

Consistent Structural Linearization in Flexible Aircraft Dynamics with Large Rigid-Body Motion

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This paper investigates the linearization, using perturbation methods, of the structural deformations in the nonlinear flight dynamic response of aircraft with slender, flexible wings. This has been achieved by first coupling a displacement-based, geometrically-nonlinear flexible-body dynamics formulation with the 3D Unsteady Vortex-Lattice Method, followed by a consistent linearization of the structural degrees of freedom, which are assumed to be small in a body-fixed reference frame. The translations and rotations of that reference frame can be arbitrarily large, however. The resulting system preserves all couplings between rigid and elastic motions and can be projected onto a few vibration modes of the unconstrained aircraft with arbitrarily-large, geometrically-nonlinear deformation at a trim condition. The dynamics of the system are then written in tensor form, with up to cubic terms due to the nonlinear rigid-body terms, and with a limited number of coefficients that can be pre-computed prior to the time-marching simulation. Numerical studies on a representative HALE UAV are presented to illustrate the approach and results are compared to the mean-axes solution.

Nomenclature

Symbols

A	aerodynamic influence coefficient matrix
$C^{B/A}$	coordinate transformation matrix from frame A to B
C	global tangent damping matrix
F	nodal external forces
I	unit matrix
K	sectional local curvature
K	global tangent stiffness matrix
M	nodal external moments
\mathcal{M}	global tangent mass matrix
N	matrix of shape functions
p	generalized displacements in modal basis
Q	global vector of generalized forces
r	position vector of the origin of body-fixed frame, A
R	local position vector along the beam reference line
s	arc-length along beam reference line
T	tangential operator
u	input vector
v	inertial translational velocity of the body-fixed frame, A

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Structural Aspects Of Flexible Aircraft Control

Angelo Miele, Aldo Frediani



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Structural Aspects of Flexible Aircraft Control (les Aspects Structuraux Du Controle Actif Et Flexible Des Aeronefs). ,2000 The Specialists Meeting dealt with Design Issues and more specifically Structural Aspects of Flexible Aircraft Control Twenty six papers and a Keynote address were presented with the following objective How the design methods used in the development of military fighter aircraft can be improved and applied to transport aircraft design applications There were three sessions covering the following topics 1 Aeroservoelasticity 2 Active Control of Flexible Structure I 2 Active Control of Flexible Structure II **Smart Materials** Mel Schwartz,2008-11-20 Explores State of the Art Work from the World s Foremost Scientists Engineers Educators and Practitioners in the Field Why use smart materials Since most smart materials do not add mass engineers can endow structures with built in responses to a myriad of contingencies In their various forms these materials can adapt to their environments by c Morphing Wing Technologies Sergio Ricci,Ferri M.H. Aliabadi,Ruxandra Botez,Fabio Semperlotti,2017-10-27 Morphing Wings Technologies Large Commercial Aircraft and Civil Helicopters offers a fresh look at current research on morphing aircraft including industry design real manufactured prototypes and certification This is an invaluable reference for students in the aeronautics and aerospace fields who need an introduction to the morphing discipline as well as senior professionals seeking exposure to morphing potentialities Practical applications of morphing devices are presented from the challenge of conceptual design incorporating both structural and aerodynamic studies to the most promising and potentially flyable solutions aimed at improving the performance of commercial aircraft and UAVs Morphing aircraft are multi role aircraft that change their external shape substantially to adapt to a changing mission environment during flight The book consists of eight sections as well as an appendix which contains both updates on main systems evolution skin structure actuator sensor and control systems and a survey on the most significant achievements of integrated systems for large commercial aircraft Provides current worldwide status of morphing technologies the industrial development expectations and what is already available in terms of flying systems Offers new perspectives on wing structure design and a new approach to general structural design Discusses hot topics such as multifunctional materials and auxetic materials Presents practical applications of morphing devices **Smart Structures and Materials** Aurelio L. Araujo,Carlos A. Mota Soares,2016-12-20 This work was compiled with expanded and reviewed contributions from the 7th ECCOMAS Thematic Conference on Smart Structures and Materials that was held from 3 to 6 June 2015 at Ponta Delgada Azores Portugal The Conference provided a comprehensive forum for discussing the current state of the art in the field as well as generating inspiration for future ideas specifically on a multidisciplinary level The scope of the Conference included topics related to the following areas Fundamentals of smart materials and structures Modeling formulation and characterization of smart actuators sensors and smart material systems Trends and developments in diverse areas such as material science including composite materials intelligent hydrogels interfacial phenomena phase

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NASA Langley Scientific and Technical Information Output: 1999 ,2000 *Advanced Design Problems in Aerospace Engineering* Angelo Miele,Aldo Frediani,2006-04-11 *Advanced Design Problems in Aerospace Engineering Volume 1* Advanced Aerospace Systems presents six authoritative lectures on the use of mathematics in the conceptual design of various types of aircraft and spacecraft It covers the following topics design of rocket powered orbital spacecraft Miele Mancuso design of Moon missions Miele Mancuso design of Mars missions Miele Wang design of an experimental guidance system with a perspective flight path display Sachs neighboring vehicle design for a two stage launch vehicle Well and controller design for a flexible aircraft Hanel Well This is a reference book of interest to engineers and scientists working in aerospace engineering and related topics

Flight Control Systems Roger Pratt,2000 Annotation Bridging the gap between academic research and real world applications this reference on modern flight control methods for fixed wing aircraft deals with fundamentals of flight control systems design then concentrates on applications based on the modern control methods used in the latest aircraft The book is written for practicing engineers who are new to the aviation industry postgraduate students in strategic or applied research and advanced undergraduates Some knowledge of classical control is assumed Pratt is a member of IEEE and is UK Member for AIAA s Technical Committee on Guidance Navigation and Control Annotation c Book News Inc Portland OR booknews com

The Standard Handbook for Aeronautical and Astronautical Engineers Mark Davies,2003 Designed as a one stop reference for engineers of all disciplines in aeronautical and aerospace engineering this handbook seeks to filter mechanical engineering applications to specifically address aircraft and spacecraft science and military engineering

Control of Linear Parameter Varying Systems with Applications Javad Mohammadpour,Carsten W. Scherer,2012-03-08 *Control of Linear Parameter Varying Systems* compiles state of the art contributions on novel analytical and computational methods for addressing system identification model reduction performance analysis and feedback control design and addresses address theoretical developments novel computational approaches and illustrative applications to various fields Part I discusses modeling and system identification of linear parameter varying systems Part II covers the importance of analysis and control design when working with linear parameter varying systems LPVS Finally Part III presents an applications based approach to linear parameter varying systems including modeling of a turbocharged diesel engines Multivariable control of wind turbines modeling and control of aircraft engines

control of an autonomous underwater vehicles and analysis and synthesis of re entry vehicles **Proceedings of the ASME Pressure Vessels and Piping Conference--2006: Fluid-structure interaction** ,2007 *Scientific and Technical Aerospace Reports* ,1995 *Research and Technology Program Digest Flash Index* ,1967 **AVST Morphing Project Research Summaries in Fiscal Year 2001** Anna-Maria R. McGowan,2002 *Standard Handbook for Aerospace Engineers, Second Edition* Brij N. Agrawal,Max F. Platzer,2018-02-26 Publisher s Note Products purchased from Third Party sellers are not guaranteed by the publisher for quality authenticity or access to any online entitlements included with the product A single source of essential information for aerospace engineers This fully revised resource presents theories and practices from more than 50 specialists in the many sub disciplines of aeronautical and astronautical engineering all under one cover The Standard Handbook for Aerospace Engineers Second Edition contains complete details on classic designs as well as the latest techniques materials and processes used in aviation defense and space systems You will get insightful practical coverage of the gamut of aerospace engineering technologies along with hundreds of informative diagrams charts and graphs Standard Handbook for Aerospace Engineers Second Edition covers Futures of aerospace Aircraft systems Aerodynamics aeroelasticity and acoustics Aircraft performance Aircraft flight mechanics stability and control Avionics and air traffic management systems Aeronautical design Spacecraft design Astrodynamics Rockets and launch vehicles Earth s environment and space Attitude dynamics and control *Innovation in Flight* Joseph R. Chambers,2005

Multidisciplinary Design Optimization Natalia M. Alexandrov,M. Yousuff Hussaini,1997-01-01 Multidisciplinary design optimization MDO has recently emerged as a field of research and practice that brings together many previously disjointed disciplines and tools of engineering and mathematics MDO can be described as a technology environment or methodology for the design of complex coupled engineering systems such as aircraft automobiles and other mechanisms the behavior of which is determined by interacting subsystems **Aeronautical Engineering** ,1991 **Technology for Large Space Systems** ,1982 *Introduction to Aircraft Aeroelasticity and Loads* Jan Robert Wright,Jonathan Edward Cooper,2008-02-28 Aeroelastic phenomena arising from the interaction of aerodynamic elastic and inertia forces and the loads resulting from flight ground manoeuvres and gust turbulence encounters have a significant influence upon aircraft design The prediction of aircraft aeroelastic stability response and loads requires application of a range of interrelated engineering disciplines This new textbook introduces the foundations of aeroelasticity and loads for the flexible aircraft providing an understanding of the main concepts involved and relating them to aircraft behaviour and industrial practice This book includes the use of simplified mathematical models to demonstrate key aeroelastic and loads phenomena including flutter divergence control effectiveness and the response and loads resulting from flight ground manoeuvres and gust turbulence encounters It provides an introduction to some up to date methodologies for aeroelastics and loads modelling It lays emphasis on the strong link between aeroelasticity and loads It also includes provision of MATLAB and SIMULINK programs for the simplified

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