

Geotechnical/ Structures

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Project Title: Development of
Autonomous Drone Inspection for
Bridge Maintenance

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Development of Autonomous Drone Inspection for Bridge Maintenance

This project aims to design, develop, and implement autonomous drone-based inspection and damage assessment of bridges.

WHAT IS THE NEED?

The Office of Structures Maintenance & Investigation (SM&I) within the Division of Maintenance is responsible for inspecting and recording condition data, load rating analysis, and the preservation of in-service state and locally owned bridges and tunnels. Maintaining quality data is the cornerstone to assuring the safety and integrity of over 26,000 bridges and tunnels in California. In addition, SM&I performs inspections for damage of state-owned bridges after events such as earthquakes, fires, floods, collisions, etc. The Office of Earthquake Engineering, Analysis, and Research (OEEAR) and SM&I work together in providing structure-related services for seismic events. The information gathered from these investigations can be used to make improvements to Caltrans Seismic design policy and guidelines and retrofit procedures. Detailed, direct observation for conditions of a bridge after significant seismic events is limited by the capacity of deploying personnel to the field. Recent advances in drone technologies allow autonomous operation of drones. These technologies are advanced to a degree that facilitates the use of autonomous drone-based damage assessment of bridges. This project aims to design, develop, and implement autonomous drone-based inspection of bridges, and assess the adoptability of autonomous drone-based technologies for complementing investigation activities for preliminary assessment of the seismic impact on bridges after an earthquake.

WHAT ARE WE DOING?

The research team will work with Caltrans bridge inspectors to identify inspection requirements for different parts of a bridge.



DRISI provides solutions and knowledge that improves California's transportation system.

The inspection requirements will be used to develop the guidelines and specifications for drone-based inspections. A 3D bridge model will be generated on a bridge selected from the inventory of bridges in California. The 3D bridge model and inspection specifications will be used to design a drone-based inspection.

A prototype drone will be designed based on the bridge inspection specification. The design will enable the prototype to regulate the captured image quality and resolution. Precise calibration of the prototype onboard camera will enable it to fly autonomously and capture high-quality images of a testbed structure (e.g., prior PEER research on a segment of the California Aqueduct). The prototype will be developed to capture high resolution and high-quality images. The captured images will be used to assess the structure for defects and damage. Parameters like wind speed, distance, traveling time, existing obstacles, and flight altitude will be investigated to optimize the performance of the prototype. The quality of bridge inspection by the prototype drone will be validated by conducting flight tests on a section of a bridge which is challenged by wind conditions, energy consumption, and illumination conditions. The flight data collected will be compared with current Caltrans drone inspection practices. A final report will be produced to include the methodology, assumptions, findings, and recommendations for the implementation of the drone prototype for Caltrans bridge inspections.

WHAT IS OUR GOAL?

The goal of this research is to design, develop, and implement autonomous drone-based inspection and damage assessment of bridges.

WHAT IS THE BENEFIT?

Autonomous drone-based inspection and damage assessment of bridges could result in more efficient and complete condition evaluation of bridges during regular and damage inspections. The

increased amount and timeliness of the condition data could enable stakeholders to make more informed and timely decisions.

WHAT IS THE PROGRESS TO DATE?

The contract for this task order was executed on April 30, 2024, and the kick-off meeting was held on May 03, 2024. The research team have produced a report providing details of drone technology specifications and regulations related to bridge inspections, and a report on the design and hardware components for the autonomous prototype drone for bridge inspection. The laboratory testing of the prototype drone has been completed and the research team are currently in preparation to demonstrate autonomous flight of the prototype drone at one of the test bridges.