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Name :
Noor Iswadi Ismail

Title :
Aerodynamic Performances of Twist Morphing MAV Wing

Supervisor :
Associate Prof. Dr. Abdul Halim Zulkifli (MS)
Prof. Dr. Mohd Zulkifly Abdullah (CS)

Performing the biomimetic morphing method on a Micro Air Vehicle (MAV) wing is very challenging tasks due to the MAV wing size limitation, limited energy budgets, complicated morphing mechanism and complex aeroelastic interactions. These issues had restricted the application of morphing wing on MAV wing platform. As a result, the impact of twist morphing on MAV wing aerodynamics and structural performances was not fully understood. Thus, this thesis presents the investigation of wing structural, aerodynamics performance and flow structure formations on a basic twist morphing MAV wing named as Twist Morphing wing. A series of morphing force intensity was imposed on Twist Morphing wing design to elucidate the impact of twist morphing mobility. Fully coupled Fluid-Structure Interaction (FSI) simulation is the main methodology used in this works. The wing structural and airflow field problems over Twist Morphing wing were solved based on a three-dimensional (3D) linear quasi-

static structural coupled with steady state, incompressible Reynolds Averaged Navier Stokes - Shear Stress Turbulence (RANS-SST) flow. The validation on aerodynamic performances showed good correlation between the FSI and wind tunnel test results. The wing structural results showed that Twist Morphing wings had produced high geometric twist magnitude (ϵ), which in turn, induced higher lift coefficient (C_L) and drag coefficient (C_D) performances on the wing. The flow structure investigations revealed that this benevolent and malevolent aerodynamics attitude contributed by low-pressure intensity and strong tip vortex (TV) strength induced on Twist Morphing wing. These phenomenon had turned out greater in Twist Morphing wing with higher morphing force (5N and 3N) configurations. However, Twist Morphing wing had also exhibited poor maximum aerodynamic efficiency ($C_L C_D / \max$) performances. The massive drag coefficient distribution had overwhelmed the successive increase in lift coefficient generation, which consequently plunged the maximum aerodynamic efficiency distribution magnitude on Twist Morphing wings. Hence, a multifidelity data Metamodel Based Design Optimization (MBDO) study was conducted to improve the maximum aerodynamic efficiency distribution on Twist Morphing wing. The optimal aerodynamic efficiency for Twist Morphing wing achieved at $C_L C_D / \max = 6.05$ with angle of attack, morphing force and velocity magnitude set at 4.67° , 2.31 N and 9.42 m/s, respectively. Detail investigation on optimization outcome showed that the optimal Twist Morphing wing exhibited better maximum aerodynamic efficiency magnitude than the non-optimal flexible wings. This is due to weak tip vortex strength, which induced low drag coefficient magnitude on the optimal Twist Morphing wing.