1999

COMPUTATIONAL AND EXPERIMENTAL INVESTIGATIONS OF VARIOUS AERODYNAMIC AND AEROELASTIC PROBLEMS

1 January 1999 – 31 December 1999
M.F. Platzer, Distinguished Professor

OBJECTIVE: Perform computational and experimental investigations of various steady and unsteady aerodynamic and aeroelastic problems.

SUMMARY: A new type of power generator was built and tested in a water tunnel using an airfoil which has the plunge and pitch degrees of freedom and therefore can be induced into a two-degree-of-freedom flutter motion. Measured power values were compared with an analysis using an inviscid unsteady panel code. Also, the dynamic stall characteristics of a flapping airfoil and the transonic flutter characteristics of the NLR 7301 airfoil was analyzed using a Navier-Stokes code.

DEVELOPMENT OF SMALL UNMANNED AIR VEHICLE

M.F. Platzer
Distinguished Professor of Aeronautics and Astronautics
Research Assistant Professor K.D. Jones
Sponsor: Naval Research Laboratory

OBJECTIVE: The objective of the proposed effort is the exploration and demonstration of flapping wing propulsion for small unmanned air vehicles

SUMMARY: Several micro-air-vehicle models of varying scales and complexity were built and tested which use two airfoils that are flapping in counterphase with variable frequency and amplitude. The thrust was measured with a laser device and compared with the numerical results obtained with a previously developed inviscid unsteady panel code.

AEROELASTIC STUDIES OF HYPERSONIC MISSILE FINS

M.F. Platzer
Distinguished Professor of Aeronautics and Astronautics
Research Associate Professor Ramesh Kolar
Sponsor: Naval Air Warfare Center, China Lake, CA

OBJECTIVE: The objective of this work is to perform an exploratory flutter analysis of the fins on the proposed Navy Hypersonic Weapons Technology Missile.

SUMMARY: A report was delivered which summarizes the vibration and flutter analysis of a representative fin using the MSC-NASTRAN code.

COMPUTATIONAL STUDY OF ABRUPT WING STALL

M.F. Platzer
Distinguished Professor of Aeronautics and Astronautics
K.D. Jones
Research Assistant Professor
Sponsor: Office of Naval Research and
Naval Air Warfare, Center, Patuxent River

OBJECTIVE: Computational Prediction of abrupt transonic wing stall on modern fighter/attack aircraft configurations using advanced Navier-Stokes codes.

SUMMARY: NAWC-supplied computations of the F-18 E/F configurations are being analyzed to establish criteria for the onset of abrupt wing stall.

VANDAL FIN FLUTTER STUDIES

Distinguished Professor M.F. Platzer
Research Associate Professor Ramesh Kolar
Sponsor: Naval Air Warfare Center, China Lake, CA

OBJECTIVE: The objective of this investigation is the flutter analysis of the fin of the VANDAL missile.

SUMMARY: An aeroelastic analysis of the VANDAL missile fin was performed. Two models were developed: a free-free fin and a cantilevered fin using MSC/NASTRAN. The structural dynamic model was then used to analyze the fin aeroelastic characteristics. The aerodynamic modeling was performed using piston theory and ZONA51 supersonic lifting surface theory.

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DEVELOPMENT OF SMALL UNMANNED AIR VEHICLE

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
K.D. Jones, Research Assistant Professor
Sponsor: Naval Research Laboratory

OBJECTIVE: The objective of the proposed effort is the exploration and demonstration of flappaing wing propulsion for small unmanned air vehicles

SUMMARY: A mechanical flapping-wing device was built, allowing for the systematic evaluation of flapping wing performance over a broad parameter space. The mechanism flaps two airfoils with variable pitch and plunge amplitude and variable phasing, and allows for the inclusion of additional stationary wings. The thrust was measured with a laser device and compared with the numerical results obtained with a previously developed inviscid unsteady panel code. Also, a micro-air vehicle using two flapping airfoils was built and preliminary tests of this vehicle were initiated.

ADVANCED MUTLIDISCIPLINARY ANALYSIS AND DESIGN OPTIMIZATION METHODS FOR SUBSONIC TRANSPORT AIRCRAFT

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
K.D. Jones, Research Assistant Professor
Sponsor: McDonnell-Douglas Aircraft Company

OBJECTIVE: To contribute to the development of advanced multidisciplinary analysis and design optimization methods for subsonic transport aircraft.

SUMMARY: This work entails the use/extension of two/three-dimensional computational fluid dynamics codes for inviscid or viscous subsonic flow over airfoils or aircraft configurations with emphasis on speeding up the computations by means of parallelization.

FIN FLUTTER ON HYPERSONIC MISSILES

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
Ramesh Kolar, Research Associate Professor
Sponsor: Naval Air Warfare Center, China Lake, CA

OBJECTIVE: The objective of this work is to perform an exploratory flutter analysis of the fins on the proposed Navy Hypersonic Weapons Technology Missile.

SUMMARY: A report was delivered which summarized the flutter analysis using piston theory aerodynamics in combination with a two-degree-of-freedom bending/torsion model.

GUST LOAD ANALYSIS

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
I.H. Tuncer, Research Assistant Professor
Sponsor: Naval Air Warfare Center, Patuxent River, MD

OBJECTIVE: The objective of this project is to perform an exploratory assessment of the gust load sensitivity of the Lockheed C-130J aircraft to Navy missions.

SUMMARY: The panel code PMARC was used to compute the aerodynamic loads on the C-130J wing.

SUBSONIC AIRCRAFT AND UNMANNED AIR VEHICLE AERODYNAMICS

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
SUMMARY OF INTERNALLY FUNDED RESEARCH PROJECT

OBJECTIVE: Perform computational investigations of the steady and unsteady aerodynamic and aeroelastic characteristics of subsonic aircraft and of unmanned air vehicle.

SUMMARY: Navier-Stokes calculations were performed to predict the flow over wing-body-canard aircraft configuration at high angle of attack. Also, the effectof airfoil geometry and flow compressibility on airfoil flutter was studied using panel, Euler and Navier-Stokes codes.

1997

OSCILLATORY AIRFOIL AERODYNAMICS

M.F. Platzer, Distinguished Professor

OBJECTIVE: Perform computational and experimental investigations of the unsteady separated flow phenomena on airfoils, of the flow control potential due to airfoil flapping, and of the flutter and gust response characteristics of airfoils, helicopter and turbomachinery blades.

SUMMARY: Water and wind tunnel experiments were performed to study the flow over double-delta wings at high incidence angles, the characteristics of separation bubbles on NACA 0012 airfoils, the influence of pressure gradients on the flow over cavities, and the ability of flapping airfoils to control flow separation. Also, boundary layer and Navier-Stokes calculations were performed to predict these flow phenomena.

DEVELOPMENT OF AN ADVANCED MISSILE AERODYNAMIC PREDICTION METHOD

M.F. Platzer, Distinguished Professor
I.H. Tuncer, Research Assistant Professor
Sponsor: Naval Air Warfare Center, Weapons Division

OBJECTIVE: Develop Navier-Stokes and panel code solutions for the vortical flow over complete missile configurations in steady or maneuvering high angle of attack flight.

SUMMARY: Navier-Stokes computations were completed for subsonic flow over a complete missile configuration, including the flow into a missile engine through a flush-mounted engine inlet, using the NASA-Ames OVERFLOW code. Also, the NASA-Ames panel code PMARC was extended to compute the flow over bodies of revolution at high angle of attack.

DEVELOPMENT OF SMALL UNMANNED AIR VEHICLE

M.F. Platzer, Distinguished Professor
K.D. Jones, Research Assistant Professor
I.H. Tuncer, Research Assistant Professor
Sponsor: Naval Research Laboratory

OBJECTIVE: The objective of the proposed effort is the exploration and demonstration of flapping wing propulsion for small unmanned air vehicles.

SUMMARY: Computations were completed to prediction the thrust of flapping/pitching airfoils and airfoil combinations as a function of frequency and amplitude of oscillation and as a function of the phase angle between flapping and pitching. Also, a wind tunnel model was designed and built to measure the thrust as a function of these parameters and a first set of measurements was completed.

ADVANCED MULTIDISCIPLINARY ANALYSIS AND DESIGN OPTIMIZATION METHODS FOR SUBSONIC TRANSPORT AIRCRAFT

M.F. Platzer, Distinguished Professor
K.D. Jones, Research Assistant Professor
Sponsor: McDonnell-Douglas Aircraft Company

OBJECTIVE: To contribute to the development of advanced multidisciplinary analysis and design optimization methods for subsonic transport aircraft.

SUMMARY: This work entails the use/extension of three-dimensional computational fluid dynamics codes for viscous subsonic/transonic flow over a wing/body/nacelle/pylon configuration and the development of new turbulence models. Also, it involves the use of a finite element code to determine the aircraft deformation under loading and to speed up the computations by means of parallelization.

1996

HIGH LIFT STUDIES FOR ENHANCED FIGHTER MANEUVERABILITY

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics

OBJECTIVE: Identify promising methods for the generation and exploitation of dynamic lift in order to achieve enhanced fighter aircraft maneuverability. To this end, perform detailed experimental studies on double delta wings and canard-wing configurations

SUMMARY: Water tunnel flow visualization studies were conducted to determine the effect of Reynolds number on the vortex development over cropped double-delta wings.

NUMERICAL INVESTIGATION OF HIGH ANGLE OF ATTACK MISSILE AERODYNAMICS

M.F. Platzer, Distinguished Professor
I.H. Tuncer, Research Assistant Professor
Sponsor: Naval Air Warfare Center, Weapons Division

OBJECTIVE: Develop Navier-Stokes and panel code solutions for the vortical flow over complete missile configurations in steady or maneuvering high angle of attack flight.

SUMMARY: Navier-Stokes computations were completed for subsonic flow over a complete missile configuration at high angle of attack using the NASA-Ames OVERFLOW code. Also, the NASA-Ames panel code PMARC was extended to compute the flow over bodies of revolution at high angle of attack.

EXPERIMENTAL STUDY OF BOUNDARY LAYER ENERGIZATION

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
Sponsor: Office of Naval Research

OBJECTIVE: The objective of the proposed effort is the exploration and demonstration of a new boundary layer acceleration and flow control device.

SUMMARY: Water tunnel tests showed that the use of flapping airfoils is a promising method of suppressing flow separation.

ADVANCED MULTIDISCIPLINARY ANALYSIS AND DESIGN OPTIMIZATION METHODS FOR SUBSONIC TRANSPORT AIRCRAFT

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics
Sponsor: McDonnell-Douglas Aircraft Company

OBJECTIVE: To contribute to the development of advanced multidisciplinary analysis and design optimization methods for subsonic transport aircraft.

SUMMARY: This work entails the use/extension of three-dimensional computational fluid dynamics codes for viscous subsonic/transonic flow over a wing/body/nacelle/pylon configuration and the development of new turbulence models. Also, it involves the use of a finite element code to determine the aircraft deformation under loading and to speed up the computations by means of parallelization.

AIRFOIL STALL INVESTIGATIONS

M.F. Platzer, Distinguished Professor
Department of Aeronautics and Astronautics

OBJECTIVE: To develop computational methods for the analysis of stall onset on airfoils and turbomachinery blades.

SUMMARY: Navier-Stokes were developed which showed that the incorporation of boundary transition is the key to the computation of separation bubbles and of dynamic stall phenomena on airfoils and turbomachinery blades.

1993

DYNAMIC LIFT STUDIES FOR ENHANCED FIGHTER MANEUVERABILITY

M.F. Platzer, Professor of Aeronautics and Astronautics
S.K. Hebbar, Research Associate Professor
J.A. Ekaterinaris, Research Associate Professor
Sponsor: Naval Air Warfare Center
Aircraft Division, Johnsville, PA

OBJECTIVE: Identify promising methods for the generation and exploitation of dynamic lift in order to achieve enhanced fighter aircraft maneuverability. To this end, perform detailed experimental studies on double delta wings and complete aircraft configurations in dynamic motion and obtain computational solutions for steady and unsteady high angle of attack wing flows.

SUMMARY: Water tunnel studies were conducted to determine the following effects: (a) pitch rate/sideslip effects on leading-edge extension vortices of an F/A-18 aircraft model, (b) dynamic effects during sideslipping of a canard-configured fighter model, (c) the effect of canard oscillations on the vortical flow development,(d) the effect of fillets on the vortex development over double-delta wings. Also, computational solutions were obtained for the vortical flow field and the vortex breakdown phenomenon on high angle of attack wing flows.

AIRCRAFT AND JET ENGINE UNSTEADY FLOW COMPUTATIONS

M.F. Platzer, Professor of Aeronautics and Astronautics
J.A. Ekaterinaris, Research Associate Professor
Sponsor: Naval Air Systems Command

OBJECTIVE: Develop computational methods and obtain computational solutions for steady and unsteady flows over fighter aircraft configurations and helicopter blades at high angles of attack and through jet engine compressors and turbines.

SUMMARY: Potential flow, viscous-inviscid interaction and compressible Navier-Stokes computations were completed to study the dynamic stall characteristics of oscillating and rapidly pitching airfoils and the interaction effects between airfoils. Also, Navier-Stokes solutions were obtained for subsonic flow over canard-wing configurations at high angles of attack.

FLOW OVER MISSILE CONFIGURATIONS AT HIGH INCIDENCE

M.F. Platzer, Professor of Aeronautics and Astronautics
J.A. Ekaterinaris, Research Associate Professor
S.K. Hebbar, Research Associate Professor
Sponsor: Naval Air Warfare Center, Weapons Division

OBJECTIVE: Develop Navier-Stokes solutions for the vortical flow over complete missile configurations in steady or maneuvering high angle of attack flight.

SUMMARY: Navier-Stokes computations were completed for subsonic flow over a close-coupled canard-wing configuration for which extensive experimental data are available for comparison. Also, Navier-Stokes solutions were obtained for subsonic flow over a representative missile configuration at high angle of attack. In addition, a new viscous-inviscid interaction method was developed for two-dimensional unsteady compressible airfoil flows. Also, force and moment data were acquired on a NAWC-designed missile.

AERODYNAMICS OF OSCILLATING DEVICES AT LIFT AUGMENTORS

M.F. Platzer, Professor of Aeronautics and Astronautics
S.K. Hebbar, Research Associate Professor
Sponsor: Naval Air Systems Command

OBJECTIVE: Investigate the unsteady flow physics of multi-element airfoils for potential application to enhance the aerodynamic performance characteristics of aircraft.

SUMMARY: An aerodynamic analysis of flapping airfoils and airfoil combinations was completed which demonstrated the Katzmayr effect of producing a forward thrust due to flapping. Furthermore, it was shown that there exist conditions of favorable interference between two flapping airfoils which enhance this propulsive effect. Flow visualization studies were completed in two wind tunnels which demonstrated the propulsive vortex shedding from flapping airfoils.

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AIRCRAFT AND JET ENGINE UNSTEADY FLOW COMPUTATIONS

M.F. Platzer, Professor of Aeronautics and Astronautics
J.A. Ekaterinaris, Research Associate Professor
Sponsor: Naval Air Systems Command

OBJECTIVE: Develop computation methods and obtain computational solutions for steady and unsteady flows over fighter aircraft configurations and helicopter blades at high angles of attack and through jet engine compressors and turbines.

SUMMARY: Potential flow, viscous-inviscid interaction and compressible Navier-Stokes computations were completed to study the dynamic stall characteristics of oscillating and rapidly pitching airfoils and the interaction effects between airfoils.

DYNAMIC LIFT STUDIES FOR ENHANCED FIGHTER MANEUVERABILITY

M.F. Platzer, Professor of Aeronautics and Astronautics
S.K. Hebbar, Research Associate Professor
J.A. Ekaterinaris, Research Associate Professor
Sponsor: Naval Air Warfare Center
Aircraft Division, Johnsville, PA

OBJECTIVE: Identify promising methods for the generation and exploitation of dynamic lift. To this end, perform detailed experimental and computational studies on airfoils, double delta wings and complete aircraft configurations in dynamic motion.

SUMMARY: Water tunnel studies were conducted to determine the following effects: a) pitch rate/sideslip effects on leading-edge extension vortices of an F/A-18 aircraft model, b) dynamic effects during sideslipping of a canard-configured fighter model, c) the effect of canard oscillations on the vortical flow development, d) the effect of fillets on the vortex development over double-delta wings. Furthermore, Navier-Stokes calculations were continued for flows over airfoils, double-delta wings and wing-body configurations at high angles of attack.