

Advances in Industrial Control

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Smart Helicopter Rotors

Optimization and Piezoelectric Vibration
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Smart Helicopter Rotors Ranjan Ganguli,Dipali Thakkar,Sathyamangalam Ramanarayanan Viswamurthy,2015-12-16
Exploiting the properties of piezoelectric materials to minimize vibration in rotor blade actuators this book demonstrates the potential of smart helicopter rotors to achieve the smoothness of ride associated with jet engined fixed wing aircraft Vibration control is effected using the concepts of trailing edge flaps and active twist The authors optimization based approach shows the advantage of multiple trailing edge flaps and algorithms for full authority control of dual trailing edge flap actuators are presented Hysteresis nonlinearity in piezoelectric stack actuators is highlighted and compensated by use of another algorithm The idea of response surfaces provides for optimal placement of trailing edge flaps The concept of active twist involves the employment of piezoelectrically induced shear actuation in rotating beams Shear is then demonstrated for a thin walled aerofoil section rotor blade under feedback control vibration minimization Active twist is shown to be significant in reducing vibration caused by dynamic stall The exposition of ideas materials and algorithms in this monograph is supported by extensive reporting of results from numerical simulations of smart helicopter rotors This monograph will be a valuable source of reference for researchers and engineers with backgrounds in aerospace mechanical and electrical engineering interested in smart materials and vibration control

Advances in Industrial Control aims to report and encourage the transfer of technology in control engineering The rapid development of control technology has an impact on all areas of the control discipline The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control *International Aerospace Abstracts* ,1999 **Anisotropic Piezoelectric Twist Actuation of Helicopter Rotor Blades** William Keats Wilkie,1997 *Smart Helicopter Rotor with Piezoelectric Bender Actuated Trailing-edge Flaps* Nikhil Koratkar,2000 *An Aeroelastic Analysis of Helicopter Rotor Blades Incorporating Piezoelectric Fiber Composite Twist Actuation* ,1996 *A Study of the Thermal Effects in a Smart Structure Helicopter Rotor* ,1999 One concept being considered for active noise and vibration control of helicopter rotors is a trailing edge flap design driven by a high displacement piezoelectric actuator device The proposed device requires an 800 V power supply and draws a current on the order of 3 A Thus depending on the duty cycle and efficiency of the mechanism some portion of the 240 W of electrical input energy will be converted to heat This study provides an initial estimate of the temperatures that may be encountered if no provisions are made for cooling the actuator Also included are a discussion of the heat transfer calculation assuming conduction and radiation as the dominant modes and a description of HEAT 8 the computer code used **Multidisciplinary Optimization of Helicopter Rotor Blades Including Design Variable Sensitivity** Thomas R. McCarthy,1992

Aerolastic Optimization of a Helicopter Rotor Joon Won Lim,1988 *Multi-disciplinary Optimization of a Helicopter Rotor and Flight Control System* Vineet Sahasrabudhe,1996 *Multidisciplinary Adjoint-based Design Optimization Techniques for Helicopter Rotors* Enrico Fabiano,2017 Helicopter rotor design optimization is a challenging task due to the

multidisciplinary nature of rotorcraft design the helicopter operates in a highly unsteady aerodynamic environment highly flexible slender rotor blades highlight the importance of blade aeroelasticity while the ever more stringent noise requirements that the helicopter must satisfy underlines the need to include aeroacoustic considerations early in the design process Such a large scale problem can be efficiently solved with the use of gradient based optimization methods In gradient based optimization the gradient of the objective function with respect to the design variables is needed to determine a search direction The objective function's gradient can be computed either with the finite difference approach the tangent or forward linearization approach and the adjoint or reverse approach The finite difference approach is easy to implement but its cost scales with the number of design variables and can be affected by the choice of the step size used in the differentiation The tangent or forward approach computes the exact gradient vector of the objective function by exact differentiation of the computational code however its cost still scales linearly with the number of design variables On the other hand the adjoint or reverse approach computes the sensitivity vector with respect to a potentially infinite number of design variables at a cost essentially independent of the design variables making the adjoint technique the only viable approach when the number of design variables is large Hence it is the adjoint approach that makes gradient based optimization techniques competitive for large scale problems characterized by a large number of design parameters such as the current helicopter design problem The focus of this work is the development of a high fidelity multidisciplinary adjoint technique that encompasses the three disciplines of aerodynamics structural mechanics and aeroacoustics for rotorcraft problems Upon successful implementation and verification the multidisciplinary adjoint method is applied to the problem of noise minimization of a flexible rotor in trimmed forward flight with no performance penalty Optimization results highlight the potential of high fidelity

multidisciplinary design optimization for helicopter rotors **Fully Integrated Aerodynamic/dynamic Optimization of Helicopter Rotor Blades**, 1992 **Integrated Aerodynamic/dynamic Optimization of Helicopter Rotor Blades**, 1989

Aeroelasticity and Structural Optimization of Composite Helicopter Rotor Blades with Swept Tips K. A. Yuan, 1994 *Weight Optimization of a Helicopter Rotor Blade Modeled Using Finite Element Techniques* Robert William Buchanan, 1972 *Performance Optimization of Helicopter Rotor Blades*, 1991 *Aeroelastic Optimization of a Composite Helicopter Rotor* Ranjan Ganguli, 1992 *Integration of Dynamic, Aerodynamic, and Structural Optimization of Helicopter Rotor Blades* National Aeronautics and Space Administration, 2018-12-31 Summarized here is the first six years of research into the integration of structural dynamic and aerodynamic considerations in the design optimization process for rotor blades Specifically discussed here is the application of design optimization techniques for helicopter rotor blades The reduction of vibratory shears and moments at the blade root aeroelastic stability of the rotor optimum airframe design and an efficient procedure for calculating system sensitivities with respect to the design variables used are discussed Peters David A NASA CR 189018 NAS 1 26 189018 NAG1 710 **Optimal Placement of Tuning Masses for Vibration Reduction in**

Helicopter Rotor Blades ,1988 **Aeroelastic Optimization of a Helicopter Rotor** Joon W. Lim,1988 *Integration of Dynamic, Aerodynamic, and Structural Optimization of Helicopter Rotor Blades* David A. Peters, Georgia Institute of Technology. School of Aerospace Engineering. Project no. E-16-694,1986

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