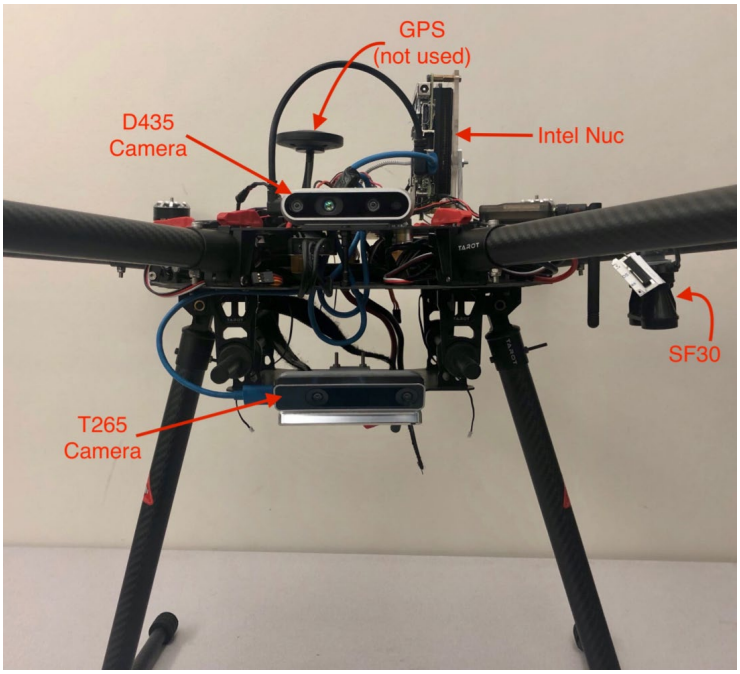
Research Recap

Mobility21
A USDOT NATIONAL UNIVERSITY TRANSPORTATION CENTER

Contact Sensing for Improved Inspection of Transportation Infrastructure

Purpose: The purpose of this project was to develop an autonomous, small unmanned aerial system capable of taking contact sensing measurements from transportation infrastructure in unmapped, GPS-denied, and previously unknown environments. This technology has the potential to be extremely useful in cases where taking hands-on measurements could be prohibitively slow and expensive.

Approach: The team developed a simple contact inspection system with the potential for low-cost and high-performance. This was achieved by using a novel configuration of tilted propellers with vision-based state estimation and control to allow flight without GPS. Additionally, the team minimized the need for prior knowledge of the environment with visual servoing control and used combined measurements from various onboard sensors to ascertain state estimation. The team aimed to develop a custom hexarotor to forgo more expensive solutions for leveling the forward- mounted contact sensor.



Key Findings:

Use of CSRT Tracker

Using the CSRT tracker to maintain the target's location within the camera field of view worked very well in almost all tests, except for those with insufficient features.

Visual Servoing

The primary finding for the visual servoing effort in this project was that commanding position setpoints based on RGB-D data of a given target is sufficient for control of a sUAS.

State Estimation

Overall, robust localization and state estimation was achieved utilizing the onboard sensor suite, despite the lack of conventional means of localization, such as GPS.

Conclusion: This project developed a fully-actuated hexacopter based system and developed prototypes and integrated all the software and hardware component technologies for an aerial contact inspection system. The results indicate that state estimation, tracking, and control in a bridge environment is a valid concept and an aerial contact inspection system could be a feasible option to assess the state of transportation infrastructure.

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Project Record:

- https://ppms.cit.cmu.edu/media/project_files/Mobility21_Report_Scherer.pdf
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