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Tech Brief

USE OF SMALL UNMANNED AIRCRAFT SYSTEMS FOR ROADSIDE ASSET MANAGEMENT

Introduction

Small Unmanned Aircraft Systems (UAS) may assist State Departments of Transportation (State DOTs) with the management of transportation assets. The United States contains almost 4 billion miles of roadway and 600,000 bridges that serve as essential infrastructure within the national transportation and economic systems (FHWA, 2017). In turn, those assets include other types of supporting structures or assets such as High Mast Light Poles (HMLP), overhead signs, culverts and pipes, and pedestrian access ramps. UAS can assist State DOTs with the management of these assets.

Key Takeaways

- UAS may be helpful throughout the entire lifecycle of transportation asset management.
- UAS can increase safety when inspecting transportation infrastructure and supporting assets.
- State DOTs are reporting increased safety, efficiency, and cost savings by using UAS as a supplemental tool.

State DOTs are required to update every four years, its Transportation Asset Management Plan that outlines their assets and the management, forecasting, funding strategies, planning, and overall lifecycles of said assets (23 U.S.C. 119(e)(6)(B); FHWA, 2018a, p.2). Asset management is defined as "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based on quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the life cycle of the assets at minimum practicable cost" (23 U.S.C.101(a)(2)).

UAS are a supplemental tool that nearly all State DOTs have adopted for transportation asset management (AASHTO, 2019).

Use Cases

This document provides established use cases regarding the integration of UAS by State DOTs in roadside asset management.

U.S. Department of Transportation
Federal Highway Administration

High Mast Lighting Poles

Figure 1. UAS Inspecting HMLP. Source: NJDOT

The New Jersey DOT (NJDOT) uses UAS to assist with its inspection of 250 HMLP. NJDOT noted that traditional inspections of HMLP using binoculars result in a lack of data collection and limitations to the angles necessary for a thorough inspection (Stewart et al., 2018). Secondary inspections are often needed for a closer look that are done with bucket trucks. The use of these bucket trucks involves lane or shoulder closures that may negatively impact the public and present risks to highway workers such as work zone intrusions, equipment operator injuries, and car crashes.

While the lighting structure is still in, the UAS can be used to perform a steady, full 360-degree rotation inspection of the outer area, underneath area and the top of the lighting structure.

Inspection crews can also use the UAS to provide key aerial perspectives while the lighting structure is lowered down using the pulley system. The aerial perspective is especially helpful in identifying when the lighting structure coming down unevenly (Puppala & Congress, 2019). UAS can be used to further investigate these types of concerns and collect information that can then be used to determine if repairs are needed.

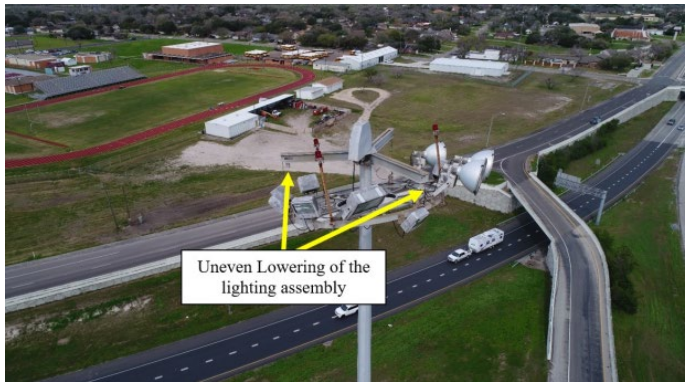

Figure 2. UAS Image of HMLP Lighting Assembly. Source: TxDOT

Figure 3. UAS Inspection of HMLP. Source: NJDOT

UAS also can be used to inspect the pole itself from the ground level to the top of the pole. With strategically planned flight paths, inspection crews can quickly inspect all sides of the pole while gathering important data on the condition of the pole itself.

State DOTs have found that using UAS for HMLP inspections has led to increased safety by reducing work zone and operator injury risks. UAS have also increased efficiency by gathering the required data with the primary inspection and have resulted in savings in labor hours and equipment (Stewart et al., 2018).

Culverts and Pipes

The Oregon DOT (ODOT) has researched the use of UAS to assist with the inspection of culverts and pipes. Imagery and videos from UAS can be used to inspect many characteristics of culverts and pipes including identification of cracking, documentation of material condition, detection of leakage, and inspection of joints and gaskets. ODOT found that UAS are an effective inspection tool for conduits and pipes that present excessive safety risk to humans or when remote vehicles can't be used, as seen in Figure 4.

Figure 4. UAS Inspection of Deteriorated Culvert. Source: ODOT

Figure 5. UAS Inspection of Large Pipe. Source: MDOT

The Maryland DOT (MDOT) has also used UAS for confined space inspection which enables the operator access to difficult locations that may be cost prohibitive if inspecting using other means (Alexander, 2021).

Many benefits are realized from using UAS for culvert inspection, aside from achieving data capture in areas difficult to access. UAS may be used in certain contaminated areas where humans would otherwise not enter. Not only time can be saved by using UAS for confined space inspection, but cost savings can be realized by the reduction in specialized equipment necessary for mobilizing humans into the proper position to carry out hands-on inspection (Alexander, 2021).

Overhead Signs

The Utah DOT (UDOT) has used UAS to help with the inspection of roadway overhead signs. UDOT has traditionally inspected overhead signs using bucket trucks that are positioned in the shoulder or in a roadway lane. This equipment requires the closure of lanes of traffic and active or passive traffic control. UDOT reports how time consuming this process of traditional inspection is, resulting in an average of two signs inspected each day. When UDOT began using UAS to inspect the overhead signs this number was increased to an average of 16 signs per day. UDOT reported a $100,000 savings on the overhead signs inspection project using UAS (Wheeler, 2022).

Figure 6. UAS Overhead Sign Inspection. Source: UDOT

Pedestrian Access Ramps

UDOT has also used UAS and remote sensors to analyze pedestrian access ramps. UAS, equipped with high-resolution sensors can capture detailed aerial imagery, which can be used to create three-dimensional (3D) point clouds of pedestrian access ramps. This data provides invaluable insights into the condition, compliance with accessibility standards, and potential hazards of these ramps. Traditionally UDOT engineers use a tape measure and smart level to inspect the slope of the pedestrian ramp to determine if it is within design standards and tolerances (Farhadmanesh et al., 2022).

Figure 7. 3D Model of Pedestrian Ramp. Source: UDOT

Using UAS and remote sensors, UDOT collected data of various pedestrian ramps and created 3D models to analyze compared to traditional in-field measurement inspections. Figure 7 shows a 3D model produced using photogrammetry. It was found that using these data collection and analysis methods resulted in highly accurate slope measurements and was a viable tool that could be used to assist with these inspections (Farhadmanesh et al., 2022).

FAA Regulations

UAS operators in both the public and private sectors must also adhere to statutory and regulatory requirements. Public aircraft operations (including UAS operations) are governed under the statutory requirements for public aircraft established in 49 USC § 40102 and § 40125. Additionally, both public and civil UAS operators may operate under the regulations promulgated by the Federal Aviation Administration. The provisions of 14 CFR part 107 apply to most operations of UAS weighing less than 55 lbs. Operators of UAS weighing greater than 55 lbs may request exemptions to the airworthiness requirements of 14 CFR part 91 pursuant to 49 USC §44807. UAS operators should also be aware of the requirements of the airspace in which they wish to fly as well as the requirements for the remote identification of unmanned aircraft. The FAA provides extensive resources and information to help guide UAS operators in determining which laws, rules, and regulations apply to a particular UAS operation. For more information, please see https://www.faa.gov/uas/.

Conclusion

UAS have become a widely used tool across State DOTs and many transportation asset management use cases have been established (AASHTO, 2019). The management of transportation infrastructure, encompassing an extensive network of roadways, bridges, high mast light poles, culverts, pipes, overhead signs, pedestrian ramps, and many other assets is a complex and critical task. UAS technology has emerged as a supplementary tool that enhances the efficiency, safety, and cost-effectiveness of asset management processes. By adopting UAS for inspections and data collection, State DOTs have been able to achieve an array of advantages, including improved safety, reduced operational costs, and enhanced data quality (FHWA, 2018b).

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Task Manager:
James Gray
UAS and Construction Technology Engineer Federal Highway Administration
1200 New Jersey Avenue, SE Washington, DC 20590
703-509-3464 / James.Gray@dot.gov

Authors: Paul Wheeler, Aaron Organ, Jag Mallela, PhD, WSP USA

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