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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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05 Aircraft Design, Testing and Performance **3**

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06 Aircraft Instrumentation **N.A.**

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07 Aircraft Propulsion and Power **4**

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08 Aircraft Stability and Control **6**

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

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

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Typical Report Citation and Abstract

❶ **19970001126** NASA Langley Research Center, Hampton, VA USA
❷ **Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes**
❸ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA;
❹ Mar. 1996; 130p; In English
❺ Contract(s)/Grant(s): RTOP 505-68-70-04
❻ Report No(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
❼ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10’ to 50’, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65’ swept forebody serrations tended to roll together, while vortices from 40’ swept serrations were more effective in generating additional lift caused by their more independent nature.
❽ Author
❾ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*

Key

1. Document ID Number; Corporate Source
2. Title
3. Author(s) and Affiliation(s)
4. Publication Date
5. Contract/Grant Number(s)
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9. Subject Terms

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 346)

APRIL 18, 1997

01
AERONAUTICS

19970011348 NASA Ames Research Center, Fluid Dynamics Research Branch, Moffett Field, CA USA
Turbulence Measurements in the Near Field of a Wingtip Vortex
Chow, Jim, Institute for Defense Analyses, USA; Zilliac, Greg, NASA Ames Research Center, USA; Bradshaw, Peter, Stanford Univ., USA; Feb. 1997; 258p; In English; Original contains color illustrations
Contract(s)/Grant(s): NCC2-55; RTOP 505-59-53
Report No.(s): NASA-TM-110418; NAS 1.15:110418; A-961558; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

The roll-up of a wingtip vortex, at Reynolds number based on chord of 4.6 million was studied with an emphasis on suction side and near wake measurements. The research was conducted in a 32 in. x 48 in. low-speed wind tunnel. The half-wing model had a semi-span of 36 in. a chord of 48 in. and a rounded tip. Seven-hole pressure probe measurements of the velocity field surrounding the wingtip showed that a large axial velocity of up to 1.77 U(sub infinity) developed in the vortex core. This level of axial velocity has not been previously measured. Triple-wire probes have been used to measure all components of the Reynolds stress tensor. It was determined from correlation measurements that meandering of the vortex was small and did not appreciably contribute to the turbulence measurements. The flow was found to be turbulent in the near-field (as high as 24 percent RMS w - velocity on the edge of the core) and the turbulence decayed quickly with streamwise distance because of the nearly solid body rotation of the vortex core mean flow. A streamwise variation of the location of peak levels of turbulence, relative to the core centerline, was also found. Close to the trailing edge of the wing, the peak shear stress levels were found at the edge of the vortex core, whereas in the most downstream wake planes they occurred at a radius roughly equal to one-third of the vortex core radius. The Reynolds shear stresses were not aligned with the mean strain rate, indicating that an isotropic-eddy-viscosity based prediction method cannot accurately model the turbulence in the cortex. In cylindrical coordinates, with the origin at the vortex centerline, the radial normal stress was found to be larger than the circumferential.
Author
Turbulent Flow; Near Fields; Wing Tips; Vortices; Wind Tunnel Tests; Flow Measurement; Stress Tensors; Reynolds Stress

02
AERODYNAMICS

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

19970011297 Stanford Univ., Center for Turbulence Research, Stanford, CA USA
Large-Eddy Simulation of Flow Around a NACA 4412 Airfoil Using Unstructured Grids
Jansen, Kenneth, Stanford Univ., USA; Annual Research Briefs-1996; Dec. 1996, pp. 225-232; In English; Also announced as 19970011281; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

Large-eddy simulation (LES) has matured to the point where application to complex flows is described. The extension to higher Reynolds numbers leads to an impractical number of grid points with existing structured-grid methods. Furthermore, most real world flows are rather difficult to represent geometrically with structured grids. Unstructured-grid methods offer a release from both of these constraints. However, just as it took many years for structured-grid methods to be well understood and reliable tools for LES, unstructured-grid methods must be carefully studied before we can expect them to attain their full potential.
Derived from text
Vortices; Airfoils; Reynolds Number; Computerized Simulation; Digital Simulation; Structured Grids (Mathematics)

19970011591 Institute for Computer Applications in Science and Engineering, Hampton, VA USA

Analysis of the Hessian for Aerodynamic Optimization: Inviscid Flow

Arian, Eyal, Institute for Computer Applications in Science and Engineering, USA; Ta'asan, Shlomo, Carnegie-Mellon Univ., USA; Apr. 1996; 24p; In English

Contract(s)/Grant(s): NAS1-19480

Report No.(s): AD-A309055; ICASE 96-28; NASA-CR-198328; NAS 1.26:198328; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

In this paper we analyze inviscid aerodynamic shape optimization problems governed by the full potential and the Euler equations in two and three dimensions. The analysis indicates that minimization of pressure dependent cost functions results in Hessians whose eigenvalue distributions are identical for the full potential and the Euler equations. However the optimization problems in two and three dimensions are inherently different. While the two dimensional optimization problems are well-posed the three dimensional ones are ill-posed. Oscillations in the shape up to the smallest scale allowed by the design space can develop in the direction perpendicular to the flow, implying that a regularization is required. A natural choice of such a regularization is derived. The analysis also gives an estimate of the Hessian's condition number which implies that the problems at hand are ill-conditioned. Infinite dimensional approximations for the Hessians are constructed and preconditioners for gradient based methods are derived from these approximate Hessians.

DTIC

Inviscid Flow; Optimization; Aerodynamic Configurations

19970011616 Army Aviation Systems Command, Hampton, VA USA

Flow Field Around a Hovering Rotor

Tung, C., Army Aviation Systems Command, USA; Low, S., Army Aviation Systems Command, USA; Feb. 1997; 44p; In English

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

Report No.(s): NASA-TM-110426; NAS 1.15:110426; A-975370; USAATCOM-TR-96-A-012; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A lifting surface hover code developed by the Analytical Method Inc. (AMI) was used to compute the average and unsteady velocity flow field of an isolated rotor without ground effect. The predicted velocity field compares well with experimental data obtained by hot-wire anemometry and by Laser Doppler Velocimetry. A subroutine 'DOWNWASH' was written to predict the velocity field at any given point in the wake for a given blade position.

Author

Downwash; Helicopter Wakes; Unsteady Flow; Velocity Distribution; Prediction Analysis Techniques; Hovering; Applications Programs (Computers); Flow Distribution

19970011655 Maryland Univ., Dept. of Aerospace Engineering, College Park, MD USA

Aerodynamic Characteristics of Rotor Airfoils as Affected by Simulated Ballistic Damage

Robinson, Keith Wayne, Maryland Univ., USA; Jan. 1995; 178p; In English

Report No.(s): AD-A309509; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

Tests were made using a 2-D insert in a subsonic wind tunnel to examine the effects of simulated ballistic damage on the aerodynamic characteristics of ten helicopter rotor blade sections. Two undamaged baseline blade sections, comprised of SC1095 and SC1095R8 airfoils, were tested and then modified with different simulated ballistic damage configurations. These comprised of a circular hole with the surrounding skin removed, fore and aft circular holes, and an aft wedge-shaped hole. One blade section was subjected to actual ballistic damage near the trailing edge. The sectional lift, drag and pitching moment were measured at positive and negative angles of attack at Reynolds numbers of one, two, and three million. Pressure measurements were also made for two configurations fitted with pressure taps. Additional tests were conducted over a full 360 degree range in angle of attack for a Reynolds number of one million. The measurements were complemented by oil flow visualization on the blade sections. The simulated damage caused large disturbances in the flowfield near and downwind of the damaged regions. Generally, flow separation was initiated at the upstream leading edge of the damage, followed by a growth in separation, both in span and intensity, with increasing angle of attack. The aerodynamic characteristics were significantly degraded, with up to a 60 percent reduction in lift-curve-slope, a loss of maximum lift capability of nearly 30 percent, and a significant decrease in the lift-to-drag ratio due to drag increases of up to nearly 340 percent at low angles of attack.

DTIC

Blades; Aerodynamic Characteristics; Rotary Wings; Trailing Edges; Pitching Moments; Lift Drag Ratio; Flow Visualization; Boundary Layer Separation; Angle of Attack

19970011739 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Nonlinear Analysis of Airfoil Flutter at Transonic Speeds
Morton, Scott A., Air Force Inst. of Tech., USA; May 1996; 211p; In English
Report No.(s): AD-A308477; AFIT/DS/ENY/96-6; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

Hopf-bifurcation analysis is used to determine flutter boundaries of a pitch and plunge airfoil (PAPA) at transonic Mach number conditions. The PAPA model is a coupling of the Euler equations and a two-degree-of-freedom structural model composed of linear and torsional springs. The Euler equations are discretized using an upwind total variation diminishing scheme (TVD) of Harten and Yee. Equilibrium solutions of the PAPA model are computed using Newton's method and dynamic solutions are explicitly integrated in time with first-order accuracy. The Hopf-bifurcation point, which models the flutter condition, is computed directly by solving an extended system of equilibrium equations following the approach of Griewank and Reddien. The extended system is solved using a blocked Gauss-Seidel Newton relaxation scheme to improve computational resource requirements.
DTIC
Airfoils; Flutter; Transonic Speed; TVD Schemes; Euler Equations of Motion; Upwind Schemes (Mathematics)

05
AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

19970011279 General Accounting Office, National Security and International Affairs Div., Washington, DC USA
C-17 Aircraft: Cost of Spare Parts Higher Than Justified
Rodrigues, Louis ., General Accounting Office, USA; Apr. 1996; 29p; In English; Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
Report No.(s): AD-A308884; GAO/NSIAD-96-48; No Copyright; Avail: Issuing Activity (Defense Technical Information Center (DTIC)), Microfiche

The C-17 is being developed and produced by McDonnell Douglas. The Congress has authorized procurement of 40 C-17 aircraft through fiscal year 1996. As of October 1, 1995, McDonnell Douglas had delivered 22 production aircraft to the Air Force. In November 1995, the Department of Defense (DOD) announced plans to buy an additional 80 C-17 aircraft. In addition to procuring the aircraft, the Air Force is purchasing spare parts to support the C-17. In January 1994, we reported that the Air Force had frequently ordered C-17 spare parts prematurely. We noted that premature ordering occurred because the Air Force used inaccurate and outdated information, bought higher quantities than justified, or did not follow regulations governing the process. As a result, DOD revised its guidance to limit the initial procurement of spares, and the Air Force canceled orders for millions of dollars of C-17 parts. Initial spares for the C-17 are being procured under two contracts. Some are being provided under the C-17 development contract through interim contractor support. That support, which started in mid-1993, involves providing spares and technical support for two C-17 squadrons through June 1996.
DTIC
C-17 Aircraft; Costs; Procurement; Spare Parts

19970011513 Air Force Inst. of Tech., Wright-Patterson AFB, OH USA
Common Instructional Interaction Strategies and Their Effects on the Construction of Fragile Knowledge in Flight Simulation
Mullas, Michael W., Colorado Univ., USA; Jan. 1996; 130p; In English
Report No.(s): AD-A309013; AFIT/CI-96-008D; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The construction of fragile knowledge hinders the learning process--in some cases it can produce tragic consequences. This study examined the effects of common instructional interaction strategies on fragile knowledge construction in learners during procedural skill acquisition. It also examined whether explicit instruction on executive control strategies can eliminate or minimize fragile knowledge construction. The experimental design was a 4 X 2 factorial pretest, post-test, control group design. The two independent variables were instructional interaction strategies and executive controls. There were four levels of interaction strategies: no instructional interaction (the control group), directive interaction, question-based interaction, and mixed (directive and question-based) interaction. There were two levels of executive controls: no instruction on executive control processes; and explicit instruction on executive control processes.
DTIC
Flight Simulation; Data Acquisition; Flight Training; Knowledge

07
AIRCRAFT PROPULSION AND POWER

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

19970011366 Colorado Univ., Dept. of Aerospace Engineering Sciences, Boulder, CO USA
High-Performance Parallel Analysis of Coupled Problems for Aircraft Propulsion ***Final Report, Jan. 1993 - Jul. 1996***
Felippa, C. A., Colorado Univ., USA; Farhat, C., Colorado Univ., USA; Park, K. C., Colorado Univ., USA; Gumaste, U., Colorado Univ., USA; Chen, P.-S., Colorado Univ., USA; Lesoinne, M., Colorado Univ., USA; Stern, P., Colorado Univ., USA; Dec. 1996; 130p; In English
Contract(s)/Grant(s): NAG3-1425
Report No.(s): NASA-CR-203477; NAS 1.26:203477; CU-CAS-96-29; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

This research program dealt with the application of high-performance computing methods to the numerical simulation of complete jet engines. The program was initiated in January 1993 by applying two-dimensional parallel aeroelastic codes to the interior gas flow problem of a bypass jet engine. The fluid mesh generation, domain decomposition and solution capabilities were successfully tested. Attention was then focused on methodology for the partitioned analysis of the interaction of the gas flow with a flexible structure and with the fluid mesh motion driven by these structural displacements. The latter is treated by a ALE technique that models the fluid mesh motion as that of a fictitious mechanical network laid along the edges of near-field fluid elements. New partitioned analysis procedures to treat this coupled three-component problem were developed during 1994 and 1995. These procedures involved delayed corrections and subcycling, and have been successfully tested on several massively parallel computers, including the iPSC-860, Paragon XP/S and the IBM SP2. For the global steady-state axisymmetric analysis of a complete engine we have decided to use the NASA-sponsored ENG10 program, which uses a regular FV-multiblock-grid discretization in conjunction with circumferential averaging to include effects of blade forces, loss, combustor heat addition, blockage, bleeds and convective mixing. A load-balancing preprocessor tor parallel versions of ENG10 was developed. During 1995 and 1996 we developed the capability tor the first full 3D aeroelastic simulation of a multirow engine stage. This capability was tested on the IBM SP2 parallel supercomputer at NASA Ames. Benchmark results were presented at the 1196 Computational Aeroscience meeting.
Author
Parallel Computers; Propulsion System Performance; Aircraft Engines; Jet Engines; Massively Parallel Processors; Turbofan Engines; Computerized Simulation; Digital Simulation

19970011660 Alabama Univ., Propulsion Research Center, Huntsville, AL USA
Solar Thermal Concept Evaluation ***Final Report, 4 Mar. 1994 - 4 Jul. 1995***
Hawk, Clark W., Alabama Univ., USA; Bonometti, Joseph A., Alabama Univ., USA; Aug. 31, 1995; 51p; In English
Contract(s)/Grant(s): NASA Order H-17654-D
Report No.(s): NASA-CR-203478; NAS 1.26:203478; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Concentrated solar thermal energy can be utilized in a variety of high temperature applications for both terrestrial and space environments. In each application, knowledge of the collector and absorber's heat exchange interaction is required. to understand this coupled mechanism, various concentrator types and geometries, as well as, their relationship to the physical absorber mechanics were investigated. to conduct experimental tests various parts of a 5,000 watt, thermal concentrator, facility were made and evaluated. This was in anticipation at a larger NASA facility proposed for construction. Although much of the work centered on solar thermal propulsion for an upper stage (less than one pound thrust range), the information generated and the facility's capabilities are applicable to material processing, power generation and similar uses. The numerical calculations used to design the laboratory mirror and the procedure for evaluating other solar collectors are presented here. The mirror design is based on a hexagonal faceted system, which uses a spherical approximation to the parabolic surface. The work began with a few two dimensional estimates and continued with a full, three dimensional, numerical algorithm written in FORTRAN code. This was compared to a full geometry, ray trace program, BEAM 4, which optimizes the curvatures, based on purely optical considerations. Founded on

numerical results, the characteristics of a faceted concentrator were construed. The numerical methodologies themselves were evaluated and categorized. As a result, the three-dimensional FORTRAN code was the method chosen to construct the mirrors, due to its overall accuracy and superior results to the ray trace program. This information is being used to fabricate and subsequently, laser map the actual mirror surfaces. Evaluation of concentrator mirrors, thermal applications and scaling the results of the 10 foot diameter mirror to a much larger concentrator, were studied. Evaluations, recommendations and pit falls regarding the structure, materials and facility design are presented.
Author
Thermal Energy; Solar Energy; Concentrators; Heat Transfer; High Temperature; Lasers; Accumulators

19970011781 Foster-Miller Associates, Inc., Waltham, MA USA
Spin Synchronous X-Ray Sinography (SXS) for Nondestructive Imaging of Turbine Engines Under Load ***Final Report, Oct. 1994 - Oct 1995***
Kirchner, T., Foster-Miller Associates, Inc., USA; Burstein, P., Foster-Miller Associates, Inc., USA; Youngberg, J., Foster-Miller Associates, Inc., USA; Mar. 1996; 97p; In English
Contract(s)/Grant(s): DTRS57-92-C-00012
Report No.(s): AD-A309006; DOT/FAA/AR-95/90; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche
This report presents results from an FAA-sponsored program for early detection of subcritical flaws in turbine engines before catastrophic failure occurs. The combination of theoretical studies and experimental evidence indicates that the Synchronous X-ray Sinography (SXS) system is suitable for finding these flaws. The SXS allows high resolution imaging inspection of the interior of the rotating engine, especially turbine disks and associated components, without engine teardowns. Since these tests can be conducted at much more frequent intervals than tests that require dismantling the engine, rational requirements for finding incipient failures are not nearly as stringent as those imposed during an inspection opportunity during a dismantling. Since the trend in modern engines is towards longer intervals between teardowns, engine teardown specifically targeted for inspection of disks and other internal parts can be potentially avoided if SXS technology is employed. The heart of this Small Business Innovation Research (SBIR) Phase II program is a feasibility demonstration of the SXS approach. The second stage turbine section of a Lycoming T53 turboshaft engine was spun at 1800 rpm and a freeze-frame cross-sectional image was produced from that data. The SXS approach, which is based on variations of computed tomography (CT), demonstrated a spatial resolution consistent with the detection of a 0.008-in.-thick crack. With a state-of-the-art data acquisition system, much finer contrast and spatial resolution should be possible. It is projected that this system could allow detection of cracks of size 0.001 in. or smaller. As part of the SXS program the first-stage fan disk of the GE F101 engine was computer modeled to show the effect of engine speed on crack distortion (opening).
DTIC
Nondestructive Tests; Imaging Techniques; Inspection; Cracking (Fracturing); Aircraft Engines; Engine Parts; Turbine Engines; Failure Analysis

19970011975 Calspan Corp., Advanced Technology Center, Buffalo, NY USA
Summary Report of the Design and Operation of the WPAFB Turbine Research Facility ***Final Report***
Haldeman, C., Calspan Corp., USA; Dunn, M., Calspan Corp., USA; Jul. 1995; 61p; In English
Contract(s)/Grant(s): F33615-88-C-2825; AF Proj. 3066
Report No.(s): AD-A315908; WL-TR-96-2012; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche
This summary report is intended to provide an overview of the Wright Lab Turbine Research Facility (TRF). The format that will be used is to provide initially an overview of the facility components and operation with detailed information concerning the individual sub-systems following in separate appendices. The Turbine Research Facility discussed herein has the potential to be a world-class experimental facility capable of providing timely data of significant importance to the country's turbine designers.
DTIC
Research Facilities; Aerodynamics; Gas Turbine Engines

08
AIRCRAFT STABILITY AND CONTROL

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

19970011943 Raytheon Aircraft Co., Wichita, KS USA
Fuzzy Logic Decoupled Longitudinal Control for General Aviation Airplanes
Duerksen, Noel, Raytheon Aircraft Co., USA; Dec. 1996; 108p; In English
Contract(s)/Grant(s): NCA1-113; RTOP 538-07-11-01
Report No.(s): NASA-CR-201639; NAS 1.26:201639; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

It has been hypothesized that a human pilot uses the same set of generic skills to control a wide variety of aircraft. If this is true, then it should be possible to construct an electronic controller which embodies this generic skill set such that it can successfully control difference airplanes without being matched to a specific airplane. In an attempt to create such a system, a fuzzy logic controller was devised to control throttle position and another to control elevator position. These two controllers were used to control flight path angle and airspeed for both a piston powered single engine airplane simulation and a business jet simulation. Overspeed protection and stall protection were incorporated in the form of expert systems supervisors. It was found that by using the artificial intelligence techniques of fuzzy logic and expert systems, a generic longitudinal controller could be successfully used on two general aviation aircraft types that have very difference characteristics. These controllers worked for both airplanes over their entire flight envelopes including configuration changes. The controllers for both airplanes were identical except for airplane specific limits (maximum allowable airspeed, throttle lever travel, etc.). The controllers also handled configuration changes without mode switching or knowledge of the current configuration. This research validated the fact that the same fuzzy logic based controller can control two very different general aviation airplanes. It also developed the basic controller architecture and specific control parameters required for such a general controller.
Author
General Aviation Aircraft; Fuzzy Systems; Longitudinal Control; Artificial Intelligence; Expert Systems

09
RESEARCH AND SUPPORT FACILITIES (AIR)

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

19970011572 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH USA
Mach 5 to 7 RBCC Propulsion System Testing at NASA-LeRC HTF
Perkins, H. Douglas, National Aeronautics and Space Administration. Lewis Research Center, USA; Thomas, Scott R., National Aeronautics and Space Administration. Lewis Research Center, USA; Pack, William D., National Aeronautics and Space Administration. Lewis Research Center, USA; Dec. 1996; 16p; In English; 35th; Aerospace Sciences Meeting and Exhibit, 6-10 Jan. 1997, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA
Contract(s)/Grant(s): RTOP 505-70-6B
Report No.(s): NASA-TM-107384; NAS 1.15:107384; E-10577; AIAA Paper 97-0565; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A series of Mach 5 to 7 freejet tests of a Rocket Based Combined Cycle (RBCC) engine were cnducted at the NASA Lewis Research Center (LERC) Hypersonic Tunnel Facility (HTF). This paper describes the configuration and operation of the HTF and the RBCC engine during these tests. A number of facility support systems are described which were added or modified to enhance the HTF test capability for conducting this experiment. The unfueled aerodynamic perfor- mance of the RBCC engine flowpath is also presented and compared to sub-scale test results previously obtained in the NASA LERC I x I Supersonic Wind Tunnel (SWT) and to Computational Fluid Dynamic (CFD) analysis results. This test program demonstrated a successful configuration of the HTF for facility starting and operation with a generic RBCC type engine and an increased range of facility operating conditions. The ability of sub-scale testing and CFD analysis to predict flowpath performance was also shown. The HTF is a freejet, blowdown propulsion test facility that can simulate up to Mach 7 flight conditions with true air composition. Mach 5, 6, and 7 facility nozzles are available, each with an exit diameter of 42 in. This combination of clean air, large scale, and Mach 7 capabilities is unique to the HTF. This RBCC engine study is the first engine test program conducted at the HTF since 1974.
Author
Integral Rocket Ramjets; Engine Tests; Hypersonic Speed; Hypersonic Wind Tunnels

11
CHEMISTRY AND MATERIALS

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

19970011969 Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine, France
Impact Study on the Use of JET A Fuel in Military Aircraft During Operations in Europe ***Etude de l'impact de l'utilisation du carburant JET A par les avions militares lors des operations en Europe***
Batchelor, Graham, Advisory Group for Aerospace Research and Development, France; Moses, Cliff, Advisory Group for Aerospace Research and Development, France; Fletcher, Ron, Advisory Group for Aerospace Research and Development, France; Jan. 1997; 16p; In English
Report No.(s): AGARD-R-801; ISBN-92-836-1049-0; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

The differences in specifications and actual supply properties of kerosene fuels JET A1 and JET A are studied. Potential operation limitations within the European military arena are outlined in the case that JET A was to replace JET A1 as the base fuel in the NATO F-34 fuel specification. Interviews with the military users and the suppliers of the equipment and fuels are reported on.
Author
Jet Engine Fuels; Kerosene; Specifications; Attack Aircraft

12
ENGINEERING

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

19970011291 Stanford Univ., Center for Turbulence Research, Stanford, CA USA
A Model for the Onset of Vortex Breakdown
Mahesh, K., Stanford Univ., USA; Annual Research Briefs - 1996; Dec. 1996, pp. 143-149; In English; Also announced as 19970011281
Contract(s)/Grant(s): F49620-92-J-0128; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

A large body of information exists on the breakdown of incompressible streamwise vortices. Less is known about vortex breakdown at high speeds. An interesting example of supersonic vortex breakdown is the breakdown induced by the interaction of vortices with shock waves. The flow in supersonic engine inlets and over high-speed delta wings constitute technologically important examples of this phenomenon, which is termed 'shock-induced vortex breakdown'. In this report, we propose a model to predict the onset of shock-induced vortex breakdown. The proposed model has no adjustable constants, and is compared to both experiment and computation. The model is then extended to consider two other problems: the breakdown of a free compressible vortex, and free incompressible vortex breakdown. The same breakdown criterion is used in all three problems to predict the onset of breakdown. Finally, a new breakdown map is proposed that allows the simultaneous comparison of data from flows ranging from incompressible breakdown to breakdown induced by a shock wave.
Derived from text
Vortex Breakdown; Turbulence Models; Shock Waves; Engine Inlets; Delta Wings; Supersonic Aircraft; Supersonic Inlets

19970011668 Institute for Computer Applications in Science and Engineering, Hampton, VA USA
Numerical Simulation of Mixing Enhancement in a Hot Supersonic Jet ***Final Report***
Grosch, C. E., Old Dominion Univ., USA; Seiner, J. M., National Aeronautics and Space Administration. Langley Research Center, USA; Hussaini, M. Y., Florida State Univ., USA; Jackson, T. L., Institute for Computer Applications in Science and Engineering, USA; Dec. 1996; 64p; In English
Contract(s)/Grant(s): NAS1-19480; RTOP 505-90-52-01
Report No.(s): NASA-CR-201626; NAS 1.26:201626; ICASE-96-69; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Experimental observations show that the presence of small tabs on the edge of a hot, compressible jet exiting into a slower moving, colder ambient flow can increase the rate of spreading of the jet. This suggests that the rate of mixing of the jet and the ambient fluid is also increased. In order to elucidate the physical mechanism responsible for the increased spreading rate a set of

calculations were carried out within the framework of the compressible three dimensional Navier-Stokes equations. A series of grid refinements were made to assess the accuracy of the results. The first simulated the flow without the tabs, obtaining reasonable agreement with experimental measurements of the velocity. We then simulated the flow, without tabs, over a range of values of the convective Mach number in order to determine the dependence of the mixing on this parameter. Simulations with modeled tabs were also carried out. In these calculations the effect of the tabs on the flow was modeled by pairs of counter rotating vortices. The results of these calculations indeed show that the presence of the tabs increase the spreading rate of the jet. The basic physical mechanism responsible for the enhanced spreading rate is discussed and qualitative comparisons with flow visualizations are made.
Author
Computerized Simulation; Digital Simulation; Flow Visualization; Supersonic Jet Flow; Tabs (Control Surfaces); Navier-Stokes Equation

19970011687 Rutgers - The State Univ., Dept. of Mechanical and Aerospace Engineering, Piscataway, NJ USA
Effects of Compressibility, Pitch Rate and Reynolds Number on Unsteady Incipient Leading-Edge Boundary Layer Separation Over a Pitching Airfoil ***Final Report, 1 Apr. 1991 - 30 Mar. 1996***
Knight, Doyle D., Rutgers - The State Univ., USA; Choudhuri, Pushkar G., Rutgers - The State Univ., USA; Okong'o, Nora, Rutgers - The State Univ., USA; Apr. 1996; 155p; In English
Contract(s)/Grant(s): DAAL03-91-G-0096
Report No.(s): AD-A308347; RU-TR-MAE-190-F; ARO-28651.9-EG; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The effects of compressibility, pitch rate and Reynolds number on the initial stages of 2-D unsteady separation of laminar subsonic flow over a pitching NACA-0012 airfoil have been studied numerically. Computations have been performed using two separate algorithms (structured grid algorithm of Beam and Warming, and unstructured grid algorithm employing flux-difference splitting method of Roe) for the compressible laminar Navier-Stokes equations. The simulations show the appearance of a primary recirculating region near the leading edge, followed by a secondary and tertiary recirculating regions. The primary and secondary recirculating regions interact with each other to give rise to the unsteady separation of the boundary layer. Increasing the Mach number from 0.2 to 0.5 causes a delay in the formation of the primary recirculating region. Increasing the pitch rate also delays the formation. Increasing the Reynolds number hastens the appearance of the primary recirculating region and leads to the appearance of a shock on the top surface along with the formation of multiple recirculating regions near the leading edge. A linear stability analysis has shown that the appearance of the primary recirculating region is related to the instability of the flow.
DTIC
Airfoils; Computational Fluid Dynamics; Algorithms; Boundary Layer Separation; Compressibility; Navier-Stokes Equation; Leading Edges; Laminar Flow; Reynolds Number; Inviscid Flow; Unsteady Flow; Two Dimensional Flow; Longitudinal Control; Pitch (Inclination)

19970011694 Institute for Computer Applications in Science and Engineering, Hampton, VA USA
Optimum Transonic Airfoils Based on the Euler Equations ***Final Report***
Iollo, Angelo, Politecnico di Torino, Italy; Salas, Manuel, D., Institute for Computer Applications in Science and Engineering, USA; Dec. 1996; 36p; In English
Contract(s)/Grant(s): NAS1-19480; RTOP 505-90-52-01
Report No.(s): NASA-CR-201638; NAS 1.26:201638; ICASE-96-76; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

We solve the problem of determining airfoils that approximate, in a least square sense, given surface pressure distributions in transonic flight regimes. The flow is modeled by means of the Euler equations and the solution procedure is an adjoint- based minimization algorithm that makes use of the inverse Theodorsen transform in order to parameterize the airfoil. Fast convergence to the optimal solution is obtained by means of the pseudo-time method. Results are obtained using three different pressure distributions for several free stream conditions. The airfoils obtained have given a trailing edge angle.
Author
Transonic Flight; Transonic Flow; Airfoils; Euler Equations of Motion; Trailing Edges

19970011952 Department of the Navy, Washington, DC USA
A Squirrel Cage Type Electric Motor Rotor Assembly
Cho, C. P., Inventor, Department of the Navy, USA; Krol, William P., Jr., Inventor, Department of the Navy, USA; Sep. 05, 1996; 10p; In English
Patent Info.: Filed 5 Sep. 1996; US-Patent-Appl-SN-706593
Report No.(s): AD-D018204; No Copyright; Avail: Issuing Activity (Defense Technical Information Center (DTIC)), Microfiche

A squirrel cage type electric motor rotor assembly includes first and second end plates of circular configuration, rigid tubes extending from the first plate to the second plate, the tubes being closed at either end thereof to define enclosed chambers therein, and granules of magnetic material disposed in the chambers, the granules being packed therein with a density leaving them readily movable to align with magnetic fields.
DTIC
Magnetic Materials; Rotors; Electric Motors

13
GEOSCIENCES

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

19970011398 Sandia National Labs., Albuquerque, NM USA
Final project report: High energy rotor development, test and evaluation
Sep. 1996; 120p; In English
Contract(s)/Grant(s): DE-AC04-94AL-85000
Report No.(s): SAND-96-2205; DE97-000607; UC-1211; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

Under the auspices of the 'Government/Industry Wind Technology Applications Project' and 'Letter of Interest', Flo Wind Corp. has successfully developed, tested, and delivered a high-energy rotor upgrade candidate for their 19-meter Vertical Axis Wind Turbine. The project included the demonstration of the innovative extended height-to-diameter ratio concept, the development of a continuous span single-piece composite blade, the demonstration of a continuous blade manufacturing technique, the utilization of the Sandia National Laboratories developed SNLA 2150 natural laminar flow airfoil and the reuse of existing wind turbine and wind power plant infrastructure.
DOE
Rotors; Windpower Utilization; Wind Turbines

14
LIFE SCIENCES

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

19970011592 Veda, Inc., Dayton, OH USA
Integrated Mission Precision Attack Cockpit Technology (IMPACT), Phase 2, Cueing Benefits of Large Tactical Situation Displays, Helmet-Mounted Displays and Directional Audio ***Final Report, 1 May 1994 - 31 Dec. 1995***
Boucek, G. Scott, Veda, Inc., USA; Orr, Horace A., Veda, Inc., USA; Williams, Robert D., Veda, Inc., USA; Montecalvo, Anthony J., Veda, Inc., USA; Redden, Mark C., Veda, Inc., USA; Rolek, Evan P., Veda, Inc., USA; Cone, Scott M., Veda, Inc., USA; Barbato, Gregory J., Wright Lab., USA; Apr. 1996; 162p; In English
Contract(s)/Grant(s): F33615-93-D-3800; AF Proj. 2403
Report No.(s): AD-A309072; WL-TR-96-3076; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

The Wright Laboratory has initiated a program called the Integrated Mission/Precision Attack Cockpit Technology (IMPACT) program, whose purpose is to determine cockpit and Pilot-Vehicle Interface (PVl) requirements for a single-seat, multi-role fighter aircraft performing at night and in adverse weather. A structured systems engineering process is being utilized to focus on the conceptual phase of cockpit development. In support of this, Veda has employed a building block approach consisting of a literature review, design work, mission/human factors analysis, and pilot-in-the-loop simulation. The focus of this evaluation was on the integration of Helmet-Mounted Displays (HMD), Large Tactical Situation Displays (TSD), and Directional Audio to aid the pilot in threat and target acquisition (functions that are currently supported by a second crewmember). In order to under-

stand the effects of integrating such technologies in a fighter aircraft cockpit, the F-15E weapon system was used as a baseline for comparison. A portion of a full mission simulation was developed and executed, and required a single pilot to fly an air interdiction mission using both the baseline cockpit and the advanced IMPACT cockpit. Results indicated a significant improvement in threat acquisition time and threat acquisition success rate, and a slight improvement in target acquisition, with the IMPACT cockpit.
DTIC
Helmet Mounted Displays; Cockpits; Fighter Aircraft; Human Factors Engineering; Man Machine Systems; Threat Evaluation; Flight Tests; Pilot Performance

16
PHYSICS

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

19970011289 Stanford Univ., Center for Turbulence Research, Stanford, CA USA
Jet Noise Using Large Eddy Simulation
Bastin, F., Stanford Univ., USA; Annual Research Briefs-1996; Dec. 1996, pp. 115-132; In English; Also announced as 19970011281; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

With the advent of high-supersonic transport aircraft, supersonic jet noise becomes a major technological problem and there is a strong need for a reliable prediction approach. Our present interest is the mixing noise component induced by the turbulent flow itself. The physics of shock-associated noise is very different and must be treated in another context.
Derived from text
Jet Aircraft Noise; Supersonic Jet Flow; Supersonic Transports; Transport Aircraft; Turbulent Flow; Vortices

19970011407 Arizona State Univ., Dept. of Mechanical and Aerospace Engineering, Tempe, AZ USA
Development of Multiobjective Optimization Techniques for Sonic Boom Minimization ***Final Report, 16 May 1994- 15 Sep. 1996***
Chattopadhyay, Aditi, Arizona State Univ., USA; Rajadas, John Narayan, Arizona State Univ., USA; Pagaldipti, Naryanan S., Arizona State Univ., USA; Dec. 1996; 98p; In English
Contract(s)/Grant(s): NCC2-5064
Report No.(s): NASA-CR-203587; NAS 1.26:203587; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche

A discrete, semi-analytical sensitivity analysis procedure has been developed for calculating aerodynamic design sensitivities. The sensitivities of the flow variables and the grid coordinates are numerically calculated using direct differentiation of the respective discretized governing equations. The sensitivity analysis techniques are adapted within a parabolized Navier Stokes equations solver. Aerodynamic design sensitivities for high speed wing-body configurations are calculated using the semi-analytical sensitivity analysis procedures. Representative results obtained compare well with those obtained using the finite difference approach and establish the computational efficiency and accuracy of the semi-analytical procedures. Multidisciplinary design optimization procedures have been developed for aerospace applications namely, gas turbine blades and high speed wing-body configurations. In complex applications, the coupled optimization problems are decomposed into sublevels using multilevel decomposition techniques. In cases with multiple objective functions, formal multiobjective formulation such as the Kreisselmeier-Steinhauser function approach and the modified global criteria approach have been used. Nonlinear programming techniques for continuous design variables and a hybrid optimization technique, based on a simulated annealing algorithm, for discrete design variables have been used for solving the optimization problems. The optimization procedure for gas turbine blades improves the aerodynamic and heat transfer characteristics of the blades. The two-dimensional, blade-to-blade aerodynamic analysis is performed using a panel code. The blade heat transfer analysis is performed using an in-house developed finite element procedure. The optimization procedure yields blade shapes with significantly improved velocity and temperature distributions. The multidisciplinary design optimization procedures for high speed wing-body configurations simultaneously improve the aerodynamic, the sonic boom and the structural characteristics of the aircraft. The flow solution is obtained using a comprehensive parabolized Navier Stokes solver. Sonic boom analysis is performed using an extrapolation procedure. The aircraft wing load carrying member is modeled as either an isotropic or a composite box beam. The isotropic box beam is analyzed using thin wall theory. The composite box beam is analyzed using a finite element procedure. The developed optimization procedures yield significant improvements

in all the performance criteria and provide interesting design trade-offs. The semi-analytical sensitivity analysis techniques offer significant computational savings and allow the use of comprehensive analysis procedures within design optimization studies.
Author
Sonic Booms; Noise Reduction; Aerodynamic Characteristics; Body-Wing Configurations; Navier-Stokes Equation; Finite Element Method; Panel Method (Fluid Dynamics); Multidisciplinary Design Optimization

19
GENERAL

19970011265 NASA Langley Research Center, Hampton, VA USA
Research and Technology Highlights 1995
Dec. 1996; 150p; In English
Report No.(s): NASA-TM-4765; NAS 1.15:4765; L-17614; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The mission of the NASA Langley Research Center is to increase the knowledge and capability of the USA in a full range of aeronautics disciplines and in selected space disciplines. This mission is accomplished by performing innovative research relevant to national needs and Agency goals, transferring technology to users in a timely manner, and providing development support to other USA Government agencies, industry, other NASA Centers, the educational community, and the local community. This report contains highlights of the major accomplishments and applications that have been made by Langley researchers and by our university and industry colleagues during the past year. The highlights illustrate both the broad range of research and technology (R&T) activities carried out by NASA Langley Research Center and the contributions of this work toward maintaining USA leadership in aeronautics and space research. An electronic version of the report is available at URL http://techreports.larc.nasa.gov/RandT95. This color version allows viewing, retrieving, and printing of the highlights, searching and browsing through the sections, and access to an on-line directory of Langley researchers.
Author
Research and Development; Technology Transfer; Aerodynamics; Aeronautics; Space Exploration; Space Technology Experiments; Technologies

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