Evaluation of Energy Required for Flight by a UAV Fitted with a Variable-Span Wing Performing a Given Mission Profile

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The present work addresses the energy consumption of a small UAV fitted with a conventional fixed wing and a variable-span wing (VSW) given a prescribed mission. The mission is chosen in such a way that the multirole capability of the VSW could be exercised. The power for each flight phase is estimated using experimental aerodynamic drag polars and by measuring the power drawn from the batery for various quasi-steady flight speeds. The takeoff energy and climb power are computed from measured inflight power data. The actuation system is also characterized inflight for both the fixed wing UAV and VSW UAV. From the propulsion power, actuation power and mission definition, the propulsion and actuation energy for each flight phase is calculated. It is concluded that the VSW fitted UAV has less overall energy consumption despite the increased aircraft weight and less efficent airfoil. The energy reduction occured only in the high speed condition but was so marked that offseted the increase in energy during the takeoff, climb and loiter phases.

Nomenclature

C_D	=	wing drag coefficient
C_{D0}	=	zero-lift drag coefficient
CG	=	center of gravity
C_L	=	lift coefficient
C_P	=	propeller power coefficient
C_{P0}	=	power coefficient at zero advance ratio
D	=	drag
ESC	=	electronic speed controller
IFW	=	inboard fixed wing
UAV	=	unmanned air vehicle
J	=	propeller advance ratio
J_{max}	=	maximum advance ratio
K_1	=	lift-dependent drag factor
K_2	=	lift squared-dependent drag factor
L	=	lift
LiPo	=	lithium polymer
N	=	propeller rotational speed
NiMh	=	nickel metal hydride
OMW	=	outboard moving wing
V	=	airspeed
VSW	=	variable-span wing
α	=	angle of attack
β	=	angle of sideslip
δ	=	throttle setting
η_P	=	propeller propulsive efficiency
η_{Pmax}	=	maximum propulsive efficiency
ρ	=	air density

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