FLOW CONTROL AND PERFORMANCE ENHANCEMENT OF VTOL UAVS USING VORTEX GENERATORS AND BLOWING TECHNIQUES: A NUMERICAL APPROACH

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ABSTRACT

In this study, the aerodynamic performance of a vertical take-off and landing (VTOL) unmanned aerial vehicle (UAV) is investigated through the application of both active and passive flow control techniques. Passive control is achieved via vortex generators, while active control is implemented using blowing methods. A novel UAV design incorporating both strategies has been developed, and multiple configurations have been evaluated using Computational Fluid Dynamics (CFD) simulations. The main objective of this work is to enhance the overall flight performance of the UAV by delaying flow separation, controlling the boundary layer, and increasing aerodynamic efficiency. Various geometrical and operational parameters such as blowing magnitude, speed, angle, location and shape and size of the blowing area, as well as the shape, size and placement of the vortex generators were explored. In the first stage, each of these parameters was individually implemented and tested on the VTOL UAV design to assess its influence on aerodynamic performance. In addition, various combinations of these parameters were systematically investigated to evaluate their interactive effects and overall contribution to flow control efficiency. Preliminary results demonstrate that the integrated use of active and passive methods significantly improves aerodynamic performance, especially in transition regimes and low-speed operations. The proposed research provides important scientific insight contributions to the aerodynamic optimization of modern VTOL UAVs. This work also has been supported by Erciyes University Scientific Research Projects Coordination Unit under grant number FDK-2025-14354.

Keywords Active flow control method · passive flow control method · UAV · VTOL · Vortex Generator · Blowing Method · CFD · Performance Optimization · Separation Control

References

[1] Ö. Ö. Kanat, "Aktif Akış Kontrol ve Otonom Kontrol Yöntemlerinin Birlikte İnsansız Hava Araçları Üzerine Uygulaması", MSc Thesis, Institute of Science, Erciyes University, Kayseri, Turkey, 2020.

[2] J. C. Lin, Review of Research on Low-Profile Vortex Generators to Control Boundary-Layer Separation, Progress in Aerospace Science, 2002.

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