A Novel Morphing Nose Cone Mechanism for Aerodynamic Optimization of a Supersonic Airplane

Ott, Daniel (School: Holmen High School)

The aerodynamic efficiency of an aircraft's nose cone is crucial to overall flight performance. Traditional nose cone designs are optimized for specific speed regimes, which limits their overall efficiency. This research investigated how different nose cone geometries impact drag, weight, and volume at subsonic, transonic, and supersonic speeds to develop a morphing nose cone that dynamically adapts its shape to minimize drag. Computational fluid dynamics (CFD) simulations were conducted in ANSYS Fluent to analyze the aerodynamic performance of the Von Karman, tangent ogive, power series, elliptical, conic, and parabolic nose cone shapes. The nose cones and bounding domains were created in SolidWorks, imported into ANSYS Workbench, meshed in ANSYS Meshing, and simulated using the k-omega SST turbulence model in ANSYS Fluent. Simulations ran until convergence (a residual of 1e-6, ~5000 iterations) for 11 speed regimes between Mach 0.3 and 2.0 to capture various flight conditions. It was found that a morphing nose cone that transitions between optimal geometries based on speed significantly reduces drag when compared to static designs, resulting in a 9.5% improvement in nose cone efficiency. To achieve morphing, a telescoping mechanism was designed in SolidWorks. After five prototypes, the final mechanism was manufactured for real-world testing. The research revealed that a morphing nose cone design is feasible, improves fuel efficiency, and has less environmental impact. Future work will include creating a closed-loop feedback system, simulating more data points around Mach 1.0, and improving the morphing mechanism.

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