

Utilizing Computational Fluid Dynamics for Enhanced Aircraft Efficiency: Optimizing HERO 1 Aircraft Performance via Variable Winglet Configurations

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Aircraft winglets are fixed-wing attachments that reduce lift-induced drag on aircraft by reducing the buildup of vortices—rotating patterns of air that form—thereby reducing drag forces acting on the aircraft and increasing efficiency. This study analyzed four winglet configurations (blended, canted, wingtip fence, raked) on the HERO 1, a custom-built electric remotely piloted aircraft, to determine whether or not the winglets could reduce lift-induced drag on the aircraft, thereby increasing efficiency. Winglets were modeled on Fusion360, while Autodesk CFD and Ansys Fluent were used in the analyses, set at 250 iterations. Drag force calculated from CFD simulations directly indicates that using all winglets led to a decreased drag coefficient compared to the control model, with the raked configuration yielding a 20.01% decrease in drag coefficient compared to the control. A one-way ANOVA yielded a p-value of <0.01 , indicating strong confidence that the groups (winglet configurations) differed and directly impacted the drag coefficient. Additional non-parametric analyses yielded p-values of <0.01 , further indicating differences and statistical relevance between tested winglet configurations. This study showed that various winglet configurations led to a general decrease in HERO 1's drag coefficient, with the raked winglet configuration yielding the most significant reduction of 20.01%. Future experiments will employ higher fidelity meshes and models, run at a greater number of iterations to allow for more life-accurate data, and explore the impact of winglets on the HERO 1 at different angles of attack.