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Caltrans Division of Research, Innovation and System Information

Research Notes

Development of Integrated Unmanned Aerial Systems (UAS) Validation Center

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

Modal

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Project Title:
Development of an Integrated Unmanned Aerial Systems (UAS) Validation Center

Task Number: 3757

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Task Manager:
Nathan Loebs
Transportation Engineer
nathan.loebs@dot.ca.gov

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 or regulations 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 following is the scope

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 variety of applications.

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3. Develop methodologies to "test" whether the UAS meets specific criteria identified in Task 2 for given applications. The following specific research efforts are conducted in this task:
   a. 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. 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 standards.
   c. 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, precision standards, etc. that are required in the bullet item above so that they can be quantitatively and repeatedly evaluated.
   d. 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. 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 and space for 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 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 particular application.
- Determining how to validate that a given UAS meets the required criteria.The current industry is unregulated with regard to 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 California Department of Transportation (Caltrans) 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?

January 1, 2022 - March 31, 2022

- Hosted two UAS pilots who performed Beta testing of the UAS Evaluation Chamber for Bridge Inspection. The results are very promising and the research teams has received very good feedback. One more team is schedule to visit in August.
- A standardized "cold weather" evaluation test is completed. This test will be used to provide a relative indication of the effect of cold weather (in the range of 20F to 30F) as compared to "warm" weather (<60F) operation times of a UAV. A scoring rubric for UAS has also been developed.
- The development of a standardized "turbulence test" is completed and the testing chamber has been constructed. Beta testing of this chamber will begin next quarter. This test will be used to evaluate the performance of the UAS in turbulent wind conditions to determine the effect of turbulence on the quality of the data collected.
- Schedule a project meeting with the partner states for August, 2022.

IMAGE

Figure 1 - Photographs showing interior UAV Evaluation Chamber
Photograph 1 and 2 showing UAV within obstacle course.