Cfd Analysis Of Missile With Altered Grid Fins To Enhance

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Proceedings of a Workshop
Computational Fluid Dynamics Review 1998 (In 2 Volumes)
Optical Performance Analysis of Standard Missile Block IV A Seeker
National Conference on Frontiers in Applied and Computational Mathematics (FACM-2005)
Missile Configuration Design
Computational Methods In Engineering: Advances & Applications - Proceedings Of The International Conference (In 2 Volumes)
8-11 January 2001, Reno, NV.

WATSON GOODMAN

World Scientific
Wrap-around fin (WAF) missiles offer packaging benefits but experience rolling moments due to the curved fin design. Rolling moments stabilize unguided projectiles, but cause guidance and control problems for future guided applications. Understanding the flow field in the vicinity of the fins is critical to future missiles. Fin pressure profiles were characterized with pressure-sensitive paint. Two rectangular four-fin constructions were tested-one solid and one with a rectangular hole (slotted fin). Static pressure data were divided by free-stream total pressure for presentation. Tests were conducted at Mach numbers of 2.15, 2.28, 2.41, 2.86, 3.25, 3.50 and 3.83. Reynolds numbers based on missile diameter ranged from 4.0 x 106 to 1.3 x 10(7). Mach 2.86 pressure profiles on the solid fin were compared to computational fluid dynamic (CFD) predictions on a single wall-mounted fin. The four-fin model pressure distributions agreed with CFD, verifying that a single wall-mounted fin captures relevant WAF aerodynamics. Slotted fin pressure profiles were similar to solid fin profiles, except in the vicinity of the slot.

Flow Field and Loading Analysis on a Wrap-Around Fin Missile
Springer
The effect of the presence of a helicopter fuselage on the aerodynamic behavior of an unthrusted, jettisoned missile with forward strakes and tail control surfaces is explored. The investigative tool used for this purpose is a production-oriented, Euler, Computational Fluid Dynamics (CFD) methodology Titled Euler Tunnel Analysis (ETA). Initially, comparison of CFD computations with wind tunnel measurements for the isolated missile are used to anchor the computations in reality and provide an evaluation benchmark. The ensuing study is assumed to be sufficiently fast so as to convect rotor downwash effects downstream of the region of interest. Further, the calculations are performed in steady-state mode for each scenario. As expected, it is found that even without downwash the presence of the fuselage significantly modifies the aerodynamic properties of the missile. In addition, the vorticity confinement method (which conserves field and surface vorticity) is shown to preserve the vorticity created by the forward strakes as it convects downstream to the tail controls.

International Conference of Computational Methods in Sciences and Engineering (ICCMSE 2004) Springer Nature
An international computational aerodynamics study under the auspices of The Technical Cooperation Program (TTCP) Weapons Technology Panel 2 (APN-TP-2) involving participants from defense research laboratories of the United States, United Kingdom, Canada, and Australia was recently completed. The purpose of this study was to examine computational predictive technologies for finned missile shapes by comparing Navier-Stokes predictions to experimental data. Experimental data consisting of surface pressures on the body and fins, flow field pitot pressures, and force measurements were available for comparison to the computational results. The computational results for this study established an extensive database for evaluation and comparison. The fall database consists of results from six Navier-Stokes codes obtained by seven multi-block patched and unstructured grids for five distinct test cases. The statistical analysis techniques developed to help provide an evaluation of the predictive techniques are described. Quantitative results of the analysis of the differences between computational and experimental results are presented graphically and quantitatively in terms of medians, standard deviation, and a figure of merit to assist in the overall evaluation of the study results. The good performance achieved using the Spalart-Allmaras turbulence model and multi-block patched and unstructured grid techniques are noted in the findings.

Innovations in Sustainable Energy and Cleaner Environment
Computational Fluid Dynamic (CFD) Analysis of a Generic Missile with Grid FinsComputational Fluid Dynamic (CFD) Analysis of a Generic Missile with Grid FinsCFD Applications and Validations in Aerodynamic Design and Analysis for MissilesCFD examples at ADD are introduced to show their variety at its application in the course of a missile design. Four examples are an ogive-cylinder and boat tail, nose spike, vertical launcher internal and side jet interaction flows at supersonic flow region. Various means of validation for those complex flows are also described. This paper is thus intended to show how CFD and its validation share their role at the ADD aerodynamic research laboratory.Statistical Analysis of CFD Results for Missile Surface PressuresAn international computational aerodynamics study under the auspices of The Technical Cooperation Program (TTCP) Weapons Technology Panel 2 (APN-TP-2) involving participants from defense research laboratories of the United States, United Kingdom, Canada, and Australia was recently completed. The purpose of this study was to examine computational predictive technologies for finned missile shapes by comparing Navier-Stokes predictions to experimental data. Experimental data consisting of surface pressures on the body and fins, flow field pitot pressures, and force measurements were available for comparison to the computational results. The

computational results for this study established an extensive database for evaluation and comparison. The fall database consists of results from six Navier-Stokes codes obtained by seven multi-block patched and unstructured grids for five distinct test cases. The statistical analysis techniques developed to help provide an evaluation of the predictive techniques are described. Quantitative results of the analysis of the differences between computational and experimental results are presented graphically and quantitatively in terms of medians, standard deviation, and a figure of merit to assist in the overall evaluation of the study results. The good performance achieved using the Spalart-Allmaras turbulence model and multi-block patched and unstructured grid techniques are noted in the findings.□□Application of Multi-block CFD Techniques to a Missile GeometryThe aerodynamics of a missile body were modeled using computational fluid dynamics (CFD) techniques. A multi-block approach was used on a slender body and intersecting symmetric thin delta-wing. The CFD process and software were examined thoroughly including multi-block grid generation and interpolation, iblanking methods and flow-solver analysis. CFD results were compared with available wind tunnel data. Two Cartesian free-stream grids, a wing C-grid, a collar and body grid were used to model the body/wing geometry. The wing grid had a sharp tip and sharp leading and trailing edges. The body/wing intersection was represented with the collar grid. Both a hyperbolic grid generator, HYPGEN and an elliptic grid generator, GRIDGEN Vr 9, were evaluated. PEGSUS Vr 4.0 was used to compute the iblanking and interpolation stencil, based on the Chimera overlapping grid scheme. A single composite mesh was passed to the Navier-Stokes implicit flow-solver OVERFLOW Vr 1.6ag. Solutions were computed for inviscid and viscous flows at different Mach numbers and incidence angles. The Baldwin-Lomax shear and boundary layer turbulent models were used. Agreement was found between published wind tunnel data and the CFD solution thus validating the grid generation and flowfield solution procedure.An Assessment of Productive Computational Fluid Dynamics for Aerodynamic Design"The U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC) has been applying a Government-developed, productivity-oriented, Computational Fluid Dynamics (CFD) methodology to the aerodynamic design of Army missiles. This methodology, dubbed Enter Tunnel Analysis (ETA), uses a robust Euler solver and automated grid generation software to drastically reduce the time required to set up and execute flow field computations. ETA is described and applied to two hypervelocity missile configurations; one using a bent nose for aerodynamic control and the other using traditional canards. Comparisons are made with wind tunnel data to assess ETA's ability to produce meaningful results for use by aerodynamic designers."--Report documentation page.Proceedings of the International Conference on Systems, Science,

Control, Communication, Engineering and Technology 2015ICSSCCET 2015 Presents a guide to the essentials of job hunting, including current information on the basics of searching for jobs, getting organized, preparing râesumâes, mastering cover letters, and succeeding in interviews.

Design and Development of Aerospace Vehicles and Propulsion Systems Springer Nature This book covers the state-of-the-art advances in several areas of energy, combustion, power, propulsion, and environment, focusing on the use of conventional and alternative fuels. It presents novel developments in the areas of biofuels and value added products from various feedstock materials, along with thermal management, emission control and environmental issues from energy conversion. Written by internationally renowned experts, the chapters in this volume cover the latest fundamental and applied research innovations on cleaner energy utilization for a wide range of devices extending from micro scale energy conversion to hypersonic propulsion using hydrocarbon fuels. The book will be useful as a ready reference for managers and practicing and research engineers, as well as graduate students and research organizations and institutions.

Missile Aerodynamics Springer "The U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC) has been applying a Government-developed, productivity-oriented, Computational Fluid Dynamics (CFD) methodology to the aerodynamic design of Army missiles. This methodology, dubbed Enter Tunnel Analysis (ETA), uses a robust Euler solver and automated grid generation software to drastically reduce the time required to set up and execute flow field computations. ETA is described and applied to two hypervelocity missile configurations; one using a bent nose for aerodynamic control and the other using traditional canards. Comparisons are made with wind tunnel data to assess ETA's ability to produce meaningful results for use by aerodynamic designers."--Report documentation page.

An Assessment of Productive Computational Fluid Dynamics for Aerodynamic Design Association of Scientists, Developers and Faculties (ASDF) Computational Fluid Dynamic (CFD) Analysis of a Generic Missile with Grid FinsComputational Fluid Dynamic (CFD) Analysis of a Generic Missile with Grid FinsCFD Applications and Validations in Aerodynamic Design and Analysis for Missiles

The Concept Design of a Split Flow Liquid Hydrogen Turbopump AIAA (American Institute of Aeronautics & Astronautics) Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.

ICSSCCET 2015 Elsevier The aerodynamics of a missile body were modeled using computational fluid dynamics (CFD) techniques. A multi-block approach was used on a slender body and

intersecting symmetric thin delta-wing. The CFD process and software were examined thoroughly including multi-block grid generation and interpolation, iblanking methods and flow-solver analysis. CFD results were compared with available wind tunnel data. Two Cartesian free-stream grids, a wing C-grid, a collar and body grid were used to model the body/wing geometry. The wing grid had a sharp tip and sharp leading and trailing edges. The body/wing intersection was represented with the collar grid. Both a hyperbolic grid generator, HYPGEN and an elliptic grid generator, GRIDGEN Vr 9, were evaluated. PEGSUS Vr 4.0 was used to compute the iblanking and interpolation stencil, based on the Chimera overlapping grid scheme. A single composite mesh was passed to the Navier-Stokes implicit flow-solver OVERFLOW Vr 1.6ag. Solutions were computed for inviscid and viscous flows at different Mach numbers and incidence angles. The Baldwin-Lomax shear and boundary layer turbulent models were used. Agreement was found between published wind tunnel data and the CFD solution thus validating the grid generation and flowfield solution procedure.

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The International Conference of Computational Methods in Sciences and Engineering (ICCMSE) is unique in its kind. It regroups original contributions from all fields of the traditional Sciences, Mathematics, Physics, Chemistry, Biology, Medicine and all branches of Engineering. The aim of the conference is to bring together computational scientists from several disciplines in order to share methods and ideas. More than 370 extended abstracts have been submitted for consideration for presentation in ICCMSE 2004. From these, 289 extended abstracts have been selected after international peer review by at least two independent reviewers.

Computational Fluid Dynamics 2004 CRC Press

The flight environment of the Standard Missile, Block IV A interceptor involves high speeds that place severe aerodynamic and aero-thermal loads on the missile optical window and sensor. The supersonic flow over the missile produces aero-optical effects that can degrade IR seeker performance. This report summarizes an analysis of aero-optical aberrations due to shock front and shear layer density gradients. Computational Fluid Dynamics (CFD) models, which incorporate turbulence due to coolant spray, are used to compute the density and refractive index distribution about the IR dome. This data is then used in a ray-tracing program to determine boresite error and astigmatic lensing. These results compare favorably with computational results derived from general fluid mechanical approximations. Conclusions are drawn which indicate that boresite error may hinder seeker-targeting performance when looking in a forward direction or for low altitude intercepts.

Special Course on Modern Theoretical and Experimental Approaches to

Turbulent Flow Structure and Its Modelling Springer Science & Business Media ABSTRACT CONCEPTUAL INTERNAL DESIGN AND COMPUTATIONAL FLUID DYNAMICS ANALYSIS OF A SUPERSONIC INLET ALEMDAROĐLU, Mine M.S., Department of Aerospace Engineering Supervisor: Prof. Dr. Yusuf ÖZYÖRÜK May 2005, 144 pages In this thesis, the conceptual internal design of the air inlet of a supersonic, high altitude, solid propellant ramjet cruise missile is performed. Inviscid, compressible CFD analysis of the designed inlet is made in order to obtain qualitative and quantitative performance characteristics of the inlet at different operating conditions. The conceptual design of the inlet is realized by using analytical relations and equations, correlations derived from numerous available past experimental data and state-of-the-art design examples. The performance estimation of the designed inlet at different operating conditions is done by using one and two dimensional gas dynamics equations. The results of the performance estimation study are compared with the results of the CFD analysis and these results are discussed in detail. A commercial tool, CFD-FASTRANÒ, is used for the CFD analysis. Inlet flow phenomena such as, different shock patterns and shock positions, performance degradation at off-design operating conditions and inlet unstart are observed. Keywords: Supersonic Inlet, Ramjet, CFD, Inlet Performance Characteristics, Operating Conditions, Unstart.

Proceedings of 2021 International Conference on Autonomous Unmanned Systems (ICAUS 2021) Springer Science & Business Media This book presents selected papers presented in the Symposium on Applied Aerodynamics and Design of Aerospace Vehicles (SAROD 2018), which was jointly organized by Aeronautical Development Agency (the nodal agency for the design and development of combat aircraft in India), Gas-Turbine Research Establishment (responsible for design and development of gas turbine engines for military applications), and CSIR-National Aerospace Laboratories (involved in major aerospace programs in the country such as SARAS program, LCA, Space Launch Vehicles, Missiles and UAVs). It brings together experiences of aerodynamicists in India as well as abroad in Aerospace Vehicle Design, Gas Turbine Engines, Missiles and related areas. It is a useful volume for researchers, professionals and students interested in diversified areas of aerospace engineering.

The Aerodynamic Influence of a Helicopter on a Jettisoned Missile Allied Publishers Lattice grid fins have been studied for missile tail control for several years. A lattice grid fin can be described as an unconventional missile control surface comprised of an outer frame supported by an inner lattice grid of lifting surfaces. This unconventional fin design offers favorable lift characteristics at high angle of attack as well as almost zero hinge moments allowing the use of small and light actuators. In addition, they promise good storability for potential tube-launched and internal carriage dispenser-launched

applications. The drawback for the lattice grid fins is the high drag and potentially poor radar cross section performance produced by this unconventional control surface configuration. Current research at the United State Air Force's Aeroballistic Research Facility (ARF) at Eglin Air Force Base in Florida has indicated there is a critical transonic Mach number where normal shock waves are believed to be present within some of the grid cells. At this particular Mach number, there is a dynamic instability with severe variations of the pitch moment coefficient. A computational fluid dynamics (CFD) study was conducted to investigate these findings and elucidate the flowfield in the grid fin region. The missile model was numerically modeled in Gridgen and computational tests were run in Fluent. Finally, another fin configuration was developed that produced less drag and similar dynamic stability that the other lattice grid fin configurations tested.

New Results in Numerical and Experimental Fluid Mechanics X CUP Archive

The first volume of CFD Review was published in 1995. The purpose of this new publication is to present comprehensive surveys and review articles which provide up-to-date information about recent progress in computational fluid dynamics, on a regular basis. Because of the multidisciplinary nature of CFD, it is difficult to cope with all the important developments in related areas. There are at least ten regular international conferences dealing with different aspects of CFD.It is a real challenge to keep up with all these activities and to be aware of essential and fundamental contributions in these areas. It is hoped that CFD Review will help in this regard by covering the state-of-the-art in this field.The present book contains sixty-two articles written by authors from the US, Europe, Japan and China, covering the main aspects of CFD. There are five sections: general topics, numerical methods, flow physics, interdisciplinary applications, parallel computation and flow visualization. The section on numerical methods includes grids, schemes and solvers, while that on flow physics includes incompressible and compressible flows, hypersonics and gas kinetics as well as transition and turbulence. This book should be useful to all researchers in this fast-developing field.

Proceedings of the Third International Conference on Computational Fluid Dynamics, ICCFD3, Toronto, 12-16 July 2004

The similarities between the airplane and the missile extend beyond their flying capabilities, and at higher operational speeds, the configuration distinctions become even less apparent. " Missile Aerodynamics," a classic now available from AIAA and Nielsen Engineering and Research, Inc., combines the best of missile and airplane aerodynamics, drawing extensively from numerous technical papers to present a rational and unified account of the principles behind missile projection. Evaluate the missile versus the airplane in a multitude of areas, from longitudinal acceleration, wing loading, roll and dynamic stability, guidance and navigation, and more. J.N. Nielsen covers every aspect of missile aerodynamics, from the classification of missiles and basic

formulas to innovative aerodynamic controls. In one reliable reference, readers will find hundreds of schematics, equations, and tables with practical applications in missile design and engineering. Originally published by Nielsen Engineering and Research, Inc.

New Trends and Advances

Computational Fluid Dynamics: An Introduction grew out of a von Karman Institute (VKI) Lecture Series by the same title ?rst presented in 1985 and repeated with modi?cations every year since that time. The objective, then and now, was to present the subject of computational ?uid dynamics (CFD) to an audience unfamiliar with all but the most basic numerical techniques and to do so in such a way that the practical application of CFD would become clear to everyone. A second edition appeared in 1995 with updates to all the chapters and when that printing came to an end, the publisher requested that the editor and authors consider the preparation of a third edition. Happily, the authors received the request with enthusiasm. The third edition has the goal of presenting additional updates and clari?cations while preserving the introductory nature of the material. The book is divided into three parts. John Anderson lays out the subject in Part I by ?rst describing the governing equations of ?uid dynamics, concentrating on their mathematical properties which contain the keys to the choice of the numerical approach. Methods of discretizing the equations are discussed and transformation techniques and grids are presented. Two examples of numerical methods close out this part of the book: source and vortex panel methods and the explicit method. Part II is devoted to four self-contained chapters on more advanced material. Roger Grundmann treats the boundary layer equations and methods of solution.

Aerodynamic Analysis of a Modified, Pylon-mounted JSOW

CFD examples at ADD are introduced to show their variety at its application in the course of a missile design. Four examples are an ogive-cylinder and boat tail, nose spike, vertical launcher internal and side jet interaction flows at supersonic flow region. Various means of validation for those complex flows are also described. This paper is thus intended to show how CFD and its validation share their role at the ADD aerodynamic research laboratory.

A Step-by-step Guide to Preparing for Your Job Search

This volume contains the papers presented at the Parallel Computing Fluid Dynamics '93 Conference, Paris, 1993. A wide range of topics are covered including: networked computers, data parallel programming, domain decomposition, Euler and Navier-Stokes solvers. Researchers in this area will find this volume a useful reference in this rapidly developing field.

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