Rotorcraft Flight Control Design with Alleviation of Unsteady Rotor Loads

SPEAKER: Umberto SAETTI, Postdoctoral Fellow, School of Aerospace Engineering, Georgia Institute of Technology

ABSTRACT

Many of the critical structural limits on rotorcraft are associated with vibratory loads and fatigue limits. These loads are strongly influenced by higher-harmonic dynamics (i.e., greater than 1-per-rotor-revolution, or 1/rev) in the rotor system. Linear Time-Periodic (LTP) systems are well-suited for representing vibratory loads on rotorcraft and have been used to derive Higher-Harmonic Control (HHC) laws that mitigate the vibratory loads. Despite being a powerful approach, HHC is expensive to implement on production rotorcraft and poses safety/reliability concerns.

This talk discusses the development of rotorcraft flight control laws alternative to HHC that minimize rotor loads by acting solely through the primary flight controls (zeroth and first harmonic swashplate control). As opposed to HHC, this strategy could be readily integrated with existing or future Automatic Flight Control Systems (AFCS) on civil and military rotorcraft. The study considers control designs for both conventional and compound rotorcraft configurations. Further, since the rotorcraft manufacturers do not typically rely solely on linear systems obtained from simulation models for the development and integration of flight control laws on production rotorcraft, a novel methodology is proposed to identify LTP systems from flight-test data. The methodology is successfully applied to JUH-60A Black Hawk flight-test data. Broader implications of the methodology are presented in the context of Future Vertical Lift (FVL), flapping-wing Micro Aerial Vehicles (MAVs), and alleviation of aerodynamically-generated noise.

BIOGRAPHY

Umberto Saetti is a Postdoctoral Fellow with the School of Aerospace Engineering at Georgia Tech. His research interests lie in the area of flight dynamics, controls, system identification, and numerical methods for the analysis of linear and nonlinear time-periodic systems. Applications span aircraft, rotorcraft, and biomimetic vehicles including civil and military helicopters, flapping-wing Micro Aerial Vehicles (MAVs), small and medium-scale Unmanned Aerial Vehicles (UAV), and electric Vertical Take-Off and Landing (eVTOL) vehicles. Saetti graduated with a concurrent Ph.D. in Aerospace Engineering (with a minor in Computational Science) and M.Sc. in Electrical Engineering from Penn State in August 2019. He previously graduated with a M.Sc. in Aerospace Engineering also from Penn State in 2016. Saetti received his B.Sc. in Aerospace Engineering from Politecnico di Milano, Italy in 2014.