Use of Unmanned Aircraft in Bridge Inspection

Russell J. Brummer

Department of Geography and Geospatial Sciences, South Dakota State University

GEOG 270: Introduction to Small Unmanned Aircraft Systems

Mr. Richard Stephens

December 8, 2021

Use of Unmanned Aircraft in Bridge Inspection

For many years, small unmanned aircraft systems (sUAS) have captured the attention of the public. SUAS have seemingly endless applications including crop scouting, land surveying, search and rescue missions, and many more (Wales, 2021). SUAS have potential use for any professional or hobby pilot. A novel application of SUAS technology is in structural and bridge inspection. SUAS have the potential the make this crucial task in maintaining our nation's infrastructure safer, more efficient, and more cost-effective.

Inspections of bridges and other structures are important to ensure that safe infrastructure is maintained. During a bridge inspection, an inspector will look for signs of wear and tear such as rust, corrosion, cracking, and even paint chipping (Flyability). These small signs are great indicators of the overall health of the bridge. Inspectors also analyze "fracture-critical members" which are the major load-bearing members that keep the bridge standing (Flyability). Bridge inspections allow agencies to maximize the effect of their bridge budgets and achieve the highest possible return on investment (Leonard, 2016). However, these inspections are often easier said than done.

As important as bridge inspections are, they are not without their own sets of challenges. The current means of bridge inspection are imperfect and carry many challenges such as concerns with traffic, access, cost, and safety. During a bridge inspection, a large snooper truck is parked on the bridge. It has a basket that allows the inspector to "snoop" underneath the bridge. These trucks are quite large and often require several lanes of traffic to close to operate (Flyability). This causes a lot of stress, not only with the inspection crew but also with the community members that rely on the bridge to reach their destinations. A second challenge facing current bridge inspection techniques is access. The snooper's basket may not be able to maneuver in a way that allows the inspector to access all the tight spaces underneath the bridge (Flyability). It is crucial to inspect the entire bridge when performing an inspection. Another issue is the cost. Snooper trucks can cost more than $600,000 to purchase and $2,500 a day to rent (Flyability). The last issue is of course safety. Snooper trucks are not the easiest machinery to operate. “If mishandled in any way, the snooper truck can tip over,” (Choi, 2021). Inspecting smaller bridges can also be dangerous. These bridges are often inspected by the use of a ladder or rope access (Zinc, 2016). Both methods put people’s lives in high-risk situations; if there is a safer option, it should be pursued.

Fortunately, sUAS is an exciting and novel approach to bridge inspection that can potentially alleviate the traffic, access, cost, and safety concerns that currently impede bridge inspections. SUAS would have a smaller impact on traffic. While the big snooper truck closed several lanes for extended periods, an sUAS operation would only require the bridge to be closed for a shorter time while inspecting the portions of the bridge overtop traffic. However, while inspecting the underside of the bridge, traffic would be allowed to flow smoothly unlike an inspection performed with a snooper. Additionally, the drone would be able to fly anywhere under and around the bridge, and with the correct camera orientation and propeller bumper guards, the drone would be able to access and inspect the entire bridge easily. The sUAS operation would also be significantly cheaper. According to a study performed by Dr. Junwon Seo at South Dakota State University, a DJI Phantom 4 was used to successfully inspect a bridge (Seo et al., 2018). SUAS bridge inspections also offer a safer alternative to traditional bridge inspection methods. In 2019, slips, trips, and falls were the second leading cause of injury in the construction industry (Barnes, 2020). During sUAS operations, the pilot does not have to put themselves in hazardous positions to get a good look. Considering these factors, it seems like SUAS inspections are the best option.

SUAS bridge inspections are not without their challenges either. Turbulence, challenging flight paths, operating beyond the visual line of sight, blurred imagery, and poor lighting are all challenges unique to sUAS inspections. Navigating underneath a bridge can be quite challenging for even the most experienced remote pilots. Additionally, the sUAS may have trouble connecting to global positioning satellites while operating under a bridge (Groves, 2020). Furthermore, when flying near structures the wind speed and direction can change rapidly, this makes operating the sUAS specifically challenging. Another challenge comes from regulations where sUAS are not allowed to operate beyond the visual line of sight (BVLOS). However, sUAS artificial intelligence may help overcome both challenges. Artificial intelligence allows for smarter piloting with programmed navigation and obstacle avoidance procedures (Groves, 2020). A company called Skydio has developed an autonomy engine that enables pilots to operate "just beyond" the visual line of sight and perform Close Proximity Low Altitude (CPLA) Operations (Groves, 2020). The FAA has even allowed the North Carolina Department of Transportation (NCDOT) and Skydio to secure the first "true BVLOS" waiver (Groves, 2020). This waiver allows pilots to perform operations BVLOS underneath bridges without visual observers, "provided the drone remains within 50 feet of the bridge itself and within 1,500 feet of the remote pilot" (Groves, 2020). Turbulence, as well as vehicle motion, can contribute to blurred imagery (Morgenthal & Hallermann, 2016). Additionally, poor and inadequate lighting can cause some imagery to be nearly useless. This imagery is crucial as the sensors on the SUAS can measure things important things such as the length and width of cracks in a concrete slab (Chiampa et al., 2019) However, rigorous flight and inspection planning as well as adding necessary lights to the SUAS can alleviate these challenges (Seo et al., 2018). SUAS operations are not perfect, but there are certain practices pilots can implement to mitigate these challenges.

SUAS is a growing market with exciting applications across nearly every industry. One such use is in structural and bridge inspections. The traditional means of bridge inspection has many challenges including traffic concerns, access, cost, and safety. SUAS bridge inspections can help alleviate those challenges. However, SUAS operations do come with their own set of unique issues including challenging flight patterns, operating beyond the visual line of sight, turbulence, blurred imagery, and poor lighting. However, new technological developments, FAA waivers, proper flight planning, and mounting additional necessary lighting can help mitigate these challenges, making SUAS bridge inspections a viable, safe, efficient, and cost-effective option.

References

Barnes, I. (2020, October 23). *How drones are changing construction*. New Civil Engineer. Retrieved December 9, 2021, from https://www.newcivilengineer.com/opinion/how-drones-are-changing-construction-25-10-2020/.

Choi, C. (2021, March 11). *Advancing bridge inspection*. Inside Unmanned Systems. Retrieved December 5, 2021, from https://insideunmannedsystems.com/advancing%E2%80%A8-bridge-inspection/.

Ciampa, E., De Vito, L., & Rosaria Pecce, M. (2019). Practical issues on the use of drones for construction inspections. *Journal of Physics: Conference Series*, *1249*(1), 012016. https://doi.org/10.1088/1742-6596/1249/1/012016

Groves, B. (2020). *Better bridge inspections: NC DOT'S and SKYDIO'S breakthough BVLOS waiver* [PowerPoint Slides].

Flyability. (n.d.). *Bridge inspections: A complete guide*. Bridge Inspections: A Complete Guide. Retrieved November 27, 2021, from https://www.flyability.com/bridge-inspections.

Leonard, K. (2016, March 23). *Bridge inspections necessary for long term planning*. HR Green. Retrieved December 5, 2021, from https://www.hrgreen.com/articles/bridge-inspections-necessary-for-long-term-planning/.

Morgenthal, G., & Hallermann, N. (2016). Quality Assessment of Unmanned Aerial Vehicle (UAV) based visual inspection of structures. *Advances in Structural Engineering*, *17*(3), 289–302. https://doi.org/10.1260/1369-4332.17.3.289

Seo, J., Duque, L., & Wacker, J. P. (2018). Field application of UAS-based Bridge Inspection. *Transportation Research Record: Journal of the Transportation Research Board*, *2672*(12), 72–81. https://doi.org/10.1177/0361198118780825

Wales, M. (2021, November 26). *Drone applications at present and in the future*. Wondershare Filmora. Retrieved December 5, 2021, from https://filmora.wondershare.com/drones/drone-applications-and-uses-in-future.html.

Zinc, J. (2016, October 4). *Will drones transform bridge inspection?* Commercial UAV News. Retrieved December 5, 2021, from https://www.commercialuavnews.com/infrastructure/will-drones-transform-bridge-inspection.