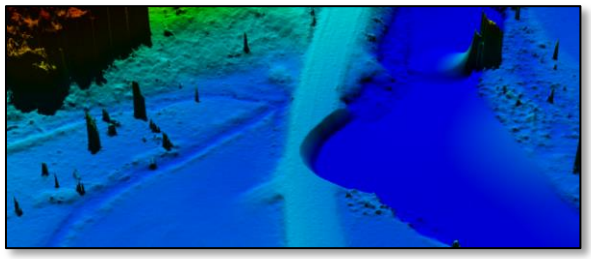

*Figure 2. 3D surface model simulation of a damaged roadway used to compute estimated fill volume for repairs.*

In addition to developing technical workflows focused on volume estimation our team developed extensive expertise in UAS operations and the applications of UAS technology to the transportation decision-making. We developed detailed UAS standard operating procedures and carried out a number of proof of concept studies for state and local transportation agencies.

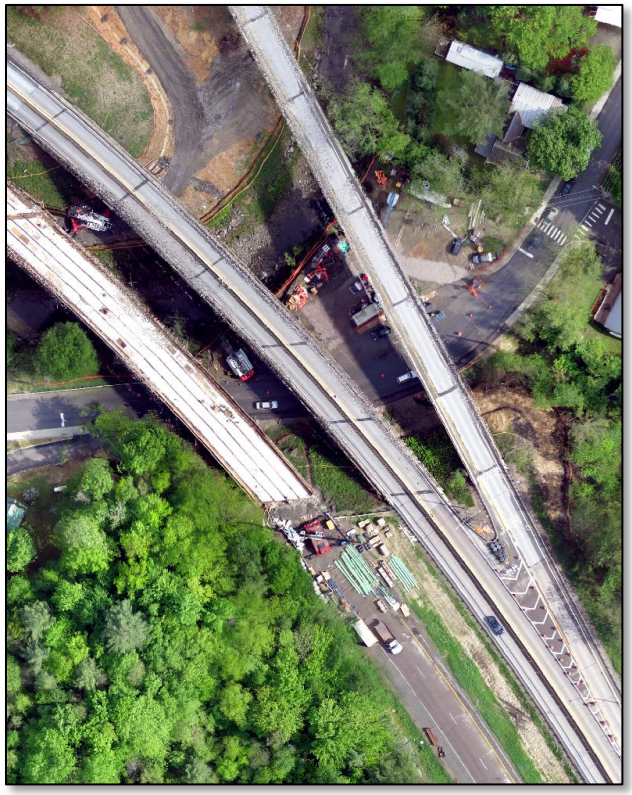

*Figure 3. UAS mapping of an active construction site.*

## Post Project Initiatives

Following the conclusion of the project we established a UAS Team at the University of Vermont. The UAS Team helps state and local transportation agencies, transportation consulting firms, and emergency responders in harnessing the power of cutting-edge UAS technology. Highlights include:

- Development of a stream woody debris budget for the Great Brook in Plainfield, VT. Woody debris in the stream caused extensive damage to one of the town's bridges during summer flooding. The woody debris budget was a key piece of information used by the consulting engineers in justifying a new bridge design.

*Figure 4. Woody debris damage to one of the bridges in Plainfield, VT caused by severe storms that hit the area in July 2015.*

- Participating in FEMA's Hard Knox disaster response exercise in September of 2015. Due to cloud cover the UAS Team was the only imagery asset capable of collecting data to support the exercise.

*Figure 5. A FEMA official holding the UAS used to capture imagery during Hard Knox 2015.*

- Responding to the October 5, 2015 Amtrak train derailment in Northfield, VT. UAS imagery was used by state and federal agencies as part of the accident investigation


*Figure 6. The UAS Team at the mobile incident command center following the Amtrak train derailment.*

- Working with five consulting engineering firms in Vermont who do contractual transportation work for the state to integrate UAS into their project scoping and planning process.

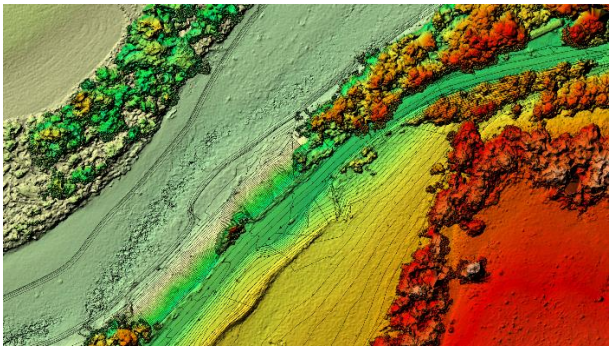

*Figure 7. UAS 3D surface model integrated with survey data from an engineering firm in support of a road construction project.*

## CONTACTS

**U.S. Department of Transportation (US DOT)**
Caesar Singh, P.E.
Director, University Grants Programs
Office of the Assistant Secretary for Research and Technology (OST-R)
1200 New Jersey Avenue, E33-306
Washington DC 20590
Tele: 202/366-3252
Email: Caesar.singh@dot.gov

**University of Vermont**
Jarlath O'Neil-Dunne
Director, Spatial Analysis Laboratory
81 Carrigan Drive, Aiken 205
Burlington, VT 05405
Tele: 802/8656-3324
Email: joneildu@uvm.edu