UAV Forge: Thrust Stand

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INTRODUCTION

The UAV Forge competition team has commissioned the design and development of a Thrust Stand, this stand will:

Allow for safe and accurate real time measurements of thrust and battery drain of their multi-rotor drones

BACKGROUND

Typically, multi rotor drones estimate thrust measurements from motor manufacture spec tables or through small scale testing using a single motor thrust stand

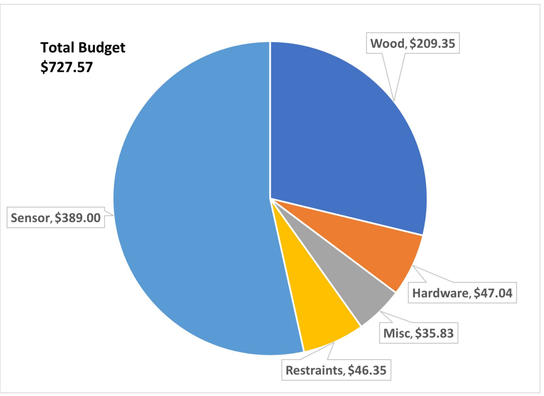
Single motor thrust stand

Thrust stands are utilized for direct measurement of motor and propeller thrust and power consumption. Generally, thrust in multirotor drones can be estimated from motor manufacture specification tables, that is taking the test data from specific motor-propeller-battery combinations to calculate an inferred thrust and power output. Thrust stands allow for direct measurement instead of estimation.

DESIGN PARAMETERS

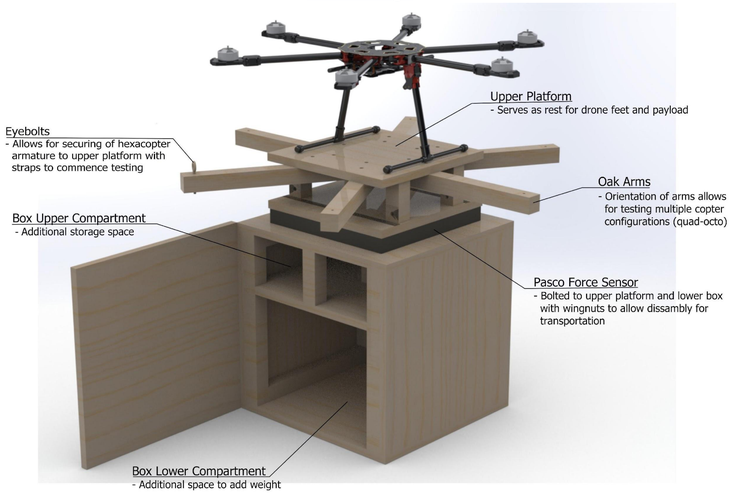
Objectives	Design Requirements
Accuracy	Measures the thrust within 1/2N
Durability	Capable of 20-25 minute tests with up to 300N forces
Portability	Can be moved around by at most 4 people
Stability	Can hold the whole drone and payload without failing
Safety	Potential risk of harm is minimal
Adaptability	Can be used with at least 2 configurations (Quadcopter and Hexacopter)

BUDGETARY CONSTRAINTS



FINAL DESIGN/PROTOTYPE

Final Design



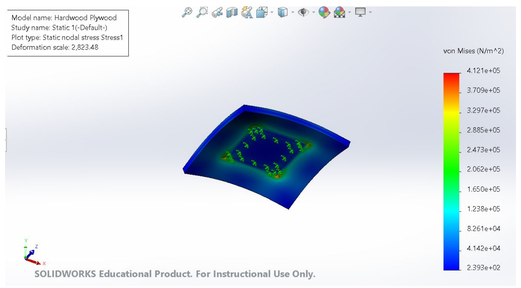
Prototype

PASCO force Sensor and Airlink
- Able to provide dynamic real-time force measurements from -1100N to +4400N
- Accurate within .1N
- Airlink allows for wireless transmission of data
- Added safety due to distance

CamJam
- Carabiner and locking mechanism to anchor drone frame to oak arms
- In conjunction with nylon rope, provides tensile force to keep drone safely attached
- Rated for 1000+N

Results and Analysis

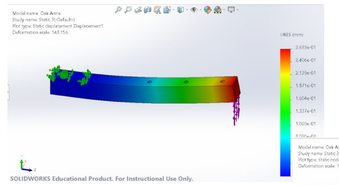
Finite Element Analysis (FEA) of Plywood Platform and Oak Arms



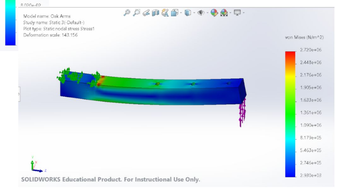
Elastic Modulus: 9.25e+9 N/m2
Poisson's Ratio: 0.22
Mass Density: 675 kg/m3
Tensile Strength: 31.05e+6 N/m2

Fixed: ~7X7 in2 area below
Force: 300 N
Size: 14X14 in2
Thickness: 0.75 in

Stress Result: 2.393e+02 - 1.650e+05 N/m2



Displacement Results



Stress Results

Elastic Modulus: 1.2e+10 N/m2
Poisson's Ratio: 0.036
Mass Density: 560 kg/m3
Tensile Strength: 5.5e+6 N/m2

Fixed: 3 in from end of arm
Force: 50 N per arm
Size: 1.5 X 1.5 in2
Length: 15 in
Holes (3X): 3 in apart

Stress Result: 2.930e+03 - 1.361e+06 N/m2
Max Displacement Results: 2.673e-01 mm

Conclusion & Future Recommendations

In conclusion, a wooden box design was chosen due to its stability and simple form factor. It utilizes oak wood arms and CAMJam to secure the drone frame to the thrust stand. The arms were deemed adequate to withstand the rigors of testing and securing the drone frame to the test apparatus, and a Pasco force platform was chosen to record the thrust data due to its ease of integration and simple ability to use.

A secondary benefit of the wooden design is the ease modification to meet future testing needs of the UAV Forge team. The drone mounting platform has sufficient pre-drilled holes to configure the stand for quadcopters or octocopters, and the mounting arms have multiple mounting points to ensure drones of multiple sizes can be tested.

For future design iterations, a means of restraining the drone feet to ensure the drone is rigidly restrained may be necessary but further testing will be required.

ACKNOWLEDGEMENTS/REFERENCES

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