Load Alleviation in Tiltrotor Aircraft through Incremental Nonlinear Control Allocation

Hafiz Noor Nabi [*]

Politecnico di Milano, 20156 Milano, Italy and Delft University of Technology, 2629 HS Delft, The Netherlands

Coen C. de Visser [†]

Delft University of Technology, 2629 HS Delft, The Netherlands

Giuseppe Quaranta [‡]

Politecnico di Milano, 20156 Milano, Italy

Marilena D. Pavel [§]

Delft University of Technology, 2629 HS Delft, The Netherlands

Tiltrotor aircraft are over-actuated systems that are capable of flying in three distinct flight modes, namely helicopter, conversion and airplane mode using multiple redundant controls. These include a combination of rotor swashplates, nacelle tilt and aerodynamic surfaces. The redundant control effectors create multiple solution to control the aircraft. Therefore, a control allocation strategy must be employed to compute a unique solution that achieve specific objectives. The main objective of control allocation is to achieve a desired response by distributing the desired moments among different control effectors. The secondary objectives of control allocation may include: control effort minimization, potentially allow recovery from off-nominal conditions and/or load alleviation. The objective of current research effort is to develop a novel Incremental Nonlinear Control Allocation (INCA) technique for XV-15 tiltrotor aircraft to alleviate loads without degradation in handling qualities. The main focus in this study has been given to oscillatory yoke chord bending and rotor flapping motion. A nonlinear dynamic inversion based attitude control strategy is employed on a quasi-Linear Parameter Varying (qLPV) flight dynamics model of XV-15 tiltrotor aircraft. Weighted Least Squares (WLS) control allocation algorithm is integrated in the above mentioned dynamic inversion attitude controller, and is solved using Active Set Method (ASM). The control allocation technique based on Active Set Method (ASM) is developed and it's performance is assessed in three aircraft configurations at various speeds and during conversion maneuver.

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[*] PhD Candidate, Dipartimento di Scienze e Tecnologie Aerospaziali, Via La Masa, 34 and Faculty of Aerospace Engineering, Control and Simulation Division, Kluyverweg 1; h.n.nabi@tudelft.nl

[†] Assistant Professor, Faculty of Aerospace Engineering, Control and Simulation Division, Kluyverweg 1; c.c.devisser@tudelft.nl

[‡] Professor, Dipartimento di Scienze e Tecnologie Aerospaziali, Via La Masa, 34; giuseppe.quaranta@polimi.it

[§] Associate Professor, Faculty of Aerospace Engineering, Control and Simulation Division, Kluyverweg 1; m.d.pavel@tudelft.nl