Plan Overview

A Data Management Plan created using DMPTool

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

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Grant: SMARTFY22N1P1G05

Template: SMART Grants Stage 1 Data Management Plan (DMP)

Project abstract:

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.

Start date: 08-14-2023

End date: 08-13-2024

Last modified: 06-07-2024

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

Project Contact Information

Please provide as much of the the following information as possible:

1. **Name of the project;**
2. **Grant number;**
3. **Name of the person submitting this DMP;**
4. **ORCiD of the person submitting this DMP (need an ORCID? Register here: https://orcid.org/);**
5. **Email and phone number of the person submitting this DMP;**
6. **Name of the organization for which the person submitting this DMP is working;**
7. **Email and phone number for the organization;**
8. **Link to organization or project website, if applicable; and,**
9. **Date the DMP was written.**

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7. Aaron.Chamberlin@dot.ca.gov
8. www.dot.ca.gov
9. 12/21/2023

Data Description

Please provide as much information as possible:

1. **Provide a description of the data that you will be gathering in the course of your project or data from a third party that you will re-use, if any;**
    1. **If there will be no data collected or re-used from another source, state that this is case;**
        1. **If you answered "No data" above, then you are finished and may skip the most of the steps and sections below, after you:**
            1. **Save your DMP as it exists;**
            2. **Submit it to your Grant Manager or the NTL staff for review.**
2. **Address the expected nature, scope, and scale of the data that will be collected, as best as you can at this stage;**
3. **As best as you can, describe the characteristics of the data, their relationship to other data, and provide sufficient detail so that reviewers will understand any disclosure risks that may apply;**
    1. **If data might be sensitive, please describe how you will protect privacy and security, if you know that now;**
    2. **You may need to update your DMP later to add more detail;**
4. **Discuss the expected value of the data over the long-term.**

1. Description of Data to be Gathered
   In the course of the project, data will be gathered through the deployment of Uncrewed Aircraft Systems (UAS) for remote, autonomous infrastructure construction inspection. This includes data collected from two primary sources:

Caltrans UAS Operations: Utilizing dock-based UAS systems to collect photo, video, photogrammetry, and LiDAR mapping data.
Third-Party Data: No third-party data will be re-used in this project.

2. Nature: The data collected will primarily consist of high-resolution imagery, video recordings, and flight logs including telemetry at the designated construction sites. These data sets will be used for inspection, measurement, and documentation of infrastructure conditions.
   Scope: Data collection will occur at two active construction sites, the Butte City Bridge Replacement project in Glenn County and the East Otay Port of Entry project in San Diego County.
   Scale: The project aims to collect data over the span of the entire project timeline, capturing multiple phases of construction and inspection activities.

3. Characteristics:

   Imagery: High-resolution images and videos captured by UAS-mounted cameras.
   Photogrammetry Data: 3D models created from aerial photographs of the construction sites.
   Geospatial Data: GPS coordinates and metadata for each data capture instance.
   Flight Logs: Detailed records of each flight, including duration, distance, altitude, and path.
   Telemetry Data: Real-time data from the UAS including speed, battery status, signal strength, and environmental conditions.
   Relationship to Other Data: The collected data will be integrated into Caltrans' Digital Construction Management System. This system will combine UAS data with other project management data to provide comprehensive insights into construction progress and quality.

   Privacy and Security Protections
   Privacy: Measures will be taken to ensure that imagery and video do not capture identifiable individuals. Any such data will be anonymized or redacted.
   Security: Data will be stored in secure, access-controlled environments. Encryption will be used for data transmission and storage. Access to the data will be restricted to authorized personnel only.

4. Long-Term Value of Data
   The data collected during this project is expected to have significant long-term value, including:

   Enhanced Safety: Improved data for construction inspection will enhance worker safety by reducing the need for physical inspections in hazardous areas.
   Cost Savings: Automated data collection will reduce the costs associated with manual inspections and rework.
   Environmental Benefits: Reduced travel for inspections will lower fuel consumption and carbon emissions.
   Scalability: Successful demonstration and data integration will provide a model for scalable UAS deployment in infrastructure projects nationwide.
   Conclusion
   This Data Description Plan outlines the types of data to be collected, their characteristics, potential disclosure risks, and measures for ensuring privacy and security. The plan emphasizes the long-term value of the data in improving safety, reducing costs, and providing environmental benefits. This plan will be updated as the project progresses to ensure that all aspects of data management are adequately addressed.

Data Format and Metadata Standards Employed

Please provide as much information as you can:

1. **Describe the anticipated file formats of your data and related files;**
2. **To the maximum extent practicable, your DMP should address how you will use platform-independent and non-proprietary formats to ensure maximum utility of the data in the future;**
    1. **If you are unable to use platform-independent and non-proprietary formats, you should specify the standards and formats that will be used and the rationale for using those standards and formats.**

3. **Identify the metadata standards you will use to describe the data.**
    1. **At least one metadata file should be a DCAT-US v1.1 (https://resources.data.gov/resources/dcat-us/) .JSON file, the federal standard for data search and discovery.**

Anticipated File Formats
The data collected in the project will be stored in the following file formats:

Imagery: JPEG, PNG
Video: MP4
Photogrammetry Data: GeoTIFF, OBJ
Geospatial Data: CSV, SHP
Flight Logs: CSV
Telemetry Data: JSON, CSV
Use of Platform-Independent and Non-Proprietary Formats
To ensure maximum utility and accessibility of the data in the future, we will prioritize the use of platform-independent and non-proprietary formats wherever possible:

Imagery: JPEG and PNG are widely used, non-proprietary formats that are supported by numerous platforms.
Video: MP4 is a widely accepted format that is platform-independent.
Photogrammetry Data: GeoTIFF is a non-proprietary format for geospatial data, while OBJ is a common format for 3D models.
Geospatial Data: CSV and SHP are standard formats for geospatial data, with CSV being non-proprietary and SHP being widely supported in GIS applications.
Flight Logs and Telemetry Data: CSV and JSON are non-proprietary and platform-independent formats.
Use of Proprietary Formats
In cases where non-proprietary formats are not feasible, we will use industry-standard proprietary formats with strong support and interoperability:

Imagery and Video: No proprietary formats will be used.
Photogrammetry Data: OBJ is used due to its widespread acceptance and support in 3D modeling software.
Geospatial Data: SHP is used because it is a standard format in GIS applications with extensive support.
Flight Logs and Telemetry Data: No proprietary formats will be used.
Metadata Standards
To ensure the data is well-described and easily discoverable, we will adhere to the following metadata standards:

Dublin Core: For general metadata descriptions.
ISO 19115: For geospatial data.
Federal Geographic Data Committee (FGDC): For metadata related to geospatial data.
DCAT-US v1.1 Metadata File
In compliance with federal standards for data search and discovery, at least one metadata file will be created in the DCAT-US v1.1 format. This metadata will be provided as a JSON file and will include:

Title: A descriptive title of the dataset.
Description: A detailed description of the dataset's content and purpose.
Keywords: Relevant keywords to aid in data discovery.
Publisher: Information about the data publisher (Caltrans).
Contact Information: Contact details for further information.
Access Level: Information on data accessibility.
Bureau Code: Relevant bureau code for federal reporting.
Program Code: Relevant program code for federal reporting.
Spatial Coverage: Geographic area covered by the dataset.
Temporal Coverage: Time period covered by the dataset.
Distribution: Links to the data files and any relevant documentation.
Licensing: Information on data usage rights and restrictions.
The DCAT-US v1.1 metadata file will ensure that the dataset is easily discoverable through federal data catalogs and compliant with national data standards.

Access Policies

In general, data from DOT-funded projects must be made publicly accessible. Exceptions to this policy are: data that contain personally identifiable information (PII) that cannot be anonymized; confidential business information; or classified information. Protecting research participants and guarding against the disclosure of identities and/or confidential business information is an essential norm in scientific research. Your DMP should address these issues and outline the efforts you will take to provide informed consent statements to participants, the steps you will take the protect privacy and confidentiality prior to archiving your data, and any additional concerns. In general, in matters of human subject research, your DMP should describe how your informed consent forms will permit sharing with the research community and whether additional steps, such as an Institutional Review Board (IRB), may be used to protect privacy and confidentiality. Additionally, when working with, or conducting research that includes Indigenous populations or Tribal communities, researcher will adhere to the CARE Principles for Indigenous Data Governance https://www.gida-global.org/care and make an explicit statement to that effect in this portion of the DMP.

Please provide as much information as possible:

1. **Describe any sensitive data that may be collected or used;**
2. **Describe how you will protect PII or other sensitive data, including IRB review, application of CARE Principles guidelines, or other ethical norms and practices;**
    1. **If you will not be able to deidentify the data in a manner that protects privacy and confidentiality while maintaining the utility of the dataset, you should describe the necessary restrictions on access and use;**
3. **Describe any access restrictions that may apply to your data;**
4. **If necessary, describe any division of responsibilities for stewarding and protecting the data among Principal Investigators or other project staff.**

1. No sensitive data will be collected. All data is subject to the California Public Records Request Act and can be provided upon request.
2. Not Applicable.
3. None.
4. Data protections are crucial to ensure no data is lost. All flight data and telemetry is stored on the Skydio Cloud interface.

Re-use, Redistribution, and Derivatives Products Policies

Recipients are reminded:

1. **Data, as a collection of facts, cannot be copyrighted under US copyright law;**
2. **Projects carried out under a US DOT SMART Grants is federally funded; therefore, as stated in grant language:**
    1. **Recipients must comply with the US DOT Public Access Plan, meaning, among other requirements, project data must be shared with the public, either by the researchers or by US DOT;**
    2. **That by accepting US DOT funding through this grant, recipients have granted to US DOT a comprehensive non-exclusive, paid-up, royalty-free copyright license for all project outputs (publications, datasets, software, code, etc.). This includes all rights under copyright, including, but not limited to the rights to copy, distribute, prepare derivative works, and the right to display and/or perform a work in public; and,**
    3. **In accordance with Chapter 18 of Title 35 of the United States Code, also known as the Bayh-Dole Act, where grant recipients elect to retain title to any invention developed under this grant, US DOT retains a statutory nonexclusive, nontransferrable,**

irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any such invention throughout the world.

Please provide as much information as possible:

1. **Describe who will hold the intellectual property rights for the data created or used during the project;**
2. **Describe whether you will transfer those rights to a data archive, if appropriate;**
3. **Identify whether any licenses apply to the data;**
    1. **If you will be enforcing terms of use or a requirement for data citation through a license, indicate as much in your DMP;**
4. **Describe any other legal requirements that might need to be addressed.**

1. The California Department of Transportation retains all rights to intellectual property created during this project. This information is freely available to the public upon request through the California Public Records Request Act (CPRA)
2. Records will be archived and stored as required by Caltrans Policy for an indefinite period of time.
3. None
4. None

Archiving and Preservation Plan

Please provide as much information as possible:

1. **State where you intend to archive your data and why you have chosen that particular option;**
2. **Provide a link to the repository;**
3. **You must describe the dataset that is being archived with a minimum amount of metadata that ensures its discoverability;**
    1. **Whatever archive option you choose, that archive should support the capture and provision of the US Federal Government DCAT-US Metadata Schema https://resources.data.gov/resources/dcat-us/**
4. **In addition, the archive you choose should support the creation and maintenance of persistent identifiers (e.g., DOIs, handles, etc.) and must provide for maintenance of those identifiers throughout the preservation lifecycle of the data;**
5. **Your plan should address how your archiving and preservation choices meet these requirements.**

1. Intellectual Property Rights for Data
The data created or used during the project will be subject to the following intellectual property rights considerations:

Ownership: The primary intellectual property rights for the data will be held by the project recipients, which in this case is the California Department of Transportation (Caltrans).
Transfer of Rights: All project outputs, including data, will be made publicly accessible in compliance with the US DOT Public Access Plan and the California Public Records Act. As such, the intellectual property rights will effectively be transferred to the public domain through US DOT's comprehensive non-exclusive, paid-up, royalty-free copyright license.
2. Transfer of Rights to Data Archives
Data Archives: The data will be stored in publicly accessible data repositories to ensure compliance with the US DOT Public Access Plan. This will include transferring data to appropriate data archives that support long-term preservation and access. Specific URL is not known at this time, however it will be accessable on the www.dot.ca.gov domain.
Public Access: The primary repository for the data will be a publicly accessible data archive managed by Caltrans and/or US DOT.

3. Licenses Applied to the Data

US DOT License: By accepting US DOT funding, Caltrans grants US DOT a comprehensive non-exclusive, paid-up, royalty-free copyright license for all project outputs, including datasets. This license includes all rights under copyright, such as copying, distributing, preparing derivative works, and the right to display and/or perform a work in public.

Creative Commons: Where applicable, data will be licensed under a Creative Commons Attribution (CC BY) license to ensure proper attribution while allowing for wide dissemination and reuse.

4. Enforcing Terms of Use and Data Citation

Terms of Use: The project will enforce terms of use through the chosen data repositories and archives. These terms will require users to comply with licensing agreements and to provide proper citation when using the data.

Data Citation: Users of the data will be required to cite the data in any publications or derivative works. The citation format will be specified in the metadata and terms of use associated with each dataset.

5. Other Legal Requirements

Bayh-Dole Act Compliance: In accordance with Chapter 18 of Title 35 of the United States Code, grant recipients may retain title to any inventions developed under this grant. However, US DOT retains a statutory nonexclusive, nontransferrable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any such invention throughout the world.

Privacy and Confidentiality: Although the data is subject to the California Public Records Act and will be publicly accessible, any data that could potentially identify individuals will be anonymized or redacted to protect privacy and confidentiality.

Public Records Act Compliance: All data collected is subject to the California Public Records Act. This means that data will be accessible upon request, and Caltrans will ensure that the data is properly prepared for public release in compliance with state regulations.

Planned Research Outputs

Data paper - "Deployment of Dock-Based UAS for Infrastructure Inspection - Results from early trials"

Overview
This research output documents the deployment and performance of dock-based Uncrewed Aircraft Systems (UAS) for remote, autonomous infrastructure inspection at two active construction sites: the Butte City Bridge Replacement project in Glenn County and the East Otay Port of Entry project in San Diego County. The project aimed to enhance safety, efficiency, and environmental sustainability by reducing the need for manual inspections and travel.

1. Summary of Flights
Butte City Bridge Replacement Project
Total Flights: 146
Duration: Each flight averaged 25 minutes
Data Collected: High-resolution imagery, videos, photogrammetry data, flight logs, telemetry data
Purpose: Monitor construction progress, inspect structural integrity, assess environmental impact
Issues Encountered:Weather Interference: High winds on several occasions delayed flights.
Technical Glitches: Minor software issues with the UAS autonomy engine were encountered and resolved with firmware updates.
Landing Issues: Difficulty in drone landing when the QR code on the dock arm was partially shaded. This issue has yet to be resolved. Future hardware will not use an arm, thereby eliminating this problem with next-generation hardware.
East Otay Port of Entry Project
Total Flights: 120
Duration: Each flight averaged 30 minutes
Data Collected: High-resolution imagery, videos, photogrammetry data, flight logs, telemetry data
Purpose: Monitor construction progress, inspect structural integrity, assess environmental impact
Issues Encountered:Signal Interference: High traffic area resulted in occasional signal interference; resolved by adjusting flight schedules.
Battery Performance: Some battery degradation was noted due to high temperatures; resolved by optimizing battery usage and storage.
2. Schematics and Power Installation
Butte City Bridge Replacement Project Schematic
Dock Location: Near the northern end of the bridge
UAS Coverage Area: Entire bridge span and surrounding area up to 1 mile
Power Installation:Source: Commercial 120/240V power supply
Data Backhaul:Service: Starlink satellite internet due to limited cellular coverage and bandwidth
Metrics: Data usage tracked monthly and included in the report
Benefits: Enabled continuous operations with reliable power supply and robust data backhaul.
East Otay Port of Entry Project Schematic
Dock Location: Central to the main construction zone
UAS Coverage Area: Entire port area and adjacent access roads
Solar Installation:Panels: 6 high-efficiency 400W 72-cell solar panels installed on-site
Capacity: 2.4 kW
Storage: 7.5 kWh of battery backup
Purpose: Provide sustainable power to the dock and UAS charging stations
Data Backhaul:Service: Starlink satellite internet due to limited cellular coverage and bandwidth
Metrics: Data usage tracked monthly and included in the report
Benefits: Enabled continuous operations with minimal environmental impact through sustainable energy use and robust data backhaul.
3. Detailed Flight Logs and Telemetry Data
Flight Logs: CSV files documenting each flight, including date, time, duration, distance, altitude, and path.
Telemetry Data: JSON files containing real-time data from the UAS, including speed, battery status, signal strength, and environmental conditions.

4. Issues and Solutions
Weather Interference: Adjusted flight schedules to avoid high winds and adverse weather conditions.
Technical Glitches: Regular firmware updates and technical support from Skydio ensured minimal downtime.
Landing Issues: The issue of the drone landing when the QR code on the dock arm was partially shaded has not been resolved yet. Future hardware designs that do not use an arm will eliminate this problem.
Signal Interference: Coordinated flight times to avoid peak traffic hours and optimized flight paths to reduce interference.
Battery Performance: Implemented best practices for battery storage and usage to extend lifespan and performance.
5. Environmental Impact
Reduction in Travel
Travel Reduction: Approximately 1/5 of the flights resulted in the reduction of a staff member traveling from the office to the field location.
Trip Distance: On average, this trip was 52 miles round trip at both locations.
Flights Reducing Travel:Butte City: 146 flights x 1/5 = 29.2 trips reduced
East Otay: 120 flights x 1/5 = 24 trips reduced
Total Trips Reduced: 53.2 trips (rounded to 53 trips)
Carbon Emission Reduction
Average Vehicle Emissions: 404 grams of CO2 per mile (EPA estimate for an average passenger vehicle)
Total Miles Reduced: 53 trips x 52 miles = 2,756 miles
Total CO2 Emissions Reduced: 2,756 miles x 404 grams/mile = 1,113,824 grams (1,114 kg or 1.1 metric tons)
This reduction in travel not only decreased fuel consumption and carbon emissions but also contributed to less traffic congestion and lower operational costs.

6. Compliance with Public Access and Licensing
Public Access: All data collected is publicly accessible under the California Public Records Act and the US DOT Public Access Plan.
Licensing: Data is licensed under a Creative Commons Attribution (CC BY) license, ensuring proper attribution and wide dissemination.
Metadata: Metadata files are created in DCAT-US v1.1 format to facilitate data discovery and compliance with federal standards.

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?
Deployment of Dock-Based UAS for Infrastructure In ...	Data paper	2024-08-29	Open	None specified		Creative Commons Attribution 4.0 International	None specified	No	No