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Editorial

The Impact of Wing Flexibility on Aerodynamics

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EDITORIAL

Better aerodynamic properties are the persistent goal of designers in the realm of aircraft design. Traditionally, flaps are employed to adjust the camber and area of the wing to produce more lift at low speeds, whereas ailerons provide moments through the asymmetric torsion of the wing. Morphing, which refers to a vehicle's capacity to change its outside design seamlessly, has gotten a lot of attention in recent years. As one of the passive morphing wings, the membrane flexible wing is a capable technology for maintaining ideal aerodynamic characteristics throughout a wide range of flight situations. The origins of membrane flexible wings can be traced back to the Wright Brothers' flyer, which pioneered human flight. They used the compliant membrane as lifting surfaces and wing wrapping to regulate the roll. The original membrane was replaced by sturdier constructions, such as rigid wings and metal control surfaces, in the following decades as a result of the revolution in both commercial and military aviation.

Most of the early work on MAVs and UAVs focused on the development of flexible wings, and several of them have flown successfully. Béguin conducted a series of investigations on a semi-span model with the sweep angle adjusted morphing wing to determine the aerodynamic performance of the three-dimensional membrane wing. The camber and thickness of the wing might be adjusted to some extent by adjusting the dynamic pressure and pre-stress. Meanwhile, the wing planform change had an effect on the lift and drag characteristics. The relatively high lift-to-drag ratio could thus be maintained under a wide range of flight circumstances. The pre-stress was updated based on the baseline model's improvement by shifting the trailing edge spar. With the sweep angle of the membrane wing modified, a simplified aircraft model is created.

The effect of sweep angle, Reynolds number, and membrane flexibility on the aerodynamic characteristics of an aeroplane is explored. The attack angle ranges from 0° to 60°. The velocity field for both rigid and flexible wings, as well as membrane deformation, are determined at the sweep angle=15° to further explain the mechanism behind the augmentation of flexible wing aerodynamic performance. The velocity field of both rigid and flexible wings with=15° was studied using Particle Image Velocimetry to reveal the mechanism behind the enhancement of flexible wing aerodynamic performance (PIV). A Charge Coupled Device (CCD) camera, a Nd:YAG double-pulsed laser as a light source, and Ethylene glycol droplets as tracer particles were used in the Micro PIV system. The laser had a power of 500 mJ and a wavelength of 532 nm. The CCD camera had a resolution of 2456 2058 pixels to capture a field of view of around 100 mm 80 mm, resulting in a magnification of 0.04 mm/pixel. The sampling frequency was 4 Hz, and the time delay between two straddle frames was 20_s. The membrane deformation reflects the impacts of the aerodynamic force on the flexible wing, whereas the deformed wing reacts to the flow field, which alters the aerodynamic properties. Because the suction force on the upper side of the flexible wing provides the majority of the lift, the upper surface membrane deformation at the wing mid-span point was measured.

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