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中国空气动力研究与发展中心

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目 录

说明：

以上论文系通过作者单位（China Aerodynam Res & Dev Ctr）检索的结果，时间截至2015年7月初。共搜集论文44篇，其中以气动中心（China Aerodynam Res & Dev Ctr）及下属单位为第一作者单位的论文24篇，占总数的54.55%。论文所在期刊分布在Q1区（JCR分区）的16篇（36.36%），Q2区10篇（22.72%）；1篇论文所在期刊影响因子大于4（9.10%），9篇大于2小于3（20.45%），16篇大于1小于2（36.36%），18篇小于1（40.10%）。

Preparation and properties of palmitic-stearic acid eutectic mixture/expanded graphite composite as phase change material for energy storage

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摘要

A novel composite PCM (phase change material) with PA-SA (palmitic-stearic acid) eutectic mixture as PCM and EG (expanded graphite) as supporting material was prepared. The optimum absorption ratio of PA-SA/EG (Palmitic-stearic acid/expanded graphite) composite PCM was determined as PA-SA:EG = 13:1 (by mass). Scanning electron microscope and Fourier transformation infrared spectroscopy results show that PA-SA was uniformly distributed in the porous network structure of EG due to the physical action. Thermal property and thermal stability of the PA-SA/EG composite KM were characterized by DSC (differential scanning calorimetry) and TGA (thermogravimetric analysis). DSC results indicated that the melting and freezing temperatures and latent heats of PA-SA/EG were measured as 53.89 degrees C and 54.37 degrees C, and 166.27 J/g and 166.13 J/g. TGA test results revealed that PA-SA/EG had a good thermal stability in working temperature range. Thermal cycling test results showed PA-SA/EG had a good thermal reliability after 720 thermal cycles. Thermal conductivity of the composite PCM was measured as 2.51 W/m K, much higher than that of PA-SA. The thermal energy storage and release rates of PA-SA/EG were also increased due to the high thermal conductivity of EG. In conclusion, the prepared PA-SA/EG composite PM can be acted as a potential material for thermal energy storage due to the acceptable thermal properties, good thermal reliability and stability, high thermal conductivity. (C) 2014 Elsevier Ltd. All rights reserved.

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Modified light-cone condition via vacuum polarization in a time-dependent field

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摘要

The onset of unconventional vacuum properties in intense fields has long been an active field of research. In this paper the vacuum polarization effect is investigated via a pump probe scheme in which a probe light propagates in the vacuum excited by a standing wave composed of two counterpropagating laser beams. The modified light-cone condition of the probe light is derived analytically for the situation that it passes through the electric (magnetic) antinode plane of the pump field and thus the probe light effectively experiences a time-dependent electric (magnetic) field. The derivation does not follow the commonly adopted assumption of treating the pump field as a constant field. Differences from the conventional light-cone conditions are identified. The light-cone condition is used to calculate the ellipticity value for a conceptual vacuum birefringence measurement. The quasistatic treatment is partly justified and the implications of the unconventional correction to previous results are discussed.

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An adaptive predictor-corrector reentry guidance based on self-definition way-points

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摘要

An adaptive predictor-corrector reentry guidance algorithm with self-defined way-points is proposed. In the guidance process, the reentry trajectory is divided into the predictor-corrector phase and the trajectory onboard generation and tracking phase which is near to the endpoint position of reentry and utilized to improve the accuracy and adaptivity of the guidance. In the first phase, the predictor-corrector algorithm is applied to solve the guidance problem between the self-defined way-points. Moreover the position parameters of reentry trajectory are translated into the parameters related to the reentry plane by orthogonal transformation in the spherical coordinate to improve robustness of guidance algorithm. In addition, the predictor-corrector algorithm is implemented using a brain emotional learning based intelligence controller (BELBIC). In the second phase, the trajectory from the current point to the endpoint is generated onboard and the linear-quadratic regulator (LQR) theory is employed for trajectory tracking. The effectivity of the proposed guidance is validated by simulations in conditions of the nominal case, the environment dispersed case and the endpoint maneuvering case. The advantages of this guidance in coping with disturbances, reducing time of numerical trajectory prediction and being suitable for maneuver endpoint are analyzed with the simulation results. (C)2014 Published by Elsevier Masson SAS.

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Debris area distribution of spacecraft under hypervelocity impact

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摘要

Cross-sectional area is an important parameter for spacecraft breakup debris as it is the directly measured data in space observation. It is significant for observing and analysing the spacecraft breakup event to accurately modelling the area distribution of the breakup debris. In this paper, experimental study has been performed on debris area distribution characteristics of spacecraft under hypervelocity impact. The tests are carried out at the ballistic ranges of CARDC. Aluminium projectiles are launched to normally impact the simulated spacecrafts at about 3.0 km/s. The simulated spacecrafts are made up of aluminium plates, filled with some simulated electronics boxes, each of which was installed with a circuit board. "Soft-catch" devices are used to recover the breakup fragments. The test results show that: 1) the relationship between the cross-sectional area and the characteristic length of debris, which can be obtained in the logarithmic coordinates by linear fitting, represents the debris shape characteristic in a certain extent; 2) the area-to-mass ratios of fragments show normal distributions in the logarithmic coordinates; 3) debris made of different materials can be distinguished by different peaks on the distribution curves; 4) the area-to-mass ratio distributions can be expressed by a linear superimposition of several normal functions which represent the main materials of the spacecraft. (C) 2014 IAA. Published by Elsevier Ltd. All rights reserved.

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Infrared Radiation Experimental Measurement and Analyse of Carbon Dioxide at High Temperature

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摘要

This paper introduces the experiment technology for measuring the radiation of high temperature gas in the high frequency plasma wind tunnel. The infrared radiation of carbon dioxide at high temperature has been measured using this technology. We introduced the principium, flow field and the working gas of the high frequency plasma wind tunnel. The experiment condition, equipment, method of data processing and the analyse of the experiment results were introduced. We had measured the infrared radiation of carbon dioxide at four different temperatures between 1 500 and 3 000 K using this technology for measuring the radiation of high temperature gas which had been developed by ourselves. Measuring the spatial distribution of the infrared radiation of carbon dioxide using Able-transform were also introduced. We have analyzed the emission spectrum at 4. 3 mu m of carbon dioxide at high temperature. The conclusion had been obtained that the center wavelength of the emission spectrum moved to the long wave when the temperature risen. The authors also had analyzed and contrasted the experiment results and the data obtained from literatures.

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Calibration of a gamma-Re (theta) transition model and its application in low-speed flows

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摘要

The prediction of laminar-turbulent transition in boundary layer is very important for obtaining accurate aerodynamic characteristics with computational fluid dynamic (CFD) tools, because laminar-turbulent transition is directly related to complex flow phenomena in boundary layer and separated flow in space. Unfortunately, the transition effect isn't included in today's major CFD tools because of non-local calculations in transition modeling. In this paper, Menter's gamma-Re (theta) transition model is calibrated and incorporated into a Reynolds-Averaged Navier-Stokes (RANS) code - Trisonic Platform (TRIP) developed in China Aerodynamic Research and Development Center (CARDC). Based on the experimental data of flat plate from the literature, the empirical correlations involved in the transition model are modified and calibrated numerically. Numerical simulation for low-speed flow of Trapezoidal Wing (Trap Wing) is performed and compared with the corresponding experimental data. It is indicated that the gamma-Re (theta) transition model can accurately predict the location of separation-induced transition and natural transition in the flow region with moderate pressure gradient. The transition model effectively imporves the simulation accuracy of the boundary layer and aerodynamic characteristics.

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Large eddy simulation on curvilinear meshes using seventh-order dissipative compact scheme

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摘要

This work investigates the performance of the high-order implicit large eddy simulation (HILES) on curvilinear meshes. The HILES is developed based on a seventh-order hybrid cell-edge and cell-node dissipative compact scheme (HDCS-E8T7) satisfying the surface conservation law (SCL). Efficiency of implicit subgrid-scale model is tested by three-dimensional Taylor-Green vortex case. According to the test of flow over a cylinder, the influence of the SCL errors has been investigated on curvilinear mesh. Then stall phenomena of thin airfoil NACA64A006 have been simulated by the HILES. The slope of lift curve, the maximum lift and the stall angle are successfully predicted. Moreover, the lift characteristic seems to be satisfactorily captured even after the stall angle. The solutions demonstrate the potential of HILES for simulating complex turbulent flow. (C) 2014 Elsevier Ltd. All rights reserved.

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Dim moving target detection algorithm based on spatio-temporal classification sparse representation

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摘要

A dim moving target detection algorithm based on spatio-temporal classification sparse representation, which can characterize the motion information and morphological feature of target and background clutter, is proposed to enhance the performance of target detection. A spatio-temporal redundant dictionary is trained according to the content of infrared image sequence, and then is subdivided into target spatio-temporal redundant dictionary describing moving target, and background spatio-temporal redundant dictionary embedding background by the criterion that the target spatio-temporal atom could be decomposed more sparsely over Gaussian spatio-temporal redundant dictionary. The target and background clutter can be sparsely decomposed over their corresponding spatio-temporal redundant dictionary, yet could not be sparsely decomposed on their opposite spatio-temporal redundant dictionary, and so their residuals after reconstruction by the prescribed number of target and background spatio-temporal atoms would differ very visibly. Some experimental results show this proposed approach could not only improve the sparsity more efficiently, but also enhance the target detection performance more effectively. (C) 2014 Elsevier B.V.

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Experimental study of vortex-structure interaction noise radiated from rod-airfoil configurations

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摘要

Vortex-structure interaction noise radiated from an airfoil embedded in the wake of a rod is investigated experimentally in an anechoic wind tunnel by means of a phased microphone array for acoustic tests and particle image velocimetry (PIV) for the flow field measurements. The rod-airfoil configuration is varied by changing the rod diameter (D), adjusting the cross-stream position (Y) of the rod and the streamwise gap (L) between the rod and the airfoil leading edge. Two noise control concepts, including "air blowing" on the upstream rod and a soft-vane leading edge on the airfoil, are applied to control the vortex-structure interaction noise. The motivation behind this study is to investigate the effects of the three parameters on the characteristics of the radiated noise and then explore the influences of the noise control concepts. Both the vortex-structure interaction noise and the rod vortex shedding tonal noise are analysed. The acoustic test results show that both the position and magnitude of the dominant noise source of the rod-airfoil model are highly dependent on the parameters considered. In the case where the vortex-structure interaction noise is dominant, the application of the air blowing and the soft vane can effectively attenuate the interaction noise. Flow field measurements suggest that the intensity of the vortex-structure interaction and the flow impingement on the airfoil leading edge are suppressed by the control methods, giving a reduction in noise. (C) 2014 Elsevier Ltd. All rights reserved.

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Aerodynamic configuration optimization by the integration of aerodynamics, aerothermodynamics and trajectory for hypersonic vehicles

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摘要

The problem of aerodynamic configuration design optimization is a multidisciplinary design optimization (MDO) problem, and recently the MDO method is widely adopted in the field of hypersonic vehicle configuration design. From the aerodynamic point of view, the aerodynamics, aerothermodynamics and trajectory are considered in this paper. Generally speaking, the aerodynamic characteristics, aerodynamic heating and trajectory are determined by the aerodynamic configuration and the design of flight trajectory. The design method considering these three disciplines is proposed. The parametric geometrical configurations are proposed, and the aerodynamic characteristics are predicted by the rapid and effective engineering method. The optimization of aerodynamic configuration considering the integration of aerodynamics, aerothermodynamics and trajectory is investigated based on the parametric geometrical configuration. Maximum lift-to-drag ratio, maximum range of the trajectory and minimum total heat load of the stagnation point are chosen as the three optimal goals. The detailed research indicates that the optimal configurations and trajectories with different weighting factors can be obtained by the optimization, and there are obvious differences between them. The optimal configuration and flight trajectory obtained by the optimization can be used as the feasible schemes in the future work.

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Debris dispersion effect in N-shape configuration

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摘要

Spacecraft shields play an important role in shielding against the impact of space debris. Increasing the dispersion degree of the debris produced by the impact of the space debris on the bumper of configuration is able to lower the concentration of debris impacting on the rear plate and thus to reduce the risk of debris perforating the rear plate. In order to improve the dispersion degree, the N-shape configuration is proposed and studied by hypervelocity impact test with the velocity of 4.80 km/s and numerical simulation with the velocities ranging from 3.0 km/s to 7.0 km/s. As a comparison, the distribution of debris impacting on the rear plate is also investigated for the parallel triple-wall configuration with the same areal density. It is found that this degree is increased in the N-shape configuration due to the oblique plate, and therefore the risk of debris perforating the rear plate is reduced compared to the case of parallel triple-wall configuration. (C) 2014 IAA. Published by Elsevier Ltd. All rights reserved.

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A Novel Video Stitching Method for Multi-Camera Surveillance Systems

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摘要

This paper proposes a novel video stitching method that improves real-time performance and visual quality of a multi-camera video surveillance system. A two-stage seam searching algorithm based on enhanced dynamic programming is proposed. It can obtain satisfactory result and achieve better real-time performance than traditional seam-searching methods. The experiments show that the computing time is reduced by 66.4% using the proposed algorithm compared with enhanced dynamic programming, while the seam-searching accuracy is maintained. A real-time local update scheme reduces the deformation effect caused by moving objects passing through the seam, and a seam-based local color transfer model is constructed and applied to achieve smooth transition in the overlapped area, and overcome the traditional pixel blending methods. The effectiveness of the proposed method is proved in the experiements.

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A new grid deformation technology with high quality and robustness based on quaternion

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摘要

Quality and robustness of grid deformation is of the most importance in the field of aircraft design, and grid in high quality is essential for improving the precision of numerical simulation. In order to maintain the orthogonality of deformed grid, the displacement of grid points is divided into rotational and translational parts in this paper, and inverse distance weighted interpolation is used to transfer the changing location from boundary grid to the spatial grid. Moreover, the deformation of rotational part is implemented in combination with the exponential space mapping that improves the certainty and stability of quaternion interpolation. Furthermore, the new grid deformation technique named "layering blend deformation" is built based on the basic quaternion technique, which combines the layering arithmetic with transfinite interpolation (TFI) technique. Then the proposed technique is applied in the movement of airfoil, parametric modeling, and the deformation of complex configuration, in which the robustness of grid quality is tested. The results show that the new method has the capacity to deal with the problems with large deformation, and the "layering blend deformation" improves the efficiency and quality of the basic quaternion deformation method significantly. (C) 2014 Production and hosting by Elsevier Ltd. on behalf of CSAA & BUAA.

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Hypersonic static aerodynamics for Mars science laboratory entry capsule

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摘要

The Mars Science Laboratory (MSL) entry capsule has been designed as a lifting entry for sufficient deceleration and precise landing performance. This paper presents the static aerodynamics analysis of the MSL capsule in the hypersonic entry process for exploration mission to Mars. Hypersonic static coefficients were derived from fully three-dimensional computational fluid dynamics solutions with a specified effective specific heat ratio on a typical trajectory state. Aerodynamic performance analysis ascertains the trim characteristics and static stability of the capsule with respect to the center of gravity (CG) location. Analysis results obtained show that CG location determines the trim characteristics and the static stability, and certain CG radial and axial shift alters the lifting entry performance, so that proper aerodynamic configuration and inner equipment layout is needed for CG adjustment to satisfy the static aerodynamics requirements. (C) 2014 IAA. Published by Elsevier Ltd. All rights reserved.

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Heat transfer characteristics and limitations analysis of heat-pipe-cooled thermal protection structure

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摘要

The theories of heat transfer, thermodynamics and fluid dynamics are employed to develop the coupled heat transfer analytical methods for the heat-pipe-cooled thermal protection structure (HPC TPS), and a three-dimensional numerical method considering the sonic limit of heat pipe is proposed. To verify the calculation correctness, computations are carried out for a typical heat pipe and the results agree well with experimental data. Then, the heat transfer characteristics and limitations of HPC TPS are mainly studied. The studies indicate that the use of heat pipe can reduce the temperature at high heat flux region of structure efficiently. However, there is a frozen startup period before the heat pipe reaching a steady operating state, and the sonic limit will be a restriction on the heat transfer capability. Thus, the effects of frozen startup must be considered for the design of HPC TPS. The simulation model and numerical method proposed in this paper can predict the heat transfer characteristics of HPC TPS quickly and exactly, and the results will provide important references for the design or performance evaluation of HPC TPS. (C) 2014 Elsevier Ltd. All rights reserved.

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Numerical solutions of the semiclassical Boltzmann ellipsoidal-statistical kinetic model equation

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摘要

Computations of rarefied gas dynamical flows governed by the semiclassical Boltzmann ellipsoidal-statistical (ES) kinetic model equation using an accurate numerical method are presented. The semiclassical ES model was derived through the maximum entropy principle and conserves not only the mass, momentum and energy, but also contains additional higher order moments that differ from the standard quantum distributions. A different decoding procedure to obtain the necessary parameters for determining the ES distribution is also devised. The numerical method in phase space combines the discrete-ordinate method in momentum space and the high-resolution shock capturing method in physical space. Numerical solutions of two-dimensional Riemann problems for two configurations covering various degrees of rarefaction are presented and various contours of the quantities unique to this new model are illustrated. When the relaxation time becomes very small, the main flow features a display similar to that of ideal quantum gas dynamics, and the present solutions are found to be consistent with existing calculations for classical gas. The effect of a parameter that permits an adjustable Prandtl number in the flow is also studied.

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Study on Heat Transfer Characteristics of Phase-Change Energy Storage Unit for Thermal Management

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摘要

The objective of the study was to investigate the heat transfer characteristics of a phase-change energy storage unit for thermal management. Considering the conduction in the solid and natural convection in the liquid, a physical and mathematical model for heat transfer was formulated. The governing conservation equations were solved using the finite-volume method on fixed grids. An enthalpy-porosity method was used for modeling the melting phenomenon of a phase-change energy storage unit. The time and space movement of the phase front, the temperature distribution, and the heat dissipation rate have been analyzed based on the model. The influence of the unit geometry, heat source location, and types of phase-change materials on the thermal performance of the energy storage unit were investigated. The model and numerical method were evaluated by comparing the numerical predictions with the experimental results. There was found to be excellent agreement between the calculation and experiment, indicating that the numerical method for heat transfer simulation of a phase-change energy storage unit is accurate. The results from the analysis elucidate the thermal performance of the phase-change energy storage unit and will provide the basis for the design and optimization of thermal management systems.

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Explicit Multi-Symplectic Splitting Methods for the Nonlinear Dirac Equation

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摘要

In this paper, we propose two new explicit multi-symplectic splitting methods for the nonlinear Dirac (NLD) equation. Based on its multi-symplectic formulation, the NLD equation is split into one linear multi-symplectic system and one nonlinear infinite Hamiltonian system. Then multi-symplectic Fourier pseudospectral method and multi-symplectic Preissmann scheme are employed to discretize the linear subproblem, respectively. And the nonlinear subsystem is solved by a symplectic scheme. Finally, a composition method is applied to obtain the final schemes for the NLD equation. We find that the two proposed schemes preserve the total symplecticity and can be solved explicitly. Numerical experiments are presented to show the effectiveness of the proposed methods.

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A Four-Equation Eddy-Viscosity Approach for Modeling Bypass Transition

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摘要

It is very important to predict the bypass transition in the simulation of flows through turbomachinery. This paper presents a four-equation eddy-viscosity turbulence transition model for prediction of bypass transition. It is based on the SST turbulence model and the laminar kinetic energy concept. A transport equation for the non-turbulent viscosity is proposed to predict the development of the laminar kinetic energy in the pre-transitional boundary layer flow which has been observed in experiments. The turbulence breakdown process is then captured with an intermittency transport equation in the transitional region. The performance of this new transition model is validated through the experimental cases of T3AM, T3A and T3B. Results in this paper show that the new transition model can reach good agreement in predicting bypass transition, and is compatible with modern CFD software by using local variables.

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Terahertz wave transmission characteristics in the plasma produced by shock tube

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摘要

The transmission characteristics of millimeter wave and terahertz wave in the nonmagnetic collisional plasma were investigated to meet the need of reentry aero-craft communication. The laws of electromagnetic wave transmission attenuation dependent on electron density, collision frequency, dielectric coefficient change of the antenna window material and electron frequency were obtained. The terahertz wave transmission attenuation (TWTA) is more fader than millimeter wave transmission attenuation (MWTA) in the same plasma. Both TWTA and MWTA in the plasma are at first enhanced and then impeded with increase of collision frequency of the plasma. With the increase of the dielectric coefficient of the antenna window material, MWTW is uplifted and there is a periodic oscillation in the MWTA curve, the periods of which is 5 GHz. TWTA experiment was carried out on the shock tube. The results are in agreement with the calculation. Terahertz wave can be likely used as the media to resolve communications blackout on reentry aero-craft.

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The effect of waves rupture diaphragm on acceleration loads of projectile

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摘要

The acceleration loads of projectile during launch process of two-stage light gas gun were studied by the developed computational fluid dynamics program. With the usage of LS-DYNA software, the diaphragm rupture pressure was calculated by finite element method. The influence of different waves rupture diaphragm on the maximum acceleration loads of projectile was analyzed, keeping the configurations of gun unchanged. It is found that the maximum acceleration loads can be reduced and the muzzle velocity objective can be achieved by choosing the ruptured wave appropriately and optimizing other operational parameters. Soft launch capability is provided for launching complex lifting configuration models up to hypervelocity.

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Research and Design of a Novel Pitch Mechanism for Supersonic Wind Tunnel

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摘要

Developing the high attack angle mechanism with good dynamic characteristics is among the key technologies for researching the advanced and highly flexible aircraft weapons. The main test device of the high attack angle mechanism is the pitch mechanism. The pitch mechanism with good dynamic and static characteristics is the key to successful wind tunnel tests. According to the design requirements of the high angle of attack in supersonic tunnel, a new structure and a new working principle of the pitch mechanism are put forward based on the study of the oversea and domestic pitch mechanism. And the error analysis of the pitch mechanism is completed by way of total differentiation method. As a result, the machining accuracy of components is determined after comprehensive analysis. According to the structure and characteristics of the new pitch mechanism in supersonic wind tunnel, the static structure strength and stiffness have been analyzed by using ANSYS system, and so does modal analysis. Computation results show that the pitch mechanism has agreed well with the agreements of the supersonic wind tunnel, and it proves that the structure form of the pitch mechanism is reasonable and reliable.

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Vibration sensitivity analysis of the 'Butterfly-gyro' structure

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摘要

The 'Butterfly-gyro' is simple to manufacture with single sided electrostatic excitation and capacitive detection, and it is considered as one kind of the microgyroscope with high sensitivity due to its unique structure. This paper provides the sensitivity analytical model by solving the dynamic equations of motion and the design guidelines for microgyroscope with high sensitivity. Using Coriolis Effect and Newton's second law, the dynamic equations are built. The sensitivity analytical model, including the denotations of Q factors and the resonant frequencies, is built. The approximate analytical expressions of Q factors and the resonant frequencies are derived by rational assumptions. Based on the sensitivity analytical model, the parametric analysis is carried out, and the design guidelines of high sensitivity are also deduced. Finally, Q factor, frequency split and other factors influencing the sensitivity are discussed in details to enhance its sensitivity. Results presented are valuable in the design and parameters optimization of the microgyroscope with high sensitivity.

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A case study of large-scale parallel I/O analysis and optimization for numerical weather prediction system

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摘要

Numerical weather forecast is a most efficient means to reduce the effects of unexpected weather events. With the increasing prediction precision and the time-critical requirement, technologies of high performance computing have been improved much. However, I/O has become a significant performance bottleneck when scaling up to thousands of processes. In this paper we analyze the I/O access patterns of GRAPES (Global/Regional Assimilation and Prediction System) for numerical weather prediction system as a case of regular multi-dimensional data access. And we implement two parallel I/O strategies based on MPI-IO and ADIOS (Adaptive I/O System), making full use of efficient synchronous I/O schemes. For ADIOS, the "MPLAMR" method is employed to improve the parallel output bandwidth, which uses aggregator processes to execute I/O operations and write to one subfile on one OST for each aggregators, reducing I/O conflicts. Experiments show that the two optimizations outperform the original sequential I/O access, achieving very impressive improvements on Tianhe-1A system and Subway Bluelight system in China. The I/O cost based on ADIOS only accounts for no more than 9% scaling up to 2K processes on Tianhe-1A system, while the sequential I/O costs more than 50% of total time when scaling to 1K or more processes. It is also found that the aggregate output based on ADIOS achieves better output performance improvements, whose peak reaches 3.84 GB/s with one time-step output on Tianhe-1A system. On the contrary, MPI-IO has obtained good input performance improvements, whose peak reaches 4.55 GB/s.

We use the GRAPES's I/O component as a benchmark to make a further study on I/O performance using ADIOS. From the rules found, we can design an efficient scheme of using "MPLAMR" for ADIOS on Tianhe-1A system. We take 15-km horizontal resolution for instance. Since the maximum number of OSTs available for our test on Tianhe-1A system is no more than 80,32 or 64 OSTs are chosen to facilitate parallel I/O.

Then the number of aggregators should be set as 64 or 128. The optimal data size of 114 MB on one OST on Tianhe-1A system can be tested by simple cases. If we use 32 OSTs with 1024 processes, then 4 time-step aggregation can be calculated out, which obtains optimal I/O performance under such number of OSTs. It is true of the situation of 64 OSTs used. Hence, time-step aggregation is useful for output optimization based on "MPLAMR", whose peak reaches 7.69 GB/s on 2K processes with 64 OSTs and 128 aggregators if 8 time-step aggregation is used.
We also examine the performance effects of data layout in the Lustre file system based on MPI-IO, which implies that data distribution on more OSTs outperforms a limited number of OSTs used, while the I/O performance is more likely to be disturbed with data distributed on most of all the OSTs. This influence is more apparent based on MPI-IO compared with ADIOS.
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Design and Evaluation of Fully Configured Models Built by Additive Manufacturing

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摘要

The cost and time relative to model building could be reduced considerably by the introduction of additive manufacturing. To evaluate the feasibility of the technique to build practical models, a real fighter was adopted as the prototype and a resin-metal hybrid model fully deployed with control surfaces was designed, validated, and tested in the paper. Connection structures that can ensure reliable connections and enable angle adjustment of control surfaces were designed in detail. Based on a careful worst-case analysis from computational fluid dynamics calculations, finite element analysis analyses for strength and stiffness validations were conducted, which shows the safety of the model in testing. First eigenfrequencies of the hybrid model and the metal model were calculated with the FEA method, and the comparison indicates resonance clearance improvement of the hybrid model duo to a remarkable weight reduction by nearly 50% to the metal one. Most aerodynamic coefficients of the hybrid model obtained from wind-tunnel testing are consistent with those of the metal model, from which it can be concluded that the hybrid model can replace metal models in the aerodynamic study for aircraft in the subsonic domain. The efficiency to build models was also improved significantly.

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A class of DG/FV hybrid schemes for conservation law IV: 2D viscous flows and implicit algorithm for steady cases

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摘要

The DG/FV hybrid schemes developed in the authors' previous work were extended to solve twodimensional Navier-Stokes equations on arbitrary grids. For the viscous term, the well-known BR2 approach was employed. In addition, to accelerate the convergence of steady flows, an efficient implicit method was developed for the DG/FV schemes. The Newton iteration was employed to solve the nonlinear system, while the linear system was solved with Gauss-Seidel iteration. Several typical test cases, including Couette flow, laminar flows over a flat plate and a NACA0012 airfoil, steady and unsteady flows over a circular cylinder, and a mixing layer problem, were simulated to validate the accuracy and the efficiency. The numerical results demonstrated that the DG/FV hybrid schemes for viscous flow can achieve the desired order of accuracy and the present implicit scheme can accelerate the convergence history efficiently. Moreover, in the same framework, the DG/FV hybrid schemes are more efficient than the same order DG schemes. (c) 2014 Elsevier Ltd. All rights reserved.

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Preparation and thermal characterization of capric-myristic-palmitic acid/expanded graphite composite as phase change material for energy storage

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摘要

Capric myristic palmitic acid ternary eutectic mixture (CA-MA-PA) was prepared as phase change material (PCM). A novel composite PCM of CA-MA-PA/expanded graphite (EG) with an optimum mass ratio (CA-MA-PA:EG= 13:1) was prepared by uniformly absorbing CA-MA-PA into the porous network structure of the EG. The melting and freezing temperatures of CA-MA-PA/EG composite PCM were measured by differential scanning calorimeter as 18.61 degrees C and 16.58 degrees C, respectively, while the melting and freezing latent heats were 128.2 J/g and 124.5 J/g, respectively. The thermal conductivity of the CA-MA-PA/EG composite PCM was measured as 3.67 W/m K and thus the thermal storage and release rates were significantly increased. The thermal cycling test results showed that CA-MA-PA/EG composite PCM has a good thermal reliability. All the above results show that the CA-MA-PA/EG composite PCM is a potential solution for latent heat storage system.

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LFT Modeling and Robust Stability Analysis of Missiles with Uncertain Parameters

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摘要

The structured singular value (mu) analysis based method has many advantages for the robust stability analysis of missiles with uncertain parameters. Nevertheless, the present linear fractional transformation (LFT) modeling process, which is the basis of mu analysis, is complex, and not suitable for automatic implementation; on the other hand, mu analysis requires a large amount of computation, which is a burden for large-scale application. A constructive procedure, which is computationally more efficient, and which may lead to a lower order realization than existing algorithms, is proposed for LFT modeling. To reduce the calculation burden, an analysis method is developed, based on skew mu. On this basis, calculation of the supremum of mu over a fixed frequency range converts into a single skew mu value calculation. Two algorithms are given, to calculate the upper and lower bounds of skew mu, respectively. The validity of the proposed method is verified through robust stability analysis of a missile with real uncertain parameters.

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Numerical investigation of unsteady vortex breakdown past 80 degrees/65 degrees double-delta wing

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摘要

An improved delayed detached eddy simulation (IDDES) method based on the k-omega-SST (shear stress transport) turbulence model was applied to predict the unsteady vortex breakdown past an 80 degrees/65 degrees double-delta wing (DDW), where the angles of attack (AOAs) range from 30 degrees to 40 degrees. Firstly, the IDDES model and the relative numerical methods were validated by simulating the massively separated flow around an NACA0021 straight wing at the AOA of 60 degrees. The fluctuation properties of the lift and pressure coefficients were analyzed and compared with the available measurements. For the DDW case, the computations were compared with such measurements as the mean lift, drag, pitching moment, pressure coefficients and breakdown locations. Furthermore, the unsteady properties were investigated in detail, such as the frequencies of force and moments, pressure fluctuation on the upper surface, typical vortex breakdown patterns at three moments, and the distributions of kinetic turbulence energy at a stream wise section. Two dominated modes are observed, in which their Strouhal numbers are 1.0 at the AOAs of 30 degrees, 32 degrees and 34 degrees and 0.7 at the AOAs of 36 degrees, 38 degrees and 40 degrees. The breakdown vortex always moves upstream and downstream and its types change alternatively. Furthermore, the vortex can be identified as breakdown or not through the mean pressure, root mean square of pressure, or even through correlation analysis. (C) 2014 Production and hosting by Elsevier Ltd. on behalf of CSAA & BUAA.

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Sparse Representation for Infrared Dim Target Detection via a Discriminative Over-Complete Dictionary Learned Online

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摘要

It is difficult for structural over-complete dictionaries such as the Gabor function and discriminative over-complete dictionary, which are learned offline and classified manually, to represent natural images with the goal of ideal sparseness and to enhance the difference between background clutter and target signals. This paper proposes an infrared dim target detection approach based on sparse representation on a discriminative over-complete dictionary. An adaptive morphological over-complete dictionary is trained and constructed online according to the content of infrared image by K-singular value decomposition (K-SVD) algorithm. Then the adaptive morphological over-complete dictionary is divided automatically into a target over-complete dictionary describing target signals, and a background over-complete dictionary embedding background by the criteria that the atoms in the target over-complete dictionary could be decomposed more sparsely based on a Gaussian over-complete dictionary than the one in the background over-complete dictionary. This discriminative over-complete dictionary can not only capture significant features of background clutter and dim targets better than a structural over-complete dictionary, but also strengthens the sparse feature difference between background and target more efficiently than a discriminative over-complete dictionary learned offline and classified manually. The target and background clutter can be sparsely decomposed over their corresponding over-complete dictionaries, yet couldn't be sparsely decomposed based on their opposite over-complete dictionary, so their residuals after reconstruction by the prescribed number of target and background atoms differ very visibly. Some experiments are included and the results show that this proposed approach could not

only improve the sparsity more efficiently, but also enhance the performance of small target detection more effectively.

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Two-dimensional complete neighborhood preserving embedding

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摘要

Complete neighborhood preserving embedding (CNPE) is an improvement to the neighborhood preserving embedding (NPE) algorithm, which can address the singularity and stability problems of NPE and at the same time preserve useful discriminative information. However, CNPE works with vectorized representations of data, and thus, the original 2D face image matrices should be previously transformed into the same dimensional vectors. Such a matrix-to-vector transform usually leads to a high-dimensional image vector space, which makes the eigenanalysis quite difficult and time-consuming. Beyond computational issues, some spatial structural information between nearby pixels may be lost after vectorization. In this paper, we develop a new scheme for image feature extraction, namely, two-dimensional complete neighborhood preserving embedding (2D-CNPE). 2D-CNPE builds the eigenmatrix and the weight matrix which characterize local neighborhood properties of data directly based on the original face images, and then, the optimal embedding axes are obtained by performing an eigen-decomposition. Experimental results on three face databases show that the proposed 2D-CNPE achieves better performance than other feature extraction methods, such as Eigenfaces, Fisherfaces, and 2D-PCA.

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Unmanned air vehicle flow separation control using dielectric barrier discharge plasma at high wind speed

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摘要

The present paper described an experimental investigation of separation control of an Unmanned Aerial Vehicle (UAV) at high wind speeds. The plasma actuator was based on Dielectric Barrier Discharge (DBD) and operated in a steady manner. The flow over a wing of UAV was performed with smoke flow visualization in the I center dot 0.75 m low speed wind tunnel to reveal the flow structure over the wing so that the locations of plasma actuators could be optimized. A full model of the UAV was experimentally investigated in the I center dot 3.2 m low speed wind tunnel using a six-component internal strain gauge balance. The effects of the key parameters, including the locations of the plasma actuators, the applied voltage amplitude and the operating frequency, were obtained. The whole test model was made of aluminium and acted as a cathode of the actuator. The results showed that the plasma acting on the surface of UAV could obviously suppress the boundary layer separation and reduce the model vibration at the high wind speeds. It was found that the maximum lift coefficient of the UAV was increased by 2.5% and the lift/drag ratio was increased by about 80% at the wind speed of 100 m/s. The control mechanism of the plasma actuator at the test configuration was also analyzed.

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Evaluation of Euler fluxes by a high-order CFD scheme: shock instability

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摘要

The construction of Euler fluxes is an important step in shock-capturing/upwind schemes. It is well known that unsuitable fluxes are responsible for many shock anomalies, such as the carbuncle phenomenon. Three kinds of flux vector splittings (FVSs) as well as three kinds of flux difference splittings (FDSs) are evaluated for the shock instability by a fifth-order weighted compact nonlinear scheme. The three FVSs are Steger-Warming splitting, van Leer splitting and kinetic flux vector splitting (KFVS). The three FDSs are Roe's splitting, advection upstream splitting method (AUSM) type splitting and Harten-Lax-van Leer (HLL) type splitting. Numerical results indicate that FVSs and high dissipative FDSs undergo a relative lower risk on the shock instability than that of low dissipative FDSs. However, none of the fluxes evaluated in the present study can entirely avoid the shock instability. Generally, the shock instability may be caused by any of the following factors: low dissipation, high Mach number, unsuitable grid distribution, large grid aspect ratio, and the relative shock-internal flow state (or position) between upstream and downstream shock waves. It comes out that the most important factor is the relative shock-internal state. If the shock-internal state is closer to the downstream state, the computation is at higher susceptibility to the shock instability. Wall-normal grid distribution has a greater influence on the shock instability than wall-azimuthal grid distribution because wall-normal grids directly impact on the shock-internal position. High shock intensity poses a high risk on the shock instability, but its influence is not as much as the shock-internal state. Large grid aspect ratio is also a source of the shock instability. Some results of a second-order scheme and a first-order scheme are also given. The comparison between the high-order scheme and the two low-order schemes indicates that high-order schemes are at a higher risk of the shock instability. Adding an entropy

fix is very helpful in suppressing the shock instability for the two low-order schemes. When the high-order scheme is used, the entropy fix still works well for Roe's flux, but its effect on the Steger-Warming flux is trivial and not much clear.
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Spatially Regularized and Locality-Constrained Linear Coding for Human Action Recognition

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摘要

To reduce quantization error, preserve the manifold of local features, distinguish the ambiguous features, and model the spatial configuration of features for Bag-of-Features (BoF) model-based human action recognition, a novel feature coding method called spatially regularized and locality-constrained linear coding (SLLC) is proposed. The spatial regularization and locality constraint are involved in the feature coding phase to model the spatial configuration of features and preserve their nonlinear manifold. The action recognition experimental results on benchmark datasets show that SLLC achieves better performance than the state-of-the-art feature coding methods such as soft vector quantization, sparse coding, and locality-constrained linear coding. (C) 2014 The Japan Society of Applied Physics

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Coupled Navier-Stokes/Direct Simulation Monte Carlo Simulation of Multicomponent Mixture Plume Flows

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摘要

A coupled particle-continuum simulation method is presented to compute the multicomponent mixture plume flow from the attitude-control engines of a satellite through the use of the Navier Stokes solver and direct simulation Monte Carlo method. In this study, the implicit hybrid flux iteration scheme for the axisymmetric compressible Navier Stokes equations is constructed to solve the inner flowfield of the nozzle. The Navier Stokes computing technique is implemented considering slip boundary theory for the near-continuum slip flow near the nozzle exit. Direct simulation Monte Carlo methods for the axisynunetric core plume and three-dimensional far-field plume flows of multispecies mixture gas are developed by using a radial weighted factor, by tracking the molecular motion trajectory, and with secondary Cartesian and unstructured cell processing techniques. A multiregion decomposition and hybrid Navier Stokes/direct simulation Monte Carlo algorithm with two-way and one-way coupling is established to solve the internal and external flow of the thruster, including the near-field, far-field, backflow, and gas-surface contaminated regions. After constructing the coupled Navier Stokes/DSMC simulation scheme, the present method is applied to solve the plume flowfield and impinging contamination effects from the satellite attitude-control engine and solar array panel; the simulation results correspond well with the experimental measurements from the low-density wind tunnel and the theoretical predictions. To study the contamination effects produced by the multicomponent mixture plume, the current method is employed to simulate a five-component mixture plume flowfield of tens of meters from two representative attitude-control engines installed in different locations of a satellite in orbit. The results of the nonreacting multicomponent flow with equivalent mole fractions can be achieved with a one-component gas simulation if the species is assigned the properties of the mixture. The deposition rate of the plume flows produced by the two teamwork engines can be superimposed on each other. This method can be used to efficiently predict the

impingement contamination effects of the gas-fired mixture plume flow on the satellite and solar array panels.
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A coupled method of Laplace transform and Legendre wavelets for nonlinear Klein-Gordon equations

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摘要

Klein-Gordon equation models many phenomena in both physics and applied mathematics. In this paper, a coupled method of Laplace transform and Legendre wavelets, named (LLWM), is presented for the approximate solutions of nonlinear Klein-Gordon equations. By employing Laplace operator and Legendre wavelets operational matrices, the Klein-Gordon equation is converted into an algebraic system. Hence, the unknown Legendre wavelets coefficients are calculated in the form of series whose components are computed by applying a recursive relation. Block pulse functions are used to calculate the Legendre wavelets coefficient vectors of nonlinear terms. The convergence analysis of the LLWM is discussed. The results show that LLWM is very effective and easy to implement. Copyright (c) 2013 John Wiley & Sons, Ltd.

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Trident pair production in colliding bright x-ray laser beams

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摘要

The development of strong x-ray lasers motivates the advancement of pair production studies into regions of higher laser frequency. In this paper, a resonant electron-positron pair production process with the absorption of two x-ray photons is considered in the impact of an energetic electron at the overlap region of two colliding x-ray laser beams. The laser-dressed QED method is justified to tackle the complexity of the corresponding multiple Feynman diagrams calculation. The dependence of the production rate as well as the positron energy distribution on the relative angles among the directions of the two laser wave vectors and the incoming electron momentum is revealed. It is shown that the non-plane-wave laser field configuration arouses additional features in the pair production process compared to the plane-wave case.

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Small moving infrared space target tracking algorithm based on probabilistic data association filter

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摘要

Numerous false alarms for low signal-to-noise ratio (SNR) would seriously debase the performance for infrared low observable (LO) space target tracking. Due to the motion (i.e. azimuth, elevation and their derivative velocity), amplitude and size of infrared target are almost invariable and highly correlative, a multi-feature association approach based on probabilistic data association (PDA) is presented to track target in this paper. Firstly, the motion, amplitude and size of target are modeled as stationary random signal afforded Gaussian distribution. The probability of motion, amplitude and size of measurement originated as the target of interest is then estimated by Gaussian distribution, and that of false alarm is distributed uniformly. Subsequently, the combined probability of motion, amplitude and size is derived by PDA, and their weight coefficients are estimated adaptively according to their fluctuations. Finally, the relevant parameters including combination measurement are predicted and updated. Some experiments are included and the results show that the performance of target tracking by the proposed approach is significantly enhanced. (C) 2013 Elsevier B.V. All rights reserved.

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Research on Robust Stability Analysis and Worst Case Identification Methods for Parameters Uncertain Missiles

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摘要

For robust stability analysis of parameters uncertainty missiles, the traditional frequency domain method can only analyze each respective channel at several interval points within uncertain parameter space. Discontinuous calculation and couplings between channels will lead to inaccurate analysis results. A method based on the v-gap metric is proposed, which is able to comprehensively evaluate the robust stability of missiles with uncertain parameters; and then a genetic-simulated annealing hybrid optimization algorithm, which has global and local searching ability, is used to search for a parameters combination that leads to the worst stability within the space of uncertain parameters. Finally, the proposed method is used to analyze the robust stability of a re-entry missile with uncertain parameters; the results verify the feasibility and accuracy of the method.

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Robust design of natural laminar flow supercritical airfoil by multi-objective evolution method

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摘要

A transonic, high Reynolds number natural laminar flow airfoil is designed and studied. The gamma-theta transition model is combined with the shear stress transport (SST) k-w turbulence model to predict the transition region for a laminar-turbulent boundary layer. The non-uniform free-form deformation (NFFD) method based on the non-uniform rational B-spline (NURBS) basis function is introduced to the airfoil parameterization. The non-dominated sorting genetic algorithm-II (NSGA-II) is used as the search algorithm, and the surrogate model based on the Kriging models is introduced to improve the efficiency of the optimization system. The optimization system is set up based on the above technologies, and the robust design about the uncertainty of the Mach number is carried out for NASA0412 airfoil. The optimized airfoil is analyzed and compared with the original airfoil. The results show that natural laminar flow can be achieved on a supercritical airfoil to improve the aerodynamic characteristic of airfoils.

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Numerical solutions of ideal quantum gas dynamical flows governed by semiclassical ellipsoidal-statistical distribution

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摘要

The ideal quantum gas dynamics as manifested by the semiclassical ellipsoidal-statistical (ES) equilibrium distribution derived in Wu et al. (Wu et al. 2012 Proc. R. Soc. A 468, 1799-1823 (doi: 10.1098/rspa.2011.0673)) is numerically studied for particles of three statistics. This anisotropic ES equilibrium distribution was derived using the maximum entropy principle and conserves the mass, momentum and energy, but differs from the standard Fermi-Dirac or Bose-Einstein distribution. The present numerical method combines the discrete velocity (or momentum) ordinate method in momentum space and the high-resolution shock-capturing method in physical space. A decoding procedure to obtain the necessary parameters for determining the ES distribution is also devised. Computations of two-dimensional Riemann problems are presented, and various contours of the quantities unique to this ES model are illustrated. The main flow features, such as shock waves, expansion waves and slip lines and their complex nonlinear interactions, are depicted and found to be consistent with existing calculations for a classical gas.

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Moving target detection approach based on spatio-temporal salient perception

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摘要

The differences in texture and motion between man-made object and natural scene are the key features for human biological visual system to detect moving object in scenery. The paper proposed a moving target detection approach based on spatio-temporal perception, which is a crucial function of the visual attention mechanism. The spatial feature including edge, orientation, texture and contrast of the image are extracted, and then the corresponding spatial salient map are constructed by fusing the features through difference of Gaussian (DOG) function, which can suppress the common and enhance the difference of local region. Then, the global motion, local motion and relative motion between continuous images are extracted by means of pyramid multi-resolution, and the moving salient map is constructed after the motion difference between moving target and background is confirmed. Finally, the spatio-temporal salient map is constructed by fusing the spatial salient map and the moving salient map through competition strategy, and the moving target could be detected by searching the maximum in the spatio-temporal salient map. Some experiments are included and the results show that the method can accurately detect the moving target in complex background.

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Applications of Lightweight Models Based on Stereo-Lithography for Transonic Wind-Tunnel

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摘要

Strength and stiffness of current lightweight models based on stereo-lithography (SL) could not meet experimental requirements of the transonic wind tunnel test. Therefore, a composite structural wind tunnel model is proposed, which is constructed by the internal metal framework and outer photopolymer resin configuration. Taking a lightweight AGARD-B model as an example, its structural strength and stiffness verified results were investigated under transonic wind-tunnel test environments, and its aerodynamic characteristics were also analyzed by comparing with those of the metal models. It is proven that applications of the lightweight models strengthened by metal framework are feasible for the transonic wind tunnel. The results indicate that the aerodynamic characteristics of the lightweight models at small angle of attacks (-2 degrees 2 degrees) are similar to the metal models and is not interfered by different stiffness, and they have slight disagreement at larger angle of attack (2 degrees < 8 degrees). In addition, the method decreases the test models' processing cycle by approximately 69%, weight by approximately 38.9%, and manufacture cost greatly. It increases inherent frequency of the test models by approximately 73.2% avoiding resonance of the test system. The lightweight models based on SL show convenience and promise in preliminary aerodynamic studies and initial selection aircrafts configuration with complex structure.

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Couple of the Variational Iteration Method and Fractional-Order Legendre Functions Method for Fractional Differential Equations

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摘要

We present a new numerical method to get the approximate solutions of fractional differential equations. A new operational matrix of integration for fractional-order Legendre functions (FLFs) is first derived. Then a modified variational iteration formula which can avoid "noise terms" is constructed. Finally a numerical method based on variational iteration method (VIM) and FLFs is developed for fractional differential equations (FDEs). Block-pulse functions (BPFs) are used to calculate the FLFs coefficient matrices of the nonlinear terms. Five examples are discussed to demonstrate the validity and applicability of the technique.

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