NASA SP-7037 (327)
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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract.

Two indexes—subject and author are included.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.

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Indexes

Two indexes are available. You may use the **Find** command under the **Tools** menu while viewing the PDF file for direct match searching on any text string. You may also view the indexes provided, for searching on *NASA Thesaurus* subject terms and author names.

Selecting an index above will link you to that comprehensive listing.

Appendix

Select **Appendix** for important information about NASA Scientific and Technical Information (STI) Office products and services, including registration with the NASA Center for AeroSpace Information (CASI) for access to the NASA CASI TRS (Technical Report Server), and availability and pricing information for cited documents.

Typical Report Citation and Abstract

ON MICROFICHE

ACCESSION NUMBER → **N96-10751#** Sandia National Labs., Albuquerque, NM. **← CORPORATE SOURCE**

TITLE → **Minimizing phylogenetic number to find good evolutionary trees**

AUTHORS → Goldberg, Leslie Ann; Goldberg, Paul W.; Phillips, Cynthia A.; Sweedyk, Elizabeth (California Univ., Berkeley, CA.); and Warnow, Tandy (Pennsylvania Univ., Philadelphia, PA.) **← AUTHORS' AFFILIATION**

PUBLICATION DATE → 1995 26 p Presented at the 1995 Symposium on Combinatorial Pattern Matching, Helsinki, Finland, 4-7 Jul. 1995 Sponsored by California Legislative Grant

CONTRACTS/GRANTS → Contract(s)/Grant(s): (DE-AC04-94AL-85000; NSF CCR-94-57800)

REPORT NO.(S) → Report No.(s): (DE95-011893; SAND-95-0831C; CONF-9507123-1) Avail: CASI HC A03/MF A01 **← AVAILABILITY AND PRICE CODE**

ABSTRACT → Inferring phylogenetic trees is a fundamental problem in computational-biology. We present a new objective criterion, the phylogenetic number, for evaluating evolutionary trees for species defined by biomolecular sequences or other qualitative characters. The phylogenetic number of a tree T is the maximum number of times that any given character state arises in T. By contrast, the classical parsimony criterion measures the total number of times that different character states arise in T. We consider the following related problems: finding the tree with minimum phylogenetic number, and computing the phylogenetic number of a given topology in which only the leaves are labeled by species. When the number of states is bounded (as is the case for biomolecular sequence characters), we can solve the second problem in polynomial time. We can also compute a fixed-topology 2-phylogeny (when one exists) for an arbitrary number of states. This algorithm can be used to further distinguish trees that are equal under parsimony. We also consider a number of other related problems. DOE

SUBJECT TERMS → *Algorithms; Biological Evolution; Chemical Evolution; Genetics; Molecular Biology*

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 327)

FEBRUARY 1996

01 AERONAUTICS (GENERAL)

N96-12169*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FAA/NASA Joint University Program for Air Transportation Research: 1993-1994
Hueschen, Richard M.; comp. Aug. 1995 118 p Conference held in Athens, OH, 14-15 Jul. 1994
Contract(s)/Grant(s): (NGL-22-009-640; NGR-36-009-017; NGL-31-001-252; RTOP 505-64-52-01)
Report No.(s): (NASA-CP-3305; L-17507; NAS 1.55:3305; DOT/FAA/CT-95/39) Avail: CASI HC A06/MF A02

This report summarizes the research conducted during the academic year 1993-1994 under the NASA/FAA sponsored Joint University Program for Air Transportation Research. The year end review was held at Ohio University, Athens, Ohio, July 14-15, 1994. The Joint University Program is a coordinated set of three grants sponsored by NASA Langley Research Center and the Federal Aviation Administration, one each with the Massachusetts Institute of Technology (NGL-22-009-640), Ohio University (NGR-36-009-017), and Princeton University (NGL-31-001-252). Completed works, status reports, and annotated bibliographies are presented for research topics which include navigation, guidance and control theory and practice, aircraft performance, human factors, and expert systems concepts applied to aircraft and airport operations. An overview of the year's activities for each university is also presented. For individual titles, see N96-12170 through N96-12180.
Air Navigation; Air Transportation; Aircraft Control; Aircraft Guidance; University Program;

N96-12359 Defence Science and Technology Organisation, Melbourne (Australia). Airframes and Engines Div.
A data screening technique for AFDAS
Molent, L.; Walker, K.; and Ogden, R. W.; 1 Aug. 1995 51 p
Report No.(s): (DSTO-TR-0204; AR-009-332) Copyright Avail: Issuing Activity (DSTO Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia)

This report presents the details of a technique which was adapted to correlate two individual Aircraft Fatigue Data Analysis System (AFDAS) data channels, or other data presented as range mean pairs, as a method of data screening or validation. Although the technique is here-in demonstrated by using operational RAAF F/A-18 AFDAS data, the approach is not aircraft type dependent, and is intended for general AFDAS (or any range mean pair) data screening purposes. A PC based program developed to implement the screening process is also described.
Author
Aircraft Safety; Applications Programs (computers); Channels (data Transmission); Computer Techniques; Data Correlation; Data Processing; Data Reduction; Screening;

N96-13570# Sandia National Labs., Albuquerque, NM.
Reliability assessment at airline inspection facilities. Volume 3: Results of an eddy current inspection reliability experiment Final Report
Spencer, Floyd; and Schurman, Donald; May 1995 174 p
Contract(s)/Grant(s): (DTFA03-91-A-00018)
Report No.(s): (AD-A295081; DOT/FAA/CT-92/12- VOL-3) Avail: CASI HC A08/MF A02

The Aging Aircraft NDI Development and Demonstration Center (AANC) at Sandia National Laboratories is charged by the FAA to support technology transfer, technology assessment, and technology validation. A key task facing the center is to establish a consistent and systematic methodology to assess the reliability of inspections through field experiments. This task is divided into three major areas: reliability of eddy current lap splice inspections at transport aircraft maintenance facilities, reliability of inspection at commuter aircraft maintenance facilities, and reliability of inspection associated with visual inspection of aircraft structural parts. Volume III is the third in a series of three describing the planning, execution, and results of an eddy current inspection field experiment. The experiment was taken to nine facilities, and five inspections were performed at each facility. All inspections took place in the environment in which actual aircraft were inspected, were accomplished using the same equipment that would be used in actual aircraft inspections, and were performed by the same people

who would do actual aircraft inspections. This document provides a detailed description of the results of that eddy current inspection reliability experiment (ECIRE).
DTIC
Aircraft Maintenance; Inspection; Nondestructive Tests; Planning; Reliability Engineering;

N96-13582# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
Aerodynamics and Aeroacoustics of Rotorcraft [L'Aerodynamique et l'Aeroacoustique des Aeronefs a Voilure Tournante]
Aug. 1995 489 p In ENGLISH and FRENCH The 75th symposium was held in Berlin, Germany, 10-13 Oct. 1994 Original contains color illustrations
Report No.(s): (AGARD-CP-552; ISBN-92-836-0015-0) Copyright Avail: CASI HC A21/MF A04

The papers prepared for the AGARD Fluid Dynamics Panel (FDP) Symposium on 'Aerodynamics and Aeroacoustics of Rotorcraft', which was held 10-13 October 1994 in Berlin, Germany are contained in this Report. In addition, a Technical Evaluator's Report aimed at assessing the success of the Symposium in meeting its objectives, and an edited transcript of the General Discussion held at the end of the Symposium are also included. The Symposium brought together scientists in different fields of aerodynamics and aeroacoustics to review and discuss their recent results in the area of rotary-wing aircraft in order to foster future development. The program included 35 papers from North American, Western Europe, and Russian organized in the following technical sessions: Dynamics Stall, Wind Turbines, Aerodynamic 3D Prediction Methods, Experimental Investigations of Helicopter Rotors, Acoustic Predictions Methods, and Interference Problems. For individual titles, see N96-13583 through N96-13617.
Aeroacoustics; Aerodynamic Stalling; Blade-vortex Interaction; Computational Fluid Dynamics; Conferences; Helicopters; Hovering; Navier-stokes Equation; Noise Prediction (aircraft); Rotary Wings; Rotor Aerodynamics; Rotor Blades; Wind Turbines;

N96-13583# United Technologies Research Center, East Hartford, CT.
New directions in rotorcraft computational aerodynamics research in the US c01
Landgrebe, Anton J.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 12 p Original contains color illustrations (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

Recent research activities in the United States are presented that are representative of the directions of research for computational aerodynamics for rotorcraft. Emphasis is given to Navier-Stokes methodology for airflow and airload prediction, and specifically the fundamental technical challenges associated with grid systems and achieving wake generation without numerical diffusion. Although the current rotorcraft CFD methods have not yet generally demonstrated sufficient accuracy for the helicopter industry, the recent rate of progress is encouraging.
Author
Aerodynamic Loads; Aircraft Design; Computational Fluid Dynamics; Grid Generation (mathematics); Helicopters; Navier-stokes Equation; Research; Rotor Aerodynamics; Structured Grids (mathematics); Unstructured Grids (mathematics);

N96-13600# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. fuer Flugmechanik.
Rotorcraft system identification: An overview of AGARD FVP Working Group 18 c01
Hamel, Peter G.; and Kaletka, Juergen; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 16p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

The AGARD FVP Panel, which for the last 20 years has sponsored activities in the field of flight vehicle system identification, decided in 1987 to set up the FVP Working Group 18, tasked with exploring and reporting on the topic of rotorcraft System Identification. Using flight test data bases from three different helicopters, specialists from research organizations and industry applied their individual evaluation techniques for data quality checking and for the identification and verification of flight-mechanical models. The accomplishments of the Working Group are documented in the Final Report. This paper gives a broad overview on the basic identification methodology and the practical approaches. Representative results are given to illustrate the main identification steps: specific flight test maneuvers and required measurements, definition of appropriate model structures, application of identification methods, and verification of the results. The Working Group mainly concentrated on the determination of 6 DOF rigid body models. Based on the experience gained in the Group, higher order models have recently been identified. Therefore, the paper also addresses the advances and gives an example for the application of the obtained models.
Author
Data Reduction; Dynamic Response; Flight Simulation; Flight Tests; Mathematical Models; Maximum Likelihood Estimates; Rotary Wing Aircraft; System Identification;

N96-13601*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Effect of individual blade control on noise radiation c01
Swanson, S. M.; Jacklin, Stephen A.; Niesl, G.; (Eurocopter Deutschland G.m.b.H., Munich, Germany.)Blaas, Achim; (Zahnradfabrik Friedrichshafen A.G., Calden, Ger-

many.)and Kube, R.; (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 12 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

In a joint research program of NASA Ames Research Center, ZF Luftfahrttechnik, the German Aerospace Research Establishment (DLR), and EUROCOPTER Deutschland, a wind tunnel test was performed to evaluate the effects of Individual Blade Control (IBC) on rotor noise. This test was conducted in the 40x80 ft wind tunnel at NASA Ames Research Center, utilizing a full scale MBB-BO 105 four-bladed rotor system. Three microphones were installed for determination of the radiated noise, two of them on a moveable traverse below the advancing blade side and one in a fixed location below the retreating side. Acoustic results are presented for flight conditions with Blade-Vortex-Interaction (BVI) noise radiation. High noise level reductions were measured for single harmonic control inputs. In addition to the single harmonic inputs, multi-harmonic inputs were evaluated by superimposing 2/rev to 6/rev harmonics. For the first time the efficiency of sharp wavelets (60 deg and 90 deg width) on acoustic noise were measured. In order to achieve an adequate wavelet shape at the blade tip, corrections were made to account for the blade torsional behavior. In parallel with the acoustic measurements, vibratory loads were measured during the BVI flight condition to correlate the effects of IBC on noise and vibrations. It is shown how noise levels and vibrations are affected by specific IBC control inputs. In addition, correlations are made between noise levels and acoustic time histories with IBC phase and amplitude variations. For one IBC input mode with high noise reducing efficiency, a sweep of the moveable microphone traverse below the advancing side shows the effect on BVI noise directivity.

Author

Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Bo-105 Helicopter; Harmonic Control; Noise Intensity; Noise Measurement; Noise Reduction; Rotary Wings; Rotor Aerodynamics; Vibratory Loads; Wind Tunnel Tests;

N96-13602*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A study of blade-vortex interaction aeroacoustics utilizing an independently generated vortex c01

Kitaplioglu, C.; and Caradonna, F. X.; (Army Aviation Systems Command, Moffett Field, CA.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 19 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

This paper presents results from an experimental study of rotor blade-vortex interaction (BVI) aerodynamics and acoustics. The experiment utilized an externally generated vortex interacting with a two-bladed rotor operating at zero thrust to minimize the influence of the rotor's own wake. The rotor blades were instrumented with a total of 60 absolute pressure transducers at three spanwise and ten chordwise stations on both the upper and lower surfaces. Acoustic data were obtained with fixed near-field microphones as well as a movable array of far-field microphones. The test was carried out in the acoustically treated test section of the NASA Ames 80- by 120-foot Wind Tunnel. Several parameters which influences BVI, such as vortex-rotor separation distance, vortex strength, and vortex sense (swirl direction), as well as rotor tip Mach number and advance ratio, were varied. Simultaneous measurements were obtained of blade surface pressure distributions, near-field acoustics, and far-field acoustics during the vortex-blade encounters.

Author

Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Far Fields; Helicopters; Near Fields; Noise Measurement; Pressure Distribution; Pressure Measurement; Rotor Aerodynamics; Surface Noise Interactions; Vortices; Wind Tunnel Tests;

N96-13608*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Effect of higher harmonic control on helicopter rotor blade-vortex interaction noise: Prediction and initial validation c01

Beaumier, P.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)Prieur, J.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.) Rahier, G.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)Spiegel, P.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)Demargne, A.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)Tung, C.; (Army Aviation Systems Command, Moffett Field, CA.)Gallman, J. M.; (Army Aviation Systems Command, Moffett Field, CA.)Yu, Y. H.; (Army Aviation Systems Command, Moffett Field, CA.)Kube, R.; (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.)and Vanderwall, B. G.; (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany.) et al In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 21 p Prepared in cooperation with Lockheed Engineering and Sciences Co., Hampton, VA (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

The paper presents a status of theoretical tools of AFDD, DLR, NASA and ONERA for prediction of the effect of HHC on helicopter main rotor BVI noise. Aeroacoustic predictions from the four research centers, concerning a wind tunnel simulation of a typical descent flight case without and with HHC are presented and compared. The results include blade deformation, geometry of interacting vortices, sec-

tional loads and noise. Acoustic predictions are compared to experimental data. An analysis of the results provides a first insight of the mechanisms by which HHC may affect BVI noise.
Author
Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Harmonic Control; Helicopters; Noise Measurement; Noise Prediction; Noise Reduction; Prediction Analysis Techniques; Rotary Wings; Rotor Aerodynamics; Wind Tunnel Tests;

N96-13615*# Maryland Univ., College Park, MD. Dept. of Aerospace Engineering.
The role and status of Euler solvers in impulsive rotor noise computations c01
Baeder, James D.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 16 p (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (NAG2-898; DAAL03-88-C-0002; DAAL03-92-G-0121) Copyright Avail: CASI HC A03/MF A04

Several recent applications (in the last five years) of Euler solvers in the computation of impulsive noise from rotor blades emphasize their emerging role in complementing other methods and experimental work. In the area of high-speed impulsive noise the use of Euler solvers as research tools has become fairly mature with very favorable comparisons with experimental data, especially in hover. The grid sizes and resulting computational times are reasonable when compared to those required for accurate surface aerodynamics alone. Furthermore, Euler solvers have provided a rich database with the resolution and accuracy needed for input to Kirchhoff and acoustic analogy methods for predicting the far-field noise. On the other hand, the application of Euler solvers to calculate blade-vortex interaction noise is still far from mature. The computational resources required for accurate calculations away from the blade are much larger than for high-speed impulsive noise. Current calculations help improve the basic understanding of the phenomena involved, but to date no comparisons with experiment have been made. Fortunately, the use of coupled Euler solver/Kirchhoff methods seems to offer promise for a robust and efficient technique for predicting both high-speed impulsive noise and blade-vortex interaction noise. Finally, a simple model problem of an isolated vortex interacting with an arbitrarily prescribed pitching airfoil demonstrates the feasibility of using Euler solvers to examine noise reduction techniques. The use of simple aerodynamic quasi-static theory and the computed lift time history as feedback to determine the required pitching motion appears sufficient to significantly dampen the unsteady loading and subsequent acoustics by an order of magnitude within a few blade passages.
Author
Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Computational Grids; Euler Equations of Motion; Far Fields; Helicopters; Hovering; Kirchhoff Law of Radiation; Noise Prediction (aircraft); Noise Reduction; Pressure Distribution; Rotor Aerodynamics; Rotor Blades;

N96-13617*# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.
Acoustic design of rotor blades using a genetic algorithm c01
Wells, V. L.; Han, A. Y.; and Crossley, W. A.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p Sponsored in cooperation with McDonnell-Douglas Helicopter Systems (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (NAG2-882) Copyright Avail: CASI HC A02/MF A04

A genetic algorithm coupled with a simplified acoustic analysis was used to generate low-noise rotor blade designs. The model includes thickness, steady loading and blade-vortex interaction noise estimates. The paper presents solutions for several variations in the fitness function, including thickness noise only, loading noise only, and combinations of the noise types. Preliminary results indicate that the analysis provides reasonable assessments of the noise produced, and that genetic algorithm successfully searches for 'good' designs. The results show that, for a given required thrust coefficient, proper blade design can noticeably reduce the noise produced at some expense to the power requirements.
Author
Aeroacoustics; Airfoil Profiles; Blade-vortex Interaction; Design Analysis; Genetic Algorithms; Helicopters; Low Noise; Noise Prediction; Noise Reduction; Rotor Blades;

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

N96-12110# Sandia National Labs., Albuquerque, NM.
Numerical simulation of supersonic wake flow with parallel computers
Wong, C. C.; and Soetrisno, M.; (Amtec Engineering, Inc., Bellevue, WA.) 1995 11 p Presented at the 13th Applied Aerodynamics Conference of the American Institute of Aeronautics and Astronautics, San Diego, CA, 19-22 Jun. 1995
Contract(s)/Grant(s): (DE-AC04-94AL-85000)
Report No.(s): (DE95-014878; SAND-94-2435C; CONF-950633-1) Avail: CASI HC A03/MF A01

Simulating a supersonic wake flow field behind a conical body is a computing intensive task. It requires a large number of computational cells to capture the dominant flow

physics and a robust numerical algorithm to obtain a reliable solution. High performance parallel computers with unique distributed processing and data storage capability can provide this need. They have larger computational memory and faster computing time than conventional vector computers. We apply the PINCA Navier-Stokes code to simulate a wind-tunnel supersonic wake experiment on Intel Gamma, Intel Paragon, and IBM SP2 parallel computers. These simulations are performed to study the mean flow in the near wake region of a sharp, 7-degree half-angle, adiabatic cone at Mach number 4.3 and freestream Reynolds number of 40,600. Overall the numerical solutions capture the general features of the hypersonic laminar wake flow and compare favorably with the wind tunnel data. With a refined and clustering grid distribution in the recirculation zone, the calculated location of the rear stagnation point is consistent with the 2D axisymmetric and 3D experiments. In this study, we also demonstrate the importance of having a large local memory capacity within a computer node and the effective utilization of the number of computer nodes to achieve good parallel performance when simulating a complex, large-scale wake flow problem.
DOE
Computerized Simulation; Conical Bodies; Free Flow; Laminar Wakes; Navier-stokes Equation; Parallel Computers; Supersonic Speed; Supersonic Wakes;

N96-12442 Illinois Univ., Urbana-Champaign, IL.
An experimental investigation of supersonic axisymmetric base flows including the effects of afterbody boattailing Ph.D. Thesis
Herrin, Jeff Lee; 1993 250 p Avail: Univ. Microfilms Order No. DA9411650

An experimental investigation of the near-wake flowfield downstream of blunt-based axisymmetric bodies in supersonic flow has been conducted. Two different axisymmetric afterbodies were examined: a circular cylinder was used as a baseline configuration, and a conical boattailed afterbody with a boattail angle of five degrees and a boattail length of one afterbody radius was used to investigate the effects of afterbody boattailing on the fluid dynamic processes in the near-wake. The primary objective of the research program was to enhance the understanding of the fluid dynamic processes inherent to axisymmetric base flows by obtaining and analyzing detailed, non-intrusive experimental data including flow visualization photographs, static pressure measurements, and mean velocity and turbulence data obtained throughout the near-wake of each afterbody with a laser Doppler velocimeter. The static pressure measurements on the base and afterbody of each model indicate a relatively constant pressure across the base with the addition of the boattail resulting in a decrease in the net afterbody drag coefficient of 21 percent from the baseline cylindrical afterbody. In general, the near-wake flowfield can be characterized by large turbulence levels in the separated shear layer, relatively large reverse velocities in the recirculation region, and gradual recompression/realignment processes as the shear layer converges on the axis of symmetry. Furthermore, the centered expansion at the base corner reduced the turbulence levels in the outer region of the shear layer relative to the approach boundary layer but enhanced the mixing and entrainment along the fluid-fluid interface between the shear layer and the recirculating region which results in large turbulence levels along the inner edge of the shear layer. In general, the effects of afterbody boattailing on the near-wake flowfield include a weaker expansion at the base corner separation point (less distortion of the shear layer and reduced turbulence production near the inner edge), reduced turbulence intensity and Reynolds shear stress levels throughout the near-wake (reduced mass entrainment in the shear layer resulting in a higher base pressure), and a mean velocity field which is qualitatively similar to that of the cylindrical afterbody.
Dissert. Abstr.
Afterbodies; Axisymmetric Bodies; Base Flow; Boattails; Flow Distribution; Near Wakes; Supersonic Flow;

N96-12563*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering.
Experimental investigation of the inlet detector configuration variation in the flow field at Mach 1.9 Final Report, period ended 31 May 1995
Hwang, Kyu C.; Tiwari, Surrendra N.; and Miley, Stanley J.; 1 Oct. 1995 142 p
Contract(s)/Grant(s): (NAG1-1556)
Report No.(s): (NASA-CR-199617; NAS 1.26:199617) Avail: CASI HC A07/MF A02

In recent years, active research has been conducted to study the technological feasibility of supersonic laminar flow control on the wing of the High Speed Civil Transport (HSCT). For this study, the F-16XL has been chosen due to its highly swept crank wing planform that closely resembles the HSCT configurations. During flights, it is discovered that the shock wave generated from the aircraft inlet introduces disturbances on the wing where the data acquisition is conducted. The flow field about a supersonic inlet is characterized by a complex three dimensional pattern of shock waves generated by the geometrical configuration of a deflector and a cowl lip. Hence, in this study, experimental method is employed to investigate the effects of the variation of deflector configuration on the flow field, and consequently, the possibility of diverting the incoming shock-disturbances away from the test section. In the present experiments, a model composed of a simple circular tube with a triangular deflector is designed to study the deflector length and the deflector base width variation in the flow field. Experimental results indicate that the lowest external pressure ratio is observed at the junction where the deflector lip and the inlet

cowl lip merge. Also, it is noted that the external pressure ratio, the internal pressure ratio, the coefficient of spillage drag, and the shock standoff distance decrease as the deflector length increases. In addition, the Redefined Total Pressure Recovery Ratio (RTPRR) increases with an increase in the deflector length. Results from the study of the effect of the deflector's base width variation on the flow field indicate that the lowest external pressure ratio is observed at the junction between the inlet cowl lip and the deflector lip. As the base width of the deflector increases, the external pressure ratio at 0 rotation increases, whereas the external pressure ratio at 180 rotation decreases. In addition, the internal pressure ratio and the coefficient of spillage drag decrease as the base width of the deflector increases. However, RTPRR and shock standoff distance increase as the base width increases. In conclusion, as deflector dimensions vary, distinctive patterns in the pressure variation around the inlet deflector are observed. With an increase in the deflector length and base width, the magnitude of shock-disturbances are weakened due to a decrease in the external pressure ratio. Also, as the deflector length and base width increase, a smaller bow shock angle is formed. Therefore, the inlet shock wave formation would be significantly altered, and consequently, shock disturbances on the wing test section can be avoided through appropriately designing the deflector.
Author
Civil Aviation; Deflectors; Engine Inlets; Flow Distribution; Laminar Flow; Pressure Effects; Pressure Ratio; Pressure Recovery; Shock Waves; Supersonic Flow; Supersonic Transports; Swept Wings; Wind Tunnel Tests;

N96-12607 Arizona State Univ., Tempe, AZ.
Unsteady aerodynamics of blade-blade interactions Ph.D. Thesis
Yao, Zhongxing; 1993 298 p Avail: Univ. Microfilms Order No. DA9411027

A time domain method has been developed for treatments of unsteady aerodynamics and vortex dynamics for all classes of blade-blade interaction problems. Extensive studies have been conducted on the airfoil-wake interaction (AWI) problem, the vortex-airfoil interaction (VAI) problem, the wake-airfoil interaction (WAI) problem, and the blade-blade interaction (BBI) problem. A newly introduced WAI problem is found instrumental in bridging the studies of the AWI problem through the VAI problem leading to the successful treatment of the BBI problem. A new 'vortex impingement' condition is introduced to improve the robustness of the discrete vortex tracking scheme and was found most effective in handling the interactions between vortex and airfoil for the VAI, WAI, and BBI problems. Various computed examples are presented for different classes of problems ranging from single airfoils to airfoils-in-tandem performing indicial or oscillatory motions. For verification, computed results are found to be in excellent agreement with all classical solutions. Also, good agreements are found between the computed results and those of the existing methods. From the present BBI study, it is concluded that any front blade movement will induce a strong interaction between the wake of the front blade and the rear blade (the front wake-rear blade interaction); hence, it alters drastically the system response and the wake structure. Any rear blade movement induces only weak interaction; hence, it remains nearly ineffective to the response. Comparative study of WAI and BBI results indicates that the effect of blade-blade interference is relatively insignificant in contrast to that of the shed front wake-rear blade interaction. As a result of the latter, a coplanar stationary blade placed in the rear of another blade in harmonic oscillation could generate considerable thrust. Consequently, the overall propulsive efficiency of this blade system increases. The present study verified this earlier finding and further concludes that the thrust and propulsive efficiency decrease with increasing blade thickness.
Dissert. Abstr.
Airfoils; Blade-vortex Interaction; Computational Fluid Dynamics; Interactional Aerodynamics; Rotor Aerodynamics; Rotor Stator Interactions; Unsteady Aerodynamics; Vortices; Wakes;

N96-12627*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
Preliminary airborne measurements for the SR-71 sonic boom propagation experiment
Haering, Jr., Edward A.; Ehernberger, L. J.; and Whitmore, Stephen A.; Sep. 1995 26 p Presented at the NASA High Speed Research Program Sonic Boom Workshop, Hampton, VA, 11-13 Sep. 1995
Contract(s)/Grant(s): (RTOP 537-03-21)
Report No.(s): (NASA-TM-104307; H-2068; NAS 1.15:104307) Avail: CASI HC A03/MF A01

SR-71 sonic boom signatures were measured to validate sonic boom propagation prediction codes. An SR-71 aircraft generated sonic booms from Mach 1.25 to Mach 1.6, at altitudes of 31,000 to 48,000 ft, and at various gross weights. An F-16XL aircraft measured the SR-71 near-field shock waves from close to the aircraft to more than 8,000 ft below, gathering 105 signatures. A YO-3A aircraft measured the SR-71 sonic booms from 21,000 to 38,000 feet below, recording 17 passes. The sonic booms at ground level and atmospheric data were recorded for each flight. Data analysis is underway. Preliminary results show that shock wave patterns and coalescence vary with SR-71 gross weight, Mach number, and altitude. For example, noncoalesced shock wave signatures were measured by the YO-3A at 21,000 ft below the SR-71 aircraft while at a low gross weight, Mach 1.25, and 31,000-ft altitude. This paper describes the design and execution of the flight research experiment. Instrumentation and

flight maneuvers of the SR-71, F-16XL, and YO-3A aircraft and sample sonic boom signatures are included.
Author
Flight Altitude; Flight Tests; Mach Number; Pressure Measurement; Sonic Booms; Sr-71 Aircraft; Supersonic Speed; Weight (mass);

N96-12743*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Reactively deposited aluminum oxide and fluoropolymer filled aluminum oxide protective coatings for polymers
Rutledge, Sharon K.; Banks, Bruce A.; and Hunt, Jason; (Ohio Aerospace Inst., Brook Park, OH.) Jun. 1995 12 p Presented at the 1995 Spring Meeting, San Francisco, CA, 17-21 Apr. 1995; sponsored by the Materials Research Society
Contract(s)/Grant(s): (RTOP 243-30-0A)
Report No.(s): (NASA-TM-106966; NAS 1.15:106966) Avail: CASI HC A03/MF A01

Reactive ion beam sputter deposition of aluminum simultaneous with low energy arrival of oxygen ions at the deposition surface enables the formation of highly transparent aluminum oxide films. Thick (12 200 A), adherent, low stress, reactively deposited aluminum oxide films were found to provide some abrasion resistance to polycarbonate substrates. The reactively deposited aluminum oxide films are also slightly more hydrophobic and more transmitting in the UV than aluminum oxide deposited from an aluminum oxide target. Simultaneous reactive sputter deposition of aluminum along with polytetrafluoroethylene (PTFE Teflon) produces fluoropolymer-filled aluminum oxide films which are lower in stress, about the same in transmittance, but more wetting than reactively deposited aluminum oxide films. Deposition properties, processes and potential applications for these coatings will be discussed.
Author
Abrasion Resistance; Aluminum Oxides; Fluoropolymers; Oxide Films; Protective Coatings; Transmittance;

N96-12778# Virginia Polytechnic Inst. and State Univ., Blacksburg, VA.
Hypersonic flow research on unstructured grids Final Report, Oct. 1991 - Oct. 1994
Walters, Robert W.; and Applebaum, Michael; 14 Dec. 1994 46 p
Contract(s)/Grant(s): (F49620-92-J-0085)
Report No.(s): (AD-A295388; AFOSR-95-0302TR) Avail: CASI HC A03/MF A01

The main accomplishments under this effort include development of numerical algorithms for solving the Navier Stokes equations with higher order spatial discretizations, a generalized thermochemical model, and a one equation turbulence model on unstructured meshes. This report focuses attention on the implementation of the thermochemical modeling, viscous fluxes, turbulence modeling, and higher order spatial discretizations. Solutions are presented for an equilibrium air nozzle, RAM II-C reentry probe, Aeroassist Flight Experiment, an analytic forebody, and the turbulent flow over a flat plate.
DTIC
Aerothermochemistry; Computational Fluid Dynamics; Hypersonic Flow; Navier-stokes Equation; Real Gases; Turbulence Models; Unstructured Grids (mathematics); Viscous Flow;

N96-12812 North Carolina Univ., Raleigh, NC.
Development of a time-accurate solution algorithm coupled to a dynamic solution-adaptive grid algorithm with applications to generic inlet/diffuser configurations Ph.D. Thesis
Benson, Rusty Allan; 1994 109 p Avail: Univ. Microfilms Order No. DA9417632

A conservation law for the governing equations of fluid flow on a moving mesh is derived. After discretization of the Navier Stokes equations using finite-volume assumptions, an explicit, multi-stage Runge-Kutta time-integration scheme is developed, with modifications to account for the movement of the nodes by a fully coupled dynamic solution-adaption algorithm such that temporal accuracy is retained. The inviscid fluxes are approximated using the Advective Upwind Split Method and the viscous fluxes are described using standard finite-volume central differencing techniques. The effects of turbulence are included using the one-equation model of Baldwin and Barth. A numerical experiment is performed to test the conservation properties of the solution methodology. Using model unsteady problems for which analytical solutions exist or for which the translation speed of unsteady features is known a priori, the ability of the dynamic solution-adaptive grid algorithm to resolve and track unsteady features of the flowfield in a time-accurate fashion is investigated. As a final test, the self excited oscillatory flow about a spike-nosed body is simulated using the developed scheme and a grid refinement study undertaken. The results of a spectral analysis of a pressure signal are compared with experiment for all cases simulated. With the method validated, the response of a generic inlet/diffuser subject to onset angle changes, perturbations in freestream conditions, and perturbations in diffuser exit conditions is examined. Two types of changes in conditions are considered, those which cause the inlet flowfield to transition to a new steady-state and those severe enough to induce the inlet to undergo a full unstart. Results, for the configurations tested, suggest that the unstart process is dominated by separations of the viscous layers due to shockwave/boundary layer interactions and that the classical unstart of a terminating normal shockwave translating through the inlet/diffuser

to be expelled out of the inlet does not occur in practical applications.
Dissert. Abstr.
Algorithms; Computational Fluid Dynamics; Conservation Laws; Finite Volume Method; Inlet Flow; Navier-stokes Equation; Runge-kutta Method; Upwind Schemes (mathematics);

N96-12971*# Cornell Univ., Ithaca, NY. School of Mechanical and Aerospace Engineering.
Multigrid methods for aerodynamic problems in complex geometries Final Report, 1 Jun. 1990 - 31 Oct. 1993
Caughey, David A.; 29 Jun. 1995 124 p
Contract(s)/Grant(s): (NAG2-665)
Report No.(s): (NASA-CR-199375; NAS 1.26:199375)
Avail: CASI HC A06/MF A02

Work has been directed at the development of efficient multigrid methods for the solution of aerodynamic problems involving complex geometries, including the development of computational methods for the solution of both inviscid and viscous transonic flow problems. The emphasis is on problems of complex, three-dimensional geometry. The methods developed are based upon finite-volume approximations to both the Euler and the Reynolds-Averaged Navier-Stokes equations. The methods are developed for use on multi-block grids using diagonalized implicit multigrid methods to achieve computational efficiency. The work is focused upon aerodynamic problems involving complex geometries, including advanced engine inlets.
Derived from text
Computational Fluid Dynamics; Engine Inlets; Euler Equations of Motion; Finite Volume Method; Inviscid Flow; Multiblock Grids; Multigrid Methods; Navier-stokes Equation; Three Dimensional Flow; Transonic Flow; Viscous Flow;

N96-12994*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A longitudinal aerodynamic data repeatability study for a commercial transport model test in the National Transonic Facility
Wahls, R. A.; Adcock, J. B.; Witkowski, D. P.; (Boeing Commercial Airplane Co., Seattle, WA.)and Wright, F. L.; (Boeing Commercial Airplane Co., Seattle, WA.) Aug. 1995 94 p
Report No.(s): (NASA-TP-3522; L-17412; NAS 1.60:3522)
Avail: CASI HC A05/MF A01

A high Reynolds number investigation of a commercial transport model was conducted in the National Transonic Facility (NTF) at Langley Research Center. This investigation was part of a cooperative effort to test a 0.03-scale model of a Boeing 767 airplane in the NTF over a Mach number range of 0.70 to 0.86 and a Reynolds number range of 2.38 to 40.0 x 10(exp 6) based on the mean aerodynamic chord. One of several specific objectives of the current investigation was to evaluate the level of data repeatability attainable in the NTF. Data repeatability studies were performed at a Mach number of 0.80 with Reynolds numbers of 2.38, 4.45, and 40.0 x 10(exp 6) and also at a Mach number of 0.70 with a Reynolds number of 40.0 x 10(exp 6). Many test procedures and data corrections are addressed in this report, but the data presented do not include corrections for wall interference, model support interference, or model aeroelastic effects. Application of corrections for these three effects would not affect the results of this study because the corrections are systematic in nature and are more appropriately classified as sources of bias error. The repeatability of the longitudinal stability-axis force and moment data has been accessed. Coefficients of lift, drag, and pitching moment are shown to repeat well within the pretest goals of plus or minus 0.005, plus or minus 0.0001, and plus or minus 0.001, respectively, at a 95-percent confidence level over both short- and near-term periods.
Author
Boeing 767 Aircraft; Confidence Limits; Error Analysis; High Reynolds Number; Mach Number; Statistical Analysis; Wind Tunnel Calibration; Wind Tunnel Tests;

N96-12999*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Separation characteristics of generic stores from lee side of an inclined flat plate at Mach 6
Wilcox, Jr., Floyd J.; May 1995 46 p
Contract(s)/Grant(s): (RTOP 505-59-30-01)
Report No.(s): (NASA-TM-4652; L-17384; NAS 1.15: 4652) Avail: CASI HC A03/MF A01

An experimental investigation was conducted to determine the aerodynamic characteristics of a store as it was separated from the lee side of a flat plate inclined at 15 deg to the free-stream flow at Mach 6. Two store models were tested: a cone cylinder and a roof delta. Force and moment data were obtained for both stores as they were moved in 0.5-in. increments away from the flat plate lee-side separated flow region into the free-stream flow while the store angle of attack was held constant at either 0 deg or 15 deg. The results indicate that both stores had adverse separation characteristics (i.e., negative normal force and pitching moment) at an angle of attack of 0 deg, and the cone cylinder had favorable separation characteristics (i.e., positive normal force and pitching moment) at an angle of attack of 15 deg. At an angle of attack of 15 deg, the separation characteristics of the roof delta are indeterminate at small separation distances and favorable at greater separation distances. These characteristics are the result of the local flow inclination relative to the stores as they traversed through the flat plate lee-side flow field. In addition to plotted data, force and moment data are tabulated and schlieren photographs of the stores and flat plate are presented.
Author

Aerodynamic Configurations; External Store Separation; External Stores; Flat Plates; Free Flow; Hypersonic Speed; Separated Flow;

N96-13016*# Maryland Univ., College Park, MD. Flight Dynamics and Control Lab.

Cooperative control theory and integrated flight and propulsion control Final Technical Report, 1990-1993

Schmidt, David K.; and Schierman, John D.; 25 Sep. 1995 144 p

Contract(s)/Grant(s): (NAG3-1575; NAG3-998)

Report No.(s): (NASA-CR-199418; NAS 1.26:199418) Avail: CASI HC A07/MF A02

The major contribution of this research was the exposition of the fact that airframe and engine interactions could be present, and their effects could include loss of stability and performance of the control systems. Also, the significance of two directional, as opposed to one-directional, coupling was identified and explained. A multivariable stability and performance analysis methodology was developed, and applied to several candidate aircraft configurations. In these example evaluations, the significance of these interactions was underscored. Also exposed was the fact that with interactions present along with some integrated control approaches, the engine command/limiting logic (which represents an important nonlinear component of the engine control system) can impact closed-loop airframe/engine system stability. Finally, a brief investigation of control-law synthesis techniques appropriate for the class of systems was pursued, and it was determined that multivariable techniques, including model-following formulations of LQG and/or H infinity methods, showed promise. However, for practical reasons, decentralized control architectures are preferred, which is an architecture incompatible with these synthesis methods. The major contributions of the second phase of the grant was the development of conditions under which no decentralized controller could achieve closed loop system requirements on stability and/or performance. Sought were conditions that depended only on properties of the plant and the requirement, and independent of any particular control law or synthesis approach. Therefore, they could be applied a priori, before synthesis of a candidate control law. Under this grant, such conditions were found regarding stability, and encouraging initial results were obtained regarding performance.

Derived from text

Aircraft Stability; Airframes; Control Theory; Controllability; Engine Airframe Integration; Engine Control; Flight Control; Propulsion; Stovl Aircraft; Systems Analysis;

N96-13017*# North Carolina State Univ., Raleigh, NC. Research Center.

Numerical simulation of supersonic and hypersonic inlet flow fields Final Report

McRae, D. Scott; and Kontinos, Dean A.; 21 Jul. 1995 40p

Contract(s)/Grant(s): (NCA2-719)

Report No.(s): (NASA-CR-199428; NAS 1.26:199428) Avail: CASI HC A03/MF A01

This report summarizes the research performed by North Carolina State University and NASA Ames Research Center under Cooperative Agreement NCA2-719, 'Numerical Simulation of Supersonic and Hypersonic Inlet Flow Fields". Four distinct rotated upwind schemes were developed and investigated to determine accuracy and practicality. The scheme found to have the best combination of attributes, including reduction to grid alignment with no rotation, was the cell centered non-orthogonal (CCNO) scheme. In 2D, the CCNO scheme improved rotation when flux interpolation was extended to second order. In 3D, improvements were less dramatic in all cases, with second order flux interpolation showing the least improvement over grid aligned upwinding. The reduction in improvement is attributed to uncertainty in determining optimum rotation angle and difficulty in performing accurate and efficient interpolation of the angle in 3D. The CCNO rotational technique will prove very useful for increasing accuracy when second order interpolation is not appropriate and will materially improve inlet flow solutions.

Author

Algorithms; Computational Fluid Dynamics; Computational Grids; Flow Distribution; Grid Generation (mathematics); Hypersonic Inlets; Inlet Flow; Inviscid Flow; Supersonic Inlets; Three Dimensional Flow; Upwind Schemes (mathematics);

N96-13040*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

The 3-D wake measurements near a hovering rotor for determining profile and induced drag

McAlister, K. W.; Schuler, C. A.; (Aerometrics, Inc., Sunnyvale, CA.)Branum, L.; and Wu, J. C.; (Georgia Inst. of Tech., Atlanta, GA.) Aug. 1995 70 p

Contract(s)/Grant(s): (RTOP 505-59-87)

Report No.(s): (NASA-TP-3577; A-950078; NAS 1.60: 3577; ATCOM-TR-95-A-006) Avail: CASI HC A04/ MF A01

Primarily an experimental effort, this study focuses on the velocity and vorticity fields in the near wake of a hovering rotor. Drag terminology is reviewed, and the theory for separately determining the profile-and-induced-drag components from wake quantities is introduced. Instantaneous visualizations of the flow field are used to center the laser velocimeter (LV) measurements on the vortex core and to assess the extent of the positional mandering of the trailing vortex. Velocity profiles obtained at different rotor speeds and distances behind the rotor blade clearly indicate the position, size, and rate of movement of the wake sheet and the core of the trailing vortex. The results also show the distribu-

tion of vorticity along the wake sheet and within the trailing vortex.
Author
Flow Velocity; Hovering; Induced Drag; Near Wakes; Rotor Dynamics; Rotors; Three Dimensional Flow; Vortices;

N96-13114# National Renewable Energy Lab., Golden, CO.
The baseline data sets for phase 2 of the combined experiment
Miller, M. S.; Shipley, D. E.; Young, T. S.; Robinson, M. C.; Luttges, M. W.; and Simms, D. A.; Jul. 1995 26 p
Contract(s)/Grant(s): (DE-AC36-83CH-10093)
Report No.(s): (DE95-009271; NREL/TP-442-6915) Avail: CASI HC A03/MF A01

The National Renewable Energy Laboratory's Combined Experiment was initiated to provide an understanding of horizontal axis wind turbine aerodynamics and their effect on the turbine structure. To this end, aerodynamic and structural baseline data sets have been defined that examine turbine performance under certain conditions. These baseline results have been discussed thoroughly in several papers. This report is an addendum to those papers and supplies additional information about the data selected in creating the baseline data sets. Several appendices are included which contain the tape and cycle numbers of the selected data, along with the average and standard deviation values for the inflow conditions, velocity, and yaw.
DOE
Aerodynamic Loads; Rotor Aerodynamics; Turbine Blades; Wind Turbines;

N96-13159*# Worcester Polytechnic Inst., MA. Dept. of Mechanical Engineering.
Delta wing vortex manipulation using pulsed and steady blowing during ramp pitching
Moreira, J.; and Johari, H.; 1 Jan. 1995 11 p Presented in unidentified conference proceeding, United States
Contract(s)/Grant(s): (NAGW-4290)
Report No.(s): (NIPS-95-05494; NASA-CR-199624; NAS 1.26:199624; AIAA PAPER 95-1817-CP) Avail: CASI HC A03/MF A01

The effectiveness of steady and pulsed blowing as a method of controlling delta wing vortices during ramp pitching has been investigated in flow visualization experiments conducted in a water tunnel. The recessed angled spanwise blowing technique was utilized for vortex manipulation. This technique was implemented on a beveled 60 delta wing using a pair of blowing ports located beneath the vortex core at 40% chord. The flow was injected primarily in the spanwise direction but was also composed of a component normal to the wing surface. The location of vortex burst was measured as a function of blowing intensity and pulsing frequency under static conditions, and the optimum blowing case was applied at three different wing pitching rates. Experimental results have shown that, when the burst location is upstream of the blowing port, pulsed blowing delays vortex breakdown in static and dynamic cases. Dynamic tests verified the existence of a hysteresis effect and demonstrated the improvements offered by pulsed blowing over both steady blowing and no-blowing scenarios. The application of blowing, at the optimum pulsing frequency, made the vortex breakdown location comparable in static and ramp pitch-up conditions.
Author
Angle of Attack; Delta Wings; Spanwise Blowing; Vortex Breakdown; Water Tunnel Tests;

N96-13204# Air Force Academy, CO.
Unsteady aerodynamics: Work unit 2300-FF-07 Final Report, Oct. 1991 - Sep. 1995
Stephen, Eric J.; Sep. 1995 113 p
Contract(s)/Grant(s): (AF PROJ. 2300)
Report No.(s): (AD-A294782; FJSRL-TR-95-0004) Avail: CASI HC A06/MF A02

This task addressed basic research to better understand unsteady, separated flows and to utilize this understanding to develop innovative concepts to control unsteady aerodynamic phenomena to enhance flight vehicle maneuverability. This effort sought to expand the flight performance boundaries by developing a capability to maneuver in the high-angle-of-attack, post-stall flight regime. The research was organized around two broad topical areas: (1) understanding and predicting the dynamics of unsteady, separated flows, and (2) controlling unsteady, separated flows to enhance aerodynamic performance. Several types of flow fields were studied to gain an understanding of unsteady, separated flows. These included flow over rectangular wings, flow over delta wing, flow over forebodies and flow in the vicinity of the tail on a fighter type aircraft. The studies were both computational and experimental. Control efforts focused on the pulsed blowing to maintain attached flow, continuous blowing to control vortex breakdown on delta wing, and the use of neural networks to predict and control unsteady aerodynamic forces.
DTIC
Aerodynamic Forces; Angle of Attack; Computational Fluid Dynamics; Delta Wings; Fighter Aircraft; Flow Distribution; Forebodies; Navier-stokes Equation; Pressure Distribution; Rectangular Wings; Separated Flow; Three Dimensional Flow; Unsteady Aerodynamics; Unsteady Flow;

N96-13249*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Low-speed longitudinal aerodynamic characteristics through poststall for 21 novel planform shapes
Gatlin, Gregory M.; and McGrath, Brian E.; (Lockheed

Engineering and Sciences Co., Hampton, VA.) Aug. 1995 116 p
Contract(s)/Grant(s): (RTOP 505-68-70-04)
Report No.(s): (NASA-TP-3503; L-17301; NAS 1.60:3503) Avail: CASI HC A06/MF A02

To identify planform characteristics which have promise for a highly maneuverable vehicle, an investigation was conducted in the Langley Subsonic Basic Research Tunnel to determine the low-speed longitudinal aerodynamics of 21 planform geometries. Concepts studied included twin bodies, double wings, cutout wings, and serrated forebodies. The planform models tested were all 1/4-in.-thick flat plates with beveled edges on the lower surface to ensure uniform flow separation at angle of attack. A 1.0-in.-diameter cylindrical metric body with a hemispherical nose was used to house the six-component strain gauge balance for each configuration. Aerodynamic force and moment data were obtained across an angle-of-attack range of 0 to 70 deg with zero sideslip at a free-stream dynamic pressure of 30 psf. Surface flow visualization studies were also conducted on selected configurations using fluorescent minitufts. Results from the investigation indicate that a cutout wing planform can improve lift characteristics; however, cutout size, shape, and position and wing leading-edge sweep will all influence the effectiveness of the cutout configuration. Tests of serrated forebodies identified this concept as an extremely effective means of improving configuration lift characteristics; increases of up to 25 percent in the value of maximum lift coefficient were obtained.
Author
Aerodynamic Characteristics; Angle of Attack; Flow Visualization; Forebodies; Highly Maneuverable Aircraft; Lift; Low Aspect Ratio Wings; Low Speed; Pitching Moments; Swept Wings; Wind Tunnel Tests; Wing Planforms;

N96-13346*# Eloret Corp., Palo Alto, CA.
Hypersonic flows as related to the National Aerospace Plane Final Technical Report, 1 Feb. 1987 - 31 Jan. 1995
Kussoy, Marvin; Huang, George; and Menter, Florian; 9 May 1995 24 p
Contract(s)/Grant(s): (NCC2-452)
Report No.(s): (NASA-CR-199365; NAS 1.26:199365) Avail: CASI HC A03/MF A01

The object of Cooperative Agreement NCC2-452 was to identify, develop, and document reliable turbulence models for incorporation into CFD codes, which would then subsequently be incorporated into numerical design procedures for the NASP and any other hypersonic vehicles. In a two-pronged effort, consisting of an experimental and a theoretical approach, several key features of flows over complex vehicles were identified, and test bodies were designed which were composed of simple geometric shapes over which these flow features were measured. The experiments were conducted in the 3.5' Hypersonic Wind Tunnel at NASA Ames Research Center, at nominal Mach numbers from 7 to 8.3 and Re/m from 4.9 x 10(exp 6) to 5.8 x 10(exp 6). Boundary layers approaching the interaction region were 2.5 to 3.7 cm thick. Surface and flow field measurements were conducted, and the initial boundary conditions were experimentally documented.
Author
Aerospace Planes; Boundary Layers; Computational Fluid Dynamics; Flow Distribution; Flow Measurement; Hypersonic Flow; Hypersonic Speed; Shock Wave Interaction; Turbulence Models; Wind Tunnel Tests;

N96-13585# Naval Postgraduate School, Monterey, CA. Navy-NASA Joint Inst. of Aeronautics.
Compressibility effects on dynamic stall of oscillating airfoils c02
Chandrasekhara, M. S.; and Carr, L. W.; (Army Aviation Systems Command, Moffett Field, CA.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 15p Sponsored in cooperation with AFOSR (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (ARO-MIPR-114-91; ARO-MIPR-132-92; ARO-MIPR-125-93) Copyright Avail: CASI HC A03/MF A04

A review of experimental results from an ongoing study of the effects of compressibility on dynamic stall of an oscillating NACA 0012 airfoil is presented. The study shows that compressibility effects become significant at a free stream Mach number of 0.3. Dynamic stall is accelerated above this Mach number, but increasing unsteadiness delays onset of stall even under compressible flow conditions. Interferometric images of the flow show that process of dynamic stall occurs rapidly over a small angle of attack range. For certain flow conditions, multiple shocks form in the flow near the airfoil leading edge. The delay of stall has been shown to be due to delayed development combined with modification of the adverse pressure gradient in the flow. Transition has been shown to significantly modify the observed flow behavior, and thus is a very important factor to be considered, especially since it occurs near the vortex formation location. Proper modelling of its effects is critical to dynamic stall flow computations.
Author
Aerodynamic Stalling; Airfoils; Angle of Attack; Compressibility Effects; Compressible Flow; Computational Fluid Dynamics; Flow Distribution; Helicopters; Leading Edges; Pressure Gradients; Rotor Aerodynamics; Subsonic Speed;

N96-13586# Turkish Aerospace Industries, Ankara (Turkey). Advanced Design Dept.
Effect of turbulence modeling on dynamic stall computations c02
Dindar, Mustafa; and Kaynak, Unver; In AGARD, Aerody-

namics and Aeroacoustics of Rotorcraft Aug. 1995 11 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

Dynamic stall phenomenon was studied numerically to investigate effects of turbulence modeling. An unsteady Navier-Stokes code capable of solving flow field around an airfoil undergoing unsteady harmonic motion was used for this purpose. A comparative study conducted between equilibrium and nonequilibrium turbulence models. It was found that, nonequilibrium effects play an important role in determining the separation and vortex shedding mechanisms of dynamic stall. First of all, in light stall, inadequacy of equilibrium models defeated by including nonequilibrium effects, and only Johnson-King model could be able to produce light stall hysteresis loop that is similar to experiment. Secondly, in the deep stall regime, vortex shedding mechanism was found to be greatly influenced by turbulence model.

Author

Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Flow Distribution; Helicopters; Navier-stokes Equation; Rotor Aerodynamics; Turbulence Models; Vortex Shedding;

N96-13587# Mil Moscow Helicopter Plant, Moscow (Russia). Aerodynamics Section.

Investigation into effect produced by blade airfoil unsteady airflow on helicopter main rotor power required c02

Ivtchin, V. A.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 8 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

The paper presents the results obtained from the analysis of experimental data on the profile drag for pitch oscillating airfoils, as well as the technique developed for application of these data in calculations of helicopter main and tail rotors. The effect of the unsteady airflow on the profile drag was not taken into account. The reason is that it is very difficult to obtain experimental data. The existing analytical techniques of obtaining unsteady airfoil aerodynamic characteristics in a drained wing section allowed to determine only an average per cycle value of the profile drag. The problem of defining the profile drag of pitch oscillating airfoils has been more completely solved by V.E. Baskin. He has developed and successfully applied his unique method of defining aerodynamic characteristics of airfoils oscillating in the airflow. This approach has allowed to determine not only the pitch moment and lift values, but the instantaneous value of the profile drag as well. The data obtained from the experiments has been used to develop a method capable of calculating rotor shaft horsepower with due account of the profile drag characteristics. The analysis for forward flight conditions has been made by using the main rotor disc vortex theory. It has taken due account of the values of the pitch oscillating airfoil lift coefficient as well. The paper presents comparison of the instantaneous profile drag values versus the angle of attack data obtained from calculations and experiments.

Author

Aerodynamic Drag; Air Flow; Airfoils; Angle of Attack; Helicopters; Rotor Aerodynamics; Unsteady Aerodynamics; Unsteady Flow;

N96-13588# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Inst. of Fluid Mechanics.

Dynamic stall control by variable airfoil camber c02

Geissler, W.; and Sobieczky, H.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

In the present numerical investigations the unsteady flow about a helicopter airfoil section under deep dynamic stall conditions has been influenced by dynamic airfoil deformation. First attempts with a dynamic variation of the airfoil thickness have already shown the favorable effects on the dynamic stall phenomenon: the dynamic stall onset could be shifted to considerably higher incidences within the oscillatory loop. In the present paper the extension of this method to more arbitrary types of dynamic deformations is discussed and the influence of a dynamic change of he airfoil leading edge curvature (nose droop) is investigated in detail. Special emphasis is placed on the variation of the Mach number. It is shown that for incompressible flow (M-alpha(sub infinity) = 0.1) the shedding of a dynamic stall vortex can be avoided at all. At a slightly higher Mach number (M-alpha(sub infinity) = 0.3) however the complete suppression of the dynamic stall vortex is a much more difficult task. The present results show the way how to proceed successfully also in the compressible flow cases. Further is is obvious that the concept of deforming airfoils has considerable potential in other areas of helicopter aerodynamics, i.e. reduce or even avoid shock motion on the advancing side and therefore reduce the problem of compressibility noise radiation.

Author

Aerodynamic Stalling; Airfoils; Camber; Compressible Flow; Computational Fluid Dynamics; Grid Generation (mathematics); Helicopters; Leading Edges; Mach Number; Navier-stokes Equation; Rotor Aerodynamics; Unsteady Aerodynamics; Unsteady Flow; Vortex Shedding;

N96-13589# Netherlands Energy Research Foundation, Petten (Netherlands).

Review of recent aerodynamic research on wind turbines with relevance to rotorcraft. Data (and riddles) on dynamic inflow, flow field of yawed rotors, and rotating 3-D stall c02

Snel, H.; and Vanholten, TH.; (Technische Univ., Delft, Netherlands.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 11 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

A review is given of recent research on the aerodynamics of wind turbine rotors. The following subjects are covered in detail: (1) The induced velocity field of rotors, including dynamic inflow and yawed flow effects; and (2) Stall delay on rotation blades. A new boundary layer formulation is outlined applicable to this phenomenon. Without any further discussion, also some references have been given concerning recent wind turbine research on: (1) simulation methods of atmospheric turbulence; (2) dynamic stall effects, comparisons between theory and experiments; and (3) effect of several types of blade tips on radiated noise.
Author

Axial Flow; Boundary Layers; Flow Distribution; Pressure Distribution; Rotating Stalls; Rotor Aerodynamics; Turbine Blades; Velocity Distribution; Wind Turbines; Yawing Moments;

N96-13590# Arrow Research, Montreal (Quebec).

Dynamic stall simulation applied to vertical-axis wind turbines c02

Tchon, Ko Foa; Halle, S.; (Ecole Polytechnique, Montreal, Quebec.)and Paraschivoiu, Ion; (Ecole Polytechnique, Montreal, Quebec.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p (For primary document see N96-13582 02-01)

Contract(s)/Grant(s): (EMRC-23440-0-9457/01-SS) Copyright Avail: CASI HC A02/MF A04

The dynamic stall on a NACA 0015 airfoil performing a rotation motion characteristic of Darrieus vertical-axis wind turbines is simulated using laminar and turbulent Navier-Stokes solvers. The numerical results are compared with experimental data and show the importance of an adequate turbulence model to realistically simulate such a phenomenon. The differences between a Darrieus rotation motion and a pure pitching motion are also discussed.
Author

Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Finite Element Method; Grid Generation (mathematics); Navier-stokes Equation; Pressure Distribution; Rotor Aerodynamics; Turbulence Models; Turbulent Flow; Velocity Distribution; Wind Turbines;

N96-13591# Risoe National Lab., Roskilde (Denmark). Test Station for Wind Turbines.

Stall hysteresis and 3D effects on stall regulated wind turbines: Experiment and modelling c02

Madsen, H. A.; and Rasmussen, F.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 9 p Sponsored by the Danish Ministry of Energy (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

The stall regulation is used for control of maximum power and loads on a major part of wind turbines today of sizes up to 50-60 m in diameter. Operation with the blades partially or fully stalled is for this type of machines a part of their normal operating regime. Aeroelastic calculations below stall using 2D airfoil data give satisfactory results but in stall and above stall the calculations indicate self excited flapwise vibrations. Fortunately, they are not in general confirmed by measurements. This discrepancy seems to be due to dynamic stall effects and the 3D airfoil characteristics for the rotating blade. Such airfoil characteristics have been measured on a 19 m stall regulated rotor and the deviations from 2D data are considerable. High normal force coefficients are measured at the root end and the lift curve has no negative slope up to 25-30 deg. angle of attack. Considerable stall hysteresis has been measured in normal operation and in particular during yawed operations. Measurements in a 4x4 m wind tunnel on the same blade has been carried ot in order to determine the airfoil characteristics without the influence of rotation. This comparison indicates that rotational effects are of some importance for the discrepancy between 2D and 3D data. A CFD calculation on a simplified model of a rotating blade and at a low Reynolds number indicates that rotation does reduce the thickness of the separated boundary layer, resulting in the increased lift. Although the use of a stall hysteresis model in aeroelastic calculations generates damping and eliminates the selfexcited vibrations, the problem still is to predict dynamic stall events, which have the correct power spectral characteristics.
Author

Aerodynamic Stalling; Aeroelasticity; Airfoils; Angle of Attack; Boundary Layer Separation; Computational Fluid Dynamics; Grid Generation (mathematics); Low Reynolds Number; Rotor Aerodynamics; Turbine Blades; Unsteady Flow; Wind Tunnel Tests; Wind Turbines;

N96-13593# National Technical Univ., Athens (Greece). Dept. of Mechanical Engineering.

Investigation of the yawed operation of wind turbines by means of a vortex particle method c02

Voutsinas, S. G.; Belessis, M. A.; and Rados, K. G.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 11 p (For primary document see N96-13582 02-01)

Contract(s)/Grant(s): (JOU2-CT92-0186; JOU2-CT92-0113) Copyright Avail: CASI HC A03/MF A04

A fully three-dimensional non-linear aeroelastic numerical investigation of the response of horizontal axis wind turbines during yawed operation was carried out. The numerical tool used, consists of a time-marching method based on the coupling of an unsteady free-wake vortex particle model and a 3D beam-type structural model. The investigation led

to a complete data base of numerical results concerning the Tjaereborg wind turbine for which extensive full scale measurements of very good quality exist. Among the points that were given particular attention are: the effect of the root vortex, the coupling with the shear of the inflow and the tower effect on the dynamics of the blades. Herein the most significant results are presented and discussed.
Author
Aeroelasticity; Computational Fluid Dynamics; Flow Distribution; Grid Generation (mathematics); Rotor Aerodynamics; Time Marching; Turbine Blades; Unsteady Flow; Velocity Distribution; Vortices; Wind Turbines; Yaw;

N96-13594# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
Methods for computation applied to helicopter rotors by ONERA [Methodes de calcul aerodynamique appliquess aux rotors d'helicopteres a l'ONERA] c02
Costes, M.; Beaumier, P.; Gardarein, P.; and Zibi, J.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 15 p In FRENCH (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

This paper presents the aerodynamic methods which are used currently at the Applied Aerodynamics Department of ONERA for the computation of helicopter rotors in hover and forward flight. They cover a wide range of algorithms, from classical blade element theory to more complex unsteady three-dimensional methods, each of them being well adapted to deal with a particular problem related to the helicopter main rotor. Typical applications for blade loads and dynamics, wake geometry, pressure distribution, performance prediction and parametric optimization are shown. Finally, the future trends in terms of CFD applications in the field of helicopter rotors at ONERA are given.
Author
Computational Fluid Dynamics; Grid Generation (mathematics); Helicopters; Horizontal Flight; Hovering; Pressure Distribution; Rotor Aerodynamics; Unsteady Flow;

N96-13595# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. of Design Aerodynamics.
Three-D Euler calculations of multibladed rotors in hover: Investigation of the wake capturing properties c02
Raddatz, J.; and Pahlke, K.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 16 p (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (IMT PROJ. AERO-2017/2060; PROJ. HELISHAPE) Copyright Avail: CASI HC A03/MF A04

The 3D flowfield of a hovering rotor is calculated solving the Euler equations. Performing a grid refinement study it is demonstrated that an Euler method is able to capture the wake and vortices of a hovering rotor without any wake modelling. Accurate prediction of these rotational flow field phenomena needs fine grids with a high resolution in the complete region of the wake system. Additionally, high accuracy for the treatment of all numerical boundaries, which affect the vortex wake, is required. On the other hand, the investigations have shown that surface airloads are less effected by a more detailed resolution of the wake system. A second part of the study is concerned with wake capturing properties on block boundaries, especially on inner boundaries of overlapping grids. Overlapping grids are very attractive for the computation of a rotor in lifting forward flight or a rotor-body flowfield in hover. The effect of overlapping grids using the chimera technique is investigated comparing Euler solutions for a hovering rotor on a chimera grid system and on conventional single block and two block calculations. The chimera solution reproduces all flow features. The present implementation shows disadvantages concerning the detailed resolution of the wake system.
Author
Computational Fluid Dynamics; Computational Grids; Euler Equations of Motion; Flow Distribution; Flow Visualization; Grid Generation (mathematics); Helicopter Wakes; Helicopters; Hovering; Navier-stokes Equation; Rotor Aerodynamics; Runge-kutta Method; Vortices;

N96-13598# Stuttgart Univ. (Germany). Inst. fuer Aerodynamik und Gasdynamik.
Cost efficient calculation of compressible potential flow around a helicopter rotor including free vortex sheet by a field panel method c02
Roettgermann, A.; and Wagner, S.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (DFG-WA424/8) Copyright Avail: CASI HC A02/MF A04

To consider compressible transonic effects a vortex lattice method for the computation of the rotor flow is coupled with a field panel method. For this purpose Cartesian grids are used which are not adapted to the contour and only discretize the domain of the nonlinear flow. The basis for this procedure is the separation of the full potential equation into the Laplacian operator and the nonlinear terms. The developed program ROFPM is validated at several test cases of the CARADONNA rotor.
Author
Blade-vortex Interaction; Compressible Flow; Computational Fluid Dynamics; Computational Grids; Helicopters; Panel Method (fluid Dynamics); Potential Flow; Rotary

Wings; Rotor Aerodynamics; Transonic Flow; Vortex Lattice Method; Vortex Sheets;

N96-13599# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

Evaluation of aerodynamic and dynamic models of the rotors of helicopters by confrontation to the experiment [Evaluation de modeles aerodynamiques et dynamiques des rotors d'helicopteres par confrontation a l'experience] c02

Bessone, J.; and Petot, D.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 9 p In FRENCH (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

This article presents the code of research 'ROTOR' developed with the ONERA and applied to the aeroelastic study of the rotors of helicopters. Confrontations of ROTOR with the experiment are then addressed. The core of the code calculates the equations of Lagrange associated with the rotor. Around various modules appear: methods of resolution, dynamic and aerodynamic models, formulations induced speeds. The structure of the rotor is regarded as a succession of basic transformations and the originality of ROTOR lies in the direct and automatic writing of the equations in matrix form. The confrontation of ROTOR with the experiment, first of all, showed the need for a very realistic modeling of the swirling wake. Locally, the dynamic model of stall ONERA clarifies very well the phenomenon of stall, improves calculations appreciably, but does not always allow to reach the experimental lift. The introduction into ROTOR of the semi-empirical correction of Houwink reduces the deficit of lift in the area of the strong stalls. Moreover, at the time of preliminary results, the models of Hopf reveal the oscillatory phenomena of the lift observed in experiments in this area. But the use of non-rectangular tips of blade will require, for the calculation of the effort aerodynamics buildings and of the deformations of blade, a finer analysis of the three-dimensional effects of end that only an aerodynamics of the CFD type seems to be able to estimate correctly.

Author

Aerodynamic Stalling; Aeroelasticity; Applications Programs (computers); Helicopters; Lift; Rotary Wings; Rotor Aerodynamics; Turbulent Wakes;

N96-13605# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany). Inst. for Fluid Mechanics.

Flow field investigation of a rotating helicopter rotor blade by three-component laser-Doppler-velocimetry c02

Seelhorst, U.; Beesten, B. M. J.; (Technische Univ., Aachen, Germany.)and Buetefisch, K. A.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 12 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

The measurement of three dimensional local flow vectors of a blade tip vortex at positions near the helicopter rotor plane were performed with a three component laser-Doppler-velocimeter (3D LDV). A 'position monitoring system' synchronized to the blade rotation gave access to blade motion parameters like lead-lag and pitching at the desired radial position of the blade. Mainly results concerning the structure of blade tip vortices were obtained. The measurements of a vortex generated at hover condition showed the correctness of 'time history' data acquisition, e.g. taking data during the time interval when one particular blade is passing the location of the measuring volume of the LDV. Vortex structure measurements at two different blade tips, a regular square tip for reference and a non-planar tip called winglet, were carried out. First of all the influence of the winglets on vortex structure and blade vortex interaction (BVI) has been investigated. Then in addition to the vortex parameters like vortex/blade miss distance, vortex core size, axial velocity deficit, vortex strength, and vorticity distribution with respect to the spatial orientation of the vortex axis, results on 3D-vorticity distribution and the temporal vortex roll up for the different blade tip vortices have been obtained. Author

Blade Tips; Blade-vortex Interaction; Flight Simulation; Flow Distribution; Horizontal Flight; Hovering; Rotary Wing Aircraft; Rotary Wings; Three Dimensional Flow; Vorticity; Wind Tunnel Tests;

N96-13610# Rome Univ., Rome (Italy). Dipt. di Meccaca e Automatica

A boundary integral method for unified transonic aerodynamic and aeroacoustic analysis of hovering rotors c02

Gennaretti, M.; Iemma, U.; and Morino, L.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p Sponsored by Agusta Eli S.p.A. (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

The subject of this paper is the unified aerodynamic and aeroacoustic analysis of transonic hovering rotors. The aerodynamic/aeroacoustic problem is stated in terms of the velocity potential, whereas the solution is determined by applying a shock-capturing boundary integral formulation. Particular emphasis is given to the analysis of the non-linear terms in the equation for the velocity potential, whose contribution cannot be neglected for the transonic flow case analysis. Their contribution is expressed in a conservative form. Starting from the solution for the potential, the Bernoulli theorem is used to determine both the pressure distribution on the body surface (aerodynamic solution) and the acoustic pressure in the field (aeroacoustic solution). Numerical results are presented in order to show the capability of the methodology in determining both the aerodynamic

and aeroacoustic solutions for transonic rotor configurations.
Author
Aeroacoustics; Bernoulli Theorem; Boundary Integral Method; Dynamic Pressure; Helicopters; Hovering; Potential Flow; Pressure Distribution; Rotor Aerodynamics; Rotor Blades; Sound Pressure; Transonic Flow;

N96-13896# Technical Univ. of Munich, Muchen (Germany).
Separation of lifting vehicles at hypersonic speed wind tunnel tests and flight dynamics simulation c02
Sachs, G.; Schoder, W.; and Kraus, W.; (Deutsche Aerospace A.G., Munich, Germany.) In AGARD, Space Systems Design and Development Testing Mar. 1995 8 p (For primary document see N96-13891 02-18) Copyright Avail: CASI HC A02/MF A03

Several topics of the separation maneuver of two-stage hypersonic vehicles are considered. Results which have been obtained from wind tunnel tests of the separation maneuver and related investigations on flight dynamics will be presented. In test facilities of DLR (Cologne), the aerodynamics characteristics of a two-stage space transportation system were investigated. The test campaign was focused on aerodynamic interference effects which exist when the two stages are in close proximity. The results of the wind tunnel tests provide a detailed data base for flight mechanics investigations. Numerical simulation of flight dynamics based on a well founded aerodynamics model is an appropriate technique to investigate such a highly dynamic maneuver. Control of both vehicles for achieving an optimal motion of the system is investigated. In addition, adequate stability and control characteristics from a piloting point of view are considered. Particular emphasis is put on a robust control technique. This is because robust control is an adequate means for dealing with a system which shows great changes. During close proximity of the first and orbital stages, system changes are due to the separation maneuver itself because of aerodynamic interference effects.
Author
Aerodynamics; Flight Simulation; Hypersonic Speed; Hypersonic Vehicles; Lifting Bodies; Space Transportation System; Wind Tunnel Tests;

N96-14003*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
Design and development of an F/A-18 inlet distortion rake: A cost and time saving solution
Yuhas, Andrew J.; (Planning Research Corp., Edwards, CA.)Ray, Ronald J.; Burley, Richard R.; (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.)Steenken, William G.; (General Electric Co., Evendale, OH.)Lechtenberg, Leon; (General Electric Co., Evendale, OH.)and Thornton, Don; (General Electric Co., Evendale, OH.) 1 Oct. 1995 22 p Presented at the 7th Biennial AIAA Flight Test Conference, Colorado Springs, CO, United States, 20-23 Jun. 1994
Contract(s)/Grant(s): (RTOP 505-68-00)
Report No.(s): (NASA-TM-4722; NAS 1.15:4722; H-2078; AIAA PAPER 94-2132; NIPS-95-05907) Avail: CASI HC A03/MF A01

An innovative inlet total pressure distortion measurement rake has been designed and developed for the F/A-18 A/B/C/D aircraft inlet. The design was conceived by NASA and General Electric Aircraft Engines personnel. This rake has been flight qualified and flown in the F/A-18 High Alpha Research Vehicle at NASA Dryden Flight Research Center, Edwards, California. The eight-legged, one-piece, wagon wheel design of the rake was developed at a reduced cost and offered reduced installation time compared to traditional designs. The rake features 40 dual-measurement ports for low- and high-frequency pressure measurements with the high-frequency transducer mounted at the port. This high-frequency transducer offers direct absolute pressure measurements from low to high frequencies of interest, thereby allowing the rake to be used during highly dynamic aircraft maneuvers. Outstanding structural characteristics are inherent to the design through its construction and use of lightweight materials.
Author
Aircraft Engines; Engine Inlets; F-18 Aircraft; Flow Measurement; Inlet Flow; Inlet Pressure; Pressure Measurement;

N96-14024# Lehigh Univ., Bethlehem, PA. Dept. of Mechanical Engineering and Mechanics.
Structure and control of three-dimensional unsteady flow in delta wings at high angle-of-attack Final Report, 15 Nov. 1993 - 14 Nov. 1994
Rockwell, Donald; 22 Mar. 1995 8 p
Contract(s)/Grant(s): (F49620-94-1-0038)
Report No.(s): (AD-A297517; AFOSR-95-0275TR) Avail: CASI HC A02/MF A01

This program has focused on the instantaneous flow structure generated by controlled motion of wings in the pitching and rolling modes, as well as application of local control techniques for mediating the flow structure. The instantaneous flow structure is characterized using high-image-density particle image velocimetry, in conjunction with new types of two and three dimensional imaging techniques. This approach provides instantaneous velocity fields, streamline patterns and vorticity distributions at crucial locations in the flow field and allows a proper basis for eventual control of the flow structure. Characterization of the flow structure in the rolling mode of wing motion has involved definition of the critical states of the flow, based on the static locations of onset of vortex breakdown. The instantaneous crossflow and streamwise topology has been defined

as a function of row angle. For pitching motion of the wing, simultaneous maneuver of the wing and application of control in the form of deflection of a leading-edge flap and blowing from the trailing-edge provide an effective, interactive means of altering the onset of vortex breakdown, thereby enhancing the effectiveness of maneuvers at high angle of attack.
DTIC
Angle of Attack; Delta Wings; Flow Distribution; Flow Visualization; Three Dimensional Flow; Unsteady Flow;

N96-14026# Central Aerohydrodynamics Inst., Zhukovsky (Russia).
Preliminary design and testing of the laboratory system to measure rotor blade deflections Final Technical Report
Fonov, Serge D.; Kulesh, Vladimir P.; Tarazov, Nikolay N.; and Bosnyakov, Serge M.; Jun. 1995 33 p
Contract(s)/Grant(s): (N68171-94-C-9137)
Report No.(s): (AD-A297603) Avail: CASI HC A03/MF A01

Research programs conducted in the National Full-Scale Aerodynamics Complex (NASA, Ames) requires a non-invasive instrumentation capability to measure the dynamic deflection of large scale rotor blades during wind tunnel test. TsAGI suggests to design, develop and test of a prototype measurement system, including mast mounted two dimensional coordinate sensor, a set of the retroreflectors installed on the blade, digital image acquisition and processing system coupled with a personal computer, synchronizing and power supply units. Measurement methodology and appropriate software must be developed and tested. This paper describes results obtained during Preliminary stage of this project, what is aimed to evaluate the possibility of the measurements, to approve required measurement accuracy, to develop measurement methodology and to formulate the technical requirements to the prototype system. All investigations were carried out on the laboratory measurement system simulating real geometry. Test results using real data are described, analyzed and compared.
DTIC
Deflection; Imaging Techniques; Laboratory Equipment; Optical Measurement; Retroreflectors; Rotary Wings; Wind Tunnel Tests;

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

N96-12170*# Massachusetts Inst. of Tech., Cambridge, MA.
An investigation of air transportation technology at the Massachusetts Institute of Technology: 1993-1994 c03
Simpson, Robert W.; and Hansman, R. John; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research:1993-1994 Aug. 1995 p 3-15 (For primary document see N96-12169 02-01) Avail: CASI HC A03/MF A02

There are two completed projects and two continuing research activities under the sponsorship of the FAA/NASA Joint University Program as the 1993-94 period ends. There were a number of publications during the year which are referenced in this report. A brief summary of the continuing research projects is provided. The completed projects were (1) Analysis of Aircraft Surface Motion at Boston Logan International Airport and (2) A State of the Art Review and Critical Analysis of World Jet Transport Safety and Aviation Fire Safety. The active research projects are (1) ASLOTS - An Interactive Adaptive System for Automated Approach Spacing of Aircraft and (2) Alerting in Automated and Datalink Capable Cockpits.
Derived from text
Air Traffic Control; Air Transportation; Aircraft Approach Spacing; Approach Control; Cockpits; Human Factors Engineering; University Program; Warning Systems;

N96-12171*# Ohio Univ., Athens, OH. Dept. of Electrical and Computer Engineering.
Investigation of air transportation technology at Ohio University: 1993-1994 c03
Lilley, Robert W.; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 18-24 (For primary document see N96-12169 02-01) Avail: CASI HC A02/MF A02

The Joint University Program (JUP) offers students, faculty, and staff of the Avionics Engineering Center the opportunity to conduct basic research relating to the safety and efficiency of the National Airspace System. During the 1993-1994 year research was continued in a variety of GPS-related technologies and also in a hybrid data uplink system. (1) Processing techniques developed for the GPS attitude determination have been applied to centimeter-level kinematic GPS aircraft positioning for flight reference systems and aircraft autoland and taxiing operations. This resulted in the first real-time kinematic GPS autoland. (2) The fault detection and isolation (FDI) algorithm developed under the Joint University Program has been fully adopted by RTCA Special Committee 159 as the baseline algorithm for sole-means navigation of GPS integrated with GLONASS, LORAN-C, or baro-altimeter. (3) A Satellite Coverage Research Analysis Model (SCRAM) has been developed which provides outage areas, outage dynamics, and availability information for satellite-based navigation systems. RTCA Special Committee 159 has adopted this model for use in their work. (4) A basic receiver structure has been simulated and tested for use with the hybrid data uplink. This

uplink utilizes the phase of an existing AM carrier to transmit digital data, thus both amplitude and phase modulation are applied, resulting in a hybrid carrier. The receiver simulation is directly applicable to real-time implementation as a result of the development platform.
Author (revised)
Air Navigation; Air Transportation; Global Positioning System; National Airspace System; University Program;

N96-12176*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
Investigation of air transportation technology at Princeton University: 1993-1994 c03
Stengel, Robert F.; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 67-75 (For primary document see N96-12169 02-01) Avail: CASI HC A02/MF A02

The Air Transportation Research Program at Princeton University proceeded along four avenues during the past year: microburst hazards to aircraft; wind rotor hazards to aircraft; flight control system robustness; and intelligent aircraft/airspace systems. This research has resulted in a number of publications, including theses, archival papers, and conference papers. An annotated bibliography of publications that appeared between June 1993 and June 1994 appears at the end of this report.
Derived from text
Air Transportation; Atmospheric Turbulence; Expert Systems; Flight Control; Flight Hazards; Flight Management Systems; Microbursts (meteorology); University Program; Wind Shear;

N96-12180*# Princeton Univ., NJ. Lab. for Control and Automation.
Intelligent aircraft/airspace systems c03
Wangermann, John P.; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 100-112 (For primary document see N96-12169 02-01) Avail: CASI HC A03/MF A02

Projections of future air traffic predict at least a doubling of the number of revenue passenger miles flown by the year 2025. To meet this demand, an Intelligent Aircraft/Airspace System (IAAS) has been proposed. The IAAS operates on the basis of principled negotiation between intelligent agents. The aircraft/airspace system today consists of many agents, such as airlines, control facilities, and aircraft. All the agents are becoming increasingly capable as technology develops. These capabilities should be exploited to create an Intelligent Aircraft/Airspace System (IAAS) that would meet the predicted traffic levels of 2005.
Derived from text
Air Traffic; Airline Operations; Automated En Route Atc; Automatic Flight Control; Decision Making; Expert Systems;

N96-13057 Failure Analysis Associates, Inc., Framingham, MA. Electrical Div.
Aircraft mishap investigation handbook for electronic hardware Final Report, Apr. 1991 - Nov. 1994
Galler, Donald; Glover, Duncan; and Kusko, Alexander; Jan. 1995 327 p Limited Reproducibility: More than 20% of this document may be affected by poor print
Contract(s)/Grant(s): (F33615-91-C-5612)
Report No.(s): (AD-A295620; FAAA-BN-R-93-12-04; WL-TR-95-4004) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This handbook contains procedures and guidelines to aid in the analysis and investigation of electrical and electronic components involved in aircraft mishap investigations. Failure analysis techniques for the evaluation of electrical and electronic components are summarized for lamps, wiring, connectors, circuit breakers, printed wiring boards, and microelectronic devices. Techniques using optical and scanning electron microscopy (SEM) for the analysis of these components are described. Energy dispersive X-ray analysis (EDAX) of elemental constituents, X-ray radiography, and specialized electrical measurements are also described.
DTIC
Aircraft Accidents; Aircraft Equipment; Electric Equipment; Electronic Equipment; Failure Analysis; Handbooks; Microelectronics;

N96-13139# Air Force Packaging Evaluation Agency, Wright-Patterson AFB, OH.
Development of the nose radome container for combat talon 2 CNU 469/E Final Report, 6 Jan. 1993 - May 1995
Tekesky, Robert S.; May 1995 20 p
Report No.(s): (AD-A295948; AFPEA-95-R-02) Avail: CASI HC A03/MF A01

The Air Force Packaging Technology and Engineering Facility (AFPTEF) provided engineering support to the Combat Talon 2 (CT2) program by developing an overseas shipping and storage container for the nose radome. CT2 is a modified C-130 aircraft designed for special operations. The shipping container provided by the prime contractor of the nose radome had several handling problems. The container, an oversized wooden container, only allowed the nose radome to be shipped by surface vehicles, ships, or C-5 aircraft. Removal of the nose radome from the container required eight personnel and a minimum of four hours. The nose radome, mounted in a vertical position, had to be rotated into a horizontal position to be placed on the C-130 aircraft. The AFPTEF container developed is a pressure treated lumber design with an aluminum structural frame to support the nose radome, in a horizontal position, during

shipping and storage. The container also houses two aluminum pallets for handling the nose radome. One pallet is used for removing the nose radome from the container and the other is used for handling the damaged nose radome and placing it back in the container. The damaged nose radome can then be shipped for repairs. With the new container, the installation procedure from start to finish requires four personnel or less and takes only two hours.
Author (revised)
Air Cargo; Aircraft Maintenance; C-130 Aircraft; Ground Handling; Packaging; Radomes;

N96-13238*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Scheduling logic for Miles-In-Trail traffic management
Synnestvedt, Robert G.; Swenson, Harry; and Erzberger, Heinz; 1 Sep. 1995 14 p
Contract(s)/Grant(s): (RTOP 505-64-13)
Report No.(s): (NASA-TM-4700; NAS 1.15:4700; A-950062; NIPS-95-05720) Avail: CASI HC A03/MF A01

This paper presents an algorithm which can be used for scheduling arrival air traffic in an Air Route Traffic Control Center (ARTCC or Center) entering a Terminal Radar Approach Control (TRACON) Facility . The algorithm aids a Traffic Management Coordinator (TMC) in deciding how to restrict traffic while the traffic expected to arrive in the TRACON exceeds the TRACON capacity. The restrictions employed fall under the category of Miles-in-Trail, one of two principal traffic separation techniques used in scheduling arrival traffic . The algorithm calculates aircraft separations for each stream of aircraft destined to the TRACON. The calculations depend upon TRACON characteristics, TMC preferences, and other parameters adapted to the specific needs of scheduling traffic in a Center. Some preliminary results of traffic simulations scheduled by this algorithm are presented, and conclusions are drawn as to the effectiveness of using this algorithm in different traffic scenarios.
Author
Air Traffic; Air Traffic Control; Algorithms; Flight Paths; Flight Plans; Radar Approach Control; Scheduling;

N96-13366*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Proceedings of the Air Transportation Management Workshop
Tobias, Leonard; ed.Tashker, Michael G.; ed. (Transportation Decision Systems, Los Altos, CA.)and Boyle, Angela M.; ed. (Navajo Co., Fremont, CA.) 1 Aug. 1995 286 p Workshop held at Moffett Field, CA , Moffett Field, CA, United States, 31 Jan. - 1 Feb. 1995
Contract(s)/Grant(s): (RTOP 505-90-60)
Report No.(s): (NASA-CP-10151; NAS 1.55:10151; A-950079; NIPS-95-05297) Avail: CASI HC A13/MF A03

The Air Transportation Management (ATM) Workshop was held 31 Jan. - 1 Feb. 1995 at NASA Ames Research Center. The purpose of the workshop was to develop an initial understanding of user concerns and requirements for future ATM capabilities and to initiate discussions of alternative means and technologies for achieving more effective ATM capabilities. The topics for the sessions were as follows: viewpoints of future ATM capabilities, user requirements, lessons learned, and technologies for ATM. In addition, two panel sessions discussed priorities for ATM, and potential contributions of NASA to ATM. The proceedings contain transcriptions of all sessions.
Author
Air Traffic Control; Air Transportation; Conferences; Free Flight; Management Systems;

N96-13989# Systems Research Labs., Inc., Dayton, OH.
Proceedings of the 1995 ATB model users' colloquium
Jun. 1995 369 p
Contract(s)/Grant(s): (AF PROJ. 7231)
Report No.(s): (AD-A297410) Avail: CASI HC A16/MF A03

The 1995 Articulated Total Body (ATB) Model Users' Colloquium was held at the Wright-Patterson Air Force Base, Dayton OH on 13-14 June 1995. This Colloquium, sponsored by the Armstrong Laboratory (AL), US Department of the Air Force, brought together eighty users of the ATB model and its derivatives (Cvs, Cal-3D, and DYNAMAN). The two day conference offered the opportunity to present and exchange the latest ATB modeling techniques and applications. Invited presentations, group discussions, and interactive exercises covered areas like model algorithms, harness belt and airbag modeling, data base development, vehicle and aircraft crashworthiness, dummy and human modeling, and accident reconstruction applications.
DTIC
Accident Prevention; Aircraft Accidents; Aircraft Safety; Biodynamics; Conferences; Crashworthiness; Data Bases;

N96-14083*# Honeywell Technology Center, Minneapolis, MN.
A concept for adaptive performance optimization on commercial transport aircraft
Jackson, Michael R.; and Enns, Dale F.; Washington, DC, United States NASA, Washington 1 Sep. 1995 67 p
Contract(s)/Grant(s): (NAS4-50021; RTOP 505-69-10)
Report No.(s): (NASA-CR-186034; NAS 1.26:186034; H-2072; NIPS-95-05905) Avail: CASI HC A04/MF A01

An adaptive control method is presented for the minimization of drag during flight for transport aircraft. The minimization of drag is achieved by taking advantage of the redundant control capability available in the pitch axis, with the horizontal tail used as the primary surface and symmetric

deflection of the ailerons and cruise flaps used as additional controls. The additional control surfaces are excited with sinusoidal signals, while the altitude and velocity loops are closed with guidance and control laws. A model of the throttle response as a function of the additional control surfaces is formulated and the parameters in the model are estimated from the sensor measurements using a least squares estimation method. The estimated model is used to determine the minimum drag positions of the control surfaces. The method is presented for the optimization of one and two additional control surfaces. The adaptive control method is extended to optimize rate of climb with the throttle fixed. Simulations that include realistic disturbances are presented, as well as the results of a Monte Carlo simulation analysis that shows the effects of changing the disturbance environment and the excitation signal parameters.
Author
Adaptive Control; Aerodynamic Drag; Cambered Wings; Commercial Aircraft; Control Surfaces; Drag Reduction; Least Squares Method; Monte Carlo Method; Transport Aircraft;

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

N96-12172*# Ohio Univ., Athens, OH.
Fault detection and exclusion in multisensor navigation systems c04
Bernath, Gregory N.; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 25-39 (For primary document see N96-12169 02-01) Avail: CASI HC A03/MF A02

In order for a multisensor navigation system to meet integrity requirements, there must be a way of detecting erroneous measurements, using only data from those measurements. This can be accomplished using a parity space estimation algorithm. Erroneous measurements must then be removed from the position solution; the entire process is called fault detection and exclusion (FDE). A baseline FDE algorithm has been determined, and is capable of working in real time on present affordable hardware.
Author
Air Navigation; Error Detection Codes; Fault Detection; Global Positioning System; Hybrid Navigation Systems;

N96-12174*# Ohio Univ., Athens, OH. Avionics Engineering Center.
GPS integrity monitoring and multipath error distributions c04
Skidmore, Trent A.; and Vangraas, Frank; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 49-55 Presented at the Institute of Navigation 49th Annual Meeting, 21-23 Jun. 1993 (For primary document see N96-12169 02-01)
Contract(s)/Grant(s): (NAG1-1423; FAA-92-G-023) Avail: CASI HC A02/MF A02

The ability to perform integrity monitoring of a differential Global Positioning System (DGPS) precision approach system is dependent upon the form of monitor used and the various noise sources acting on the reference station, the monitor, and the approaching aircraft. This paper focuses on how multipath and assumptions about its probability density function (pdf) affect the availability of the integrity monitoring function. Also discussed is a technique specified as code/carrier integrity monitoring which can be used to greatly improve integrity monitoring availability over methods employing conventional C/A-code operations.
Author
Air Navigation; Approach Control; Global Positioning System; Multipath Transmission; Position Errors; Probability Density Functions;

N96-12175*# Ohio Univ., Athens, OH. Avionics Engineering Center.
DGPS ground station integrity monitoring c04
Skidmore, Trent A.; and Vangraas, Frank; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 56-64 (For primary document see N96-12169 02-01)
Contract(s)/Grant(s): (NAG1-1423; FAA-92-G-023) Avail: CASI HC A02/MF A02

This paper summarizes the development of a unique Differential Global Positioning System (DGPS) ground station integrity monitor which can offer improved availability over conventional code-differential monitoring systems. This monitoring technique, called code/carrier integrity monitoring (CCIM), uses the highly stable integrated Doppler measurement to smooth the relatively noisy code-phase measurements. The pseudorange correction is therefore comprised of the integrated Doppler measurement plus the CCIM offset. The design and operational results of a DGPS ground station integrity monitor are reported. A robust integrity monitor is realized which is optimized for applications such as the Special Category I (SCAT-I) defined in the RTCA Minimum Aviation System Performance Standards.
Author

Air Navigation; Approach Control; Error Correcting Codes; Global Positioning System; Ground Stations; Position Errors; Range Errors;

N96-13404# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance Control Panel.

Aerospace navigation systems [Les systemes de navigation aerospatiaux]

Niemela, John; ed. (Army Communications-Electronics Command, Fort Monmouth, NJ.) Jun. 1995 425 p

Report No.(s): (AGARD-AG-331; ISBN-92-836-1018-0) Copyright Avail: CASI HC A18/MF A04

The need for an up to date, comprehensive treatise on aerospace navigation systems has been recognized. It is anticipated that the target reader of this AGARDograph will be an individual who has the responsibility for the integration of navigation equipment aboard an aerospace vehicle. The AGARDograph is organized into six sections detailing the the motivation for establishing the requirements to assure that the development of an aerospace navigation system will meet its operational requirement; reviewing the navigation coordinate frames with a discussion of inertial, terrestrial, and geodetic coordinate systems; describing modern navigation sensor technologies; addressing the system analysis and synthesis methods; representing state-of-the-art navigation system implementations in different aircraft; and describing various test methods used to verify the performance of aerospace navigation systems used in NATO countries. For individual titles, see N96-13405 through N96-13422.

Air Navigation; Doppler Navigation; Inertial Navigation; Navigation Aids; Navigation Instruments; Radar Navigation; Remote Sensors; Satellite Navigation Systems; Space Navigation; Systems Analysis; Technology Assessment;

N96-13405# Defense Mapping Agency Systems Center, Fairfax, VA.

Coordinate frames c04

Kumar, Muneendra; In AGARD, Aerospace Navigation Systems Jun. 1995 p 7-41 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

Accurate navigation requires an understanding of the three coordinate frames and systems which define positions in space. The first is the inertial frame in which the earth revolves around the sun annually. This annual motion is affected by the general precession and astronomic nutation and it takes place in the Earth Centered Inertial (ECI) frame or Conventional Inertial System (CIS). Second is the reference frame which is defined by the daily rotation of the earth around its polar axis. This Instantaneous Terrestrial System (ITS) frame requires knowledge of the sidereal time relationship with the CIS. Third frame is the geodetic or Earth Centered Earth fixed (ECEF) coordinate system defining the three-dimensional positions on the earth's surface or in its adjoining space. This frame is also known as Conventional Terrestrial System (CTS) and requires the knowledge of the earth's polar motion, the gravity field, and its size and shape. The ECI (or CIS) transformation to the ECEF (or CTS) frame makes use of the new theories of precession, astronomic nutation, change to a new J2000.0 Standard Time Epoch, the new definition of Universal Time as defined and adopted by the International Astronomical Union (IAU), and the latest ECEF frame, viz., Word Geodetic System (WGS) 1984. In the discussion that follows, all the coordinate frames or systems are right-handed and orthogonal, and positive rotation is clockwise when viewed from the origin towards the positive axis. Further, the three rotational matrices, R(sub x), R(sub y), and R represent the positive rotations about the orthogonal axes X, Y, and Z respectively.

Author

Coordinates; Earth Gravitation; Earth Orbits; Earth Rotation; Navigation Aids; Polar Wandering (geology); Three Dimensional Motion;

N96-13406# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. for Flight Guidance.

Inertial navigation c04

Stieler, B.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 45-131 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A05/MF A04

Inertial navigation system (INS) provides all information about the kinematics of a vehicle, namely attitude and heading, ground speed and position, and also angular rate and acceleration independent of any sources of reference from outside. No question about its role for military aviation, marine navigation and for missiles. A high inertial technology is nowadays a trademark for military independent of many countries. Inertial navigation is also widespread in use in civil aviation and in space flight. Any large civil aircraft is equipped with two or three inertial navigation reference systems. The advent of the 'Global Navigation Satellite System (GNSS)' will in principle not change this situation in the time to come, especially under the consideration that a solution for its undisturbed availability in times of strained political situations for the countries running the system is not yet in sight. This chapter is arranged in the following training of thoughts. The directional reference in an INS is explained with the mechanical gyro and stabilized platform as examples. It is symbolized by the weathercock in the functional diagram for a platform INS. The characteristics of the gyrostabilized platform as directional reference serve to visualize the characteristics of the 'analytic platform' in the navigational computer of modern strapdown systems. Again this is symbolized in a weathercock, the functional diagram for a strapdown system. Directional references and their error characteristics are discussed. Accelerometers as sensors for measuring the translational motion are fairly simple instruments in

principle, but the formula for their output signal on the rotating earth is lengthy and it is the basis for programming the navigational computer of an INS. These aspects are treated in Section 3. The integration of the accelerometer signal to ground speed and position and the control or computation of the directional reference is subject of the navigational computer. The interlinking of all signals within and INS causes error characteristics more benign than we would expect from our school learning. This is subject of Section 4. Also the INS for worldwide navigation, common features and differences of all mechanizations are discussed. the goal is to derive the error model appropriate for integrating the INS with the other sensors and systems discussed in this book. The main part of this chapter contains only general outline which are essential from the system point of view. Special features as coordinate systems for inertial navigation supplementing the chapter 'Navigation Coordinate Systems', digital data processing of inertial signals especially in strapdown systems, and optical gyros are treated in the appendices wich are named correspondingly with C, D,and O.
Author
Accelerometers; Computer Systems Design; Control Systems Design; Directional Control; Gyroscopes; Inertial Navigation; Navigation Aids; Navigation Satellites; Stabilized Platforms; Surface Navigation;

N96-13407# GEC-Marconi Electronic Systems Corp., Wayne, NJ.
Doppler radar navigation c04
Buell, Heinz; In AGARD, Aerospace Navigation Systems Jun. 1995 p 132-151 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

The use of the Doppler principle to measure velocity has been underway since the early 1950's. The Doppler principle or effect has been applied to many systems in which velocity is an important variable. The discussion herein will concentrate on the use of a self-contained radar in an airborne vehicle to measure the velocity of that vehicle. Fixed-wing aircraft and helicopters have used Doppler radars successfully for many years, and drone aircraft and missiles are beginning to exploit the low cost and high reliability of Doppler radars.
Author
Doppler Effect; Doppler Radar; Flight Conditions; Frequency Shift; Instrument Errors; Radar Navigation; Technology Assessment;

N96-13408# Sandia National Labs., Albuquerque, NM.
Terrain referenced navigation c04
Boozer, Drayton D.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 152-157 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A02/MF A04

Terrain referenced navigation is a technique for improving the accuracy of a navigation system by correlating a sensed elevation profile of terrain beneath a vehicle with stored terrain elevation data. Position estimates are referenced to the terrain data and are insensitive to position bias errors in the terrain data. Because of this characteristic, terrain referenced navigation systems are especially useful in applications that require accurate navigation relative to targets, obstacles, structures, and other features whose locations are derived from the same source as the stored elevation data. Example applications include low-emission terrain following/terrain avoidance, target queuing for standoff weapon terminal sensors, indirect ranging and ground proximity warning. System navigation accuracy depends primarily on the ratio of terrain roughness to terrain data vertical accuracy and secondarily on navigation system accuracy, vehicle ground clearance, ground cover, vehicle maneuvers, and update frequency. Terrain referenced navigation systems are often considered for use with terrain masking for covert, low-altitude ingress into hostile areas. Low probability of intercept radar altimeters may be used in these applications. A key issue is the availability and quality of terrain elevation data. This chapter provides avionics system developers an overview of terrain referenced navigation system capabilities and characteristics, and an outlook for future applications.
Author
Avionics; Nap-of-the-earth Navigation; Position Errors; Radar Targets; Radio Altimeters; Rangefinding; Surface Roughness; Terrain Following;

N96-13410# Directorate Research and Development Communications and Space, Ottawa (Ontario).
An overview of Omega radio navigation system c04
Liang, David F.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 177-186 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A02/MF A04

Omega is a very low frequency (VLF) navigation system using frequencies allocated for radio navigation in the band between 10 KHz and 14 KHz. Such a low frequency band enables Omega navigation system to achieve the long operating ranges required for global coverage, at the same time provides a stable and predictable propagation environment. This also makes it the only radio navigation system applicable to completely submerged submarines. Omega is a hyperbolic position fixing system, the hyperbolae are loci of constant time difference between the arrival of signals from two transmitting stations. The time difference is measured as a difference in phase of the two received signals. Each hyperbola is known as a line of position (LOP). Signals must be received from at least three stations with one of them serving as a common station, to obtain a position fix from the two LOP's. The hyperbolic mode is attractive, since it removes the need to use a precise and expensive local oscillator. It is also possible to work with two stations using a cir-

cular mode, which requires a precision local oscillator. In such a case, the position fix is obtained from the intersection of circular rather than hyperbolic LOP's.
Author
Frequency Stability; Omega Navigation System; Radio Navigation; Technology Assessment; Underwater Communication; Very Low Frequencies;

N96-13411# Northrop Corp., Hawthorne, CA. Electronics Systems Div.
AGARDograph on advanced astroinertial navigation systems c04
Levine, Seymour; In AGARD, Aerospace Navigation Systems Jun. 1995 p 187-199 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

This paper discusses modern Strapdown Astroinertial Navigation (SAIN) systems as autonomous navigators for manned aircraft, ships, missiles, and remotely piloted vehicles. These systems, which approach Global Positioning System (GPS) accuracy, do not depend upon man-made electromagnetic radiating devices that may be intentionally shut down, destroyed, or become unreliable in a hostile environment. The paper analyzes the gyroscopic accuracy, artificial stellar image stabilization, star density, sky visibility, and sky background irradiance effects on system performance. It concludes that a high-precision, reliable, low-cost stellar inertial system can be achieved by eliminating gimbals and combining a strapdown Inertial Navigation System (INS) with an Optical Wide-Angle-Lens Startracker (OWLS).
Author
Accelerometers; Autonomy; Gyroscopes; Inertial Navigation; Navigation Instruments; Navigators; Systems Analysis; Technology Assessment;

N96-13412# Smiths Industries Aerospace and Defense Systems, Inc., Grand Rapids, MI. Avionics Systems Engineering.
Magnetic heading references c04
Moore, Donald L.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 200-205 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A02/MF A04

This paper addresses the most common system for providing aircraft heading reference: the magnetic heading reference system. It begins briefly explaining the importance of a magnetic heading reference. It then addresses the fundamental characteristics of the earth's magnetic field and explains the concept of 'magnetic variation'. It discusses two of the more common styles of magnetic heading sensors along with their inherent errors. After explaining how these different compasses operate, the paper explains the different types of heading errors that occur. Section 4 addresses the in-flight errors, while Section 5 addresses the magnetic disturbances caused by the aircraft itself. Section 6 discusses calibration techniques that provide for the correction against these magnetic disturbance induced errors. Finally, this paper concludes with a brief discussion of future trends.
Author
Air Navigation; Compasses; Earth (planet); Geomagnetism; Magnetic Variations; Navigation Aids;

N96-13413# Directorate Research and Development Communications and Space, Ottawa (Ontario).
An overview of a generic multi-sensor integrated navigation system design c04
Liang, David F.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 210-230 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

Modern avionics systems are becoming increasingly sophisticated as the demands for better mission performance and higher reliability continue to escalate. Many of the missions must be carried out at ultra-low altitude under all weather and visibility conditions. The increased range, speed and accuracy of modern weapon systems, impose stringent accuracy and reliability requirements upon the aircraft navigation system. To enhance mission success in a hostile environment, the pilot amongst other things needs to operate weapon systems, target acquisition and designation systems, radar detection, night vision systems and perhaps engage in air-to-air combat. This paper describes the application of Kalman filtering technology to the design and development of a multi-sensor Generic Integrated Navigation System (GINS).
Author
Air Navigation; Avionics; Kalman Filters; Multisensor Applications; Systems Engineering; Systems Integration; Technology Assessment;

N96-13414# Wright Lab., Wright-Patterson AFB, OH. Avionics Directorate.
Deep integration of GPS, INS, SAR, and other sensor information c04
Lewantowicz, Zdzislaw H.; and Paschall, Randall N.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 231-264 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

This discussion is presented in the context of avionics sensor integration methodology. However the concepts developed and illustrations presented are in no way limited in application to military avionics systems. There is a growing number of civil applications, where information from multiple sensors is combined to improve performance, provide redundancy management, increase robustness, or achieve graceful degradation when sensor failures (or outages) occur. We are rapidly moving beyond the classical examples of sensor information integration such as in air-

craft navigation, or in control of chemical processes, nuclear plants, and jet engines. For example, the automotive industry is using several sensors for engine emissions and fuel control, vehicle active suspension, and yes, vehicle electronics (vetronics). Communication systems, position, velocity, and attitude (rotation) sensors, and other information are rapidly appearing in the consumer automobiles. These sensors provide, at affordable cost, functional capabilities, which until recently were reserved for the more expensive commercial air and ground systems. Other applications of sensor integration are either being implemented, prototyped, or considered in toys, electronics, consumer products, such as the household washers and dryers, communications, and home environment monitoring and control systems. Although the sensor integration possibilities are expanding into these other domains, this discussion focuses on deep integration of Global Positioning System (GPS), inertial navigation systems (INS), synthetic aperture radar (SAR), and other sensors which are a subset of modern aerospace systems.
Author
Air Navigation; Global Positioning System; Inertial Navigation; Remote Sensors; Synthetic Aperture Radar; Systems Integration; Technology Assessment; Technology Utilization;

N96-13416# Draper (Charles Stark) Lab., Inc., Cambridge, MA.
GPS/inertial integration overview c04
Greenspan, Richard L.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 281-294 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

GPS/Inertial integration is the process whereby a superior system navigation solution is produced by properly combining outputs from a GPS user equipment (UE) and from an inertial navigation system (INS). This process is receiving much attention because it is perceived to be a cost-effective means to satisfy navigation requirements that could not be met by either GPS or by an INS acting by itself. Some expectations levied on integrated systems are realistic; others, including hopes for mass-market commercial applications, will be delayed pending the development of suitable low-cost inertial technology. The technical basis for considering GPS/INS integration is the complementary nature of the navigation errors for each system operating stand-alone. The GPS solution is relatively noisy; the noise-driven variance of GPS positioning errors is on the order of a meter per axis, per position determination. However, GPS errors are bounded, whereas inertial navigation errors are dominated by a low-frequency component that grows in proportion to the mission duration. (The high-frequency content of inertial errors is very small, amounting to a few centimeters (rms) over tens of seconds.) One expects that an integrated navigation solution would perform like an inertial navigator whose errors were bounded by the GPS solution. This performance is actually achieved using one of the least aggressive approaches to integration; further benefits achieved using more aggressive integration options are discussed in the following sections.
Author
Global Positioning System; Inertial Navigation; Navigators; Systems Integration; Technology Assessment; Technology Utilization;

N96-13418# Litton Guidance and Control Systems, Woodland Hills, CA.
Vertical channel design considerations c04
Ausman, J. Stanley; In AGARD, Aerospace Navigation Systems Jun. 1995 p 312-327 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

The vertical channel of an inertial system is unstable. This instability is caused by the gravity compensation fed back to the vertical accelerometer output. The gravity compensation, computed as a function of altitude after doubly integrating the output of that accelerometer, creates an unstable, positive feedback loop. The time constant of this instability is about 560 seconds near the earth's surface. For ballistic missiles and rockets this does not pose a problem because the guidance is completed before the instability becomes serious. For aircraft systems, however, one must augment the inertial measurements, typically with barometric altimeter information, in order to stabilize the vertical inertial channel. Earliest mechanizations of the baro-inertial loop employed second-order feedback with constant gains. The next step was to add integral feedback in order to bias the vertical accelerometer, thus creating a third-order system. Widnall and Sinha investigated the third-order loop to find the optimum set of fixed gains. Not surprisingly, they found that the optimum set of gains depended on the values assumed for the noise characteristics of the accelerometer and the barometric altimeter. Because the noise magnitudes will vary as a function of the aircraft's flight regime, the baro-inertial feedback gains should not be constant, but should also vary. Litton first mechanized a third-order variable gain baro-inertial loop in CLASS, in all-weather close air support system, successfully demonstrated in 1972. They gradually improved upon that basic design over the years as successive systems, principally ARIS, uncovered more and more barometric altitude error characteristics which had to be accommodated. The culmination of this evolutionary development is the baro-inertial loop currently mechanized in the LN-93 and LN-94 systems for the USAF Standard RLG INU. Following a discussion of barometric and inertial errors, we will take a detailed look at the LN-93/94 conventional vertical channel mechanization, the reasons behind the loop design, and some simulation results illustrating the

loop performance when subjected to certain flight maneuvers and barometric errors.
Author
Accelerometers; Altimeters; Altitude Control; Channels (data Transmission); Design Analysis; Gravitational Effects; Inertial Navigation; Kalman Filters; Positive Feedback;

N96-13420# Army Communications-Electronics Command, Fort Monmouth, NJ. Research and Development Center.
Representative vehicle implementation: Rotary wing aircraft c04
Niemela, John; and Liang, David F.; (Directorate Research and Development Communications and Space, Ottawa, Ontario.) In AGARD, Aerospace Navigation Systems Jun. 1995 p 381-389 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A02/MF A04

Rotary wing aircraft have seen an ever expanding role in support of land and sea military operations including: search and rescue, scout, attack, troop transport, anti-submarine warfare, anti-surface ship targeting, cargo and electronic warfare. They are ideally suited for operation in confined and unprepared areas where no other form of aerial transport is suitable. For a helicopter to survive on the modern battlefield, flight profiles are mandated that impose unique requirements on the navigation system. These include contour and nap-of-the-earth flight as well as hover in defilade in close proximity to obstructions. Critical mission segments are conducted in nap-of-the-earth flight during which the pilot conceals the helicopter with terrain, foilage and buildings. These missions must be accomplished in all weather and visibility conditions. In the course of these missions, the rotary wing aircraft crew must maintain accurate self-location to maintain geographic orientation and situational awareness relative to friendly and hostile forces. A typical tactical mission profile overlaid on a contour map is shown, illustrating the non-linear flight path which takes advantage of terrain masking. For the anti-submarine warfare missions the helicopter navigation system must maintain stable and accurate tactical plots over long periods of time. In the anti-surface ship targeting role, a high degree of absolute and relative navigational accuracy are vital to rapid and successful action. There are further complicating factors as well. Operations must often take place under radio silence and shore-based or satellite navigation aids may be destroyed or jammed during wartime. The small crew of the helicopter must not be burdened with monitoring the functioning of, or updating, the navigation system.
Author
Air Navigation; Design Analysis; Flight Paths; Military Operations; Nap-of-the-earth Navigation; Navigation Aids; Rotary Wing Aircraft; Technology Assessment; Terrain Following;

N96-13422# Test Squadron (0046th), Holloman AFB, NM.
Test methodology c04
Hunt, Coy L.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 407-421 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A03/MF A04

This section of the document describes the various methods employed to evaluate the performance of aerospace navigation systems. Included are discussions regarding test equipment, test data, reference systems, environmental conditions, laboratory tests, flight test profiles and procedures, and statistical methods used to measure system performance. The test methods detailed in this document are somewhat specific and may need to be adapted to particular systems and their specifications.
Author
Air Navigation; Computer Systems Performance; Data Systems; Performance Prediction; Prediction Analysis Techniques; Space Navigation; Statistical Analysis;

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

N96-12149 California Univ., Los Angeles, CA.
The accuracy of parameter estimation in system identification of noisy aircraft load measurement Ph.D. Thesis
Kong, Jeffrey Yau-Pak; 1 Jan. 1994 141 p Avail: Univ. Microfilms Order No. DA9418893

This thesis focuses on the subject of the accuracy of parameter estimation and system identification techniques. Motivated by a complicated load measurement from NASA Dryden Flight Research Center, advanced system identification techniques are needed. The objective of the problem is to accurately predict the load experienced by the aircraft wing structure during flight determined from a set of calibrated load and gage response relationships. We can then model the problem as a black box input-output system identification from which the system parameter has to be estimated. Traditional least-square (LS) techniques and the issues of noisy data and model accuracy are addressed. A statistical bound reflecting the change in residual is derived in order to understand the effects of the perturbations on the data. Due to the intrinsic nature of the LS problem, LS solution faces the dilemma of the trade off between model accuracy and noise sensitivity. A method of relating the two conflicting performance indices is presented, thus allowing us to improve the noise sensitivity while at the same time confining the degradation of the model accuracy. Singular value decomposition (SVD) techniques for data reduction are studied and the equivalence of the correspondence analysis (CA) and total least squares criteria are proved. We also looked at nonlinear LS problems with a NASA F-111 data set as an

example. Conventional methods are neither easily applicable nor suitable for the specific load problem since the exact model of the system is unknown. Neural network (NN) does not require prior information on the model of the system. This robustness motivated us to apply the NN techniques on our load problem. Simulation results for the NN methods used in both the single load and the 'warning signal' problems are both useful and encouraging. The performance of the NN (for single load estimate) is better than the LS approach, whereas no conventional approach was tried for the 'warning signals' problem. The NN design methodology is also presented. The use of SVD, CA, and collinearity index methods are used to reduce the number of neurons in a layer. Dissert. Abstr.

Aerodynamic Loads; Least Squares Method; Neural Nets; Parameter Identification; Random Noise; System Identification; Wings;

N96-12684* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

Rotorcraft blade-vortex interaction controller Patent

Schmitz, Frederic H.; inventor (to NASA) 1 Aug. 1995 23p Filed 6 Nov. 1992

Report No.(s): (NASA-CASE-ARC-11992-2; US-PATENT-5,437,419; US-PATENT-APPL-SN-972790; US-PATENT-CLASS-244-17.11; US-PATENT-CLASS-244-1N; US-PATENT-CLASS-244-199; INT-PATENT-CLASS-B64C-27/00) Avail: US Patent and Trademark Office

Blade-vortex interaction noises, sometimes referred to as 'blade slap', are avoided by increasing the absolute value of inflow to the rotor system of a rotorcraft. This is accomplished by creating a drag force which causes the angle of the tip-path plane of the rotor system to become more negative or more positive.

Official Gazette of the U.S. Patent and Trademark Office

Blade-vortex Interaction; Controllers; Rotary Wing Aircraft;

N96-13035*# Research Inst. for Advanced Computer Science, Moffett Field, CA.

Supersonic wing and wing-body shape optimization using an adjoint formulation

Reuther, James; and Jameson, Antony; (Princeton Univ., NJ.) Jul. 1995 10 p

Contract(s)/Grant(s): (NAS2-13721)

Report No.(s): (NASA-CR-199150; NAS 1.26:199150; RIACS-TR-95-14) Avail: CASI HC A02/MF A01

This paper describes the implementation of optimization techniques based on control theory for wing and wing-body design of supersonic configurations. The work represents an extension of our earlier research in which control theory is used to devise a design procedure that significantly reduces the computational cost by employing an adjoint equation. In previous studies it was shown that control theory could be used to~eviseransonic design methods for airfoils and wings in which the shape and the surrounding body-fitted mesh are both generated analytically, and the control is the mapping function. The method has also been implemented for both transonic potential flows and transonic flows governed by the Euler equations using an alternative formulation which employs numerically generated grids, so that it can treat more general configurations. Here results are presented for three-dimensional design cases subject to supersonic flows governed by the Euler equation.

Author

Aerodynamic Configurations; Aircraft Design; Body-wing Configurations; Computational Fluid Dynamics; Control Theory; Euler Equations of Motion; Optimization; Supersonic Aircraft; Supersonic Airfoils; Supersonic Flow; Three Dimensional Flow; Wings;

N96-13037*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

Low-speed wind-tunnel investigation of the stability and control characteristics of a series of flying wings with sweep angles of 70 deg

Ross, Holly M.; Fears, Scott P.; (Lockheed Engineering and Sciences Co., Hampton, VA.)and Moul, Thomas M.; Sep. 1995 144 p

Contract(s)/Grant(s): (RTOP 505-68-30-01)

Report No.(s): (NASA-TM-4671; L-17460; NAS 1.15:4671) Avail: CASI HC A07/MF A02

A wind-tunnel investigation was conducted in the Langley 12-Foot Low-Speed Tunnel to study the low-speed stability and control characteristics of a series of four flying wings over an extended range of angle of attack (-8 deg to 48 deg). Because of the current emphasis on reducing the radar cross section (RCS) of new military aircraft, the planform of each wing was composed of lines swept at a relatively high angle of 70 deg, and all the trailing edges and control surface hinge lines were aligned with one of the two leading edges. Three arrow planforms with different aspect ratios and one diamond planform were tested. The models incorporated leading-edge flaps for improved longitudinal characteristics and lateral stability and had three sets of trailing-edge flaps that were deflected differentially for roll control, symmetrically for pitch control, and in a split fashion for yaw control. Three top body widths and two sizes of twin vertical tails were also tested on each model. A large aerodynamic database was compiled that could be used to evaluate some of the trade-offs involved in the design of a configuration with a reduced RCS and good flight dynamic characteristics.

Author

Angle of Attack; Arrow Wings; Dynamic Characteristics; Low Aspect Ratio Wings; Low Speed; Radar Cross Sections; Sideslip; Tailless Aircraft; Wind Tunnel Tests;

N96-13054 Michigan Univ., Ann Arbor, MI.
Optimal maneuvers including thrust angle-of-attack of supersonic aircraft Ph.D. Thesis
Tzeng, Yih-Feng; 1993 211 p Avail: Univ. Microfilms Order No. DA9409829

Novel methods of analyzing the optimal maneuvers of a supersonic aircraft in cruise, turning, and climb are presented. Besides much improvement in computational efficiency, some interesting results are displayed explicitly. First, the problem of fixed fuel-maximum range steady state cruise is studied with a more realistic specific fuel consumption factor as a function of the Mach number and the altitude. Therefore, the solution is applicable to the turbojet, turboprop, and the turbofan engines commonly used in modern aircraft. After this preliminary analysis, the singular perturbation-singular control theory is successfully used to relax the steady-state constraints in fixed fuel-maximum range cruise. In addition, the effect of the thrust angle-of-attack on fuel efficiency is studied and it is found to be negligible. Second, the optimal maneuvers for the fastest turning, and turning subject to prescribed end-point Mach numbers, are analyzed. As expected, with very high thrust, the maximum turning rate is conducted at high angle-of-attack. But with specified end-point Mach numbers, and moderate thrust, the angle-of-attack is usually near the stall angle-of-attack and the optimum thrust control alternates between no thrust and maximum thrust. The switching is always made at the same turning rate and the number of switches depends on the flight altitude, the end-point Mach numbers, and the heading change. The formulation allows the consideration of a variety of thrust producing propulsion systems which include the rocket, the turbojet, and the turbofan. Finally, a nonsensitive, robust, and accurate procedure is presented which does not require prior knowledge of a reference trajectory for computing the optimum trajectory for minimum-time-to-climb to an altitude. This computing procedure is also valid for a variety of propulsion systems. It is shown that for rocket-powered aircraft the optimum climb starts immediately, while for air breathing propulsion systems, it may be necessary to use a dive to accelerate the aircraft to a sufficiently high Mach number before the actual climb. Again, the effect of the thrust angle-of-attack is considered and it is found to be negligible for high speed maneuvers.
Dissert. Abstr.
Aircraft Maneuvers; Angle of Attack; Climbing Flight; Cruising Flight; Fuel Consumption; Propulsion System Performance; Supersonic Aircraft; Supersonic Flight; Thrust Control; Turning Flight;

N96-13153*# California Univ., Davis, CA.
Viscous-flow analysis of a subsonic transport aircraft high-lift system and correlation with flight data Final Report
Potter, R. C.; and Vandam, C. P.; 1 Jul. 1995 88 p Contract(s)/Grant(s): (NCC1-163)
Report No.(s): (NASA-CR-199610; NIPS-95-05535; NAS 1.26:199610) Avail: CASI HC A05/MF A01

High-lift system aerodynamics has been gaining attention in recent years. In an effort to improve aircraft performance, comprehensive studies of multi-element airfoil systems are being undertaken in wind-tunnel and flight experiments. Recent developments in Computational Fluid Dynamics (CFD) offer a relatively inexpensive alternative for studying complex viscous flows by numerically solving the Navier-Stokes (N-S) equations. Current limitations in computer resources restrict practical high-lift N-S computations to two dimensions, but CFD predictions can yield tremendous insight into flow structure, interactions between airfoil elements, and effects of changes in airfoil geometry or free-stream conditions. These codes are very accurate when compared to strictly 2D data provided by wind-tunnel testing, as will be shown here. Yet, additional challenges must be faced in the analysis of a production aircraft wing section, such as that of the NASA Langley Transport Systems Research Vehicle (TSRV). A primary issue is the sweep theory used to correlate 2D predictions with 3D flight results, accounting for sweep, taper, and finite wing effects. Other computational issues addressed here include the effects of surface roughness of the geometry, cove shape modeling, grid topology, and transition specification. The sensitivity of the flow to changing free-stream conditions is investigated. In addition, the effects of Gurney flaps on the aerodynamic characteristics of the airfoil system are predicted.
Author
Airfoil Profiles; Computational Grids; Flight Tests; Free Flow; Navier-stokes Equation; Performance Prediction; Swept Wings; Three Dimensional Flow; Transition Flow; Two Dimensional Flow; Viscous Flow; Wind Tunnel Tests;

N96-13268# Department of the Navy, Washington, DC.
Multi-pitot tube assembly Patent Application
Meunier, Robert; inventor (to Navy) 8 Dec. 1994 14 p Filed 8 Dec. 1994
Report No.(s): (AD-D017423; US-PATENT-APPL- SN-353642) Avail: CASI HC A03/MF A01

A multi-pitot tube assembly for use in flow measurements of a fluid surrounding a test structure is presented . The assembly has multiple, identically shaped preformed pitot tubes sealed within a molded polyurethane fin shape. The pitot tubes are nested together and passed through an alignment disk into separate spread holes in a common sealing plug. The surface of the plug is shaped to conform to the surface of the test structure. The pitot tubes, alignment disk and plug are inserted into a mold and polyurethane is injected to seal the individual tubes and form the fin shape from which the pitot tubes extend. The mold is removed and the assembly is attached to the test structure with the fin extending into

the medium and the sealing plug flush with the outer surface of the test structure. A watertight, 0-ring seal is provided between the plug and the test structure.
DTIC
Flow Measurement; Flowmeters; Pitot Tubes;

N96-13391*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Low-speed wind tunnel investigation of the stability and control characteristics of a series of flying wings with sweep angles of 60 deg
Moul, Thomas M.; Fears, Scott P.; (Lockheed Engineering and Sciences Co., Hampton, VA.)Ross, Holly M.; and Foster, John V.; Aug. 1995 157 p
Contract(s)/Grant(s): (RTOP 505-68-30-01)
Report No.(s): (NASA-TM-4649; L-17400; NAS 1.15: 4649) Avail: CASI HC A08/MF A02

A wind tunnel investigation was conducted in the Langley 12-Foot Low-Speed Wind Tunnel to study the low-speed stability and control characteristics of a series of four flying wings over an extended range of angle of attack (-8 deg to 48 deg). Because of the current emphasis on reducing the radar cross section of new military aircraft, the planform of each wing was composed of lines swept at a relatively high angle of 60 deg, and all the trailing-edge lines were aligned with one of the two leading edges. Three arrow planforms with different aspect ratios and one diamond planform were tested. The models incorporated leading-edge flaps for improved pitching-moment characteristics and lateral stability and had three sets of trailing-edge flaps that were deflected differentially for roll control, symmetrically for pitch control, and in a split fashion for yaw control. Top bodies of three widths and twin vertical tails of various sizes and locations were also tested on each model. A large aerodynamic database was compiled that could be used to evaluate some of the trade-offs involved in the design of a configuration with a reduced radar cross section and good flight dynamic characteristics.
Author
Aircraft Design; Directional Stability; Flight Characteristics; Lateral Stability; Leading Edge Flaps; Low Speed Stability; Radar Cross Sections; Sweptback Wings; Tail Assemblies; Tailless Aircraft; Trailing Edge Flaps; Wind Tunnel Tests;

N96-13392*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA tire/runway friction projects
Yager, Thomas J.; Jun. 1995 20 p
Contract(s)/Grant(s): (RTOP 505-63-50-19)
Report No.(s): (NASA-TM-110186; NAS 1.15:110186) Avail: CASI HC A03/MF A01

The paper reviews several aspects of NASA Langley Research Center's tire/runway friction evaluations directed towards improving the safety and economy of aircraft ground operations. The facilities and test equipment used in implementing different aircraft tire friction studies and other related aircraft ground performance investigations are described together with recent workshop activities at NASA Wallops Flight Facility. An overview of the pending Joint NASA/Transport Canada/FM Winter Runway Friction Program is given. Other NASA ongoing studies and on-site field tests are discussed including tire wear performance and new surface treatments. The paper concludes with a description of future research plans.
Author
Aircraft Tires; Friction; Runway Conditions; Runways; Surface Treatment; Wear;

N96-13579*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Acoustic flight tests of rotorcraft noise-abatement approaches using local differential GPS guidance
Chen, Robert T. N.; Hindson, William S.; and Mueller, Arnold W.; 1 Sep. 1995 38 p
Contract(s)/Grant(s): (RTOP 505-59-36)
Report No.(s): (NASA-TM-110370; NAS 1.26:110370; A-950102; NIPS-95-05299) Avail: CASI HC A03/MF A01

This paper presents the test design, instrumentation set-up, data acquisition, and the results of an acoustic flight experiment to study how noise due to blade-vortex interaction (BVI) may be alleviated. The flight experiment was conducted using the NASA/Army Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) research helicopter. A Local Differential Global Positioning System (LDGPS) was used for precision navigation and cockpit display guidance. A laser-based rotor state measurement system on board the aircraft was used to measure the main rotor tip-path-plane angle-of-attack. Tests were performed at Crows Landing Airfield in northern California with an array of microphones similar to that used in the standard ICAO/FAA noise certification test. The methodology used in the design of a RASCAL-specific, multi-segment, decelerating approach profile for BVI noise abatement is described, and the flight data pertaining to the flight technical errors and the acoustic data for assessing the noise reduction effectiveness are reported.
Author
Acoustics; Blade-vortex Interaction; Flight Tests; Global Positioning System; Helicopter Design; Noise Reduction; Rotary Wing Aircraft;

N96-13584# Naval Postgraduate School, Monterey, CA. Navy-NASA Joint Inst. of Aeronautics.
Present capabilities of predicting two-dimensional dynamic stall c05
Ekaterinaris, J. A.; Srinivasan, G. R.; (Sterling Software, Inc., Moffett Field, CA.)and McCroskey, W. J.; (Army Avi-

ation Systems Command, Moffett Field, CA.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 23 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

The current status of computational methods in predicting dynamic stall is summarized. Computed results for unsteady, attached and separated, turbulent flows over airfoils undergoing oscillatory motion are presented. The compressible form of the Reynolds-averaged Navier-Stokes equations is used. Numerical integration of the governing equations is performed with an approximately factorized algorithm. The inviscid fluxes are evaluated using both central differences and an upwind-biased method. The ability of several turbulence models, widely used for the prediction of steady flows, is tested for the unsteady flows. Solutions computed with algebraic, one-equation, and two-equation turbulence models are compared with experimental data. For the fully turbulent flows with tripped boundary layer most turbulence models predict lift hysteresis reasonably well. Some turbulence models give good qualitative agreement with the measured drag and pitching moment hysteresis loops. The computed results for untripped flows, where a small transitional region at the leading edge exist, show that the key to the accurate prediction of the unsteady loads at stall conditions is the modeling of this transition region at the leading edge. A simplified criterion for the transition onset is used, and the transitional flow region is computed with a modified form of the turbulence model. The computed solutions, where the transitional flow region is included, show that the small laminar/transitional separation bubble formed during the pitch-up motion has a decisive effect on the near wall flow and the development of the unsteady loads. Finally, the numerical solutions show some sensitivity to the kind of numerical algorithm used despite the reasonably fine grids used.
Author

Aerodynamic Stalling; Airfoils; Computational Fluid Dynamics; Computational Grids; Helicopters; Inviscid Flow; Leading Edges; Navier-stokes Equation; Numerical Integration; Rotor Aerodynamics; Separated Flow; Turbulence Models; Turbulent Flow; Two Dimensional Models; Unsteady Flow;

N96-13596# Sikorsky Aircraft, Stratford, CT.

Forward flight rotor airloads predictions using a coupled Navier-Stokes/full-potential analysis c05

Berezin, C.; and Sankar, L.; (Georgia Inst. of Tech., Atlanta, GA.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

Unsteady airloads predictions from a hybrid Navier-Stokes/full-potential code for a model UH-60A rotor in forward flight are presented. The code splits the physical domain into a near blade viscous region surrounded by an inviscid potential region. The two regions are coupled through boundary conditions on the interface surface separating them. In addition, the interface surface has been modified to dynamically adjust its position normal to the blade surface depending on the instantaneous distribution of vorticity in the viscous region. This allows roughly a 50 percent reduction of CPU time usage when compared with a standalone Navier-Stokes code. Comparison of the hybrid code surface pressures with the standalone Navier-Stokes results shows good agreement in quadrants one, two, and four. The hybrid code overpredicts the extent of a separated region in the third quadrant which suggests further improvements to the unsteady interface boundary conditions are needed.
Author

Aerodynamic Loads; Aircraft Design; Boundary Conditions; Computational Fluid Dynamics; Computational Grids; Helicopters; Horizontal Flight; Navier-stokes Equation; Potential Flow; Potential Theory; Rotor Aerodynamics; Unsteady Aerodynamics;

N96-13604# Defence Research Agency, Bedford (England). Flight Dynamics and Simulation Dept.

In flight research with instrumented main and tail rotor blades using the DRA Bedford aeromechanics research Lynx helicopter c05

Tarttelin, P. C.; and Martyn, A. W.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 12 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

This paper serves to inform the reader about in-flight research at DRA Bedford on the DRA's Aeromechanics Lynx Control and Agility Testbed (ALYCAT) using instrumented main and tail rotor blades. The paper describes the instrumentation, data analysis techniques and flight test programs, with the initial results from recent trials using instrumented main rotor blades on ALYCAT presented for the first time, and results from the earlier trials using an instrumented tail rotor blade presented in more detail.
Author

Applications Programs (computers); Blade-vortex Interaction; Data Reduction; Flight Control; Flight Tests; Helicopters; Pressure Distribution; Pressure Sensors; Rotary Wings; Rotor Aerodynamics; Strain Gages;

N96-13606# Aix-Marseilles Univ. (France). Inst. de Mechanique des Fluides.

Determination of the aerodynamic loads of the rotor in hovering, using a laser technique of velocimetry [Determination des charges aerodynamiques du rotor en vol stationnaire, a l'aide d'une technique de velocimetrie laser] c05

Berton, E.; Favier, D.; Maresca, C.; and Nsimba, M.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft

Aug. 1995 6 p In FRENCH (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (DGA-90/169; DGA-92/061) Copyright Avail: CASI HC A02/MF A04

The study of the aerodynamic burden-sharing on a rotor of operative helicopter in hovering, is approached in this paper by means of a new technique of exploration by laser velocimetry, coupled to assessment of momentum and Kutta (KMA Method). The effectiveness of this method is evaluated for various parametric configurations of the hovering.
Author
Aerodynamic Loads; Helicopters; Hovering; Rotary Wings; Rotor Aerodynamics;

N96-13613# National Research Council of Canada, Ottawa (Ontario). Applied Aerodynamics Lab.
Analysis of rotor forces in a ship airwake c05
Syms, G.; and Zan, S. J.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 12 p Sponsored in cooperation with the National Research Council of Canada Original contains color illustrations (For primary document see N96-13582 02-01)
Contract(s)/Grant(s): (DND-FE-220792-NRC-05) Copyright Avail: CASI HC A03/MF A04

This paper examines the helicopter/ship dynamic interface by combining both experimental and numerical analyses. The flow field over the flight deck of a frigate model was mapped experimentally in a wind tunnel using both stationary and flying hot-film sensors. Using the velocity time-histories measured in the wind tunnel, a numerical representation of the airwake which shares the same spectral characteristics was generated. A blade-element model fo the main rotor of a helicopter was then 'flown' in this numerical airwake to determine the steady and unsteady loads acting on the rotor. The results of a set of test simulations indicate: (1) that an increase in unsteady rotor loads occurs when spatial cross-correlation functions are included in the generation of the numerical flow field; (2) that the fluctuating vertical velocity has a greater effect on the unsteady rotor loads than the fluctuating horizontal velocity; and (3) that the spectra of unsteady forces and moments show similar broadband and resonant behavior at different free-stream velocities.
Author
Flow Distribution; Helicopters; Hovering; Interactional Aerodynamics; Loads (forces); Numerical Analysis; Rotor Aerodynamics; Ships; Velocity Distribution; Wakes; Wind Tunnel Tests;

N96-13614# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.
A theoretical and experimental investigation into the rotor blade aeroelastic behaviour of a shipborne helicopter during rotor engagement and braking c05
Newman, S. J.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p Sponsored by the DRA (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

Under normal operating flight procedures, a helicopter main rotor revolves at a strictly controlled speed. The centrifugal forces generated keep balance with the aerodynamic loads with the result that the rotor blade motion, in particular the blade flapping, is maintained under control. To reach the normal rotational speeds the rotor must of course pass through lower speeds, both during acceleration and deceleration, and during these periods the blades can fall prey to the phenomenon of blade sailing. With this, not inconsiderable aerodynamic loads can be generated when the helicopter is operating in high winds and with the reduced centrifugal forces because of the lower rotor speeds, the blade flapping motion can build up to dangerously large deflections.
Author
Aeroelasticity; Air Flow; Aircraft Carriers; Flow Distribution; Helicopters; Rotary Wings; Rotor Blades; Wind Effects; Wind Tunnel Tests;

N96-13946# Federal Aviation Administration, Cambridge, MA.
Strain fields in Boeing 737 fuselage lap splices. Field and laboratory measurements with analytical correlations Final Report, Jan. 1994 - Mar. 1995
Jeong, David Y.; Roach, Dennis P.; Canha, Joseph V.; Brewer, John C.; and Flournoy, Thomas H.; Jun. 1995 211p
Report No.(s): (AD-A297402; DOTVNTSC-FAA-95-10; DOT/FAA/CT-95/25) Avail: CASI HC A10/MF A03

In support of the Federal Aviation Administration Technical Center's (FMTC) National Aging Aircraft Research Program (NAARP), Sandia National Laboratories and the John A. Volpe National Transportation Systems Center (Volpe Center) are conducting research to determine if current rules for design, inspection, and maintenance are sufficient to ensure the safe operation of the aging fleet. Particular emphasis has been given to a phenomenon of multiple cracking that appears to be an attribute of airplanes that have been in service for some time. This phenomenon is commonly referred to as Widespread Fatigue Damage (WFD). Several experimental and analytical studies have been initiated by FAATC to understand the phenomenon of WFD. Some of these research activities include: collection of strain gage data from a Boeing 737 airplane conducted by the Aging Aircraft Nondestructive Inspection Validation Center (AANC); laboratory testing of full-scale curved panels conducted by Foster-Miller, Inc. (FMI); and modeling of fuselage lap splices by the Votpe Center. This report documents the strain gage testing of the Boeing 737 airplane acquired by the AANC. Additionally, correlations among the three research

activities mentioned above have been performed, and are described in this report.
DTIC
Aging (materials); Boeing 737 Aircraft; Cracking (fracturing); Data Acquisition; Fatigue (materials); Fatigue Life; Fuselages; Inspection; Stress-strain Relationships;

N96-13981# Insitu Group, Underwood, WA.
A small autonomous aircraft for remote sensing of the atmosphere, phase 1 Final Technical Report, 1 Aug. 1994 - 31 Jan. 1995
McGeer, Tad; 30 Mar. 1995 43 p
Contract(s)/Grant(s): (F49620-94-C-0044)
Report No.(s): (AD-A295418; AFOSR-95-0270TR) Avail: CASI HC A03/MF A01

In 1992, The Insitu Group began development of a very small, very long-range autonomous aircraft (or aerosonde) for economical meteorological reconnaissance in remote and oceanic regions of the globe. Prototype work was done over the first two years of the program, and in the last half of 1994 the focus moved to development of an aircraft suitable for field trials. All of the necessary components were produced during the Phase 1 period, including airframe, avionics, powerplant, ground equipment, and software. We are now proceeding toward integrated flight tests, and initial deployment in a meteorological field experiment late in 1995.
DTIC
Aircraft Design; Aircraft Performance; Meteorological Research Aircraft; Remote Regions; Remote Sensing;

N96-14084*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
A historical overview of flight flutter testing
Kehoe, Michael W.; 1 Oct. 1995 20 p Presented at the AGARD Structures and Materials Panel Meeting, Rotterdam, Netherlands, 8-10 May 1995
Contract(s)/Grant(s): (RTOP 505-63-50)
Report No.(s): (NASA-TM-4720; NAS 1.15:4720; H-2077; NIPS-95-05908) Avail: CASI HC A03/MF A01

This paper reviews the test techniques developed over the last several decades for flight flutter testing of aircraft. Structural excitation systems, instrumentation systems, digital data preprocessing, and parameter identification algorithms (for frequency and damping estimates from the response data) are described. Practical experiences and example test programs illustrate the combined, integrated effectiveness of the various approaches used. Finally, comments regarding the direction of future developments and needs are presented.
Author
Aircraft Stability; Dynamic Structural Analysis; Excitation; Experiment Design; Flutter Analysis; Histories; Procedures; Unsteady Aerodynamics;

N96-14087# Army Research Lab., Watertown, MA. Materials Directorate.
Joint technical coordinating group on aircraft survivability. Interlaboratory ballistic test program Interim Report, FY93 - FY94
Graves, John H.; and Kolev, Hermann; Jun. 1995 52 p
Report No.(s): (AD-A297279; ARL-TR-755; JTCG/AS-95-V-007) Avail: CASI HC A04/MF A01

Analysis of experimental data from interlaboratory ballistic tests indicate that results from different facilities are not fully comparable for each of the two armor materials tested. The Materials Directorate of the Army Research Laboratory (ARL-MD) provided each of the nine laboratories participating in this program with a set of metallic armor panels and a set of macrocomposite armor panels consisting of a ceramic adhesively bonded to Kevlar reinforced plastic. ARL-MD stipulated the velocity for the first projectile fired at each set of armor panels and an obliquity of 0 deg. The lead test engineer at each laboratory selected all subsequent velocities. Each laboratory shot a series of ARL-MD provided U.S. 0.50 caliber armor piercing (AP) M2 projectiles at the panels and calculated a V(sub 50) protection ballistic limit (PBL) in accordance with MIL-STD-662E. We present the results from each laboratory for both armor panel types on which we performed two different statistical analyses. We also include a series of recommendations for improving the reproducibility of interlaboratory ballistic test data.
DTIC
Aircraft Survivability; Armor; Impact Tests; Projectiles; Terminal Ballistics; Test Facilities;

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

N96-13415# Integrity Systems, Inc., Belmont, MA.
Federated filter for fault-tolerant integrated navigation c06
Carlson, Neal A.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 265-280 (For primary document see N96-13404 02-04)
Contract(s)/Grant(s): (F33615-87-C-1520) Copyright Avail: CASI HC A03/MF A04

This paper describes federated filter applications to integrated, fault-tolerant navigation systems. The federated filter is an optimal or near-optimal estimator for decentralized, multisensor data fusion. Its decentralized estimation architecture is based on theoretically sound information-sharing principles. Federated filters consist of one or more sensor-dedicated local filters, generally operating in parallel, plus a master combining filter. The master filter periodically combines (fuses) the local filter solutions to form the best total solution. Fusion generally occurs at a reduced rate,

relative to the local measurement rates. The method is well suited to real-time system implementation, and can provide significant improvements in data throughput, fault tolerance, and system modularity. This paper discusses federated filter applications to integrated navigation system sin terms of operating modes, accuracy, fault tolerance, computational efficiency (throughput), and real-time system features. Numerical simulation results are presented to demonstrate federated filter performance characteristics.
Author
Fault Tolerance; Filters; Multisensor Applications; Multisensor Fusion; Navigation; Performance Prediction; Systems Integration; Technology Assessment;

N96-13419# McDonnell-Douglas Aerospace, Saint Louis, MO.
Aerospace navigation systems requirements for fixed wing aircraft c06
Bedoya, Carlos A.; In AGARD, Aerospace Navigation Systems Jun. 1995 p 330-380 (For primary document see N96-13404 02-04) Copyright Avail: CASI HC A04/MF A04

The purpose of this paper is fourfold: (1) to provide the radar with a status report on the state-of-the-art of navigation system technology as applied to fixed wing aircraft; (2) recommend a disciplined systems engineering process to be used in determining navigation system requirements as they relate to navigation, sensor cueing and targeting as well as weapon requirements; (3) examples of how to functionally decompose each aircraft and analyze its mission requirements into the navigation system requirements; and (4) a typical set of requirements for a fixed wing aircraft. The results will allow the navigation systems designer to have a process he can follow in determining or verifying the requirements of a particular application as well as a baseline set of requirements.
Author
Air Navigation; Control Systems Design; Design Analysis; Inertial Navigation; Navigation Instruments; Space Navigation; Systems Engineering; Systems Integration;

N96-13568 Department of the Navy, Washington, DC.
Helmet head tracking mounting device Patent
Horvat, Christina A.; inventor (to Navy)Bradley, Gary F.; inventor (to Navy)and Rhodes, Carroll L.; inventor (to Navy) 23 May 1995 7 p Filed 23 Feb. 1993
Report No.(s): (AD-D017562; US-PATENT-5,416,922; US-PATENT-APPL-SN-021388; US-PATENT-CLASS-2-6.2) Avail: US Patent and Trademark Office

A unified, low-profile, lightweight and strong component mounting system for an aircrew member's helmet is disclosed. The system includes a substantially rectangular mounting bracket that carries necessary power, communications, and optical inputs to the components; mounting hardware; and specially designed interface pieces for each component. The system is designed to securely and easily snap-lock onto the helmet and is positioned to stay balanced while attached to eliminate crewmember discomfort.
DTIC
Flight Clothing; Head Movement; Helmets; Mounting; Tracking (position);

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

N96-12152*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A numerical study of the effect of wake passing on turbine blade film cooling
Heidmann, James D.; 1 Oct. 1995 14 p Presented at the 31st Joint Propulsion Conference and Exhibit, San Diego, CA, 10-12 Jul. 1995; cosponsored by AIAA, ASME, SAE, and ASEE
Report No.(s): (NASA-TM-107077; NAS 1.15:107077; AIAA PAPER 95-3044; E-9949) Avail: CASI HC A03/MF A01

Time-accurate and steady three-dimensional viscous turbulent numerical simulations were performed to study the effect of upstream blade wake passing unsteadiness on the performance of film cooling on a downstream axial turbine blade. The simulations modeled the blade as spanwise periodic and of infinite span. Both aerodynamic and heat transfer quantities were explored. A showerhead film cooling arrangement typical of modern gas turbine engines was employed. Showerhead cooling was studied because of its anticipated strong sensitivity to upstream flow fluctuations. The wake was modeled as a region of zero axial velocity on the upstream computational boundary which translated with each iteration. This model is compatible with a planned companion experiment in which the wakes will be produced by a rotating row of cylindrical rods upstream of an annular turbine cascade. It was determined that a steady solution with appropriate upstream swirl and stagnation pressure predicted the span-average film effectiveness quite well. The major difference is a 2 to 3 percent overprediction of span-average film effectiveness by the steady simulation on the pressure surface and in the showerhead region. Local overpredictions of up to 8 percent were observed in the showerhead region. These differences can be explained by the periodic relative lifting of the boundary layer and enhanced mixing in the unsteady simulations.
Author
Computational Fluid Dynamics; Computational Grids; Film Cooling; Finite Difference Theory; Flow Distribution; Gas Turbine Engines; Heat Transfer; Three Dimensional Flow;

Turbine Blades; Turbulent Flow; Unsteady Flow; Viscous Flow; Wakes;

N96-12153*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Instrumentation development for study of Reynolds Analogy in reacting flows
Deturris, Dianne J.; 1 Aug. 1995 26 p
Contract(s)/Grant(s): (RTOP 505-70-62-01)
Report No.(s): (NASA-TM-110196; NAS 1.15:110196) Avail: CASI HC A03/MF A01

Boundary layers in supersonic reacting flows are not well understood. Recently a technique has been developed which makes more extensive surface measurements practical, increasing the capability to understand the turbulent boundary layer. A significant advance in this understanding would be the formulation of an analytic relation between the transfer of momentum and the transfer of heat for this flow, similar to the Reynolds Analogy that exists for laminar flow. A gauge has been designed and built which allows a thorough experimental investigation of the relative effects of heat transfer and skin friction in the presence of combustion. Direct concurrent measurements made at the same location, combined with local flow conditions, enable a quantitative analysis to obtain a relation between the surface drag and wall heating, as well as identifying possible ways of reducing both.
Author
Friction Measurement; Heat Transfer; Reacting Flow; Skin Friction; Strain Gages; Supersonic Combustion; Supersonic Combustion Ramjet Engines; Supersonic Flow; Turbulent Boundary Layer; Wall Flow;

N96-12220 Lawrence Livermore National Lab., Livermore, CA.
Terminal ballistic experiments for the development of turbine engine blade containment technology
Gogolewski, R. P.; and Cunningham, B. J.; 25 Jan. 1995 44p
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
Contract(s)/Grant(s): (W-7405-ENG-48)
Report No.(s): (DE95-014164; UCRL-ID-120930) Avail: CASI HC A03

The ballistic experiments reported herein were conducted in three sets between October 1993 and November 1994. The first set of experiments examined the ballistic failure of annealed titanium plates. These experiments were performed in a manner consistent with earlier experiments conducted at United Technologies' Pratt and Whitney Division. The second set of experiments examined the ballistic performance of select aluminum and titanium alloys in single-plate and laminate form. In both sets of experiments, the failure modes of the targets were observed and catalogued. The third set of experiments evaluated underlying issues associated with geometric scaling. Blunt .30-and .50-caliber hard steel projectiles impacted on geometrically similar annealed titanium plates.
DOE
Aluminum Alloys; Destructive Tests; Impact Tests; Terminal Ballistics; Titanium Alloys; Turbine Blades; Turbine Engines;

N96-12502*# NYMA, Inc., Brook Park, OH.
Off-design computer code for calculating the aerodynamic performance of axial-flow fans and compressors Final Report
Schmidt, James F.; Jul. 1995 93 p
Contract(s)/Grant(s): (NAS3-27186; RTOP 538-03-11)
Report No.(s): (NASA-CR-198362; E-9764; NAS 1.26:198362) Avail: CASI HC A05/MF A01

An off-design axial-flow compressor code is presented and is available from COSMIC for predicting the aerodynamic performance maps of fans and compressors. Steady axisymmetric flow is assumed and the aerodynamic solution reduces to solving the two-dimensional flow field in the meridional plane. A streamline curvature method is used for calculating this flow-field outside the blade rows. This code allows for bleed flows and the first five stators can be reset for each rotational speed, capabilities which are necessary for large multistage compressors. The accuracy of the off-design performance predictions depend upon the validity of the flow loss and deviation correlation models. These empirical correlations for the flow loss and deviation are used to model the real flow effects and the off-design code will compute through small reverse flow regions. The input to this off-design code is fully described and a user's example case for a two-stage fan is included with complete input and output data sets. Also, a comparison of the off-design code predictions with experimental data is included which generally shows good agreement.
Author
Applications Programs (computers); Axial Flow; Axisymmetric Flow; Performance Prediction; Rotor Aerodynamics; Steady Flow; Turbocompressors; Turbofans; User Manuals (computer Programs);

N96-12748*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Rapid calibration of seven-hole probes
Ericksen, A. L.; (Science Applications International Corp., Seattle, WA.)Gallington, R. W.; (Science Applications International Corp., Seattle, WA.)Rao, B. M.; (Science Applications International Corp., Seattle, WA.)and Barankiewicz, W. S.; 1 Sep. 1995 22 p
Contract(s)/Grant(s): (NAS3-27008; RTOP 505-68-30)
Report No.(s): (NIPS-95-05135; NASA-TM-107040; NAS 1.15:107040; E-9868) Avail: CASI HC A03/MF A01

This paper summarizes the major conclusions and some of the key supporting analyses resulting from the calibration and application of two small seven hole probes at NASA Lewis Research Center. These probes can produce reasonably accurate and rapid surveys of unknown steady flow fields which may include flow angles up to 70 degrees and Mach numbers up to 0.8. The probes were calibrated with both 'complete' and 'reduced' test matrices. Both types of test matrices produced similar results suggesting the the reduced matrices are adequate for most purposes. The average accuracy fo the calibration was about the same as that achieved in previous seven hole probe calibrations. At the higher Mach numbers, the calibration was sensitive to the diameter of the free jet in the calibration facility. Over a narrow angular range at the higher Mach numbers, the system had serious repeatability problems. This lack or repeatability apparently results from aliasing of high frequency (20 to 40 Hz) noise with the data acquisition system sampling frequency of 10 Hz. Analyses show that these noise frequencies are probably not related to airflow dynamics in the connecting tubing.
Author
Air Flow; Flow Distribution; Flowmeters; Holes (mechanics); Sampling; Steady Flow; Wind Tunnel Apparatus; Wind Tunnel Calibration;

N96-12771# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
Heterogeneous-phase reactions of nitrogen dioxide with vermiculite-supported magnesium oxide (As applied to the control of jet engine test cell emissions) Ph.D. Thesis
Kimm, Larry T.; 1995 216 p
Report No.(s): (AD-A294695; AFIT/CI/CIA-95-006D) Avail: CASI HC A10/MF A03

Controlling nitrogen oxides (NO(x)) from a non-steady-state stationary source like a jet engine test cell (JETC) requires a method that is effective over a wide range of conditions. A heterogeneous, porous, high surface area sorbent material comprised of magnesium oxide powder attached to a vermiculite substrate has been commercially developed for this purpose. Data from extensive laboratory testing of this material in a packed-bed flow system are presented. NO2 removal efficiencies, kinetics, and proposed NO2 removal mechanisms over a range of representative JETC exhaust gas characteristics are described. Exhaust gas variables evaluated included: NO2 concentration, temperature, flow rate (retention time), oxygen content and moisture content. Availability of water and oxygen were found to be important variables. It is probable that water is necessary for the conversion of MgO to Mg(OH)2, which is a more reactive compound having thermal stability over the range of temperatures evaluated. Gaseous oxygen serves to oxidize NO to NO2, the latter being more readily removed from the gas stream. The presence of oxygen also serves to offset thermal decomposition of NO2 or surface nitrite/nitrate. Effective 'lifetime' and regenerability of the exposed sorbent material were also evaluated. NO2 removal efficiencies were found to greatly exceed those for NO, with a maximum value greater than 90 percent. The effective conversion of NO to NO2 is a crucial requirement for removal of the former. The reaction between NO2 and MgO-vermiculite is first-order with respect to NO2.
DTIC
Chemical Reactions; Engine Tests; Exhaust Gases; Gas Flow; Heterogeneity; Jet Engines; Magnesium Oxides; Nitrogen Oxides;

N96-12861# Naval Postgraduate School, Monterey, CA.
Methods for continuous improvement of fielded jet engine reliability and maintainability M.S. Thesis
Lucas, Steve A.; and Hammond, Terrence E.; Dec. 1994 56p
Report No.(s): (AD-A294757) Avail: CASI HC A04/MF A01

This thesis investigates methods for constructing fielded jet engine reliability and maintainability (R&M) baselines, and methods for establishing R&M targets using benchmarking. The procedures developed can be applied with any fielded jet engine. Emphasis is placed on demonstrating the use of the Naval Aviation Logistics Analysis (NALDA) database in conjunction with existing spreadsheet software programs to develop frequency distributions and failure rate functions for selected figures of merit. Comparison of the calculated figures of merit with (1) values specified in the Logistics Analysis Support Record or (2) a calculated benchmark value provide analysts and program managers with an index of R&M performance. Use of continuous process improvement (CPI) concepts and the Pareto Principle are reviewed as approaches to improving fielded jet engine R&M figures of merit. A cumulative degradation model is presented that can be used to construct maintenance policy. Practical application of the methods and procedures are demonstrated using the General Electric TF-34 engine as a test case.
DTIC
Aircraft Maintenance; Aircraft Reliability; Engine Failure; Figure of Merit; Jet Engines; Maintainability; Reliability Engineering; Total Quality Management;

N96-13045*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A comparison of multivariable control design techniques for a turbofan engine control
Garg, Sanjay; and Watts, Stephen R.; (United Technologies Corp., West Palm Beach, FL.) Sep. 1995 14 p Presented at the 40th Gas Turbine and Aeroengine Congress and Exposition, Houston, TX, 5-8 Jun. 1995; sponsored by ASME

Contract(s)/Grant(s): (RTOP 505-62-50)
Report No.(s): (NASA-TM-107060; E-9915; NAS 1.15:107060; ASME 95-GT-258) Avail: CASI HC A03/MF A01

This paper compares two previously published design procedures for two different multivariable control design techniques for application to a linear engine model of a jet engine. The two multivariable control design techniques compared were the Linear Quadratic Gaussian with Loop Transfer Recovery (LQG/LTR) and the H-Infinity synthesis. The two control design techniques were used with specific previously published design procedures to synthesize controls which would provide equivalent closed loop frequency response for the primary control loops while assuring adequate loop decoupling. The resulting controllers were then reduced in order to minimize the programming and data storage requirements for a typical implementation. The reduced order linear controllers designed by each method were combined with the linear model of an advanced turbofan engine and the system performance was evaluated for the continuous linear system. Included in the performance analysis are the resulting frequency and transient responses as well as actuator usage and rate capability for each design method. The controls were also analyzed for robustness with respect to structured uncertainties in the unmodeled system dynamics. The two controls were then compared for performance capability and hardware implementation issues.
Author

Control Systems Design; Engine Control; H-infinity Control; Linear Quadratic Gaussian Control; Multivariable Control; Turbofan Engines;

N96-13226*# Duke Univ., Durham, NC. Dept. of Mechanical Engineering and Material Science.

Sensitivity analysis for aeroacoustic and aeroelastic design of turbomachinery blades Final Report

Lorence, Christopher B.; and Hall, Kenneth C.; 1 May 1995 162 p
Contract(s)/Grant(s): (NAG3-1433)
Report No.(s): (NIPS-95-05590; NASA-CR-199569; NAS 1.26:199569) Avail: CASI HC A08/MF A02

A new method for computing the effect that small changes in the airfoil shape and cascade geometry have on the aeroacoustic and aeroelastic behavior of turbomachinery cascades is presented. The nonlinear unsteady flow is assumed to be composed of a nonlinear steady flow plus a small perturbation unsteady flow that is harmonic in time. First, the full potential equation is used to describe the behavior of the nonlinear mean (steady) flow through a two-dimensional cascade. The small disturbance unsteady flow through the cascade is described by the linearized Euler equations. Using rapid distortion theory, the unsteady velocity is split into a rotational part that contains the vorticity and an irrotational part described by a scalar potential. The unsteady vorticity transport is described analytically in terms of the drift and stream functions computed from the steady flow. Hence, the solution of the linearized Euler equations may be reduced to a single inhomogeneous equation for the unsteady potential. The steady flow and small disturbance unsteady flow equations are discretized using bilinear quadrilateral isoparametric finite elements. The nonlinear mean flow solution and streamline computational grid are computed simultaneously using Newton iteration. At each step of the Newton iteration, LU decomposition is used to solve the resulting set of linear equations. The unsteady flow problem is linear, and is also solved using LU decomposition. Next, a sensitivity analysis is performed to determine the effect small changes in cascade and airfoil geometry have on the mean and unsteady flow fields. The sensitivity analysis makes use of the nominal steady and unsteady flow LU decompositions so that no additional matrices need to be factored. Hence, the present method is computationally very efficient. To demonstrate how the sensitivity analysis may be used to redesign cascades, a compressor is redesigned for improved aeroelastic stability and two different fan exit guide vanes are redesigned for reduced downstream radiated noise. In addition, a framework detailing how the two-dimensional version of the method may be used to redesign three-dimensional geometries is presented.
Author

Aeroacoustics; Aeroelasticity; Aircraft Design; Aircraft Engines; Airfoil Profiles Nonlinearity; Cascade Flow; Computational Grids; Engine Design; Finite Element Method; Flow Distribution; Grid Generation (mathematics); Turbomachine Blades; Turbomachinery; Unsteady Flow;

N96-13345*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

Challenges in aeropropulsion

Campbell, Donald C.; Sep. 1995 18 p Presented at the 12th ISABE Conference, Melbourne, Australia, 10-15 Sep. 1995; sponsored by ISABE
Contract(s)/Grant(s): (RTOP 538-06-15)
Report No.(s): (NASA-TM-107048; E-9893; NAS 1.15:107048) Avail: CASI HC A03/MF A01

Aeropropulsion technologies must progress to satisfy increasingly stringent global environmental requirements with economically viable air transportation systems. In this paper, key propulsion technologies to meet future needs are identified and the associated challenges are briefly discussed. Also discussed are NASA's vision, NASA's changing role in meeting today's challenge of a shrinking research budget, and propulsion technology impacts on the environment and air transport economics. Critical aeropropulsion technology drivers are identified and their impact evaluated. The aviation industry is critical to the nation's economy, job creation, and national security. NASA's advanced aeropro-

pulsion technology programs and their relation to the aviation industry are discussed.
Author
Aerospace Engineering; Aircraft Engines; Aircraft Industry; Engine Design; Propulsion; Technology Assessment;

N96-13386*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Axisymmetric inlet minimum weight design method
Nadell, Shari-Beth; Aug. 1995 40 p
Contract(s)/Grant(s): (RTOP 505-69-50)
Report No.(s): (NASA-TM-106948; E-9686; NAS 1.15:106948) Avail: CASI HC A03/MF A01

An analytical method for determining the minimum weight design of an axisymmetric supersonic inlet has been developed. The goal of this method development project was to improve the ability to predict the weight of high-speed inlets in conceptual and preliminary design. The initial model was developed using information that was available from inlet conceptual design tools (e.g., the inlet internal and external geometries and pressure distributions). Stiffened shell construction was assumed. Mass properties were computed by analyzing a parametric cubic curve representation of the inlet geometry. Design loads and stresses were developed at analysis stations along the length of the inlet. The equivalent minimum structural thicknesses for both shell and frame structures required to support the maximum loads produced by various load conditions were then determined. Preliminary results indicated that inlet hammershock pressures produced the critical design load condition for a significant portion of the inlet. By improving the accuracy of inlet weight predictions, the method will improve the fidelity of propulsion and vehicle design studies and increase the accuracy of weight versus cost studies.
Author (revised)
Construction; Critical Loading; Frames; High Speed; Loads (forces); Pressure Distribution; Supersonic Inlets;

N96-13439*# Rotary Power International, Inc., Wood-Ridge, NJ.
Two rotor Stratified Charge Rotary Engine (SCRE) engine system technology evaluation Final Report
Hoffman, T.; Mack, J.; and Mount, R.; Oct. 1994 127 p Original contains color illustrations
Contract(s)/Grant(s): (NAS3-26920; RTOP 505-62-11)
Report No.(s): (NASA-CR-195395; E-9193; NAS 1.26:195395) Avail: CASI HC A07/MF A02; 4 functional color pages

This report summarizes results of an evaluation of technology enablement component technologies as integrated into a two rotor Stratified Charge Rotary Engine (SCRE). The work constitutes a demonstration of two rotor engine system technology, utilizing upgraded and refined component technologies derived from prior NASA Contracts NAS3-25945, NAS3-24628 and NAS-23056. Technical objectives included definition of, procurement and assembly of an advanced two rotor core aircraft engine, operation with Jet-A fuel at Take-Off rating of 340 BHP (254kW) and operation at a maximum cruise condition of 255 BHP (190kW), 75% cruise. A fuel consumption objective of 0.435 LBS/BHP-Hr (265 GRS/kW-Hr) was identified for the maximum cruise condition. A critical technology component item, a high speed, unit injector fuel injection system with electronic control was defined, procured and tested in conjunction with this effort. The two rotor engine configuration established herein defines an affordable, advanced, Jet-A fuel capability core engine (not including reduction gear, propeller shaft and some aircraft accessories) for General Aviation of the mid-1990's and beyond.
Author
Aircraft Engines; Engine Design; Fuel Injection; Rotary Engines; Rotors;

N96-13444*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Application of thin-film thermocouples to localized heat transfer measurements
Lepicovsky, J.; (NYMA, Inc., Brook Park, OH.)Bruckner, R. J.; and Smith, F. A.; 1 Oct. 1995 12 p Presented at the 31st Joint Propulsion Conference and Exhibit, San Diego, CA, United States, 10-12 Jul. 1995; cosponsored by AIAA, ASME, SAE, and ASEE
Contract(s)/Grant(s): (NAS3-27186)
Report No.(s): (NASA-TM-107045; NAS 1.15:107045; E-9890; AIAA PAPER 95-2834; NIPS-95-05322) Avail: CASI HC A03/MF A01

The paper describes a proof-of-concept experiment on thin-film thermocouples used for localized heat transfer measurements applicable to experiments on hot parts of turbine engines. The paper has three main parts. The first part describes the thin-film sensors and manufacturing procedures. Attention is paid to connections between thin-film thermocouples and lead wires, which has been a source of problems in the past. The second part addresses the test arrangement and facility used for the heat transfer measurements modeling the conditions for upcoming warm turbine tests at NASA LeRC. The paper stresses the advantages of a modular approach to the test rig design. Finally, we present the results of bulk and local heat flow rate measurements, as well as overall heat transfer coefficients obtained from measurements in a narrow passage with an aspect ratio of 11.8. The comparison of bulk and local heat flow rates confirms applicability of thin-film thermocouples to upcoming warm turbine tests.
CASI
Air Cooling; Engine Tests; Experiment Design; Heat Transfer; Internal Flow; Surface Cooling; Thermocouples; Thin Films; Turbine Blades; Turbine Engines;

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

N96-12177*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
Aircraft control in wake vortex wind shear c08
Wold, Gregory R.; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 76-81 (For primary document see N96-12169 02-01) Avail: CASI HC A02/MF A02

In the past, there have been a number of fatal incidents attributable to wake vortex encounters, involving both general aviation and commercial aircraft. In fact, the wake vortex hazard is considered to be the single dominant safety issue determining the aircraft spacing requirements at airports. As the amount of air traffic increases, the number of dangerous encounters is likely only to increase. It is therefore imperative that a means be found to reduce the danger. That is the purpose of this research: to use nonlinear inverse dynamic (NID) control methods in the design of an aircraft control system which can improve the safety margin in a wake vortex encounter.
Derived from text
Aircraft Control; Aircraft Wakes; Dynamic Control; Flight Control; Nonlinear Systems; Wind Shear; Wing Tip Vortices;

N96-13109# Naval Postgraduate School, Monterey, CA.
An integrated approach to the design of an aircraft gain scheduled controller M.S. Thesis
Berglund, Erik; Mar. 1995 62 p
Report No.(s): (AD-A295906) Avail: CASI HC A04/MF A01

This thesis addresses the problem of integrated design of the aircraft plant parameters and of the corresponding feedback controller. The plant parameters are typically the sizes of the control surfaces or other aerodynamical surfaces of the aircraft. The approach is to rewrite the aircraft dynamic requirements as linear matrix inequalities (LMI's) and to optimize a linear cost function associated with aircraft plant parameters, while meeting the LMI constraints. An algorithm using Matlab and LMI-Lab has been developed. This algorithm has been used for integrated plant/controller design of an F-4 aircraft at five different flight conditions. The result consists of a set of controllers one for each flight condition, and a single solution for the optimal sizes of the F-4 stabilator and spoiler control surfaces.
DTIC
Aerodynamic Stability; Aircraft Control; Aircraft Design; Control Surfaces; Controllers; Feedback Control; Flight Control;

N96-13229*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
System identification methods for aircraft flight control development and validation
Tischler, Mark B.; 1 Oct. 1995 22 p
Contract(s)/Grant(s): (RTOP 505-59-36)
Report No.(s): (NIPS-95-05604; NASA-TM-110369; NAS 1.15:110369; A-950097; USAATCOM-TR-95-A-007) Avail: CASI HC A03/MF A01

System-identification methods compose a mathematical model, or series of models, from measurements of inputs and outputs of dynamic systems. The extracted models allow the characterization of the response of the overall aircraft or component subsystem behavior, such as actuators and on-board signal processing algorithms. This paper discusses the use of frequency-domain system-identification methods for the development and integration of aircraft flight-control systems. The extraction and analysis of models of varying complexity from nonparametric frequency-responses to transfer-functions and high-order state-space representations is illustrated using the Comprehensive Identification from FrEquency Responses (CIFER) system-identification facility. Results are presented for test data of numerous flight and simulation programs at the Ames Research Center including rotorcraft, fixed-wing aircraft, advanced short takeoff and vertical landing (ASTOVL), vertical/short takeoff and landing (V/STOL), tiltrotor aircraft, and rotor experiments in the wind tunnel. Excellent system characterization and dynamic response prediction is achieved for this wide class of systems. Examples illustrate the role of system-identification technology in providing an integrated flow of dynamic response data around the entire life-cycle of aircraft development from initial specifications, through simulation and bench testing, and into flight-test optimization.
Author
Aircraft Design; Computerized Simulation; Control Systems Design; Dynamic Response; Fixed Wings; Flight Control; Flight Tests; Mathematical Models; Performance Tests; Rotary Wing Aircraft; System Identification; Vertical Landing; Vertical Takeoff;

N96-13230*# Wyle Labs., Inc., Hampton, VA.
Divergence analysis report for the bodies of revolution model support systems
Rash, Larry C.; 1 Apr. 1983 278 p
Contract(s)/Grant(s): (NAS1-16331)
Report No.(s): (NIPS-95-05605; NASA-CR-198219; NAS 1.26:198219) Avail: CASI HC A13/MF A03

This report documents the sting divergence analyses of nine different model and model support systems that were performed in preparation for a series of wind tunnel tests at the National Transonic Facility at NASA Langley Research Center in Hampton, Virginia. The models were missile shaped bodies of revolution and the model support systems

included a force and moment balance and tapered sting sections. The sting divergence results were obtained from a computer program that solved a two-point boundary value problem which used a second order Runge-Kutta integration technique. The computer solution was based on constant section properties between discrete stations along the sting sections, a procedure was developed and included to evaluate the properties for the minimum number of stations along the tapered sections that would produce no more than one half of one percent error in the divergence results. Also included in the report are development of the aerodynamic input data, listings of all input and output computer data, and summary sheets that highlight the input and the critical sting divergence dynamic pressure for each respective configuration.
Author
Aerodynamic Configurations; Aerodynamic Forces; Balance; Bodies of Revolution; Divergence; Missile Bodies; Support Systems; Wind Tunnel Models; Wind Tunnel Tests;

N96-13399*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Integrated flight and propulsion controls for advanced aircraft configurations
Merrill, Walter; and Garg, Sanjay; Sep. 1995 10 p Presented at the 86th Meeting on Advanced Aeroengine Concepts and Controls, Seattle, WA, 24-29 Sep. 1995; sponsored by Advisory Group for Aerospace Research and Development
Contract(s)/Grant(s): (RTOP 505-62-50)
Report No.(s): (NASA-TM-107067; E-9928; NAS 1. 15: 107067) Avail: CASI HC A02/MF A01

The research vision of the NASA Lewis Research Center in the area of integrated flight and propulsion controls technologies is described. In particular the Integrated Method for Propulsion and Airframe Controls developed at the Lewis Research Center is described including its application to an advanced aircraft configuration. Additionally, future research directions in integrated controls are described.
Author
Aircraft Configurations; Aircraft Control; Engine Control; Flight Control; Propulsion;

N96-13544*# Kansas Univ., Lawrence, KS. Dept. of Aerospace Engineering.
Design, analysis, and control of a large transport aircraft utilizing selective engine thrust as a backup system for the primary flight control Ph.D. Thesis
Gerren, Donna S.; Washington, DC, United States NASA, Washington 1 Sep. 1995 460 p
Contract(s)/Grant(s): (NAG2-789; RTOP 505-69-32)
Report No.(s): (NASA-CR-186035; NAS 1.26:186035; H-2073; NIPS-95-05901) Avail: CASI HC A20/MF A04

A study has been conducted to determine the capability to control a very large transport airplane with engine thrust. This study consisted of the design of an 800-passenger airplane with a range of 5000 nautical miles design and evaluation of a flight control system, and design and piloted simulation evaluation of a thrust-only backup flight control system. Location of the four wing-mounted engines was varied to optimize the propulsive control capability, and the time constant of the engine response was studied. The goal was to provide level 1 flying qualities. The engine location and engine time constant did not have a large effect on the control capability. The airplane design did meet level 1 flying qualities based on frequencies, damping ratios, and time constants in the longitudinal and lateral-directional modes. Project pilots consistently rated the flying qualities as either level 1 or level 2 based on Cooper-Harper ratings. However, because of the limited control forces and moments, the airplane design fell short of meeting the time required to achieve a 30 deg bank and the time required to respond a control input.
Author
Aircraft Design; Control Systems Design; Flight Characteristics; Flight Control; Thrust Control; Transport Aircraft;

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

N96-12151*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
The NASA Langley 16-foot Transonic Tunnel: Historical overview, facility description, calibration, flow characteristics, and test capabilities
Capone, Francis J.; Bangert, Linda S.; Asbury, Scott C.; Mills, Charles T. L.; and Bare, E. Ann; 1 Sep. 1995 204p
Contract(s)/Grant(s): (RTOP 505-59-30-04)
Report No.(s): (NASA-TP-3521; NAS 1.60:3521; L-17445) Avail: CASI HC A10/MF A03

The Langley 16-Foot Transonic Tunnel is a closed-circuit single-return atmospheric wind tunnel that has a slotted octagonal test section with continuous air exchange. The wind tunnel speed can be varied continuously over a Mach number range from 0.1 to 1.3. Test-section plenum suction is used for speeds above a Mach number of 1.05. Over a period of some 40 years, the wind tunnel has undergone many modifications. During the modifications completed in 1990, a new model support system that increased blockage, new fan blades, a catcher screen for the first set of turning vanes, and process controllers for tunnel speed, model attitude, and jet flow for powered models were installed. This report presents a complete description of the Langley 16-Foot Transonic Tunnel and auxiliary equipment, the cal-

ibration procedures, and the results of the 1977 and the 1990 wind tunnel calibration with test section air removal. Comparisons with previous calibrations showed that the modifications made to the wind tunnel had little or no effect on the aerodynamic characteristics of the tunnel. Information required for planning experimental investigations and the use of test hardware and model support systems is also provided.
Author
Fluid Flow; Transonic Wind Tunnels; Wind Tunnel Calibration;

N96-12693# Dayton Univ., OH. Research Inst.
Effect of terrain shape and object grouping on perception of change in altitude in a flight simulator Interim Technical Report, Jun. 1988 - Sep. 1994
Kleiss, James A.; and Hubbard, David C.; May 1995 15 p
Contract(s)/Grant(s): (F33615-90-C-0005)
Report No.(s): (AD-A294608; AL/HR-TR-1994-0169)
Avail: CASI HC A03/MF A01

Previous experiments have revealed that three major types of scene elements are perceived in flight simulator visual scenes: texture on the terrain, discrete objects, and terrain shape. Both texture and vertical objects spaced evenly on the terrain have been shown to affect performance of simulated low-altitude flight tasks. Although terrain shape and object grouping affect scene perception, their importance for performance-based tasks has not been evaluated. The present experiment sought to determine the degree to which terrain shape and object grouping influence detection of altitude change in a flight simulator. Both terrain shape and object grouping were found to have significant positive effects on detection of altitude change. The effects were traced to particular combinations of factors suggesting that relevant information is highly specific in nature. A demonstrated advantage for terrain exhibiting a high density of steeply sloped hills implies that terrain in flight simulators should be rendered with a high degree of accuracy.
DTIC
Altitude; Computer Graphics; Flight Crews; Flight Paths; Flight Simulators; Flight Training; Terrain; Visual Perception;

N96-12860# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
Joint sealants for airfield pavements Final Report, Oct. 1991 - Dec. 1993
Lynch, Larry N.; and Newman, J. K.; Apr. 1995 151 p
Contract(s)/Grant(s): (DTFA01-90-Z-02069)
Report No.(s): (AD-A294754; DOT/FAA/CT-94/53) Avail: CASI HC A08/MF A02

The objective was to evaluate the field performance of five different types of pavement joint sealant materials at five different airports located in varying climatic regions. Each of the sealant materials was installed at all five airports. The same contractor was used to install the sealants at each of the five airports and the same lot number of the various sealants was installed at each airport. The sealants were stored in a temperature-controlled warehouse until they were needed at the job site and 100 percent inspection was provided at each airport. These controls helped to minimize any variations in the service life of the sealants that were not material related. Differential scanning calorimetry and fourier transform infrared spectroscopy were investigated as potential laboratory analysis techniques for joint sealants. The results of the field evaluations indicate the conformance of a sealant material to an appropriate material specification does not automatically signify satisfactory field performance; different types of sealants do perform differently based upon climatic exposure; and no revisions are necessary to procedures listed in the FAA Item P-605 for joint sealing projects. The research delineated the fact that material characterization procedures are needed for pavement joint sealants. These types of procedures could be used in material specifications that would be more indicative of sealant performance.
DTIC
Airports; Chemical Analysis; Environmental Tests; Joints (junctions); Pavements; Runways; Sealers; Sealing;

N96-13039*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
Vertical flight training: An overview of training and flight simulator technology with emphasis on rotary-wing requirements
Alderete, Thomas S.; Ascencio-Lee, Carmen E.; Bray, Richard; Carlton, John; Dohme, Jack; Eshow, Michelle M.; Francis, Stephen; Lee, Owen M.; Lintern, Gavan; and Lombardo, David A.; et al 1994 341 p
Report No.(s): (NASA-RP-1373; NAS 1.61:1373; DOT/FAA/CT-94/83) Avail: CASI HC A15/MF A03

The principal purpose of this publication is to provide a broad overview of the technology that is relevant to the design of aviation training systems and of the techniques applicable to the development, use, and evaluation of those systems. The issues addressed in our 11 chapters are, for the most part, those that would be expected to surface in any informed discussion of the major characterizing elements of aviation training systems. Indeed, many of the same facets of vertical-flight training discussed were recognized and, to some extent, dealt with at the 1991 NASA/FAA Helicopter Simulator Workshop. These generic topics are essential to a sound understanding of training and training systems, and they quite properly form the basis of any attempt to systematize the development and evaluation of more effective, more efficient, more productive, and more economical approaches to aircrew training. Individual chapters address the following topics: an overview of the vertical flight indus-

try: the source of training requirements; training and training schools: meeting current requirements; training systems design and development; transfer of training and cost-effectiveness; the military quest for flight training effectiveness; alternative training systems; training device manufacturing; simulator aero model implementation; simulation validation in the frequency domain; cockpit motion in helicopter simulation; and visual space perception in flight simulators.
Derived from text
Flight Simulation; Flight Training; Pilot Training; Rotary Wing Aircraft; Vertical Flight;

N96-13100*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Flight demonstration of integrated airport surface automation concepts
Jones, Denise R.; and Young, Steven D.; 9 Nov. 1995 7p Presented at the 14th AIAA/IEEE Digital Avionics Systems Conference, Cambridge, MA, 5-9 Nov. 1995
Report No.(s): (NIPS-95-05493; NASA-TM-111126; NAS 1.15:111126) Avail: CASI HC A02/MF A01

A flight demonstration was conducted to address airport surface movement area capacity issues by providing pilots with enhanced situational awareness information. The demonstration showed an integration of several technologies to government and industry representatives. These technologies consisted of an electronic moving map display in the cockpit, a Differential Global Positioning System (DGPS) receiver, a high speed VHF data link, an ASDE-3 radar, and the Airport Movement Area Safety System (AMASS). Aircraft identification was presented to an air traffic controller on AMASS. The onboard electronic map included the display of taxi routes, hold instructions, and clearances, which were sent to the aircraft via data link by the controller. The map also displayed the positions of other traffic and warning information, which were sent to the aircraft automatically from the ASDE-3/AMASS system. This paper describes the flight demonstration in detail, along with preliminary results.
Author
Air Traffic Control; Airfield Surface Movements; Airport Surface Detection Equipment; Collision Avoidance; Flight Instruments; Flight Tests; Global Positioning System; Surface Navigation; Surveillance Radar; Taxiing;

N96-13167*# Lockheed Engineering and Sciences Co., Hampton, VA.
Mass properties calibration of the NASA Langley low frequency vibration test apparatus
Javeed, Mehzad; and Russell, James W.; 1 Sep. 1995 38 p
Contract(s)/Grant(s): (NAS1-19000; RTOP 693-89-00-01)
Report No.(s): (NIPS-95-05577; NASA-CR-198208; NAS 1.26:198208) Avail: CASI HC A03/MF A01

This report presents a description and calibration results of the modified NASA Langley Low Frequency Vibration Test Apparatus. The description includes both the suspension system and the data acquisition system. The test apparatus consists of a 2 inch thick, 21 inch diameter aluminum plate that is suspended from an advanced suspension system using a 40 foot long cable system. The test apparatus employed three orthogonally aligned pairs of Sundstrand QA-700 servo accelerometers that can measure accelerations as low as 1 micro-g. The calibration involved deriving the mass and moments of inertia of the test platform from measured input forces and measured acceleration responses. The derived mass and moments were compared to test platform mass properties obtained initially from measurements with a special mass properties instrument. Results of the calibration tests showed that using the product of the test apparatus mass and the measured accelerations, the disturbance force at the center of gravity (CG) can be determined within 4 percent on all three axes. Similarly the disturbance moments about the X, Y, and Z axes can be determined within 5 percent by using the product of the measured moments of inertia and the angular accelerations about the X, Y, and Z axes.
CASI
Angular Acceleration; Calibrating; Data Acquisition; Servomechanisms; Vibration Tests;

N96-14086# Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.
The Virtual Environment Performance Assessment Battery (VEPAB): Development and evaluation Interim Report, Jul. 1992 - Jun. 1994
Lampton, Donald R.; Knerr, Bruce W.; Goldberg, Stephen L.; Bliss, James P.; Moshell, Michael J.; and Blau, Brian S.; Jun. 1995 71 p
Contract(s)/Grant(s): (DA PROJ. 202-62785-A-790)
Report No.(s): (AD-A297277; ARI-TR-1029) Avail: CASI HC A04/MF A01

The Virtual Environment (VE) Performance Assessment Battery (VEPAS) is a set of tasks developed to support research on training applications of VE technology. VEPAS measures human performance on vision, locomotion, tracking, object manipulation, and reaction time tasks performed on three-dimensional, interactive VEs. It can be used to provide a general orientation for interacting in VEs and to determine entry-level performance and skill acquisition of users. In addition, VEPAB allows comparison of task performance, side effects and aftereffects, and subjective reactions across different VE systems. By providing benchmarks of human performance, VEPAB can promote continuity in training research across different technologies, separate research facilities, and dissimilar subject populations. This report describes the development of VEPAB and summarizes the results of an experiment to test the sensitivity of the tasks to

differences between input control devices and to examine practice effects.
DTIC
Education; Environment Simulation; Human Performance; Human-computer Interface; Psychomotor Performance; Training Evaluation; Training Simulators; Virtual Reality;

N96-14096*# Old Dominion Univ., Norfolk, VA. Dept. of Aerospace Engineering.
Large angle magnetic suspension text fixture Final Report, 1 Apr. - 31 Oct. 1995
Britcher, Colin P.; 1 Nov. 1995 181 p
Contract(s)/Grant(s): (NAG1-1056)
Report No.(s): (NASA-CR-199699; NAS 1.26:199699; NIPS-95-05966) Avail: CASI HC A09/MF A02

In lieu of a final report for this project for the period 1 April 1995 through 31 October 1995, a compilation of three reports are included herein. The three reports are: (1) 'Design and Implementation of a Digital Controller for a Magnetic Suspension and Vernier Pointing System', (2) 'Influence of Eddy Currents on the Dynamic Characteristics of Magnetic Suspensions and Magnetic Bearings', and (3) 'Design and Implementation of a Digital Controller for a Magnetic Suspension and Vernier Pointing System'.
Derived from text
Antenna Design; Eddy Currents; Magnetic Bearings; Magnetic Suspension; Pointing Control Systems;

10 ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

N96-12074# Meteorological Satellite Center, Tokyo (Japan). System Engineering Div.
Requirements of MTSAT/Imager c18
Kigawa, Seiichiro; ed. In its Meteorological Satellite Center Technical Note, No. 30, 1995 Mar. 1995 p 33-39 In ENGLISH and JAPANESE (For primary document see N96-12072 02-47) Avail: CASI HC A02/MF A02

The Multi-functional Transport SATellite (MTSAT) will be launched using Japan's H-2 rocket in 1999 as a successor to the Geostationary Meteorological Satellite-5 (GMS-5). The goals of the MTSAT system are to: maintain the satellite imaging, image data distribution, and meteorological data collection from data collection platforms for meteorological services for a five year mission life; and (2) provide air traffic controls for civil aviation services for a ten year mission life. The imaging function will be performed by the Imager (visible and infrared) Radiometer, part of the MTSAT payloads. The requirements for the imaging function are summarized in table form.
Author (revised)
Data Collection Platforms; Geosynchronous Orbits; Infrared Radiometers; Meteorological Satellites; Meteorological Services; Payloads; Satellite Imagery; Synchronous Platforms;

N96-12749*# Houston Univ., TX. Systems Design Lab.
An analytic model for footprint dispersions and its application to mission design
Rao, J. R. jagannatha; and Chen, Yi-Chao; 3 Nov. 1992 36 p
Contract(s)/Grant(s): (NAG9-616)
Report No.(s): (NIPS-95-05464; NASA-CR-185706; NAS 1.26:185706) Avail: CASI HC A03/MF A01

This is the final report on our recent research activities that are complementary to those conducted by our colleagues, Professor Farrokh Mistree and students, in the context of the Taguchi method. We have studied the mathematical model that forms the basis of the Simulation and Optimization of Rocket Trajectories (SORT) program and developed an analytic method for determining mission reliability with a reduced number of flight simulations. This method can be incorporated in a design algorithm to mathematically optimize different performance measures of a mission, thus leading to a robust and easy-to-use methodology for mission planning and design.
Author
Algorithms; Flight Simulation; Footprints; Load Distribution (forces); Mathematical Models; Missile Trajectories; Reliability Analysis; Statistical Distributions;

N96-13074 Michigan Univ., Ann Arbor, MI.
Second-order analytic solutions for re-entry trajectories Ph.D. Thesis
Kim, Eun-Kyou; 1993 128 p Avail: Univ. Microfilms Order No. DA9409730

With the development of aeroassist technology, either for near-earth orbital transfer with or without a plane change or for planetary aerocapture, it is of interest to have accurate analytic solutions for reentry trajectories in an explicit form. Starting with the equations of motion of a non-thrusting aerodynamic vehicle entering a non-rotating spherical planetary atmosphere, a normalization technique is used to transform the equations into a form suitable for an analytic integration. Then, depending on the type of planar entry modes with a constant angle-of-attack, namely, ballistic flythrough, lifting skip, and equilibrium glide trajectories, the first-order solutions are obtained with the appropriate simplification. By analytic continuation, the second-order solutions for the altitude, speed, and flight path angle are derived. The closed form solutions lead to explicit forms for the

physical quantities of interest, such as the deceleration and aerodynamic heating rates. The analytic solutions for the planar case are extended to three-dimensional skip trajectories with a constant bank angle. The approximate solutions for the heading and latitude are developed to the second order. In each type of trajectory examined, explicit relations among the principal variables are in a form suitable for guidance and navigation purposes. The analytic solutions have excellent agreement with the numerical integrations. They also provide some new results which were not reported in the existing classical theory.
Dissert. Abstr.
Aeroassist; Aerocapture; Equations of Motion; Reentry Trajectories; Trajectory Analysis; Transfer Orbits;

N96-13234*# California Univ., Los Angeles, CA.
Minimal time change detection algorithm for reconfigurable control system and application to aerospace
Kim, Sungwan; 1 Jan. 1994 6 p
Contract(s)/Grant(s): (NCC2-374)
Report No.(s): (NIPS-95-05569; NASA-CR-199529; NAS 1.26:199529) Avail: CASI HC A02/MF A01

System parameters should be tracked on-line to build a reconfigurable control system even though there exists an abrupt change. For this purpose, a new performance index that we are studying is the speed of adaptation- how quickly does the system determine that a change has occurred? In this paper, a new, robust algorithm that is optimized to minimize the time delay in detecting a change for fixed false alarm probability is proposed. Simulation results for the aircraft lateral motion with a known or unknown change in control gain matrices, in the presence of doublet input, indicate that the algorithm works fairly well. One of its distinguishing properties is that detection delay of this algorithm is superior to that of Whiteness Test.
Author
Algorithms; Change Detection; Control Theory; Error Detection Codes; False Alarms; Fault Tolerance; On-line Systems; Time Lag;

N96-13917# Institut Superieur des Affaires, Jouy-en-Josas (France).
A preliminary study of the air data sensing problem on a re-entry vehicle c18
Hettena, E.; In AGARD, Space Systems Design and Development Testing Mar. 1995 8 p (For primary document see N96-13891 02-18) Copyright Avail: CASI HC A02/MF A03

A brief review of different measurement techniques for speed, pressure, and temperature on a re-entry vehicle is given in order to evaluate their applicability and limitations to the design of an air data system. A pressure-sensors based air data system is then assumed and an engineering aerodynamic model is used to investigate the influence of the measurement errors on the relevant air data parameters necessary for light guidance and control.
Author
Aerodynamic Characteristics; Air Data Systems; Flight Characteristics; Reentry Vehicles;

11 CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

N96-13032 Texas A&M Univ., College Station, TX.
A model for dynamic and aeroelastic response of composite structures with damage evolution Ph.D. Thesis
Kim, Young Ik; 1993 134 p Avail: Univ. Microfilms Order No. DA9410819

Damage effects on the dynamic and aeroelastic response of composite (lamina) structures are investigated. The dynamic and aeroelastic responses are shown to depend upon the distribution and accumulation of damage. The continuum damage theory (or the internal state damage theory) is introduced to describe damage. Two damage cases are studied: the first case is based on the assumption that damage state is static (damage is independent of the previous aeroelastic response); the second case is related to the growth of damage which is interacting with aeroelastic responses. The dynamic response and aeroelastic stability are examined in both the time domain and frequency domain. During the time domain analysis the damage evolution laws are employed. Stability characteristics are examined in the frequency domain. A wing-like composite (lamina) plate with clamped boundary is considered. Unsteady aerodynamic loads are provided by piston theory. For analysis purposes, the finite element representation based on the DKT (discrete Kirchhoff triangle) element is employed.
Dissert. Abstr.
Aeroelasticity; Aircraft Structures; Damage; Dynamic Response; Dynamic Structural Analysis; Laminates; Structural Stability;

N96-13798# Southwest Research Inst., San Antonio, TX. Belvoir Fuels and Lubricants Research Facility.
Effect of fuel composition and prestressing on lubricity Interim Report, Oct. 1992 - Mar. 1995
Lacey, P. I.; and Westbrook, S. R.; Aug. 1995 67 p
Contract(s)/Grant(s): (DAAK70-92-C-0059)
Report No.(s): (AD-A297747; TFLRF-307) Avail: CASI HC A04/MF A01

Fuel lubricity -- or the ability of the fuel to prevent wear during sliding -- is sensitive to chemical composition. At present, increasingly severe fuel specifications are being implemented to minimize exhaust emissions. The refinery processes needed to achieve these goals are inadvertently

removing many of the surface-active components necessary for wear resistance. To compound this effect, engine operating conditions are becoming more severe; fuel injection pressures are increasing dramatically, while uncooled engines that use the fuel as a heat sink are also being investigated. The present study investigates the relationship between previously validated laboratory-scale wear tests and various fuels' parameters. In general, fuel lubricity is found to be adversely affected by decreasing sulfur and aromatics content, and appears to be most closely related to diaromatics. Laboratory wear tests and full-scale equipment tests were performed to define the effects of operating temperature and thermal prestressing of the fuel. The effects of temperature on wear appear to be fuel composition sensitive. Indeed, the corrosion inhibitor additives tested had little effect at high temperatures. As a result, it is likely that conventional laboratory-scale wear tests performed at room temperature may not fully reflect real-world operating conditions.
DTIC
Corrosion Prevention; Diesel Fuels; Jet Engine Fuels; Lubrication; Prestressing; Sulfur; Temperature Effects; Thermal Cycling Tests; Thermal Stresses; Wear Resistance; Wear Tests;

12 ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

N96-12173*# Ohio Univ., Athens, OH.
Hybrid system GMSK digital receiver implementation in real time c33
Koshal, Sanjiv; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 40-48 (For primary document see N96-12169 02-01) Avail: CASI HC A02/MF A02

This paper is concerned with the design, simulation, and implementation of a hybrid system using the GMSK type of signal format for phase modulation and demodulation. The performance of the designed transceiver structure is evaluated using the bit error rate (BER) curves. The simulated system was also successfully implemented in real time.
Author
Aircraft Communication; Bit Error Rate; Demodulation; Phase Shift Keying; Transmitter Receivers;

N96-12271# Argonne National Lab., IL.
A permanent-magnet rotor for a high-temperature superconducting bearing
Mulcahy, T. M.; Hull, J. R.; Uherka, K. L.; Abboud, R. G.; (Commonwealth Research Corp., Chicago, IL.)Wise, J. H.; and Carnegie, D. W.; 1995 5 p Presented at the 14th International Conference on Magnet Technology, Tampere, Finland, 11-16 Jun. 1995
Contract(s)/Grant(s): (W-31-109-ENG-38)
Report No.(s): (DE95-014230; ANL/ET/CP-85212; CONF-950691-1) Avail: CASI HC A01/MF A01

Design, fabrication, and performance, of a 1/3-m dia., 10-kg flywheel rotor with only one bearing is discussed. To achieve low-loss energy storage, the rotor's segmented-ring permanent-magnet (PM) is optimized for levitation and circumferential homogeneity. The magnet's carbon composite bands enable practical energy storage.
DOE
High Temperature Superconductors; Levitation; Magnetic Bearings; Permanent Magnets; Rotors; Superconducting Magnets;

N96-12352*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Instantaneous flow measurements in a supersonic wind tunnel using spectrally resolved Rayleigh scattering
Seasholtz, Richard G.; Buggele, Alvin E.; and Reeder, Mark F.; 1 Sep. 1995 16 p Presented at the International Symposium on Optical Science, Engineering, and Instrumentation, San Diego, CA, 9-14 Jul. 1995; sponsored by the Society of Photo-Optical Instrumentation Engineers
Contract(s)/Grant(s): (RTOP 505-62-50)
Report No.(s): (NASA-TM-107042; NAS 1.15:107042; E-9870) Avail: CASI HC A03/MF A01

Results of a feasibility study to apply laser Rayleigh scattering to non-intrusively measure flow properties in a small supersonic wind tunnel are presented. The technique uses an injection seeded, frequency doubled Nd:YAG laser tuned to an absorption band of iodine. The molecular Rayleigh scattered light is filtered with an iodine cell to block light at the laser frequency. The Doppler-shifted Rayleigh scattered light that passes through the iodine cell is analyzed with a planar mirror Fabry-Perot interferometer used in a static imaging mode. An intensified CCD camera is used to record the images. The images are analyzed at several subregions, where the flow velocity is determined. Each image is obtained with a single laser pulse, giving instantaneous measurements.
Author
Flow Measurement; Imaging Techniques; Laser Outputs; Light Scattering; Rayleigh Scattering; Supersonic Wind Tunnels; Yag Lasers;

N96-12729# United Technologies Corp., East Hartford, CT.
An analysis of wake-stator interaction in airfoil cascades Final Report, 15 Dec. 1991 - 14 Jan. 1995

Barnett, M.; and Sondak, D. L.; Mar. 1995 41 p
Contract(s)/Grant(s): (F49620-92-C-0017)
Report No.(s): (AD-A295339; AFOSR-95-0266TR) Avail: CASI HC A03/MF A01

A computational study has been conducted in order to provide insight into the details of the unsteady flow in the leading-edge region of airfoil cascades during wake-stator interaction. The calculations are performed at off-design operating conditions, since the flow at conditions near to those at which stall onset occurs is of particular interest in helping to understand the mechanisms responsible for compressor stall. A thorough understanding of these mechanisms will provide the underpinnings needed to design compressors with favorable stall characteristics, using fewer design iterations than are typical with the present state of the art. The results obtained during this study show that the use of highly refined grids leads to the resolution of complex unsteady phenomena associated with wake-stator interaction. The structure of the interaction is shown to change significantly as the magnitude of the wake deficit is increased, with shedding from the leading-edge separation bubble suppressed compared to that observed for the cases with small wake deficit or no wake disturbance.
DTIC
Boundary Layer Separation; Cascade Flow; Leading Edges; Rotating Stalls; Rotor Stator Interactions; Stator Blades; Turbocompressors; Unsteady Flow; Wakes;

N96-13014*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Mach 10 experimental database of a three-dimensional scramjet inlet flow field
Holland, Scott D.; Sep. 1995 220 p
Contract(s)/Grant(s): (RTOP 506-40-41-02)
Report No.(s): (NASA-TM-4648; L-17349; NAS 1.15:4648) Avail: CASI HC A10/MF A03

The present work documents the experimental database of a combined computational and experimental parametric study of the internal aerodynamics of a generic three-dimensional sidewall compression scramjet inlet configuration at Mach 10. A total of 356 channels of pressure data, including static pressure orifices, pitot pressures, and exit flow rakes, along with oil flow and infrared thermography, provided a detailed experimental description of the flow. Mach 10 tests were performed for three geometric contraction ratios (3, 5, and 9), three Reynolds numbers (0.55 x 10(exp 6) per foot, 1.14 x 10(exp 6) per foot, and 2.15 x 10(exp 6) per foot), and three cowl positions (at the throat and two forward positions). For the higher contraction ratios, a large forward separation of the inflow boundary layer was observed, making the high contraction ratio configurations unsuitable for flight operation. A decrease in the freestream unit Reynolds number (Re) of only a factor of 2 led to a similar upstream separation. Although the presence of such large-scale separations leads to the question of whether the inlet is started, the presence of internal oblique swept shock interactions on the sidewalls seems to indicate that at least in the classical sense, the inlet is not unstarted. The laminar inflow boundary layer therefore appears to be very sensitive to increases in contraction ratio (CR) or decreases in Reynolds number; only the CR = 3 configuration with 0.25, and 50 percent cowl at Re = 2.15 x 10(exp 6) per foot operated 'on design'.
Author
Computational Fluid Dynamics; Engine Inlets; Flow Distribution; Hypersonic Speed; Inlet Flow; Internal Flow; Laminar Boundary Layer; Oblique Shock Waves; Pressure Measurement; Shock Wave Interaction; Supersonic Combustion Ramjet Engines; Three Dimensional Flow; Wind Tunnel Tests;

N96-13078*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering.
A concept for transition mapping on a 10 deg-cone in the National Transonic Facility using flow-pressure variation Technical Report, Nov. 1993 - Aug. 1995
Gartenberg, Ehud; Sep. 1995 49 p
Contract(s)/Grant(s): (NAS1-19858; RTOP 505-59-54-01)
Report No.(s): (NASA-CR-198209; NAS 1.26:198209) Avail: CASI HC A03/MF A01

A conceptual study was performed to define a technique for mapping the boundary-layer transition on a 10 deg-Cone in the National Transonic Facility (NTF) as a means of determining this cryogenic-tunnel suitability for laminar flow testing. A major challenge was to devise a test matrix using a fixed surface pitot probe, varying the flow pressure to pr oduce the actual Reynolds numbers for boundary-layer transition. This constraint resulted from a lack of a suitable and reliable electrical motor to drive the probe along the cone's surface under cryogenic flow conditions. The initial phase of this research was performed by the author in collaboration with the late Dr. William B. Igoe from the Aerodynamics Division at NASA Langley Research Center. His comments made during the drafting of this document were invaluable and a source of inspiration.
Author
Boundary Layer Transition; Cones; Cryogenics; Laminar Flow; Pressure Distribution; Pressure Measurement; Reynolds Number; Transonic Wind Tunnels; Wind Tunnel Tests;

N96-13130 Northwestern Univ., Evanston, IL.
Fatigue reliability method with in-service inspections Final Report
Fleming, M.; Harkness, H.; Moran, B.; and Belytschko, T.; May 1995 28 p Limited Reproducibility: More than 20% of this document may be affected by poor print
Report No.(s): (AD-A295795; DOT/FAA/CT-94/88) Avail: Issuing Activity (Defense Technical Information Center

(DTIC))

The first order reliability method (FORM) has traditionally been applied to probabilistic fatigue analyses for single inspection intervals. Accounting for inspections then requires several sequential FORM analyses and that the random distribution of crack lengths be recharacterized following each inspection. The augmented FORM presented here allows the reliability analyses to span several inspection periods without explicit characterization of the crack length distribution subsequent to each inspection. The method thereby preserves the attractive feature of FORM in that relatively few realizations in the random variable space need to be considered. Examples are given which show that the present methodology gives estimates which are in good agreement with the Monte Carlo simulations and is efficient even for complex components.

DTIC

Aircraft Construction Materials; Commercial Aircraft; Crack Propagation; Fatigue (materials); Fatigue Tests; Nondestructive Tests; Prediction Analysis Techniques; Reliability Analysis;

N96-13245*# Sverdrup Technology, Inc., Brook Park, OH.

Aerodynamic evaluation of two compact radial-inflow turbine rotors

Simonyi, P. Susan; Roelke, Richard J.; (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.)Stabe, Roy G.; Nowlin, Brentley C.; (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.)and Dicicco, Danielle; (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.) Jul. 1995 71 p

Contract(s)/Grant(s): (RTOP 505-62-10)

Report No.(s): (NASA-TP-3514; E-9213; NAS 1.60:3514)

Avail: CASI HC A04/MF A01

The aerodynamic evaluation of two highly loaded compact radial turbine rotors was conducted at the NASA Lewis Research Center Small Engine Component Test Facility (SECTF). The experimental results were used for proof-of-concept, for modeling radial inflow turbine rotors, and for providing data for code verification. Two rotors were designed to have a shorter axial length, up to a 10-percent reduced diameter, a lighter weight, and equal or higher efficiencies with those of conventional radial inflow turbine rotors. Three configurations were tested: rotor 1, having a 40-percent shorter axial length, with the design stator (stator 1); rotor 1 with the design stator vanes closed down (stator 2); and rotor 2, slightly shorter axially and having higher loading, with stator 2. The stator had 36 vanes and the rotors each had 14 solid blades. Although presently uncooled, the rotor blades were designed for thicknesses which would allow cooling passages to be added. The overall stage performance measurements and the rotor and stator exit flow field surveys were obtained. Measurements of steady state temperatures, pressures, mass flow rates, flow angles, and output power were made at various operating conditions. Data were obtained at corrected speeds of 80, 90, 100, 110, and 120 percent of design over a range of equivalent inlet-to-exit pressure ratios of 3.5, 4.0, 4.5, and 5.0, the maximum pressure ratio achieved. The test showed that the configuration of rotor 1 with stator 1 running at the design pressure ratio produced a flow rate which was 5.6 percent higher than expected. This result indicated the need to close down the stator flow area to reduce the flow. The flow area reduction was accomplished by restaggering the vanes. Rotor 1 was retested with the closed-down stator vanes and achieved the correct mass flow. Rotor 2 was tested only with the restaggered vanes. The test results of the three turbine configurations were nearly identical. Although the measured efficiencies of the compact designs fell 2 to 3 points below the predicted efficiency of 91 percent, they did meet and exceed by up to 2.5 percentage points the efficiences of state-of-the-art turbines found in the literature.

Author

Aerodynamics; Engine Design; Engine Parts; Performance Tests; Radial Flow; Test Facilities; Turbine Wheels;

N96-13354*# Arizona State Univ., Tempe, AZ. Dept. of Mechanical and Aerospace Engineering.

Hybrid laminar flow control experiments in the NASA - Ames, 11-foot tunnel

Saric, William S.; Jul. 1995 22 p

Contract(s)/Grant(s): (NCA2-745)

Report No.(s): (NASA-CR-199360; NAS 1.26:199360)

Avail: CASI HC A03/MF A01

It was proposed to design and conduct experiments in the NASA-Ames Research Center, 11-foot wind tunnel, that would assess the role of freestream turbulence and surface roughness on swept-wing transition to turbulence. The work was to be a cooperative effort that had direct application to hybrid laminar flow control (HLFC) airfoils. The first part of the proposed work, initiated in FY92 and continued into FY93, concentrated on the design of such an experiment whose results may be compared with results obtained in other wind-tunnel facilities. At the same time, concurrent work in the Arizona State University (ASU) Unsteady Wind Tunnel would be conducted on the effects of surface roughness. The second part of the work, which was to be initiated in FY94, would have consisted of experiments conducted in both the 11-foot tunnel at NASA-Ames and the ASU Unsteady Wind Tunnel. However, this work was not continued. This report summarizes the experimental design considerations and some preliminary experiments that made up the first part of the work.

Author

Boundary Layer Control; Boundary Layer Transition; Drag Reduction; Laminar Boundary Layer; Surface Roughness

Effects; Swept Wings; Turbulence Effects; Wind Tunnel Tests;

N96-13474*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
Heat transfer predictions for two turbine nozzle geometries at high Reynolds and Mach numbers
Boyle, R. J.; and Jackson, R.; (Defence Research Agency, Farnborough, Hampshire, England.) Sep. 1995 18 p Presented at the 40th Gas Turbine and Aeroengine Congress and Exposition, Houston, TX, 5-8 Jun. 1995; sponsored by ASME
Contract(s)/Grant(s): (RTOP 505-62-52)
Report No.(s): (NASA-TM-106956; E-9706; NAS 1.15:106956) Avail: CASI HC A03/MF A01

Predictions of turbine vane and endwall heat transfer and pressure distributions are compared with experimental measurements for two vane geometries. The differences in geometries were due to differences in the hub profile, and both geometries were derived from the design of a high rim speed turbine (HRST). The experiments were conducted in the Isentropic Light Piston Facility (ILPF) at Pyestock at a Reynolds number of 5.3 x 10(exp 6), a Mach number of 1.2, and a wall-to-gas temperature ratio of 0.66. Predictions are given for two different steady-state three-dimensional Navier-Stokes computational analyses. C-type meshes were used, and algebraic models were employed to calculate the turbulent eddy viscosity. The effects of different turbulence modeling assumptions on the predicted results are examined. Comparisons are also given between predicted and measured total pressure distributions behind the vane. The combination of realistic engine geometries and flow conditions proved to be quite demanding in terms of the convergence of the CFD solutions. An appropriate method of grid generation, which resulted in consistently converged CFD solutions, was identified.
Author
Aerodynamic Heat Transfer; Computational Fluid Dynamics; Guide Vanes; High Reynolds Number; Nozzle Geometry; Transonic Flow; Turbines; Turbulence Models;

N96-13476# Vibration Inst., Willowbrook, IL.
Life extension of aging machinery and structures Report, 1 Jan. - 20 Apr. 1995
Pusey, Henry C.; and Pusey, Sallie C.; 20 Apr. 1995 420p Presented at the 49th Meeting of the Society for Machinery Failure Prevention Technology, Virginia Beach, VA, 18-20 Apr. 1995
Report No.(s): (AD-A295371; MFPT-49) Avail: CASI HC A18/MF A04

This document presents the proceedings of the 49th meeting of the Society for Machinery Failure Prevention Technology (MFPT) which was held in Virginia Beach, Virginia on April 18-20, 1995. There are session papers on Failure Analysis, Diagnostics, Life Extension, Sensors Technology, Time Frequency Analysis and Detection, and Monitoring and Response.
DTIC
Aging (materials); Aircraft Maintenance; Life (durability); Machinery; Structural Analysis;

N96-13522*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
A comparison of hypersonic vehicle flight and prediction results
Iliff, Kenneth W.; and Shafer, Mary F.; Washington, DC United States NASA Washington 1 Oct. 1995 44 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, United States, 11-14 Jan. 1993
Contract(s)/Grant(s): (RTOP 505-65-50)
Report No.(s): (NASA-TM-104313; NAS 1.15:104313; H-2074; AIAA PAPER 93-0311; NIPS-95-05906) Avail: CASI HC A03/MF A01

Aerodynamic and aerothermodynamic comparisons between flight and ground test for four hypersonic vehicles are discussed. The four vehicles are the X-15, the Reentry F, the Sandia Energetic Reentry Vehicle Experiment (SWERVE), and the Space Shuttle. The comparisons are taken from papers published by researchers active in the various programs. Aerodynamic comparisons include reaction control jet interaction on the Space Shuttle. Various forms of heating including catalytic, boundary layer, shock interaction and interference, and vortex impingement are compared. Predictions were significantly exceeded for the heating caused by vortex impingement (on the Space Shuttle OMS pods) and for heating caused by shock interaction and interference on the X-15 and the Space Shuttle. Predictions of boundary-layer state were in error on the X-15, the SWERVE, and the Space Shuttle vehicles.
Author
Aerothermodynamics; Boundary Layer Transition; Ground Tests; Hypersonic Vehicles; Reentry Effects; Reentry Vehicles; Space Shuttles;

N96-13592# Technical Univ. of Denmark, Lyngby (Denmark). Dept. of Fluid Mechanics.
A viscous-inviscid interaction model for rotor aerodynamics c34
Filippone, A.; and Sorensen, J. N.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 10 p Sponsored in part by CIRA S.p.A. (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

This paper presents a numerical model for viscous-inviscid interactive computations of rotor flows. The model presented is fairly general, as it allows for both steady and unsteady calculations. The basic methodology for deriving the outer inviscid solution is a fully three-dimensional

boundary element method. The inner viscous domain, i.e. the boundary layer, is described by the two-dimensional Navier-Stokes equations. For the interactive procedure a blade strip approach is used. The outer inviscid solution provides the distribution of induced velocities to be used as boundary condition for the Navier-Stokes solver. The outer solution is then updated with new boundary conditions, arising from the viscous effects. For unsteady flow calculations a time marching procedure is used. Some preliminary results are presented for the rotor blade of a wind turbine.
Author
Boundary Element Method; Computational Fluid Dynamics; Inviscid Flow; Navier-stokes Equation; Rotor Aerodynamics; Time Marching; Turbine Blades; Unsteady Flow; Velocity Distribution; Viscous Flow; Wind Turbines;

N96-13597# Textron Bell Helicopter, Fort Worth, TX.
Computational fluid dynamics development and validation at Bell Helicopter c34
Narramore, J. C.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 13 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

An overview of the development of the Computational Fluid Dynamics (CFD) methodology at Bell Helicopter Textron is given. As new technologies have been developed their functionality has been assessed by their ability to reproduce wind tunnel measurements in a timely manner. Examples of some of these correlation study results are provided.
Author
Aerodynamic Drag; Angle of Attack; Computational Fluid Dynamics; Data Correlation; Dynamic Pressure; Flow Visualization; Helicopters; Lift; Navier-stokes Equation; Pitching Moments; Rotor Aerodynamics;

N96-13756*# Jackson and Tull, Inc., Albuquerque, NM.
The Cryogenic Test Bed experiments: Cryogenic heat pipe flight experiment CRYOHP (STS-53). Cryogenic two phase flight experiment CRYOTP (STS-62). Cryogenic flexible diode flight experiment CRYOFD c34
Thienel, Lee; and Stouffer, Chuck; (OAO Corp., Lanham, MD.) In NASA. Goddard Space Flight Center, The 1995 Shuttle Small Payloads Symposium Sep. 1995 p 21-30 (For primary document see N96-13754 02-12) Avail: CASI HC A02/MF A03

This paper presents an overview of the Cryogenic Test Bed (CTB) experiments including experiment results, integration techniques used, and lessons learned during integration, test and flight phases of the Cryogenic Heat Pipe Flight Experiment (STS-53) and the Cryogenic Two Phase Flight Experiment (OAST-2, STS-62). We will also discuss the Cryogenic Flexible Diode Heat Pipe (CRYOFD) experiment which will fly in the 1996/97 time frame and the fourth flight of the CTB which will fly in the 1997/98 time frame. The two missions tested two oxygen axially grooved heat pipes, a nitrogen fibrous wick heat pipe and a 2-methylpentane phase change material thermal storage unit. Techniques were found for solving problems with vibration from the cryo-collers transmitted through the compressors and the cold heads, and mounting the heat pipe without introducing parasitic heat leaks. A thermally conductive interface material was selected that would meet the requirements and perform over the temperature range of 55 to 300 K. Problems are discussed with the bi-metallic thermostats used for heater circuit protection and the S-Glass suspension straps originally used to secure the BETSU PCM in the CRYOTP mission. Flight results will be compared to 1-g test results and differences will be discussed.
Author
Compressors; Cryogenics; Diodes; Flight Tests; Heat Pipes; Heat Storage; Postflight Analysis; Test Stands; Thermostats; Two Phase Flow;

N96-13813# Naval Postgraduate School, Monterey, CA.
Pressure sensitive paint measurement on a rotor M.S. Thesis
Varner, Donald R.; Mar. 1995 66 p
Report No.(s): (AD-A297733) Avail: CASI HC A04/MF A01

Toward the development of a measurement system for transonic compressor rotors, the static pressure field over a high-speed test rotor was recorded using pressure sensitive paint (PSP) and an electronically-gated, intensified CCD video camera and frame-grabber. Semi-conductor digital logic circuits were developed to form a phase-locked image capture system which acquired ultra-high-speed, low-light-level gated images once per revolution (1/Rev). A monostable pulse circuit was developed to sum more than 200 gated images over a one-second integration period to build a single image. Rotor speed was measured on an oscilloscope using the 1/Rev trigger-pulse. Also, a pressure vessel was constructed and used to calibrate the PSP over varying pressure and temperature ranges to yield qualitative image intensity versus pressure data. Finally, the static pressure field data over the rotor surface was measured and presented as a 256 grey-scale and color image.
DTIC
Compressor Rotors; Paints; Pressure Distribution; Pressure Measurement; Rotor Blades; Static Pressure; Transonic Compressors;

N96-13828 Duke Univ., Durham, NC.
On the nonlinear aeroelasticity of panels Ph.D. Thesis
Reynolds, Robert R.; 1993 136 p Avail: Univ. Microfilms Order No. DA9416888

The nonlinear aeroelasticity of thin, elastic panels in supersonic and subsonic air flows is studied. Two-dimensional panels in high Mach-number supersonic and low

velocity (incompressible) subsonic flows are modeled using nonlinear, large deflection plate equations. Solutions of the governing partial differential equations are obtained via numerical integration. It is found that, for supersonic flow, the panel can flutter periodically or aperiodically. The critical dynamic pressure that leads to this dynamic instability can depend upon the initial conditions of the panel (e.g. the modal displacements and velocities). The complexity of the aperiodic motion is measured using fractal dimension estimates and Karhunen-Loeve decomposition. It is shown that the motion is of relatively low dimension (D approximately equal to 2). The panel in subsonic flow is shown to be statically stable for all dynamic pressures when structural damping is present. This result is verified using a two-mode, dynamic, linear stability analysis about the nonlinear, static equilibria of the panel. In addition, experimental studies of the divergence behavior of elastic panels were conducted in a low speed wind tunnel. These tests showed that a panel with clamped span-wise edges and free leading and trailing edges undergoes a static divergence type instability. This divergence has two forms. In the first case, the shape of the diverged panel is that of one of the natural bending modes of the panel. The aspect ratio of the panel determines which mode dominates this behavior. The second type of divergence is a localized, large deflection near the leading edge of the panel. If severe enough, this latter behavior may inhibit bending mode divergence.
Dissert. Abstr.
Aeroelasticity; Flutter Analysis; Panel Flutter; Panels; Structural Stability; Subsonic Flutter; Supersonic Flutter; Wind Tunnel Tests;

N96-13871# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany).
HPM coupling to a cylindrical target with selected built-in components c32
Magg, M.; and Nitsch, J. B.; (NBC Defense Research and Development Inst., Munster, Germany.) In AGARD, High Power Microwaves (HPM), Volume 1 Mar. 1995 10 p (For primary document see N96-13860 02-32) Copyright Avail: CASI HC A02/MF A03

A numerical simulation of HPM coupling to small missiles is described. The main interest is the current induced on the interior cabling in the resonance region. The results of the numerical solution agree very well with real measurements performed on a test model. For a more realistic missile design we will find a very big reduction of the HPM coupling into the missile if its metallic fin system is replaced by a nonconducting one. Finally, we comment on the relation between maximum possible response and the shape of the incident microwave pulse.
Author
Cylindrical Bodies; Electromagnetic Coupling; Microwaves; Missile Design; Targets;

N96-13872# Fraunhofer-Inst. fuer Naturwissenschaftlich-Technische Trendanalysen, Euskirchen (Germany).
Coupling measurements on intelligent missiles at microwave frequencies c32
Braun, CH.; Guidi, P.; and Schmidt, H. U.; In AGARD, High Power Microwaves (HPM), Volume 1 Mar. 1995 13p (For primary document see N96-13860 02-32) Copyright Avail: CASI HC A03/MF A03

This paper describes our low power microwave coupling measurements on terminally guided missiles in the frequency range between 100 and 8000 MHz. The plane wave excitation experiments have been carried out in our field coupling facility, which consists of an asymmetric triplate transmission line with maximum field levels of about 40 V/m in the working volume. As test objects we examined five (semi) autonomous guided missiles. Three of them, former experimental studies from the Diehl company (GE), are presented in this paper. The test objects were positioned in the simulator in three orthogonal orientation with respect to the external field and were not connected to a power supply (inactive condition). In order to be able to systematically analyze the interaction of the external electromagnetic fields with the avionics and its wiring, we had to divide the investigations into three independent phases, namely, external interaction with the fuselage, mode of penetration to the interior of the missile and excitation of the electrical systems and the cabling. The coupling paths depend very much on the design principles of the airframe. The main threat identified was back door coupling via those wings and fins, which are not attached galvanically to the outer surface of the hull. Because of flight guidance, these parts are fastened through slots to the bearings of the motor drives inside the missile. The dominant cable resonances sometimes can be traced back to the resonances of the wings and/or fins and the type of cabling. Another threat was coupling via the long slots required for the folding wings. These shafts penetrate the whole body and enable the external fields to couple into the interior. The peak amplitudes at the ends of the cables were found to be between 50 to 500 (micro A/(V/m)), depending on the test object.
Author
Airframes; Avionics; Microwave Coupling; Microwave Frequencies; Missiles; Plane Waves; Transmission Lines; Wiring;

N96-13947# Stanford Univ., CA.
Graduate student support in supersonic diagnostics and flow, (FY91 AASERT) Final Technical Report, 15 Jun. 1992 - 14 Jun. 1995
Bowman, Craig T.; 14 Jul. 1995 3 p
Contract(s)/Grant(s): (F49620-92-J-0327)
Report No.(s): (AD-A297936; AFOSR-95-0533TR) Avail: CASI HC A01/MF A01

This project is directed toward obtaining a more fundamental understanding of mixing and chemical reaction in supersonic flows. The research effort comprises three interrelated elements: (1) an experimental study of mixing and combustion in a supersonic plane mixing layer; (2) development of laser-based diagnostics for high-speed flows; and, (3) simulations of compressible reacting flows.
DTIC
Mixing Layers (fluids); Reacting Flow; Supersonic Combustion; Supersonic Flow;

N96-14016 Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
The dependence of the time-asymptotic structure of 3-D vortex breakdown on boundary and initial conditions Ph.D. Thesis
Tromp, Jeffrey Curtis; Jul. 1995 251 p Limited Reproducibility: More than 20% of this document may be affected by poor print
Report No.(s): (AD-A297454; AFIT/DS/ENY/95-4) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The three-dimensional, compressible Navier-Stokes equations are solved numerically to simulate vortex breakdown in tubes. Time integration is performed with an implicit Beam-Warming algorithm, which uses fourth-order compact operators to discretize spatial derivatives. Initial conditions are obtained by solving the steady, compressible, and axisymmetric form of the Navier-Stokes equations using Newton's method. Stability of the axisymmetric initial conditions is assessed through 3-D time integration. Unique axisymmetric solutions at a Reynolds number of 250 lose stability to 3-D disturbances at a critical value of vortex strength, resulting in 3-D and time-periodic flow. Axisymmetric solutions at a Reynolds number of 1000 contain regions of nonuniqueness. Within this region, 3-D time integration reveals only unique solutions, with nonunique, axisymmetric initial conditions converging to a unique solution that is steady and axisymmetric. Past the primary limit point, which approximately identifies critical flow, the solutions bifurcate into 3-D periodic flows.
DTIC
Axisymmetric Flow; Boundary Conditions; Compressible Flow; Computational Fluid Dynamics; Flow Visualization; Mathematical Models; Navier-stokes Equation; Three Dimensional Flow; Time Dependence; Vortex Breakdown; Vortices;

13 GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

N96-12390 Tufts Univ., Medford, MA.
VHF lightning sensors and field measurements: An application to airport weather monitoring Ph.D. Thesis
Friel, III, Patrick Joseph; 1993 178 p Avail: Univ. Microfilms Order No. DA9407527

This work develops tools for evaluating VHF lightning location sensors. Such sensors may be used to predict convective weather phenomena that are hazardous to aviation, particularly microbursts. VHF or UHF sensors are prime candidates to collect the desired cloud-to-ground and intracloud location data because these sensors can locate intracloud flashes better than existing wide areas sensors. Local area VHF lightning location systems are evaluated with respect to their suitability in providing accurate three-dimensional source position. The systems considered use time difference of arrival (TDOA) and interferometric measuring techniques. A hybrid system which uses both techniques is also considered. Wideband (6 MHz) VHF lightning radiation data was obtained at an Orlando, Florida site. Wideband data are presented in terms of a 'duty cycle' which is defined in this work. Duty cycle should be a useful tool in evaluating detection efficiency. The study suggests the modeling of VHF radiation as a log normal rather than Gaussian random process. An algorithm is described which separates impulsive radiation from the more continuous radiation that occurs in lightning flashes. This algorithm can be used to provide real-time impulsive lightning data to TDOA systems. The algorithm can also be used as a tool to understand the statistical nature of lightning. A cost-effective, five-site TDOA system with a site spacing of 1 km is presented and evaluated for possible airport deployment.
Dissert. Abstr.
Aviation Meteorology; Interferometry; Lightning; Meteorological Instruments; Radio Meteorology; Very High Frequencies; Weather Stations;

N96-12401# Range Commanders Council, White Sands Missile Range, NM. Meteorology Group.
Catalog of atmospheric acoustic prediction models
Jun. 1995 52 p
Report No.(s): (AD-A296731; RCC-383-95) Avail: CASI HC A04/MF A01

This document contains, in its early chapters, some background information on acoustic propagation effects, explosion characteristics, and atmospheric effects of explosions as well as a brief explanation of sonic booms and their effects. In the latter chapters, summaries and descriptions of

a number of models currently in use at various member ranges have been provided.
DTIC
Acoustic Propagation; Acoustic Properties; Acoustic Velocity; Atmospheric Attenuation; Atmospheric Effects; Catalogs (publications); Explosions; Sonic Booms; Sound Pressure; Sound Waves; Transmission Loss;

N96-13672*# State Univ. of New York, Albany, NY. Atmospheric Sciences Research Center.
Radon measurements aboard the Kuiper Airborne Observatory c46
Kritz, Mark A.; and Rosner, Stefan W.; In Astronomical Society of the Pacific, Airborne Astronomy Symposium on the Galactic Ecosystem: From Gas to Stars to Dust, Volume 73 1995 p 353-356 (For primary document see N96-13618 02-88) Avail: CASI MF A06

We have carried out three (piggyback) radon-related projects aboard the KAO. The first, which was limited to upper tropospheric measurements while in level flight, revealed the systematic occurrence of unexpectedly high radon concentrations in this region of the atmosphere. The second project was an instrument development project, which led to the installation of an automatic radon measurement system aboard the NASA ER-2 High Altitude Research Aircraft. In the third, we installed a new system capable of collecting samples during the normal climb and descent of the KAO. The results obtained in these projects have resulted in significant contributions to our knowledge of atmospheric transport processes, and are currently playing a key role in the validation of global circulation and transport models.
Author
Air Sampling; Atmospheric Circulation; Atmospheric Composition; Radon; Stratosphere; Trace Elements; Troposphere;

N96-13996# Naval Postgraduate School, Monterey, CA.
Operational evaluation of surveillance effectiveness for airborne search of maritime regions M.S. Thesis
Johnston, David L.; Mar. 1995 88 p
Report No.(s): (AD-A297682) Avail: CASI HC A05/MF A01

Airborne maritime surveillance missions are time consuming, resource intensive activities, that must be carefully planned if poor utilization of highly expensive assets is to be avoided. This thesis develops a decision aid to provide aircraft tasking authorities with accurate estimates of target detection probabilities for different size search areas, using the surface traffic characteristics and predicted sensor performance for the area of operations. The decision aid uses simulation to evaluate estimates of surveillance effectiveness to a level of accuracy and sophistication not previously available. Surveillance estimates are calculated using mission-specific aircraft, sensor, and scenario information. The model can be utilized for a wide variety of aircraft/sensor combinations and blue water mission scenarios. Surveillance estimates are presented graphically for each evaluated search area size. This facilitates the selection of the correct size to achieve a desired level of surveillance effectiveness or provides a measure of the aircraft's surveillance effectiveness for a given size search area.
DTIC
Aerial Reconnaissance; Marine Environments; Mission Planning; Radar Detection; Reconnaissance Aircraft; Search Radar; Surveillance; System Effectiveness;

14 LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

No abstracts in this category.

15 MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

N96-12178*# Princeton Univ., NJ. Lab. for Control and Automation.
Research of Stochastic Robustness: Results and conclusions c63
Marrison, Chris; In NASA. Langley Research Center, FAA/NASA Joint University Program for Air Transportation Research: 1993-1994 Aug. 1995 p 82-92 (For primary document see N96-12169 02-01) Avail: CASI HC A03/MF A02

With stochastic robustness we are creating tools to design robust compensators for practical systems. During this year, the stochastic robustness research achieved the following results: refined the search tools needed for synthesis; successfully designed robust compensators for the American Controls Conference benchmark problem; and successfully designed robust compensators for a nonlinear hypersonic aircraft model with uncertainties in 28 parameters.
Derived from text
Compensators; Control Systems Design; Feedback Control; Genetic Algorithms; Linear Quadratic Regulator; Robustness (mathematics); Stochastic Processes;

N96-12436 Michigan Univ., Ann Arbor, MI.
Full order eigenpair perturbations with mode tracking applications in aeroelasticity and optimization Ph.D. Thesis

Eldred, Michael Scott; 1993 124 p Avail: Univ. Microfilms Order No. DA9409681

General methodology for calculating changes in eigenvalues and eigenvectors resulting from parameter perturbations in the eigenproblems is presented for self-adjoint and nonself-adjoint cases. Perturbing the eigenproblems and retaining all terms leads to coupled equations for the eigenpair perturbations which must be solved iteratively. The familiar singularity in the solution for the eigenvector change is removed using Nelson's method, which is successful despite the approximate nature of the singularity. The normalization task necessary for the eigenvector perturbation also retains all terms, leading to a quadratic equation for a weighting factor which, for the self-adjoint case, has a uniquely defined correct root. For the nonself-adjoint case, magnitude normalization is not sufficient to define unique perturbed left and right eigenvectors, and an additional phase correction is imposed. Enhancements to the basic algorithm that are discussed are the use of under-relaxation and the computation of perturbations in the presence of repeated eigenvalues. The resulting algorithms, the higher order eigenpair perturbation algorithm (HOEP) and its complex extension (C-HOEP), are robust in that they can converge to the exact eigenpairs for very large parameter perturbations. Mode tracking techniques are developed and applied to problems in structural optimization and aeroelastic analysis. The goal is to eliminate difficulties caused by 'mode-switching' (i.e. frequency crossing). Out of several candidate methods, two methods for mode tracking are successful. The first method is the higher order eigenpair perturbation algorithm. By computing perturbations for each eigenpair individually, it maintains the correspondence between the baseline and perturbed eigenpairs. The second method is the cross-orthogonality check method which uses mass orthogonality (self-adjoint case) or mass biorthogonality (nonself-adjoint case) to reestablish correspondence after a standard reanalysis. Applications of mode tracking technology that are presented are frequency-constrained optimization, optimization with mode shape constraints, V-g aeroelastic analysis, and p-k aeroelastic analysis. Each application procedure is outlined and examples are given. Recommendations are made based on method efficiency and robustness in the example problems.
Dissert. Abstr.

Aeroelasticity; Eigenvalues; Eigenvectors; Perturbation; Structural Analysis; Structural Design;

N96-12948*# Allied-Signal Aerospace Co., Teterboro, NJ. Bendix Test Systems Div.

Embedding CLIPS in a database-oriented diagnostic system c61

Conway, Tim; In NASA. Johnson Space Center, First CLIPS Conference Proceedings, Volume 2 15 Aug. 1990 p 765-770 (For primary document see N96-12913 02-63) Avail: CASI HC A02/MF A04

This paper describes the integration of C Language Production Systems (CLIPS) into a powerful portable maintenance aid (PMA) system used for flightline diagnostics. The current diagnostic target of the system is the Garrett GTCP85-180L, a gas turbine engine used as an Auxiliary Power Unit (APU) on some C-130 military transport aircraft. This project is a database oriented approach to a generic diagnostic system. CLIPS is used for 'many-to-many' pattern matching within the diagnostics process. Patterns are stored in database format, and CLIPS code is generated by a 'compilation' process on the database. Multiple CLIPS rule sets and working memories (in sequence) are supported and communication between the rule sets is achieved via the export and import commands. Work is continuing on using CLIPS in other portions of the diagnostic system and in reimplementing the diagnostic system in the Ada language.
Author

Artificial Intelligence; C (programming Language); Computer Programming; Computer Systems Design; Data Base Management Systems; Embedding; Interprocessor Communication; Pattern Registration; Systems Integration;

N96-12949*# Southwest Research Inst., San Antonio, TX.

UFC advisor: An AI-based system for the automatic test environment c61

Lincoln, David T.; and Fink, Pamela K.; In NASA. Johnson Space Center, First CLIPS Conference Proceedings, Volume 2 15 Aug. 1990 p 771-782 (For primary document see N96-12913 02-63) Avail: CASI HC A03/MF A04

The Air Logistics Command within the Air Force is responsible for maintaining a wide variety of aircraft fleets and weapon systems. To maintain these fleets and systems requires specialized test equipment that provides data concerning the behavior of a particular device. The test equipment is used to 'poke and prod' the device to determine its functionality. The data represent voltages, pressures, torques, temperatures, etc. and are called testpoints. These testpoints can be defined numerically as being in or out of limits/tolerance. Some test equipment is termed 'automatic' because it is computer-controlled. Due to the fact that effective maintenance in the test arena requires a significant amount of expertise, it is an ideal area for the application of knowledge-based system technology. Such a system would take testpoint data, identify values out-of-limits, and determine potential underlying problems based on what is out-of-limits and how far. This paper discusses the application of this technology to a device called the Unified Fuel Control (UFC) which is maintained in this manner.
Author

Aircraft Maintenance; Artificial Intelligence; Automatic Control; Computer Systems Design; Expert Systems; Fuel Control; Knowledge Based Systems; Knowledge Bases (artificial Intelligence);

N96-13073 Michigan Univ., Ann Arbor, MI.
A quadtree-based adaptively-refined Cartesian-grid algorithm for solution of the Euler equations Ph.D. Thesis
Dezeeuw, Darren L.; 1993 147 p Avail: Univ. Microfilms Order No. DA9409674

A method for solution of the steady two-dimensional Euler equations is presented. The scheme is designed to overcome the difficulties associated with geometric complexity and the existence of disparate length scales in the computed flow-fields. An adaptively-refined Cartesian grid defined by a tree-based data structure is used. Connectivity information is obtained from the data tree via the parent/children relationships of the cells. Initial grid generation is enhanced by geometry-based cell adaptation. The solution is converged to a steady state using a linear reconstruction and an approximate Riemann solver. Multi-stage time stepping and multigrid convergence acceleration are used to advance the solution in time. Solution adaptation is achieved through the use of solution-based gradient information. This enables the grid resolution to match more closely the local length scales of the flow. The initial grid is generated with a minimum of user input for any complex configurations. The user need only specify a set of points defining the bodies, the base grid resolution, and cell size thresholds for the geometry-based adaptation. With proper thresholds, the grid is automatically adapted to the curvature of a body, providing the resolution required to resolve that body adequately. The grid is then improved through the use of solution-based adaptation. The difficulties associated with the small cut cells created by the arbitrary way that the Cartesian grid cuts through the body are overcome by using local time-stepping, coupled with a linear reconstruction method designed specifically for unstructured grids. The solutions obtained show the second-order global accuracy of the scheme. Results are presented for airfoils at subsonic, transonic, and supersonic speeds. The results compare favorably with benchmark solutions on structured grids with substantially more cells. Also included are a channel flow, several axisymmetric jet flows, and several multi-element airfoil flows. In all cases, the small cut cells generated by the intersection of the body with the Cartesian grid have no adverse effect on the smoothness of the solution. The broad range of results presented demonstrates the geometric flexibility of this approach, as well as the accuracy and efficiency attainable by solution-based adaptation.
Dissert. Abstr.
Algorithms; Computational Fluid Dynamics; Grid Generation (mathematics); Steady Flow; Structured Grids (mathematics); Two Dimensional Flow;

N96-13157*# Washington Univ., Seattle, WA. Dept. of Aeronautics and Astronautics.
Development of an automatic block generation algorithm Final Report
Eberhardt, Scott; and Kim, Byoungsoo; 1 Jan. 1995 18 p
Contract(s)/Grant(s): (NCC2-5099)
Report No.(s): (NASA-CR-199546; NIPS-95-05582; NAS 1.26:199546) Avail: CASI HC A03/MF A01

A method for automatic multiblock grid generation is described. The method combines the modified advancing front method as a predictor with an elliptic scheme as a corrector. It advances a collection of cells by one cell height in the outward direction using modified advancing front method, and then corrects newly-obtained cell positions by solving elliptic equations. This predictor-corrector type scheme is repeatedly applied until the field of interest is filled with hexahedral grid cells. Given the configuration surface grid, the scheme produces block layouts as well as grid cells with overall smoothness as its output. The method saves human-time and reduces the burden on the user in generating grids for general 3D configurations. It is used to generate multiblock grids for wings in their high-lift configuration.
Author (revised)
Computational Fluid Dynamics; Grid Generation (mathematics); Multiblock Grids; Predictor-corrector Methods;

N96-13449*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
Simulated dynamic response of a multi-stage compressor with variable molecular weight flow medium
Babcock, Dale A.; 1 Sep. 1995 46 p
Report No.(s): (NASA-TM-110199; NAS 1.15:110199; NIPS-95-05640) Avail: CASI HC A03/MF A01

A mathematical model of a multi-stage compressor with variable molecular weight flow medium is derived. The modeled system consists of a five stage, six cylinder, double acting, piston type compressor. Each stage is followed by a water cooled heat exchanger which serves to transfer the heat of compression from the gas. A high molecular weight gas (CFC-12) mixed with air in varying proportions is introduced to the suction of the compressor. Condensation of the heavy gas may occur in the upper stage heat exchangers. The state equations for the system are integrated using the Advanced Continuous Simulation Language (ACSL) for determining the system's dynamic and steady state characteristics under varying operating conditions.
Author
Compressors; Computerized Simulation; Dynamic Response; Mathematical Models;

N96-14097*# Institute for Computer Applications in Science and Engineering, Hampton, VA. School of Mathematical Sciences.
A far-field non-reflecting boundary condition for two-dimensional wake flows Final Report
Danowitz, Jeffrey S.; (Tel-Aviv Univ., Ramat-Aviv, Tel-Aviv, Israel.)Abarbanel, Saul A.; (Tel-Aviv Univ., Ramat-Aviv, Tel-Aviv, Israel.)and Turkel, Eli; (Tel-Aviv Univ.,

Ramat-Aviv, Tel-Aviv, Israel.) 1 Sep. 1995 35 p Submitted for publication in Journal of Computational Physics
Contract(s)/Grant(s): (NAS1-19480)
Report No.(s): (NASA-CR-198214; NAS 1.26:198214; ICASE-95-63; NIPS-95-05970) Avail: CASI HC A03/MF A01

Far-field boundary conditions for external flow problems have been developed based upon long-wave perturbations of linearized flow equations about a steady state far field solution. The boundary improves convergence to steady state in single-grid temporal integration schemes using both regular-time-stepping and local-time-stepping. The far-field boundary may be near the trailing edge of the body which significantly reduces the number of grid points, and therefore the computational time, in the numerical calculation. In addition the solution produced is smoother in the far-field than when using extrapolation conditions. The boundary condition maintains the convergence rate to steady state in schemes utilizing multigrid acceleration.
Author
Airfoils; Boundary Conditions; Compressible Flow; Computational Grids; Far Fields; Grid Generation (mathematics); Multigrid Methods; Navier-stokes Equation; Numerical Analysis; Steady Flow; Two Dimensional Flow; Viscous Flow; Wakes;

16 PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

N96-13385*# General Electric Co., Cincinnati, OH.
Active control of fan noise-feasibility study. Volume 2: Canceling noise source-design of an acoustic plate radiator using piezoceramic actuators
Pla, F. G.; and Rajiyah, H.; Mar. 1995 150 p
Contract(s)/Grant(s): (NAS3-26617; RTOP 538-03-11)
Report No.(s): (NASA-CR-195440; E-9475; NAS 1.26:195440) Avail: CASI HC A07/MF A02

The feasibility of using acoustic plate radiators powered by piezoceramic thin sheets as canceling sources for active control of aircraft engine fan noise is demonstrated. Analytical and numerical models of actuated beams and plates are developed and validated. An optimization study is performed to identify the optimum combination of design parameters that maximizes the plate volume velocity for a given resonance frequency. Fifteen plates with various plate and actuator sizes, thicknesses, and bonding layers were fabricated and tested using results from the optimization study. A maximum equivalent piston displacement of 0.39 mm was achieved with the optimized plate samples tested with only one actuator powered, corresponding to a plate deflection at the center of over 1 millimeter. This is very close to the deflection required for a full size engine application and represents a 160-fold improvement over previous work. Experimental results further show that performance is limited by the critical stress of the piezoceramic actuator and bonding layer rather than by the maximum moment available from the actuator. Design enhancements are described in detail that will lead to a flight-worthy acoustic plate radiator by minimizing actuator tensile stresses and reducing nonlinear effects. Finally, several adaptive tuning methods designed to increase the bandwidth of acoustic plate radiators are analyzed including passive, active, and semi-active approaches. The back chamber pressurization and volume variation methods are investigated experimentally and shown to be simple and effective ways to obtain substantial control over the resonance frequency of a plate radiator. This study shows that piezoceramic-based plate radiators can be a viable acoustic source for active control of aircraft engine fan noise.
Author
Active Control; Actuators; Aerodynamic Noise; Engine Noise; Jet Aircraft Noise; Noise Reduction; Piezoelectric Ceramics; Sound Generators; Turbofan Engines;

N96-13446*# McDonnell-Douglas Aerospace, Long Beach, CA.
Airframe noise prediction evaluation Final Report
Yamamoto, Kingo J.; Donelson, Michael J.; Huang, Shumei C.; and Joshi, Mahendra C.; 1 Oct. 1995 92 p
Contract(s)/Grant(s): (NAS1-20103; RTOP 538-03-13-03)
Report No.(s): (NASA-CR-4695; NAS 1.26:4695; CRAD-9310-TR-0129; NIPS-95-05717) Avail: CASI HC A05/MF A01

The objective of this study is to evaluate the accuracy and adequacy of current airframe noise prediction methods using available airframe noise measurements from tests of a narrow body transport (DC-9) and a wide body transport (DC-10) in addition to scale model test data. General features of the airframe noise from these aircraft and models are outlined. The results of the assessment of two airframe prediction methods, Fink's and Munson's methods, against flight test data of these aircraft and scale model wind tunnel test data are presented. These methods were extensively evaluated against measured data from several configurations including clean, slat deployed, landing gear-deployed, flap deployed, and landing configurations of both DC-9 and DC-10. They were also assessed against a limited number of configurations of scale models. The evaluation was conducted in terms of overall sound pressure level (OASPL), tone corrected perceived noise level (PNLT), and one-third-octave band sound pressure level (SPL).
Author
Aerodynamic Noise; Aircraft Models; Aircraft Noise; Flight Tests; Noise Measurement; Noise Prediction; Prediction

Analysis Techniques; Proving; Scale Models; Wind Tunnel Tests;

N96-13603# Tsentralni Aerogidrodinamicheskii Inst., Moscow (USSR). Aerodynamics Div.

External noise of single rotor helicopters c71

Samokhin, V. F.; and Rozhdestvensky, M. G.; (Mil Moscow Helicopter Plant, Moscow, Russia.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 8 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

Intensity, acoustical radiation spectrum, as well as single-rotor external noise level are analyzed in the paper based on the experimental data obtained from testing actual helicopters. The helicopter acoustical far-field is shown to be a superposition of the main and tail rotor fields. The external noise spectrum measured on the ground contains discrete and broadband components. Discrete component frequencies are multiples of the main and tail rotor passage frequencies and fall within the frequency ranges 20-160 Hz and 100-500 Hz respectively. Continuous spectrum radiation can be seen within the whole sound frequency range, but the maximum intensity is registered at 500-3,000 Hz frequencies. It has been found that the intensity of the helicopter acoustical radiation in the direction corresponding to the maximum external noise level and the power required by the main and tail rotors change according to the same law. The helicopter acoustical field is asymmetric relative to the vertical plane running through the longitudinal axis of the aircraft. The helicopter external noise level measured in PNdb has been found to be defined by the tail rotor acoustical radiation with a discrete frequency spectrum within 100-500 Hz and the continuous spectrum radiation within 500-3,000 Hz. The tail rotor configuration is shown to affect the helicopter acoustic response. Experimental studies of the external noise produced by the same helicopter first equipped with a tail rotor with symmetrical layout of the blades and then with an X-shaped tail rotor have allowed to establish that its tail rotor is the dominating source of the helicopter broadband noise. The X-shaped tail rotor has allowed to reduce the helicopter noise by 3-5 PNdb in level flight.

Author

Aeroacoustics; Aerodynamic Noise; Continuous Spectra; Far Fields; Frequency Ranges; Helicopters; Noise Intensity; Noise Measurement; Noise Reduction; Noise Spectra; Rotary Wings; Sound Pressure; Tail Rotors;

N96-13607# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany).

Initial results from the higher harmonic control aeroacoustic rotor test (HART) in the German-Dutch wind tunnel c71

Kube, R.; Splettstoesser, W. R.; Wagner, W.; Seelhorst, U.; Yu, Y. H.; (Army Aviation Systems Command, Moffett Field, CA.)Boutier, A.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)Micheli, F.; (Office National d'Etudes et de Recherches Aerospatiales, Paris, France.)and Mercker, E.; (Duits-Nederlandse Windtunnel, North East Polder, Netherlands.) In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 11p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

Within a four nation research project jointly conducted by AFDD, NASA, ONERA, DLR and DNW the HHC effects on BVI noise and vibrations were investigated. The project had the objective to gain a physical understanding of the involved mechanisms and comprised theoretical as well as experimental studies. The latter ones were performed in the German Dutch Wind Tunnel (DNW) and had the overall goal to provide information about all relevant parameters. For that purpose, different measurement techniques like laser light sheet, laser doppler velocimetry as well as acoustic and non-intrusive blade deflection measurements were applied to a highly instrumented hingeless model rotor. All of these techniques were employed at different rotor conditions for different HHC settings, thus yielding a very comprehensive data base. It gives a physical insight in the mechanisms involved in BVI noise and vibration reduction by higher harmonic control and forms the basis for an improved understanding and modeling of these complex phenomena.

Author

Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Flow Visualization; Harmonic Control; Noise Measurement; Noise Reduction; Nonintrusive Measurement; Pressure Distribution; Rotary Wings; Rotor Aerodynamics; Vibratory Loads; Wind Tunnel Tests;

N96-13609# Italian Aerospace Research Center, Capua (Italy). Acoustics Branch.

Calculation of high-speed noise from helicopter rotor using different descriptions of quadrupole source c71

Ianniello, S.; and Debernardis, E.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 7 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A02/MF A04

The problem of quadrupole noise prediction is addressed and treated through the acoustic analogy approach, comparing different solution forms for the FW-H equation including the nonlinear source term. In particular, results obtained using the volume integration of the quadrupole source are presented. A comparison is established with results from a set of acoustic Euler calculations; a comparative analysis of the computing time is conducted, and methods to reduce the computational effort requested by the volume integration are proposed. Then, a particular description of quadrupole source term is introduced, giving rise to some

surface integrals. Their role is investigated in order to assess how they affect the quadrupole noise calculation.
Author
Aeroacoustics; Aerodynamic Noise; Helicopters; Noise Prediction (aircraft); Numerical Integration; Quadrupoles; Rotary Wings; Rotor Blades; Transonic Flow;

N96-13611# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. of Design Aerodynamics.
Aeroacoustic calculation of helicopter rotors at DLR c71
Schultz, K.-J.; Lohmann, D.; Lieser, J. A.; and Pahlke, K. D.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 19 p (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

The rotor noise level is one of the main design parameters for future rotorcrafts. This fact requires accurate aeroacoustic prediction tools. The two most annoying contributors to rotor noise radiation are blade vortex interaction impulsive noise (BVI) and highspeed compressibility impulsive noise (HI). At DLR great effort is concentrated on the two impulsive noise phenomena. The paper presents examples of (1) the prediction of lowspeed BVI impulsive noise using aerodynamic input from a quasisteady formulation of the panel method LBS and the linear terms of the FWH-equation for acoustic calculation, and (2) the prediction of highspeed hover and forward flight impulsive noise using transonic aerodynamic input from a 3D-EULER code and the FWH-equation including the nonlinear quadrupole term for the acoustic calculation. The calculated results are compared with experimental data from the AH-1/OLS (UH-1H) model tests in DNW,1982, and from the HELINOISE test (BO 105 model in DNW). The prediction of lowspeed BVI noise is highly dependent on the used wake model for the blade pressure calculation, while the acoustic calculation is quite straight forward. The comparison of experimental data with calculated acoustic results using blade pressure input from the LBS code in connection with Beddoes wake model shows satisfactory agreement. In the highspeed case the perturbation velocity field solution of the EULER code provides the input for the quadrupole volume integral in the FWH-equation. Four different solutions to solve the quadrupole term are presented for the hover case: volume integration, two kinds of pre-integration in blade normal direction and an approximation using the blade surface values. In comparison with experimental data the different calculated results for the hover case shows that the expensive volume integration provides the best solution, but the approximated approaches are also satisfactory. For the highspeed forward flight case the quadrupole approach with pre-integration has been selected and quite successfully applied.
Author
Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Computational Grids; Helicopters; Horizontal Flight; Hovering; Noise Prediction (aircraft); Panel Method (fluid Dynamics); Pressure Distribution; Quadrupoles; Rotor Aerodynamics; Rotor Blades;

N96-13612# Eurocopter France, Marignane (France). Dept. Aeromechanique.
Predicting helicopter external noise: Numerical methods as conceived by an industrialist [Prevision du bruit externe des helicopteres: Les methodes numeriques vues par un industriel] c71
Toulmay, Francois; Falchero, Danielle; and Arnaud, Gilles; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 17 p In FRENCH (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

This paper investigates the methods used for rotor rotational noise, impulsive noise from blade/vortex interaction, high speed noise, rotor broadband noise, the various types of fenestron noise, and noise from the turboshaft engines. From the helicopter manufacturer's standpoint i.e. with respect to the prediction capability of the full chain of codes, including unsteady airloads calculation, an analysis of strengths and deficiencies is made and illustrated with experimental correlations. From this point of view, the fenestron is hovering flight and the rotational noise of rotors are both satisfactorily predicted, but in the event of interactions, the load calculation does not offer the full desired accuracy. Research regarding high speed noise is in progress and the research on broadband noise must be resumed. As regards turboengines, there is no alternative to the experimental approach for the helicopter manufacturer.
Author
Aerodynamic Loads; Aerodynamic Noise; Blade-vortex Interaction; Helicopters; Hovering; Noise Prediction (aircraft); Numerical Analysis; Rotor Aerodynamics; Rotor Blades; Unsteady Aerodynamics;

N96-13616# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
The use of Kirchhoff's method in rotorcraft aeroacoustics c71
Lyrintzis, Anastasios S.; In AGARD, Aerodynamics and Aeroacoustics of Rotorcraft Aug. 1995 16 p Sponsored by Minnesota Supercomputer Inst. and Cray Research, Inc. (For primary document see N96-13582 02-01) Copyright Avail: CASI HC A03/MF A04

A comprehensive review of the use of Kirchhoff's method in rotorcraft aeroacoustics is given. Kirchhoff's integral formulation allows radiating sound to be evaluated based on quantities on an arbitrary control surface S if the wave equation is assumed outside. The control surface S is assumed to include all the nonlinear flow effects and noise sources. Thus only surface integrals are needed for the calculation of the far-field sound. A numerical CFD method can

be used for the evaluation of the flow-field solution in the near-field and thus on surface S. Kirchhoff's integral formulation has been extended to an arbitrary, moving, deformable piecewise-continuos surface. The available Kirchhoff formulations are reviewed and various rotorcraft aeroacoustic applications are given. The relative merits of Kirchhoff's method are also discussed.
Author
Aeroacoustics; Aerodynamic Noise; Blade-vortex Interaction; Computational Fluid Dynamics; Flow Distribution; Hovering; Kirchhoff Law of Radiation; Navier-stokes Equation; Rotary Wing Aircraft; Rotor Aerodynamics; Transonic Flow;

N96-13730# Wyle Labs., Inc., Arlington, VA.
An investigation of active noise reduction of jet engine runup noise Final Report, Jul. 1993 - Oct. 1994
Gibson, Robert G.; Stusnick, Eric; Smith, Jerome P.; Burdisso, Ricardo A.; and Fuller, Chris R.; Aug. 1995 135 p Prepared in cooperation with Virginia Polytechnic Institute and State Univ.
Contract(s)/Grant(s): (F41624-93-C-9001)
Report No.(s): (AD-A297840; WR-94-26; AL/OE-TR-1995-0113) Avail: CASI HC A07/MF A02

Active Noise Reduction techniques are used in this study to attenuate low-frequency broadband noise from jet engine exhaust. The low-frequency sound radiation from aircraft engine runup operations can result in a noise or vibration problem in nearby communities, even when aircraft are in test facilities such as hush houses or engine test cells. Experimental results are presented for the active reduction of broadband exhaust noise from both a stationary, unsuppressed jet engine and a jet engine installed in a small-scale simulated hush house. The control method is the feedforward filtered-x LMS algorithm and is implemented for both single-input, single-output and multi-input, multi-output systems. One-third octave band attenuations of up to 15 dB are achieved at error microphone locations, and large areas of significant noise reduction surround the error microphone locations. The areas of attenuation generally agree with analytical predictions.
DTIC
Active Control; Engine Noise; Engine Tests; Feedforward Control; Jet Engines; Long Wave Radiation; Noise Reduction; Phase Control; Prediction Analysis Techniques; Sound Waves;

17 SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

N96-12698# Armstrong Lab., Brooks AFB, TX. Human Resources Directorate.
Integrated Maintenance Information System: User field demonstration and test. Executive summary Interim Report, Nov. 1993 - Mar. 1995
Thomas, Donald L.; Mar. 1995 32 p
Contract(s)/Grant(s): (F33615-88-C-0024)
Report No.(s): (AD-A295812; AL/HR-TR-1995-0033) Avail: CASI HC A03/MF A01

This Executive Summary summarizes the results of a field test and demonstration of the Integrated Maintenance Information System (IMIS). The IMIS project was an advanced development demonstration project which developed and field tested the technology to provide the maintenance technician with the capability to access all of the technical information (interactive electronic technical manuals, interactive diagnostics instructions, work orders, supply availability and ordering, historical data, training material, etc.) required to maintain aircraft via a single, integrated system, regardless of the source of that information. In the final phase of the project, an IMIS Demonstration System was developed and tested. In the field test, the performance of technicians on troubleshooting tasks when using the IMIS was compared with their performance on comparable tasks when using the paper technical orders. Test results indicated that technicians were able to perform the tasks significantly faster, used fewer parts, and made fewer serious errors when using the IMIS. In addition, the test indicated that, when using the IMIS, non-specialist (crew chief) technicians could perform the tasks as effectively as the specialists.
DTIC
Aircraft Maintenance; Computer Techniques; Human-computer Interface; Information Systems;

18 SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

N96-13722*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SOFIA: The future of airborne astronomy c89
Erickson, Edwin F.; and Davidson, Jacqueline A.; In Astronomical Society of the Pacific, Airborne Astronomy Symposium on the Galactic Ecosystem: From Gas to Stars to Dust, Volume 73 1995 p 707-773 Original contains color illustrations (For primary document see N96-13618 02-88)

Avail: CASI MF A06

For the past 20 years, the 91 cm telescope in NASA's Kuiper Airborne Observatory (KAO) has enabled scientists to observe infrared sources which are obscured by the earth's atmosphere at ground-based sites, and to observe transient astronomical events from anywhere in the world. To augment this capability, the United States and German Space Agencies (NASA and DARA) are collaborating in plans to replace the KAO with a 2.5 meter telescope installed in a Boeing 747 aircraft: SOFIA - The Stratospheric Observatory for Infrared Astronomy. SOFIA's large aperture, wide wavelength coverage, mobility, accessibility, and sophisticated instruments will permit a broad range of scientific studies, some of which are described here. Its unique features complement the capabilities of other future space missions. In addition, SOFIA has important potential as a stimulus for development of new technology and as a national resource for education of K-12 teachers. If started in 1996, SOFIA will be flying in the year 2000.

Author

Astronomical Observatories; Infrared Astronomy; Infrared Radiation; Infrared Spectra; Infrared Telescopes; Sofia (airborne Observatory); Stratosphere;

19 GENERAL

No abstracts in this category.

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