International Journal of Mechanical Engineering Research and Technology

ISSN 2454-535X

Email ID: info.ijmert@gmail.com or editor@ijmert.net

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

A UAV THAT HARMS FROM BIOLOGY AND USES FALCON AND ALBATROSS ELEMENTS FOR SURGICAL ENVIRONMENTAL MONITORING AND DATA COLLECTION

Dr. Rajashekar
Assistant Professor, Department of Aeronautical Engineering,
Sathyabama Institute of Science and Technology, Chennai, India

Shiva Kumar
Department of Aeronautical Engineering,
Sathyabama Institute of Science and Technology,
Chennai, India

Received on: 03 Apr 2025 Accepted Date: 10 May 2025 Published on: 31 May 2025

ABSTRACT

This study presents a bio-inspired UAV that combines the exceptional flying skills of albatrosses and falcons, providing a versatile option for high-tech data collecting and monitoring of the environment. Falcons are perfect for traversing complex and dynamic situations, like as thick woodlands or urban areas, because to their fast dives, agility, and nimble movements. Albatrosses, on the other hand, are great at traversing huge areas like deserts and seas because they glide smoothly over great distances with little exertion. By fusing these two distinct flying traits, the Falcon-Albatross Hybrid UAV is able to glide for extended periods of time and move quickly and precisely, making it suitable for a variety of habitats. The UAV can gather high-quality environmental data across vast regions for long periods of time and perform thorough ecological monitoring thanks to its sophisticated sensors and hybrid propulsion system. Not only does the bio-inspired design help with conservation and sustainable management of the environment, but it also opens up new avenues for monitoring ecosystems and detecting environmental changes in a variety of settings. Using simulations in Autodesk CFD and Autodesk Fusion 360, this research compares the UAV's flying efficiency, stability, and data gathering capabilities in detail. It shows that there are considerable improvements in energy efficiency and adaptability compared to traditional UAV designs.

Exploring the World of Bio-Inspired Unmanned Aerial Vehicles (UAVs) with a Focus on Environmental Monitoring and Energy Efficiency

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

I. INTRODUCTION

Engineering has seen a recent uptick in the use of nature-based design ideas, especially in the creation of UAVs (Unmanned Aerial Vehicles) with niche uses. Improving UAV performance by emulating the efficiency, flexibility, and mobility of birds and other animals, bio-inspired design draws on nature's intricately balanced structures and functions to tackle difficult technical problems. In order to improve the capabilities for collecting data and monitoring the environment, this research focuses on a hybrid UAV design that takes inspiration from two different bird species: the albatross and the peregrine falcon. The UAV is well-suited for a variety of surveillance jobs because to its hybrid design, which combines the flying qualities of both birds for an optimal mix of speed, agility, and endurance.
Falcons are a great role model for unmanned aerial vehicles (UAVs) because of their exceptional dive speed and dexterity, which are crucial for navigating complex and ever-changing terrain with precision and speed. When keeping an eye on vast woodlands or busy cities, these skills really come in handy. Alternatively, unmanned aerial vehicles (UAVs) intended for extended flights over vast regions like deserts or seas might do well to take cues from the albatross, which is superb at long-distance gliding with little energy usage. Because of its effective gliding mechanics and wings with a high aspect ratio, the albatross can traverse great distances with little energy expenditure.
The hybrid unmanned aerial vehicle (UAV) known as the Falcon-Albatross combines the aerodynamic agility of the falcon with the energy efficiency of the albatross. This UAV is ideal for a wide range of environmental data gathering jobs because to its versatile wing design and hybrid propulsion system, which allow it to fly both short, fast missions and longer surveillance flights.
The UAV is built to assist in long-term environmental monitoring and preservation initiatives across expansive regions, thanks to its sophisticated sensors and hybrid flight dynamics.

II. LITERATURE REVIEW

Previous research has explored the concept of bio-inspired UAV design, focusing on mimicking bird flight mechanics to improve UAV performance in environmental applications. Studies have shown that birds like the albatross and falcon possess aerodynamic efficiencies that outperform traditional UAV designs, especially in terms of energy use during long glides and stability during high-speed maneuvers. Albatross-inspired UAVs have demonstrated enhanced endurance in long flights, while falcon-inspired models offer valuable insights into high-speed control and agility.

However, challenges remain in accurately replicating avian flight mechanics in UAVs, primarily due to limitations in measurement technologies and testing environments. For example, wind tunnel tests on preserved bird models may not fully capture the complexities of real-world flight dynamics. This study builds on these insights by combining the key morphological and functional traits of both albatrosses and falcons, aiming to optimize both stability and efficiency for improved environmental monitoring.

International Journal of Mechanical Engineering Research and Technology
ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

III. METHODOLOGY

A. Design approach

The UAV design in this study is based on the unique flight mechanics of the albatross and peregrine falcon. Using Autodesk Fusion 360, a 3D model was created that combines the falcon's wing shape for enhanced agility with the albatross's high aspect ratio wings for efficient gliding. The design includes morphing wings that can adjust during flight, improving stability and maneuverability in response to changing environmental conditions. Additionally, the tail structure is engineered to allow dual-axis rotation, providing greater control during high-speed movements and ensuring stability during gliding.

The design approach involves the design concept that is the basement of this design.

B. Abilities of Falco peregrinus

Falcons are celebrated for their exceptional aerodynamic capabilities, which enable them to achieve incredible speed and agility. Their streamlined bodies, with a sleek, tapered shape, reduce air resistance, allowing for fast and efficient movement through the air. The long, pointed wings of a falcon minimize drag and optimize their lift-to-drag ratio, supporting powerful, sustained flight and sharp, precise maneuvers. One of their most remarkable abilities is their high-speed dive, or "stoop," where they tuck in their wings and dive toward their prey at speeds of over 240 mph (386 km/h), making them the fastest animals on Earth. This combination of a streamlined body, narrow wings, and the ability to adjust wing shape as needed allows falcons to excel in both high-speed chases and agile navigation through complex environments.

Fig 1 Falco peregrinus.

C. Abilities of Albatross

Albatrosses are extraordinary gliders, renowned for their unique aerodynamic abilities that allow them to cover vast distances with minimal energy. Their long, slender wings are specially adapted for dynamic soaring, a technique that takes advantage of wind currents above the ocean to keep them flying without constant flapping. With a high aspect ratio, their wings maximize lift and reduce drag, enabling them to travel thousands of miles with minimal physical effort. The locking mechanism in their shoulder joints allows their wings to remain extended without continuous muscle strain, further improving their energy efficiency. These specialized aerodynamic features make albatrosses masters of long-duration flight, perfectly suited for extended missions over open water, where they can stay airborne for days or even weeks without needing to rest.

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

Fig 2 Albatross

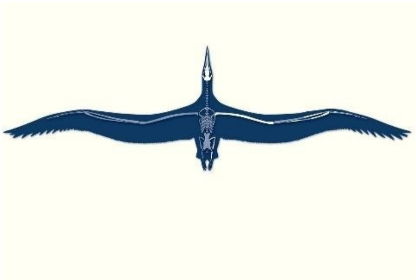

Fig 3 wingspan of the Albatross

IV. CAD DESIGN OF THE CONCEPT

By combining these remarkable abilities, we have designed a hybrid UAV that maximizes both its potential and versatility. The Falcon-Albatross UAV represents a unique fusion of agility and endurance, inspired by nature. Just as falcons rely on explosive bursts of speed for quick takeoffs and sharp maneuvers, this UAV is capable of rapid acceleration when required. With the expansive wingspan of an albatross, it offers enhanced endurance and greater reliability, making it well-suited for a wide range of applications.

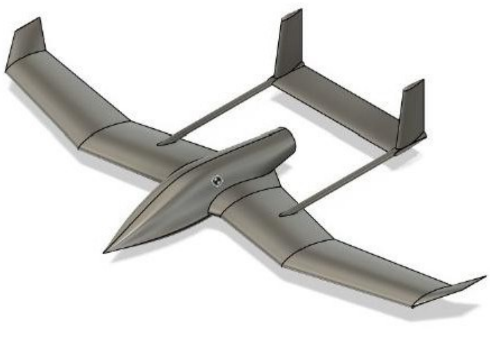

Fig4 3D view of the design

International Journal of Mechanical Engineering Research and Technology
ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

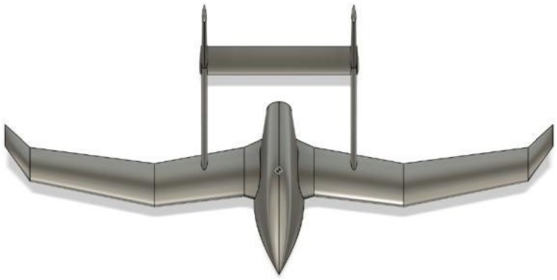

Fig 5 Top view of the design

V. SIMULATION APPROACH

The simulation process involves first analyzing the aerodynamic properties of the airfoil and its components, followed by an evaluation of the overall aerodynamic performance of the designed UAV. This approach allows for virtual testing and optimization of the UAV’s aerodynamic efficiency, structural integrity, and control systems, eliminating the need for expensive physical prototypes. It also enables safety assessments and the development of effective flight strategies, ensuring the UAV's reliability and performance in real-world conditions.

A. Aerodynamic Analysis of the Airfoil

Fig 6 NACA 6412 airfoil

The NACA 6412 is a cambered airfoil known for its strong aerodynamic performance, making it a popular choice for UAV applications. Its design, featuring a 4% camber at 40% of the chord and a 12% thickness, enhances lift generation, which is particularly beneficial for low-speed flight. Conducting an aerodynamic analysis of this airfoil is essential for improving UAV performance, ensuring stability, and minimizing drag. This involves evaluating key factors such as lift, drag, and stall characteristics across various angles of attack. Tools like XFOIL, ANSYS Fluent, or wind tunnel testing help analyze pressure distribution, boundary layer behavior, and overall aerodynamic efficiency. The airfoil’s lift coefficient (Cl) increases with the angle of attack, but exceeding critical angles can cause flow separation and stall. Its cambered shape provides additional lift at lower speeds, making it well-suited for UAVs used in environmental monitoring, surveillance, and agricultural tasks. Drag coefficient (Cd) plays a crucial role in determining flight endurance and efficiency, as excessive drag increases energy consumption. Understanding the aerodynamic behavior of the NACA 6412 enables UAV designers to optimize propulsion systems, improve flight efficiency, and ensure stable performance in varying atmospheric conditions.

B. Velocity Magnitude of the NACA 6412 Airfoil:

The airflow velocity around the NACA 6412 airfoil of the Falcon-Albatross UAV varies depending on factors like angle of attack, Reynolds number, and flight conditions. During cruise, the UAV moves at a freestream velocity of approximately 15–25 m/s. As air flows over the airfoil, it accelerates along the upper surface, creating a low-pressure region where speeds can reach 20–30 m/s, while the lower surface maintains a comparatively higher pressure with velocities ranging between 15–20 m/s.

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

Near the wingtips and trailing edges, slight acceleration occurs due to vortex effects, with localized speeds exceeding 25 m/s. The airflow remains well-attached throughout, ensuring consistent lift generation and minimizing flow separation. A smooth pressure gradient across the airfoil enhances aerodynamic efficiency, improving the lift-to-drag ratio and overall flight stability of the UAV.

C. Aerodynamic Analysis of the UAV

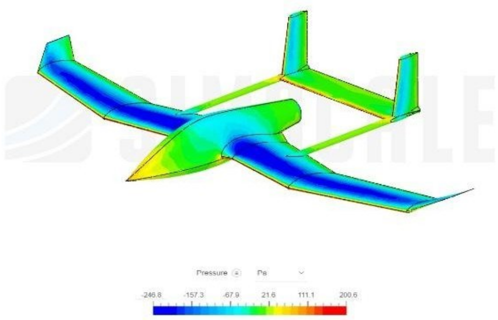

Fig 7 Aerodynamic analysis of the UAV

The designed UAV was analyzed using Autodesk CFD, and Sim scale CDF focusing on managing velocity magnitude through its aerodynamic design. The Falcon-Albatross UAV is engineered for exceptional aerodynamic efficiency, drawing inspiration from nature to enhance lift, minimize drag, and improve overall stability. Its lift mechanism relies on a pressure difference across the wing surfaces, with higher pressure underneath and lower pressure above, ensuring steady lift generation.

The even distribution of aerodynamic forces across the wings contributes to flight stability, reducing the likelihood of sudden pitch or roll deviations. Additionally, the tailplane benefits from a low-pressure stabilization effect, providing precise pitch control and maintaining flight equilibrium.

To reduce drag, the UAV features a streamlined fuselage and carefully designed wing-body junctions, which help maintain smooth airflow and minimize resistance. The incorporation of tapered wingtips helps diminish wingtip vortices, leading to a more efficient lift-to-drag ratio. Furthermore, the rear-mounted pusher motor configuration is strategically positioned to reduce interference drag, thereby enhancing propulsion efficiency

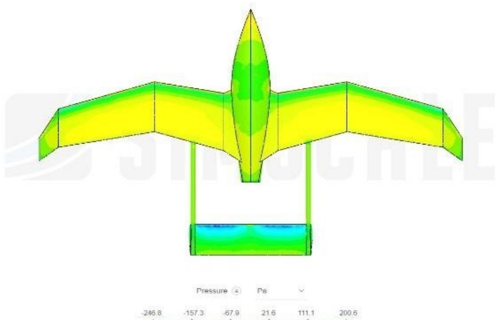

Fig 8 Aerodynamic analysis of the UAV

International Journal of Mechanical Engineering Research and Technology
ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

These aerodynamic improvements significantly boost energy efficiency, lowering power consumption and extending flight duration. The UAV's high lift-to-drag ratio makes it ideal for long-endurance missions, such as environmental monitoring, surveillance, and mapping. The twin-boom tail design enhances stability in both yaw and pitch, ensuring smooth maneuverability even in challenging wind conditions. Additionally, a well-balanced pressure distribution across the airframe reduces structural stress, enhancing durability and reliability.

Designed to adapt to a variety of operational conditions, the Falcon-Albatross UAV delivers consistent aerodynamic performance across different speed ranges. Its optimized wing structure and reduced flow separation contribute to seamless takeoff, stable cruising, and efficient landings. These advanced aerodynamic features make it a highly capable and reliable platform for a wide range of aerial applications.

D. airflow traces of the UAV

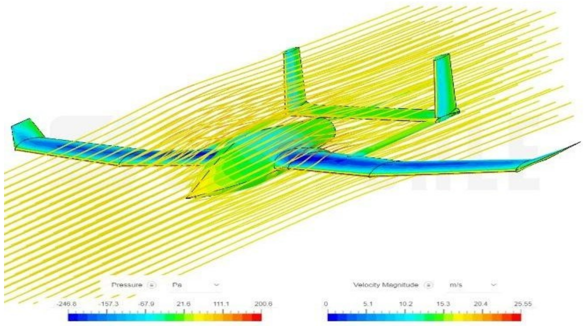

Fig 9 Airflow traces

The airflow patterns around the UAV demonstrate smooth and efficient attachment across most of the airframe, with minimal disruptions. Both the wings and fuselage exhibit a well-balanced pressure distribution, which plays a crucial role in maintaining stable lift generation. The color gradients in the visualization highlight a high-pressure buildup on the underside of the wings (shown in warmer tones) and a corresponding low-pressure region on the upper surface, enabling effective lift production. The velocity distribution indicates streamlined airflow over the fuselage and wings, with increased speeds near the wingtips and trailing edges, helping to minimize drag. While some wake turbulence is present behind the fuselage and twin-boom tail, its impact is well-controlled due to the UAV's aerodynamic refinements. These characteristics collectively enhance flight stability, reduce drag, and improve overall aerodynamic efficiency, ensuring optimal lift-to-drag performance.

VI. ENVIRONMENTAL MONITORING AND DATA COLLECTION

The Falcon-Albatross UAV is designed with environmental monitoring and data collection in mind, making it an invaluable tool for ecological research and conservation efforts. Equipped with an array of advanced sensors, this UAV can monitor various environmental parameters with high precision. Sensors such as multispectral and thermal cameras, air quality sensors, and LiDAR systems enable the UAV to gather data on vegetation health, temperature variations, pollutant levels, and terrain mapping. This comprehensive sensor suite allows for the collection of real-time data crucial for tracking climate changes, assessing natural habitats, and supporting proactive environmental management.

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

Table: 1. Sensor used in drones

Sensor Type	Function	Application
Thermal Infrared Sensor	Detects temperature variations to identify heat signatures and monitor environmental temperature changes..	Used for detecting temperature distribution and monitoring heat anomalies in ecosystems.
LiDAR (Light Detection and Ranging)	Maps terrain and vegetation structures with high accuracy using laser pulses..	Applied for high-precision mapping of topography and vegetation density.
RGB Camera	Captures standard color images.	Employed for capturing detailed visual images to document and analyze environmental conditions.
Hyperspectral Sensor	Captures a broad range of wavelengths for detailed analysis.	Utilized for detailed analysis of the spectral properties of vegetation and land surfaces to assess health and composition..
Ultrasonic Sensor	Used for measuring distance and detecting obstacles by emitting sound waves and analyzing their reflections.	Used for obstacle detection and altitude maintenance to enhance flight safety and precision in UAV operations.
GPS/GNSS	Provides location data for precision navigation.	Essential for real-time positioning, navigation, and accurate georeferencing during data collection missions.

VII. MATERIALS

The Falcon-Albatross UAV can be constructed using advanced additive manufacturing methods, such as 3D printing, which provide several distinct advantages. This approach results in a lightweight yet strong structure, enhancing the UAV's overall performance. The use of 3D printing offers significant benefits, including greater design flexibility, rapid prototyping capabilities, and cost-effectiveness. Additive manufacturing enables the creation of complex geometries and lightweight frameworks that are difficult or even impossible to produce through conventional manufacturing techniques.

A. PLA (Polylactic Acid)

PLA (Polylactic Acid) is a popular material for 3D printing and presents multiple advantages for building UAVs like the Falcon-Albatross. Its lightweight properties contribute to a reduced overall UAV weight, which, in turn, enhances fuel efficiency and prolongs flight endurance—a critical feature during the albatross-inspired gliding phase.

For the Falcon-Albatross UAV, PLA is particularly well-suited for non-structural or low-load components, such as the outer shell, wings, or certain internal parts. It is ideal for early design iterations and testing phases. However, for components that experience higher stress or extreme conditions, PLA can be reinforced by blending with stronger materials or replaced with more robust alternatives to meet specific performance needs. Additionally, PLA's biodegradable nature makes it an environmentally friendly option, aligning well with the UAV's mission for environmental monitoring and sustainability-focused projects.

International Journal of Mechanical Engineering Research and Technology
ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

B. Carbon Fiber Rods

Carbon fiber rods are an excellent choice for UAV applications due to their remarkable combination of strength, stiffness, and low weight. These rods are frequently used in structural elements such as the frame, wings, and support structures to provide the necessary rigidity and durability without adding significant mass. Their superior strength-to-weight ratio enhances the UAV's performance, allowing for greater stability and maneuverability, particularly in demanding environments. Carbon fiber rods also offer exceptional resistance to fatigue, corrosion, and environmental wear, enabling the UAV to withstand harsh conditions during extended flights.

The integration of carbon fiber rods contributes to the aerodynamic efficiency of the Falcon-Albatross UAV, ensuring that it maintains structural integrity while minimizing the risk of deformation or failure under dynamic flight loads. This added resilience supports the UAV's capability to perform reliably during long-duration missions, further boosting its operational effectiveness.

VIII. FABRICATION

Fig 10 Fabricated Prototype

The Falcon-Albatross UAV prototype is designed with a twin-boom tail and a tapered main wing, incorporating the NACA 6412 airfoil for superior aerodynamic performance. Its streamlined fuselage minimizes pressure drag, while the rear-mounted pusher motor reduces interference drag, optimizing propulsion efficiency. Built for endurance, the UAV boasts a high lift-to-drag ratio, ensuring stable flight even in challenging wind conditions. The carefully optimized wing design promotes smooth airflow attachment, minimizing flow separation and enhancing lift generation.

Fig 11 Fabricated Prototype

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

Additionally, the lightweight yet robust airframe enhances both maneuverability and structural resilience. This prototype marks a significant milestone in the UAV's development, paving the way for real-world validation through flight testing and wind tunnel experiments. Future enhancements, such as winglets and refined control surfaces, will further improve its stability and efficiency, making it a versatile platform for a wide range of aerial applications.

IX. RESULT

A. Aerodynamic Efficiency and Stability

The simulation results indicate substantial enhancements in aerodynamic efficiency, lift, and stability. The Falcon-Albatross Hybrid UAV showcases superior gliding performance compared to traditional UAV models, marked by reduced energy consumption during sustained flights. Simulation data on lift and drag coefficients highlight that the hybrid wing design achieves an effective balance between maneuverability and stability, enabling extended operational capabilities across varied environmental conditions.

B. Environmental Data Collection Capabilities

Simulated monitoring scenarios confirm the UAV's proficient data collection capabilities, demonstrating reliable sensor performance and prolonged mission duration due to its hybrid propulsion system. The UAV is capable of covering vast geographic regions with minimal interruptions, making it well-suited for continuous environmental monitoring of ecosystems, agricultural zones, and conservation areas.

X. DISCUSSION

A. Impact of Bio-inspired Design

The bio-inspired design of the Falcon-Albatross Hybrid UAV presents significant practical benefits for environmental monitoring. This design effectively merges the endurance needed for large-scale observation with the agility required to navigate complex landscapes. The hybrid UAV is especially valuable for applications in agriculture, ecosystem surveillance, and conservation, where precise navigation and sustained flight time are critical.

B. Challenges and Limitations

Challenges persist in replicating bird-like maneuvering and optimizing energy use for the hybrid propulsion system. While features such as morphing wings and adaptive tail structures provide considerable control advantages, their real-world implementation demands further refinement. Future developments could focus on advancing sensor integration and enhancing power sources to boost the UAV's capabilities and autonomous functions.

XI. CONCLUSION

By proving the practicality and benefits of the hybrid Falcon-Albatross UAV for ecological monitoring, this work significantly contributes to the field of bio-inspired UAV design. The prototype's successful manufacturing proves that its aerodynamic improvements may be used in the real world, bridging the gap between theory and practice. Enhancing ecological data collecting and helping sustainable conservation efforts, the UAV incorporates flying mechanics inspired by falcons and albatrosses. This provides adaptation across varied environmental circumstances. To further consolidate its position as a dependable platform for cutting-edge environmental research and aerial surveillance, further development will include flight testing and other improvements to increase its stability, efficiency, and operating capabilities.

International Journal of Mechanical Engineering Research and Technology

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

REFERENCE

[1] Alerstam, T. Radar observations of the stoop of the Peregrine Falcon Falco (1987) pp:234-242

[2] Bowers, A. H., Murillo, O. J., Red, R., Jensen, Eslinger, B., & Gelzer, C. On wings of the minimum induced drag: Spanload implications for aircraft and birds (2016) pp:364-368

[3] Brown, L. A. British birds of Prey. London: Collins. (1976) pp-455-

[4] Brown, M., & Vos, R. Conceptual design and evaluation of blended-wing- body aircraft. (2018) pp:188-194

[5] Brücker, C., & Weidner, C. Separation control via self-adaptive hairy flap let arrays. (2013) pp:397-406

[6] Chitty, J., & Lierz, M. Raptor husbandry and falconry techniques. BSAVA Manual of Raptors, Pigeons and Passerines. (2008) pp:287-299

[7] del Hoyo, J., Elliott, A., Sargatal, J., & Collar, N. J. Handbook of the birds of the world, Vol. 5. (1999) pp:367-365

[8] Favier, J., Dauptain, A., Basso, D., & Bottaro, A. A Passive separation control using a self-adaptive hairy coating. J. Fluid Mech (2009) pp:627-633

[9] Favier, J., Pinelli, A., & Piomelli, U. Control of the separated flow around an airfoil using a wavy leading edge inspired by humpback whale flippers. Comptes Rendus Mecanique (2012) pp:340-347

[10] Franklin, D. C. Evidence of disarray amongst granivorous bird assemblages in the savannas of northern Australia, a region of sparse human settlement. Biological Conservation. (1999) pp:99-107

[11] Hartley, R., & Zisserman, A. Multiple view geometry in computer vision Cambridge, UK, New York: Cambridge University Press. (2003) pp:199-208

[12] Hassanalian, M., Abdelmoula, H., Ben Ayed, S., & Abdelk, A. Effects of birds' wing color on their flight performance for biomimetic purposes (2017) pp:470-474

[13] Hassanalian, M., Abdelmoula, H., Ben Ayed, S., & Abdelkefi, A. Thermal impact of migrating birds' wing color on their flight performance: Possibility of new generation of biologically inspired drones. Journal of Thermal Biology (2017) pp:566-580

[14] Hoerner, S. F. Fluid dynamic drag. Published by author (1965) pp:299-314

[15] Hustler, K. Breeding biology of the peregrine falcon in Zimbabwe. Ostrich. (1983) pp:175-189

[16] Lawson, N. J., & Wu, J. Three-dimensional particle image velocimetry: error analysis of stereoscopic techniques (1997) pp:368-371

[17] Lentink, D., Müller, U. K., Stamhuis, E. J., de Kat, R., van Gestel, W., et al. How swifts control their glide performance with morphing wings (2007) pp:446-461.

[18] Lu, F. K. Surface oil flow visualization. (2010) pp:590-595

[19] Lyu, Z., & Martins, J. R. R. A. Aerodynamic design optimization studies of a blended-wing-body aircraft. Journal of Aircraft (2014) pp:230-238

[20] Nachtigall, W. Vogelflügel und Gleitflug. Introduction to the aerodynamic perspective of the wing. (1975) pp:234-242

[21] Nachtigall, W. The Gliding Flight of Birds..(1998) pp:432-443

[22] Newton, L. J. Stability and control derivative estimation for the bell-shaped lift distribution (2019) pp:278-289

[23] Nielsen, J. N., & Schwind, R. G. Decay of a vortex pair behind an aircraft. In Aircraft Wake Turbulence and Its Detection. (1971) pp:228-243

[24] Orton, D. A. The speed of a peregrine's dive. The Field, September (1975) pp:88-99

[25] Panagiotou, P., Ioannidis, G., Tzivinikos, I., & Yakinthos, K. Experimental investigation of the wake and the wingtip vortices of a UAV model. Aerospace (2017) pp:57-71

ISSN 2454 – 535X
http://www.ijmert.com
Vol.17 Issue 2, 2025

[26] Pellerito, V., Hassanalian, M., Sedaghat, A., Sabri, F., Borvayeh, L., & Sadeghi Performance analysis of a bioinspired albatross airfoil with heated top wing surface: experimental study (2019) pp:570-

[27] Podbregar, N. Das Secret of Flight – On the Trail of Animal Flyers Springer Berlin Heidelberg (2013) pp:243-270

[28] Ratcliffe, D. A. The peregrine falcon. Vermillion, S.D: Buteo Books. (1980) pp:344-356

[29] Richter, J., Hainline, K., Louis, S., Agarwal, R. K., & Richter, J., & Hainline, K. Examination of proverse yaw in bell-shaped spanload aircraft. (2011) Pp:489-496

[30] Savage, C. Peregrine Falcons. San Francisco (1992) pp-456

[31] Shreyas, J. V., Devrajan, S., & Sreenivas, K. R. Aerodynamics of bird and insect flight. (2009) pp:237-248

[32] Stempeck, A., Hassanalian, M., & Abdelkefi, A. Aerodynamic performance of albatross-inspired wing shape for marine unmanned air vehicles (2018) pp:560-578

[33] Su, J. Y., Ting, S. C., Chang, Y. H., & Yang, J. T. A passerine spread its tail to facilitate a rapid recovery of its body posture during hovering. Journal of the Royal Society Interface (2012) pp:380-393

[34] Tucker, G. C., & Parrot, V. A. Aerodynamics of gliding in a falcon and other birds. Journal of Experimental Biology (1970) pp:345-358

[35] Tucker, V. A. Gliding birds: descending flight of the white-backed vulture, gyps africanus. Journal of Experimental Biology (1988) pp:344-351.

[36] Tucker, V. A. Aerodynamics of gliding flight in a harris' hawk, parabuteo unicintus. Journal of Experimental Biology (1990) pp:489-492

[37] Williamson CJ UAV performs first ever perched landing using machine learning algorithms (2017) pp:216-223.