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目　　次

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CONTENTS

《哈尔滨工业大学学报》

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本刊被下列数据库列为刊源期刊

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第四十六卷 第十一期 二〇一四年十一月
第四十六卷 第十一期 二〇一四年十一月
第四十六卷 第十一期 二〇一四年十一月

《哈尔滨工业大学学报》征稿简则

《哈尔滨工业大学学报》主要报道自然科学领域的基础理论、工程技术与应用方面的最新研究成果,欢迎省(部)级以上政府基金资助项目(国家自然科学基金、863、973、博士点基金等)相关论文。报道方向包括航天、机械、能源、动力、材料、电气、电子、信息与控制、计算机、化工、生物工程、土木工程、市政环境、暖通空调、道路、桥梁、交通工程、工程力学及有关交叉性学科。

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PIE+MOM 的 Mamdani 模糊系统通用逼近性充要条件

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摘　要: 为了解决如何构造具有通用逼近性能的 Mamdani 模糊系统问题,提出一类 Mamdani 模糊系统具有通用逼近性的充要条件. 该模糊系统采用乘积推理机(product inference engine, PIE)和最大值平均(mean of maximum, MOM)解模糊器,按模糊规则后件分为单点规则后件和模糊数规则后件两种情况,分别根据 Weierstrass 第一定理和隶属度函数性质给出了严格证明. 最后通过示例证明该充要条件的有效性.

关键词: Mamdani 模糊系统;乘积推理机;MOM;通用逼近性

中图分类号: TP273.4　　**文献标志码**: A　　**文章编号**: 0367-6234(2014)11-0001-07

Sufficient and necessary condition of Mamdani fuzzy systems with PIE and MOM as universal approximators

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Abstract: Focusing on whether fuzzy system can approximate any given function, the sufficient and necessary theory of one type of fuzzy systems as universal approximators was investigated. Mamdani fuzzy systems with product inference engine (PIE) and mean of maximum (MOM) defuzzificator can be classified two cases according to rule consequent: simple point rule consequent and fuzzy set rule consequent. Based on Weierstrass´s first theorem and properties of membership functions, sufficient and necessary condition is proved respectively. A simulation example is given to show the effectiveness of the proposed method.

Keywords: mamdani fuzzy system; PIE; MOM; approximation

离散广义分段仿射系统弹性 H_∞ 滤波器的设计

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2.大庆油田电力集团 燃机电厂，230604 黑龙江 大庆）

摘　要：为消除未知情况下外部干扰和测量噪声对控制系统性能的不利影响，以一类参数不确定性体现为范数有界形式的离散广义分段仿射系统为模型，研究具有 H_∞ 性能指标渐近稳定弹性滤波器的设计问题.通过采用广义分段仿射 Lyapunov 函数、投影定理以及几个基本引理，提出了对于由所设计弹性滤波器构成的滤波误差动态系统满足鲁棒 H_∞ 性能指标的反馈控制器设计方法.通过求解一组包含参变量的 LMIs，可以得到保证广义分段仿射系统具有 H_∞ 性能的反馈控制器增益和渐近稳定弹性滤波器的待定系统矩阵，仿真结果证明了所提设计方法的有效性.

关键词：广义分段仿射系统；弹性滤波器；分段 Lyapunov 函数；LMIs
中图分类号：TH13　　**文献标志码**：A　　**文章编号**：0367-6234(2014)01-0008-09

Design of resilient H_∞ filter for discrete-time piecewise-affine singular systems

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Abstract: This paper investigates the robust admissibility analysis and resilient filter controller synthesis for a class of discrete-time piecewise affine singular systems with asymptotic stability which possesses H_∞ performance is considered in this paper, in order to eliminate the adverse effects of external disturbances and measurement noise of control system performance. By using the piecewise-affine singular Lyapunov functions combined with Projection lemma and some basic lemmas, an approach of designing robust H_∞ feedback controller is given, the conclusions ensure resilient filtering error dynamic system possessing H_∞ performance. It is shown that the controller gains can be obtained by solving a family of LMIs parameterized by scalar variables. The feedback controller gain and resilient filter system matrix can ensure the stability of systems and guarantee the H_∞ performance of the piecewise-affine singular systems. Finally, the practicability of the proposed methodologies is confirmed via some simulation examples.

Keywords: piecewise-affine singular systems; resilient filter; piecewise Lyapunov function; LMIs

基于摄像测量法的在轨柔性结构模态参数辨识

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摘　要：针对在轨传感器布置困难的问题，提出一种利用数字摄像测量技术对在轨大型柔性结构进行模态参数辨识的方法. 阐述了三维动态重构技术、相机标定算法和像素点特征提取算法原理. 利用一类柔性星载天线模型进行了地面试验，采用高速数字摄像机记录模型的自由振动响应过程，并从采集的图像序列中提取给定测点的位移振动数据，通过特征系统实现法(ERA)辨识星载天线模型的前5阶固有频率、阻尼比等模态参数. 结果表明，数字摄像测量方法可以在满足在轨测试设备简单要求的同时，有效地辨识柔性天线的在轨模态参数.

关键词：模态辨识；摄像测量；三维重构；柔性结构

中图分类号：TB123　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0017-07

Videogrammetric based modal identification of on-orbit flexible structures

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Abstract: A modal test method based on videogrammetric for large flexible structure on orbit is presented. The methods of 3D dynamic reconstruction, camera calibration and pixel extraction are described. A ground experiment is performed using a kind of antenna model and two fast cameras. Image data is acquired frame by frame during the free vibration period of the model, and vibration signals are obtained by a time series of images. The ERA method is applied to identify the modal parameters of the antenna model, and the experimental results show that the videogrammetric is a promising method for on-orbit vibration measurement which avoids the difficulty of installing accelerometers on the flexible structures.

Keywords: modal identification; videogrammetric; 3D dynamic reconstruction; flexible structures

不同头型运动体高速入水空泡数值模拟

马庆鹏，魏英杰，王 聪，赵成功

（哈尔滨工业大学 航天学院，150001 哈尔滨）

摘 要：运动体头型对其入水流场的流动分布、流体动力及入水弹道均有较大的影响. 针对此问题基于有限体积法离散、求解雷诺平均的 Navier-Stokes 方程，考虑空化效应，并引入动网格技术，对带有不同角度锥头圆柱体的高速入水问题开展数值模拟研究，得到不同头型条件下高速入水运动参数及空泡形态发展规律、流场的压力分布及速度分布规律，分析了头型对入水空泡流场的影响. 研究结果表明，空泡半径的扩张规律受头型及其阻力系数的影响，半径大小与阻力系数近似满足一定的关系式；入水初期，运动体头部受到极强的冲击载荷，锥角越大，压力峰值也越高；锥体表面压力系数与锥角大小直接相关，锥角较大时压力系数也较大. 同时，锥角大小对运动体肩部排开水的速度也有较大影响，运动体在相同速度下，锥角较大时，肩部排开水的速度也较大.

关键词：多相流；阻力系数；高速入水；锥头；圆柱体

中图分类号：V131.2　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0024-06

Numerical simulation of high-speed water entry cavity of cylinders

MA Qingpeng, WEI Yingjie, WANG Cong, ZHAO Chenggong

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Abstract: The fluid dynamics of the multiphase flow induced by water entry of high speed projectiles with various heads are different. Numerical simulation for modeling the high-speed water entry problem of projectiles with different heads at an initial impact velocity was performed. Finite Volume Method was introduced to solve the Reynolds Averaged Navier-Stokes equations, and the motion of the projectiles and cavity formation were obtained. The results showed that the cavity radius was related to the angle and the drag coefficient of the cone heads. The distribution of pressure coefficient on the cone and velocity around the shoulder of the projectiles were also obtained. During the initial stage of the water entry, there will be an extremely high pressure load. When the angle of the cone head is larger, the pressure gets higher, the pressure coefficient is larger, and the velocity of the water which is arranged by the projectile is higher.

Keywords: multiphase flow; drag coefficient; high-speed water entry; cone; cylinder

人头面部轮廓数学模型的研究

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摘　要：针对现有图像处理技术中提取人脸轮廓线光滑性差的问题，提出一种人头面部轮廓的分段建模方法. 通过轮廓特征点定义和轮廓分段，采用超椭圆、圆弧和抛物线等曲线建立了人头面部轮廓数学模型，选取 100 组 5 种脸型的真实人头面图像经图像处理及优化后，用获得的轮廓样本参数对模型进行验证. 结果表明，对于任一样本，该模型在进行参数优化后都能保证模型平均误差在 1.2%以下，最大误差在 2.6%以下，验证了该模型的有效性和普适性. 提出了基于该模型的脸型判定方法，给出了各类脸型的模型参数范围.

关键词：人头面部轮廓；数学模型；超椭圆曲线；脸型判定方法

中图分类号：TP391　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0030-07

Research on mathematical model for human head-face contour

WU Weiguo, YAN Yunxue

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Abstract: Face contour extracted by most existing extraction technology has the problem of non-smooth. Aimed at this situation, an segmentation modeling method for head-face contour is proposed. The piecewise function model is established using hyperelliptic curve, elliptic curve, circular curve and parabolic curve according to points definition and segmentation of contour. Contour sample´s parameters obtained from the processing and optimization of 100 real human head-face images which contains five kinds of face verify the effectiveness and universality of the model. The result shows that the average error is under 1.2% and the maximum error is under 2.6% for each sample after optimizing the model. Finally the range of model parameters corresponding to each type of face is given by face shape classification based on the mathematical model.

Keywords: head-face contour; mathematical model; hyperelliptic curve; face shape classification

面阵列凸点按需喷射打印平台控制

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（哈尔滨工业大学 机电工程学院，150001 哈尔滨）

摘　要：为实现面阵列电子封装互联钎料凸点的按需式喷射打印，建立一套钎料金属微熔滴按需喷射打印沉积三轴运动平台，并在 PC+运动控制卡的基础上，利用 LabVIEW 开发了一套微滴喷射打印平台多轴运动控制系统.控制系统可根据互联凸点的坐标数据信息，利用蚁群算法对钎料凸点喷射打印过程中平台的运动路径进行优化，能有效地提高喷射打印效率，实现了凸点打印平台的运动控制.用激光干涉仪对平台运动过程中的定位精度及重复定位精度的测量结果表明，平台的运动满足球栅阵列(BGA)封装凸点打印的精度要求.

关键词：封装；钎料凸点；按需喷射；多轴运动控制；路径规划；蚁群算法

中图分类号：TH16　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0037-05

Plane array package interconnect bump drop-on-demand printing platform control system

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Abstract: A micro-droplet printing deposition 3-axis motion platform was established to achieve efficient plane array package interconnect solder bumps jet printing. The platform and the multi-axis motion control system were developed based on LabVIEW, with the structure of "PC + motion control card". According to the coordinate data of the solder bumps, the jet printing movement path optimization was realized with ant colony algorithm, and the efficiency of movement was also improved effectively. A laser interferometer was used to measure the repeatability and positioning accuracy of the motion platform, and the results showed that the motion platform could meet the accuracy requirement of the BGA packaging technology.

Keywords: packaging; solder bump; drop-on-demand; multi-axis motion control; path planning; ant colony algorithm

四轮驱动车辆路面附着系数实时估计

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摘　要：针对目前无法直接测得车辆路面附着系数的问题，通过设计扩张状态观测器及利用递推最小二乘法来实时估计该值.建立7自由度车辆模型，给出车轮受力平衡方程，设计二阶非线性扩张状态观测器.根据轮胎驱动转矩及车轮转速估计当前利用附着系数，并对观测器进行仿真.结果表明，观测器能够有效观测利用附着系数.在已观测出的利用附着系数的基础上，推导了利用附着系数与峰值附着系数间的递推公式，利用递推最小二乘法设计峰值附着系数估计器，并在Matlab/Simulink中进行仿真.结果表明，估计器可以较为快速有效地实现峰值附着系数识别，较为准确地实时估计附着系数.

关键词：四轮驱动车辆；利用附着系数；扩张状态观测器；峰值附着系数

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Real-time road condition estimation for four-wheel-drive vehicle

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Abstract: The road condition can be estimated by the extended state observer and the recursive least square method based on a 7DOF nonlinear vehicle model. in which the wheel force is analyzed, the force equilibrium equation is put forward and then the second order nonlinear extended state observer is designed. The results show that the extended state observer can achieve the observation of the utilization adhesion coefficient. Then a recurrence formula is derived based on the simplified tire model. The model shows the relationship between the utilization adhesion coefficient and the peak adhesion coefficient. The peak adhesion coefficient estimator is designed based on the recursive least square method, and the Matlab/Simulink simulation results show that the estimator can identify the peak adhesion coefficient quickly. The adhesion coefficient estimator can obtain the real-time estimation accurately.

Keywords: four-wheel-drive vehicle; utilization adhesion coefficient; extended state observer; peak adhesion coefficient

混合刷式密封泄漏特性的数值研究

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摘　要：为分析某型号汽轮机改进的刷式密封结构的密封性能，采用 non-Darcian 多孔介质模型的 Reynolds-averaged Navier-Stokes 方程数值求解方法，对泄漏流动特性及转子表面、刷束自由高度和保护高度的压力、速度、湍流动能分布规律进行数值研究，并与迷宫密封进行相应的比较.结果表明：相同的间隙和压比下，混合刷式密封流场分布要比迷宫密封复杂，泄漏量明显小于迷宫密封；相同的结构和参数下，泄漏量随着压比的上升而增加；转子表面的轴向压力和湍流动能从进口到出口呈现阶梯状递减趋势，保护高度的径向压力基本趋于常数值；刷束径向速度和湍流动能随着压比的上升而增加，刷束下半部分和后挡板保护高度对泄漏特性影响比较大.研究结果为汽轮机刷式密封的结构设计，改善性能，提供了理论依据.

关键词：混合刷式密封；non-Darcian 多孔介质模型；泄漏流动特性；分布规律；数值研究

中图分类号：TK262　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0047-06

Numerical study of leakage flow characteristics in hybrid brush seal

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Abstract: To know the sealing performance of an improved brush seal on turbine, the leakage flow characteristics and distribution on rotor surface, bristle pack free height and fence height were numerically analyzed by adopting a non-Darcian porous medium model. And a corresponding comparison between labyrinth seal and brush seal was performed. The analysis shows that at the same clearance and pressure ratio the flow fields in hybrid brush seal are more complex than that in labyrinth seal and the leakage rate of brush seal is significantly less than that of labyrinth seal, at the same structure and parameters the leakage rate increase with the rise in pressure ratio. More over, the axial static pressure and turbulent kinetic energy of rotor surface gradually decline with a ladder-like distribution from inlet to outlet, the racial static pressure of fence height tends to be constant values. The radial velocity and turbulent kinetic energy increase with the rise in pressure ratio. The lower parts of the bristle and the fence height have obvious effect on the leakage characteristics. The results provide theoretical basis for the design of brush seal structure and the improvement of performance.

Keywords: hybrid brush seal; non-Darcian porous medium model; leakage flow characteristics; distribution; numerical analysis

超临界碳化对水泥基材料性能和孔径结构的影响

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摘　要：为了考察超临界碳化技术在水泥基材料改性方面的应用，研究超临界碳化对水泥基材料微观和宏观性能的影响，基于此设计了超临界二氧化碳碳化试验研究水泥砂浆、水泥净浆和混凝土试件的碳化深度、强度、孔径分布以及二氧化碳吸收量的变化.试验分析表明，超临界碳化可以快速实现水泥基材料的碳化，大幅提高试件强度，改善材料的孔径分布，使材料的中细径孔大幅降低，提高材料的抗渗透能力，为改善重金属等危害废物的水泥基固化效果提供了依据.同时超临界碳化可以将大量二氧化碳转化在碳酸钙中沉淀吸收，具有重要的环境保护意义.

关键词：超临界碳化；二氧化碳；材料改性；水泥基材料；孔径分布

中图分类号：TU528.57　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0052-06

Effects of supercritical carbonation on the property and pore structure of cement-based materials

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Abstract: To investigate the application of supercritical carbonation technology on cement-based material modification, and to study the effects of supercritical carbonation on microscopic and macroscopic properties of cement-based materials, in this paper, the supercritical carbonation tests have been done to study the change of carbonation depth, strength, pore structure and carbon dioxide absorption of the cement paste, mortar and concrete. It is shown that supercritical carbonation is a powerful tool to achieve the fast carbonation, improve the pore structure, enhance the strength and leach resistance of the material, and absorb a large number of CO_2, which is significant meaningful for optimizing the hazard waste cement solidify and the environmental protection.

Keywords: supercritical carbonization; carbon dioxide; material modified; cement-base material; pore distribution

固定序 Bellman-Ford 算法的一个改进

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摘　要: 通过对固定序 Bellman-Ford 算法进行修正, 获得了一种求解边数不大于 k 的最短路问题的新算法.相对于原始算法,修正后的算法通过改变点的标号过程,使得在第 k 次迭代后每一条路径的边数均不超过 k. 新算法被证明是正确的,它的计算复杂性为 $O(km)$. 实验表明,在大规模情形下,相对于修正的先进先出算法,该算法具有显著的竞争优势.

关键词: 算法;Bellman-Ford 算法; 先进先出; 固定序; 最短路问题

中图分类号: TP301.6　　**文献标志码**: A　　**文章编号**: 0367-6234(2014)11-0058-06

An improvement on fixed order Bellman-Ford algorithm

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Abstract: In the paper, Bellman-Ford algorithm with fixed order is modified in order to solve the shortest path problem with not more than k edges. After the k-th iteration, each path must own no more than k edges by modifying the labeling process of the origin algorithm. The modified algorithm proves true and its worst-case complexity is $O(km)$. In contrast to the modified Bellman-Ford algorithm with FIFO order, experiments show that the algorithm has the significant competitive advantage in the large-scale case.

Keywords: algorithm; Bellman-Ford algorithm; FIFO order; fixed order; the shortest path problem

QFD 和 AHP 相结合的产品质量多维评估模型

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摘　要: 产品设计是一个将用户需求自顶向下转换为各级产品性能要求的复杂过程,在每一级设计过程中都需要对多个可选项进行评估以便选择出满足性能要求的产品.为了得到每个产品可选项较为客观的质量权值,首先将产品设计描述为产品结构与或树模型,基于该模型提出一种 QFD 和 AHP 相结合的产品质量多维评估模型,通过 QFD 将用户需求转换为各级产品的质量准则,采用 AHP 对各级产品的多个可选项的质量进行评价,两步结果相结合计算得出产品的各个可选项相对用户需求的质量权值.最后通过一个仿真实例对评估模型进行了验证.仿真实例验证了所提出评估模型的可行性和有效性.

关键词: 产品设计;质量功能配置;层次决策方法;产品质量评价

中图分类号: F272　　**文献标志码**: A　　**文章编号**: 0367-6234(2014)11-0063-07

A QFD and AHP combined multiple dimensional evaluation model for product quality

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Abstract: To get the objective quality weight values for the alternates of each product, first, the product design is formulated as a product and/or tree model. Next, based on this model, a QFD and AHP combined multiple dimensional evaluation model for product quality is proposed. In the evaluation model, the customer requirements are transformed into the quality criteria of each level of a product by QFD and the quality of the alternates for each level of a product is evaluated by AHP, then their results are combined to compute the quality weight values for the alternatives of each level of a product. Finally, the evaluation model is demonstrated by a simulated example.

Keywords: product design; quality function deployment; analytic hierarchy process; product quality evaluation

单轴扫频诱发帆板同步钢索旋转振动分析

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摘　要：为明确某帆板面内单轴扫频力学环境试验中同步钢索振动幅度过大和限位结构被破坏的原因，考虑集中质量和限位结构影响，采用有限段方法建立帆板同步钢索系统的动力学模型，对其在面内单轴扫频激励条件的响应进行数值模拟，结果再现了标志点的响应从面内振动发展到面外振动，再到绕两支撑点轴旋转振动的复杂振动模式，同时给出限位接触力和钢索标志点振幅，仿真结果与试验状态吻合.分析表明，持续旋转振动钢索施加在限位孔壁上的交变接触力是导致限位结构破坏的主要原因.

关键词：帆板；钢索；旋转振动；有限段方法；多体动力学；扫频激励

中图分类号：V415.4　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0070-06

Whirling response analysis of a cable on solar array under single-axial swept frequency excitation

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Abstract: To find the reason of limiting hole fracture and over-expected vibration amplitude on the mechanical environmental test to a Close Cable Loop (CCL) under only single-axial inner-plane swept frequency excitation, the finite segment method of multi-body dynamics was introduced to model and simulate the cable system with a concentrated mass and a position limiting hole, the cable vibration response and the contact force in limiting hole were obtained. The results showed that the vibration response started from inner-plane vibration to outer-plane vibration and to continuous rotational vibration. Cable vibration amplitude enhanced continuously due to rotational vibration process, and attenuated suddenly. The response process and vibration amplitude was coincided with the test. Continuous rotational vibration under swept frequency excitation is the key reason for the problem of fractures.

Keywords: solar panel; steel string; rotational vibration; finite-segment method; multi-body dynamics; swept frequency excitation

Shearlet 变换与核各向异性扩散的图像噪声抑制

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摘　要：为了更有效地抑制图像噪声，改善图像视觉效果，提出了一种基于非下采样 Shearlet 变换（nonsubsampled shearlet transform，NSST）与核各向异性扩散的图像噪声抑制方法.首先对含噪图像进行非下采样 Shearlet 变换；然后对所得到的低频和高频分量分别进行改进的全变差（improved total variation，ITV）扩散与核各向异性扩散（kernel anisotropic diffusion，KAD）；最后对扩散后的低频和高频分量进行非下采样 Shearlet 逆变换得到噪声抑制后的图像.给出了实验结果，并且依据主观视觉效果和峰值信噪比、结构相似度两种定量评价指标，与近年来提出的基于小波阈值收缩结合全变差、基于复 Contourlet 域非线性扩散、自适应 Shearlet 域约束的全变差等 3 种噪声抑制方法进行了比较.实验结果表明，该方法的噪声抑制能力更强，且更为完整地保留了图像的边缘和细节信息.

关键词：图像处理；噪声抑制；非下采样 Shearlet 变换；改进的全变差扩散；核各向异性扩散

中图分类号：TN911.73　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0076-08

Noise suppression of image based on nonsubsampled shearlet transform and kernel anisotropic diffusion

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Abstract: To suppress noise of image more efficiently and further improve image visual effects, a noise suppression method of image based on shearlet transform and kernel anisotropic diffusion is proposed. Firstly, a noisy image is decomposed by nonsubsampled shearlet transform(NSST). Then the obtained low-frequency component and high-frequency components are processed by improved total variation (ITV) diffusion and kernel anisotropic diffusion (KAD), respectively. Finally, the noise suppressed image is obtained by synthesizing diffused low-frequency component and high-frequency components through inverse nonsubsampled shearlet transform(INSST). Experimental results are given, in terms of subjective visual effect and two quantitative evaluation indicators such as peak signal to noise ratio (PSNR), structural similarity (SSIM), a comparison is made with three recent proposed noise suppression methods based on wavelet threshold shrinkage and TV, based on nonlinear diffusion in complex contourlet domain, and using TV with adaptive shearlet domain restraint. A large number of experimental results show that the proposed method has stronger noise suppression ability and preserves edge and detail information more completely.

Keywords: image processing; noise suppression; nonsubsampled shearlet transform; improved total variation diffusion; kernel anisotropic diffusion

细长体出水过程中阻尼系数变化分析

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摘　要：针对细长体出水过程中黏性阻尼系数和兴波阻尼系数的变化，采用弹性体振动理论和流体势流理论相结合的方式对其进行研究. 对于黏性阻尼项，建立简化的涡激振动模型，将涡激振动的阻力和升力项考虑到结构振动方程中，获得考虑涡激振动后的阻尼系数增量. 对于兴波阻尼项，采用时域格林函数法，首先计算规则球体振动问题，并将计算结果与相关文献对比，发现二者吻合良好. 在验证算法的基础上，采用细长体模型，分别计算不同振动频率和不同出水高度对于兴波阻尼系数的影响. 计算结果表明：涡激振动引起的黏性阻尼增量随着洋流增大、波浪增高或者空泡长度减短而增加；兴波阻尼和细长体的出水高度、固有振型和振动频率密切相关，所对应的细长体在头部出水、振动频率 0.5 Hz 左右诱发的兴波阻尼最大. 一阶和二阶弹性振动诱发的兴波阻尼系数较小，工程中可忽略.

关键词：细长体；振动；粘性阻尼；兴波阻尼

中图分类号：U664.113　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0084-06

Variation of the damp coefficients of a slender body during water exit

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Abstract: To study the variation of the damp coefficients of a slender body during water exit, the vibration theory of an elastic body and the potential flow theory of fluid are adopted. For viscous damp coefficient, vortex induced vibration (VIV) model is introduced and the lift and drag forces are included in the structure vibration equation. The increment of damp coefficient by VIV is therefore obtained. For wave-making damp coefficient, time-domain Green Function is adopted. The problem of a sphere oscillating on the free surface is calculated first and compared with the published paper, and the results agree well with each other, which validates the numerical model and procedure in this paper. Based on this, the wave-making damp coefficient of a slender body under different vibration frequencies and different lengths during water exit are calculated and analyzed. The results show that the increment of damp coefficient by VIV rises with the increase of current, wave and the reduction of cavitation, while the wave-making damp coefficient is closely related to the length of water exit, the natural vibration mode and the vibration frequency of the slender body. For the case studied in this paper, the wave-making damp coefficient peaks when the head of the body comes out of the water and the vibration frequency is around 0.5 Hz, and the wave-making damp coefficient induced by the first and second order elastic vibration respectively is quite small, which can be neglected in the engineering application.

Keywords: slender body; vibration; viscous damping; wave-making damping

大型直缝焊管压力矫直载荷修正系数优化

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摘　要：依据多次三点弯曲压力矫直控制策略，分别给出了基于最小二乘曲线拟合原理和基于弯曲变形能相等原理的最优载荷修正系数的确定方法. 由有限元仿真结果可知，前者计算出的最优载荷修正系数偏大，这是由于忽略了当加载弯矩大于理论矫直弯矩时对管件的影响远大于加载弯矩未达到理论矫直弯矩时的影响，而包含该因素影响的基于弯曲变形能相等原理计算出的最优载荷系数则比较适用. 不同几何尺寸、不同初始挠度分布、不同矫直次数的小尺寸管坯矫直的物理模拟实验结果验证了基于弯曲变形能相等原理计算最优载荷修正系数的可行性与可靠性，可将初始直线度为4‰~10‰的管件矫正到1.1‰以内. 这为多次三点弯曲压力矫直控制策略提供了便捷途径，也为自动化和智能化矫直奠定了基础.

关键词：压力矫直；三点弯曲；载荷修正系数；弯曲变形能

中图分类号：TG306　　**文献标志码**：A　　**文章编号**：0367-6234(2014)11-0090-05

Optimization research on load correction coefficient in process of press straightening for LSAW pipes

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Abstract: To optimize load correction coefficient, based on press straightening control strategy with multi-step three-point bending process, two methods of least squares curve fitting and equivalent bending deformation energy were proposed. The simulation results of the Longitudinally Submerged Arc Welding(LSAW) pipe show that the optimum load correction coefficient calculated by least squares curve fitting method is bigger than normal. This is due to that, when the actual loading moment is greater than the theoretical straightening moment, the impact on the pipes is greater. However, the optimum load correction coefficient calculated by the equivalent bending deformation energy method, is more applicable, which is verified by the straightening physical simulation experiments of small sized pipes with different geometries, initial deflection distribution and straightening step. The straightness of the pipes with their initial straightness of 4‰~10‰ can be improved within 1.1‰. Thus, this method provides a convenient way to carry out the press straightening control strategy with multi-step three-point bending process.

Keywords: press straightening; three-point bending; load correction coefficient; bending deformation energy

新型 3D-Turbo 码原理分析与性能研究

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摘　要: 为改善中高信噪比下传统 Turbo 的错误平台性能,介绍一种改进的 Turbo 码(3D-Turbo Codes),通过增加一个码率为 1 的后编码器,对传统 Turbo 编码器得到的部分校验比特进行后编码. 给出 3D-Turbo 码的编码结构,分析了影响性能的主要因素,研究 3D-Turbo 码的迭代译码过程并详细推导了 Max-Log-Map 算法,最后对 3GPP2 标准下的 3D-Turbo 码性能进行仿真. 研究结果表明,与 3GPP2 Turbo 码相比,3D-Turbo 码通过增加很小的复杂度,可以有效改善错误平台性能.因此,在中高信噪比且对误码率要求严格的场景下,3D-Turbo 码有广阔的应用空间.

关键词: 3D-Turbo 码;3GPP2;错误平台;收敛特性

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Theoretical analysis and performance study of 3-dimension Turbo codes

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Abstract: In order to prevent high error floor of classic Turbo at middle and high SNRs, a modified Turbo codes, named as 3D-Turbo codes, is proposed in which some of the parity bits from the classical encoders are further encoded by a rate-1 post encoder. The encoder structure of 3D-Turbo Codes is introduced and analysis of main factors affecting performance is provided, then the iterative decoding process and detailed derivation of the Max-Log-Map algorithm of 3D-Turbo Codes is presented, performance based on 3GPP2 standards is simulated. The theoretical analysis and results show that 3D-Turbo Codes have lower error floor compared to 3GPP2 Turbo Codes, at the expense of a very small increase in complexity. Therefore, under middle or high SNRs and strict BER requirement, 3D-Turbo Codes are expected to have extensive application prospects.

Keywords: 3D-Turbo Codes; 3GPP2; error floor; convergence performance

具有最优模型传递矩阵的交互式多模型算法

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摘　要：在传统的交互式多模型(IMM,interacting multiple model)算法中,描述模型马尔科夫切换过程的模型传递矩阵被定义成一个常值矩阵,并且将子滤波器间的相关性信息遗漏. 然而,由于实际环境的复杂性,传统的 IMM 算法无法满足飞行器跟踪的需求. 为此,提出一种具有最优模型传递矩阵的交互式多模型(OMTM-IMM,optimal mode transition matrix IMM)算法,该算法在考虑子滤波器相关性的前提下,以线性最小方差理论为基础,推导出最优的模型传递矩阵，该传递矩阵更加符合实际情况,理论分析和仿真实验表明该算法有效地提高了飞行器跟踪精度.

关键词：交互式多模型算法;常值模型传递矩阵;最优模型传递矩阵;线性最小方差理论;相关性

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Interacting multiple model algorithm with optimal mode transition matrix

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Abstract：The traditional interacting multiple model (IMM) algorithm usually models the mode evolutions as Markov processes with constant mode transition matrix and leaves the correlative information among sub-filters out. However，because of the complexity of the practical application，the traditional IMM algorithm is unsuitable in aircraft tracking. To solve these problems，an optimal mode transition matrix IMM algorithm (OMTM-IMM) is presented. The new algorithm uses the linear minimum variance theory to calculate the optimal mode transition matrix according to the correlations between sub-filters. In this case，the new matrix further approaches the truth one，and the estimation accuracy can be improved. This conclusion can be support by the following theoretical derivation and simulations in aircraft tracking.

Keywords：IMM；constant mode transition matrix；adaptable mode transition matrix；linear minimum variance theory；correlation

模型不确定非线性系统的自适应模糊 Backstepping 预测控制

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摘　要: 为解决一类模型不确定严格反馈非线性系统的跟踪控制问题,提出一种使闭环系统稳定且滚动时域性能指标在线最小化的自适应模糊反步预测控制策略.模糊系统用来逼近该设计过程中的未知非线性项,自适应参数直接用来估计最优逼近权值向量范数的平方,从而只有一个自适应参数需要在线调节;同时考虑模糊基函数的性质,所设计的控制律与自适应律均不含模糊基函数项,理论证明该方法设计的控制器保证闭环系统所有信号是半全局有界的,并且跟踪误差收敛于零的某一邻域.该方法所设计的控制器形式简单,计算量小,更易于实际应用,仿真算例验证提出算法的有效性.

关键词: 模型不确定;滚动时域;模糊自适应控制;反步设计;预测控制

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Adaptive fuzzy backstepping predictive control for a class for nonlinear systems with model uncertainty

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Abstract: To overcome the tracking control problem for a class of strict-feedback nonlinear system with model uncertain, an adaptive fuzzy backstepping predication control algorithm which can make the closed-loop system stable and minimize the receding horizon guaranteed cost on-line is proposed. Fuzzy logic systems are employed to approximate the unknown term in the design process. As the adaptive parameter are directly used to estimate the norm of the optimal approximation weight vector, only one parameter need to be tuned on-line. Considering the property of the fuzzy basis function, the designed control laws and adaptive laws do not contain the fuzzy basis function term. Theoretically, it is proved that the using the constructed controller can guarantee that all signals in closed-loop are semi-globally uniformly ultimately bounded, and the tracking error convergence to a small neighborhood of the origin. As the form of the controller designed in this way is simplicity and the computation is small, this control strategy is easily realized in practice. Finally, the simulation results demonstrate the feasibility of the proposed scheme.

Keywords: model uncertain; receding horizon; fuzzy adaptive control; backstepping design; prediction control

一种基于局部不变特征的 SAR 图像配准新算法

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摘　要：针对 SAR 图像配准中匹配效率低、误匹配对多和配准精度差的问题，提出一种基于局部不变特征的 SAR 图像配准新算法. 首先，使用加速分割检测特征（features from accelerated segment test，FAST）检测算法，检测 SAR 图像的 FAST 角点；使用 DAISY 描述子对 FAST 特征进行描述，得到 SAR 图像不变特征。其次，采用基于 KD 树的欧氏距离匹配策略，实现特征点对的粗匹配；采用 RANSAC 算法去除误匹配，实现特征点对精匹配. 然后，采用仿射变换模型，实现图像插值和图像变换，实现 SAR 图像粗配准。最后，建立配准精度评估反馈机制，实现配准优化. 通过使用不同时相、不同工作模式 HJ-1C 星载 SAR 和不同极化、不同波段机载 AIRSAR 图像配准实验，提出算法与经典不变特征配准算法相比，具有适配性好、配准效率高的优点.

关键词：成孔径雷达图像(SAR)；局部不变特征；FAST 检测子；DAISY 描述子；图像配准

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A novel and efficient algorithm using local invariant feature for sar image registration

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Abstract: Aiming at the problems of low performance matching, more mismatching pairwise, and low registration precision, which are the characteristic of traditional SAR image registration methods, we propose a novel and efficient local invariant feature-based algorithm. First, the feature points are detected by features from accelerated segment test(FAST) method and described by DAISY descriptor in SAR image. Second, Kd-tree-based dual-matching strategy and random sample consensus (RANSAC) are used to establish fine feature matching. Third, affine transform model is estimated for image resampling and transformation, and rough registration is implemented. Finally, feedback mechanism is constituted for fine registration based on the estimation of registration precision. The flexibility and efficiency is demonstrated by experiments with slant range SAR images acquired from different working model, different times, viewpoints, wavelengths and polarizations.

Keywords: synthetic aperture radar (SAR) image; local invariant feature; FAST detector; DAISY descriptor; image registration

一种改进的 CSGC 频谱分配算法

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摘　要：基于图论着色的频谱分配算法未充分考虑用户实际带宽需求，针对这一问题，本文在原算法基础上提出了一种改进的 CSGC 频谱分配算法.该算法引入了空闲频谱和用户请求两个时间因子，通过设置用户优先级函数，在进行二次频谱分配时最大限度地满足用户需求.仿真结果表明，该算法不仅保留了原 CSGC 算法的性能，而且大幅度提高了频谱利用率.

关键词：图论；频谱；分配；CSGC；用户优先级

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A CSGC improved algorithm of spectrum allocation

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Abstract：To solve the problem that the spectrum allocation algorithm based on graph theory coloring algorithm has not fully considered the actual bandwidth needs of users，this paper proposes a spectrum allocation based on user priority algorithm improved CSGC and the original algorithm. The algorithm introduces two time factors that are respectively called idle spectrum and user demand，by setting the user priority，the function can meet the needs of users during the second spectrum allocation. Simulation results show that the algorithm not only retains the performance of the original algorithm CSGC，but also greatly improves the spectrum utilization.

Keywords：graph；spectrum；allocation；CSGC；user′s priority

基于 CPAC 的非圆磨削数控系统的开发

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摘　要：为解决非圆磨削系统中工艺不足的问题，提出在 CPAC（computer programmable automation controller）控制器平台上开发一套非圆磨削数控系统.以分段三次样条曲线拟合为数学基础，介绍 $X-Y$ 加工方式下刀心轨迹坐标计算；介绍非圆磨削中恒速磨削的重要性，以等弧长密化插值为原则，提出两种实现恒速磨削的方法；介绍非圆磨削加工中的误差测量方法，并进行误差补偿；最后，集成了系统并在三轴龙门铣床进行加工，实验证明系统满足非圆磨削的需要.

关键词：非圆磨削；恒速磨削；误差补偿

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Development of NC system for non-circular grinding based on CPAC

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Abstract: To promote the defective craft in non-circular grinding NC system, a special NC system for non-circular grinding is presented based on CPAC. First, on the basis of piecewise cubic spline fitting as mathematical foundation, the cutter center coordinates of $X-Y$ is calculated. Second, the importance of constant speed grinding is produced, and two algorithms based on constant length of arc interpolation are put forward to realize constant speed grinding. Third, the method of error measuring and compensation is given. Finally, integrated system is completed and applied to three-axis milling machine. The experiment proves that the system can meet the needs of non-circular grinding.

Keywords: non-circular grinding, constant speed grinding, error compensation