Plan Overview

A Data Management Plan created using DMP Tool

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Title: Deploying UAS Innovations for Remote, Autonomous Infrastructure Construction Inspection to Enhance Safety, Save Time, Reduce Costs

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Project abstract:

Project Narrative
Identification and Understanding of the Problem to be Solved: The California Department of Transportation (Caltrans) seeks to more efficiently, cost-effectively and climate consciously conduct assessments and inspections associated with its expanded portfolio of infrastructure projects arising from Infrastructure Investment and Jobs Act (IIJA) investments. Believing advancing Uncrewed Aircraft Systems (UAS) technology is key to addressing this workload and workforce issue in a repeatable and scalable manner, Caltrans proposes a Stage 1 Strengthening Mobility and Revolutionizing Transportation (SMART) demonstration to validate the innovative use of dock-based UAS fully designed, assembled and supported in the US for remote autonomous operations. While Caltrans currently utilizes manually piloted UAS across all divisions and has completed more than 10,000 UAS flights, evolution to remote autonomous operations will be an operational force multiplier for the Caltrans workforce, the environment and the citizens and communities of California.
Understanding of Current Conditions: Caltrans is currently engaged in 791 active infrastructure construction contracts valued at $11.9B and has a pipeline of approximately 2100 additional projects to be completed over the next 4 years. Approximately 800 of these active and pending projects are located in Historically Disadvantaged Communities. Caltrans currently uses manually piloted UAS to assess infrastructure conditions and to collect data for design, construction and maintenance of transportation infrastructure. The Caltrans Division of Construction has 71 licensed pilots conducting photo, video, photogrammetry and light detection

and ranging (LIDAR) mapping missions on active construction projects. The use of UAS technology has proven to save time and money and provide better data to assist in administering infrastructure construction contracts compared to traditional inspection methods, and UAS-enhanced projects have fewer worker injury claims. Caltrans' utilization of UAS is repeatable and scalable across projects and contracts due to technology maturity, solid training and detailed data collection and analysis. A limiting factor, however, is the current requirement for all 71 pilots to drive to and from each site to fly manual, visually observed missions. Travel, sometimes hundreds of miles, reduces the number of missions a pilot can fly in any given time period, which extends project timelines, requires costly fuel expenditures and generates calculable carbon emissions.
Caltrans pilots are developed and supported through a robust training program comprising a UAS Safety Management System (SMS) and statewide, division-based trainers. The Caltrans UAS SMS was developed in concert with the University of California Merced over a 3 year period of time, and has now been used to train over 200 Caltrans UAS pilots across the state. This Training program has been used to train a variety of staff, ranging from student assistants, to maintenance staff, to senior level bridge engineers. The current training program has been set up for basic part 107 flight operations for pilot and visual observers, but is structured to expand as needed.
Appropriateness of Proposed Solution: The California Legislature recently passed Assembly Bill 1037 which requires Caltrans to implement digital construction management technologies by July 1, 2026. Use of digital construction management technologies reduces delivery time and cost, develops more sustainable infrastructure, improves worker safety, enables remote work and

generates data for decision making. The proposed solution leverages recent innovations in UAS technology that address Caltrans' need to generate inspection and assessment data more frequently and more efficiently. "Drone in a box" solutions comprise semi-permanent site deployed, dock-mounted UAS that operators can fly confidently from remote locations due to the onboard autonomy and obstacle avoidance capabilities of the aircraft.
Caltrans' Stage 1 project proposes to install dock-mounted UAS at two active and fully permitted infrastructure construction sites to validate the enhanced capabilities of dock-based UAS to augment traditional inspection tasks. Manually piloted, visually observed UAS have demonstrated efficiencies over physical inspections, and docked systems represent another opportunity to expand usage and enhance capabilities. The two sites identified for the demonstration are the Butte City Bridge Replacement project in Glenn County, CA and the East Otay Port of Entry project in San Diego County, CA. The Butte City project is replacing a 4200' long structurally deficient bridge that spans the Sacramento River with a modern cast in place concrete structure. This bridge serves as a major economic engine for the local community, as it is the only river crossing for 20 miles in either direction. The East Otay Port of Entry project will construct a new freight port of entry from Mexico into the United States. These two projects will provide data on the operation of the dock -based UAS, the amount of carbon emission reduction realized by operators not driving to and from the sites to conduct flights and the statistical reduction of worker injury. A second component of the Stage 1 demonstration will integrate assessment data into the secure, cyber-aware Digital Construction Management System Caltrans is currently developing. The core integration will be to automate the UAS data capture and processing functions into this Common Data environment to provide data useful for the inspection, measurement, and payment of contract bid items. Legacy processes currently in use are heavily reliant on manual processes. This integration will provide detailed, actionable data to improve the overall inspection and management of a variety of critical infrastructure projects administered by Caltrans. Data generated through the Stage 1 demonstration will inform an understanding of how to best repeat and scale docked UAS utilization in Stage 2 and as a nationwide model.
The Stage 2 grant implementation will further develop concepts and best practices learned from the initial deployments of these dock-based systems. The operations will progress from remotely monitored into fully automated flights that can be monitored by remote operations centers. Additional training and procedures will be developed to expand the use of these systems statewide. Stage 2 implementation will add locations, expand the types of inspections to be completed and work toward the automated integration of data into project management systems to further streamline inspection and contract management workflows.
Expected Benefits: Successful completion of a Stage 1 demonstration and subsequent Stage 2 deployment of dock-based UAS technology will measurably reduce the fuel consumption and carbon footprint of the assessment and inspection process, enhance worker safety, generate process efficiencies that will allow Caltrans to enhance transportation equity by engaging more community-impacting construction infrastructure projects and improve the overall process of critical infrastructure inspection. These savings and efficiencies

will enable Caltrans to better optimize the use of field staff to complete field inspection work and to engage more simultaneous contracts offering unionized hiring and training opportunities.

Start date: 08-15-2023

End date: 08-14-2024

Last modified: 07-08-2024

Copyright information:

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Data Collection

What data will you collect or create?

Flight data will be collected at both project sites for all flights conducted with the Dock Based UAS systems. Flight Duration, data collected, and any related notes are collected and stored on the manufacturer of the system's cloud environment.

How will the data be collected or created?

All flight data, including telemetry is collected and stored autonomously by the Skydio X2 system, and is transmitted and stored in the Skydio Remote Operations cloud environment.

Documentation and Metadata

What documentation and metadata will accompany the data?

All metadata associated with each flight is stored, including flight telemetry, duration, and success or failure of each flight is stored in the Skydio remote operations cloud. this data can be output in a variety of formats such as .csv or .xls formats. photos and videos taken are stored in .jpg or .mp4 format at are also stored on each cloud environment.

Ethics and Legal Compliance

How will you manage any ethical issues?

Here are the steps and considerations that Caltrans will take to ensure compliance with California's ethics policies:

Ethics Training:

Caltrans employees may undergo regular ethics training to ensure they are aware of the ethical standards and rules they are expected to follow.
Code of Conduct:

Caltrans likely has a comprehensive code of conduct that outlines the ethical expectations for its employees. This may cover issues such as conflicts of interest, gifts, and post-employment restrictions.
Conflict of Interest Policies:

The agency would likely have specific policies addressing conflicts of interest, ensuring that employees avoid situations where their personal interests could conflict with their professional duties.
Transparency and Accountability:

Caltrans may emphasize transparency in its operations, disclosing information about its projects, contracts, and decision-making processes. This helps build public trust and accountability.
Whistleblower Protections:

The agency may have mechanisms in place to protect employees who report unethical behavior or violations. Whistleblower protections are important for fostering a culture of transparency.
Review and Oversight:

Regular reviews and oversight mechanisms can be implemented to ensure compliance with ethical standards. This may include internal audits and external reviews by oversight bodies.
Adherence to State Laws and Regulations:

Caltrans would closely follow state laws and regulations related to ethics. These may be outlined in the California Government Code, the Political Reform Act, or other relevant statutes.
Collaboration with Ethics Commission:

Caltrans may collaborate with the California Fair Political Practices Commission (FPPC) or other relevant ethics commissions to ensure alignment with state guidelines.
Public Engagement:

Engaging with the public and stakeholders can help ensure that decisions are made transparently and that the public has an opportunity to provide input, reducing the risk of unethical practices.
Periodic Reviews and Updates:

The agency would periodically review and update its ethics policies to adapt to changing circumstances and legal requirements.
It's crucial for Caltrans to stay informed about any changes in California's ethics policies and promptly update its internal guidelines accordingly. Additionally, the agency may seek legal counsel to ensure ongoing compliance with state regulations.

How will you manage copyright and Intellectual Property Rights (IP/IPR) issues?

Managing copyright and intellectual property rights (IP/IPR) issues is crucial for Caltrans, as it deals with various projects, designs, and innovations. The agency must navigate legal considerations and adhere to relevant laws to protect its intellectual property and respect the rights of others. Below are general steps that Caltrans might take to manage copyright and intellectual property issues:

Identification of Intellectual Property:

Caltrans would identify and document all intellectual property created or used in its projects. This includes designs, plans, software, and any other creative works.
Employee Training and Awareness:

Conducting training programs to educate employees about copyright and intellectual property rights ensures that staff members are aware of the importance of protecting these rights and avoiding infringement.
Establishment of Policies and Guidelines:

Caltrans would likely establish clear policies and guidelines regarding the creation, use, and protection of intellectual property. These policies would specify the rights and responsibilities of employees and contractors.
Documentation and Record-keeping:

Maintaining detailed records of the creation, use, and ownership of intellectual property helps in tracking and managing rights. Proper documentation is essential for legal protection and potential licensing agreements.
Contractual Agreements:

Caltrans would include clauses in contracts with employees, contractors, and third-party vendors specifying the ownership and usage rights of intellectual property. This is critical to avoid disputes over ownership.
Licensing Agreements:

When appropriate, Caltrans may enter into licensing agreements with external entities, allowing the use of its intellectual property under specified terms. This could include licensing for the use of designs, software, or other proprietary information.
Protection of Sensitive Information:

Implementing measures to protect sensitive intellectual property, such as restricting access to certain information and securing digital assets, helps prevent unauthorized use or disclosure.

Monitoring and Enforcement:

Regularly monitoring the use of intellectual property and enforcing rights when necessary is crucial. Caltrans may use legal means to address any infringement, including issuing cease and desist notices or pursuing legal action.
Collaboration with Legal Experts:

Collaborating with legal experts, such as intellectual property attorneys, helps Caltrans stay informed about changes in laws and ensures that its practices align with legal requirements.
Open Source and Collaboration Policies:

If Caltrans engages in open-source development or collaborations with external entities, it would establish policies to govern the sharing and usage of intellectual property in these contexts.
Public Domain Considerations:

Caltrans should be mindful of works that may be in the public domain, ensuring that it complies with copyright laws and respects the rights of others when using public domain materials.
Periodic Review and Updates:

Regularly reviewing and updating intellectual property policies ensures that they remain relevant and effective in addressing emerging challenges and legal developments.
By taking these steps, Caltrans can manage copyright and intellectual property issues effectively, protecting its own creations and respecting the rights of others in the process. It's important to note that legal considerations may vary, and Caltrans would need to adapt its approach to comply with applicable laws and regulations.

Storage and Backup

How will the data be stored and backed up during the research?

Data collected for all flight information is stored on the Skydio Remote Operations cloud, which is stored and backed up on West Coast, and East Coast datacenters. RTO and RPO are 15 min. and 45 min respectively.

How will you manage access and security?

Authentication and Authorization:

Access to Skydio Cloud would likely require user authentication through secure methods such as usernames and passwords. Multi-factor authentication (MFA) may also be employed for an additional layer of security. Authorization mechanisms would define what actions each authenticated user is allowed to perform.
Encryption:

Data transmission to and from Skydio Cloud may be encrypted using secure protocols such as HTTPS (SSL/TLS) to protect data from unauthorized access during transit. Additionally, stored data may be encrypted to safeguard it at rest.
Role-Based Access Control (RBAC):

RBAC could be implemented to control access based on user roles and responsibilities. Different users or groups may have different levels of access, ensuring that individuals only have access to the resources necessary for their tasks.
Audit Trails and Logging:

Skydio Cloud might maintain detailed logs of user activities and system events. These logs serve as an audit trail that can be reviewed to identify suspicious or unauthorized activities.
Firewalls and Network Security:

Network security measures, including firewalls, may be implemented to control and monitor traffic to and from Skydio Cloud. These measures help protect against unauthorized access and potential attacks.

Regular Security Audits and Assessments:

Skydio may conduct regular security audits and assessments to identify vulnerabilities and address potential security risks. This proactive approach helps ensure that the platform remains resilient to evolving threats.
Incident Response Plan:

A well-defined incident response plan would be in place to address security incidents promptly. This plan would include procedures for identifying, containing, eradicating, recovering from, and documenting security incidents.
Data Backups and Redundancy:

Regular data backups and redundancy measures can mitigate the impact of data loss or system failures. This ensures that critical information is recoverable in the event of an unexpected incident.
Compliance with Industry Standards:

Skydio Cloud may adhere to industry standards and regulations related to data security and privacy. Compliance with standards such as ISO 27001 or SOC 2 may be sought to demonstrate a commitment to security.
User Education and Training:

Users may receive education and training on security best practices to reduce the risk of unintentional security breaches. This can include guidance on creating strong passwords, recognizing phishing attempts, and other security awareness topics.

Selection and Preservation

Which data are of long-term value and should be retained, shared, and/or preserved?

All data collected related to the dock flights will be stored long term on the Skydio Cloud environment until the completion of the SMART Grant reporting period.

What is the long-term preservation plan for the dataset?

At the end of the SMART Grant phase 1 performance period, all data will be archived and stored on Caltrans servers in accordance with current Caltrans and California Department of Technology data retention policies.

Data Sharing

How will you share the data?

The California Department of Transportation plans on sharing relevant data related to Dock Based UAS operations and deployment with other State Department of Transportations and the Federal Highway Administration. Caltrans participates in several UAS groups sponsored by the Federal Highway Administration through the EDC-5 and EDC-6 programs. Information is also shared with groups such as the International Highway Engineering Exchange Program (IHEEP). Caltrans also participates in organizations such as Association for Unmanned Vehicle Systems (AVUSI) and will be participating in a panel discussing dock based UAS at the upcoming Xponential 2024 conference in San Diego.

Are any restrictions on data sharing required?

Ther are no known restrictions on data sharing as it relates to this grant.

Responsibilities and Resources

Who will be responsible for data management?

Aaron Chamberlin, Project Lead will be responsible for data management. Aaron's contact information is as follows: Email: Aaron.Chamberlin@dot.ca.gov Phone: (916) 798-6028

What resources will you require to deliver your plan?

All resources needed to complete this plan exist internally at Caltrans. All hardware and software will be purchased form Skydio, Inc. At the end of the reporting period, data stored on the Skydio Cloud system will be moved to Caltrans internal servers.

Planned Research Outputs

Data paper - "Enhancing Infrastructure Inspection: A Dock-Based Unmanned Aerial Systems Approach"

1. Introduction:
Briefly introduce the significance of infrastructure inspection.
Highlight challenges in traditional inspection methods.
Introduce the concept of dock-based UAS as a solution.
2. Literature Review:
Review existing literature on infrastructure inspection methods.
Explore studies on UAS applications in various industries.
Identify gaps in research and opportunities for dock-based UAS.
3. Methodology:
Describe the approach taken for implementing dock-based UAS for infrastructure inspection.
Detail the types of infrastructure targeted (e.g., bridges, roads, buildings).
Explain the choice of UAS platforms, sensors, and docking systems.
4. Docking System Design and Implementation:
Provide a detailed explanation of the design and functionality of the dock.
Discuss any innovations or improvements made to existing docking systems.
Highlight the compatibility with various UAS models.
5. Data Collection and Analysis:
Explain the data collection process during infrastructure inspections.
Discuss the types of sensors used and the quality of data obtained.
Present any challenges encountered and solutions implemented during data analysis.
6. Case Studies:
Include case studies showcasing the application of dock-based UAS in real-world infrastructure inspection scenarios.
Present findings related to efficiency, cost-effectiveness, and data accuracy.
7. Comparative Analysis:
Compare the results of dock-based UAS inspections with traditional methods.
Evaluate the advantages and limitations of the dock-based approach.
8. Safety and Regulatory Considerations:
Discuss safety measures implemented during UAS operations.
Address compliance with aviation regulations and standards.
9. Future Directions:
Propose potential improvements and advancements for dock-based UAS technology.
Suggest areas for further research and development.
10. Conclusion:
Summarize the key findings and contributions of the research.
Emphasize the potential impact of dock-based UAS on the field of infrastructure inspection.
11. References:
Cite all the sources and references used throughout the research output.

12. Acknowledgments (if applicable):
Thank individuals, organizations, or agencies that contributed to the research.

13. Appendices (if applicable):
Include additional supplementary material such as technical drawings, additional data, or code used in the research.

This structure provides a framework for presenting a comprehensive and detailed research output on the application of dock-based UAS for infrastructure inspection. Researchers can tailor the content to the specifics of their study and the intended audience.

Planned research output details

Title	Type	Anticipated release date	Initial access level	Intended repository(ies)	Anticipated file size	License	Metadata standard(s)	May contain sensitive data?	May contain PII?
Enhancing Infrastructure Inspection: A Dock-Based ...	Data paper	2024-12-14	Open	None specified	40 MB	Creative Commons Attribution 4.0 International	None specified	No	No