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DEPARTMENT OF TRANSPORTATION

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TECHNICAL SUMMARY

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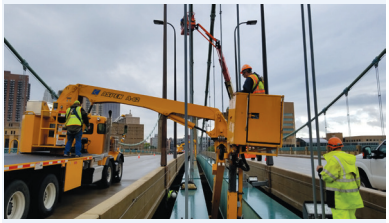
PROJECT COST:
$99,980



Using a "snooper" truck during a bridge inspection requires closing at least some lanes of traffic.

MnDOT Continues to Develop UAS Expertise for Bridge Inspection

Researchers continued to advance expertise for using UAS to inspect Minnesota bridges. Using UAS can reduce inspection costs by up to 40 percent compared to using traditional methods. UAS inspections also require fewer crew members, shorten or eliminate traffic closures, and improve safety for crews and the public.

What Was the Need?

Rapidly evolving unmanned aircraft systems (UAS), or commercial drones, offer a sophisticated tool that allows bridge inspectors to evaluate difficult structures with fewer crew members and in less time.

Before UAS, inspectors had limited options to access areas below and above bridge decks. Traditional access methods include using ropes and climbing gear, ladders, lifts or under-bridge inspection vehicles. Many of these methods require expensive traffic control measures, closing traffic lanes to public use and requiring extra equipment and crew members to ensure safety. UAS, however, can keep inspectors out of harm's way with little or no traffic closure in certain situations.

Since 2015, MnDOT's Bridge Office has been conducting award-winning research into the use of UAS for bridge inspections. In Phase I, researchers established the value of using UAS for these inspections. In Phase II, they tested a senseFly albris with improved infrared and video capability and increased operational flexibility on larger and more complex structures.

MnDOT intends to develop a UAS bridge inspection and training service that will be made available to state and local agencies throughout Minnesota. To achieve this goal, MnDOT must continue building its UAS inspection expertise and improve the system's data processing and communication capability.

What Was Our Goal?

The goal of this project was to continue developing UAS expertise as part of a statewide UAS bridge inspection plan. Phase III research would improve inspection quality and safety, explore the use of a collision-tolerant UAS for confined spaces and calculate the cost-effectiveness of UAS for bridge inspections.

What Did We Do?

Researchers conducted 39 bridge inspections using the drone from Phase II and a newly acquired Flyability Elios drone, which flies within a protective rolling cage to reach confined spaces. Using both drones demonstrated that UAS could inspect an entire bridge.

In this project, researchers focused on improving three critical capabilities of UAS for effective inspections. First, UAS must effectively detect deficiencies in bridge structures, a capability well-established in the previous two studies but expanded in this project with the addition of the confined space system. Second, they must thoroughly document deficiencies, which was achieved with drone imagery and data gathering, and ground-based photography. These methods improved upon the conventional documentation methods of digitally recording pen-and-paper records. Third, UAS must clearly communicate inspection results to bridge engineers and owners. Investigators explored advancements in modeling bridges and inspection data to generate images and reports from drone-derived data and images, and ground-based photography.

continued

"A drone won't replace an actual inspector but will enhance inspections. It saves time and considerable cost if we want to reach remote areas."

—Jennifer Wells,
State Bridge Inspection Engineer, MnDOT Bridge Office

"We are using reality modeling in the field—collecting high-resolution images with the drone to generate a digital, 3-D twin of the bridge. The process is an innovative and effective way to communicate inspection results."

—Barritt Lovelace,
Regional Manager, Collins Engineers, Inc.

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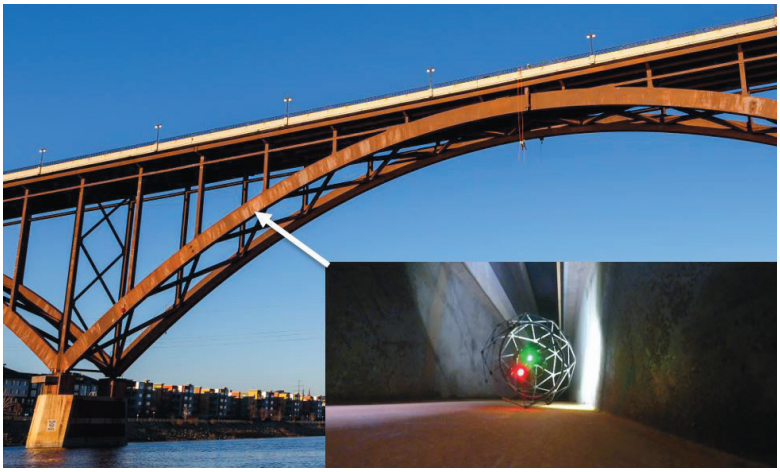

Bridge inspectors used multiple UAS, including a new drone that flies within a cage that can roll in confined spaces, preventing collision damage.

Researchers also evaluated UAS inspection expenditures, comparing the costs associated with using under-bridge inspection vehicles, ropes and other tools to the costs of using UAS.

What Did We Learn?

UAS were cost-effective and safe for evaluating structural components above and below bridge decks and driving surfaces.

In detecting deficiencies, the units worked well under the direct control of inspectors and autonomously. The Elios proved highly effective at locating deficiencies in confined spaces—between beams on multibeam bridges, on and above beams in low-clearance and remote locations, and within box beams and culverts where its cage prevents collision damage to the UAS.

For documenting deficiency data, the two systems collected high-quality video and still imagery. UAS data aligned with geolocation points that coordinate with non-UAS inspection tools and data sources, including ground-based non-drone photography.

Processing software generated 3-D models of bridges with precisely located deficiency information and imagery, provided photo-mosaic images of bridges and bridge elements from various angles that could include non-UAS photography, and reported detailed findings. An appendix to the project's final report includes full bridge inspection reports.

UAS saved an average of 40 percent in inspection costs on the bridges evaluated in the study. Savings greatly increased in situations that would otherwise require under-bridge inspection vehicles, which with traffic closures can cost about $5,000 per day. Drone equipment can be used by bridge inspectors for about $300 per day, with postprocessing costs of $120 per hour. Federal regulations prohibit UAS use over traffic, but traffic closures related to drone use typically last minutes rather than hours. Fewer crew members are needed for UAS inspections and safety is improved, making UAS attractive even for low-risk bridges. Traditional access methods continue to be necessary for hands-on inspection of fracture-critical members and areas where deficiencies need verification.

What's Next?

The three phases of this research have established the effectiveness of UAS in over 60 Minnesota bridge inspections. MnDOT now has two inspectors who are fully licensed to conduct UAS inspections. Phase IV has been funded to develop a program for Metro District inspections. The implementation team will inspect structures over an 18-month period and develop operational procedures and manuals for UAS. Funding will also be sought to fully equip a UAS unit for inspections throughout the state bridge system.

This Technical Summary pertains to Report 2018-26, "Improving the Quality of Bridge Inspections Using Unmanned Aircraft Systems (UAS)," published July 2018. The full report can be accessed at mndot.gov/research/reports/2018/201826.pdf.