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Opinion Article

The Static Analysis of the Wings Aeroelastic Modeling Proximity

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DESCRIPTION

In the creation of Unmanned Aerial Vehicles (UAVs), the use of multiple wings appears to be more practical and significant. Numerous wing designs have the potential to enhance the aerodynamic performance, stability, mobility, weight reduction, and cost-effectiveness of Unmanned Aerial Vehicles (UAVs). Vertical takeoff and landing may be a more practical application due to improved stability. Additionally, the creation of micro-air vehicles with a biplane design for improved aerodynamic performance and thrust efficiency appears promising. In general, research to comprehend the various aspects and applications of such innovative designs is still ongoing. The aerodynamic interaction effect is arguably an important consideration in the aeroelastic design, particularly for these flying vehicles, in contrast to conventional vehicles [1].

Because of the interaction between the fluid and the structure, the aeroelastic phenomena in a flying vehicle are unavoidable. For aircraft's vulnerable single lifting surfaces like the wings, tails, and control surfaces, this has been thoroughly examined. The classical aeroelastic theory, which is based on the linear assumption of structures and aerodynamics, is frequently used to solve aeroelastic problems [2,3]. The aeroelastic challenges posed by a single lifting surface configuration are not novel and significant given the extensive amount of research that has been conducted on the topic. However, this is not the case when there are multiple lifting surfaces in the configuration. According to research, the flow interaction alters the aerodynamic characteristics of lifting surfaces within close proximity. As a result, the lifting surfaces may become more susceptible to aeroelastic instabilities like flutter as a result of the change in the system's dynamic. A nonlinear aerodynamic model and robust numerical methods are also required for the aeroelastic analysis of this configuration, making it more difficult.

It was demonstrated that for thick airfoils, the critical flutter speed decreases even more when the gap between the lower and upper airfoils is reduced. From a three-dimensional perspective, more research is needed to learn more about the aeroelastic properties of adjacent wings [4]. Additionally, unless other design constraints necessitated a greater distance between the wings, it is practical, from the point of view of innovative vehicle design, to position the wings closer together to improve aerodynamic efficiency. If this is the case, one wing might not be impacted at all by other wings, and as a result, the gap or stagger's impact on the aeroelastic behavior may be negligible. However, the impact on the dynamic aeroelastic instability becomes an important factor that has not been reported when the wings are close together. As a result, the aeroelastic behavior of wings in close proximity to various geometric parameters is examined in this paper.

Wings are modeled as a cantilever flat plate in a biplane arrangement in aeroelastic modeling. Wings are assumed to be linear, and structural modeling employs the Finite Element Method (FEM). The Unsteady Vortex Lattice Method (UVLM) is used to simulate the interference caused by unsteady flow between the wings. The flexible multi-body dynamic integrator of MSC is used to connect structural and aerodynamic models to create an interactive simulation framework. Adams solved the aeroelastic time-domain differential equations of motion. The gap, sweep angles, dihedral angles, and stagger of a biplane arrangement are all aeroelastic solutions that are presented.

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