Performance Of Propeller Blade as Glider Wing for a Transformable UAV

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Abstract

- The main objective is to create a wing that can operate under glide and propeller mode
- This research focus on studying the aerodynamic forces of Schleicher ASK 21 glider wing and AH-64 Apache propeller blade.
- Using Solidworks, I created a scaled down 1:47 wing models
- By performing this study, I will be able to determine how well propeller blade will perform if it is used as a glider wing.

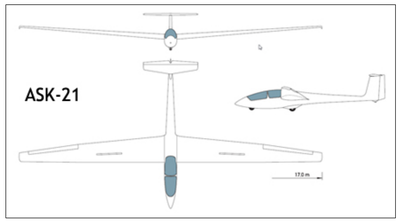

Figure 1: Schleicher ASK 21 glider

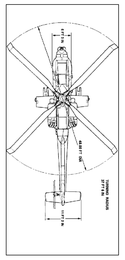

Figure 2: AH-64 Apache

Background

- The aerodynamics and design of glider wings can be explained by four forces lift, drag, weight, and thrust [1].
- Thrust is supply by the conversion of potential energy of the elevated weight of the glider into kinetic energy
- The lift equation (1) includes coefficient of lift, CL, velocity, V, air density, ρ, and wing surface area, S.

$$L = C_L \cdot V^2 \cdot \frac{\rho}{2} \cdot S \ (1)$$

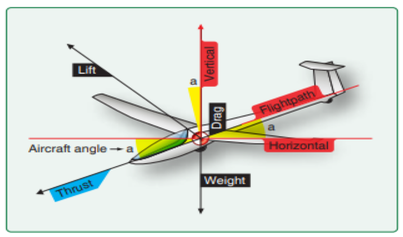

Figure 3: 4 Forces of Glider Wings

References

[1] Glider Handbook, Chapter 3: Aerodynamics of Flight. FAA, www.faa.gov/regulations_policies/handbooks_manuals/aircraft/glider_handbook/media/gfh_ch03.pdf.
[2] Williams Soaring Center, Williams, CA. (n.d.). Retrieved July 31, 2020, from https://www.williamssoaring.com/fleet/ask21-ask.html
[3] "Boeing AH-64 Apache". Jane's Information Group. 13 October 2000. https://fas.org/man/dod-101/sys/ac/ah-64.htm
[4] An Experimental Study on the Aerodynamic and Aeroacoustic Performances of a Bio-Inspired UAV Propeller Zhe Ning and Hui Hu 35th AIAA Applied Aerodynamics Conference. June https://www.aere.iastate.edu/~huhui/paper/2017/AIAA2017-3747-Ning-Zhe.pdf

Results

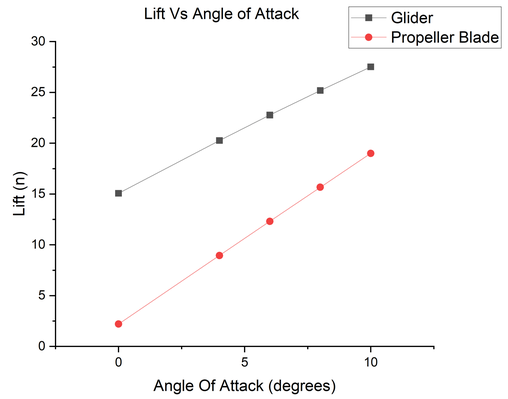

Figure 8: Lift vs AOA of Glider Wing and Propeller Blade

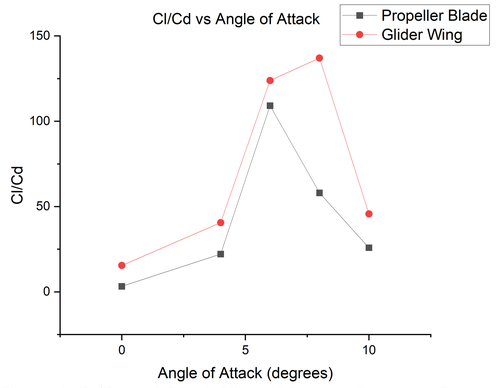

Figure 9: Cl/Cd vs AOA of Glider Wing and Propeller Blade

- Using inlet velocity of 120 m/s and angle of attack from 0 degrees to 10 degrees, the Lift and Coefficient of Lift to Drag ratio were obtained through Ansys Fluent.
- The lift of the glider wing was about 12.857 N higher than the lift of propeller wing at 0 degrees. The difference decreases as the AOA increases.
- The difference between the Coefficient of Lift to drag ratio was minimum at 6 degrees angle of attack. The ratio was 123.9 for glider and 109.1 for propeller blade.
- **This shows promising results for using the AH-64 Propeller Blade as glider wings at 6 degrees angle of attack.**

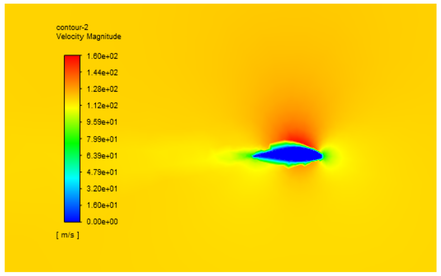

Figure 10: Velocity Distribution of Glider Wing at 0 degrees

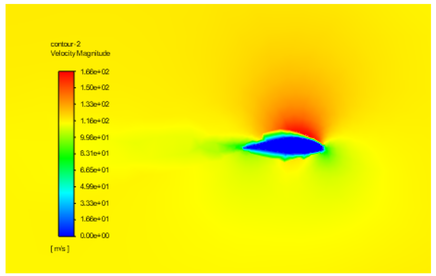

Figure 11: Velocity Distribution of Glider Wing at 10 degrees

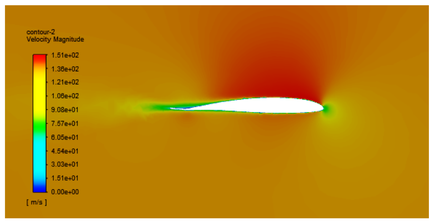

Figure 12: Velocity Distribution of Propeller Blade at 4 degrees

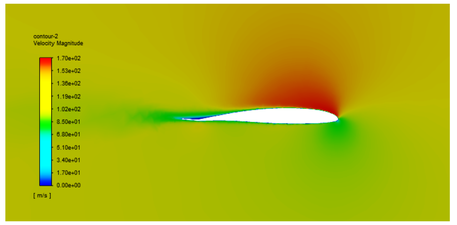

Figure 13: Velocity Distribution of Propeller Blade at 10 degrees

Methods and Materials

- Schleicher ASK 21 glider wing model:

	Length (cm)
Chord Tip	1.1
Chord Root	3.3
Wingspan	36
Aspect Ratio	16:1

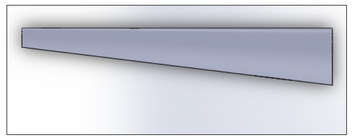

Figure 4: ASK 21 in Solidworks (Top view)

- Airfoil [2]:
  - Root: FX S02-196
  - Tip: FX 60-126

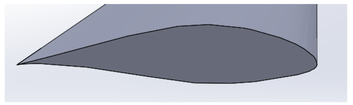

Figure 5: FX S02-196 airfoil

- AH-64 Apache Propeller Blade model:

	Length (cm)
Chord Tip	2.25
Chord Root	2.25
Wingspan	36
Aspect Ratio	16:1

Figure 6: AH-64 in Solidworks (Top view)

- Airfoil [3]:
  - Root: HH-02
  - Tip: HH-02

Figure 7: HH-02 airfoil

Future Direction

- Focus on improving the lift of the propeller blade and designing a mechanism to rotate the propeller blade 180 degrees to convert the helicopter into a glider.
- To increase the lift of the Propeller Blade, we can change the pitch of the propeller blade, tamper the wings, and increase the chord length near the mid span of the wing [4].

Acknowledgements

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