Development and Testing of Novel Hybrid Airfoil Designs for Enhanced Low-Speed Lift and Efficiency

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This project investigates the optimization of airfoil designs to enhance low-speed aerodynamic performance and reduce the risk of aerodynamic stalls—a leading contributor to aircraft accidents. The central hypothesis asserts that while all tested airfoils will generate measurable lift, the cambered airfoil will outperform the others, particularly the widely used Clark Y airfoil, which serves as the control. To evaluate this, four airfoil models—Cambered, Symmetrical, NACA 4412, and Clark Y—were designed and 3D printed. A custom wind tunnel, constructed from accessible materials, was used to conduct lift tests at a consistent airflow speed of 56.3 km/h. Each airfoil was tested in three 30-second trials, and average lift heights were recorded. The cambered airfoil demonstrated the highest average lift at 10.77 cm, followed by the Clark Y (10.36 cm), NACA 4412 (10.1 cm), and Symmetrical (9.83 cm). Statistical analysis using a one-way ANOVA test yielded an F-value of 23.8 and a p-value of 0.000244, indicating a statistically significant difference in lift among the airfoils tested. These findings support the hypothesis and suggest that refining airfoil designs can meaningfully enhance lift generation at low speeds. The implications include improved aircraft efficiency, reduced stall risk, lower fuel consumption, and environmental benefits. Furthermore, such advancements can facilitate operations at rural or regional airports with shorter runways, contributing to a more sustainable and accessible aviation industry.

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