The Virtual Winglet: A Novel Approach to Boundary Layer Manipulation and Wingtip Vortex Suppression

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Physical winglets offer widespread lift to drag force improvement for commercial and cargo aircraft; unfortunately, their improvements cannot be applied to fighter or short take-off and landing (STOL) aircraft. The Virtual Winglet was designed, tested, and implemented throughout the course of this research and can effectively improve the maneuverability, range, fuel efficiency, and safety of airplanes without the disadvantages of physical winglets. The targeted and energy-efficient design ejects relatively high-speed air out on the underside of the leading-edge of a wingtip. The high velocity creates an air curtain and a low-pressure system, attracting the surrounding fluid towards it. Through this induced pressure gradient, the Virtual Winglet can delay or eliminate the flow separation point while energizing the boundary layer. The design also suppresses the degree of turbulence and full formation of wing-tip vortices. Overall, these impacts attribute to a lift improvement of 13.76% for an average run of 10 m/s ambient flow and 40 m/s Virtual Winglet speed, with a net lift-to-drag ratio improvement of 5.4%. When compared to physical winglets which average improvement of 4%, the Virtual Winglet is a suitable and superior high-lift device substitution. The Virtual Winglet can most benefit STOL aircraft to provide increased lift and drag when producing a smooth landing. The same 10x40 average run when modeled on a typical STOL aircraft design provides an overall improvement for STOL landings of over 7.6%. This simple design can truly benefit the aircraft themselves as well as the human lives affected by them.

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