SUMMARY PAGE

The Gravity of Infrastructure

What if we could obtain a complete picture of critical infrastructure subsurface deterioration?

ARPA-I Ideas Challenge

Topic Area: Knowledge: *Tools that allow infrastructure operators to understand everything they need to know about their transportation infrastructure systems*.

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1. Summary Page

Maintaining critical transportation infrastructure is one of the United States' most important and costly public safety challenges, requiring billions of dollars annually for inspection, repair, and operation. Low-cost, routine monitoring of these assets enables early detection of structural issues, enhances safety by preventing failures, saves taxpayers money by avoiding costly emergency repairs, and extends the lifespan of these critical infrastructures. Although significant progress has been made in automating the assessment of roadway-visible assets (e.g. potholes and signage), routine inspection of hard-to-reach (e.g. roadside) and logistically complex (e.g. bridges) assets remains difficult and costly. The inspection of many subsurface infrastructure assets is still performed manually, often requiring specialized and costly equipment and significant labor. As a result, **achieving a complete and holistic understanding of infrastructure deterioration is not yet possible at an affordable cost to stakeholders.**

To overcome these challenges, **we propose a novel sensor fusion approach that combines LiDAR** (Light Detection and Ranging) **for high resolution surface mapping and target identification with quantum gravimetry for depth-resolved imaging based on bulk density variation (Fig. 1).**

By combining LiDAR and quantum gravimetry, **our sensor design improves on state-of-the-art approaches in nearly every category of interest for infrastructure assessment**. Our low-SWaP, fieldable quantum gravimetry solution is made possible by integrated photonics technology and a novel atom interferometry approach developed through internal research at Leidos. These advances result in a quantum gravimeter that is more rugged and fieldable than existing commercial offerings by using a fundamentally new drone-based approach to isolate cold-atom interferometry from its environment. Additionally, we build on decades of Leidos experience in LiDAR and AI-based drone control to build this fully-integrated quantum sensor tailored to addressing critical needs in infrastructure assessment.

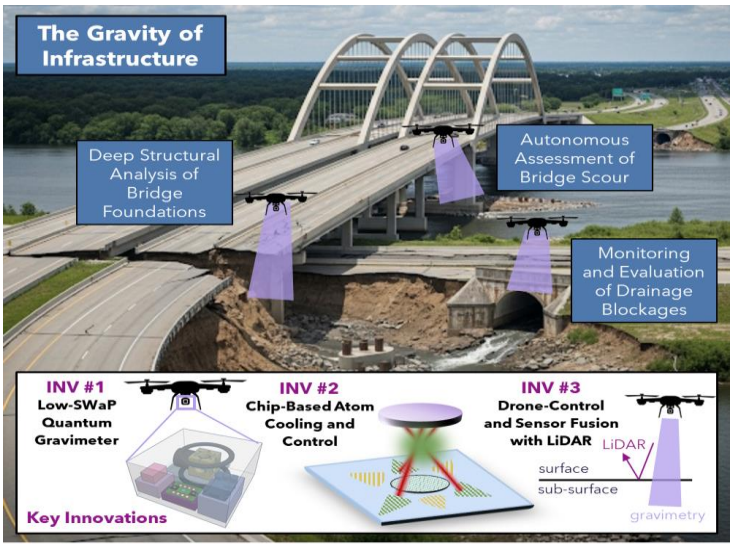

Figure 1: Leidos quantum gravimeter addresses needs in evaluation and monitoring of critical infrastructure.

Quantum gravimetry aligns closely with the U.S. DOT's top priorities by enhancing safety, supporting infrastructure modernization, and advancing infrastructure planning through innovative and ubiquitous sensing approaches. Given the importance of cost-efficiency and resilience, we identify three key areas of impact: **(1) Rapid assessment of critical infrastructure during emergencies and natural disasters; (2) Timely, cost-effective assessment of drainage and culverts; (3) Routine, autonomous assessment of bridges.**