

# DRISI

CALTRANS DIVISION OF RESEARCH,  
INNOVATION AND SYSTEM INFORMATION

# Research Notes

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Project Title:  
Development of an Integrated  
Unmanned Aerial Systems (UAS)  
Validation Center TPF-5(387)

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Task Manager:  
Edwin Yeung  
Transportation Engineer  
edwin.yeung@dot.ca.gov

## Development of an Integrated UAS Validation Center

Develop the standards, protocols, and testing requirements that a given UAS must meet and demonstrate for a particular application.

### WHAT IS THE NEED?

Unmanned Aerial Systems (UAS) have the potential to drastically change how civil infrastructure is inspected, monitored, and managed. Deployment of UAS in areas such as bridge inspection and accident reconstruction will likely have far-reaching impacts and evolve over time, with new uses and users emerging as technology matures. With new technology, limitations exist until new protocols are established, and industry must move forward with an appropriate level of caution. For example, speculation regarding the ability of a UAS to replace a human bridge inspector is frequently observed in trade magazines, presentations, and in the literature. With no standard tests to verify such claims, agencies are left to rely upon vendor's promotional material when making decisions about UAS deployment.

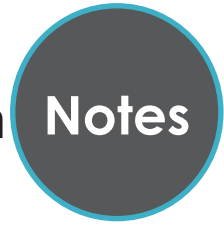
### WHAT ARE WE DOING?

The scope is:

1. Identify areas that need UAS validation in the context of civil engineering infrastructure. Possibilities include bridge and traffic signal inspection, accident reconstruction, construction site monitoring, site assessment and inspection of railroad way.
2. Conduct stakeholder workshops, including owners, engineers, pilots, and academics, to identify performance criteria which UAS must meet for a given applications.
3. Develop methodologies to "test" whether the UAS meets specific criteria identified in Task II for given applications. The specific research efforts are primarily conducted in this task.
  - a. The development of pilot and UAS navigation testing and validation obstacle courses, communication with the airport tower, filing of the flight-plan, as well as the required written testing criteria for the pilot.
  - b. The development of camera and other sensor accuracy and precision requirements, such as lighting standards, contrast detection, color sensing capabilities, distance and volume measurement requirements, and image quality



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standards.

c. The development of test methods and test equipment to objectively, and consistently measure that a given UAS is providing sufficient lighting (i.e., do small light optic measurement devices need to be installed at strategic locations under the bridge). Other devices will need to be developed to ensure standard contrast testing, accuracy and precision standards, etc. required in the bullet item above can be quantitatively and repeatedly evaluated.

d. The development of a test bed (e.g., full-scale bridge specimens, accident scenarios, etc.) in which navigation skills of the UAS are tested under specific conditions, such as a pre-defined wind speed.

e. The development of UAS performance criteria when communication or line-of-sight is lost.

4. Conduct stakeholder workshops to present results from Task 3 and refine as necessary.
5. Conduct a beta version roll-out of the validation criteria at Purdue University's Center for Aging Infrastructure (CAI) and the Steel Bridge Research, Inspection, Training, and Engineering Center (S-BRITE). This site allows testing on multiple full-scale bridge components, signal and luminaire structures as well as space to create accident reconstruction and simulated construction sites related to transportation components.
6. Based on the results of Task 5, further revise the validation criteria and submit a final report with detailed UAS performance measures and guidance for specific applications.
7. Provide testing using the performance criteria developed and issue "certificates of performance" to UAS which satisfactorily meet the performance criteria testing for specific applications

## WHAT IS OUR GOAL?

This pooled-fund study proposes to develop the standards, protocols, and testing requirements that a given UAS must meet and demonstrate

for a particular application. As an example, considerations

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CALIFORNIA DEPARTMENT OF TRANSPORTATION regarding UAS deployment for bridge inspection may include (but are not limited to) the following:

- Safety in constrained locations where line of site is limited
- Imaging system performance in poorly lit environments
- Control of the UAS while flying between large steel girders
- Adequate resolution of the imaging system for detecting the damage of interest

The objectives of the study are two-fold:

- Development of the specific criteria a given UAS must meet for each application
- Determining how to validate that a given UAS meets the required criteria.

The current industry is unregulated about establishing the required level of performance for UAS in civil engineering applications. The results of this study will be the development of the performance measures and validation criteria that agencies can use when making decisions about deployment of UAS in the context of civil engineering.

## WHAT IS THE BENEFIT?

The Department can potentially benefit from the outcome of this research by implementing the resulting recommendations and potential solution from this pooled fund study. The public may benefit from the implementation of the results of this research which have the potential to improve the effectiveness in leveraging UAS technologies.

## WHAT IS THE PROGRESS TO DATE?

- The standardized "practical" test examples have been revised and updated based on feedback received from beta testing. The examples illustrate the steps Project Partners can follow to select a bridge from their

inventory, apply the test, and develop a rubric following the bridge chosen.

- The audio narration for the video animations for the evaluation chamber and wind turbulence evaluation chamber have been finalized. The video animations illustrate the general guidelines of each test. Closed captioning has been included in the videos.
- Hosted UAV pilot and inspector from external DOT to beta test evaluation chamber, wind turbulence evaluation chamber, and practical test. The inspectors provided written and oral feedback on both chambers, the pilot's checklist, and suggestions for the "practical" test. The inspectors also provided feedback on the video animations, narration, and closed captioning.
- The wind turbulence evaluation chamber was tested by adding a cover to its entrance to allow repeatability in terms of lighting. The results have been analyzed and implemented in the guidelines.
- Hosted a project virtual panel meeting with the Project partners on August 1st at 3:30 pm. The meeting provided additional background and explanation of the tests, obtained feedback on the current version of the tests, and discussed the potential for an initial implementation study.
- Revised the rubric methodology for the evaluation chamber and practical test procedure based on beta-testing from the Project partner. The results complemented the feedback provided by other visitors and gave a better idea of the test duration, time spent during post-processing, and refinement of grading parameters in the rubric.