

Drone-Enabled Sensing and Monitoring of Tree Canopies

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Abstract

This multiphase project proposed by The Morton Arboretum aims to employ a DJI Matrice 600 Pro unmanned aerial vehicle (UAV) to deploy a universal sensor mount (USM) capable of accommodating small scientific instruments onto tree canopy branches. The team conceptualized and designed a novel system that will be capable of achieving the arboretum's ultimate objective. The team fabricated and tested prototypes of the USM and deployment system (DS) components of this system.

Introduction

Objectives:

1. Conceptualize and design a system capable of accomplishing the arboretum's objective.
 - *USM*: Passively clamps to tree branches ranging from 3 to 10 cm in diameter.
 - *DS*: Suspended from the UAV by a pole and actuates the USM clamps.
 - *Retrieval System (RS)*: Suspended from the UAV by a pole and is used to retrieve the USM.
 - *Controller System (CS)*: Allows the UAV pilot to remotely control the DS.
2. Prototype and test the subsystems.



Figure 1: The Morton Arboretum's DJI Matrice 600 Pro UAV

Methods and Materials

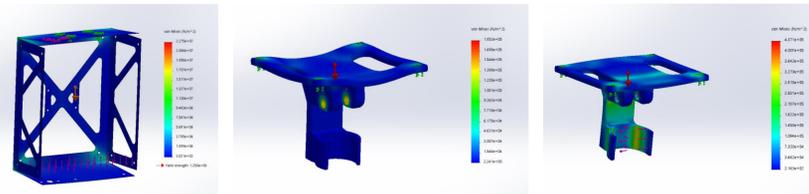


Figure 2: Finite element analyses performed on system components

USM: Employs torsional springs to passively clamp onto target tree branches. Arrays of holes on the platform permit wide ranges of payloads to be attached.

DS: Employs two 35 kg-cm servo motors to actuate the USM clamping arms and to secure the body of the USM during flight.



Figure 3: USM design



Figure 4: DS design

Results

The USM prototype was tested on tree branch sizes in the target range and functions as desired. For bench testing, the DS servos were controlled with an Arduino Uno and potentiometers. The DS can lock the USM within its housing, but the polylactic acid (PLA) drive shaft cannot withstand enough torque to open the USM clamps.

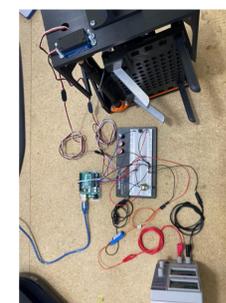


Figure 5: Bench testing the USM and DS

Discussion

The team redesigned aluminum 6061 components of the USM and DS due to unforeseen circumstances. So, the initial prototypes consist of almost entirely of 3D printed PLA components. Bench tests of the DS prototype made clear that the drive shaft should be made from aluminum as was originally intended.



Figure 6: USM and DS prototypes

Conclusions

To progress towards The Morton Arboretum's goal of deploying and retrieving small scientific instruments from tree canopy branches with a DJI Matrice 600 Pro UAV, the team has conceptualized, designed, and prototyped a novel system. Further optimization of the DS is recommended before the prototype is integrated with the UAV.

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