SparrowHawk

Variable Wing Configuration Test Platform

Project Introduction

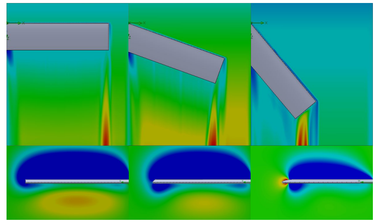
SparrowHawk is an ongoing project to build a drone with variable sweep wings. The goal is to create a drone that will dynamically adjust the wing position in flight to optimize efficiency during different stages of flight.

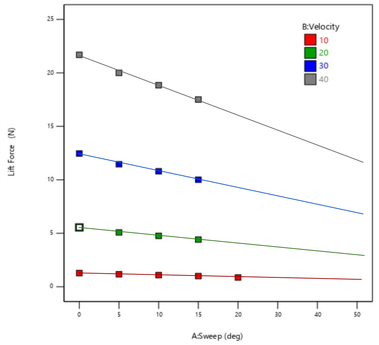
If successful this will allow for longer flight times, and a multipurpose drone with good high and low speed flight characteristics.

For this project, we aimed to do some initial analysis to assess the feasibility of the project, and then build a prototype and test it to determine real world effectiveness.

CFD Analysis

To find the efficacy of sweeping wings to improve efficiency, we performed a parametric CFD study of the wing at varying speeds and wing angles in solidworks.



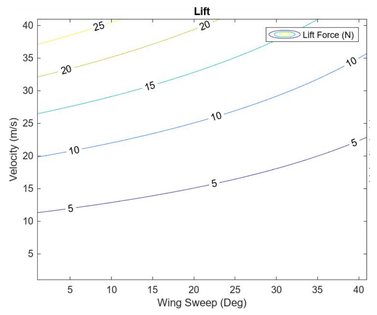


We used a combination of Design Expert 13 and curve fitting in sheets to perform multivariate analysis of the data. We found the Lift and Drag force follow the functions shown below. When compared to CFD data both equations have R^2 values >0.99.

$$F_{Lift} = \frac{-74v^2s + 6200v^2 - 550vs + 30700v + 3025s - 295000}{500000}$$

$$F_{Drag} = \frac{-21v^2s + 2540v^2 - 90vs + 4120v + 1300s - 24000}{2000000}$$

Visualizing these equations in MATLAB we found that as sweep increase both lift and drag decrease. So to maximize efficiency for a given velocity you should sweep to the highest angle that still provides lift equal to or greater than the planes weight.

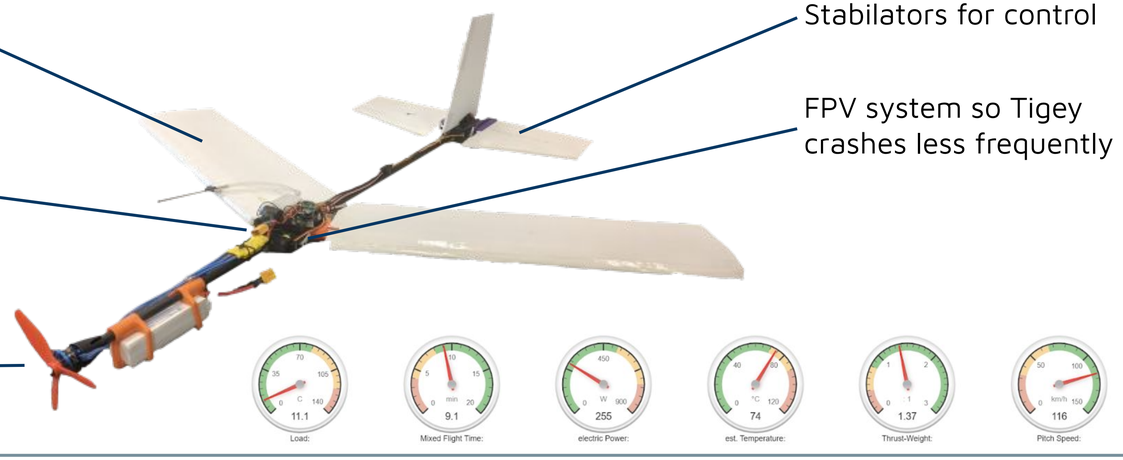


SparrowHawk Test Platform

Lightweight foamboard and carbon fiber construction (700g)

Pitot tube, barometer and arduino data logger with remote trigger

Electrical power system based on Ecalc analysis



Stabilators for control

FPV system so Tigey crashes less frequently

Flight Testing & Results

Pitot Tube Testing

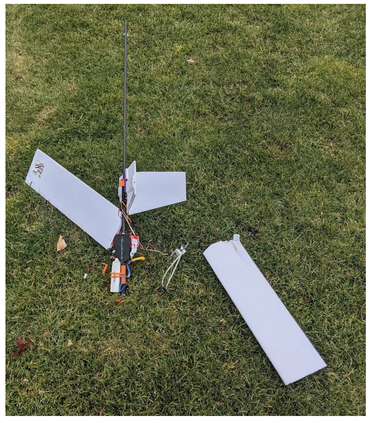
We initially tried to calibrate the pitot tube by mounting it to a car. This let us reach the good testing velocity, but the data was inconsistent likely due to high winds.

Flight Testing Plan

While extracting speed from the pitot tube proved challenging, we decided to fly a set course at a fixed throttle value and wing sweep and estimate efficiency based on flight time.

Crash

Unfortunately our test platform experienced a rapid midair unscheduled disassembly. This was due to the tail not being attached well enough to the main spar and rotating mid flight.



Conclusion

Despite not being able to complete flight testing, our CFD analysis indicates that improved efficiency can be achieved with variable sweep wings. Our test platform shows that a functional prototype can be created, and a future redesign could allow us to test the real world efficiency gain of this design.