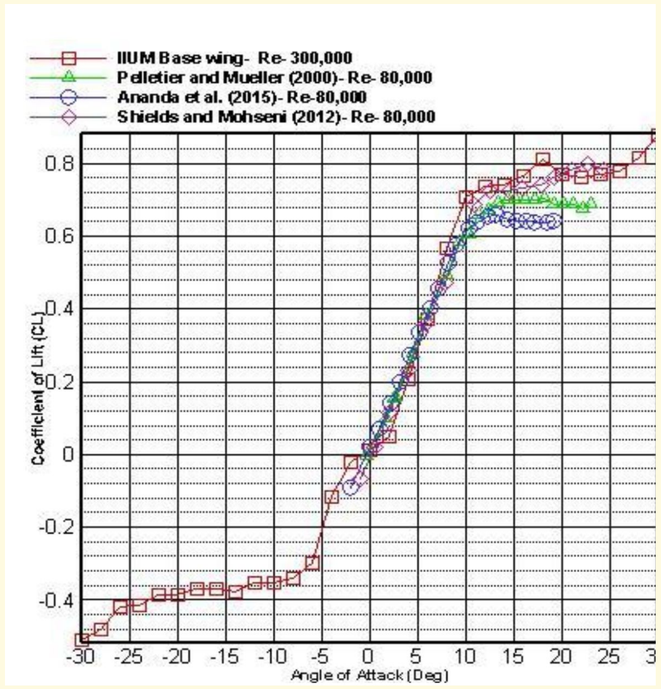
FIRE: THE FIRST-YEAR INNOVATION & RESEARCH EXPERIENCE
BIOINSPIRED ROBOTICS

Wingeneered: The Bald Eagle-Inspired Flight Innovator

Abhinav Narayana Reddy, Ekansh Sahu

Introduction/AIM

Our project aims to **analyze the aerodynamic mechanism of bald eagle-inspired wingtips, providing insight into natural flight mechanisms and contributing to bio-inspired design by mimicking the flexibility and curvature of natural wingtips.**



The Bald Eagle use slotted and spiral-shaped wingtips to reduce induced drag, achieving high lift-to-drag ratios, particularly at low Reynolds numbers of 10^4–10^6[3]. Our experimental design utilizes

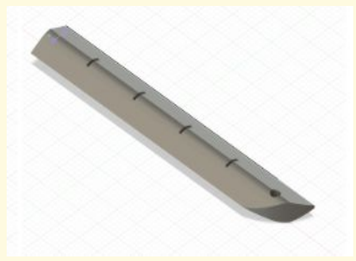
- Flat plate wings with an aspect ratio of 3[2] and incorporates flexible tips for testing.
- Experimental investigation of a new spiral wingtip[3], flexible curved wingtips increased the lift coefficient .

Methodology

The wingtips were designed and optimized first. We started with a living hinge inspired design that was based on laser cut wood.
It was quite brittle and unreliable.

3D printed TPU based wing tips that was lighter and much more flexible. It still had slats to give it smoother motion.Shape was made to be aerofoil. For actuation, we iterated from a tension based mechanism to a torsional mechanism. Both did not function well.

Finally we settled in a classic pulley based mechanism using a servo motor for precise angular control and good strength.
Our final assembly involved:



- 4 different size wingtips proportioned based on results [3] made of **TPU 85 -A**. With an **aerofoil shape**.
- A **futaba micro servo** with a servo horn to which plastic twine is attached with a knot.
- The plastic twine is attached to the wingtip where there is a hole. The wingtip has several slats to allow flexibility. It is fixed at the ends to the wing itself.

Wing Tip	Length(mm)	Width(mm)
1	65	10
2	68	10
3	63	10
4	51	10

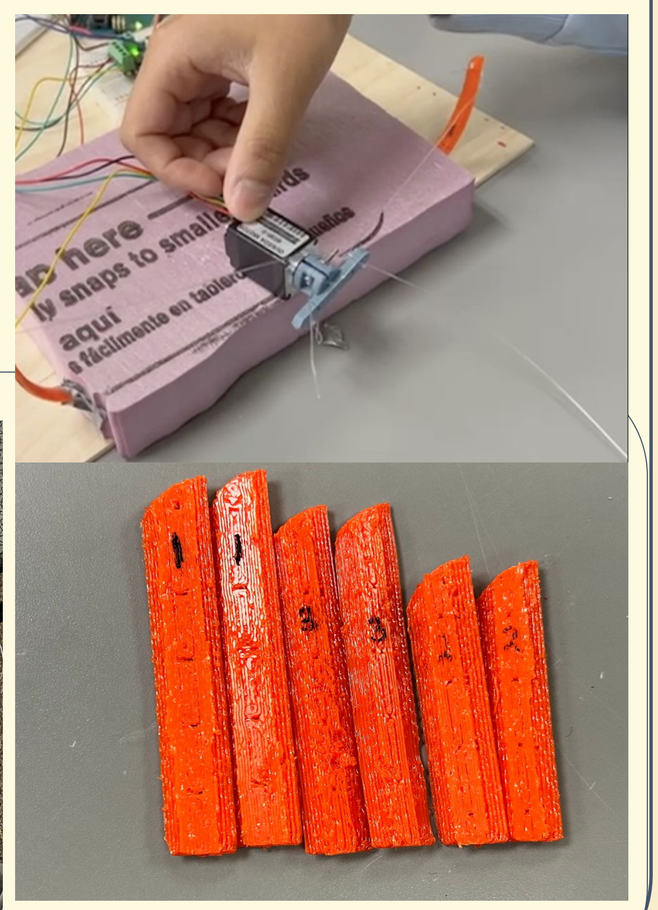
Motivation

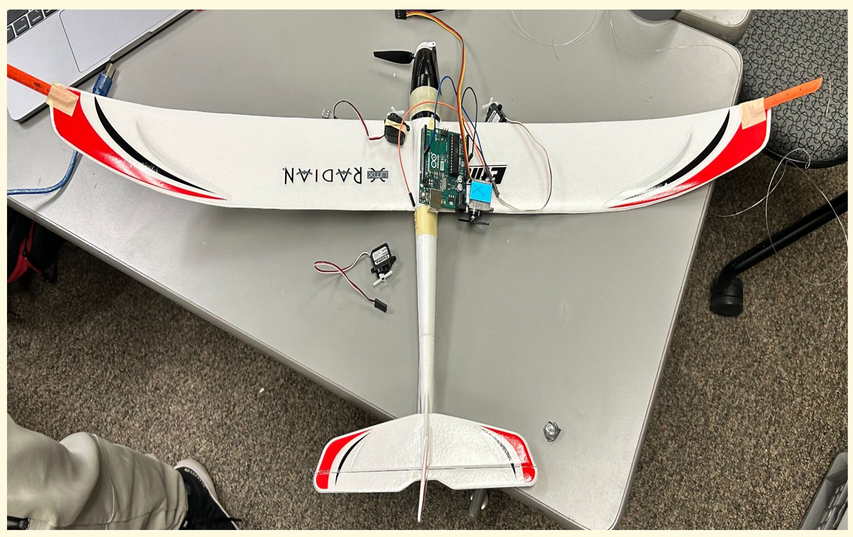
Our project found its roots in the chesapeake bay, deriving from one of its iconic species, **the Bald Eagle** (Haliaeetus leucocephalus).

- Improving the energy efficiency in drones or aircraft could support more sustainable research and monitoring efforts in the Chesapeake Bay region, aiding conservation projects and habitat restoration.

Results & Future

- We would like to change the design of the wingtip and the wing to observe what leads to more ideal coefficients for drag and lift.
- We would also like to work on a new body, parts of which we modify according to different previous studies and researches that we would find in the future.





References

[1] D. Liu, B. Song, W. Yang, X. Yang, D. Xue, and X. Lang, “A brief review on aerodynamic performance of Wingtip slots and research prospect,” Journal of Bionic Engineering, vol. 18, no. 6, pp. 1255–1279, Nov. 2021, doi: 10.1007/s42235-021-00116-6.
[2] F. N. Khan, B. Batul, and A. Aizaz, “A CFD analysis of WingTip devices to improve lift and drag characteristics of aircraft wing,” IOP Conference Series Materials Science and Engineering, vol. 642, no. 1, p. 012006, Oct. 2019, doi: 10.1088/1757-899x/642/1/012006.
[3] N. Siddiqui, M. Aldeeb, W. Asrar, and E. Sulaeman, “Experimental investigation of a new spiral wingtip,” International Journal of Aviation Aeronautics and Aerospace, Jan. 2018, doi: 10.15394/ijaaa.2018.1213.
[4] “Biology Stack Exchange,” Biology Stack Exchange. https://biology.stackexchange.com/