Michigan Department of Transportation
RESEARCH Administration

RESEARCH SPOTLIGHT

Project Information

REPORT NAME: Integration of Unmanned Aerial Systems Data Collection into Day-to-Day Usage for Transportation Infrastructure—A Phase III Project

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Integrating drones into MDOT's day-to-day traffic and asset management

Previous research by the Michigan Department of Transportation (MDOT) illustrated the capabilities of unmanned aerial systems (UAS, sometimes called drones) for a variety of asset and traffic management purposes. Case studies of four applications common to MDOT's day-to-day operations will help expand the uses of drones and illustrate new potential, such as the integration of high-resolution geospatial data integrated into MDOT's workflows and databases. Overall, the efficient and effective data collection afforded by UAS will improve MDOT worker safety, increase mobility and offer a significant return on agency investment.

PROBLEM

MDOT's day-to-day management of the transportation system requires significant and ongoing data collection. As technology changes, capabilities to collect timely, detailed and accurate data evolve. Integrating data into systems and platforms that the agency uses to carry out its mission is challenging (and is often a moving target).

In 2013, MDOT initiated a three-phase investigation into the viability and potential of using UAS for data collection for a variety of day-to-day operations. Phases one and two demonstrated that several types of drones are able to perform comparably to traditional data collection methods in a variety of applications. As highlighted in an MDOT video Research Spotlight, the research showed the capabilities, efficiencies and cost-effectiveness UAS can offer.

Traffic can be viewed, and traffic density analyzed, in real time with data from unmanned aerial systems processed through automated machine learning algorithms.

Phase three expanded on the previous work, enabling MDOT to incorporate UAS as an established data collection tool into the agency's daily operations. With a better understanding of the platforms, sensing technologies and data collection potential,

(continued)

> *"Collecting data with UAS results in safer and more efficient management of our transportation system, which translates into increased mobility for road users. Now, we can more effectively integrate this tool into our day-to-day operations."*
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> **Steven J. Cook, P.E.**
> Project Manager

MDOT sought to apply the technology to four real-world data collection activities: monitoring traffic, surveying, and inspecting bridges and construction sites.

RESEARCH

Investigators explored how and where to fly UAS to effectively monitor traffic and how to analyze live-stream data. For bridge and construction inspections, data collected from a variety of bridge sites represented the range of conditions MDOT inspectors encounter and demonstrated the capacities of artificial intelligence (AI) to enhance collected data. To monitor construction, drones flown over pavement removal, concrete and asphalt paving projects collected thermal imagery and orthoimagery, which geometrically corrects an image to make the scale uniform.

Tests of UAS-based light detection and ranging (LiDAR) data identified topographic characteristics for design surveys. The data was compared to existing mobile LiDAR and traditional survey data to determine its utility and accuracy.

Lastly, the team explored how UAS-collected data and methods could be integrated into MDOT's existing workflows and databases.

RESULTS

The research revealed a number of findings in the four test applications:

Traffic monitoring: In addition to identifying optimal flying heights and when to use single or multiple drones for specific purposes, researchers developed algorithms for analyzing live-stream video to provide quantitative data on traffic counts, flow and density. These analyses are applicable to both daily traffic operations and analytical traffic studies.

Bridge inspection: UAS imagery processed through an algorithm detected the location, depth and surface area of bridge deck concrete surface defects such as spalling. A different process used thermal imagery to detect delamination in bridge decks to a greater and safer extent than traditional methods. UAS was also able to access dangerous or difficult-to-reach bridge locations and process data with AI into 3-D models to better illustrate bridge lifecycles and maintenance needs.

Construction inspection: Drones can support MDOT project managers in the field by monitoring the progress and quality of a project during construction. UAS-collected thermal images may help identify problem areas such as temperature segregation in recently laid asphalt, and can also estimate work progress, or paving rates, without having additional workers in dangerous situations or potentially disrupting construction.

LiDAR for design survey: While field conditions like dense vegetation may influence the accuracy of UAS-based LiDAR, the data collected was generally comparable to other survey data gathered by traditional methods. The right kind of reflective ground control targets can help with collecting high-quality LiDAR data.

Finally, the research team developed workflow diagrams that integrate and map UAS data into MDOT's workflows, databases and decision processes for the four investigated uses. They also conducted demonstration and training sessions for MDOT staff.

IMPLEMENTATION

Across the state, MDOT's certified pilots are already using UAS for design surveys, monitoring material stockpiles and mapping invasive species. Drawing from this research, the agency will continue to expand use of UAS while exploring solutions to regulatory challenges for using the tool in certain situations (such as over traffic). Finally, MDOT will continue to acquire equipment and train staff in ways to integrate UAS into their daily operations.

Research Administration

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This final report is available online at
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